



1997 Ground Water Extraction Summary Report

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Overview of the Extraction Reporting Program

History of the Extraction Reporting Program

In February 1993, the Monterey County Board of Supervisors adopted Ordinance No. 3663, which required water suppliers within Zones 2, 2A, and 2B to report water-use information for ground water extraction facilities and service connections. Ordinance No. 3717, which replaced Ordinance No. 3663, was adopted in October 1993; it modified certain other requirements in the old ordinance but kept the ground water extraction reporting requirements in place for wells with a discharge pipe having an inside diameter of at least 3 inches.

Monterey County Water Resources Agency (Agency) has collected ground water extraction data from well operators for water reporting years beginning November 1 and ending October 31, starting with the 1992-1993 water reporting year. The information received from the over 400 well operators in the above-referenced zones of the Salinas Valley is compiled by the Ground water Extraction Management System (GEMS), a computer database maintained by the Agency. The intent of the ground water extraction reporting program is to measure and document the amount of ground water extracted from Zones 2, 2A, and 2B of the Salinas Valley Ground Water Basin each year.

Since 1991, the Agency has required the annual submittal of Agricultural Water Conservation Plans, which outline the best management practices that are adopted each year by growers in the Salinas Valley. In 1996, an ordinance was passed that requires the filing of Urban Water Conservation Plans. Developed as the urban counterpart of the agricultural water conservation plans, this program provides an overview of per capita water use and the best management practices being implemented by urban water users as conservation measures.

1997 Ground Water Extraction Summary Report

The purpose of this report is to summarize the data collected in February 1998 from these annual reporting programs: Ground Water Extraction Reporting, Agricultural and Urban Water Conservation Plans, and Water and Land Use Information. The *agricultural* data from the ground water extraction reporting program covers the water reporting year of **November 1, 1996, through October 31, 1997**; the *urban* data covers **calendar year 1997**. The agricultural and urban water conservation plans adopted for 1998 are also summarized, as are temperature, precipitation, and reference evapotranspiration data from the California Irrigation Management Information System (CIMIS) and local weather stations. With this information, this report is intended to present a snapshot of current water pumping within the Salinas Valley, including agricultural and urban water conservation improvements that are being implemented to reduce total water pumping.

Explanation of Reporting Methods

The ground water extraction reporting program allows water users to report water well extractions by three different measuring methods, using calculations based on water flowmeter, electrical meter, or hour meter (timer) data. The Agency requires regular pump efficiency testing to ensure the accuracy of the data reported. The summary of ground water extractions presented in this report is compiled from data generated from all three reporting methods.

Disclaimer Regarding Quality of Data

While the Agency has made every effort to ensure the accuracy of the data presented in this report, it should be noted that the data is submitted by the individual reporting parties and is not verified by the Agency. In addition, since so many factors affect the calculations, no reporting method is 100 percent reliable at all times.

The Agency did not receive ground water extraction reports from approximately seven percent (7%) of the wells in the Salinas Valley for the 1996-1997 water reporting year. Agricultural and Urban Water Conservation Plan submittals for 1998 were short by twelve percent (12%) and twenty percent (20%), respectively.

Notes Regarding Data Reporting Format

Ground water extraction data is presented in this report by measurement in acre-feet. One acre-foot is equal to 325,851 gallons.

Ground Water Extraction Data Summary

The Agency has designated subareas of the Salinas Valley Ground Water Basin whose boundaries are drawn where discernible changes occur in the hydrogeologic conditions. These boundaries are shown in Figure 1.

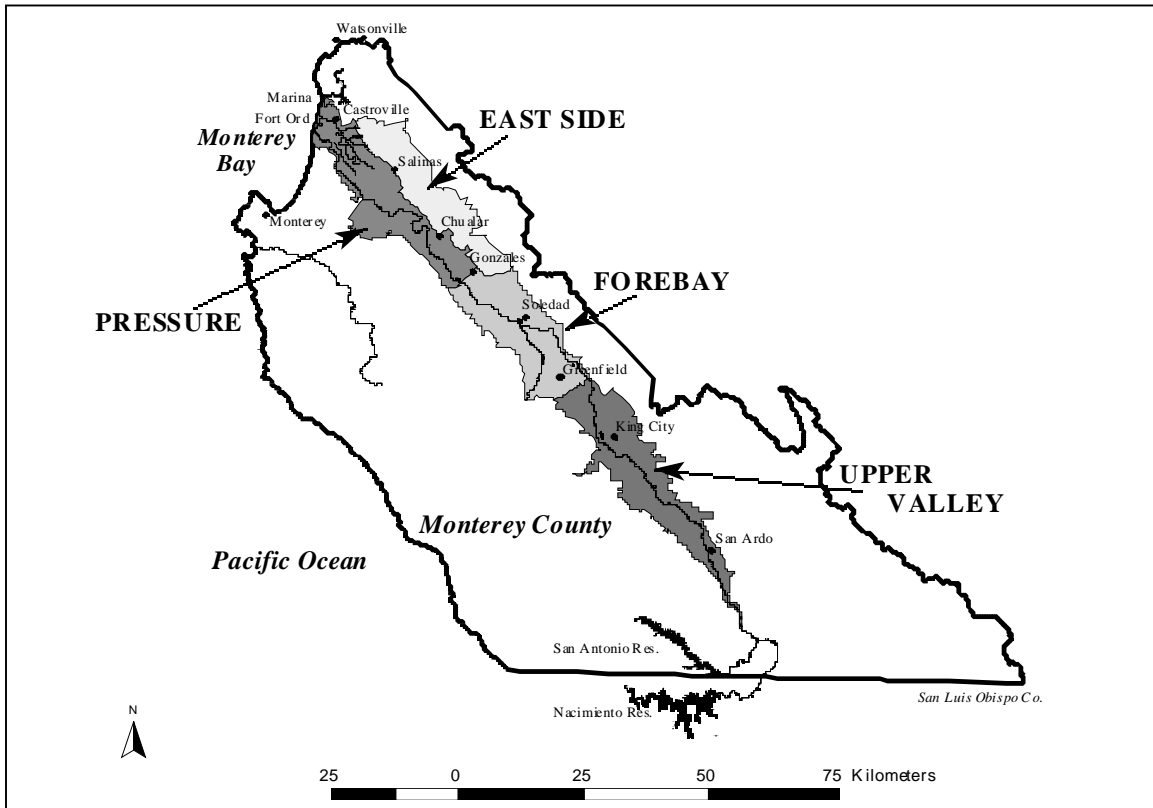


Figure 1: Salinas Valley subareas

Summary of Methods Used for Extraction Reporting

The distribution of methods used for extraction reporting for the 1996-1997 water reporting year is shown in Table 1; a percentage distribution by volume is shown in Figure 2.

Table 1. Total extraction data by reporting method

<i>Reporting Method</i>	<i>Acre-Feet per Reporting Method</i>	<i>Wells per Reporting Method</i>
Water Flowmeter	377,001	1,208
Electrical Meter	218,460	507
Hour Meter	2,678	8
Total	598,139	1,723
Average ('95-'97)	555,363	1,798

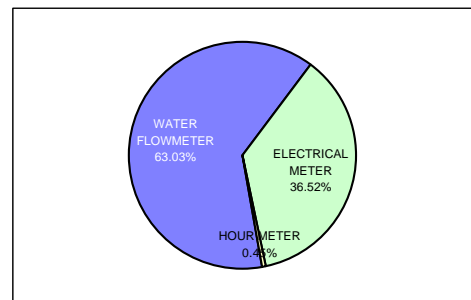


Figure 2: Percentage by volume of methods used for extraction reporting

Ground Water Extraction Data Summary

Total Extraction Data by Subarea and Type of Use

The total ground water extractions from Zones 2, 2A, and 2B for the 1996-1997 water reporting year are summarized by subarea and (1) type of use (agricultural and urban) in Table 2, and (2) percentage in Figure 3.

Table 2. Total extraction data by subarea and type of use

<i>Subarea</i>	<i>Agricultural Pumping (acre-feet)</i>	<i>Urban Pumping (acre-feet)</i>	<i>Total Pumping (acre-feet)</i>
Pressure	123,812	22,176	145,988
East Side	105,824	14,343	120,167
Forebay	155,548	5,470	161,017
Upper Valley	166,716	4,249	170,966
Total	551,900	46,238	598,139

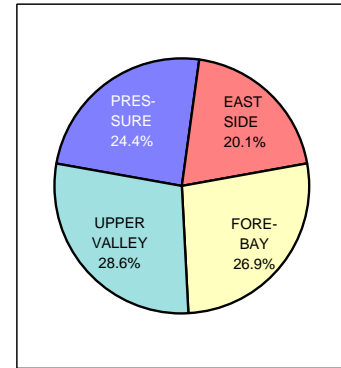


Figure 3: Percentage of total extractions by subarea

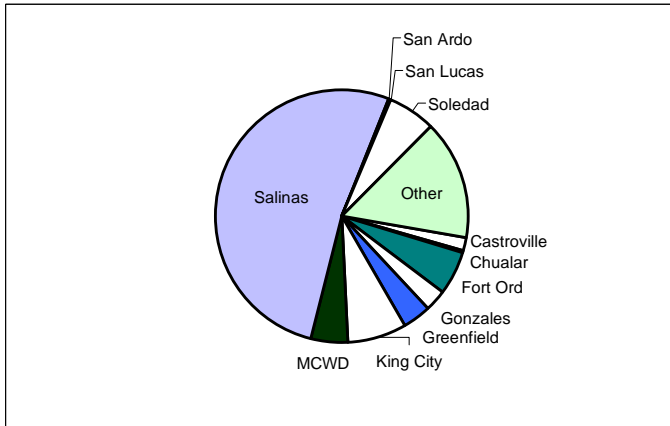


Figure 4: Percentage representation of urban extraction by city or area

Urban Extraction Data by City or Area

The total ground water extractions attributed to urban (residential, commercial/institutional, industrial, and governmental) pumping for the 1997 water reporting year are summarized by city or area in Table 3. Figure 4 is a graphic representation of each city or area's percentage of the total urban pumping for 1997.

Table 3. Urban extraction data by city or area

<i>City or Area</i>	<i>Urban Pumping (acre-feet)</i>	<i>Percentage of Total</i>
Castroville	720	1.6%
Chualar	124	0.3%
Fort Ord	2,574	5.6%
Gonzales	1,336	2.9%
Greenfield	1,594	3.4%
King City	3,552	7.7%
Marina Coast Water District	2,147	4.6%
Salinas	24,096	52.1%
San Ardo	137	0.3%
San Lucas	60	0.1%
Soledad	2,829	6.1%
Other Unincorporated Areas	7,069	15.3%
Total	46,238	100%

Agricultural Water Conservation Plans

The Agricultural Water Conservation Plans include irrigated acreage, irrigation method, and crop category. This information reflects the changing trends toward more efficient irrigation methods in the Salinas Valley. Tables 4, 5, 6, and 7 show the distribution of irrigation methods by crop type for 1993, 1996, 1997, and 1998, respectively.

Table 4. 1993 distribution of irrigation methods by crop type

1993	Furrow (acres)	Sprinkler & Furrow (acres)	Hand Move Sprinklers (acres)	Solid Set Sprinklers (acres)	Linear Move (acres)	Drip (acres)	Other¹ (acres)	Total (acres)
Vegetables	2,349	84,060	30,764	6,607	3,827	3,682	0	131,289
Field Crops	575	2,173	2,236	90	50	48	0	5,172
Berries	1	0	0	0	0	4,158	0	4,159
Grapes	261	0	0	13,347	0	15,976	0	29,584
Tree Crops	0	0	122	251	0	1,216	10	1,599
Forage	41	202	1,327	0	48	0	189	1,807
Total	3,227	86,435	34,449	20,295	3,925	25,080	199	173,610

Table 5. 1996 distribution of irrigation methods by crop type

1996	Furrow (acres)	Sprinkler & Furrow (acres)	Hand Move Sprinklers (acres)	Solid Set Sprinklers (acres)	Linear Move (acres)	Drip (acres)	Other² (acres)	Total (acres)
Vegetables	4,209	77,925	33,160	6,434	4,093	6,546	0	132,367
Field Crops	529	740	1,358	310	39	422	0	3,398
Berries	0	0	0	0	0	4,374	0	4,374
Grapes	0	0	0	8,155	0	21,240	0	29,395
Tree Crops	0	0	12	131	0	1,195	0	1,338
Forage	186	690	249	20	0	0	1,141	2,286
Total	4,924	79,355	34,779	15,050	4,132	33,777	1,141	173,158

Table 6. 1997 distribution of irrigation methods by crop type

1997	Furrow (acres)	Sprinkler & Furrow (acres)	Hand Move Sprinklers (acres)	Solid Set Sprinklers (acres)	Linear Move (acres)	Drip (acres)	Other³ (acres)	Total (acres)
Vegetables	3,264	82,114	21,085	5,620	3,278	12,061	0	127,422
Field Crops	267	1,598	1,245	241	39	72	0	3,462
Berries	0	0	0	0	0	3,977	0	3,977
Grapes	12	550	0	6,245	0	27,734	0	34,541
Tree Crops	0	0	10	433	0	1,679	0	2,122
Forage	121	46	171	179	0	48	298	863
Total	3,664	84,308	22,511	12,718	3,317	45,571	298	172,387

Table 7. 1998 distribution of irrigation methods by crop type

1998	Furrow (acres)	Sprinkler & Furrow (acres)	Hand Move Sprinklers (acres)	Solid Set Sprinklers (acres)	Linear Move (acres)	Drip (acres)	Other⁴ (acres)	Total (acres)
Vegetables	1,739	73,876	28,581	4,795	2,748	11,589	228	123,556
Field Crops	304	630	618	262	39	4	0	1,857
Berries	0	0	0	0	0	3,237	0	3,237
Grapes	10	2,174	0	4,528	0	26,879	0	33,591
Tree Crops	0	0	65	209	0	1,710	0	1,984
Forage	18	5	439	172	0	102	225	961
Total	2,071	76,685	29,703	9,966	2,787	43,521	453	165,186

^{1, 2, 3, & 4} "Other" may include different combinations of irrigation systems or areas that were not irrigated.

Agricultural Water Conservation Plans

For the past eight years, Salinas Valley growers have submitted Agricultural Water Conservation Plans to the Agency. Table 8 shows the number of acres, by year, on which selected “Best Management Practices,” or water conservation measures, have been implemented.

Table 8. Agricultural “Best Management Practices” implemented from 1991 through 1998

<i>Best Management Practices</i>	<i>1991 Acres</i>	<i>1992 Acres</i>	<i>1993 Acres</i>	<i>1994 Acres</i>	<i>1995 Acres</i>	<i>1996 Acres</i>	<i>1997 Acres</i>	<i>1998 Acres</i>
12 Months Set Aside	4,705	4,810	6,586	6,096	5,064	3,123	3,508	2,058
Summer Fallow/ Other Fallow	1,480	6,546	5,953	4,081	6,486	6,208	2,241	2,277
Flowmeters	31,702	26,404	39,206	127,971	122,054	126,031	122,475	132,225
Time Clock/Pressure Switch	131,237	131,237	142,162	134,985	121,645	137,297	135,954	137,414
Soil Moisture Sensors	39,549	39,549	51,348	43,883	43,188	51,428	56,936	58,854
Pre-Irrigation Reduction	92,865	112,290	117,899	108,454	104,937	99,429	104,203	101,649
Reduced Sprinkler Spacing	64,613	72,226	81,736	74,409	75,451	78,925	78,142	81,856
Sprinkler Improvements	70,035	97,233	104,160	107,626	102,053	116,809	110,523	108,507
Off-Wind Irrigation	100,274	109,050	115,984	101,765	94,810	113,381	111,076	102,873
Leakage Reduction	96,672	109,589	117,455	112,135	110,973	119,727	125,334	120,006
Micro Irrigation System	18,120	22,952	24,408	25,506	29,307	37,991	42,367	40,893
Surge Flow Irrigation	9,334	18,230	22,588	37,866	15,202	19,772	20,507	16,192
Tailwater Return System	20,357	25,034	21,020	20,994	15,101	22,707	21,121	22,803
Land Leveling/Grading	55,186	60,563	59,413	58,963	57,749	64,164	65,143	57,625

Note: Since different practices may be applied to the same acreage, “total acreage” is not a meaningful figure.

Summary of Reported Unit Agricultural Water Pumped by Subarea

Table 9 presents the average unit agricultural water pumped (acre-feet/acre) by subarea, calculated using the reported acreage and water pumped for the 1996-1997 water reporting year. The data used for Table 9 represent a subset of the totals shown in Table 2; only wells with complete reports of extraction data and acreage information could be used in the calculation.

Based on the Agency’s 1995 land use estimate, the acreage ratio of grapes to vegetables for the Upper Valley is approximately 0.6. The 1996-1997 reported grape acreage (with pumping information) was almost double that of the vegetable acreage for the Upper Valley. This disproportionate reporting of pumping information by crop skews the calculation of acre-feet/acre for the Upper Valley towards the lower water usage of grapes. It was determined that the data reported for the Upper Valley could not be used for calculating the acre-feet/acre figure for that subarea; therefore, the acre-feet/acre figure shown in Table 9 for the Upper Valley subarea is an estimate based on the figure calculated for 1995-1996.

Table 9. Reported unit agricultural water pumped by subarea

<i>Subarea</i>	<i>Pressure</i>	<i>East Side</i>	<i>Forebay</i>	<i>Upper Valley</i>	<i>Overall Average</i>
Unit Water Pumped (acre-feet/acre)	2.87	2.92	3.16	3.45	3.10

Please note that weather patterns, soil types, and crop types affect the amount of water needed for irrigation. Even during a normal rain year, pumping rates will vary from one area to another.

Nutrient Management Measures

Contact Monterey County Water Resources Agency’s Water Quality staff at (831) 755-4860.

Urban Water Conservation Plans

This is the third year of data collection for the Urban Water Conservation Plan program. Table 10 shows the implementation of “Best Management Practices” – for 1996, 1997, and 1998 – as a percentage of total acreage reported. It is important to note that, while all of the listed practices apply to the “large” water systems (over 200 customer connections), not all apply to the “small” water systems (between 2 and 200 customer connections). The practices that apply *only* to the large systems are printed in **bold** below.

Table 10. Urban “Best Management Practices” implemented in 1996, 1997, and 1998

<i>Best Management Practices</i>	1996	1997	1998
Provide speakers to community groups and media	21%	52%	56%
Use paid and public service advertising	42%	51%	55%
Provide conservation information in bill inserts	56%	90%	66%
Provide individual historical water use information on water bills	82%	85%	62%
Coordinate with other entities in regional efforts to promote water conservation practices	30%	82%	64%
Work with school districts to provide educational materials and instructional assistance	51%	52%	44%
Implement requirements that all new connections be metered and billed by volume of use	66%	91%	92%
Establish a program to retrofit any existing unmetered connections and bill by volume of use	38%	62%	80%
Offer free interior and exterior water audits to identify water conservation opportunities	35%	35%	40%
Provide incentives to achieve water conservation by way of free conservation fixtures (showerheads, hose end timers) and/or conservation “adjustments” to water bills	50%	50%	51%
Enforcement and support of water conserving plumbing fixture standards, including requirement for ultra low flush toilets in all new construction	35%	35%	38%
Support of State/Federal legislation prohibiting sale of toilets using more than 1.6 gallons/flush	74%	76%	72%
Program to retrofit existing toilets to reduce flush volume (with displacement devices)	52%	82%	91%
Program to encourage replacement of existing toilets with ultra low flush (through rebates, incentives, etc.)	20%	20%	46%
Provide guidelines, information, and/or incentives for installation of more efficient landscapes and water-saving practices	86%	94%	94%
Encourage local nurseries to promote use of low water use plants	52%	56%	64%
Develop and implement landscape water conservation ordinances pursuant to the “Water Conservation in Landscaping Act”	3%	3%	21%
Identify and contact top industrial, commercial, and/or institutional customers directly; offer and encourage water audits to identify conservation opportunities	3%	3%	3%
Review proposed water uses for new commercial and industrial water service, and make recommendations for improving efficiency before completion of building permit process	4%	27%	47%
Complete an audit of water distribution system at least every three years as prescribed by AWWA	22%	55%	76%
Perform distribution system leak detection and repair whenever the audit reveals that it would be cost effective	66%	93%	93%
Advise customers when it appears possible that leaks exist on customer’s side of water meter	68%	68%	93%
Identify irrigators of large landscapes (3 acres or more) and offer landscape audits to determine conservation opportunities	11%	33%	36%
Provide conservation training, information, and incentives necessary to encourage use of conservation practices	51%	51%	36%
Encourage and promote the elimination of non-conserving pricing and adoption of conservation pricing policies	24%	24%	52%
Implementation of conservation pricing policies	24%	25%	52%
Enact and enforce measures prohibiting water waste as specified in Agency Ordinance No. 3539 or as subsequently amended, and encourage the efficient use of water	53%	78%	91%
Implement and/or support programs for the treatment and reuse of industrial waste water / storm water / waste water	48%	48%	44%

Of those practices that apply to both large and small water systems, those having the greatest effective or immediate water savings are “Implement requirements that all new connections be metered and billed by volume of use,” “Establish a program to retrofit any existing unmetered connections and bill by volume of use,” “Program to retrofit existing toilets to reduce flush volume (with displacement devices),” “Encourage and promote the elimination of non-conserving pricing and adoption of conservation pricing policies,” and “Implementation of conservation pricing policies.” The practice that is most used is “Enact and enforce measures prohibiting water waste as specified in Agency Ordinance No. 3539 or as subsequently amended, and encourage the efficient use of water.” The practice that is least used is “Establish a program to retrofit any existing unmetered connections and bill by volume of use.”

Climatic Data Summary

Reference Evapotranspiration (ET_o)

Changes in agricultural water use from year to year are influenced by many factors, with changes in weather, irrigation practices, and cropping patterns being the most significant. The effects of weather changes on crop water needs can be seen in the rate of *evapotranspiration*.

Evaporation is the physical change of water from liquid to vapor. This process requires energy in the form of heat, received in this case from the sun. Evaporation rates are also significantly affected by relative humidity and wind speed; evaporation rates are increased when the relative humidity is low and the air is warm.

Transpiration is the venting of water vapor through the leaf pores of a living plant. The rate of transpiration depends on the differences between the amount of moisture inside the leaf and the amount of moisture outside the leaf (in the air); the rate is proportional to the relative water vapor saturation of the air (i.e. the higher the humidity, the lower the transpiration rate, and vice-versa). Soil moisture evaporation (E) combined with plant transpiration (T) produces *evapotranspiration* (ET).

Reference evapotranspiration (ET_o) is calculated using temperature, humidity, wind speed, and radiation in an energy balance-aerodynamics equation. The result approximates the water required to grow healthy, non-stressed four-to seven-inch tall Fescue grass. ET_o is normally presented in inches per day and is considered constant over a specific area.

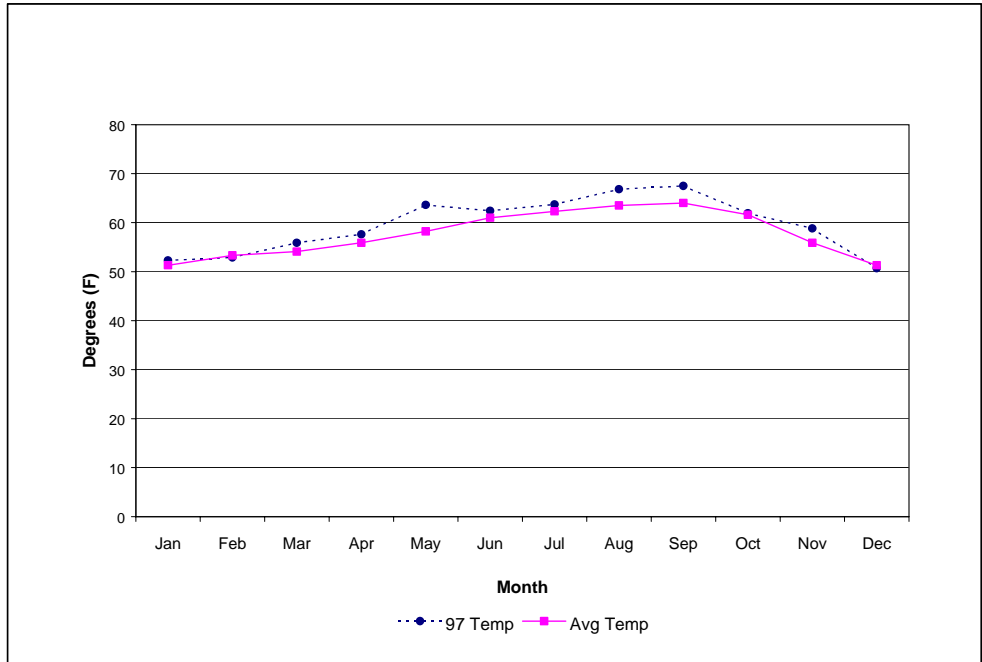


Figure 5: Salinas average temperature compared to 1997 monthly data

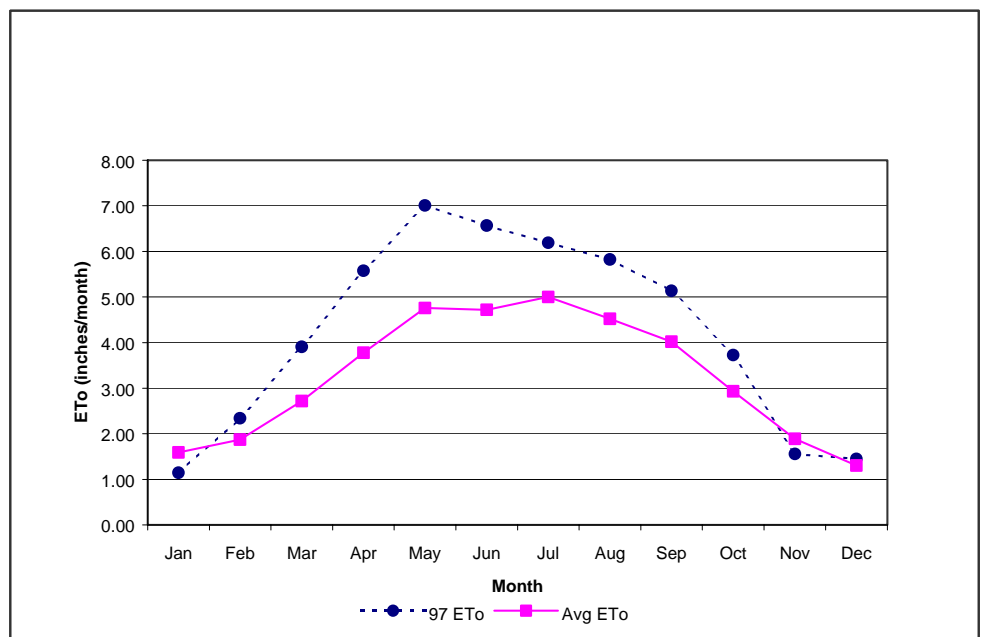


Figure 6: Salinas average ET_o compared to 1997 monthly data

Climatic Data Summary

The CIMIS Network

The California Irrigation Management Information System (CIMIS) is a network of automated weather stations located throughout the state. The CIMIS program is sponsored and managed by the California Department of Water Resources (DWR) in cooperation with local governments. In Monterey County, six CIMIS stations are in operation; two are owned by DWR and four belong to the Agency.

CIMIS calculates ET_0 based on the real-time data derived from the CIMIS station, including temperature, humidity, solar radiation, soil temperature, rainfall, and wind speed and direction.

The data are accessed via phone line by the DWR computer in Sacramento and, after processing, are then available to the user via the Internet or computer modem. The data are available in two formats; one presents average data for the last seven days, and the other presents average monthly data for the last year. The data are available for all the sites within a regional system.

ET_0 data can provide insight into relative water demands. The data can be used in calculating irrigation duration and frequency by observing recent past ET_0 values to determine a trend. Then, the accepted approach is to expect a persistence of the trend and apply yesterday's ET_0 values to today's irrigation using a factor for the direction of the trend. A "crop coefficient" for the specific crop to be irrigated is also included in the calculations.

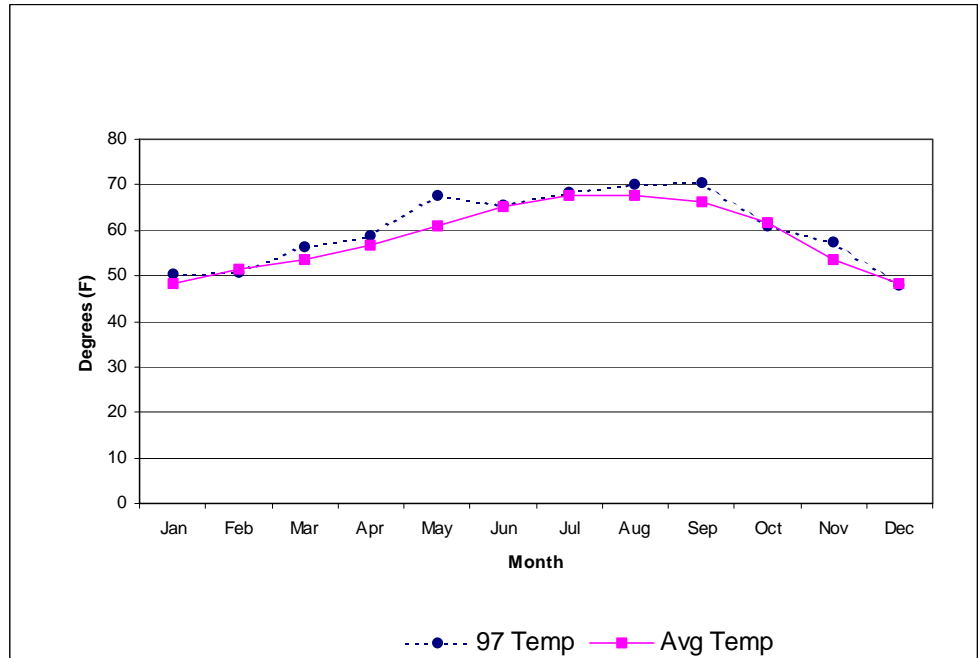


Figure 7: King City average temperature compared to 1997 monthly data

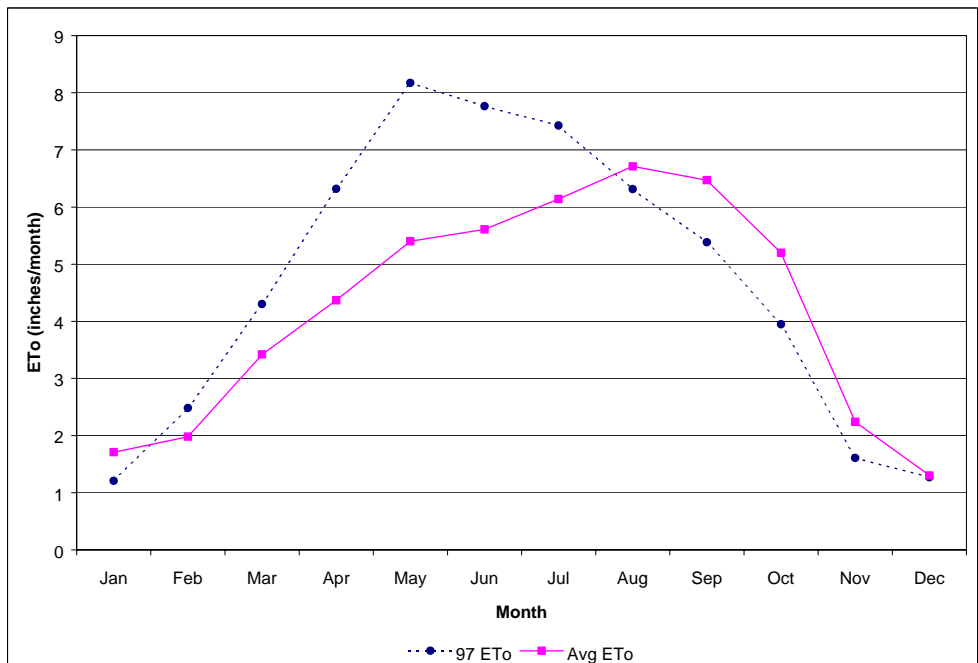


Figure 8: King City average ET_0 compared to 1997 monthly data

Climatic Data Summary

Minor changes in daily evapotranspiration rates in the Salinas Valley are common and are related to local day-to-day meteorological variations. Long-term or seasonal variations, however, are associated with large-scale anomalies of Pacific sea surface temperatures (SSTs).

1997 Weather Patterns and ET_o

During 1997, SSTs along coastal California were gradually increasing as a precursor to the El Niño phenomenon of 1998. This SST influence directly translated to increased land temperatures and ET_o in the Salinas Valley, especially in the northern portions. The relative proximity to the bay waters was the significant factor determining the amount of increase.

Salinas and the northern Salinas Valley, in close proximity to the Pacific Ocean, were highly influenced by the warmer SSTs. Land temperatures exceeded normal levels from early March to October, with a maximum anomaly occurring during May. November experienced some above normal temperatures, as well. Figure 5 shows a comparison of 1997 land temperature data to the long-term average established in Salinas. ET_o climbed to its maximum anomaly in May and remained above normal through early November.

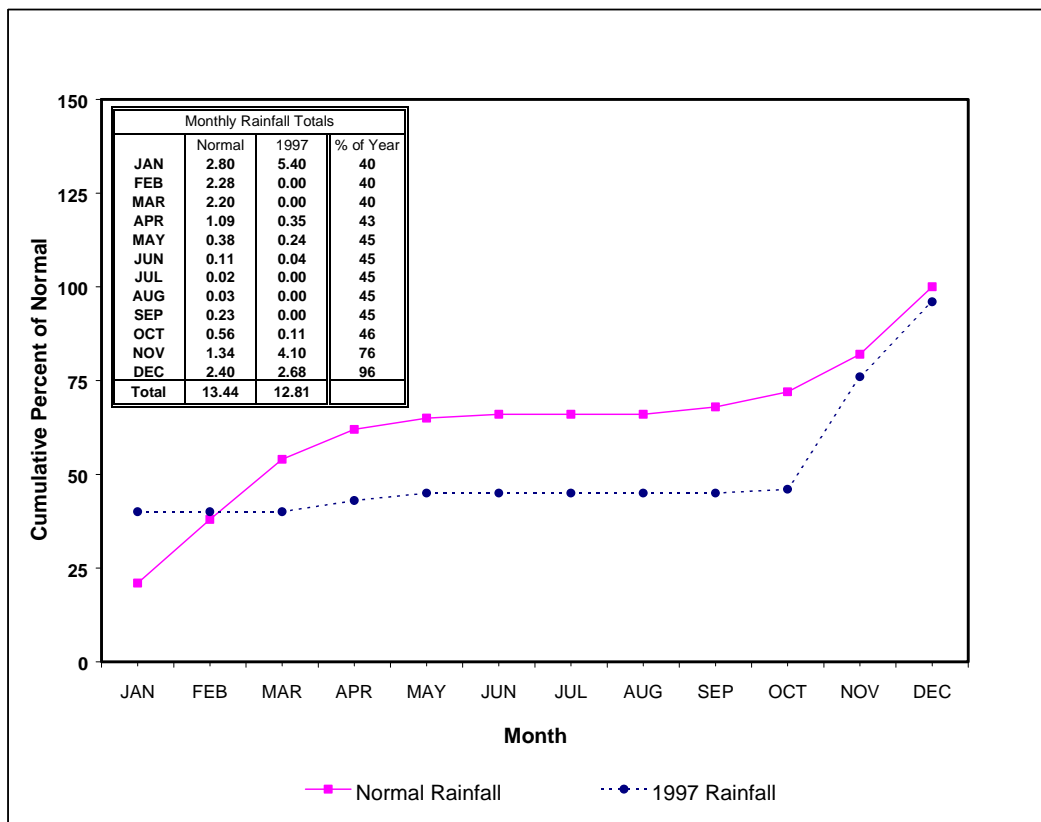


Figure 9: Salinas Airport normal rainfall compared to 1997 monthly data

Figure 6 shows a comparison of 1997 ET_o data to the long-term monthly average established for Salinas.

King City and the southern Salinas Valley were less influenced by the SSTs. Land temperatures exceeded normal levels from early March to June, with a maximum anomaly occurring during May. Temperatures began to climb again to above normal in July and remained so until early October.

November experienced some above normal temperatures, as well. Figure 7 shows a comparison of 1997 land temperature data to the long-term average established in King City. ET_o climbed to its maximum anomaly in May, returning to near normal in August. It is theorized that, from August through the end of the year, the increased humidity associated with the approaching El Niño resulted in below normal ET_o. Figure 8 shows a comparison of 1997 ET_o data to the long-term monthly average established for King City.

Now you can access ET_o and rainfall data on the World Wide Web! This Internet address will take you directly to the data selection screen: http://www.dpla.water.ca.gov/cgi-bin/cimis/cimis/data/input_form

Climatic Data Summary

1997 Rainfall

Rainfall during 1997 began with an exceptionally wet January, leading to flood conditions on the Salinas and Pajaro Rivers. Both Salinas Airport (Figure 9) and King City (Figure 10) received approximately twice their normal historical January rainfall amounts, as did the remainder of the Central Coast. This very wet start to the year was actually a fortuitous event, as the remainder of the winter and spring rain activity was virtually nonexistent.

For the first time since 1873, when rainfall was first recorded at the Salinas Airport, both February and March were completely dry. For the same two months, King City recorded only 0.16 inches of rain. January rainfall accounted for approximately 40 percent of the total rainfall for 1997.

By late October, Pacific sea surface temperatures were increasing as the El Niño phenomenon gradually developed and began to positively influence storm rainfall productivity on the Central Coast. At the beginning of November, Salinas had only

accumulated 46 percent of the year's normal rainfall, and King City had accumulated only 43 percent. Heavy, El Niño-influenced rainfall during November and December increased the year's total for Salinas and King City to 96 percent and 105 percent of normal, respectively.

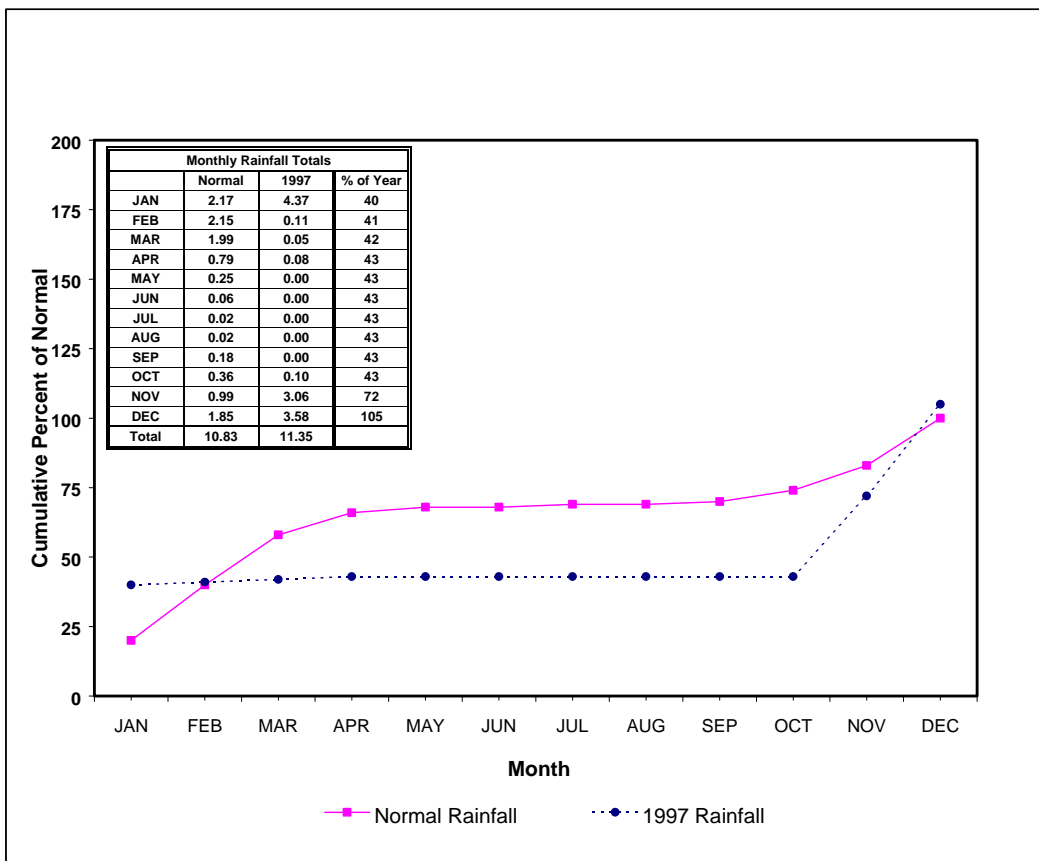


Figure 10: King City normal rainfall compared to 1997 monthly data

Climatic Data and Pumping

Comparing 1995-1996 pumping statistics to those of 1996-1997 indicates varying increases throughout all of the Salinas Valley hydrologic subareas. The East Side reported the largest increase, with agricultural and urban increases averaging 14 percent over 1995-1996 levels. The Pressure Area and Forebay both reported increases of 3 percent, and the Upper Valley reported an increase of 7 percent. All subareas combined reported increases of 6 percent over 1995-1996 levels.

It is apparent that increases and decreases in crop water requirements and pumping are closely related to similar fluctuations in temperature and ET_0 . However, with the data currently available, no permanent ratios can be established to inter-relate temperature, ET_0 , and pumping. Other associated variables, such as precipitation, soil type, and crop type, can significantly affect the ET_0 data, and the frequency and accuracy of annual extraction reporting can significantly affect the pumping data. Although the connections may seem obvious, only loose associations can be drawn when relating these data. For 1997, it seems apparent that the warmer temperatures in the Salinas Valley, reflected in the elevated ET_0 , together with the very dry months leading into summer, led to increases in crop water requirements and pumping.

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**If you would like more information regarding Monterey County Water Resources Agency's
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