GRASSLAND BASIN IRRIGATION AND DRAINAGE STUDY

VOLUME 1 - FINAL REPORT

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- **Joe Karkoski** - Regional Water Quality Control Board. Mr. Karkoski provided an analysis of the drainage flows and water quality.
- **Dr. Dennis Wichelns** - Dr. Wichelns provided an analysis of the on-farm practices being adopted within each of the districts that are having an impact on the irrigation efficiency values for the study area.
- **John Fio** - US Geological Survey, Sacramento. Mr. Fio provided an analysis of the subsurface water components of the water balance.

DISTRICT PERSONNEL

This project was completed with the assistance and close cooperation of the water and drainage districts in the Grassland Area. Information on the amounts of delivered water, tailwater, tile water, and irrigated acreage (as well as other data) for the last 12 years was provided. Particular thanks are extended to:

- **Steve Chedester** - Firebaugh Canal Water District
- **Dennis Falaschi, Don Anderson, and Marcos Hedrick** - Panoche Water District
- **David Dermer** - Pacheco Water District
- **David Cone** - Broadview Water District
- **Mike Porter, Bob Pfitzer, and Chris White** - Central California Irrigation District
- **Doyle Perry** - Charleston Drainage District

All of these individuals took time from their very busy schedules to respond to repeated requests for information. In addition, this report required input from several other entities.

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- **Dr. Walt Bremer** - Cal Poly, Landscape Architecture Department. Dr. Bremer helped to generate the GIS database used for this project.
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- **Charles Tilt** - Cal Poly, Irrigation Training and Research Center. Mr. Tilt performed the pre-plant irrigation efficiency analysis.

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ABBREVIATIONS

United States Department of Agriculture/ Agricultural Research Service	ARS
Available Water Holding Capacity	AWHC
Broadview Water District	BWD
Columbia Canal Company	CCC
Central California Irrigation District	CCID
Charleston Drainage District	CDD
Cubic Feet per Second	CFS
California Regional Water Quality Control Board	CRWQCB
Central Valley Regional Water Quality Control Board	CVRWQCB
District Irrigation Efficiency	DIE
Delta-Mendota Canal	DMC
Drainage Opperation Plant	DOP
Distribution Uniformity	DU
California Department of Water Resources	DWR
Electrical Conductivity	EC
Electrical Conductivity of a Soil Paste Extract	ECe
Drainage Water Electrical Conductivity	ECdw
Environmental Impact Report	EIR
Enivironmental Impact Survey	EIS
Crop Evapotranspiration	ETc
Firebaugh Canal Water District	FCWD
Firebaugh Drainage Association	FDA
Geographic Information System	GIS
Grassland Water District	GWD
Irrigation Efficiency	IE
Panoche Drainage District	PDD
Panoche Water District	PeWD
Pacheco Water District	PoWD
Soil Conservation Service	SCS
San Luis Canal Company	SLCC
San Luis Water District	SLWD
Soil Moisture Depletion	SMD
State Water Resources Control Board	SWRCB
Total Dissolved Solids	TDS
United States Bureau of Reclamation	USBR
United States Fish and Wildlife Service	USFWS
United States Geological Survey	USGS
United States Salinity Laboratory	USSL
United States Weather Bureau	USWB
Water Conservation Plan	WCP
Water Conservation Report	WCR
Water Drainage Report	WDR
Westlands Water District	WWD

EXECUTIVE SUMMARY

This project analyzed the district irrigation efficiency for 6 subareas of the Grassland Basin roughly representing 80,000 acres on the west side of the San Joaquin Valley near Firebaugh, California. The subareas are identified in this report as Broadview Water District (BWD), Central California Irrigation District (CCID-Camp 13), Charleston Drainage District (CDD), Firebaugh Canal Water District (FCWD), Pacheco Water District, (PoWD), and Panoche Drainage District (PDD). The time span for this study was the period from 1981 through 1992.

The objectives of this project were as follows:

- Determine the district irrigation efficiency for the 6 subareas.
- Update district drainage policies and water reuse.
- Update the geographical information system (GIS).
- Perform a pre-plant irrigation efficiency analysis.
- Establish a relationship between the drainage volumes and the district irrigation efficiency.
- Determine the maximum district irrigation efficiency attainable.
- Determine the impact of optimizing district irrigation efficiency on loads and concentrations leaving the districts.
- Determine actual farm practices, salt build-up, cropping, etc. that have been impacted by drainage and surface runoff water reuse.

The following is a summary of the tasks completed in this report.

Section 1 Summary: Re-Use Of Surface Runoff And Subsurface Drain Water

The significant increase in the re-use of surface runoff and subsurface drain water, at both the farm-level and district-level in the Grassland Drainage Basin, have provided farmers and districts with much-needed augmentations of contractual water supplies and have resulted in significant reductions in the volume of drainage water discharged from districts to the San Joaquin River and its tributary sloughs. The desire to achieve regional water quality objectives will also remain in place, although farmers and districts realize that reductions in drain water volume may not increase the probability that the Mud Slough (North) and Salt Slough water quality objectives can be met.

The previous six years have provided farmers, district managers, and regional water quality authorities with an opportunity to observe the short-term challenges for re-using subsurface drain water. Many farmers have also begun to observe or to report on the potential long-term impacts of re-using subsurface drain water in the Grassland Drainage Basin. Several themes describing the opportunities and challenges to re-using drainage water have emerged during interviews with farmers and district managers in the region.

- One of the principal concerns expressed by all of the managers interviewed in this study is the difficulty and expense involved in distributing recycled drainage water throughout a large portion of an irrigation district. Several of the managers reported that their current water delivery and return systems do not permit them to deliver recycled drainage water to all of the lands that may have generated the drainage water.

- The equity and efficiency issues regarding drainage water re-use are short-term issues that district managers have attempted to address through careful adjustment of water volumes and concentrations in response to specific requests from farmers receiving recycled drainage water. In the long-term, district managers suggest that expensive construction projects may be required to build new recirculation facilities for moving drainage water to all portions of an irrigation district.

- Some of the managers also reported a concern regarding the linkage between water quality objectives in the San Joaquin River, Mud Slough (North), and Salt Slough, and the volumes and concentrations of drainage water released at district discharge outlets. In particular, the managers perceive a lack of information regarding the specific strategies that districts should pursue in managing subsurface drain water. Strategies designed to reduce drain water volumes and loads will likely result in higher concentrations of boron and selenium at district discharge outlets. Thus, while the probability of achieving water quality objectives in the San Joaquin River will be increased, the concentrations of boron and selenium in Mud Slough (North) and Salt Slough will also be increased.

- Several farmers operating in the Grassland Drainage Basin were also interviewed in this study, to receive input regarding the short-term and long-term implications of re-using subsurface drain water. One of the farmers has been re-using drainage water for more than six years to augment limited water supplies. That farmer reports no yield effects on cotton and sugar beets, to date, but he does report noticeable damage on a field of alfalfa hay. This is the first year he has noticed

the damage, but he feels this is the beginning of permanent difficulty with his recycling program, unless he is able to leach salts from the soil in the near future. In recent years, he has had to increase the volume of water delivered to his fields, as the quality of water has declined. Continued application of high-salt water to his fields has resulted in saline soils that restrict the ability of plants to extract water.

- The large expense required to construct ideal facilities for maximizing the potential re-use of drain water will not be allocated by districts, given current economic conditions and uncertainty regarding water supply and drainage issues. Districts and farmers will likely continue to pursue short-term solutions to district-wide drainage management issues until a clearer plan is presented to them regarding their individual or district roles in achieving regional water quality objectives.

Section 2 Summary: Drainage

Recycling

The districts in the study area have different options available for handling surface runoff and subsurface drainage. The drainage strategy is made up of five different policy levels: Acceptance, Separation, District Level Recycling, Holding, and Assimilation Water. Each of these levels was analyzed for each district. **Table ES-1** is a listing of these drainage policies and a brief description of the policy.

Table ES-1
District-Level Drainage Policies

Policy	Description
Acceptance	Decision by districts to accept or deny drainage or surface water into district surface drains.
Separation	If a district accepts both tile water and tailwater, the next policy decision is whether or not to keep them separate.
Recycling	The next policy decision is whether or not a district will recycle any of the water back into the supply.
Holding	Storage of drainage water could be required to meet water quality standards.
Assimilation	Blending of the drain water with better quality water to meet water quality standards.

- Acceptance Of Tailwater and Tilewater. All districts are currently accepting both tile water and tailwater. However, PDD's formal policy is to not accept tailwater and that policy will soon be completely enforced. BWD has plans for installing a new turnout on the San Luis Canal. If this installation is completed, BWD will no longer accept tailwater either. Although this report does not include detailed information about on-farm recycling, there is already considerable on-farm recycling of tailwater in the study region especially within PDD and PoWD.

- Separation Of Tailwater And Tilewater. CDD's drainage system keeps tile water separate from tailwater on the upslope side of the DMC. Once pumped across the DMC, tile water and tailwater are commingled in the open drains. PoWD is attempting to keep tile water and tailwater separated. All other districts commingle tile water and tailwater.

- District Level Recycling. CDD does not recycle any drainage water at the district level. CCID, while recycling substantial amounts of drainage water in other parts of their system, is recycling only one tile sump of ten in the 6,000 acre Camp 13 Study Area. PeWD has only recycled drainage water in the past two years. PoWD, and BWD recycle substantial amounts of drainage water. FCWD recycles a significant portion of their drainage water.

- Holding Facilities. Only Panoche Water District (PeWD) has an external holding facility, and this is only a pilot project.

- Assimilation. CCID has indicated that it can blend its problem drainage water with its own irrigation water. FCWD and BWD have not indicated what their formal policies will be in the future. CDD, PDD, and PoWD have indicated that they will maximize their use of the San Joaquin River's assimilative capacity. Formal policies are lacking at all districts that would govern the extent of recycling, the allowable water quality limits for blended irrigation water, and division of the assimilative capacity of the San Joaquin River among the area drainers.

Obviously the on-going drought has had an impact on the amount of recycling and drainage. It is impossible to accurately predict district operations in a normal year. Looking at pre-drought years would probably not be appropriate due to the change in the political/regulatory climate regarding agricultural drainage in the area.

Geographical Information System (GIS)

The GIS database was updated and utilized several times throughout the course of this project. The database has been transmitted to the USBR (through Internet), USSL in Riverside (tape file),

and to the USGS in Sacramento (tape file). Copies of the file can be made for other entities wishing to perform analysis of the study area using GIS. **Appendix A** includes a detailed description of the GIS developed for this project.

An ARC/INFO database has been developed for this project to manage all of the map data. Although initial maps were down-loaded from the Bureau of Reclamation's computer in Sacramento at the start of the project, many changes to the existing data were found to be necessary. Therefore, data was re-digitized from existing map sources and field checking using a USGS 7.5 minute quad series as the base. The quads are as follows:

Charleston School	Mendota Dam	Laguna Seca
Dos Palos	Firebaugh	
Oxalis	Broadview Farms	
Poso Farm	Hammonds Ranch	

These maps were supplemented with field information and other map bases received from various agencies. The GIS database presently contains basic information. The location data has been used extensively to generate maps and determine the physical interrelationships between districts. Parameters have been assigned to each of the input points and segments (such as the length and direction of flow). However, detailed information has not been incorporated into the database. For example, the monthly solute loadings for each sump for the 12 year study period are available in computer spreadsheet files. These files contain a tremendous amount of data that has not been filtered nor added to the ARCINFO database. As other entities utilize the database to expand the analysis of the study area, that data will be retrieved and used to update (and expand) the master files maintained at Cal Poly.

Subsurface Flows

John Fio, with the USGS in Sacramento, used the GIS to perform an analysis of the base flow for the study area. The sump discharge data for all of the sumps in the study area was analyzed for the study period. Low flows have been assumed to approximate the most accurate determination of the base flow. The base flow was defined for this study as the net groundwater inflow to the region from outside of the study area boundaries measured in the surface discharge measurements during the nonirrigated periods.

Sump discharge data from Broadview, CCID-Camp 13, Charleston, Firebaugh, Pacheco, and Panoche districts was obatined and formatted to a single spreadsheet application. High flows

(January through September - in general) were separated from low flows during the non-irrigated time of the year (October-December).

The data collection effort uncovered an important recommendation for future activities for the districts. All data should be reported in a consistent format with well-defined protocols for data storage and retrieval. For example, all data could be provided in ASCII format. Retrieval of the raw data was a significant amount of the expense for this portion of the study due to differences in reporting formats, embedded graphs, and programmed cell formulas.

The estimated drainflow for this study in 1992 (most complete data set) was as follows; Broadview-52 AF, CCID C13-No Estimate, Charleston-30 AF, Firebaugh-409 AF, Pacheco-575 AF, Panoche-970 AF. The total low flow volume was 2,036 AF for the entire study area. The total sump flow was estimated at 15,165 AF. The low flow represents about 13% of the total sump flow for the study area. The low flow total would respresent a minimum base flow since it does not account for baseflow during the irrigation months.

An estimate of incidental recharge below the Corcoran clay was also required for the water balance in this study. Preliminary results from a steady-state groundwater-flow model construicted by Fio (in review) indicate the following simulated incidental recharge to the aquifer below the Corcoran Clay; Panoche-0.54 AF/yr, Broadview-0.31 AF/yr, Firebaugh-.26 AF/yr.

Well pumping estimates were made by contacting individual growers in the study area. It was not possible to obtain values that were reasonable. Estimates of groundwater pumping were made by evaluating the ETc requirements. This was significant for Panoche Drainage District in 1991 and 1992 where groundwater pumping represented about 30% of the water supply.

Section 3 Summary: District Irrigation Efficiency - Crop ET (ETc) Approach

The DIE includes water lost from operational discharges and seepage losses from supply canals. The irrigation efficiency is calculated with the following equation:

$$DIE = \frac{(\text{ETc with adjustment} + \text{Leaching required for salt control} - \text{Effective Rain})}{\text{Irrigation Water Applied}} \times 100$$

Where; DIE = District Irrigation Efficiency (%)

ETc = Adj. ETc values (reduction for poor stands and bare spots)

Leaching = Water applied for leaching of salts

Effective Rain = Rain used by crops or for salt control

Table ES-2 summarizes the calculated values. The low irrigation efficiency values in 1983 and 1986 occured during years that were high rainfall amount years. Broadview Water District had high values in 1981 and 1982 which then decreased in 1983 when BWD obtained an outlet to the San Joaquin River. The 80% efficiency represented a very high efficiency with 100% recycling of tailwater and tilewater. Since the water quality degraded to a unsatisfactory value, the ***80% may well represent the range of maximum sustainable irrigation efficiency.*** Note that after several years of high irrigation efficiency, the DIE drops in value significantly in Broadview. This can be partially explained by the result of leaching done in subsequent years to make up for short water years. This means that the highest values on the table may reflect levels that are not maintainable.

Figure ES-1 shows the irrigation efficiency using the ETc approach graphically. The trend is definitely one of increasing irrigation efficiency over the 12 years of the study. This reflects a necessary reaction by growers and districts to respond to decreasing water supplies and increasing environmental, political, and social concerns of drainage.

Table ES-2
District Irrigation Efficiency
ETc Approach

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Broadview	81%	81%	58%	57%	55%	51%	56%	58%	62%	73%	87%	94%
CCID	48%	48%	44%	51%	61%	63%	71%	73%	87%	77%	66%	71%
Charleston	59%	62%	62%	43%	42%	47%	45%	55%	68%	68%	71%	73%
Firebaugh	55%	55%	61%	53%	51%	52%	53%	61%	68%	75%	77%	70%
Pacheco	67%	84%	72%	77%	68%	67%	75%	70%	60%	68%	76%	86%
Panoche	58%	40%	62%	54%	61%	57%	61%	66%	72%	75%	78%	80%

Section 4 Summary: Pre-Plant Irrigation Efficiency

Examination of pre-plant irrigation efficiencies for five of the Grassland Basin districts was completed in order to determine the potential for reduction of drainage water from the area during the period of time when pre-plant irrigation events occur (December through March). In theory, the time frame for the poorest irrigation efficiencies occurs during the pre-plant irrigations since irrigations are required for germination, but the soil moisture deficit may not warrant the quantity of water applied.

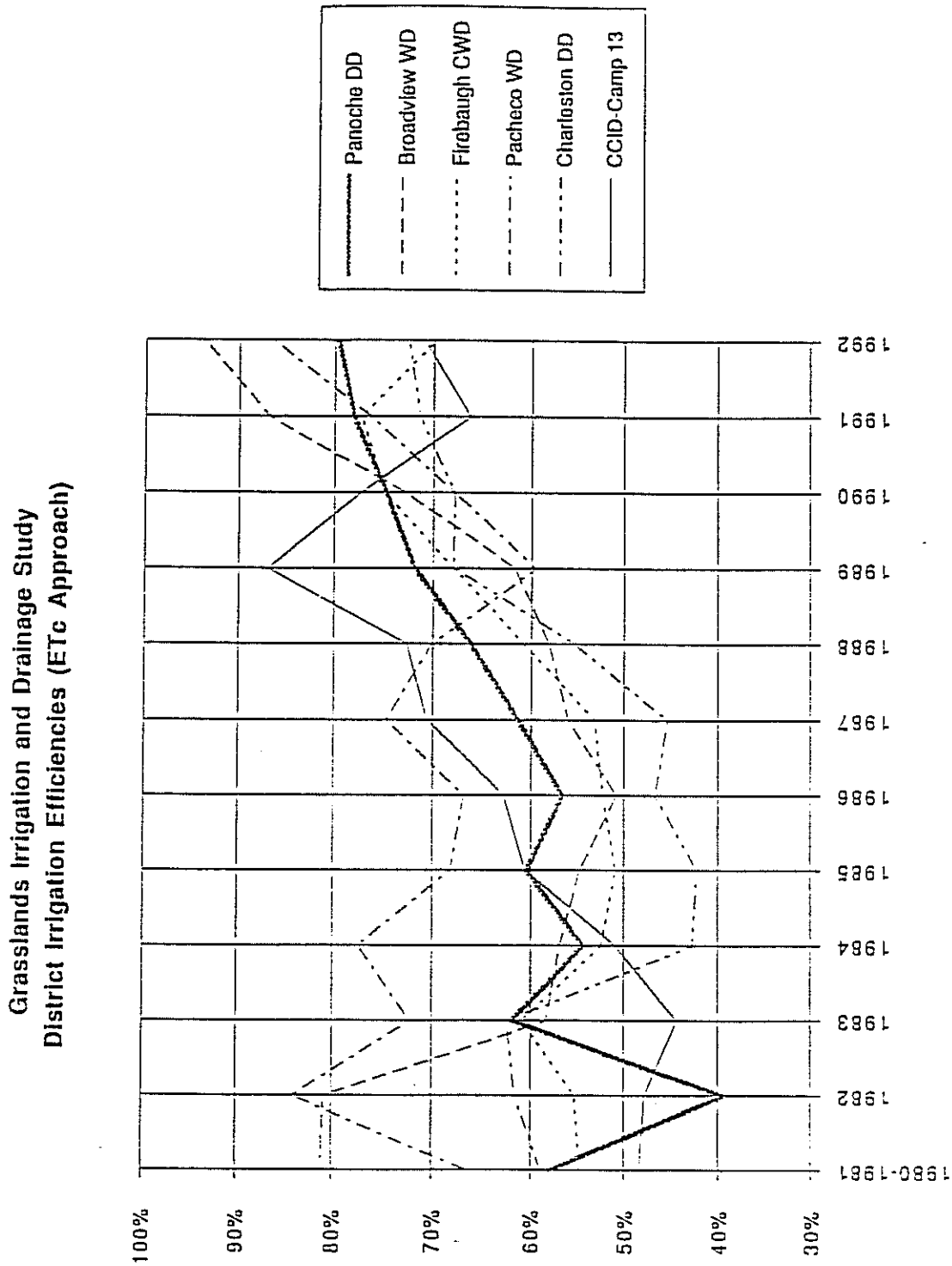

Grasslands Irrigation and Drainage Study
District Irrigation Efficiencies (ETc Approach)
Panoche DD
Broadview WD
Firebaugh CWD
Pacheco WD
Charleston DD
CCID-Camp 13
100%
90%
80%
70%
60%
50%
40%
30%
1980-1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

Figure ES-1

The study of the pre-plant irrigation efficiencies depends on the application of broad-based and theoretical assumptions about agricultural practices to highly variable and site specific cropping and irrigation patterns. Furthermore, the information available from the water districts involved is general in nature. Given these limitations, quantifying the data and arriving at specific numbers for district-wide pre-plant irrigation efficiencies for a certain portion of the cropping season is a task which requires a certain amount of professional skill to evaluate the results.

The intention in this portion of the study was to obtain numbers which would reflect trends in pre-plant irrigation efficiencies and indicate the degree of need for modifying irrigation practices during the time of year when pre-plant irrigation occurs. **Figure ES-2** shows the irrigation efficiency using the Pre-Plant Irrigation Efficiency approach graphically. Results indicated overirrigation (low irrigation efficiencies) prior to 1990. Results also indicated poor irrigation efficiencies during high rainfall years. Rainfall in the pre-plant months tended to decrease the irrigation efficiency in this analysis. However, the rainfall may not have been beneficial to the individual farmer depending on several factors. Results for 1990 through 1992 generally indicated underirrigation during the pre-plant months (high irrigation efficiencies). The following main conclusions were drawn from the data:.

- The data indicate that growers are adjusting water deliveries in response to the quantity of effective rainfall.
- Low PIE values can generally be explained where growers are applying excess water in one year to satisfy leaching requirements from previous years.
- High PIE values from 1990-1992 in some of the districts reflect inadequate water supplied for leaching.
- 1993 can be expected to be a low PIE year if water was available.

Section 5 Summary: Regional Irrigation Efficiency - Water Balance Approach

This section of the study was designed to be a check against the DIE which was computed with the ETc approach. The Water Balance approach used the reported district drainage (and its quality) to determine the DIE. If a district acts hydrologically as a "bathtub" , this is a reasonable approach. Because there are difficulties in determining drainage outflows from individual didtricts, the data was eventually grouped to estimate a regional IE.

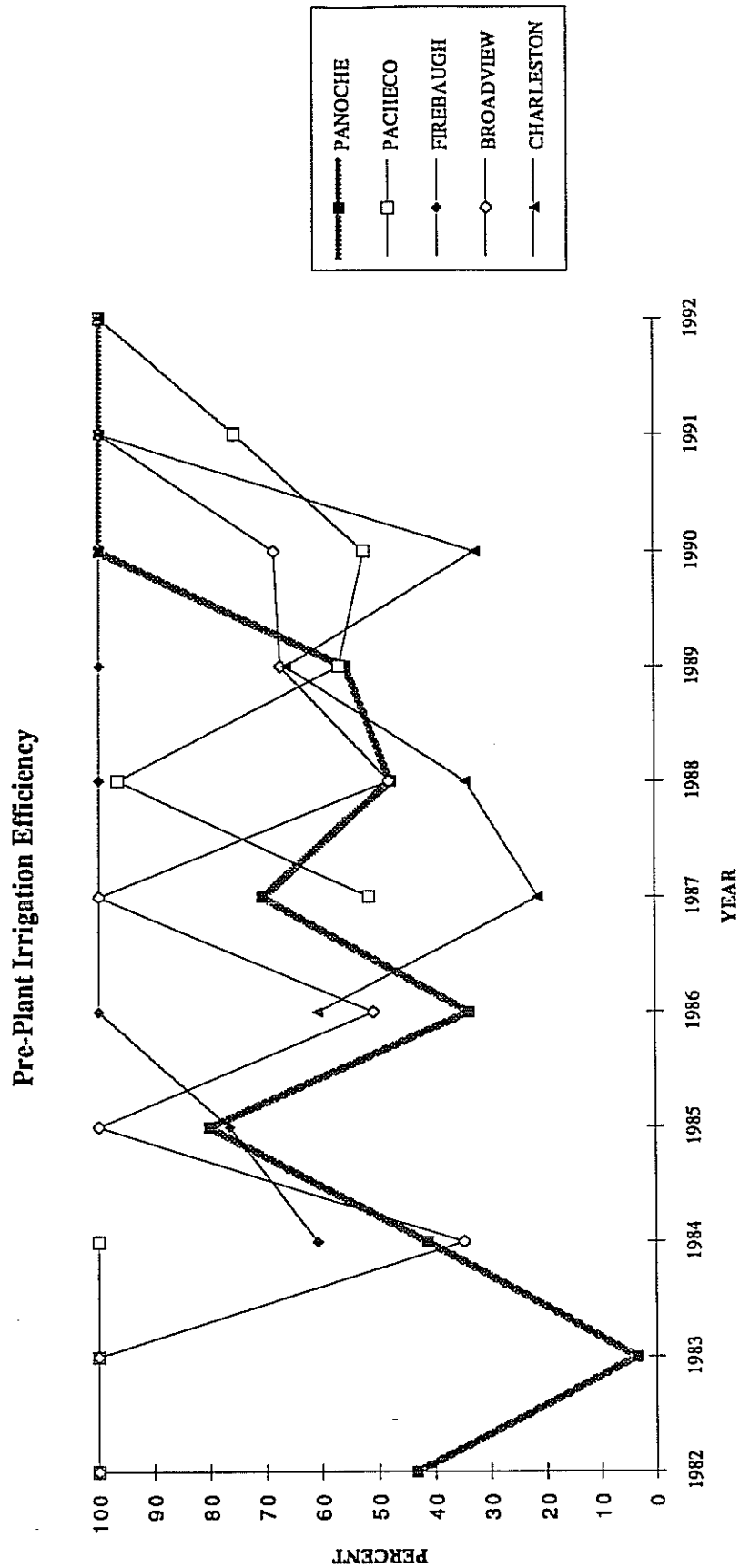

Pre-Plant Irrigation Efficiency
PANOCHE
PACHECO
FIREBAUGH
BROADVIEW
CHARLESTON
PERCENT
100
90
80
70
60
50
40
30
20
10
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
YEAR

Figure ES-2

Since 1985, additional data has been collected and reported for the drainage volumes discharged by the districts. Using this data and some assumptions regarding subsurface water flows, an estimate of the irrigation efficiency using a "bathtub" or water balance approach was completed in order to verify the validity of the values generated by the theoretical ETc approach.

The Regional Irrigation Efficiency values were determined for water years 1986 to 1992 depending on what information was available. In this report, 1986 refers to the water year October 1, 1985 through September 30, 1986. The goal was to verify the relative values of the DIE estimates using the ETc approach. Note on this table that Broadview Water District, CCID-Camp 13, and Firebaugh Canal Water District are referred to as the Eastside Districts. This was done since they all drain through one, common drainage point (FC-5).

Table ES-3 shows the calculation of the district irrigation efficiency based using a water balance approach and using the following equation:

$$IE = \frac{\text{Irrigation Water Beneficially Used}}{\text{Irrigation Water Applied}} \times 100$$

Also shown on this table is the comparison to the Regional IE estimate from the ETc approach. The data for the regional irrigation efficiency for both approaches is shown in **Figure ES-3**. The values trend similar to each other indicating increasing irrigation efficiencies as the drought continued into the 6th year (1992). The values are 5% or less difference starting in 1987. The values are within 3% in the years 1989 through 1992. This close comparison of results of two entirely different calculation procedures validates the assumptions used in the ETc Irrigation Efficiency approach.

Table ES-3
Irrigation Efficiency - Water Balance Approach

	1986	1987	1988	1989	1990	1991	1992
Panoche (DIE)	64%	61%	64%	69%	69%	72%	69%
Pacheco (DIE)	48%	45%	73%	66%	72%	79%	68%
Charleston (DIE)	59%	59%	52%	69%	72%	82%	83%
Eastside Districts (BWD, FCWD, CCID-Camp 13)	66%	68%	74%	75%	78%	77%	77%
Regional IE (Water Balance Approach-Weighted)	**64%**	**64%**	**69%**	**72%**	**73%**	**76%**	**74%**
Regional IE (ETc Approach)	**56%**	**59%**	**64%**	**70%**	**75%**	**78%**	**77%**

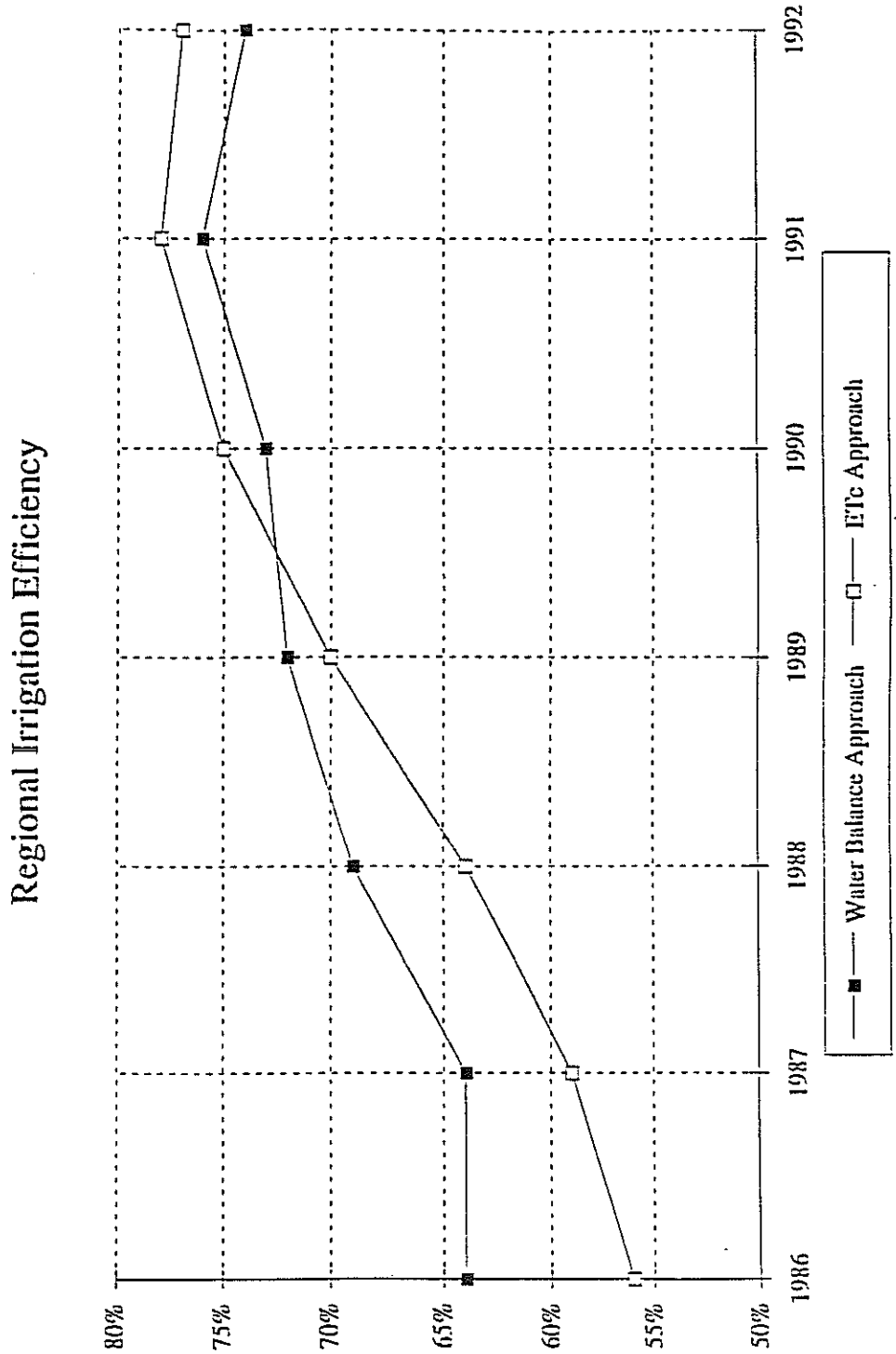

Regional Irrigation Efficiency
80%
75%
70%
65%
60%
55%
50%
1986
1987
1988
1989
1990
1991
1992
Water Balance Approach
ETc Approach

Figure ES-3

Section 6 Summary: Conclusions

One effect of the drought may well be a reduction in the ETc adjustment factor as farmers stress crops. Another factor might be farmers planting more acreage than prudent; hoping for extra water to appear in mid-season. Without the additional water, some acreage will be abandoned. These abandoned acreages would have to be considered separately if performing further analyses in the same manner as this study.

The results of this study indicate that most of the districts were able to improve DIE. The main problem is whether they can maintain the high levels of irrigation efficiency without being impacted by increasing salinity in the rootzones. Based on the pre-plant analysis, the data indicated that significant underirrigation was being practiced due to the limited irrigation water supplies. If the trend were to continue, excessive levels of salts in the rootzone would be expected.

The results also indicate a basic need for better coordination among the districts in the data collection and recording efforts. The districts might invest in a common spreadsheet and word processing format to aid in information transfer. There has been much data collected for this study area. However, most of the data is not readily accessible for data analysis. Some of the data monitoring sites need to be improved. For example, wells and drainage sumps must be fitted with flowmeters. Other suggestions include standardized procedures for the collection of water quality data, improved drainage discharge point measuring stations, and standardized format for reporting irrigated acreage and water delivery data (suggest the September through October format).

An important assumption made in this study was adjusting the ETc downwards to account for nonuniformity and bare spots (about 15%). This tended to decrease DIE using the ETc approach because it decreases beneficial use for the same amount of applied irrigation water. This assumption appeared to be verified by comparing the ETc approach results of DIE with the water balance approach.

Other Significant Results:

- The water balance approach has identified several destinations of water that have not been used in previous reports. These include an estimate of the amount of rainfall runoff that enters the drains. The total amount ranged from about **4,500 AF to 10,000 AF** for the entire study area based on 50% of the total rainfall between October and March. Another estimated value was the amount of deep percolation losses below the Corcoran Clay layer. This report estimated losses of

about **23,100 AF** per year for the study area. This is compared to the measured drainage volume in 1992 of **30,500 AF**. This is significant because a salt balance of this region needs to include an estimate of the salt removed with the water passing through the Corcoran Clay.

- Due to the fluctuating characteristics of the water quality data from the sumps and the district drains, it was felt it was not possible to draw conclusions regarding the expected selenium, salinity, or boron levels with additional recycling. Future data collection efforts need to focus on consistant water quality measurements and accurate flow measurement devices. Reported water quality measurements appear to use averaging techniques that may not accurately reflect the water quality in the drains. Some of the drainage discharge measurement sites need improvements to ensure accurate water measurement. Concentrations and loads analysis was graphically performed in **Appendix G**. Included in this section are EC, Se, B versus time of year, EC versus Drainage Volume, and EC versus Se ratios.

- In addition, special analyses were made of the sumps in Panoche Drainage District. It was found that 50% of the reported load of Se into the discharge of the district comes from 5 of 61 sumps. 80% of the loading comes from 10 of the sumps. These sumps are located close to each other on the eastern side of the district. If flows from these sumps could be minimized, the impact on the drain Se loading would be significant. Future studies may want to focus on water table control in these areas to minimize drainage volumes. For example, maintaining higher water tables could force additional upflux from the shallow water table. It is recognized that these regions may be draining significant flows from upslope water users. PDD has also been at the forefront in researching methods to remove harmful salts from the drainage water.

- It was found that the water quality from individual sumps varies significantly and that this is due to variations in the timing of the water quality samples. Apparently, water samples are drawn when convenient and costs do not allow consideration for the timing of irrigation events. However, the data indicates that reductions in the drainage volumes will definitely reduce the EC, Se, and B loadings in the drains with the tradeoff of some increase in the concentrations.

Future of the Grassland Basin

Long-term success for farmers in the Grassland Drainage Basin might be defined as "maintaining acceptable agricultural profitability while meeting the water quality standards in the San Joaquin River". This success will depend on the drainers' ability, in the Grassland Area, to control the timing and amount of salt movement to the San Joaquin River. This ability will be affected by:

- Modifications to on-farm tile drain systems and irrigation practices that could possibly reduce the pickup of salts, especially selenium (ie., closer tile line spacings, maintenance of higher water table, and water table control for maximum crop use).
- Individual district strategies for disposal of drainage water (increase DIE).
- Cooperation among the districts in jointly meeting water quality standards.

Unblended agricultural drainage that leaves a district's boundaries will almost always be of worse quality than the water quality standards of the San Joaquin River. Thus, drainage water must be blended with better-quality water. There are two possible sources for blending water:

1. The natural flows of the San Joaquin River
2. High quality drainage water which leaves a district

Future actions by various regulatory agencies may restrict the amount of San Joaquin River water which can be used by districts to blend with their drainage water. If this occurs, districts will have to use their own irrigation water supply. In either case, districts can develop a management strategy if they have internal control of drainage amounts, qualities, and destinations.

Increasing the DIE will result in reduced drain water volumes and lower loads. Reduced drain water volumes and loads will result in higher concentrations of boron and selenium at district discharge outlets. Thus, while the probability of achieving water quality objectives in the San Joaquin River will be increased, the concentrations of boron and selenium in Mud Slough (North) and Salt Slough will also be increased.

There are two reasonable approaches available towards increasing the DIE in this area.

- The first is the classical approach of improved water management on both district and on-farm levels.

- The second path is a relatively new idea. This approach is an integrated approach which attempts to maximize the ratio of crop yield to the unit-water applied. Through improved management of the soil fertility, planting, irrigation, and other agronomic factors, the zones in a field which have weak or bare crop growth will be eliminated or minimized. Therefore, with a stronger crop, the field ET will increase because there are more and healthier plants. The applied water would remain about the same. The net result is less deep percolation and a higher IE.

Sustainable District Irrigation Efficiencies

There are two important and related questions which the ITRC has addressed in this study:

- What is the highest District Irrigation Efficiency (DIE) which can be sustained in this
- How much tile water recycling can be done?

The evidence to date indicates that the answers are three-fold:

- If there is under-irrigation on fields (caused by a combination of short durations and non-uniformity), any tile water recycling appears to be unsustainable in that some portions of the fields will accumulate unacceptably high and toxic salt levels.
- If there is no under-irrigation on fields (ie, all non-uniformity is compensated for with extra water application, and irrigation scheduling is sufficient to have no stress anywhere), about 30% of the deep percolation through the root zone can be recycled without raising the average root zone ECe to more than about 2.5 dS/m. The remaining 70% of the root zone deep percolation will either exit through the Corcoran Clay layer or be discharged (via tiles and then surface drains) from the district. Because of the uncertainties of the magnitude of the flow rate downward through the Corcoran Clay layer, it is impossible to predict the precise amount of tile water that must be discharged from the district via surface drains.
- The maximum sustainable DIE is about 80% in this region.

These conclusions are based upon the following:

1. All on-farm irrigation has non-uniformity (Distribution Uniformity, DU, of less than 100%) of water distribution across a field. Typical well-managed and well-designed irrigation systems have a DU of about 75-80%.

2. To avoid under-irrigation, with a DU of 75% and about 5% non-beneficial evaporation loss, the Irrigation Efficiency (IE) of a farm with no recycling is about 70%

$$IE = DU \times (1 - \frac{\%\ evap\ loss}{100})$$

$$= 75 \times (1 - \frac{5}{100})$$

$$= 71\%$$

3. A simple spread sheet was developed to examine soil salinities across a field with a linear DU pattern and varying percentages of tile recycling. A 30% recycling of root zone deep percolation, accomplished through blending tile water with supply water, indicated that the drainwater EC and blended water EC stabilize within a couple of years. This assumes **no under-irrigation** (a key assumption, as explained below). Estimated stabilized values were:

   EC of source water = 0.6 dS/m (assumed)
   ECe at "worst spot" in the field = 2.6 dS/m
   ECe at "best spot" in the field = 0.5 dS/m

   ECiw (blended) = 0.8 dS/m

   ECdw = 2.5 dS/m

4. The numbers in item (3) above do not match what is actually seen in field. In particular, Broadview Water District has excellent data since about 1980. That data shows the following:

- Before BWD had an outlet for its tile drain water, the EC of the blended irrigation water was about 3.0 dS/m, higher than predicted in (3).

- This report has estimated that the present annual DIE values and pre-irrigation DIE values are in the range of 90%.

- Soil salinities measured throughout BWD by Lesch and Rhoades in 1991 are much higher than the ECe's predicted.

- The high DIE values in BWD are indicative of under-irrigation on parts of fields. That under-irrigation leads to salt build-up (due to no leaching) in some parts of fields, and very concentrated tile drain water in the areas with some leaching. That concentrated tile drain water is then recirculated on all the field, compounding the problem.

5. The district farmers see processing tomatoes as a key crop in their economic rotation. Tomatoes have a threshold (critical maximum) ECe of about 2.5 dS/m for soil salinity. Therefore, this discussion of sustainability revolves around the objective of maintaining a soil salinity distribution such that there is no yield decline of tomatoes anywhere in the field due to salt buildup.

In summary, the evidence indicates that the best strategy for soil productivity sustainability requires **all** three of the following:

- Have high irrigation DU's.

- Have excellent irrigation scheduling and water depth control, and avoid under-irrigation

- Recycle no more than about 30% of the root zone deep percolation, which may be equivalent to 40-60% of the tile water.

SECTION 1

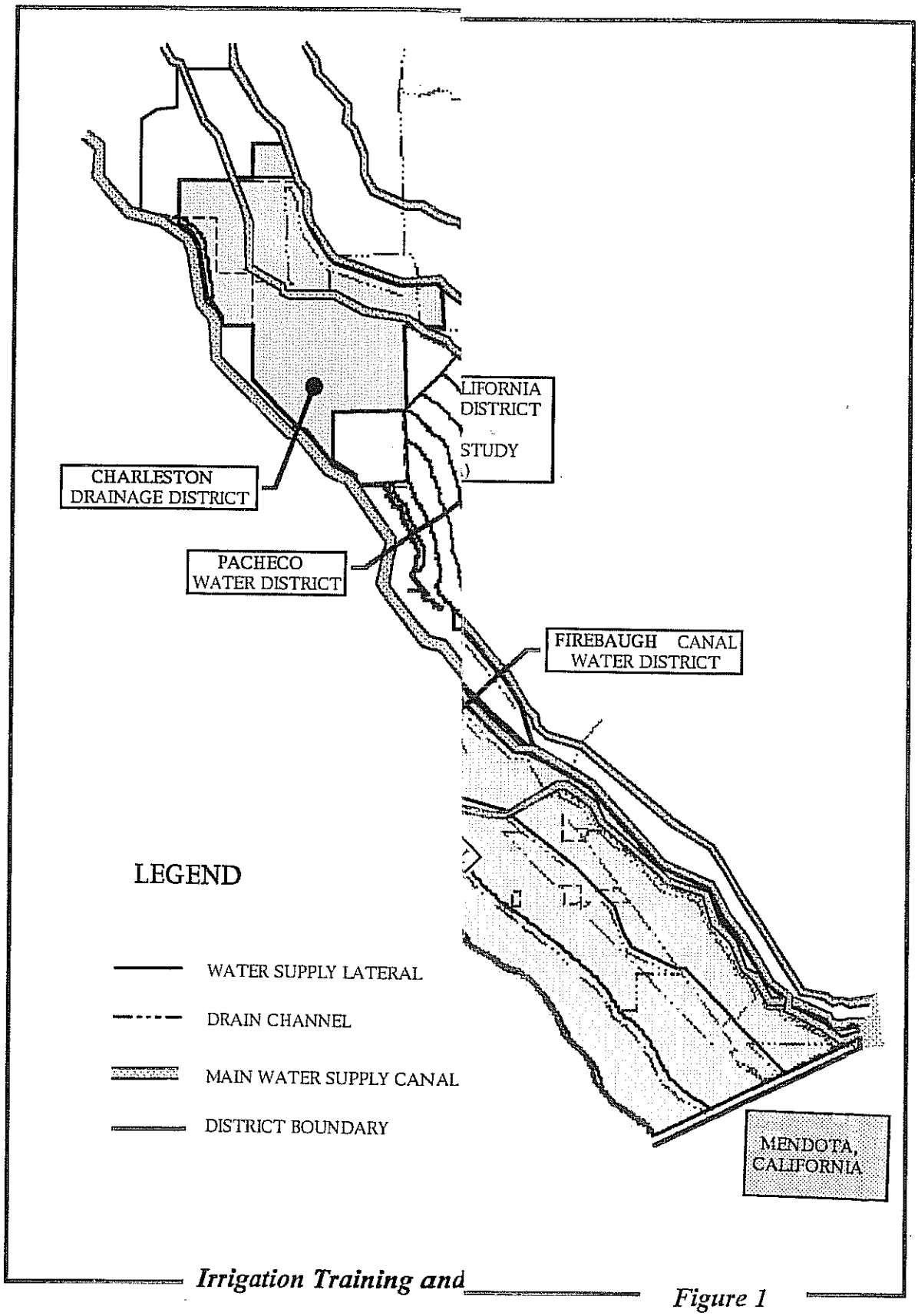
RE-USE OF SURFACE RUNOFF AND SUBSURFACE DRAIN WATER

INTRODUCTION

This project analyzed 6 subareas of the Grassland Basin roughly representing 80,000 acres on the west side of the San Joaquin Valley near Firebaugh, California. The subareas are identified in this report as Broadview Water District (BWD), Central California Irrigation District (CCID-Camp 13), Charleston Drainage District (CDD), Firebaugh Canal Water District (FCWD), Pacheco Water District, (PoWD), and Panoche Drainage District (PDD). These areas are shown on **Figure 1.** The time span was from 1981 through 1992. This first section describes some of the actions districts and individual growers have implemented with regards to the reuse of surface runoff and subsurface flows.

Surface runoff from agricultural fields and water collected in subsurface drains have been the focus of much attention among farmers, district staff, and regional water quality authorities in recent years. Surface runoff, also called tailwater, is often generated when siphon tubes, or gated pipes are used to irrigate with furrows or bordered checks that may be 1/6-mile to 1/2-mile long. Sprinkler irrigation systems usually generate less tailwater than surface methods, but a poorly managed sprinkler system can result in surface runoff. The quality of surface runoff is generally equivalent to the quality of water delivered to the field, but the runoff usually contains silt and nutrients that are collected from the soil surface.

Water collected in subsurface drains on the west side of the San Joaquin Valley often contains a mixture of salts, boron, selenium, and other elements. Some of these elements, including boron and selenium, occur naturally in the Valley's soils but are harmful to plants or wildlife at high concentrations. Selenium concentrations in subsurface drain water have been a concern to state and regional water quality authorities who are responsible for protecting water quality in the San Joaquin River and its tributary sloughs. The Regional Water Quality Control Board for the Central Valley Region of California has called on farmers in the region to reduce the volume of subsurface drain water and the associated loads of boron and selenium that are discharged into the River and its tributary sloughs each year.



Irrigation Training and

Figure 1

ON AND DRAINAGE STUDY
IN STUDY AREA

Although the principle target of water quality authorities in the San Joaquin Valley is subsurface drain water, it is not possible to separate this issue from the management of surface runoff because both types of water are often mixed and transported in the same drainage ditches. In fact, surface runoff helps to reduce the concentrations of boron and selenium in drainage ditches, but it also contributes to the volume of water and the loads of salt and selenium in those ditches. It may be desirable to reduce the volume of surface runoff moving through regional drainage ditches in order to reduce the total volume of drainage water requiring disposal or treatment, but this will cause the concentrations of salt and selenium in those ditches to increase.

Many farmers in the San Joaquin Valley have already begun reducing tailwater volumes to a very small portion of the total water delivered to farm fields in order to maximize the area that can be irrigated with limited water supplies. Many of these farmers have begun using shorter furrow lengths and shorter irrigation set times to improve distribution uniformity. They have also hired night irrigators to monitor water deliveries carefully through the night. Other farmers have begun using sprinkler irrigation systems to maximize the value of limited water supplies. The most significant factor in tailwater reduction has come from installation of on-farm tailwater return systems. All of these improvements in farm-level water management have contributed to significant reductions in surface runoff in recent years.

The motivation to manage water deliveries carefully is likely to remain in place during the near future, as water supplies will continue to be restricted and as the value of water increases both directly, due to increases in price, and indirectly, through water marketing opportunities. Farmers who have purchased sprinkler systems will continue to use them and farmers who have implemented more intensive management of surface irrigation systems will likely continue these practices. Hence, the volume of surface runoff entering district-level and regional drainage ditches will continue to be less than the volumes observed during the mid-1980's. However, there will still be surface runoff (tailwater) in most of these ditches because it is often expensive to separate surface runoff (tailwater) from subsurface drain water (tilewater) at the farm level.

This outlook for tailwater volumes in the region has important implications for policies regarding the re-use and disposal of subsurface drain water. For example, if tailwater volumes will be declining over time, the concentrations of salt and selenium in regional drainage ditches will be increasing, regardless of the volume of subsurface drain water in those ditches. This will make the commingled drainage water less desirable for re-use among farmers who have the opportunity to use the drainage water at some point along the regional drainage ditches. In addition, the drainage water that enters the San Joaquin River or its tributary sloughs will contain higher concentrations

of salt and selenium than were present when there was a significant tailwater component in the drainage water.

However, it is probably desirable to maintain these reductions in tailwater volumes because they result from improvements in water management that are necessary to maximize the value of limited water supplies. In addition, the reductions in tailwater volume will lead to reductions in the total volume of drainage water requiring treatment or disposal. This may result in significant cost savings when regional drainage water treatment or transportation facilities are constructed in the future.

Specific farm-level and district-level strategies for re-using surface runoff and subsurface drain water are described in the following sections of this report. Throughout that discussion, "surface water" and "tailwater" are used interchangeably, while "subsurface drain water" refers specifically to the water collected in subsurface drains. The term "drainage water" is used to describe the commingled mixture of tailwater and subsurface drain water or "tilewater" that flows through farm-level, district-level, and regional drainage ditches.

FARM-LEVEL RE-USE STRATEGIES

There are several activities that may be undertaken by farmers and by irrigation or drainage districts to re-use subsurface drain water. In most cases, there will be "economies of scale" or "economies of concentration," that make district-level re-use of subsurface drain water more attractive than farm-level re-use. However, in the interest of completeness, farm-level re-use activities are presented here. In principle, farmers can re-use subsurface drain water that is generated as a result of their irrigations in one of four ways:

1. Maintain a high water table that can be used by plants to satisfy a portion of crop water requirements (sub-irrigation).

   This practice is not widely accepted in the Valley because farmers are concerned about allowing saline drainage water to accumulate in the crop root zone. In addition, most of the existing drainage systems were installed to provide rapid and effective removal of saline water. The subsurface drain lines in these systems were installed on a slope to facilitate water movement from the upper end of a field to a collector system at the bottom

of a field. It is difficult to achieve uniform sub-irrigation when the drainage lines are installed with such a slope.

Farmers are concerned that efforts to sub-irrigate with saline water may cause salt accumulation problems in lower portions of a field before the upper part of a field receives adequate water. It may be possible to modify existing drainage systems to provide sub-irrigation by cutting drain lines and installing regulator valves at specific linear intervals. Field demonstrations are required to examine the potential of this approach.

Sub-irrigation can also be accomplished by planting deep-rooted crops and allowing these crops to utilize water in the shallow water table. During the drought, many fields of alfalfa seed in the Broadview Water District were irrigated only once or twice per year. A large portion of the crop water requirement of these fields was satisfied by the shallow water table.

2. Collect subsurface drain water in a sump and deliver the water to an adjacent field, via gravity flow.

   Much of the subsurface drain water generated in the Grassland Drainage Basin is collected in sumps that are connected to subsurface collector lines in one or more fields. When the water in a sump reaches a pre-determined level, drain water is pumped automatically from the sump and into a ditch that carries the drain water away from the field. At present, most of these ditches carry both subsurface drain water and surface runoff from many farms in a district.

   It would be possible to pump drain water from a sump into a farm-level ditch to carry the drain water to another field, but the drain water would need to be blended with surface runoff or fresh water before it is used to irrigate corps. The ratio of fresh water to drain water that would be required at the farm level may be quite large, particularly if the farmer is generating only a small amount of surface runoff. It may also be difficult to schedule irrigations on adjacent fields in a manner that allows drain water from one field to be used on another field, at the same time. This will be particularly difficult when a farmer has several fields of different crops that are irrigated at different times during the season.

3. Collect subsurface drain water in a sump and re-circulate the water to the point where fresh water deliveries are received, and then blend the drain water with the fresh water deliveries.

   This strategy would not require farmers to coordinate irrigation on adjacent fields, but the drain water would need to be blended with fresh water before re-use occurs. Farmers could install a single system to pump both drain water and surface runoff back to the upper end of a field, but with diminished tailwater volume, sufficient dilution of the subsurface drain water will be difficult. Also, if 100% the tile water was recirculated, it appears that the root zone salinities would become so high as to be toxic to some crops such as tomatoes.

4. Collect subsurface drain water in a sump and deliver it to a field of eucalyptus trees or some other crop that is planted for the purpose of receiving subsurface drain water.

   This strategy is currently being practiced by at least two farmers on the west side of the San Joaquin Valley and additional farmers may adopt this practice in the future. The goal is to dispose of drain water by irrigating a crop that is not affected by salt accumulation into the soil. Eucalyptus trees are expected to be very salt tolerant and they may even be harvested for sale as firewood. However, the market for firewood in the San Joaquin Valley may be limited and farmers are concerned about the long-term implications of applying large amounts of saline drain water to a portion of their farmland. There are also many unsolved problems related to frost damage to the trees, final disposal of the more concentrated drain water, and the bioaccumulation and ultimate destinations of various salt components.

All of these drain water re-use strategies are physically feasible at the farm level, but they may not be economically feasible, given the cost to modify existing subsurface drainage systems and the difficulty of blending saline drain water with limited surface water supplies. For these reasons, most current re-use of drain water in the region is accomplished at the district level, where large volumes of fresh water and tailwater are available for dilution. In addition, districts are able to blend drain water with surface water supplies when delivering water to several farmers during a given time period. This provides districts with greater flexibility in blending drain water than is possible for a single farming operation.

Another form of farm-level re-use occurs when farmers located downslope of regional or district-level drainage ditches choose to use water from those ditches for irrigation. These farmers may blend the drainage water with their own fresh water supplies, or they may use the drainage water directly for irrigation. Farmers who use drainage water in this manner will usually monitor the electrical conductivity of the drainage water very carefully and will make decisions daily regarding drainage water use and blending. Many farmers in the Grassland Drainage Basin who re-use drainage water have become very skilled in the use of portable electrical conductivity meters. These farmers check the conductivity of drainage water and delivery water in their farming operations regularly.

DISTRICT LEVEL RE-USE STRATEGIES

Irrigation and drainage districts can promote the re-use of subsurface drain water among district farmers and they can also provide re-circulation services that may not be economically feasible at the farm level. For example, districts can collect subsurface drain water from a large number of farms in a series of collector drains that carry drainage water, via gravity, to points of low elevation in the district. These drains may carry both subsurface drain water and surface runoff, or they may carry only subsurface drain water. The district, after collecting the subsurface drain water, can determine the optimal district-level strategy for re-use or disposal of the drain water.

The set of policies available to districts, regarding subsurface drain water can be summarized as follows:

- Accept no subsurface drain water and no surface runoff from farmers in the district,
- Accept only subsurface drain water, and require farmers to eliminate or re-use all of their surface runoff,
- Accept both subsurface drain water and surface runoff in a single set of district drainage ditches,
- Accept both subsurface drain water and surface runoff in separate ditches, to maintain separation of surface runoff and subsurface drainage water,

- Re-use the drainage water by blending it with fresh water deliveries at one or more locations in the district, or

- Discharge the drainage water into regional drainage ditches that carry the water to the San Joaquin River or its tributary sloughs.

District managers will likely choose some combination of these policies in selecting an optimal strategy for managing drain water volumes and the salt concentration in water deliveries. For example, it may be optimal to blend significant amounts of drainage water with fresh water deliveries during some months and it may be optimal to discharge drainage water in order to maintain high-quality water deliveries in other months. The existing design of district drainage ditches and delivery systems may also place constraints on the extent to which a district can recirculate drainage water in a given time period, as well as on where in the district the irrigation water can be re-applied.

All of the districts that reuse subsurface drain water in the Grassland Drainage Basin have adopted policies describing the maximum concentration of total dissolved solids that will be permitted in water deliveries to farmers. These values vary among districts, but are generally in the range of 1,000 to 1,400 parts per million of total dissolved solids. District staff monitor the salt concentration in water deliveries on a daily basis and they adjust blending ratios, as needed, to maintain delivered water quality within the stated policy objective.

Districts delivering blended water must coordinate blending ratios to accommodate farmers using sprinklers to germinate young plants or to irrigate melons and tomatoes during early-season irrigation events. Sprinklers place water directly on the leaves of plants. Salt can damage the plants as the water evaporates and leaves the salt on the plant surface. Districts may need to provide better quality water during specific irrigation events or to farmers using sprinkler systems, in order to maintain farm-level support of the district's drain water re-use strategy.

CURRENT RE-USE ACTIVITIES IN THE GRASSLAND DRAINAGE BASIN

Farm-level and district-level re-use of surface runoff and subsurface drain water have increased significantly in recent years in the Grassland Drainage Basin. Much of the motivation for this

increase in re-use has been generated by significant reductions in surface water supplies to federal irrigation districts in the region. Persistent drought conditions resulted in a 50% reduction in surface water supplies during 1990 and 75% reductions in 1991 and 1992. Water supplies were reduced by 50% in 1993, due to restriction on the pumping of water through the Delta formed by the Sacramento and San Joaquin Rivers. Those restrictions were imposed due to implementation of the Endangered Species Act. Additional motivation has been provided by increased prices for surface water supplies, uncertainty regarding surface water allocations, and a desire among farmers and district mangers to achieve water quality objectives in the San Joaquin River and its tributary sloughs.

Some of the increase in re-use at the farm level is due to specific policies and programs implemented by irrigation and drainage districts, while some of the increase is due to farm-level incentives regarding water availability and cost. For example, farmers in the Panoche Drainage District are not allowed to discharge surface runoff into district drainage ditches and, therefore, must either eliminate surface runoff or re-use the runoff on the original field or on a field located downslope from where the runoff is generated. The small volume of surface runoff that is currently collected by the Panoche Drainage District will be reduced even further, as the district plans to enforce its tailwater policy more aggressively in the future.

The tailwater policy adopted at the Panoche Drainage District allows that district to collect and manage a smaller total volume of drainage water by removing surface runoff from district drainage ditches. Over time, the district will have only subsurface drain water in its drainage ditches and the district manager will be able to determine the optimal combination of volumes for re-use and disposal, throughout the year, without needing to accommodate large volumes of surface runoff in the drainage system.

None of the other districts in the Grassland Drainage Basin has a specific tailwater policy, but several farmers in those districts have begun re-using surface runoff to augment their contractual water allocation. One relatively large farming operation in the Charleston Drainage District installed a re-circulation system that captures both surface runoff and subsurface drain water in a single re-circulation basin. The commingled drainage water can then be pumped uphill and blended with fresh water supplies at one of two locations where the farmer receives his water deliveries. This system was used often during 1992 and 1993 to increase that farmer's water supply.

The Charleston Drainage District does not provide any district-level re-circulation of drainage water, largely because it is not a water supply district and it does not have the facilities to accomplish a blending task. However, the district manager does work with farmers to coordinate

the re-use of commingled drainage water at several points along the district's principal drainage ditch. In addition, the district has assisted farmers in the construction of tailwater recovery ditches to promote the re-use of surface runoff. The district has also constructed diversion structures that allow farmers to separate the surface runoff and subsurface drain water in locations where this is feasible.

At least two farmers in the Charleston Drainage District are able to utilize some of the drainage water that flows through the district's drainage ditch, at certain times of the year, provided that the electrical conductivity is within acceptable limits. Coordination of re-use activities among farmers in Charleston is sometimes required, to maximize the potential for re-using drainage water, because the district is relatively small and the actions of one farmer can have a significant impact on the volume and concentration of water flowing in the district's drainage ditch.

Two farmers in the Broadview Water District have installed field-level tailwater re-circulation systems in recent years, but no farmers have begun to reuse subsurface drainage water directly from sumps located on their farms. At the present time, Broadview collects all surface runoff and subsurface drainage water in district ditches and the district manager determines the optimal strategy for blending some of the drainage water with fresh water deliveries during some portions of the year and discharging a portion of the drainage water at other times.

District-level re-use of tailwater and subsurface drain water is also provided in the Firebaugh Canal Water District and in the Pacheco Water District. In Firebaugh, surface runoff and subsurface drain water from one portion of the district are pumped into one of the district's water delivery canals, where the commingled drainage water is blended with fresh water before being delivered to farmers at lower elevations in the gravity-flow delivery system. The Pacheco Water District collects surface runoff and subsurface drain water from all farmers in the district and recirculates the commingled drainage water through its water delivery system. At the present time, Pacheco is not able to distribute recycled drainage water throughout the entire district, but structural improvements that will increase the land area served by the recirculation system will be constructed in the near future.

OPPORTUNITIES AND CHALLENGES

The significant increase in the re-use of surface runoff and subsurface drain water, at both the farm-level and district-level in the Grassland Drainage Basin, have provided farmers and districts with much-needed augmentations of contractual water supplies and have resulted in significant reductions in the volume of drainage water discharged from districts to the San Joaquin River and

its tributary sloughs. Water supplies will likely be constrained in the region during the near future, as environmental issues regarding the Delta remain unresolved and as state and federal agencies continue to restrict the use of Delta pumps during critical months. The desire to achieve regional water quality objectives will also remain in place, although farmers and districts realize that reductions in drain water volume may not increase the probability that the Mud Slough (North) and Salt Slough water quality objectives can be met.

Some re-use of surface runoff and subsurface drain water will continue to occur in the Grassland Drainage Basin in the 1994 crop year, for the reasons noted above. However, the amount of re-use that occurs during 1994, and during later years, will be determined by:

- The impact that re-use has on long-term crop productivity,
- The current farm-level outlook regarding water supply, drainage issues, and regional water quality objectives, and
- The ability of farmers and districts to address the technical and financial constraints that limit the efficient re-use of subsurface drain water.

In addition, the amount of re-use that occurs in the future can be influenced by specific incentive programs or drainage discharge policies adopted by the Regional Water Quality Control Board.

The previous six years have provided farmers, district managers, and regional water quality authorities with an opportunity to observe the short-term challenges for re-using subsurface drain water. Many farmers have also begun to observe or to report on the potential long-term impacts of re-using subsurface drain water in the Grassland Drainage Basin. Several themes describing the opportunities and challenges to re-using drainage water have emerged during interviews with farmers and district managers in the region.

The managers of the Broadview Water District, the Central California Irrigation District, the Charleston Drainage District, the Firebaugh Canal Water District, the Pacheco Water District, and the Panoche Drainage District were interviewed during July and August of 1993. All of the managers have been involved with, or have observed, the re-use of surface runoff and subsurface drain water, at either the farm level or the district level, during recent years. Several of the managers who have developed significant experience in managing a re-use program at the district level have described some of the constraints they perceive regarding the short-term and long-term viability of reusing subsurface drain water.

One of the principle concerns expressed by all of the managers interviewed in this study is the difficulty and expense involved in distributing recycled drainage water throughout a large portion of an irrigation district. Several of the managers reported that their current water delivery and return systems do not permit them to deliver recycled drainage water to all of the lands that may have generated the drainage water. In some cases, the small size of the area that can receive recycled drainage water creates both an equity issue and an efficiency issue that the manager must resolve.

In some districts, when drainage water generated in one portion of the district is recycled and delivered to farmers in another portion of the district, the farmers receiving the drainage water have expressed displeasure with the recycling policy. Their recommendation is that the farmers generating the drainage water should be the farmers who receive the recycled drainage water in their water deliveries. From an efficiency perspective, it may not be possible to achieve the desired level and uniformity of salt concentration in water delivered to farmers, when the area for distributing the drainage water is limited. In some cases, farmers located closer to the point where drainage water is mixed with fresh water receive water with a higher salt concentration than do farmers located further along the distribution system.

The equity and efficiency issues regarding drainage water re-use are short-term issues that district managers have attempted to address through careful adjustment of water volumes and concentrations in response to specific requests from farmers receiving recycled drainage water. In the long-term, district managers suggest that expensive construction projects may be required to build new recirculation facilities for moving drainage water to all portions of an irrigation district. This would permit maximum blending of drainage water with fresh water supplies and would appear to be more equitable from the perspective of farmers in some portions of the district. However, the managers also described a reluctance to undertake such construction projects, given the existing uncertainty regarding water supply, the drainage situation, and environmental issues in the region.

Many of the managers also described the issue of maintaining consistency among water management objectives and drainage reduction goals, particularly as these goals and objectives become embodied in district-level policies that affect farm-level activities. For example, several managers reported that the recent increase in sprinkler use among farmers has resulted in a need for better quality water from irrigation districts, just as districts have increased their re-use of subsurface drain water. Farmers germinating young crops with sprinklers require high quality (low salt) irrigation water, to prevent damaging the young plants. Therefore, district managers

must be careful not to deliver high-salt irrigation water during times when farmers are sprinkling young plants. This issue was not as critical before farmers began using sprinkler systems.

Some of the managers also reported a concern regarding the linkage between water quality objectives in the San Joaquin River, Mud Slough (North), and Salt Slough, and the volumes and concentrations of drainage water released at district discharge outlets. In particular, the managers perceive a lack of information regarding the specific strategies that districts should pursue in managing subsurface drain water. Strategies designed to reduce drain water volumes and loads will likely result in higher concentrations of boron and selenium at district discharge outlets. Thus, while the probability of achieving water quality objectives in the San Joaquin River will be increased, the concentrations of boron and selenium in Mud Slough (North) and Salt Slough will also be increased.

During the years 1986 through 1992, several districts had achieved significant reductions in drainage water volume through aggressive recycling programs conducted to augment limited water supplies. However, in general, the average concentrations of salt, boron, and selenium in the drainage water released by districts have either remained constant or have increased.

District managers realize that reductions in drainage water volume and loads in regional ditches will increase the probability of achieving water quality objectives in the San Joaquin River, at the cost of higher concentrations of salt, boron, and selenium in regional drainage ditches. This will make it more difficult to achieve water quality objectives in the tributary sloughs, where there is very little dilution water available during the irrigation season. The managers also realize that the water quality objectives in the sloughs may not be achievable as long as there is <u>any</u> volume of drainage water in the system. Hence, there is good support among district managers for maintaining reductions in drainage water volume and loads, but there is also some reluctance to pursue achievement of the water quality objectives in the tributary sloughs.

Several farmers operating in the Grassland Drainage Basin were also interviewed in this study, to receive input regarding the short-term and long-term implications of re-using subsurface drain water. One of the farmers has been re-using drainage water for more than six years to augment limited water supplies. That farmer reports no yield effects on cotton and sugar beets, to date, but he does report noticeable damage on a field of alfalfa hay. This is the first year he has noticed the damage, but he feels this is the beginning of permanent difficulty with his recycling program, unless he is able to leach salts from the soil in the near future.

This same farmer reports an important relationship regarding water volume and quality when re-using subsurface drain water. In recent years, he has had to increase the volume of water delivered

to his fields, as the quality of water has declined. Continued application of high-salt water to his fields has resulted in saline soils that restrict the ability of plants to extract water. Therefore, he must keep the soils more moist than usual in order for plants to extract the water. His average water deliveries to cotton, alfalfa, and sugar beets have increased, even though he is re-using the subsurface drain water to augment his limited water supply. It should be noted that although continued recirculation of tile water will require both a high leaching fraction and more frequent irrigations (to keep the soil salts more dilute), such management generally requires a modification of the irrigation system design or irrigation duration to prevent gross over-irrigation. If, for example, hand more sprinklers are used more frequently, the hours per application should be reduced accordingly. With furrow irrigation, more frequent irrigations may require the use of shorter furrows, alternate furrow irrigation, torpedo compaction, or other measures to reduce the depth infiltrated per irrigation.

Another farmer operating in the region reports actual crop damage in 1993 when using sprinklers to irrigate young cotton plants. The farmer was blending subsurface drain water and surface runoff with fresh water, but the resulting salt concentration was high enough to damage the young plants. He replaced the sprinklers with siphon tubes when he noticed the damage. The remainder of the field was taller and looked healthier in late July, when the interview with this farmer was conducted.

A farmer operating in another irrigation district reported damage to a young tomato crop, while sprinkling the plants with irrigation water measuring about 1,000 parts per million in total dissolved solids. The farmer complained about water quality to the water district manager, who explained that the district's current recycling policy allowed for water to be delivered at that concentration. However, the farmer was concerned that this policy was not consistent with motivating farmers to use sprinkler irrigation systems and suggested that better water quality was required to operate sprinklers successfully. It is possible that events such as these occurred in many irrigation districts during the drought, as district managers worked to augment their water supplies through intensive recycling efforts.

Some farmers in the Grassland Drainage Basin are able to use commingled drainage water as a supplement to limited water supplies, provided that the salt and boron concentrations in the drainage water are not excessive. One such farmer is located along a district drainage ditch that carries commingled drainage water past fields that he rotates in cotton, alfalfa hay, and corn. During past years, the salt concentration has been reasonable and he has been able to use significant quantities of water from the drainage ditch. During the most recent two years, however, farmers in the district have increased their re-use of surface runoff, resulting in a higher

proportion of subsurface drain water in the district drainage ditch. As a result, the salt concentration has increased and opportunities to reuse the commingled drainage water have been reduced. At a minimum, the farmer must now use a larger amount of fresh water to dilute the drainage water before delivering it to crop fields.

The farmer providing this observation suggested that farmers discharging drainage water into district ditches should be required to discharge both surface runoff and subsurface drain water, or to re-use both components on their farm, rather than discharging only the subsurface drain water. The farmer felt that this policy would motivate all farmers to pay greater attention to the impacts that their water management practices have on farmers located along district drainage ditches and in other areas of an irrigation district.

The farm-level observations reported in this study are consistent with the comments of district managers regarding the limited opportunities for re-using subsurface drain water efficiently and equitably, given the existing water delivery and drain water collection systems. The large expense required to construct ideal facilities for maximizing the potential re-use of drain water will not be allocated by districts, given current economic conditions and uncertainty regarding water supply and drainage issues. Districts and farmers will likely continue to pursue short-term solutions to district-wide drainage management issues until a clearer plan is presented to them regarding their individual or district roles in achieving regional water quality objectives.

SECTION 2

DRAINAGE

OVERVIEW

Long-term success for farmers in the Grassland Drainage Basin might be defined as "maintaining acceptable agricultural profitability while meeting the water quality standards in the San Joaquin River." This success will depend on the drainers' ability, in the Grassland Area, to control the timing and amount of salt movement to the San Joaquin River. This ability will be affected by:

- Modifications to on-farm tile drain systems and irrigation practices that could possibly reduce the pickup of salts, especially selenium.
- Individual district strategies for disposal of drainage water.
- Cooperation among the districts in jointly meeting water quality standards.

Unblended agricultural drainage that leaves a district's boundaries will almost always be of worse quality than the water quality standards of the San Joaquin River. Thus, drainage water must be blended with better-quality water. There are two possible sources for blending water:

1. The natural flows of the San Joaquin River
2. High quality drainage water which leaves a district

The amount of high quality water available for blending is the "assimilative capacity" of a district.

Future actions by various regulatory agencies may restrict the amount of San Joaquin River water which can be used by districts to blend with their drainage water. If this occurs, districts will have to use the assimilative capacity of their own irrigation water supply. In either case, districts can develop a management strategy if they have internal control of drainage amounts, qualities, and destinations. Without internal control, meeting water quality standards will hinge on the variable assimilative capacity of the San Joaquin River, or on unplanned, and possibly excessive releases of district irrigation water. Irrigation water may or may not be available when needed, especially considering demand by district farmers during critical crop growth periods.

DRAINAGE DECISION TREE

The decision tree for a district's drainage water control/release strategy is made up of five different policy levels: Acceptance, Separation, District Level Recycling, Holding, and Assimilation Water. Each of these levels will be discussed along with their implications. **Table 1** is a listing of these drainage policies and a brief description of each policy. A **Drainage District Decision Tree** which is shown in **Figure 2** shows how these policies interact.

Table 1
District-Level Drainage Policies

Policy	Description
Acceptance	Decision by districts to accept or deny drainage or surface water into district surface drains.
Separation	If a district accepts both tile water and tailwater, the next policy decision is whether or not to keep them separate.
Recycling	The next policy decision is whether or not a district will recycle any of water back into the supply.
Holding	Storage of drainage water could be required to meet water quality standards.
Assimilation	Blending of the drain water with better quality water to meet water quality standards.

ACCEPTANCE

The Acceptance level of the decision tree involves the decision by districts to accept or deny drainage water into district surface drains. Irrigation can result in surface runoff (tailwater), subsurface drainage collected in tile drain systems (tile water), or both. A district's drainage acceptance policy depends on:

- **Timing.** A district may have specific times of the year when it accepts either tile water or tailwater. It may always refuse to accept any drainage water.
- **Quality.** There may be some minimum (or maximum) water quality that is required before drainage water is accepted by a district.

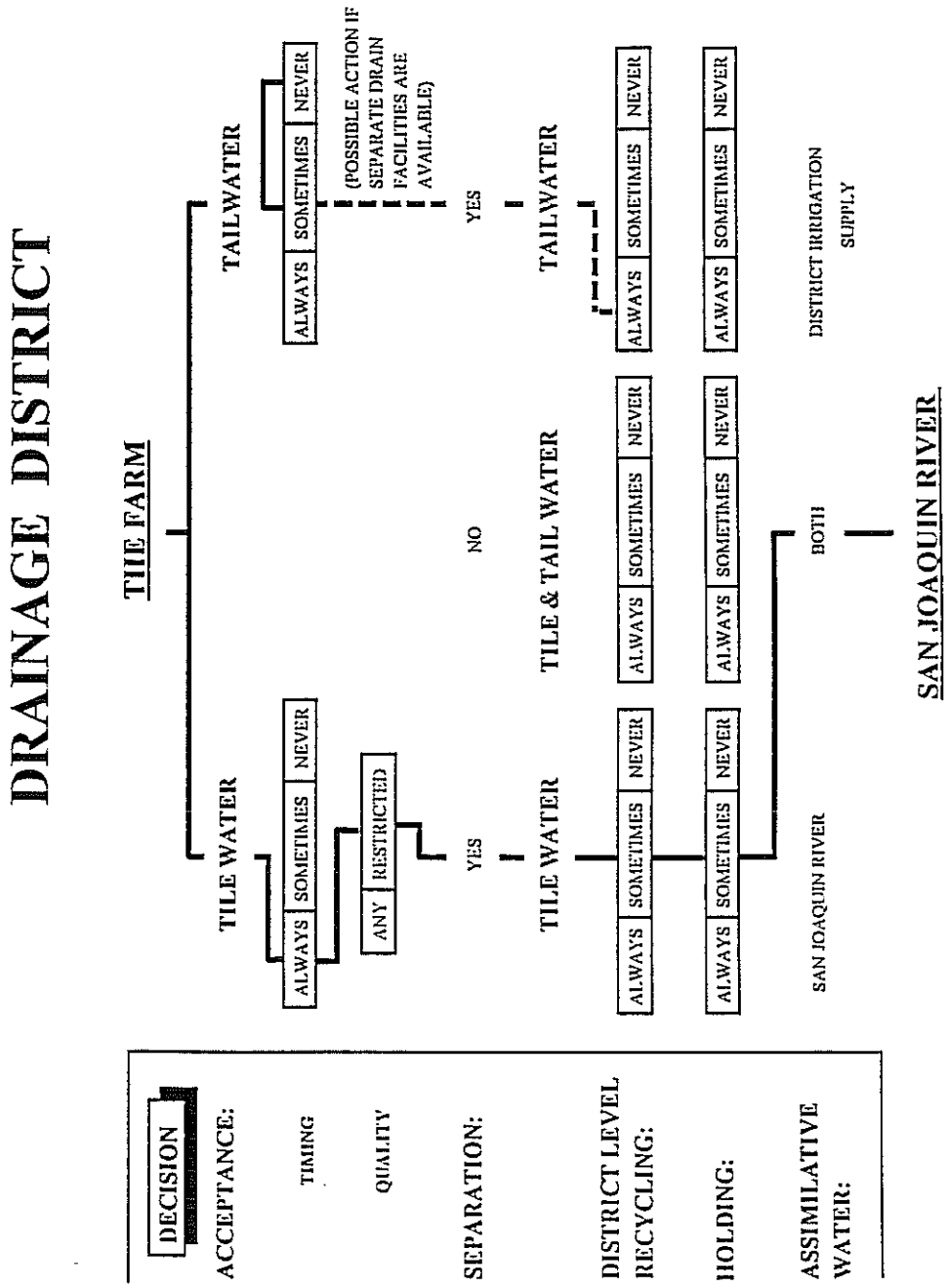

DRAINAGE DISTRICT
TILE FARM
TILE WATER
TAILWATER
ALWAYS
SOMETIMES
NEVER
ANY
RESTRICTED
YES
NO
(POSSIBLE ACTION IF SEPARATE DRAIN FACILITIES ARE AVAILABLE)
TILE & TAIL WATER
SAN JOAQUIN RIVER
BOTH
DISTRICT IRRIGATION SUPPLY
DECISION
ACCEPTANCE:
TIMING
QUALITY
SEPARATION:
DISTRICT LEVEL RECYCLING:
HOLDING:
ASSIMILATIVE WATER:

Figure 2

Tailwater salt and selenium concentrations are considerably lower than those in tile water. The acceptance of tailwater into surface drains along with tile water dilutes the tile water and results in larger water volumes than if tile water alone was accepted. Four possible reasons for denial of tailwater are:

1. It minimizes the handling costs, power for pumping, and pipeline/ditch sizes.
2. It may be the only way of separating tile water and tailwater.
3. It will minimize the required facility size if utilizing external storage.
4. Nematodes and viruses may be spread throughout the district if tailwater from an infested field is later recycled through district canals.

In the San Joaquin Valley, tailwater which is recycled on-farm is not considered to contribute significantly to the salt loading of the soil profile.

Although a district can refuse to accept tailwater, it cannot do so indefinitely with tile water. A grower cannot recirculate his own tile water indefinitely. However, it may be a district policy to set a minimum total salinity level of the tile water before acceptance. There are at least three reasons for such a policy:

1. This would again minimize handling costs to the district as it would reduce the volume of drainage water in the system.
2. It may be district policy to store salts internally (ie., in the soil or in the shallow groundwater system) when no assimilative capacity is available.
3. If externally storing salts is part of a district's strategy, this will tend to concentrate salts in solution and reduce the required size of the storage facility.

On-farm recycling of tailwater requires additional capital expenses by the individual farmer. There may be a valid argument that district level recycling is more cost effective. However, if a district institutes tiered water pricing, as many districts in the Grassland Area have done, on-farm recycling will almost always be more economical because the cost of recycling water on-farm is generally less expensive than purchasing recycled water later at a higher price. On-farm recycling also enables farmers to purchase less water from the district.

SEPARATION

If a district accepts both tile water and tailwater the next policy decision is whether or not to keep them separate. (If the Acceptance policy is not to take tailwater, the Separation policy is automatic: tile water and tailwater are separated.) Although separation of tile water and tailwater

requires dual drainage facilities, it provides better control over the movement of salts into, through, and out of the district than a mixed drainage system. Two benefits of separating tile water and tailwater are:

1. Minimization of the size of any holding facility, as storage would only be for tile water.
2. Increased control over the resulting water quality of delivered irrigation water if a district is recycling its drainage. The district may decide to recycle only the better quality tailwater.

DISTRICT LEVEL RECYCLING

The next policy decision is whether or not a district will recycle any of its drainage water back into the irrigation supply. If tile water and tailwater are kept separate, a district may opt to always recycle tailwater and never recycle tile water. It may be more realistic for the district to decide to sometimes recycle tailwater and to sometimes recycle tile water. Tailwater may not be recycled if there is no demand for irrigation water. Tile water may be recycled if the quality is at some level (and irrigation demand is at some level).

District level recycling will certainly increase the costs of some district operations. However, benefits include:

- A reduction of the required size of any external holding facility.
- An increase in the IE of the district, helping to minimize total water costs to the farmers by reducing the amount of State Water Project or Central Valley Project water used by the district.
- A reduction in the amount of water imported into a district reduces the amount of salt imported.

As with on-farm recycling of tile water, district level recycling provides a way of temporarily (less than one month) storing salts within the soils of fields when assimilative capacity is not available. Thus, the drainage system becomes a closed loop from irrigation water, to soil water, to drainage water, and back to irrigation water. Just as recycling of tile water on-farm cannot continue indefinitely without a decrease in productivity, neither can district level recycling of tile water continue indefinitely unless there is sufficient natural drainage out of the district.

HOLDING

If a district does not recycle drainage water there are only two other options:

1. The drainage water flows immediately to the San Joaquin River.
2. The drainage water is temporarily stored in some type of holding facility (reservoir).

Storage of drainage water would be required if there was no assimilative capacity available to meet water quality standards in either the San Joaquin River or in the district.

In at least two cases in the study area, drainage water flowing to the San Joaquin River is presently being picked up for irrigation by farmers outside of any water or drainage district. Unless this use can be consistently regulated it may not be justifiable as part of a district's policy decisions. The study assumed that once drainage water leaves the control of a district, it is destined for the San Joaquin River.

External holding is an expensive option. There are capital and maintenance costs for the facility, environmental concerns, and the basic problem of finding inexpensive, relatively flat land to use for the facility in the midst of a highly productive agricultural area. However, external holding does provide the quickest and simplest option for storing salts in order to meet water quality standards when the assimilative capacities constantly vary.

ASSIMILATION WATER

Agricultural drainage will almost always be of worse quality than water quality standards. This is especially true of tile water. Thus drainage will generally have to be blended with better quality water to meet water quality standards. Blending water can come from the fresh water flows of the San Joaquin River or irrigation water supplies. For assimilation purposes, tailwater can be considered part of irrigation supplies because of its relatively high water quality. Thus a policy must be formulated for choosing which assimilative capacity is used.

Note that if the district which discharges drainage is a "pure" drainage district (as opposed to a water or irrigation district) it may not have access to fresh water supplies. In these cases, some type of agreement will be needed with associated member farmers or water supply districts. A prime example of this situation is the CDD.

Increased use of a district's assimilative capacity will always require some investment. If deep wells are in place, a district may opt to increase groundwater pumping. Groundwater pumping will almost always be more expensive than surface water supplies. Groundwater quality in many areas is suspect.

If there are no deep wells in a district, surface irrigation water supplies must be used as a source of a district's assimilative capacity. This capacity may be increased in the future for two reasons:

1. On-farm IE may increase.
2. Cropped acreage may decrease.

If a district must select between these two options, improvements of on-farm IE may be preferable. Improvements in on-farm IE will usually cost money. However, in some cases there is a possibility of actually improving profitability due to a reduction in labor, energy, and fertilizer costs, as well as the possibility of increased crop quality or yield. In general, reducing cropped acreage will only reduce profits, assuming there are no other changes in management.

The question related to the assimilative capacity of the San Joaquin River is: "What portion of the total assimilative capacity of the San Joaquin River is claimed by each individual district, and by the districts as a group in relation to other drainers to the San Joaquin River?." Some possible bases for the division of the San Joaquin River's assimilative capacity are, irrigable acreage, historical drainage discharges, or historical salt loads. The extent to which each district can claim the San Joaquin River's assimilative capacity will ultimately be a political/regulatory decision.

INTERRELATIONSHIPS OF DECISIONS

A district's drainage policy decisions are interrelated at all levels. The following issues must be considered when determining a district's drainage policy:

- Tile drainage must be transported off the farm at some time unless adequate natural drainage exists. This does not necessarily mean the first time it is collected.
- External facilities are a means of storing salts when the assimilative capacity of either the San Joaquin River or the district is low. Minimizing the size, and thus costs, of the facility require concentrating the salt solution as much as possible.
- The maximum EC of drainage water occurs when the soils and shallow groundwater of the entire district are at the maximum acceptable salinity (assuming all farmers are irrigating with correct leaching fractions).
- Immediate acceptance of tile water and district level recycling will eventually balance the salt load in individual fields throughout a district, given that the blended water is equally available to all lands in the district. More salts will be imported than exported to those fields with low salinity. Less salts will be imported than exported in fields with high salinity. This assumes that farmers irrigate to ensure correct leaching fractions. Theoretically all fields in a district will eventually be at the same average root zone EC if they are irrigated with the same on-farm IE's and leaching fractions. In reality, each

field will have a somewhat different IE and leaching fraction due to different crops, soil types, management practices, time of planting, and irrigation methods.

- The restriction of tile drainage until a certain ECdw is reached will also help to balance the salt load because those fields with low salinity will be irrigated with recycled water until maximum salinity is reached.
- The ECdw may be increased by improving on-farm IE (through higher DU's and irrigation scheduling based on crop water requirements) because there will be less deep percolation.
- The costs to a district to move drainage water are minimized when the drainage flows are minimized (neglecting fixed costs). The costs to farmers may not be minimized when on-farm recycling is minimized. The equivalent cost of on-farm recycled water may be much less than a district's or deep well water.
- Control of the blending process of salts and irrigation water (or San Joaquin River assimilative capacity) is maximized when surface runoff and tile drainage are kept separate.
- Response time to available assimilative capacity is minimized with external storage of salts.
- Internal storage of salts (through recycling of tile water) raises many questions (see discussion under Internal Storage of Salts).

TEMPORARY SALT STORAGE

Driving all policy decisions is the amount of salts that a district must dispose of and the assimilative capacity available. If salts have been collected for disposal, and assimilative capacity is not available, then salts must be stored to avoid violating the San Joaquin River water quality standards. Whether a district decides to use internal or external storage will affect many of the previously discussed policy decisions.

External Storage of Salts

Storing salts externally requires a storage facility, called a holding pond. Salts are stored externally in solution. The less concentrated the solution, the larger the holding pond must be. Thus, it is desirable to concentrate salts as much as possible for external storage.

The ability to separate tailwater and tile water becomes extremely important if a district is planning to utilize external storage. It is important for a district to have the ability to measure water quality in individual sumps and at various locations within the district drainage system. If the water in

certain parts of the drainage system is of high enough quality, it may be recycled into the irrigation supply to reduce the stored volume of drainage water.

The disadvantages of external storage are the initial capital outlays, maintenance, possible negative environmental impacts, and regulatory requirements (possibly including an EIR or a WDR). The advantages of the external storage of salts are a relatively quick response time when taking advantage of the San Joaquin River's assimilative capacity, absolute knowledge of the minimum amount of district assimilative capacity that may be required, and continual maintenance of both a good district salt balance and a healthy soil root zone.

Internal Storage of Salts

Internal storage means that salts are stored in the soil, thus raising the salinity of the district. This can be accomplished by:

- A district sometimes not accepting tile water, forcing farmers to recycle tile water on-farm or reduce leaching fractions so tile water volume is minimized.
- A district recycling some or all tile water.

Internal storage does not require an external facility, thus no land needs be taken out of production. Additionally, there are no environmental impacts to deal with. There is a limit to the amount of internal storage available. Excessive internal storage is a temporary measure at best since excess salts must eventually be leached out.

There are significant problems regarding the effectiveness of internal storage:

- Salts cannot be removed from the soil quickly when assimilative capacity is available. Soil leaching takes weeks or months, not days or hours.
- Stored salts may start to impact agricultural productivity when no assimilative capacity is available.
- In many cases tile systems are impacted by upslope lateral flows and cannot be shut off without reducing the root zone depth.

- If tile water is being recycled, water of poor quality may have significant negative impacts on crop production if it is applied during critical growth stages such as germination.

- The assimilative capacity of the San Joaquin River may become available, but there may not be enough district irrigation water available to leach salts from the soil. Or, there may not be enough water to go both into a reclamation mode and regular irrigation mode at the same time.

- Commodity prices may rise at the same time the San Joaquin River's assimilative capacity becomes available. In that situation, irrigation water required to leach salts could temporarily become very valuable for crop production, but instead may be needed for leaching.

- There are many times of the year in which farmers cannot leach salts, due to agronomic, soil, or equipment constraints.

CURRENT POLICIES

Each of the districts that are responsible for drainage disposal will now be discussed. The methods by which irrigation water moves into the district and drainage water moves out of the district to the San Joaquin River will be identified. Finally, district policy will be discussed in the framework of the five policy levels, Acceptance, Separation, District Level Recycling, Holding, and Assimilation Water.

BROADVIEW WATER DISTRICT

IRRIGATION WATER DELIVERY

The irrigation water supply for Broadview Water District comes from four sources:

1. A contract with the USBR,
2. One private well (in 1977 and 1991),
3. Subsurface drainage water from twenty-five tile systems within the district, and
4. Unregulated surface drainage from those lands of the Firebaugh Drainage Association lying inside and outside of the district's boundaries.

Referring to **Figure 3**, USBR water is pumped from Station 1, Broadview, on the DMC into BWD's Main Canal. The first lift of the Main Canal is actually a 60 inch reinforced concrete pipeline which discharges into the open channel of the main canal just south of Nees Reservoir. The water flows south in the Main Canal through as many as five more lift stations; Station 2, Station 3, Station 4, Station 5, and Station 6. Pond 5 of the Main Canal begins with a short section of 36 inch and 30 inch diameter pipelines which discharge into the open channel. The last 1/2 mile of the Main Canal after Station 6 in Reach 8 is a 26 inch diameter pipeline.

The farmer owned deep well is located in the southwest corner of Section 14, T13S, R13E. The amount of water pumped from this well is measured but not regulated. Well water is not pumped into the district's laterals.

Water may be turned east out of the Main Canal into one of nine district laterals named 33-1 (turnout), 33-3, Chuck (lateral), 4-1, 4-3, 9-1, 9-3, 16-1, and 16-3 (laterals). Also, water may be delivered west of the Main Canal into the Section 8 lateral. The laterals distribute water by gravity flow to the individual fields except for six turnouts which require pumps. Turnouts are provided at the southwest corners of most quarter-sections within the district.

DRAINAGE DISPOSAL

The FDA includes BWD plus approximately 2230 acres (as of 1991) that are in WWD south and east of BWD. BWD has an agreement with the FDA whereby BWD will allow only surface drainage from the 2230 acres to flow into BWD drains depending on operation to the San Joaquin River. The district either picks up the drainage water at the Nees Pump Station or discharges it to the San Joaquin River in order to meet operational requirements. BWD has informed those farmers in WWD which drain into the FDA that drainage service will be terminated when BWD requires its farmers to recycle.

Currently, the drainage water flowing from the 2230 acres of FDA consists only of tailwater. No tile water is allowed into BWD.

BWD has a system of open drains which convey mixed tailwater and tile water. Many of BWD's fields have farmer owned tile drain systems. The majority of tile drain installation occurred between 1965 and 1980. Tile water is collected at various sumps and pumped into the open drains. The sumps and pumps are also owned and maintained by BWD farmers. BWD supplies and reads the water meters on the pumps. BWD has no means of separating tailwater and tile water.

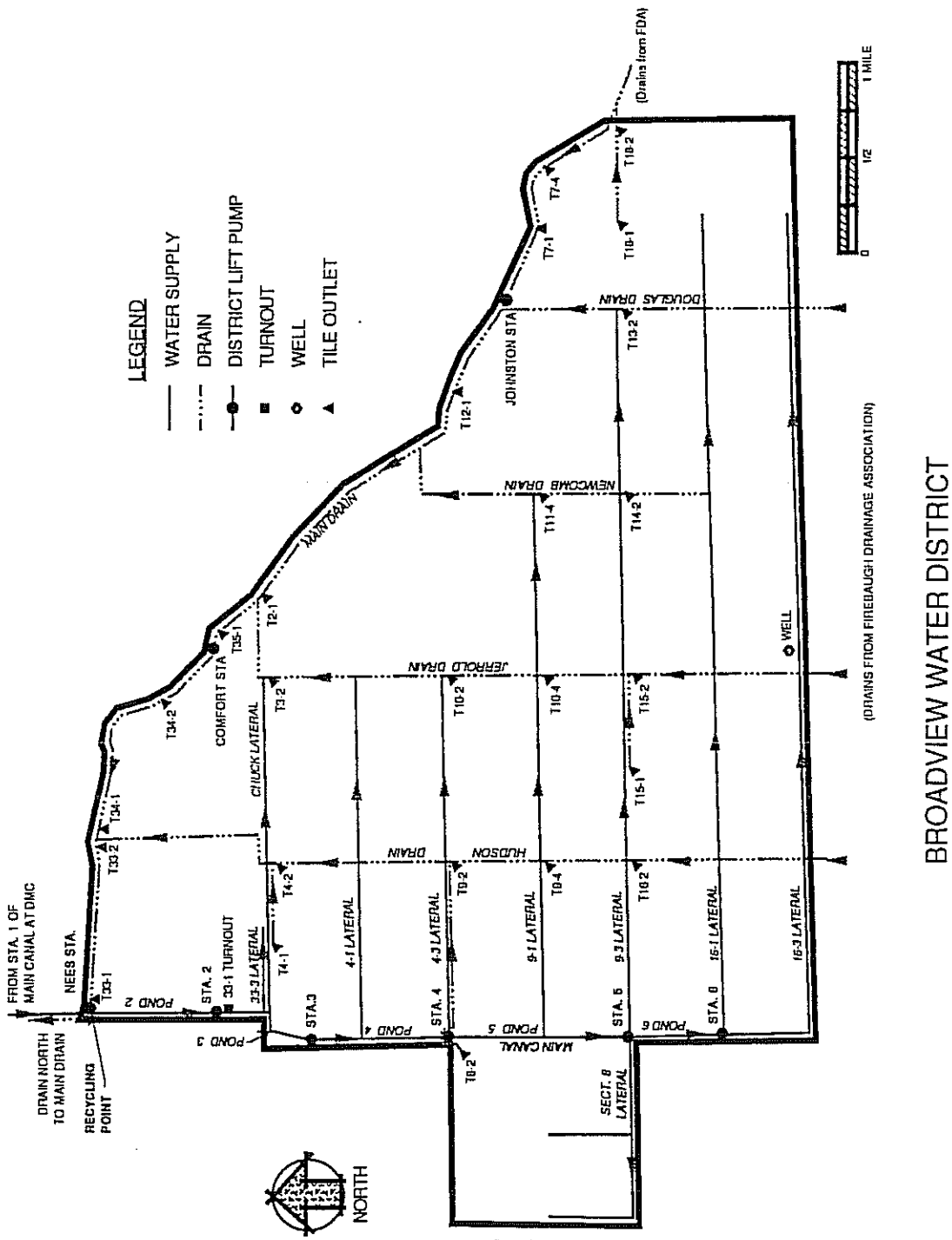

LEGEND
WATER SUPPLY
DRAIN
DISTRICT LIFT PUMP
TURNOUT
WELL
TILE OUTLET
0
1/2
1 MILE
(Drains from FDA)
T18-2
T7-4
T7-1
T18-1
DOUGLAS DRAIN
T13-2
JOHNSTON STA
T12-1
NEWCOMB DRAIN
T11-4
T14-2
MAIN DRAIN
T2-1
T35-1
COMFORT STA
JERROLD DRAIN
T3-2
T10-2
T10-4
T15-2
T15-1
WELL
(DRAINS FROM FIREBAUGH DRAINAGE ASSOCIATION)
T34-2
T34-1
CHUCK LATERAL
HUDSON DRAIN
T33-2
T4-2
T9-2
T9-4
T16-2
T4-1
4-1 LATERAL
4-3 LATERAL
9-1 LATERAL
9-3 LATERAL
16-1 LATERAL
16-3 LATERAL
FROM STA. 1 OF MAIN CANAL AT DMC
NEES STA.
T33-1
POND 2
STA. 2
33-1 TURNOUT
33-3 LATERAL
STA. 3
STA. 4
STA. 5
STA. 6
POND 3
POND 4
POND 5
POND 6
MAIN CANAL
T8-2
SECT. 8 LATERAL
DRAIN NORTH TO MAIN DRAIN
RECYCLING POINT
NORTH
BROADVIEW WATER DISTRICT

Figure 3

The drainage water flows, by gravity, in a northerly direction toward the drain that runs the length of BWD's northern boundary. The drain (labeled FDA Drain) flows northwesterly until it terminates at the Main Canal at the Nees Pump Station. At this point, drainage water is either recycled through the Nees Pump Station into the Main Canal or discharged through the Drain Outlet pipeline to the San Joaquin River. There are two pump stations in the perimeter drain; Comfort and the Johnston.

The BWD Drain Outlet north of the Nees Pump Station is a pipeline which terminates into a drain owned by FCWD about 3/8 mile north of the DMC. The pipeline size restricts the flowrate from BWD to a maximum of 25 cfs, but at the DMC the size of the outlet pipe increases to a 35 cfs capacity so the district can add up to 10 cfs of water for dilution.

Referring to **Figure 3**, it is seen that the Broadview Drain goes through the measuring point BV-3, over the DMC, discharges into a FCWD drain and unites with FCWD spill water. The drain then flows west and connects with the Crooked Drain (which also carries drainage from FCWD), flows northwest to a siphon under CCID's Outside Canal and intersects with the Main Drain which parallels CCID's Main Canal.

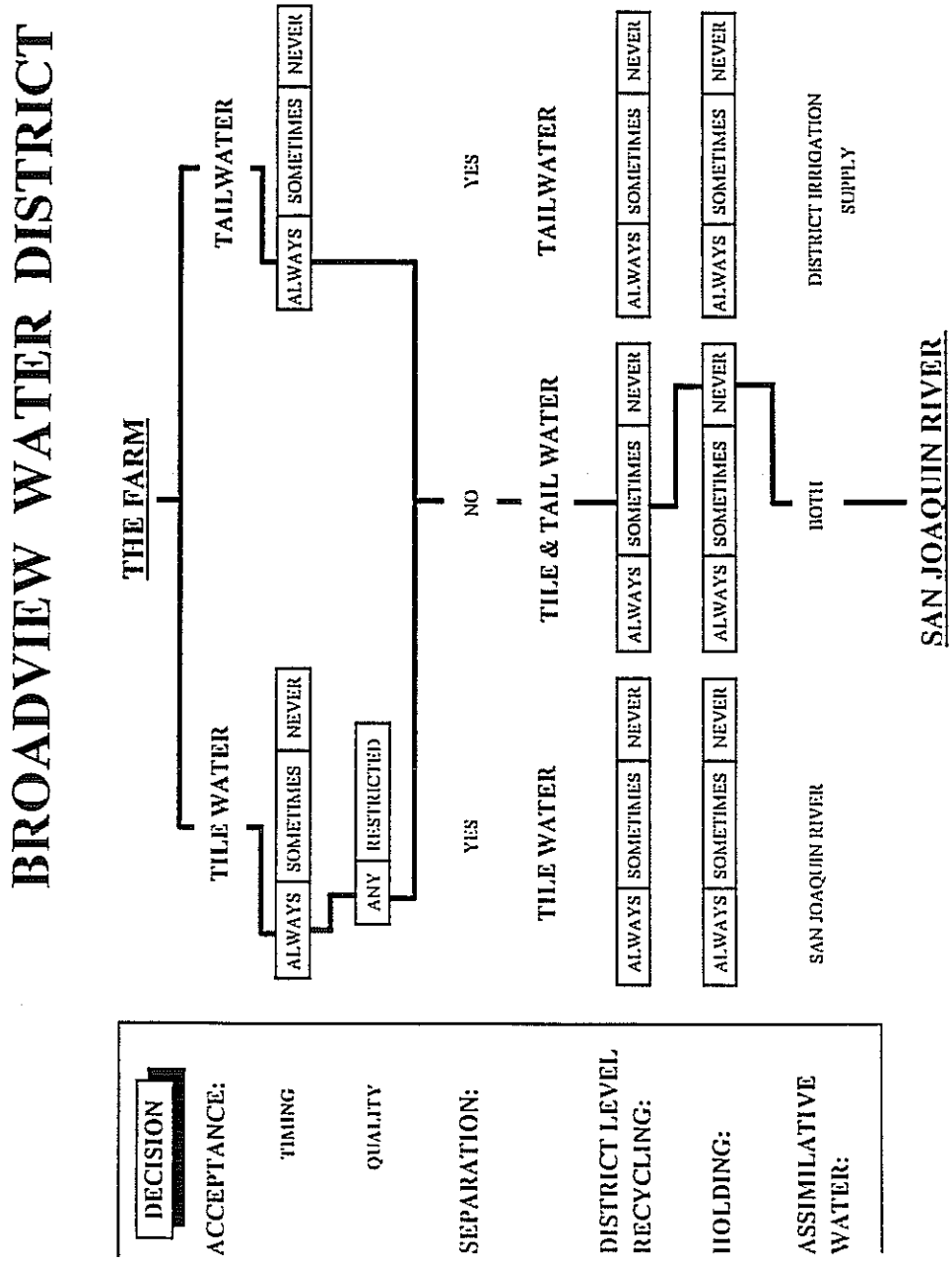
The drainage water in the Main Drain may flow through the southern portion of GWD in the Agatha or Camp 13 Canals, depending on GWD operations. (Refer to the section "Grassland Water District Drainage Operations" for a description of how agricultural drainage is conveyed through GWD). BWD drainage water eventually enters the San Joaquin River through either Salt Slough or Mud Slough (North).

DISTRICT DRAINAGE POLICY

SUMMARY

BWD's drainage policy (**Figure 4**) can be summarized according to the five policy levels as follows:

- **Acceptance-** BWD will accept either tile water or tailwater from within BWD.
- **Separation-** BWD does not separate the tailwater and tile water.
- **District Level Recycling-** BWD will recycle drainage at a district level to meet peak irrigation water demands and discharge limitations (quality, quantity, etc.)


BROADVIEW WATER DISTRICT
THE FARM
TILE WATER
TAILWATER
ALWAYS
SOMETIMES
NEVER
ANY
RESTRICTED
YES
NO
YES
TILE WATER
TILE & TAIL WATER
TAILWATER
ALWAYS
SOMETIMES
NEVER
ALWAYS
SOMETIMES
NEVER
ALWAYS
SOMETIMES
NEVER
ALWAYS
SOMETIMES
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ALWAYS
SOMETIMES
NEVER
ALWAYS
SOMETIMES
NEVER
SAN JOAQUIN RIVER
BOTH
DISTRICT IRRIGATION SUPPLY
SAN JOAQUIN RIVER
DECISION
ACCEPTANCE:
TIMING
QUALITY
SEPARATION:
DISTRICT LEVEL RECYCLING:
HOLDING:
ASSIMILATIVE WATER:

Figure 4

- **Holding-** BWD does not have an external storage facility except the drainage system itself.

- **Assimilation Water-** BWD has no formal policy regarding the use of the assimilative capacity of the San Joaquin River or the district. BWD has the ability to dilute the drainage discharges with DMC water. This has been done in the past to help BWD meet water quality requirements when GWD used rain water for irrigation. In 1991, some water was used for dilution from another source.

ACCEPTANCE

BWD will accept both tile water of any quality and tailwater from land within BWD. BWD does not accept tile water from the 2230 acres of the FDA outside of BWD. There are approximately 1280 acres (of the district's approx. 9,000 irrigable acres) in the southeastern portion of the district that are serviced by farmer owned tailwater return systems. At present, on-farm tailwater reuse is encouraged. BWD management feel that if all farmers recycled their tailwater on-farm there would be little, if any, need for recycling of drainage water to supplement the current pumping capacity on the DMC. Because BWD is concerned about its drainage problem, the use of any on-farm recycled drainage water or on-farm well water for irrigation is metered. The well water and recycled water are not charged for by the district, but the volumes are included in the calculation of the total volume of irrigation water applied to a field, and thus affect the tiered price of delivered water.

BWD has plans to install a 160 cfs outlet on the San Luis Canal that would supply water to the district via gravity flow. If this outlet becomes operational, BWD policy will be to require all farmers to recycle all tailwater on-farm. This project is currently on hold due to the threat of legal action by the NRDC if the USBR renews the BWD water service contract without a full EIS.

SEPARATION

BWD does not separate tile water and tailwater. However, when (and if) the new outlet on the San Luis Canal is operational it will be BWD policy to accept only tile water, thus in effect separating tile water and tailwater.

DISTRICT LEVEL RECYCLING

Most recycling of drainage water is done at a district level rather than on-farm. As previously noted, tailwater and tile water eventually flow into the Main Drain. This drain terminates at the

Main Canal at the Nees Pump Station. At this point, drain water can be pumped into the Main Canal for recycling on BWD land or discharged in the Broadview Drain Outlet Pipe.

There are three sets of criteria that govern the amount of recycling in BWD:

1. BWD's contract with GWD allows BWD drainage water to flow through GWD conveyance channels. BWD began draining through GWD channels in January 1983. Under the agreement between BWD and GWD, BWD can discharge up to 35 cfs through GWD. The water must be less than 2,500 ppm TDS and contain less than 6 ppm of Boron.

   BWD's drainage pipeline (the Drain Outlet pipeline north of Nees Pump Station) restricts drain flows from BWD to a maximum of 25 cfs. BWD can add up to 10 cfs from its DMC supply if needed to meet the contract water quality requirements.

   The original intent of the BWD/GWD agreement was to provide BWD with an outlet for its drainage, and thus the ability to maintain a salt balance, and also to provide an additional water supply to GWD, which was and is chronically short of water.

   GWD (which consists primarily of waterfowl habitat) has not used BWD drain water since 1985, although they continue to convey drainage water, on its way to the San Joaquin River, in their supply channels . Thus, the water quality standards in the BWD/GWD contract currently do not have an effect on the amount of recycling by BWD since GWD does not use BWD drainage water. BWD has shut off drainage through GWD during fall flood periods so as to not impact GWD water quality.

2. Agronomic considerations for BWD crops in terms of both water supply and water quality govern recycling. BWD has a water supply contract with the USBR for 27,000 acre-feet/year delivered from the DMC. However, pumping capacity at their main outlet on the DMC of 125 cfs is sometimes less than total grower demand in the district. In these situations BWD uses some of its drainage water to augment the DMC water.

   Peak irrigation water requirements occur during two periods of the year; the pre-plant irrigation season which occurs from December through January, and the hottest parts of summer through July and August. However, many of BWD's farmers are switching to sprinkler systems for pre-plant irrigation, which may alleviate some of the capacity problems during that time. It is expected that in the future, recycling to handle peak delivery requirements will only occur in summer months.

In the 1991 crop year, BWD opened its drainage outlet a total of 208 days. Thirty of the days on which the outlet was closed took place between November 15, 1990 and February 16, 1991; the pre-plant irrigation season. The drain was closed for another 84 days from June 5, 1991 through August 27, 1991; the peak summer water use period.

The average TDS of BWD irrigation water before and after drainage recycling is shown in **Table 2**. Due to the experience of having no drainage outlet before 1983, BWD growers are acutely aware of the effects of salinity. For the long term, BWD seeks to remain a net salt exporter, which was the case until 1991.

When recycling, short term considerations include potential germination problems and the desire to grow salt sensitive crops, such as processing tomatoes and melons. **Table 2** shows the average salinity in BWD irrigation water has remained below about 800 ppm TDS since the drainage outlet became available in 1983. BWD seeks to keep short term peaks in salinity below 1000 ppm TDS for 1991 and 1992, and preferably below 800 ppm TDS.

3. Water quality standards are set by the CVRWQCB for the San Joaquin River. It is not clear how BWD will coordinate its drainage operations with other drainers to meet these water quality standards.

Table 2
Salinity of Delivered Water
Broadview Water District

Year	Average Salinity of Delivered Water ECw, dS/m
1981	3.21
1982	2.89
1983	0.89
1984	0.74
1985	0.65
1986	0.67
1987	0.56
1988	0.87
1989	0.75
1990	1.06
1991	1.25
1992	1.00

Note: Previous to 1983, BWD did not have an outlet and was recycling all tile and tail water.

HOLDING

BWD does not have an external holding facility. If drainage is not recycled it flows directly to the San Joaquin River.

ASSIMILATION WATER

BWD does not have a formal policy for the use of the assimilative capacity of the San Joaquin River or the district. Recent DOP's submitted by BWD to the CVRWQCB have not indicated what their final policy will be. The drainage and irrigation water supplies of the BWD are shown in **Table 3**.

Table 3
Drainage and Irrigation Water Supply
Broadview Water District

Year	Delivered Water (AF)	Irrigated Acreage (Ac)	Tile Drainage Total (AF)	Drainage Out of District (AF)
1981	28,932	9,025		
1982	25,211	8,828		
1983	15,690	5,510		
1984	31,911	8,960		
1985	28,240	8,665		
1986	24,628	8,169	4,626	
1987	23,308	7,870	3,704	
1988	25,891	8,736	3,628	
1989	25,200	8,686	3,735	
1990	20,582	8,160	3,464	
1991	12,902	5,539	1,808	
1992	9,086	4,483	853	

Note: Drainage data is combined with CCID and FCWD. See section under FCWD.

CENTRAL CALIFORNIA IRRIGATION DISTRICT

CAMP 13 STUDY AREA

IRRIGATION WATER DELIVERY

The Central California Irrigation District (CCID) is party to an agreement between the USBR and several holders of pre-1914 riparian water rights on the San Joaquin River. The agreement, negotiated in the late 1930s, is referred to as the Exchange Contract. The water districts that are party to the agreement are referred to as the Exchange Contractors.

In summary, the Exchange Contract provided the USBR with the water rights necessary to build the Friant Dam, the Friant-Kern Canal, and the Madera Canal. The USBR was then able to deliver San Joaquin River water to lands along the western slope of the Sierra Nevada mountain range. In return for the water rights, the USBR agreed to deliver water from the Sacramento River, stored at Shasta Dam, to the Exchange Contractors through the DMC.

The DMC begins at the Tracy Pumping Plant on the southern edge of the Sacramento/San Joaquin Delta and flows southerly to the Mendota Pool near the town of Mendota. CCID's two main canals, the Main and the Outside, begin at the Mendota Pool and flow northwesterly towards the town of Los Banos where the canals turn north. Both CCID canals end north of the town of Gustine. Although there are some turnouts delivering water directly from the DMC to fields in CCID, the majority of CCID's DMC water is delivered through the Mendota Pool into the two main CCID canals.

The Exchange Contract includes restrictions on maximum monthly flowrate and volume. CCID also has over 40 district owned wells to supplement their DMC water during peak water use months. There is also an undetermined number of privately owned wells in the district.

DRAINAGE DISPOSAL

There are several drainage districts within CCID boundaries disposing of both tile water and tailwater. One area within CCID, which is not in a separate drainage district, discharges significant quantities of selenium with its tile water. This area is referred to as the Camp 13 and is the focus of this discussion.

The approximately 6,000 acres of the Camp 13 lie between the Main and Outside Canals and extends from the City of Firebaugh to about one mile east of Brannon Avenue as shown in **Figure 5**. The fields within Camp 13 are supplied water by gravity flow from turnouts on the Outside Canal. There are no active private or district owned wells within Camp 13.

Tile water is collected in eleven sumps throughout Camp 13. Nine of these sumps pump into the Main Drain which parallels the Main Canal. The Main Drain also carries tailwater from farms in Camp 13 and drainage water from PWD, FCWD, and BWD/FDA. The drainage water eventually flows into the GWD through either the Agatha or Camp 13 Canals. (Refer to the section "Grassland Water District Drainage Operations" for a discussion of how agricultural drainage is moved through GWD). Drainage water from Camp 13 eventually enters the San Joaquin River through either Salt Slough or Mud Slough (North).

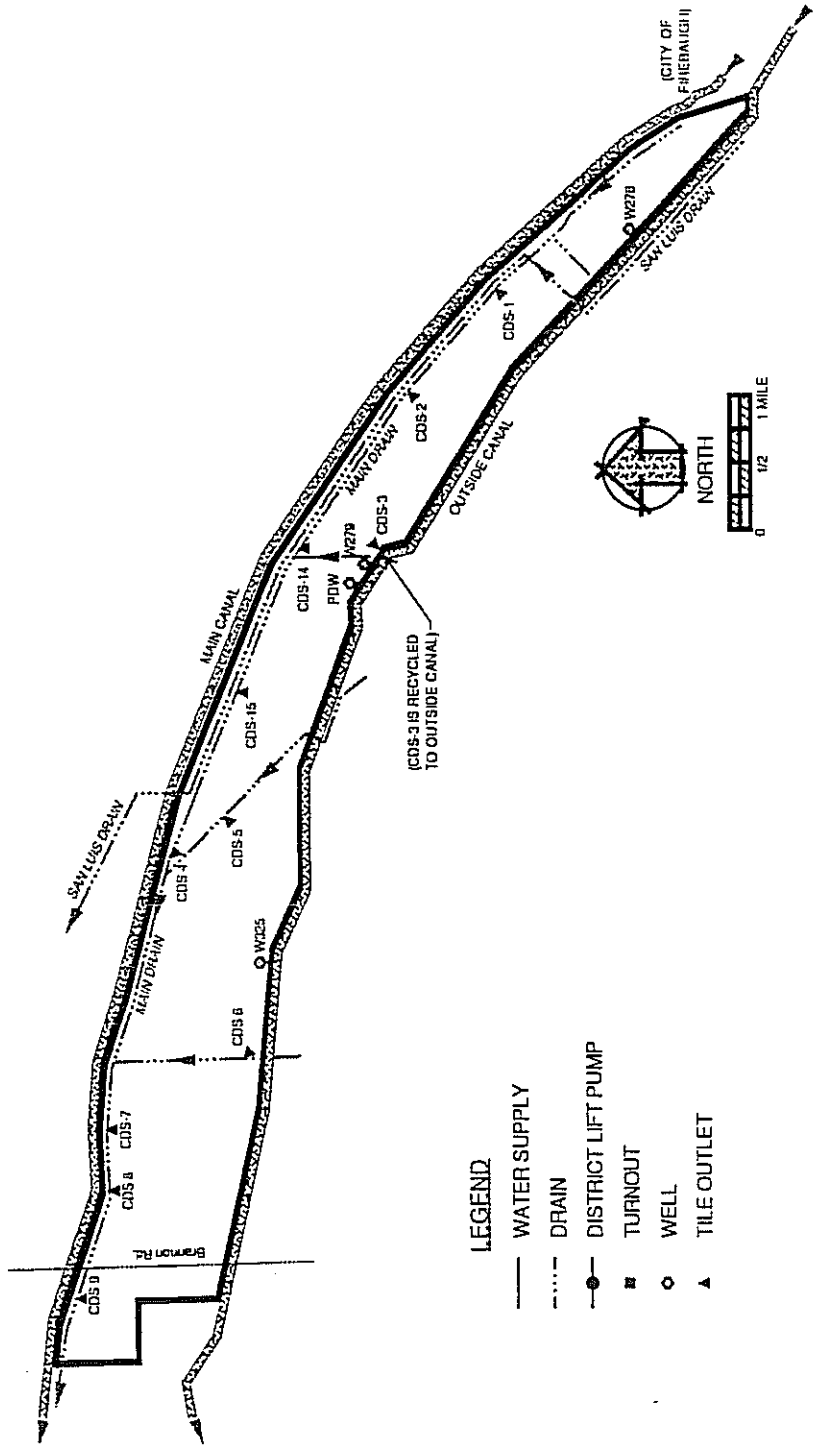
The tile systems, sumps, and pumps within Camp 13 are owned and maintained by farmers. CCID installed hour meters on the sump pumps. The hours of operation, along with PG&E records, and estimates of pump lift and efficiency, are the bases for estimates of CCID tile water from Camp 13.

DISTRICT DRAINAGE POLICY

SUMMARY

CCID's drainage policy (**Figure 6**) can be summarized according to the five policy levels as follows:

- **Acceptance-** CCID will accept either tile water or tailwater.
- **Separation-** CCID does not separate the tailwater and tile water.
- **District Level Recycling-** One sump in Camp 13 is recycling tile water back into the Outside Canal. All others are not recycled. (This is true for other parts of CCID also.)
- **Holding-** CCID does not have an external holding facility except the drainage system itself.
- **Assimilation Water-** CCID has no formal policy regarding the use of the assimilative capacity of the San Joaquin River or the district. An appendix to CCID's 1992 DOP indicated that using district assimilative capacity would be no problem.



CCID (CAMP 13) STUDY AREA

Figure 5

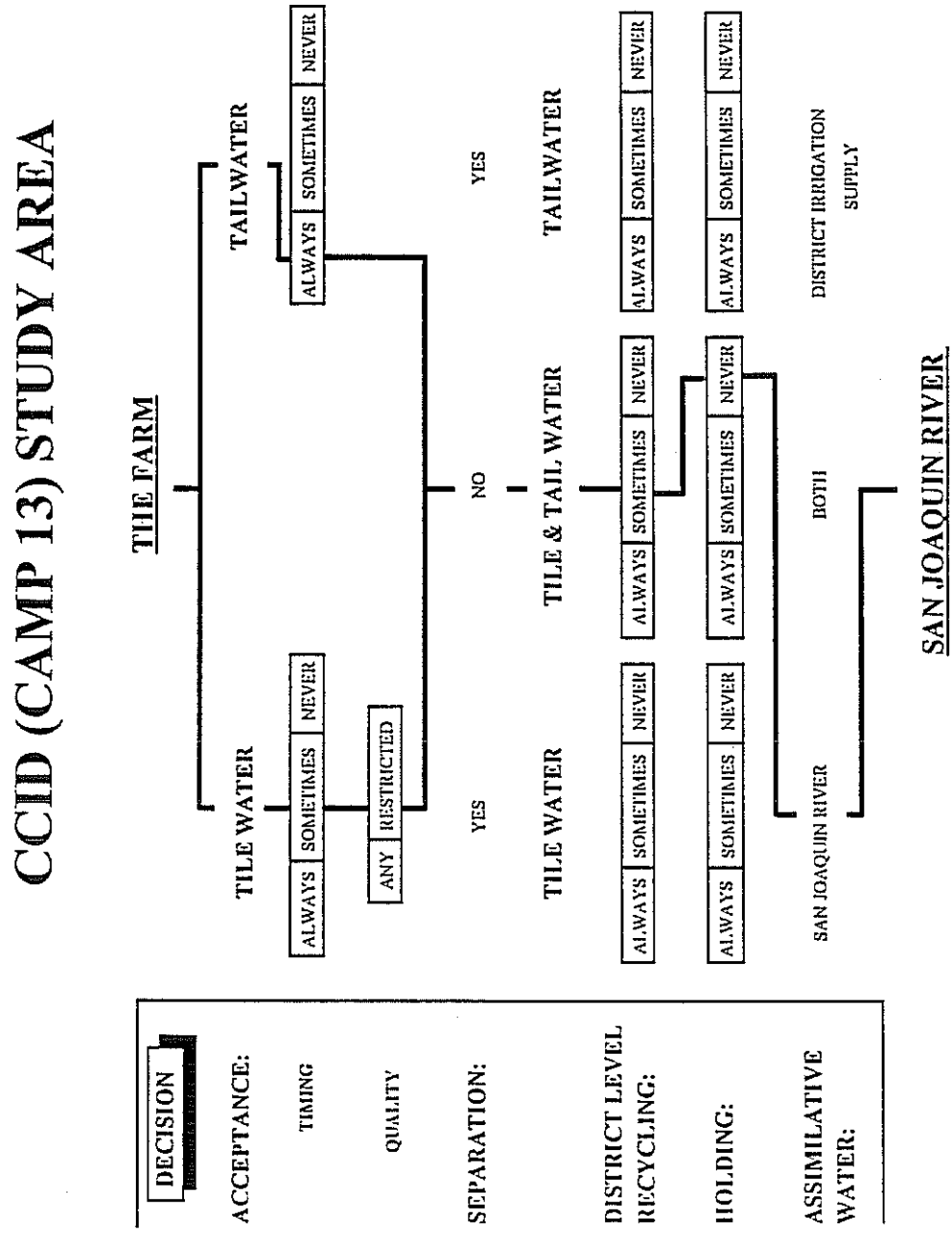

CCID (CAMP 13) STUDY AREA
THE FARM
TILE WATER
ALWAYS
SOMETIMES
NEVER
ANY
RESTRICTED
YES
NO
TAILWATER
ALWAYS
SOMETIMES
NEVER
YES
TILE WATER
ALWAYS
SOMETIMES
NEVER
TILE & TAIL WATER
ALWAYS
SOMETIMES
NEVER
TAILWATER
ALWAYS
SOMETIMES
NEVER
SAN JOAQUIN RIVER
BOTH
DISTRICT IRRIGATION SUPPLY
SAN JOAQUIN RIVER
DECISION
ACCEPTANCE:
TIMING
QUALITY
SEPARATION:
DISTRICT LEVEL RECYCLING:
HOLDING:
ASSIMILATIVE WATER:

Figure 6

ACCEPTANCE

CCID will accept tile water or tailwater into its drainage system.

SEPARATION

CCID does not separate tile water and tailwater.

DISTRICT LEVEL RECYCLING

Certain sumps and drains within CCID pump back into the delivery system at various points within the entire service area of CCID. There is no formal policy regarding this recycling.

Currently there is one sump in Camp 13 which recycles tile water by pumping drainage water directly back into the Outside Canal. There are no records for how much drainage water is recycled in this manner. CCID currently does not recycle any tailwater or tile water collected by the other nine active sumps in Camp 13.

In its 1991 DOP, CCID stated that it was attempting to work with farmers in the district to construct facilities to take all drainage from Camp 13 back into CCID supply canals.

HOLDING

CCID does not have an external holding facility.

ASSIMILATION WATER

CCID does not have a formal policy regarding the assimilative capacity required to blend drainage water in Camp 13. In its 1992 DOP, CCID indicated that taking the drainage water back into the Main Canal would cause no significant degradation to the irrigation supply water quality. The DOP indicated a maximum expected tile water flow of 2 cfs. Using average water qualities, CCID estimated that blending 2 cfs of tile water with 16 cfs of irrigation supply water would dilute the drainage water sufficiently to meet the water quality standards of the San Joaquin River. CCID's Main Canal handles at least 1200 cfs during most of the irrigation season in the reach next to Camp 13. It could be expected that farmers immediately downstream from any planned discharge of drainage water into the Main Canal would receive irrigation water degraded to some degree, depending on the speed and effectiveness of blending. The drainage and irrigation water supplies of the CCID are shown in **Table 4**.

Table 4
Drainage and Irrigation Water
CCID Camp 13 Study Area

Year	Delivered Water (AF)	Irrigated Acreage (Ac)	Tile Drainage Total (AF)	Drainage Out of District (AF)
1981	15,251	3,183		
1982	15,251	3,183		
1983	15,251	3,183		
1984	15,251	3,183		
1985	18,914	5,411		
1986	15,072	4,540		
1987	16,255	5,072		
1988	16,738	5,219		
1989	11,049	4,066		
1990	13,081	4,436		
1991	16,351	4,555		
1992	14,546	4,900		

Note: Drainage Out of District data is combined with BWD and FCWD. See section under FCWD. There is no data available for the tile drainage data in CCID Camp 13 area.

CHARLESTON DRAINAGE DISTRICT

IRRIGATION WATER DELIVERY

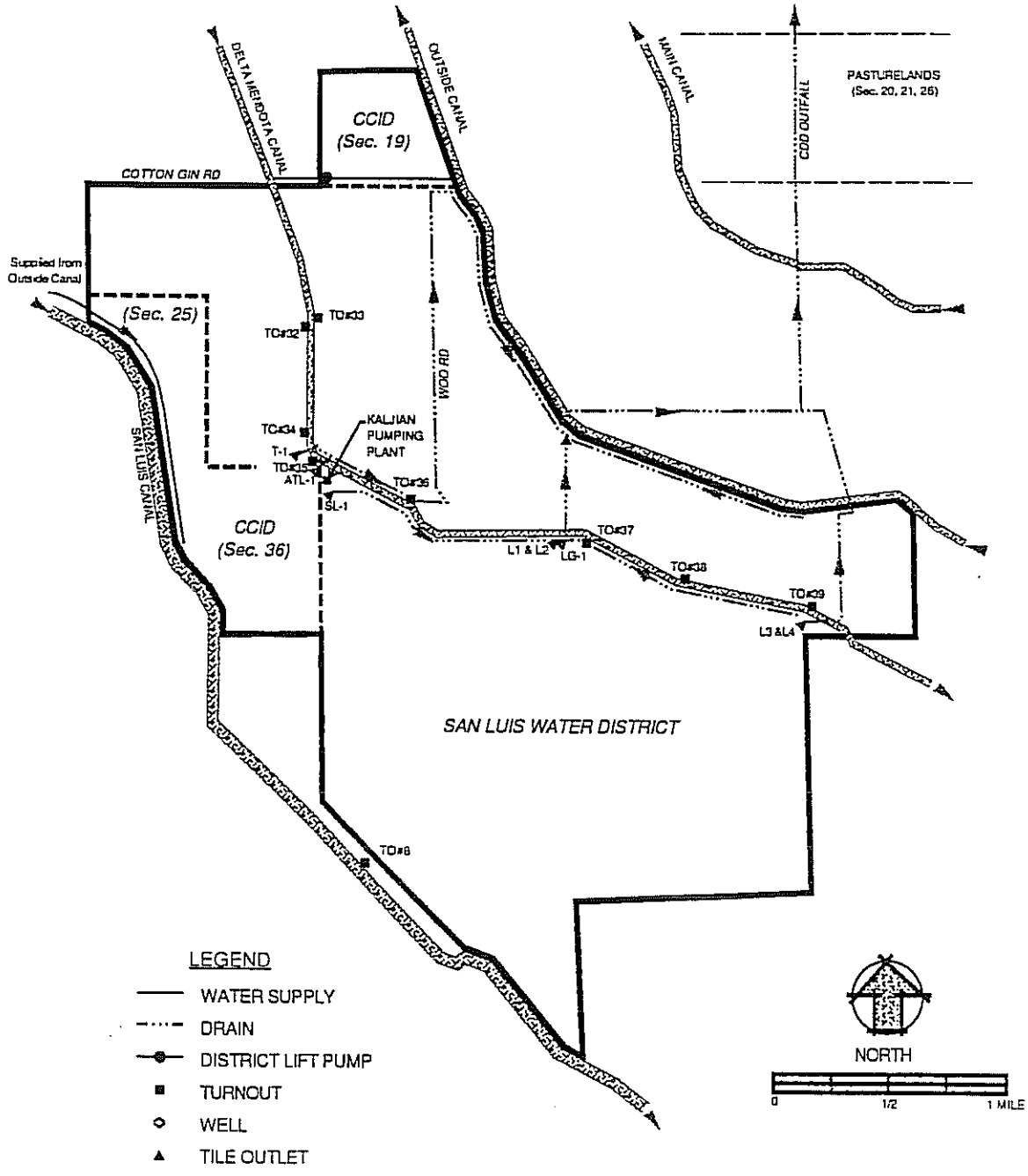
Fields within Charleston Drainage District are supplied with water from both the SLWD and CCID. Referring to **Figure 7**, CCID water is delivered from a turnout on the DMC to 160 acres in the southwest quarter of Section 19, T11S, R11E. CCID water, originally delivered from the Outside Canal to a large farm in CCID, but outside of CDD, flows into CDD through a farmer owned system to fields in Sections 25 and 36 of T11S, R10E. All other irrigation water is SLWD water delivered from four turnouts on the upslope side (westerly) and four turnouts on the downslope side (easterly) of the DMC. There are no deep wells in CDD.

DRAINAGE DISPOSAL

Approximately 3,600 acres of CDD's 4,275 acres have subsurface tile drain systems installed, all of which are farmer owned and maintained. The tile water from drain systems on the upslope side of the DMC is collected at sumps and pumped across the DMC. Tile water from drain systems on the downslope side of the DMC flows by gravity to the perimeter drain where it mixes with tailwater and the drainage water from the upslope side.

Tile water may be kept separate from tailwater on the upslope side of the DMC. Tailwater is recirculated through farmer owned systems on both sides of the DMC. Connections are in place to allow the recirculation of tile water from fields on both sides of the DMC. It is unknown how much tile water or tailwater is currently recycled.

Tile water is collected in six sumps on the upslope side of the DMC designated as T-1, ALT-1, SL-1, L-1/L-2, LG-1, and L-3/L-4. It can be kept separate from tailwater until pumped across the DMC.



CHARLESTON DRAINAGE DISTRICT

Figure 7

Drainage water from T-1 and ALT-1 is pumped across the DMC near the Kaljian Pumping Plant to an open drain on the downslope side of the DMC. The drainage water flows southerly to Woo Road, turns north, intercepts Cotton Gin Road, where it then turns southeasterly along CCID's Outside Canal. It flows by gravity across the Outside Canal near the intersection of Sections 29, 30, 31, and 32 of T11S, R11E, then north to the main CDD outfall drain. The outfall drain flows north again, through measuring point CH-1 into GWD's Gadwall Canal. (Refer to the section "Grassland Water District Drainage Operations" for a description of how agricultural drainage is conveyed through GWD). CDD drainage water eventually enters the San Joaquin River through either Salt Slough or Mud Slough (North).

Drainage water from SL-1, L-1/L-2, and LG-1 is pumped north across the DMC at LG-1 to an open drain that intercepts the previously mentioned drain that runs along CCID's Outside Canal.

Drainage from L-3/L-4 is pumped across the DMC northward to a gravity siphon that crosses the Outside Canal and then meets the main CDD outfall.

Tile water from CDD lands, on the downslope side of the DMC, is collected and flows by gravity to the drain paralleling CCID's Outside Canal and then through the CDD outfall.

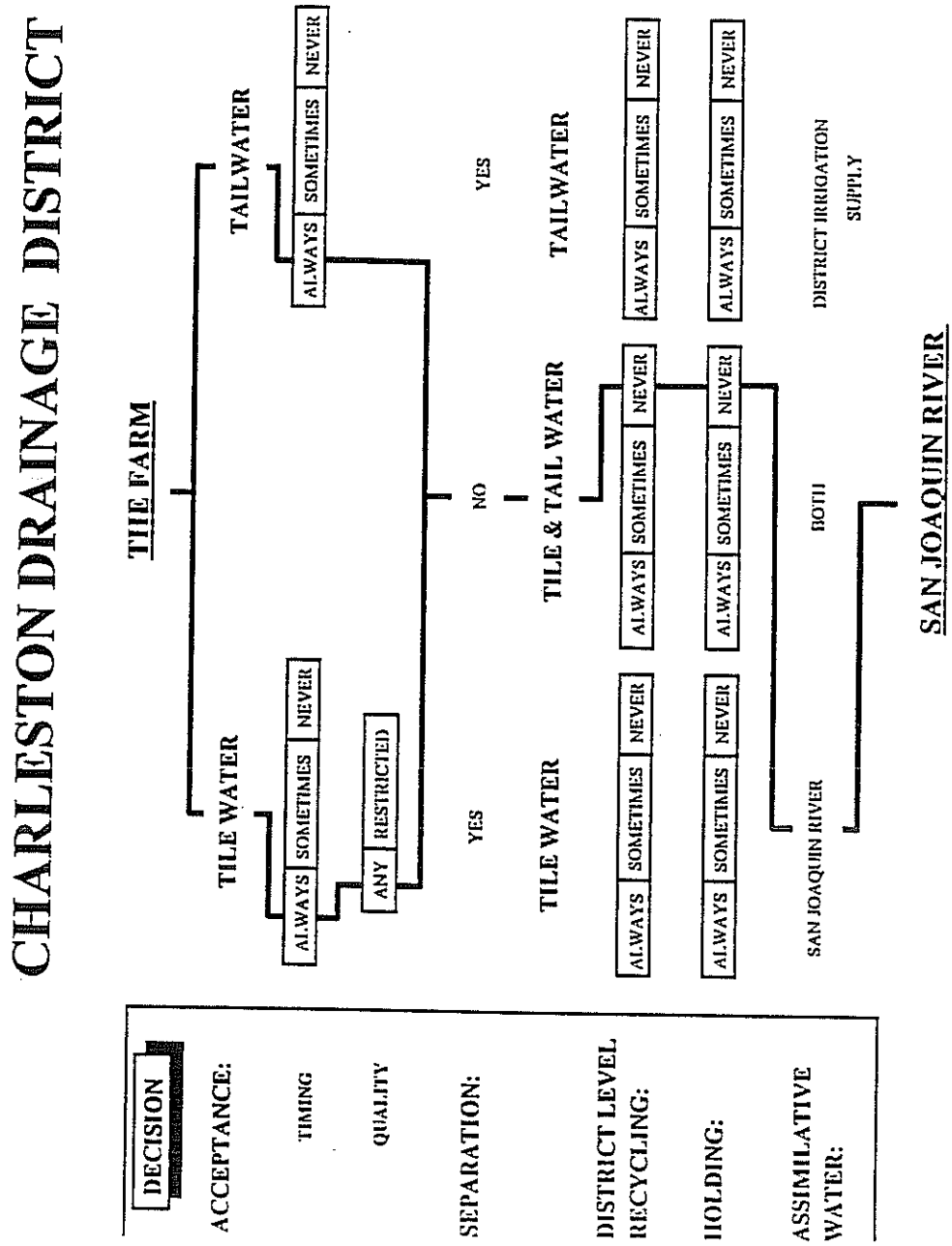
The CDD outfall is continually open. There are no means available, except for voluntary recycling by CDD farmers, for restricting CDD drainage to the San Joaquin River.

DISTRICT DRAINAGE POLICY

SUMMARY

CDD's drainage policy (**Figure 8**) can be summarized as follows:

- **Acceptance-** CDD will accept either tile water or tailwater.
- **Separation-** CDD keeps some tile water separate from tailwater on the upslope side of the DMC. However, as soon as it is pumped to the downslope side, it is mixed with tailwater.
- **District Level Recycling-** CDD does not recycle drainage water at a district level.
- **Holding-** CDD does not have an external holding facility except the drainage system itself.


CHARLESTON DRAINAGE DISTRICT
THE FARM
TILE WATER
TAILWATER
ALWAYS
SOMETIMES
NEVER
ANY
RESTRICTED
YES
NO
YES
TILE WATER
TILE & TAIL WATER
TAILWATER
ALWAYS
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SAN JOAQUIN RIVER
BOTH
DISTRICT IRRIGATION SUPPLY
SAN JOAQUIN RIVER
DECISION
ACCEPTANCE:
TIMING
QUALITY
SEPARATION:
DISTRICT LEVEL RECYCLING:
HOLDING:
ASSIMILATIVE WATER:

Figure 8

- **Assimilation Water-** CDD has no formal policy regarding the use of the assimilative capacity of the San Joaquin River or the district. In its 1992 DOP, CDD indicated that it plans to utilize the maximum assimilative capacity of the San Joaquin River.

ACCEPTANCE

CDD will accept either tile water or tailwater.

SEPARATION

There is no formal policy regarding separation of tile water and tailwater. The two can be kept separate on the upslope side of the DMC.

DISTRICT LEVEL RECYCLING

There is significant reuse of tailwater, and possibly tile water, through farmer owned systems. A large, farmer owned tailwater return system was installed in 1991 near sumps L-1/L-2 on the upslope side of the DMC. This system can return tailwater to the western most CDD boundary near TO #8 on the San Luis Canal. Another reuse pump was installed on the eastern perimeter drain and recirculates a mix of tile water and tailwater. No district records are kept of how much drainage water is recycled within CDD.

Also, some CDD drainage water flowing in the main outfall is picked up for use on pasture lands east and west of the outfall drain, outside of CDD boundaries, in Sections 20, 21, and 26, T11S, R11E. However, drainage water from this land also returns to the CDD outfall. This use is upstream of CDD's CH-1 measuring point.

There is no recycling of collected tile water at a district level by CDD within CDD boundaries.

HOLDING

CDD does not have a holding facility.

ASSIMILATION WATER

CDD's 1992 DOP indicated it will attempt to utilize the San Joaquin River's assimilitive capacity when available. There is no indication of the district's operational plans when assimilitive capacity is not available. The drainage and irrigation water supplies of the CDD are shown in **Table 5.**

Table 5
Drainage and Water Supply
Charleston Drainage District

Year	Delivered Water (AF)	Irrigated Acreage (Ac)	Tile Drainage Total (AF)	Drainage Out of District (AF)
1981	14,030	3,618		
1982	11,973	3,643		
1983	11,591	3,612		
1984	13,691	3,477		
1985	12,119	3,232		3,090
1986	10,264	2,897		3,186
1987	13,891	3,724		4,769
1988	14,428	3,582		6,136
1989	12,263	3,602	130	2,799
1990	11,127	3,494	2,425	2,126
1991	10,218	3,890		781
1992	9,630	3,890	319	781

FIREBAUGH CANAL WATER DISTRICT

IRRIGATION WATER DELIVERY

Firebaugh Canal Water District is party to an agreement between the USBR and several holders of pre-1914 riparian water rights on the San Joaquin River. The agreement, negotiated in the late 1930s, is referred to as the Exchange Contract. The water districts that are party to the agreement are referred to as the Exchange Contractors.

In summary, the Exchange Contract provided the USBR with the water rights necessary to build the Friant Dam, the Friant-Kern Canal, and the Madera Canal. The USBR was then able to deliver San Joaquin River water to lands along the western slope of the Sierra Nevada mountain range. In return for the water rights, the USBR agreed to deliver water from the Sacramento River, stored at Shasta Dam, to the Exchange Contractors through the DMC.

The DMC starts at the Tracy pumping plant on the southern edge of the Sacramento/San Joaquin Delta and flows southerly to end at the Mendota Pool near the town of Mendota. The Mendota

Pool has traditionally been used by FCWD, CCID, and CCC as their turnout point on the San Joaquin River.

Referring to **Figure 9**, FCWD draws water from the Mendota Pool and pumps it up into the Intake Canal. The Intake Canal flows west to supply the First, Second, and Third Lift Canals. These three canals then flow roughly parallel northwesterly along the prevailing ground contour to distribute irrigation water throughout the district. Water is delivered via gravity turnouts to the individual fields.

There are ten district owned deep wells. However, the groundwater in the district is of very poor quality. The wells are not used except in times of very low surface water supplies. There are no farmer owned deep wells in the district.

DRAINAGE DISPOSAL

Approximately half of the 21,700 irrigable acres are served by farmer owned subsurface drainage systems, which include collector sumps and pumps. FCWD maintains a series of open drains and recycling lift pumps to dispose of both tile water and tailwater.

As discussed below, tile water from twelve subsurface collector sumps is recycled back into FCWD supply canals. There are several other flow paths for the remaining drainage water. Some drainage water flows to the Delta/Mendota Wasteway. Some drainage water is recycled back into CCID's Outside Canal. A large portion goes through GWD on its way to the San Joaquin River. Drainage water directed through GWD goes through measuring points FC-1, FC-2, or FC-3. All drainage water ends up in the Main Drain paralleling CCID's Main Canal. From there the drainage water goes through GWD's Agatha or Camp 13 Canals. (Refer to the section "Grassland Water District Drainage Operations" for a discussion of how agricultural drainage is moved through GWD). FCWD drainage water that is not recycled in FCWD or CCID canals eventually enters the San Joaquin River through either the Delta/Mendota Canal Wasteway, Salt Slough or Mud Slough (North).

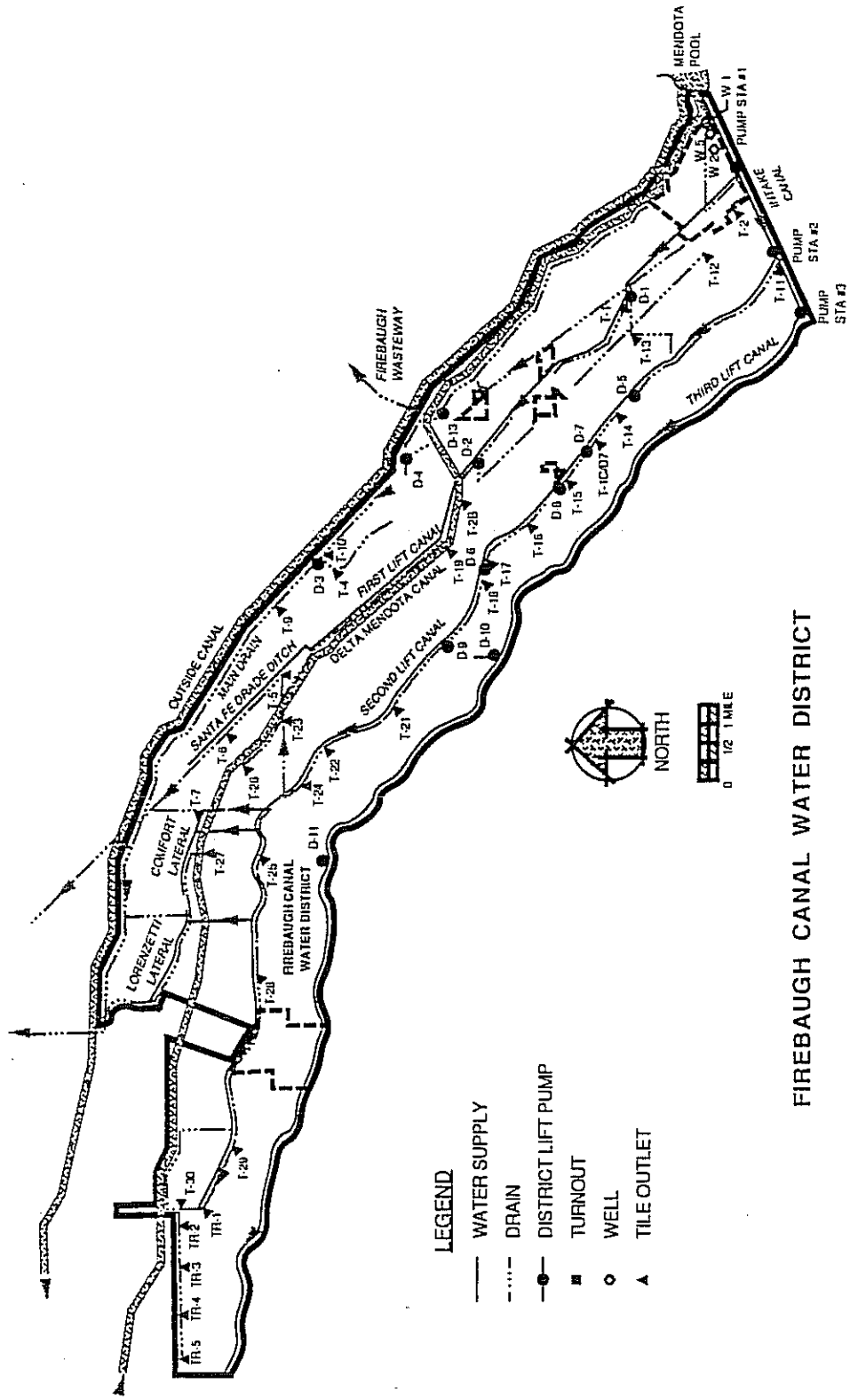

FIREBAUGH CANAL WATER DISTRICT
LEGEND
WATER SUPPLY
DRAIN
DISTRICT LIFT PUMP
TURNOUT
WELL
TILE OUTLET
NORTH
0 1/2 1 MILE
MENDOTA POOL
PUMP STA #1
PUMP STA #2
PUMP STA #3
INTAKE CANAL
THIRD LIFT CANAL
FIREBAUGH WASTEWAY
FIRST LIFT CANAL
DELTA MENDOTA CANAL
SECOND LIFT CANAL
OUTSIDE CANAL
MAIN DRAIN
SANTA FE GRADE DITCH
COMFORT LATERAL
LORENZETTI LATERAL
FIREBAUGH CANAL WATER DISTRICT

Figure 9

DISTRICT DRAINAGE POLICY

SUMMARY

FCWD's drainage policy (**Figure 10**) can be summarized according to the five policy levels as follows:

- **Acceptance-** FCWD will accept either tile water or tailwater.
- **Separation-** FCWD does not separate tailwater and tile water.
- **District Level Recycling-** FCWD will recycle all drainage water in certain drains at several points within the district, mostly south of Nees Avenue.
- **Holding-** FCWD does not have an external holding facility except the drainage system itself.
- **Assimilation Water-** FCWD has no formal policy regarding the use of the assimilative capacity of the San Joaquin River or the district. It has not been noted that FCWD has used its irrigation water supply to dilute drainage.

ACCEPTANCE

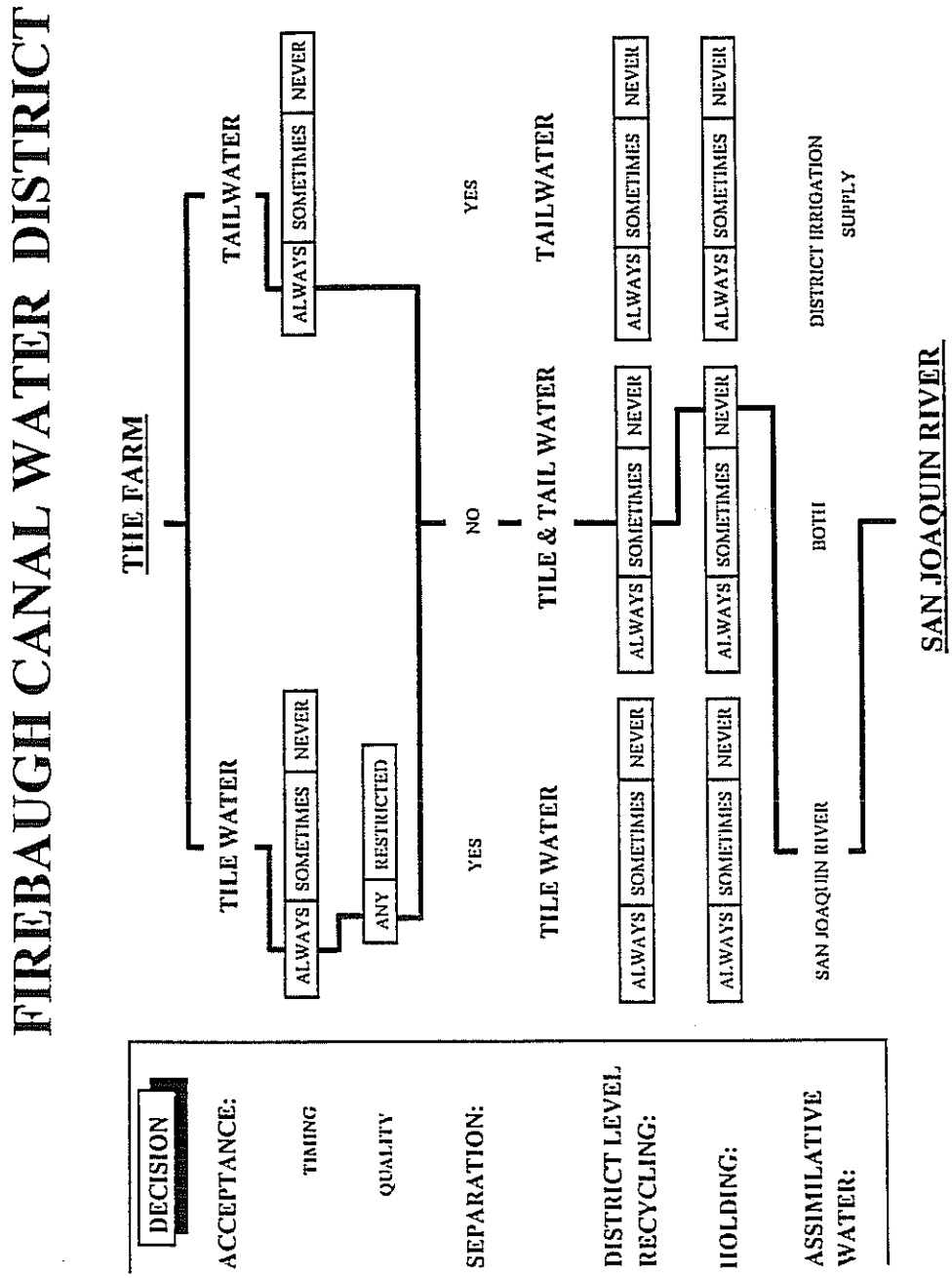
FCWD will accept both tailwater and tile water. FCWD's policy is to encourage on-farm recycling of tailwater.

SEPARATION

FCWD does not separate tile water and tailwater.

DISTRICT LEVEL RECYCLING

According to FCWD's 1992 DOP, tile water is being recycled from 12 sumps. The sumps being recycled are named T-1, T-2, T-4, T-9, T-11, T-12, T-13, T-14, T-15, T-16, T-17, and T-18. These sumps lie in the southern part of FCWD. The sumps collecting the tile water pump to open drains. There are low lift pumps in the open drains that then recycle both the tile water and tailwater back into FCWD supply canals.


FIREBAUGH CANAL WATER DISTRICT
THE FARM
TILE WATER
TAILWATER
ALWAYS
SOMETIMES
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ANY
RESTRICTED
YES
NO
YES
TILE WATER
TILE & TAIL WATER
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SAN JOAQUIN RIVER
BOTH
DISTRICT IRRIGATION SUPPLY
SAN JOAQUIN RIVER
DECISION
ACCEPTANCE:
TIMING
QUALITY
SEPARATION:
DISTRICT LEVEL RECYCLING:
HOLDING:
ASSIMILATIVE WATER:

Figure 10

There does not appear to be any formal decision making process regarding the amount of recycling. The recycling sumps are controlled automatically.

HOLDING

FCWD does not have an external holding facility.

ASSIMILATION WATER

FCWD does not have a formal policy regarding the use of the assimilative capacity of the San Joaquin River or the district. FCWD's DOPs discuss the continuing efforts to reduce the volume drainage water, but do not address total salt loading to the San Joaquin River, or how the district will coordinate with other drainers to meet water quality standards. The drainage and irrigation water supplies to FCWD are shown in **Table 6.**

Table 6
Drainage and Irrigation Water Supply
Firebaugh Canal Water District

Year	Delivered Water (AF)	Irrigated Acreage (Ac)	Tile Drainage Total (AF)	Drainage Out of Districts (AF)
1981	75,645	21,938		
1982	66,132	20,244		
1983	47,400	16,784		
1984	80,268	20,691		
1985	75,432	19,731		22,907
1986	62,966	19,825	3,537	31,191
1987	79,545	20,981	3,968	32,265
1988	75,106	23,282	3,698	26,041
1989	70,326	24,746	3,294	22,626
1990	63,903	25,458	3,363	16,964
1991	57,141	24,678	3,116	13,491
1992	59,569	24,894	3,045	13,491

Note: Drainage Out of District data is the combined drainage from FCWD, BWD and CCID-Camp 13. The data is from the monitoring point FC-5.

PACHECO WATER DISTRICT

IRRIGATION WATER DELIVERY

Pacheco Water District has water supply contracts with the CCID and the USBR. CCID water is pumped out of the Outside Canal into PoWD's Main Lift Canal. USBR water was originally delivered by pumping out of the DMC into the Main Lift Canal. Recently an outlet was constructed on the San Luis Canal east of PoWD at Eagle Field Road and the majority of the USBR supply now comes from this outlet.

There are several farmer owned wells within PoWD. These are used to supplement the surface water supply in years of curtailed allotment. Substantial pumping occurred in 1991 due to the drought and a reduction in USBR supplies. Some of this pumped water was directed to the DMC and used in other districts.

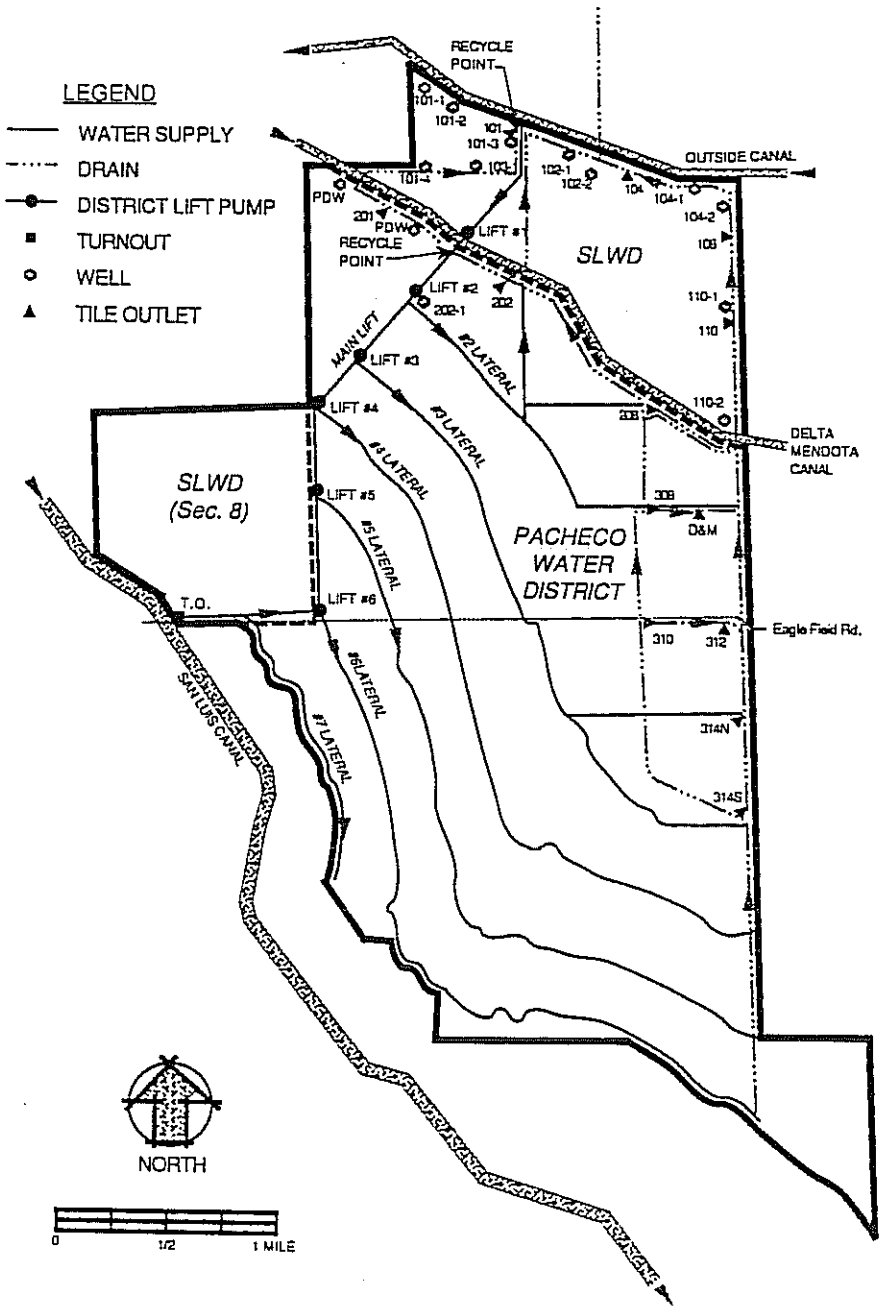
Referring to **Figure 11**, PoWD's water supply originally moved uphill from the Outside Canal and DMC in the Main Lift canal southwesterly through a series of six pump stations, Lifts #1 through #6. Water was directed into a series of six PoWD laterals to move by gravity southeasterly across the district. Gravity turnouts completed the delivery system to the individual fields.

With the installation of the San Luis Canal outlet, the majority of PoWD's water supply in a normal year comes from the San Luis Canal and flows by gravity down to the Main Lift Canal at the Lift #6 pump station. Water is diverted directly into Laterals #6 and #7. Water moves downhill through the Main Lift Canal northeasterly for distribution through Laterals #5, #4, #3, and #2.

Water is delivered to Section 8 of T12S, R11E, which lies outside of PoWD boundaries, through farmer owned ditches connected to the Main Lift Canal.

DRAINAGE DISPOSAL

PoWD maintains the drainage system and other lands that were originally part of Sam Hamburg Farms. There are approximately 5,900 acres drained, of which 4,400 acres are in PoWD.



PACHECO DRAINAGE AREA

Figure 11

Tile drain systems were first installed on farmland between the DMC and CCID's Outside Canal beginning in 1955. In 1962, installations began in fields south of the DMC. The last tile drain systems were installed in 1975. PoWD's 1985 WCP estimated that 2750 acres within the district and 933 acres outside of the district had tile drains installed. The drainage systems are owned and maintained by the landowners.

Tile water is collected at various sumps and pumped into a series of open drains. The drainage system, which consists of sumps, open drains, and outlet channel to GWD, are owned and maintained by PoWD.

The drainage system begins with a spill point at the end of Lateral #6 near the southeastern boundary of PoWD. The open drain flows north by gravity along the eastern boundary of PoWD. At sump 314S, the drain splits into two drains with the second drain paralleling the first about 1/2 mile west of the PoWD boundary. The second drain is reserved for tailwater only, while tile water is directed to the eastern boundary drain.

The eastern drain continues north to siphon under the DMC until it intercepts CCID's Outside Canal. There it turns west for approximately 3/4 of a mile to the PoWD outfall point. There it siphons under the Outside Canal into a pipeline and reappears at measuring point PO-1 as a concrete lined channel. This channel spills into the Main Drain that parallels CCID's Main Canal.

The second drain that splits off from the eastern boundary drain at sump 314S also flows north until it intercepts the DMC. It then flows northwesterly to where it intercepts the Main Lift Canal. There is a siphon under the DMC located at about tile sump 202. Drainage water flowing through this siphon will flow north until it intercepts CCID's Outside Canal. There it connects with the drain paralleling the Outside Canal. Drainage water can then move to the PoWD outfall point, siphon under the Outside Canal and flow to the Main Drain through measuring point PO-1.

There are two subsurface drain system collector sumps on the west side of the PoWD Main Lift Canal. Sump 101, which is located near the pumps on the Outside Canal, pumps across the Main Lift Canal to the drain paralleling the Outside Canal. Sump 201 pumps into an open drain paralleling the DMC. This drain siphons under the DMC then flows east to where it intercepts the Main Lift Canal. There it turns north to where it intercepts the CCID Outside Canal. Drainage water can be pumped over the Main Lift Canal into the parallel drain that siphons under the Outside Canal (this drain also connects with the two eastern boundary drains) and flow to the Main Drain through measuring point PO-1.

Thus, all drainage water from tile drains can flow to the Main Drain through PO-1.

Once in the Main Drain, PoWD drainage water will go through the GWD via either the Agatha or the Camp 13 Canals. (Refer to the section "Grassland Water District Drainage Operations" for a discussion of how agricultural drainage is moved through GWD). Drainage water from PoWD eventually enters the San Joaquin River through either Salt Slough or Mud Slough (North).

DISTRICT DRAINAGE POLICY

SUMMARY

PoWD's drainage policy (**Figure 12**) can be summarized according to the five policy levels as follows:

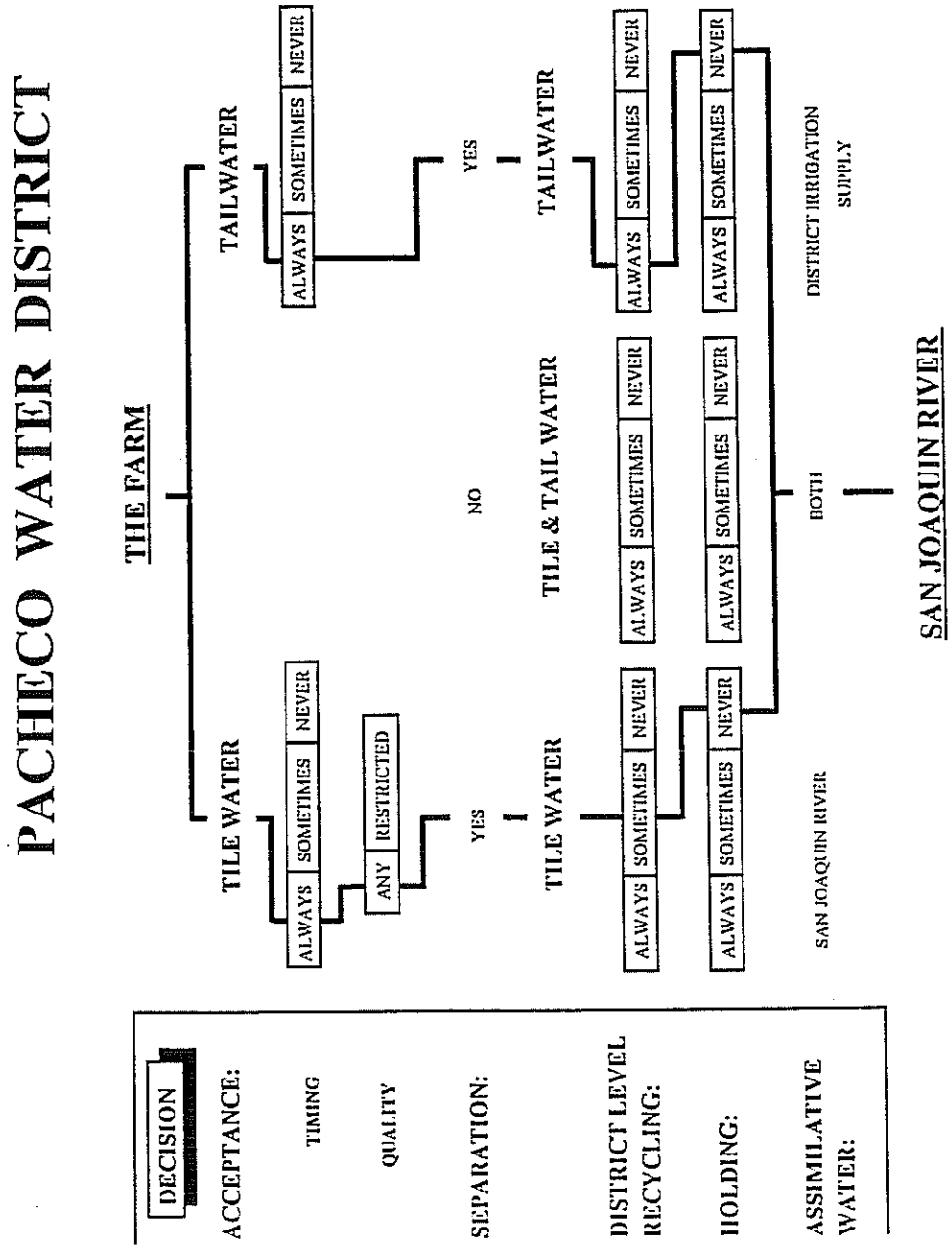
- **Acceptance.** PoWD will accept either tile water or tailwater.
- **Separation.** PoWD does attempt to separate tailwater and tile water.
- **District Level Recycling.** PoWD will recycle drainage water at a district level, but only for meeting peak irrigation water demands.
- **Holding.** PoWD does not have an external holding facility, except the drainage system itself.
- **Assimilation Water.** PoWD's DOPs indicate that it will maximize the assimilative capacity of the San Joaquin River. PoWD has used the assimilative capacity of the district in the past to meet water quality standards mandated by its contract with GWD.

ACCEPTANCE

PoWD will accept tile water or tailwater, but encourages on-farm recycling of tailwater.

SEPARATION

PoWD separates tile water from tailwater.


PACHECO WATER DISTRICT
THE FARM
TILE WATER
ALWAYS
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NEVER
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RESTRICTED
YES
NO
TAILWATER
TILE & TAIL WATER
SAN JOAQUIN RIVER
DISTRICT IRRIGATION SUPPLY
BOTH
DECISION
ACCEPTANCE:
TIMING
QUALITY
SEPARATION:
DISTRICT LEVEL RECYCLING:
HOLDING:
ASSIMILATIVE WATER:

Figure 12

RECYCLING

Tile water and tailwater can be recycled by PoWD at two places. Much of the tailwater is captured immediately for use in downstream supply laterals before it reaches the drain system. Tailwater is not measured.

Note that all drainage water can end up in the drain east of the Main Lift Canal paralleling CCID's Outside Canal. There is a relatively flat gradient between the start of the Main Lift Canal and the drain siphon under the Outside Canal. Thus drainage water can either be turned north through point PO-1 for disposal through GWD to the San Joaquin River, or pumped back into the Main Lift Canal.

The second point of recycling is at the Lift #1 outlet works just south of the DMC. There are drains that parallel the DMC on both sides of the Main Lift Canal. Pumping works are in place that will allow drainage water from the northwest side of the Main Lift Canal to be transferred to the southeast side drain. The gradient in the southeast side drain is flat enough so that drainage water can be held for pumping up into the Main Lift Canal or turned through the siphon under the DMC to continue north. If it continues north, the drainage water will end up in the drain paralleling the CCID Outside Canal.

This point is the primary point for recycling of tailwater. Tile water normally flows to the drain paralleling CCID's Outside Canal for disposal through measuring point PO-1 and the GWD channels.

The recycling works are also owned and maintained by PoWD.

Originally, this system worked well to distribute the salt load from any recycled drainage water because irrigation water was moved uphill from Lift #1 to distribution through Laterals #2-7. The drainage water was blended with the entire fresh water supply as it was pumped out of the DMC and CCID's Outside Canal. Thus, recycled drainage water would be spread over the entire district.

Currently however, the majority of PoWD's supply comes from the new outlet on the San Luis Canal and flows by gravity northeasterly in the Main Lift Canal. Thus, drainage water that flows into the northern part of PoWD will tend to stay there resulting in a net movement of salt from the southern to the northern portion of PoWD. This curtails PoWD's recycling capability since a certain minimum water quality must be available to all farmers. Currently PoWD attempts to keep delivered water quality in the 900 to 1000 ppm TDS range with a maximum limit of 1400 ppm TDS.

PoWD is aware of the problems associated with concentrating salts in the northern portion of the district. The 1989, 1990, and 1991 DOPs discuss the installation of a system to pump drainage water to a mixing pond near the new San Luis Canal outlet. This would provide the maximum blending capacity to further reduce the required discharges to the San Joaquin River.

PoWD reported in its 1991 DOP that 1,500 acre-feet were recycled in 1990 and 2050 acre-feet in 1991. Blending and reuse are a management decision. There are three sets of criteria that govern the amount of recycling:

1. PoWD's contract with GWD allows PoWD drainage water to flow through GWD conveyance channels. An agreement was signed between Sam Hamburg Farms, predecessors to PoWD and PDD, and GWD in December, 1962. The agreement allows PoWD to discharge drainage water to the GWD. GWD can then use the water or convey it to the San Joaquin River at their discretion.

   The purpose of this agreement was to provide Sam Hamburg Farms with an outlet for their tile water and to provide a water supply for GWD. There were no firm water quality standards set forth in the original agreement.

   GWD (which consists primarily of wildfowl habitat) has not used PoWD drainage water since 1985, although they continue to convey the drainage water in their supply channels on its way to the San Joaquin River.

2. Agronomic considerations for PoWD crops in terms of both water supply and quality. In a normal year, PoWD is not concerned with total water supply. However, all growers are aware of the long term effects of a salt imbalance. As previously noted, the blending capabilities of PoWD are now constrained by the fact that all drainage water flows to the northern district and most of the fresh irrigation water supply comes in near the southern boundary. The district recycles drainage water as able, but attempts to deliver water of a certain minimum quality to the field.

3. Water quality standards set by the CVRWQCB for the San Joaquin River. In response to these standards, PoWD has drastically reduced the volume of drainage water to the San Joaquin River. Table 1, taken from the 1990 DOP, shows the reduction in total drainage water discharge. Some of this reduction is due to improved on-farm irrigation practices, which reduced tailwater. In addition, the drought has reduced the total water supply to the district in 1990 and 1991. The 1991 DOP estimates that 1,500 acre-feet of drainage water was recycled in 1990 and 2,050 acre-feet in 1991.

HOLDING

PoWD does not have an external holding facility except for the drainage system itself.

ASSIMILATION WATER

PoWD DOPs from 1989 through 1991 indicated that the criteria for recycling will be the available assimilative capacity of the San Joaquin River. The 1991 DOP includes a graph that specifically identifies the 1986-88 average discharge of selenium, the 1991 discharge, and the allowable discharge based on assimilative capacity in the San Joaquin River. Thus, in 1991, recycling was increased to improve a curtailed irrigation supply and to attempt to meet water quality standards in the San Joaquin River. The drainage and irrigation water supplies of the PoWD are shown in **Table 7.**

Table 7
Drainage and Irrigation Water Supply
Pacheco Water District

Year	Delivered Water (AF)	Irrigated Acreage (Ac)	Tile Drainage Total (AF)	Drainage Out of District (AF)
1981	12,653	4,410		
1982	9,763	4,410		
1983	9,751	3,696		
1984	10,775	3,696		
1985	9,000	3,100		2,531
1986	7,770	3,500		3,884
1987	9,756	4,028	5,717	5,176
1988	10,217	4,179	5,394	2,664
1989	13,063	3,648	6,609	5,122
1990	11,569	4,254	5,286	3,160
1991	11,572	4,369	5,624	2,716
1992	8,107	3,705	4,232	2,716

PANOCHE DRAINAGE DISTRICT

IRRIGATION WATER DELIVERY

Irrigation water supplies for fields in the Panoche Drainage District come from two sources. The water districts that make up PDD (Panoche Water District (PeWD), Oro Loma Water District, Eagle Field Water District, and Mercy Springs Water District) have water supply contracts with the USBR for delivery of Central Valley Project water. There are also forty-two farmer owned deep wells within PeWD, which is the main component of PDD.

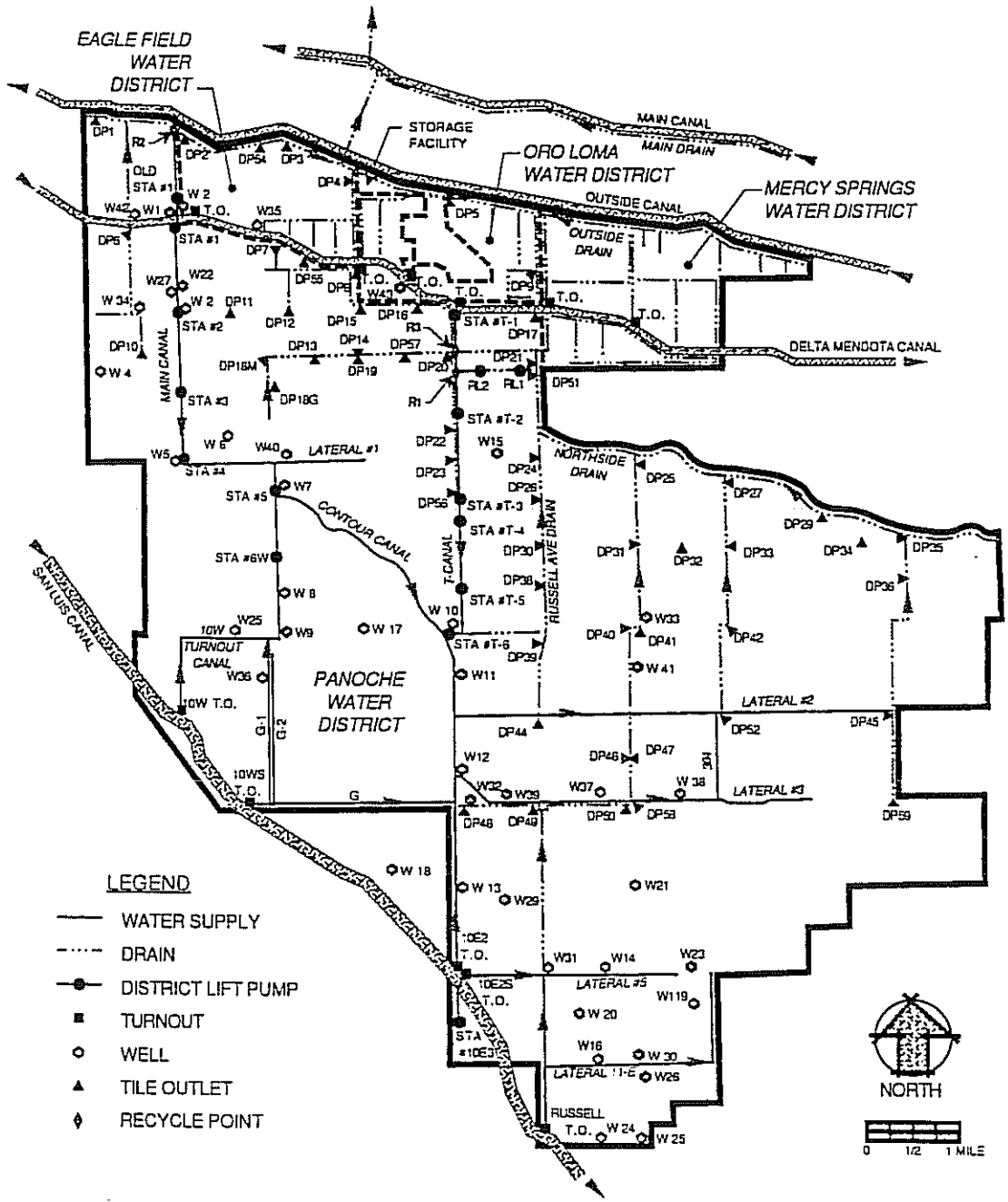
Originally, USBR supplies were delivered to PeWD from pump stations on the DMC. Three outlets were installed on the San Luis Canal with the construction of the State Water Project and the San Luis Unit. Fifty percent of PeWD's USBR contract water was delivered through these outlets. This significantly reduced PeWD's pumping costs. In 1991, one additional outlet on the San Luis Canal became operational and PeWD now estimates that seventy percent of USBR water is delivered from the San Luis Canal.

Water supplies to the other three water districts in PDD also come primarily from USBR contracts for DMC water.

Water from the DMC is pumped uphill through a series of lifts either on the Main Canal or the T-Canal. Water generally moves south and east along prevailing ground contours through a series of laterals as shown on **Figure 13**.

Water from the San Luis Canal is fed into the PeWD system at several points along the San Luis Canal; 10W TO #1, 10WS TO (the newest turnout), 10E2 TO #2, and Russell T.O. The use of San Luis Canal water significantly reduces pumping costs to PeWD and also provides higher quality water than the DMC.

Water is delivered from the PeWD laterals to individual farmers through both gravity outlets and low-lift pumps.



PANOCHE DRAINAGE DISTRICT

Figure 13

DRAINAGE DISPOSAL

The PDD is responsible for disposal of tailwater and tile water from PeWD, Eagle Field Water District, Oro Loma Water District, and Mercy Springs Water District. PDD's drainage system is a series of deep, open drain channels. These channels collect tile water from farmer owned tile systems and sumps, tailwater, and water from intercepted high water tables.

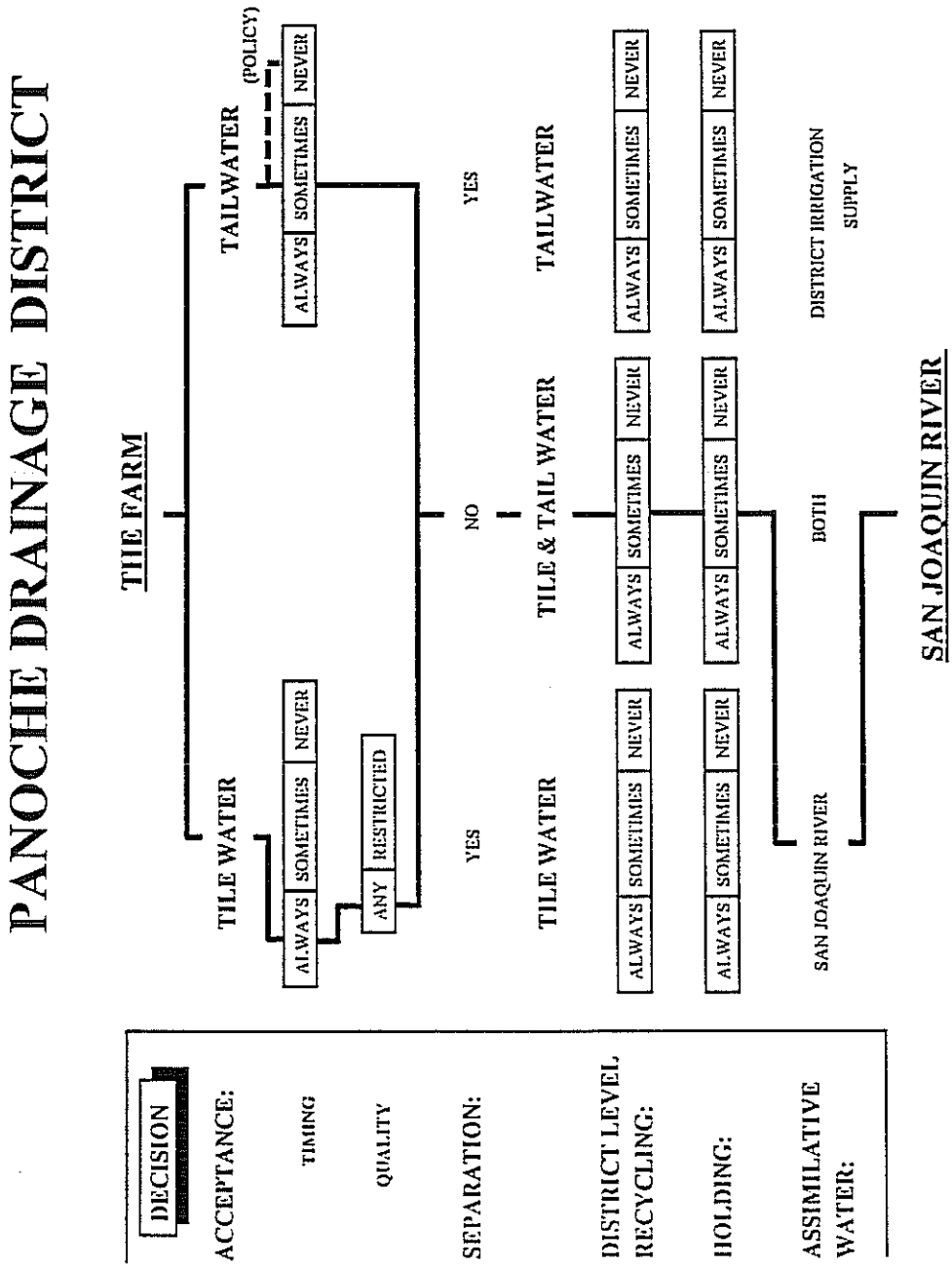
Drainage water generally moves northward until it ends up in the Outside Drain, which parallels the CCID Outside Canal. This drain siphons under the Outside Canal through PDD's main measuring point PE-14. From there the drainage water moves through the southern section of GWD. (See the section "Grassland Water District Drainage Operations" for a description of how agricultural drainage is conveyed through GWD canals). PDD drainage water eventually enters the San Joaquin River through either Salt Slough or Mud Slough (North).

DISTRICT DRAINAGE POLICY

SUMMARY

PDD's drainage policy (**Figure 14**) can be summarized according to the five policy levels as follows:

- **Acceptance-** PDD policy is not to accept tailwater. This policy is becoming more strictly enforced each year.
- **Separation-** PDD does not separate tile water from tailwater, when it does accept tailwater.
- **District Level Recycling-** PDD has recycled some drainage in the past year, but there is no formal policy in place. The amount of recycling is constrained by water quality downstream of the recycling points.
- **Holding-** PDD has constructed a small holding facility in order to store drainage during the flood-up of Grassland Water District. The facility is a pilot project to study feasibility.


PANOCHE DRAINAGE DISTRICT
THE FARM
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SEPARATION:
DISTRICT LEVEL RECYCLING:
HOLDING:
ASSIMILATIVE WATER:

Figure 14

- **Assimilation Water-** PDD's DOPs indicate that it will maximize its use of the assimilative capacity of the San Joaquin River. There is no formal policy regarding the use of the district's assimilative capacity.

ACCEPTANCE

PDD's policy is not to accept tailwater. This policy has been adopted in the last two years. It is not yet strictly enforced to allow its members time to adapt to the change. However, it will be more strictly enforced in the future.

SEPARATION

With full enforcement of the "no tailwater" policy, PeWD will in effect separate tile water from tailwater. It does not do so at present.

RECYCLING

There are three locations where drainage water from PDD's system can be recycled into the PeWD supply laterals. These are shown as points R-1, R-2, and R-3 in **Figure 13**. The amount of recycling is constrained by the resulting water quality downstream of these recycling points. In their 1991 DOP, PDD reported recycling 400 acre-feet in water year 1990-91. In comparison, the USBR contract water supply for PeWD is 94,000 acre-feet annually.

Due to the difficulty in distributing the increased salt loads to all areas of the district, recycling is only part of the PDD strategy to meet water quality standards. Because of the layout of the supply and drain channels, the drainage water of large areas is currently being recycled into the supply for a much smaller area when recycling occurs.

HOLDING

PDD has recently installed an approximately 100 acre (300 acre-feet) external storage facility for drainage water. The storage site is shown as "Storage Facility" on **Figure 13**. Drainage water is stored during periods when Grassland Water District needs all its conveyance facilities to maximize flood-up using fresh water and acceptable quality drainage water. Following the flood-up, PDD drainage water will be released.

In its 1991 DOP, PDD also discussed a proposal whereby the subsurface drainage sumps would be operated in a sequential manner. This practice would store salts in the soil when there is no assimilative capacity in the San Joaquin River. However, PDD notes several operational questions

concerning this practice that have not been resolved to their satisfaction. It is unknown when, if ever, this practice would be adopted.

ASSIMILATION WATER

PDD's current strategy for meeting the water quality standards in the San Joaquin River rests on selenium removal processes (which are still in field testing), temporary storage of drainage water (either externally or internally), and maximum use of the assimilative capacity of the San Joaquin River. The drainage and irrigation water supplies of the PDD are shown in **Table 8.**

PDD/GWD DRAINAGE AGREEMENT

PDD has an agreement with GWD that allows them to convey their drainage water through GWD. The original intent of the PDD/GWD agreement was to provide PDD with an outlet for its drainage, and thus the ability to maintain a salt balance, and to provide an additional water supply to GWD, which was, and is, chronically short of water.

GWD (which is primarily composed of wildfowl habitat) has not used PDD drain water since 1985. GWD continues to convey the drain water in their supply channels on its way to the San Joaquin River.

Table 8
Drainage and Irrigation Water Supply
Panoche Drainage District

Year	Delivered Water (AF)	Irrigated Acreage (Ac)	Tile Drainage Total (AF)	Drainage Out of District (AF)
1981	97,344	34,151		34,411
1982	89,155	19,986		34,861
1983	75,306	29,703		43,278
1984	109,511	30,754		38,359
1985	98,241	33,375		30,468
1986	92,487	33,153		33,257
1987	98,119	32,208		34,724
1988	97,196	33,795		30,144
1989	91,300	35,686		24,875
1990	81,258	31,799		19,835
1991	69,706	28,126	3,295	13,475
1992	63,416	27,742	6,715	13,532

GRASSLAND WATER DISTRICT DRAINAGE OPERATIONS

The lands of Grassland Water District are divided into a northern and a southern section as shown in **Figure 15**. All of the agricultural drainage water from PoWD, PDD, CDD, and BWD that flows to the San Joaquin River must move through GWD channels. In addition, a major portion of FCWD drainage water and that from CCID's Camp 13 Study Area move through GWD.

Except for drainage water from CDD, drainage water flows into the Main Drain that parallels CCID's Main Canal between GWD's Agatha and Camp 13 Canals. Agricultural drainage water may flow through the southern portion of GWD through the Agatha or Camp 13 Canals depending on GWD operations. GWD can turn all agricultural drainage water through the Agatha Canal while delivering fresh water supplies (delivered from CCID's Main Canal) through the Camp 13 Canal, or vice-versa.

This system of alternating fresh water and drainage water in the two canals is termed "Flip-Flop" by the area drainers. It is necessitated by the selenium content of the agricultural drainage water. Prior to 1985, GWD would utilize agricultural drainage water for irrigation and "fall flood up" (flooding of the duck ponds in anticipation of migrations on the Pacific Flyway). As a result of the problems at Kesterson Reservoir the USFWS issued water quality guidelines for habitat use. In 1989, the SWRCB adopted a 2 ppb selenium standard for water used by GWD. Since 1985, GWD has not used agricultural drainage water.

However, a large part of GWD's total water supply was this agricultural drainage water. Out of necessity, the agricultural districts continue to drain through GWD channels. This maintains agricultural productivity while providing GWD with enough revenues to allow it to buy fresh water when available. The "Flip-Flop" system allows agricultural drainage to continue while simultaneously allowing GWD to deliver fresh water, when available, to its own users.

Both the Agatha and Camp 13 Canals eventually drain into Mud Slough (South) which in turns drains into the Santa Fe Canal. The Santa Fe flows northwesterly and eventually meets the San Luis Canal. Drainage water can continue north through the Santa Fe Canal, which eventually spills into Mud Slough (North). Mud Slough (North) then spills to the San Joaquin River. If required by GWD operations, drainage water can be diverted north through the San Luis Canal and discharged through the City Gates to Mud Slough (South). Mud Slough (South) spills into Salt Slough which in turn spills into the San Joaquin River.

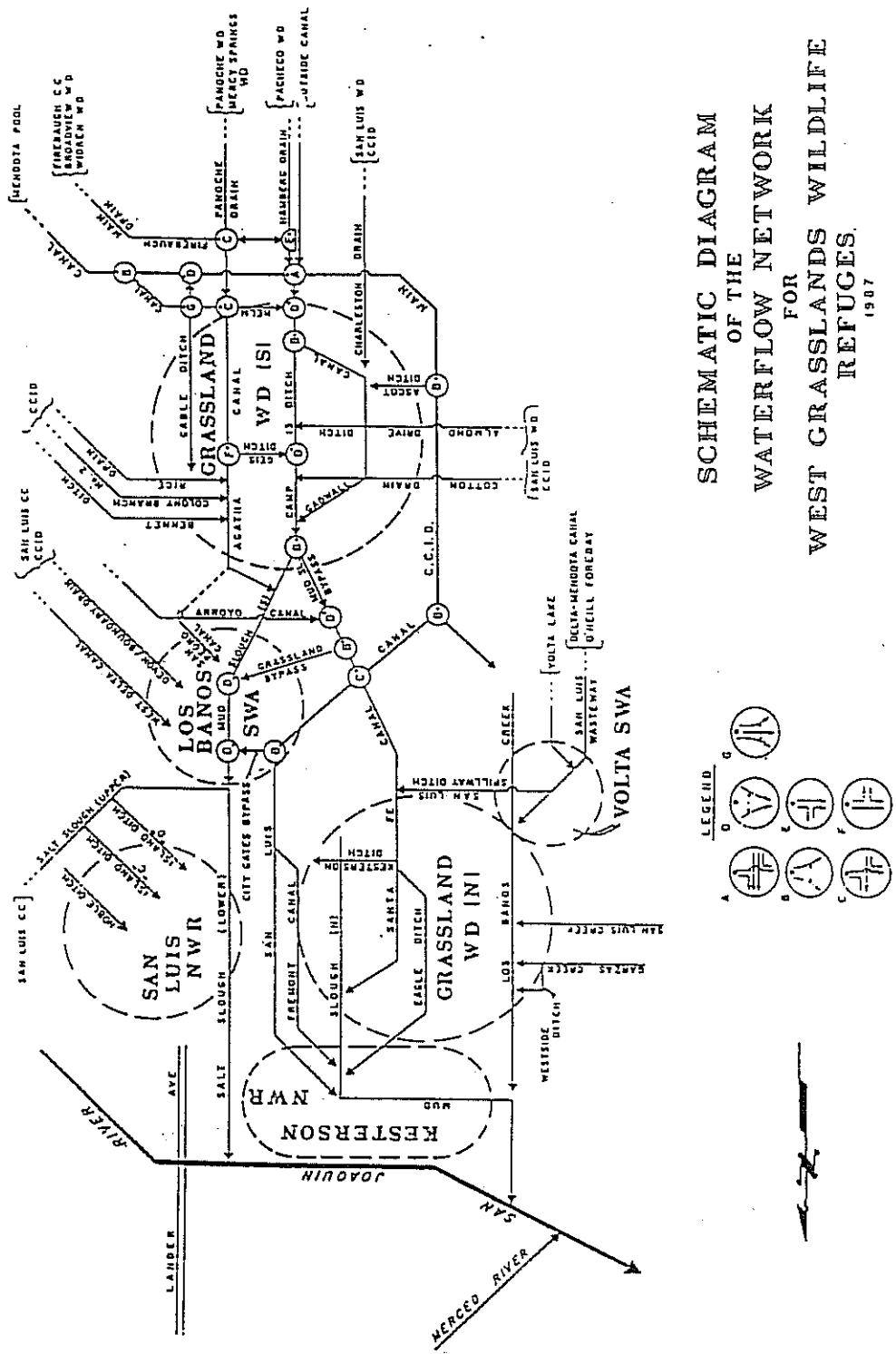
SCHEMATIC DIAGRAM
OF THE
WATERFLOW NETWORK
FOR
WEST GRASSLANDS WILDLIFE
REFUGES
1987
LEGEND
GRASSLAND WD (S)
GRASSLAND WD (N)
LOS BANOS SWA
VOLTA SWA
SAN LUIS NWR
KESTERSON NWR
SAN JOAQUIN RIVER
MERCED RIVER
LANDER AVE
C.C.I.D.
MAIN CANAL
CHARLESTON DRAIN
PANOCHE DRAIN
HAMBERG DRAIN
SAN LUIS WD
CCID
SAN LUIS CC
SALT SLOUGH (LOWER)
SALT SLOUGH (UPPER)
CITY GATES BYPASS
SAN LUIS CANAL
FREMONT SLOUGH (N)
SANTA FE
EAGLE DITCH
LOS BANOS CREEK
SAN LUIS CREEK
GARZAS CREEK
WESTSIDE DITCH
SPILLWAY DITCH
SAN LUIS WASTEWAY
VOLTA LAKE
DELTA-MENDOTA CANAL
O'NEILL FOREBAY
ARROYO CANAL
GRASSLAND BYPASS
MUD SLOUGH (S)
MUD SLOUGH (N)
AGATHA CANAL
CAMP
GADWALL
COTTON DRAIN
ALMOND DRIVE DITCH
ASCOT DITCH
GEIS DITCH
RICE DRAIN
COLONY BRANCH
BENNETT DITCH
CABLE DITCH
MENDOTA POOL
FIREBAUGH CC
BROADVIEW WD
WIDREN WD
PANOCHE WD
MERCY SPRINGS WD
PACHECO WD
WESTSIDE CANAL
SAN LUIS CC
DEVON/BOUNDARY DRAIN
WEST DELTA CANAL
SAN LUIS WD
CCID
SAN LUIS CC
CCID

Figure 15

There is a temporary cross connection, termed the "Blake-Porter Bypass", that is located just upstream of the confluence of the Santa Fe and San Luis Canals. This connection can be used to turn drainage water in the Santa Fe Canal into the Boundary Drain, which is owned by San Luis Canal Company. The bypass allows GWD to convey fresh water into its northern section while agricultural drainage water still flows to the San Joaquin River.

The Boundary Drain spills into Salt Slough which in turn terminates at the San Joaquin River. Thus, agricultural drainage water from PoWD, PDD, BWD, CCID's Camp 13 Study Area, and a portion of FCWD eventually enters the San Joaquin River through either Salt Slough or Mud Slough (North).

The drainage water from CDD takes a slightly different route. The CDD drainage water outfall spills to GWD's Gadwall Canal. The Gadwall Canal spills into Mud Slough (South). At this point, CCD drainage water joins with the drainage water from the other upslope agricultural districts. Mud Slough (South) then spills into the Santa Fe Canal upstream of the Blake-Porter Bypass.

DRAINAGE OPERATIONS SUMMARY

SUMMARY OF STUDY AREA

Table 9 summarizes district policies in terms of the five decision levels and also the amount of recycling and drainage currently occurring (as estimated by the districts).

Table 9
Summary of Drainage Policies and Recycling of Various Districts

District	Acceptance	Separation	Drainage Water Recycling Percentage Based on the Total Drainage Volume[1] On-Farm Level Tail	On-Farm Level Tile	District Level Tail	District Level Tile	Holding	Assimilation
BWD[2]	Both	None	13	0	50	50	No holding policy or facility	No policy, now using SJR. Can add 10-25 CFS for dilution
CCID[5]	Both	None	8	0	10	10	No holding policy or facility	No policy, now using SJR
CDD[3]	Both	Separate upslope side of DMS, blend on downslope	0	0	0	0	No holding policy or facility	Use SJR to maximum, not a supply district
FCWD	Both	None	13	0	5	30	No holding policy or facility	No policy, now using SJR
PDD[4]	Tile only	None	90	5	1	4	100 acre holding pond	Use SJR to maximum, not a supply district
PoWD	Both	Separate	94	0	94	55	No holding policy or facility	Use SJR to maximum, has used district capacity

Notes:

1. On-farm estimates are based upon the acreage served with on-farm recycling systems, because on-farm return systems are rarely metered. Numbers will vary from year to year. Data generally reflects 1991 conditions.
2. BWD provides drainage for the FDA consisting of BWD and approximately 2230 acres (1991), 1,590 acres (1992 and 1993), 0 acres (1994) laying outside of BWD.
3. CDD consists of lands laying in CCID and SLWD. (4275 acres supplied by SLWD; 500 acres supplied by CCID water).
4. PDD consists of Panoche, Oro Loma, Eagle Field, and Mercy Springs Water Districts.
5. Only 1 of 10 active tile pumps recycles into outside Canal.

ACCEPTANCE

All districts are currently accepting both tile water and tailwater. However, PDD's formal policy is to not accept tailwater and that policy will soon be completely enforced. BWD has plans for installing a new turnout on the San Luis Canal. If this installation is completed, BWD will no longer accept tailwater either. Although this report does not include detailed information about on-farm recycling, there is already considerable on-farm recycling of tailwater in the study region.

SEPARATION

CDD's drainage system keeps tile water separate from tailwater on the upslope side of the DMC. Once pumped across the DMC, tile water and tailwater are commingled in the open drains. PoWD is attempting to keep tile water and tailwater separated. All other districts commingle tile water and tailwater.

DISTRICT LEVEL RECYCLING

CDD does not recycle any drainage water at the district level. CCID, while recycling substantial amounts of drainage water in other parts of their system, is recycling only one tile sump of ten in the 6,000 acre Camp 13 Study Area. PeWD has only recycled drainage water in the past year, and then only approximately 500 acre-feet. PoWD, and BWD recycle substantial amounts of drainage water.

HOLDING

Only PeWD has an external holding facility, and this is only a pilot project.

ASSIMILATION WATER

CCID has indicated that it can blend its problem drainage water with its own irrigation water. FCWD and BWD have not indicated what their formal policies will be in the future. CDD, PDD, and PoWD have indicated that they will maximize their use of the San Joaquin River's assimilative capacity.

Formal policies are lacking at all districts that would govern the extent of recycling, the allowable water quality limits for blended irrigation water, and division of the assimilative capacity of the San Joaquin River among the area drainers.

AMOUNT OF RECYCLING, DRAINAGE, AND WATER SUPPLIES

Obviously the on-going drought has had an impact on the amount of recycling and drainage. It is impossible to accurately predict district operations in a normal year. Looking at pre-drought years would probably not be appropriate due to the change in the political/regulatory climate regarding agricultural drainage in the area.

RECOMMENDATIONS

The recommendations in this section are based upon the following assumptions:

- The water quality in the San Joaquin River will deteriorate in the future rather than improve.
- Districts will be required to have a formal policy regarding the technical decisions of timing and water quality releases to the San Joaquin River.
- Future water supplies to the districts will continue to be lower than historical (prior to 1985) averages.
- Districts must consistently maintain a low ECe in the soil in order to farm high value crops.

These assumptions lead to the conclusion that salt releases to the San Joaquin River will be carefully controlled in the future. Furthermore, the districts must have the ability to respond quickly to varying San Joaquin River water qualities. The result of these assumptions and conclusions is a recommended **Drainage District Decision Tree** which is shown in **Figure 2.**

ACCEPTANCE

Districts should not accept any tailwater. All surface runoff should be recycled on-farm. This will maximize district control over problem drainage water. This also will maintain maximum fresh water supplies for growers, especially in the case of boron and selenium laden tile water. In those cases where existing district facilities allow separation of tile water and tailwater, acceptance of tailwater may continue if desired. Some tile systems may have high quality (ie., low salinity) discharges. In order to minimize the size of holding ponds, only tile water with at least some predetermined EC or selenium concentration should be accepted. For example, tile water with an EC of less than 5.0 dS/m might be rejected by the district. This value can change with time, depending upon the available storage in the holding reservoir.

SEPARATION

In all cases, tile water should be kept separate from tailwater.

DISTRICT LEVEL RECYCLING

Recycling facilities should be in place to allow recycling of tile water as water quality allows or operations require. Recycling when water quality allows will maintain maximum DIEs. Recycling may be required when assimilative capacity is not available and external holding facilities are full. Recycling of tile water throughout the entire district will tend to "average out" the soil EC's. Recycling pipelines or ditches must terminate at irrigation water inlets to the districts so that drainage water will mix in all areas.

HOLDING

Depending on the anticipated salt load, and especially loads of constituents such as selenium, boron, molybdenum, and arsenic, external holding facilities will probably be warranted. If salts have to be temporarily stored when assimilative capacity is not available, external storage minimizes response time when assimilative capacity does become available. Also, in this situation, external storage continually maintains acceptable agricultural productivity (because of maintaining both required leaching fractions and sufficient rootzones.)

ASSIMILATION WATER

The extent of the use of fresh water flows of the San Joaquin River, or irrigation water that has to be conveyed through the San Joaquin/Sacramento Delta for the express purpose of diluting agricultural drainage so as to maintain water quality standards in the San Joaquin River, is a political/regulatory decision.

FUTURE

In the future, formal rules must be defined by each district which address the following issues:

- If the water quality of received tile water is an occasional barrier to meeting San Joaquin River water quality standards, there should be written guidelines for acceptable EC of tile water.

- If recycling of tile water (via district irrigation canals) is to be a normal occurrence, there should be written guidelines governing the limits of water quality to be delivered

to any one farmer in the district. No farmer should be asked to take more salt than any other, without some compensation.

- Holding facilities will be necessary if assimilative capacity will be limited at any time. One of the limits on assimilative capacity will be fresh water flows in the San Joaquin River, if the assimilative capacity of the San Joaquin River is to be used. There should be written guidelines that govern the use of the assimilative capacity of the San Joaquin River. These guidelines must be agreeable to the CVRWQCB, the Grassland Drainers, and all downstream users. They will be based upon specific monitoring locations, water qualities, and river flow rates.

- If there is no external holding facility and the assimilative capacity of the district is to be used, there should be some mechanism in place to predict the need and availability of the district's assimilative capacity. It may also be desirable to perform daily predictions (not control) of on-farm irrigation schedules on a district-wide basis. Some districts, notably BWD, CCID, and FCWD may have sufficient supplies available to blend.

GEOGRAPHICAL INFORMATION SYSTEM (GIS)

A Geographic Information System (GIS) is an organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information. Simply put, the GIS is a computer system capable of holding and using data describing places on the earth's surface. Data that a GIS can store and use can be represented as related data layers including, hydrology, topography, land use, utilities, soils, streets, districts, and parcels. A GIS was created for the study area.

A GIS differs from other computer programs, such as, spreadsheets, statistics packages, or drafting programs in that a GIS allows spatial operations to be done on the data. Other program packages are only capable of answering aspatial queries, or questions not requiring the stored value of latitude and longitude or describing where places are in relation to each other. A GIS readily answers spatial queries.

The GIS database was updated and utilized several times throughout the course of this project. The database has been transmitted to the USBR (through Internet), USSL in Riverside (tape file),

and to the USGS in Sacramento (tape file). Copies of the file can be made for other entities wishing to perform analysis of the study area using GIS. **Appendix A** includes a detailed description of the GIS developed for this project.

An ARC/INFO database has been developed for this project to manage all of the map data. Although initial maps were down-loaded from the Bureau of Reclamation's computer in Sacramento at the start of the project, many changes to the existing data were found to be necessary. Therefore, data was re-digitized from existing map sources and field checking using a USGS 7.5 minute quad series as the base. The quads are as follows:

Charleston School	Mendota Dam	Laguna Seca
Dos Palos	Firebaugh	
Oxalis	Broadview Farms	
Poso Farm	Hammonds Ranch	

These maps were supplemented with field information and other map bases received from various agencies. The GIS database presently contains basic information. The location data has been used extensively to generate maps and determine the physical interrelationships between districts. Parameters have been assigned to each of the input points and segments (such as the length and direction of flow). However, detailed information has not been incorporated into the database. For example, the monthly solute loadings for each sump for the 12 year study period are available in computer spreadsheet files. These files contain a tremendous amount of data that has not been filtered nor added to the ARCINFO database. As other entities utilize the database to expand the analysis of the study area, that data will be retrieved and used to update (and expand) the master files maintained at Cal Poly.

SUBSURFACE FLOW ANALYSIS

An estimate of subsurface flows was needed to estimate several components of the water balance. The subsurface lateral flow between districts, and the vertical flow to the deep aquifer. Estimates of these values were obtained from John Fio (personal communication). John Fio, with the USGS in Sacramento, used the GIS to perform an analysis of the base flow for the study area. The sump discharge data for all of the sumps in the study area was analyzed for the study period. Fio's analysis and data is included in **Appendix H.** Low flows have been assumed to approximate the most accurate determination of the base flow. The base flow was defined for this study as the net

groundwater inflow to the region from outside of the study area boundaries measured in the surface discharge measurements during the nonirrigated periods.

Sump discharge data from Broadview, CCID-Camp 13, Charleston, Firebaugh, Pacheco, and Panoche districts was obatined and formatted to a single spreadsheet application. High flows (January through September - in general) were separated from low flows during the non-irrigated time of the year (October-December).

The data collection effort uncovered an important recommendation for future activities for the districts. All data should be reported in a consistent format with well-defined protocols for data srorage and retrieval. For example, all data could be provided in ASCII format. Retrieval of the raw data was a significant amount of the expense for this portion of the study due to differences in reporting formats, embedded graphs, and programmed cell formulas.

The estimated lowflow in 1992 (most complete data set) was as follows; Broadview-52 AF, CCID C13-No Estimate, Charleston-30 AF, Firebaugh-409 AF, Pacheco-575 AF, Panoche-970 AF. The estimated total flow for these sumps was as follows; Broadview-853 AF, CCID C13-No Estimate, Charleston-320 AF, Firebaugh-3,045 AF, Pacheco-4,232 AF, Panoche-6,715 AF. The total low flow volume was 2,036 AF for the entire study area. The taoal flows (The total sump flow was estimated at 15,165 AF. The low flow represents about 13% of the total sump flow for the study area. The low flow total would respresent a minimum base flow since it does not account for baseflow during the irrigation months. This means that about 13% of the sump drainwater volumes placed into drains is from outside of the study area.

An estimate of incidental recharge below the Corcoran clay was also required for the water balance in this study. Preliminary results from a steady-state groundwater-flow model construicted by Fio (in review) indicate the following simulated incidental recharge to the aquifer below the Corcoran Clay; Panoche-0.54 AF/yr, Broadview-0.31 AF/yr, Firebaugh-.26 AF/yr.

Well pumping estimates were made by contacting individual growers in the study area. It was not possible to obtain values that were reasonable. Estimates of groundwater pumping were made by evaluating the ETc requirements. This was significant for Panoche Drainage District in 1991 and 1992 where groundwater pumping represented about 30% of the water supply.

SECTION 3

DISTRICT IRRIGATION EFFICIENCY: ETc APPROACH

OVERVIEW

The 1991 DIE Report (Burt et al, 1991) calculated district irrigation efficiencies using a number of definitions for four water districts in the Los Banos area; Broadview Water District, Firebaugh Canal Water District, Panoche Water District, and Pacheco Water District. A second report was completed in 1992 (Burt et al, 1992) which examined DIE's for two more districts; Charleston Drainage District and an approximately 5,000 acre subarea of Central California Irrigation District, often referred to as Camp 13. In addition, due to slight changes in the manner in which effective rainfall and crop water usage were calculated, the 1992 DIE Report recalculated the efficiencies for the original four districts. Particular attention was paid to PoWD which was seen to be at a much lower efficiency than the others in the previous study.

This study represents the 1993 DIE Report and is a further refinement of the previous two reports. Some of the added analysis includes a scrutiny of the water delivery and acreage data supplied by the districts. Some of the data was supplied as water delivered to the individual turnouts instead of to the district. Some of the data was supplied as water year or crop year instead of calendar year. This report changed the basis for the time frame of the analysis. This report uses a water year, or October 1 to September 30 timeline. This allowed a more ready backcheck of data against the RWQCB, USBR, and other data sources.

Also included was a refinement of the method of handling effective precipitation and leaching requirement. Based on an extensive analysis of the pre-plant irrigation efficiencies, it was determined that previous methods to determine effective precipitation quantities were overestimating the benefit of the rainfall.

Since 1985, additional data has been collected and reported for the drainage volumes discharged by the districts. Using this data and some assumptions regarding subsurface water flows, an estimate of the irrigation efficiency using a "bathtub" or water balance approach was completed in

order to verify the validity of the values generated by the theoretical ETc approach. The water balance approach is described in the next section of the report.

District Irrigation Efficiency is defined as:

$$DIE = \frac{\text{Applied Irrigation Water which is Beneficially Used} \times 100}{\text{Applied Irrigation Water}}$$

Where;

The boundary of beneficial use is the district. "Beneficial use of applied irrigation water" includes crop ET, leaching to maintain a salt balance, and leaching for reclamation. "Applied irrigation water" refers to water entering the district boundaries including contract water, district/grower wells, upwards flux into the root zone of groundwater originating from outside the district, and surface inflows from outside the district. Rainfall can be either surface runoff or infiltrated soil moisture that could end up as crop ETc, salt balance leaching, reclamation leaching, or non-beneficial deep percolation.

The DIE values were determined for water years 1981 to 1992 depending on what information was available. In this report, 1981 refers to the water year October 1, 1980 through September 30, 1981. The goal was to identify the relative level of DIE and any trends up or down. Another goal was to determine the maximum attainable irrigation efficiencies.

DATA ANALYSIS - ETc APPROACH

The following describes the process used to determine the district irrigation efficiency of the various districts. It is described in **levels** for the general objectives. The detailed information discussed in this section required to calculate the final DIE values is described in **steps**.

Level I: Data requirements identified.

- Estimates of ETo (CIMIS)
- Crop coefficient (Kc) curves for the different crops
- Estimates of Kc reductions due to uneven growth
- Acreages for the different crops by year
- Water supplies into the districts
- Water quality delivered to the farm

- Estimates of gross rainfall
- Estimates of effective rainfall

Level II: Sources for the required data identified.

- The Districts themselves, including personal conversations, searches of water delivery records, the DOP's submitted to the CVRWCQB, the annual crop and water supply reports to the USBR (for Reclamation Districts), and the 1985 WCP's submitted to the USBR (for Reclamation Districts).
- The USBR for their records of water deliveries through the DMC and the San Luis Canal (California Aqueduct).
- The DWR sponsored CIMIS network for ETo and gross rainfall information.
- The University of California and USSL, technical publications, and private consultants for crop coefficient curves and salinity-tolerance data.
- The USBR and DWR for functions relating effective and gross rainfall.

Level III: Initial data transformations are done.

- Step 1: Assess Kc values for crops
- Step 2: Report ETo from CIMIS. Estimate years where data not available.
- Step 3: Calculate annual ETc based on ETo and crop coefficients
- Step 4: Report irrigated acreage for each District
- Step 5: Calculate crop water use
- Step 6: Calculations of effective rainfall
- Step 7: Report the water delivered for each district
- Step 8: Calculations of leaching requirements

Level IV: The estimate of DIE are determined based on the definition of beneficial use and delivered water. The beneficial use for each crop and the water supplies to the districts are calculated. This value is represented by the sum of the crop ETc and the leaching requirement less the amount of water supplied by effective precipitation. This report uses 50% of the total rainfall during October through March as effective rain.

- Step 9: Calculate the District Irrigation Efficiency (DIE)

Level VI: A check of calculated expected drainage is compared to the measured drainage through Grassland Water District. Level VI is discussed in section 5.

PROCEDURE

A single spreadsheet was developed for the entire study area using the ETc approach. The spreadsheet is available in PC-Compatible format or Macintosh format. The entire spreadsheet in its original format is included in **Appendix** D.

STEP 1: Crop Coefficients

Determination of the crop coefficients.

The crop coefficient is a dimensionless number (usually between 0.0 and 1.2) that is multiplied by the reference evapotranspiration (ETo) value to arrive at a crop evapotranspiration (ETc) estimate. Average crop coefficients were determined from various sources including DWR published values, the University of California Cooperative Extension, locally developed Kc's and Kc's reported from Westlands Water District. The daily values used for each of the crops in this report are included in **Appendix B**. The following table are the monthly Kc's used in this report.

Table 10
Monthly Crop Kc Values

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Fallow	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Misc.	0.00	0.00	0.00	0.06	0.30	0.59	1.02	0.92	0.00	0.00	0.00	0.00
Cotton	0.05	0.00	0.00	0.00	0.00	0.00	0.10	0.23	0.70	1.03	1.02	0.56
Alfalfa	0.79	0.57	0.36	0.25	0.32	0.82	0.90	0.90	0.90	0.90	0.90	0.90
Wheat	0.00	0.04	0.23	0.54	0.95	1.17	1.04	0.47	0.00	0.00	0.00	0.00
Melons	0.00	0.00	0.00	0.00	0.00	0.04	0.18	0.43	0.94	0.18	0.00	0.00
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.05	0.24	0.40	0.90	1.10	0.85	0.00
Sugar Beets	1.10	1.10	1.10	1.10	1.04	0.44	0.00	0.13	0.38	0.96	1.10	1.10
Barley	0.00	0.03	0.23	0.53	0.93	1.15	0.98	0.30	0.00	0.00	0.00	0.00
Beans	0.00	0.00	0.00	0.00	0.00	0.03	0.14	0.78	1.14	0.56	0.00	0.00
Seed Alf.	0.00	0.03	0.20	0.24	0.47	0.74	0.97	0.97	0.66	0.19	0.00	0.00
Rice	0.00	0.00	0.00	0.00	0.00	0.19	0.95	1.14	1.25	1.17	1.02	0.00
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.36	0.88	1.10	0.93	0.27
Vegetable	0.00	0.00	0.00	0.06	0.30	0.59	1.02	0.92	0.00	0.00	0.00	0.00
Pasture	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Stonefruit	0.89	0.00	0.00	0.00	0.00	0.50	0.78	0.89	0.98	0.98	0.98	0.97
Walnut/Apple	0.42	0.06	0.00	0.00	0.00	0.54	0.84	0.95	1.06	1.14	1.09	0.77
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.16	0.51	1.04	0.93	0.59

Upon evaluation of aerial photography and site visits, it was determined that maximum Kc's were not being achieved in the study area due to stunted growth and bare ground spots included in the acreage figures. A detailed visual analysis of the crops was completed to determine the impact. Slides of each section in the study area were evaluated and assessed a reduction factor. The overall reduction factor was 86%. All of the Kc values were multiplied by 86% to reflect the reduction in crop water use due to stunted growth and bare ground.

STEP 2: ETo

Obtain the reference evapotranspiration (ETo) values.

ETo was obtained from the CIMIS database in Sacramento. Reference Evapotranspiration (ETo) is a term used to estimate the ET rate of a reference crop. The reference crop used for the CIMIS program is grass, which is close clipped, actively growing, completely shading the soil, and well watered. Data for this study was obtained from the CIMIS station #7 located near Firebaugh, California. The station is located on the Tellis Ranch and was activated in September of 1982. Values for 1981 and 1982 were from the 1983 set of data. The following table summarizes the values reported for the ETo. Note that the ETo does not vary significantly on a year to year basis.

Table 11
Monthly ETo (in Inches) at CIMIS Station #7, Telles Ranch

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1981*	3.83	1.96	1.14	1.19	2.05	3.80	5.75	7.70	8.45	8.50	7.09	5.43	57
1982*	3.83	1.96	1.14	1.19	2.05	3.80	5.75	7.70	8.45	8.50	7.09	5.43	57
1983	3.83	1.96	1.14	0.85	1.80	3.00	4.84	8.80	9.57	9.24	7.48	5.73	58
1984	3.45	1.35	0.95	0.98	2.16	4.60	5.77	8.96	8.55	8.57	7.11	6.28	59
1985	3.83	1.75	1.74	0.96	2.37	3.53	6.43	7.56	8.57	8.19	7.19	5.40	58
1986	3.88	1.81	0.77	1.24	2.03	3.50	5.59	7.50	8.04	7.90	7.30	5.07	55
1987	4.02	2.54	0.73	1.32	1.71	3.78	6.65	7.71	8.29	8.25	7.06	5.40	57
1988	3.66	1.62	1.39	1.21	2.65	5.20	4.98	7.25	7.47	8.40	6.72	5.31	56
1989	3.30	1.59	0.94	1.49	1.70	3.83	5.75	7.86	8.58	8.95	7.40	5.12	57
1990	3.94	1.98	1.05	1.34	1.94	3.76	6.14	7.02	8.44	8.46	7.03	5.41	57
1991	4.44	2.55	1.51	1.31	2.09	2.97	5.61	6.66	8.57	8.57	6.51	5.15	56
1992	3.96	2.44	1.17	0.73	1.81	3.01	5.81	8.12	7.74	7.94	7.52	5.69	56
Average	3.83	1.96	1.14	1.15	2.03	3.73	5.76	7.74	8.39	8.46	7.12	5.45	56.7

* Note: 1981 and 1982 are average values.

STEP 3: ETc

Calculation of the crop ETc.

The annual crop ETc was obtained by summing the calculated monthly ETo values reported by CIMIS by the Kc values for each crop. The equation for ETc is:

ETc = Kc x Factor (stunted growth) x ETo

Where, ETc = Monthly crop evapotranspiration
Kc = Average monthly crop coefficient
Factor = Adjustment factor for stunted growth and bare spots (86%)
ETo = Monthly reference evapotranspiration (grass reference)

The following table represents the average ETc for the entire study time from of 1981 through 1992. For this report, each year was evaluated individually. Tables 13 through 24 represent the ETc calculated for each year.

Table 12
Average Monthly ETc (in Inches): 1981-1992

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Inches
Fallow	0.20	0.10	0.06	0.06	0.10	0.19	0.30	0.40	0.43	0.44	0.37	0.28	**3**
Misc.	0.00	0.00	0.00	0.06	0.52	1.89	5.05	6.13	0.00	0.00	0.00	0.00	**14**
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.51	1.50	5.03	7.50	6.25	2.65	**24**
Alfalfa	2.60	0.97	0.35	0.25	0.57	2.63	4.46	5.99	6.50	6.55	5.51	4.22	**41**
Wheat	0.00	0.06	0.22	0.53	1.66	3.75	5.17	3.12	0.00	0.00	0.00	0.00	**15**
Melons	0.00	0.00	0.00	0.00	0.00	0.11	0.89	2.89	6.80	1.33	0.00	0.00	**12**
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.15	1.19	2.65	6.52	8.00	5.20	0.00	**24**
Sugar Beets	3.62	1.85	1.08	1.09	1.82	1.42	0.00	0.84	2.76	7.00	6.74	5.16	**33**
Barley	0.00	0.06	0.22	0.52	1.63	3.69	4.87	1.99	0.00	0.00	0.00	0.00	**13**
Beans	0.00	0.00	0.00	0.00	0.00	0.09	0.69	5.18	8.20	4.09	0.00	0.00	**18**
Seed Alf.	0.00	0.06	0.20	0.24	0.82	2.36	4.82	6.45	4.79	1.40	0.00	0.00	**21**
Rice	0.00	0.00	0.00	0.00	0.00	0.60	4.73	7.59	9.02	8.54	6.26	0.00	**37**
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.61	2.37	6.33	8.00	5.71	1.29	**24**
Vegetable	0.00	0.00	0.00	0.06	0.52	1.89	5.05	6.13	0.00	0.00	0.00	0.00	**14**
Pasture	2.97	1.52	0.88	0.89	1.57	2.89	4.46	5.99	6.50	6.55	5.51	4.22	**44**
Stonefruit	2.94	0.00	0.00	0.00	0.00	1.60	3.88	5.95	7.04	7.13	6.00	4.54	**39**
Walnut/Apple	1.39	0.10	0.00	0.00	0.00	1.72	4.14	6.31	7.65	8.27	6.68	3.61	**40**
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.16	1.06	3.66	7.59	5.67	2.79	**21**

Table 13
Monthly ETc (in Inches): 1981

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Fallow	0.20	0.10	0.06	0.06	0.11	0.20	0.30	0.40	0.44	0.44	0.37	0.28	**3**
Misc.	0.00	0.00	0.00	0.06	0.53	1.93	5.04	6.10	0.00	0.00	0.00	0.00	**14**
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.51	1.49	5.07	7.54	6.22	2.64	**24**
Alfalfa	2.60	0.97	0.35	0.26	0.57	2.67	4.45	5.96	6.54	6.58	5.49	4.20	**41**
Wheat	0.00	0.06	0.22	0.55	1.67	3.82	5.17	3.11	0.00	0.00	0.00	0.00	**15**
Melons	0.00	0.00	0.00	0.00	0.00	0.12	0.89	2.88	6.85	1.34	0.00	0.00	**12**
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.15	1.19	2.64	6.56	8.04	5.17	0.00	**24**
Sugar Beets	3.62	1.85	1.08	1.12	1.83	1.45	0.00	0.84	2.78	7.04	6.71	5.14	**33**
Barley	0.00	0.06	0.22	0.54	1.65	3.75	4.86	1.98	0.00	0.00	0.00	0.00	**13**
Beans	0.00	0.00	0.00	0.00	0.00	0.09	0.69	5.16	8.26	4.12	0.00	0.00	**18**
Seed Alf.	0.00	0.06	0.20	0.25	0.83	2.40	4.82	6.42	4.83	1.41	0.00	0.00	**21**
Rice	0.00	0.00	0.00	0.00	0.00	0.61	4.72	7.55	9.09	8.58	6.23	0.00	**37**
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.61	2.36	6.38	8.04	5.68	1.28	**24**
Vegetable	0.00	0.00	0.00	0.06	0.53	1.93	5.04	6.10	0.00	0.00	0.00	0.00	**14**
Pasture	2.97	1.52	0.88	0.92	1.59	2.94	4.45	5.96	6.54	6.58	5.49	4.20	**44**
Stonefruit	2.94	0.00	0.00	0.00	0.00	1.63	3.88	5.92	7.09	7.17	5.97	4.52	**39**
Walnut/Apple	1.39	0.10	0.00	0.00	0.00	1.75	4.14	6.28	7.70	8.32	6.65	3.60	**40**
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.16	1.06	3.69	7.64	5.64	2.77	**21**

Table 14
Monthly ETc (in Inches): 1982

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Fallow	0.20	0.10	0.06	0.06	0.11	0.20	0.30	0.40	0.44	0.44	0.37	0.28	**3**
Misc.	0.00	0.00	0.00	0.06	0.53	1.93	5.04	6.10	0.00	0.00	0.00	0.00	**14**
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.51	1.49	5.07	7.54	6.22	2.64	**24**
Alfalfa	2.60	0.97	0.35	0.26	0.57	2.67	4.45	5.96	6.54	6.58	5.49	4.20	**41**
Wheat	0.00	0.06	0.22	0.55	1.67	3.82	5.17	3.11	0.00	0.00	0.00	0.00	**15**
Melons	0.00	0.00	0.00	0.00	0.00	0.12	0.89	2.88	6.85	1.34	0.00	0.00	**12**
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.15	1.19	2.64	6.56	8.04	5.17	0.00	**24**
Sugar Beets	3.62	1.85	1.08	1.12	1.83	1.45	0.00	0.84	2.78	7.04	6.71	5.14	**33**
Barley	0.00	0.06	0.22	0.54	1.65	3.75	4.86	1.98	0.00	0.00	0.00	0.00	**13**
Beans	0.00	0.00	0.00	0.00	0.00	0.09	0.69	5.16	8.26	4.12	0.00	0.00	**18**
Seed Alf.	0.00	0.06	0.20	0.25	0.83	2.40	4.82	6.42	4.83	1.41	0.00	0.00	**21**
Rice	0.00	0.00	0.00	0.00	0.00	0.61	4.72	7.55	9.09	8.58	6.23	0.00	**37**
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.61	2.36	6.38	8.04	5.68	1.28	**24**
Vegetable	0.00	0.00	0.00	0.06	0.53	1.93	5.04	6.10	0.00	0.00	0.00	0.00	**14**
Pasture	2.97	1.52	0.88	0.92	1.59	2.94	4.45	5.96	6.54	6.58	5.49	4.20	**44**
Stonefruit	2.94	0.00	0.00	0.00	0.00	1.63	3.88	5.92	7.09	7.17	5.97	4.52	**39**
Walnut/Apple	1.39	0.10	0.00	0.00	0.00	1.75	4.14	6.28	7.70	8.32	6.65	3.60	**40**
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.16	1.06	3.69	7.64	5.64	2.77	**21**

Table 15
Monthly ETc (in Inches): 1983

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Fallow	0.20	0.10	0.06	0.04	0.09	0.15	0.25	0.45	0.49	0.48	0.39	0.30	**3**
Misc.	0.00	0.00	0.00	0.04	0.46	1.52	4.24	6.97	0.00	0.00	0.00	0.00	**13**
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.43	1.71	5.74	8.20	6.56	2.78	**26**
Alfalfa	2.60	0.97	0.35	0.18	0.50	2.11	3.75	6.81	7.41	7.15	5.79	4.44	**42**
Wheat	0.00	0.06	0.22	0.39	1.47	3.02	4.35	3.55	0.00	0.00	0.00	0.00	**13**
Melons	0.00	0.00	0.00	0.00	0.00	0.09	0.75	3.29	7.75	1.46	0.00	0.00	**13**
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.12	1.00	3.02	7.43	8.74	5.46	0.00	**26**
Sugar Beets	3.62	1.85	1.08	0.80	1.61	1.14	0.00	0.96	3.15	7.65	7.08	5.42	**34**
Barley	0.00	0.06	0.22	0.39	1.45	2.96	4.09	2.27	0.00	0.00	0.00	0.00	**11**
Beans	0.00	0.00	0.00	0.00	0.00	0.07	0.58	5.89	9.35	4.47	0.00	0.00	**20**
Seed Alf.	0.00	0.06	0.20	0.18	0.73	1.90	4.05	7.33	5.46	1.54	0.00	0.00	**21**
Rice	0.00	0.00	0.00	0.00	0.00	0.48	3.97	8.63	10.29	9.33	6.58	0.00	**39**
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.51	2.70	7.22	8.74	5.99	1.35	**27**
Vegetable	0.00	0.00	0.00	0.04	0.46	1.52	4.24	6.97	0.00	0.00	0.00	0.00	**13**
Pasture	2.97	1.52	0.88	0.66	1.39	2.32	3.75	6.81	7.41	7.15	5.79	4.44	**45**
Stonefruit	2.94	0.00	0.00	0.00	0.00	1.29	3.26	6.76	8.03	7.79	6.30	4.77	**41**
Walnut/Apple	1.39	0.10	0.00	0.00	0.00	1.38	3.48	7.17	8.72	9.04	7.01	3.80	**42**
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.13	1.21	4.17	8.30	5.95	2.93	**23**

Table 16
Monthly ETc (in Inches): 1984

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Fallow	0.18	0.07	0.05	0.05	0.11	0.24	0.30	0.46	0.44	0.44	0.37	0.32	**3**
Misc.	0.00	0.00	0.00	0.05	0.56	2.33	5.06	7.10	0.00	0.00	0.00	0.00	**15**
Cotton	0.14	0.00	0.00	0.00	0.00	0.00	0.52	1.74	5.13	7.60	6.24	3.05	**24**
Alfalfa	2.34	0.67	0.29	0.21	0.60	3.24	4.47	6.94	6.62	6.63	5.50	4.86	**42**
Wheat	0.00	0.04	0.19	0.45	1.76	4.62	5.18	3.62	0.00	0.00	0.00	0.00	**16**
Melons	0.00	0.00	0.00	0.00	0.00	0.14	0.89	3.35	6.92	1.35	0.00	0.00	**13**
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.19	1.19	3.07	6.64	8.11	5.19	0.00	**24**
Sugar Beets	3.26	1.28	0.90	0.93	1.93	1.75	0.00	0.97	2.81	7.10	6.73	5.94	**34**
Barley	0.00	0.04	0.19	0.45	1.74	4.54	4.88	2.31	0.00	0.00	0.00	0.00	**14**
Beans	0.00	0.00	0.00	0.00	0.00	0.11	0.69	6.00	8.36	4.15	0.00	0.00	**19**
Seed Alf.	0.00	0.04	0.16	0.20	0.88	2.91	4.83	7.47	4.88	1.42	0.00	0.00	**23**
Rice	0.00	0.00	0.00	0.00	0.00	0.74	4.74	8.79	9.19	8.65	6.25	0.00	**38**
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.61	2.75	6.45	8.11	5.70	1.48	**25**
Vegetable	0.00	0.00	0.00	0.05	0.56	2.33	5.06	7.10	0.00	0.00	0.00	0.00	**15**
Pasture	2.67	1.04	0.74	0.76	1.67	3.56	4.47	6.94	6.62	6.63	5.50	4.86	**45**
Stonefruit	2.65	0.00	0.00	0.00	0.00	1.97	3.89	6.89	7.17	7.22	5.99	5.22	**41**
Walnut/Apple	1.25	0.07	0.00	0.00	0.00	2.12	4.15	7.30	7.79	8.38	6.67	4.16	**42**
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.16	1.23	3.73	7.69	5.66	3.21	**22**

Table 17
Monthly ETc (in Inches): 1985

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Fallow	0.20	0.09	0.09	0.05	0.12	0.18	0.33	0.39	0.44	0.42	0.37	0.28	**3**
Misc.	0.00	0.00	0.00	0.05	0.61	1.79	5.64	5.99	0.00	0.00	0.00	0.00	**14**
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.58	1.47	5.14	7.27	6.31	2.62	**24**
Alfalfa	2.59	0.86	0.54	0.21	0.66	2.48	4.98	5.85	6.63	6.34	5.57	4.18	**41**
Wheat	0.00	0.05	0.34	0.44	1.94	3.55	5.77	3.05	0.00	0.00	0.00	0.00	**15**
Melons	0.00	0.00	0.00	0.00	0.00	0.11	1.00	2.83	6.94	1.29	0.00	0.00	**12**
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.14	1.33	2.59	6.65	7.75	5.24	0.00	**24**
Sugar Beets	3.62	1.66	1.65	0.91	2.12	1.35	0.00	0.82	2.82	6.78	6.80	5.11	**34**
Barley	0.00	0.05	0.34	0.44	1.90	3.49	5.44	1.95	0.00	0.00	0.00	0.00	**14**
Beans	0.00	0.00	0.00	0.00	0.00	0.08	0.77	5.06	8.38	3.96	0.00	0.00	**18**
Seed Alf.	0.00	0.05	0.30	0.20	0.96	2.24	5.38	6.30	4.89	1.36	0.00	0.00	**22**
Rice	0.00	0.00	0.00	0.00	0.00	0.57	5.28	7.41	9.21	8.27	6.32	0.00	**37**
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.68	2.32	6.46	7.75	5.76	1.27	**24**
Vegetable	0.00	0.00	0.00	0.05	0.61	1.79	5.64	5.99	0.00	0.00	0.00	0.00	**14**
Pasture	2.96	1.35	1.35	0.74	1.83	2.73	4.98	5.85	6.63	6.34	5.57	4.18	**45**
Stonefruit	2.94	0.00	0.00	0.00	0.00	1.51	4.33	5.81	7.19	6.90	6.06	4.49	**39**
Walnut/Apple	1.39	0.09	0.00	0.00	0.00	1.62	4.62	6.16	7.81	8.01	6.74	3.58	**40**
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.18	1.04	3.74	7.35	5.72	2.76	**21**

Table 18
Monthly ETc (in Inches): 1986

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Fallow	0.20	0.09	0.04	0.06	0.10	0.18	0.29	0.39	0.41	0.41	0.38	0.26	**3**
Misc.	0.00	0.00	0.00	0.06	0.52	1.78	4.90	5.94	0.00	0.00	0.00	0.00	**13**
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.50	1.45	4.82	7.01	6.41	2.46	**23**
Alfalfa	2.63	0.89	0.24	0.27	0.57	2.46	4.33	5.81	6.22	6.11	5.65	3.92	**39**
Wheat	0.00	0.06	0.15	0.57	1.66	3.52	5.02	3.03	0.00	0.00	0.00	0.00	**14**
Melons	0.00	0.00	0.00	0.00	0.00	0.11	0.87	2.80	6.51	1.25	0.00	0.00	**12**
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.14	1.15	2.57	6.24	7.47	5.32	0.00	**23**
Sugar Beets	3.67	1.71	0.73	1.17	1.82	1.33	0.00	0.82	2.64	6.54	6.91	4.80	**32**
Barley	0.00	0.05	0.15	0.57	1.63	3.46	4.73	1.93	0.00	0.00	0.00	0.00	**13**
Beans	0.00	0.00	0.00	0.00	0.00	0.08	0.67	5.02	7.86	3.82	0.00	0.00	**17**
Seed Alf.	0.00	0.05	0.13	0.26	0.82	2.22	4.68	6.25	4.59	1.31	0.00	0.00	**20**
Rice	0.00	0.00	0.00	0.00	0.00	0.56	4.59	7.36	8.64	7.98	6.42	0.00	**36**
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.59	2.30	6.06	7.47	5.85	1.20	**23**
Vegetable	0.00	0.00	0.00	0.06	0.52	1.78	4.90	5.94	0.00	0.00	0.00	0.00	**13**
Pasture	3.00	1.40	0.60	0.96	1.57	2.71	4.33	5.81	6.22	6.11	5.65	3.92	**42**
Stonefruit	2.98	0.00	0.00	0.00	0.00	1.50	3.77	5.77	6.75	6.66	6.15	4.22	**38**
Walnut/Apple	1.41	0.09	0.00	0.00	0.00	1.61	4.02	6.11	7.33	7.73	6.84	3.36	**39**
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.15	1.03	3.51	7.09	5.81	2.59	**20**

Table 19
Monthly ETc (in Inches): 1987

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Fallow	0.21	0.13	0.04	0.07	0.09	0.20	0.34	0.40	0.43	0.43	0.36	0.28	**3**
Misc.	0.00	0.00	0.00	0.07	0.44	1.92	5.83	6.11	0.00	0.00	0.00	0.00	**14**
Cotton	0.17	0.00	0.00	0.00	0.00	0.00	0.59	1.49	4.97	7.32	6.19	2.62	**23**
Alfalfa	2.72	1.25	0.23	0.28	0.48	2.66	5.15	5.97	6.42	6.39	5.46	4.18	**41**
Wheat	0.00	0.08	0.14	0.61	1.40	3.80	5.97	3.11	0.00	0.00	0.00	0.00	**15**
Melons	0.00	0.00	0.00	0.00	0.00	0.12	1.03	2.88	6.71	1.30	0.00	0.00	**12**
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.15	1.37	2.64	6.43	7.80	5.15	0.00	**24**
Sugar Beets	3.80	2.40	0.69	1.25	1.53	1.44	0.00	0.84	2.73	6.83	6.68	5.11	**33**
Barley	0.00	0.07	0.14	0.60	1.37	3.73	5.62	1.99	0.00	0.00	0.00	0.00	**14**
Beans	0.00	0.00	0.00	0.00	0.00	0.09	0.80	5.16	8.10	3.99	0.00	0.00	**18**
Seed Alf.	0.00	0.07	0.13	0.27	0.69	2.39	5.57	6.43	4.73	1.37	0.00	0.00	**22**
Rice	0.00	0.00	0.00	0.00	0.00	0.61	5.46	7.56	8.91	8.33	6.21	0.00	**37**
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.70	2.37	6.25	7.80	5.66	1.27	**24**
Vegetable	0.00	0.00	0.00	0.07	0.44	1.92	5.83	6.11	0.00	0.00	0.00	0.00	**14**
Pasture	3.11	1.97	0.57	1.02	1.32	2.93	5.15	5.97	6.42	6.39	5.46	4.18	**44**
Stonefruit	3.09	0.00	0.00	0.00	0.00	1.62	4.48	5.93	6.96	6.95	5.95	4.49	**39**
Walnut/Apple	1.46	0.13	0.00	0.00	0.00	1.74	4.78	6.29	7.56	8.07	6.62	3.58	**40**
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.18	1.06	3.62	7.41	5.62	2.76	**21**

Table 20
Monthly ETc (in Inches): 1988

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Fallow	0.19	0.08	0.07	0.06	0.14	0.27	0.26	0.37	0.39	0.43	0.35	0.27	**3**
Misc.	0.00	0.00	0.00	0.06	0.68	2.64	4.37	5.74	0.00	0.00	0.00	0.00	**13**
Cotton	0.15	0.00	0.00	0.00	0.00	0.00	0.45	1.41	4.48	7.45	5.90	2.58	**22**
Alfalfa	2.48	0.80	0.43	0.26	0.74	3.66	3.85	5.61	5.78	6.50	5.20	4.11	**39**
Wheat	0.00	0.05	0.27	0.56	2.16	5.23	4.47	2.93	0.00	0.00	0.00	0.00	**16**
Melons	0.00	0.00	0.00	0.00	0.00	0.16	0.77	2.71	6.05	1.32	0.00	0.00	**11**
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.21	1.03	2.49	5.80	7.95	4.90	0.00	**22**
Sugar Beets	3.46	1.53	1.31	1.14	2.37	1.98	0.00	0.79	2.46	6.96	6.36	5.02	**33**
Barley	0.00	0.05	0.27	0.55	2.13	5.14	4.21	1.87	0.00	0.00	0.00	0.00	**14**
Beans	0.00	0.00	0.00	0.00	0.00	0.12	0.60	4.85	7.30	4.07	0.00	0.00	**17**
Seed Alf.	0.00	0.05	0.24	0.25	1.08	3.29	4.17	6.04	4.26	1.40	0.00	0.00	**21**
Rice	0.00	0.00	0.00	0.00	0.00	0.84	4.09	7.11	8.03	8.48	5.91	0.00	**34**
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.52	2.23	5.63	7.95	5.38	1.25	**23**
Vegetable	0.00	0.00	0.00	0.06	0.68	2.64	4.37	5.74	0.00	0.00	0.00	0.00	**13**
Pasture	2.83	1.25	1.08	0.94	2.05	4.02	3.85	5.61	5.78	6.50	5.20	4.11	**43**
Stonefruit	2.81	0.00	0.00	0.00	0.00	2.23	3.36	5.57	6.27	7.08	5.66	4.42	**37**
Walnut/Apple	1.33	0.08	0.00	0.00	0.00	2.39	3.58	5.91	6.81	8.22	6.30	3.52	**38**
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.14	1.00	3.26	7.54	5.35	2.71	**20**

Table 21
Monthly ETc (in Inches): 1989

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Fallow	0.17	0.08	0.05	0.08	0.09	0.20	0.30	0.41	0.44	0.46	0.38	0.26	**3**
Misc.	0.00	0.00	0.00	0.08	0.44	1.94	5.04	6.22	0.00	0.00	0.00	0.00	**14**
Cotton	0.14	0.00	0.00	0.00	0.00	0.00	0.51	1.52	5.14	7.94	6.49	2.49	**24**
Alfalfa	2.24	0.79	0.29	0.32	0.47	2.70	4.45	6.08	6.64	6.93	5.73	3.96	**41**
Wheat	0.00	0.05	0.19	0.69	1.39	3.85	5.16	3.17	0.00	0.00	0.00	0.00	**14**
Melons	0.00	0.00	0.00	0.00	0.00	0.12	0.89	2.94	6.95	1.41	0.00	0.00	**12**
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.16	1.19	2.70	6.66	8.47	5.40	0.00	**25**
Sugar Beets	3.12	1.50	0.89	1.41	1.52	1.46	0.00	0.86	2.82	7.41	7.00	4.84	**33**
Barley	0.00	0.05	0.19	0.68	1.37	3.78	4.86	2.02	0.00	0.00	0.00	0.00	**13**
Beans	0.00	0.00	0.00	0.00	0.00	0.09	0.69	5.26	8.38	4.33	0.00	0.00	**19**
Seed Alf.	0.00	0.04	0.16	0.31	0.69	2.43	4.81	6.55	4.90	1.49	0.00	0.00	**21**
Rice	0.00	0.00	0.00	0.00	0.00	0.62	4.72	7.71	9.22	9.04	6.51	0.00	**38**
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.61	2.41	6.47	8.47	5.93	1.21	**25**
Vegetable	0.00	0.00	0.00	0.08	0.44	1.94	5.04	6.22	0.00	0.00	0.00	0.00	**14**
Pasture	2.55	1.23	0.73	1.15	1.32	2.96	4.45	6.08	6.64	6.93	5.73	3.96	**44**
Stonefruit	2.53	0.00	0.00	0.00	0.00	1.64	3.88	6.04	7.20	7.54	6.24	4.26	**39**
Walnut/Apple	1.20	0.08	0.00	0.00	0.00	1.76	4.13	6.41	7.82	8.75	6.94	3.39	**40**
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.16	1.08	3.74	8.04	5.89	2.62	**22**

Table 22
Monthly ETc (in Inches): 1990

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Fallow	0.20	0.10	0.05	0.07	0.10	0.19	0.32	0.36	0.44	0.44	0.36	0.28	**3**
Misc.	0.00	0.00	0.00	0.07	0.50	1.91	5.38	5.56	0.00	0.00	0.00	0.00	**13**
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.55	1.36	5.06	7.51	6.17	2.63	**23**
Alfalfa	2.67	0.98	0.33	0.29	0.54	2.65	4.75	5.43	6.53	6.55	5.44	4.19	**40**
Wheat	0.00	0.06	0.21	0.62	1.58	3.78	5.51	2.83	0.00	0.00	0.00	0.00	**15**
Melons	0.00	0.00	0.00	0.00	0.00	0.11	0.95	2.62	6.83	1.33	0.00	0.00	**12**
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.15	1.27	2.41	6.55	8.00	5.13	0.00	**24**
Sugar Beets	3.73	1.87	0.99	1.27	1.74	1.43	0.00	0.76	2.77	7.01	6.65	5.12	**33**
Barley	0.00	0.06	0.21	0.61	1.56	3.71	5.19	1.81	0.00	0.00	0.00	0.00	**13**
Beans	0.00	0.00	0.00	0.00	0.00	0.09	0.74	4.70	8.25	4.10	0.00	0.00	**18**
Seed Alf.	0.00	0.06	0.18	0.28	0.79	2.38	5.14	5.85	4.82	1.41	0.00	0.00	**21**
Rice	0.00	0.00	0.00	0.00	0.00	0.61	5.04	6.88	9.07	8.54	6.18	0.00	**36**
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.65	2.15	6.37	8.00	5.63	1.28	**24**
Vegetable	0.00	0.00	0.00	0.07	0.50	1.91	5.38	5.56	0.00	0.00	0.00	0.00	**13**
Pasture	3.05	1.53	0.81	1.04	1.50	2.91	4.75	5.43	6.53	6.55	5.44	4.19	**44**
Stonefruit	3.02	0.00	0.00	0.00	0.00	1.61	4.14	5.40	7.08	7.13	5.92	4.50	**39**
Walnut/Apple	1.43	0.10	0.00	0.00	0.00	1.73	4.41	5.72	7.69	8.28	6.59	3.58	**40**
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.97	3.68	7.60	5.60	2.76	**21**

Table 23
Monthly ETc (in Inches): 1991

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Fallow	0.23	0.13	0.08	0.07	0.11	0.15	0.29	0.34	0.44	0.44	0.34	0.27	**3**
Misc.	0.00	0.00	0.00	0.07	0.54	1.51	4.92	5.27	0.00	0.00	0.00	0.00	**12**
Cotton	0.19	0.00	0.00	0.00	0.00	0.00	0.50	1.29	5.14	7.60	5.71	2.50	**23**
Alfalfa	3.01	1.26	0.47	0.28	0.58	2.09	4.34	5.15	6.63	6.63	5.04	3.99	**39**
Wheat	0.00	0.08	0.30	0.60	1.71	2.99	5.04	2.69	0.00	0.00	0.00	0.00	**13**
Melons	0.00	0.00	0.00	0.00	0.00	0.09	0.87	2.49	6.94	1.35	0.00	0.00	**12**
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.12	1.16	2.28	6.65	8.11	4.75	0.00	**23**
Sugar Beets	4.20	2.41	1.43	1.24	1.87	1.13	0.00	0.72	2.82	7.10	6.16	4.87	**34**
Barley	0.00	0.07	0.30	0.60	1.68	2.93	4.74	1.72	0.00	0.00	0.00	0.00	**12**
Beans	0.00	0.00	0.00	0.00	0.00	0.07	0.68	4.46	8.38	4.15	0.00	0.00	**18**
Seed Alf.	0.00	0.07	0.26	0.27	0.85	1.88	4.70	5.55	4.89	1.42	0.00	0.00	**20**
Rice	0.00	0.00	0.00	0.00	0.00	0.48	4.61	6.53	9.21	8.65	5.72	0.00	**35**
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.59	2.04	6.46	8.11	5.22	1.22	**24**
Vegetable	0.00	0.00	0.00	0.07	0.54	1.51	4.92	5.27	0.00	0.00	0.00	0.00	**12**
Pasture	3.44	1.97	1.17	1.01	1.62	2.30	4.34	5.15	6.63	6.63	5.04	3.99	**43**
Stonefruit	3.41	0.00	0.00	0.00	0.00	1.27	3.78	5.12	7.19	7.22	5.49	4.28	**38**
Walnut/Apple	1.61	0.13	0.00	0.00	0.00	1.37	4.03	5.43	7.81	8.38	6.10	3.41	**38**
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.92	3.74	7.69	5.18	2.63	**20**

Table 24
Monthly ETc (in Inches): 1992

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Fallow	0.20	0.13	0.06	0.04	0.09	0.16	0.30	0.42	0.40	0.41	0.39	0.29	**3**
Misc.	0.00	0.00	0.00	0.04	0.47	1.53	5.09	6.43	0.00	0.00	0.00	0.00	**14**
Cotton	0.17	0.00	0.00	0.00	0.00	0.00	0.52	1.57	4.64	7.04	6.60	2.76	**23**
Alfalfa	2.68	1.20	0.36	0.16	0.51	2.12	4.50	6.28	5.99	6.15	5.82	4.40	**40**
Wheat	0.00	0.08	0.23	0.34	1.48	3.03	5.22	3.28	0.00	0.00	0.00	0.00	**14**
Melons	0.00	0.00	0.00	0.00	0.00	0.09	0.90	3.04	6.27	1.25	0.00	0.00	**12**
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.12	1.20	2.78	6.01	7.51	5.48	0.00	**23**
Sugar Beets	3.75	2.31	1.11	0.69	1.62	1.15	0.00	0.88	2.54	6.58	7.11	5.38	**33**
Barley	0.00	0.07	0.23	0.33	1.45	2.97	4.91	2.09	0.00	0.00	0.00	0.00	**12**
Beans	0.00	0.00	0.00	0.00	0.00	0.07	0.70	5.44	7.56	3.84	0.00	0.00	**18**
Seed Alf.	0.00	0.07	0.20	0.15	0.74	1.91	4.86	6.77	4.42	1.32	0.00	0.00	**20**
Rice	0.00	0.00	0.00	0.00	0.00	0.48	4.77	7.96	8.32	8.02	6.61	0.00	**36**
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.61	2.49	5.84	7.51	6.02	1.34	**24**
Vegetable	0.00	0.00	0.00	0.04	0.47	1.53	5.09	6.43	0.00	0.00	0.00	0.00	**14**
Pasture	3.07	1.89	0.91	0.57	1.40	2.33	4.50	6.28	5.99	6.15	5.82	4.40	**43**
Stonefruit	3.04	0.00	0.00	0.00	0.00	1.29	3.92	6.24	6.49	6.69	6.34	4.73	**39**
Walnut/Apple	1.44	0.12	0.00	0.00	0.00	1.39	4.18	6.62	7.05	7.77	7.05	3.77	**39**
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.16	1.12	3.38	7.13	5.99	2.91	**21**

STEP 4: Irrigated Acreage

Report the irrigated acreage values.

Irrigated acreage was reported for the water year in most cases. Some of the districts report acreage based on a calendar year. Some of the districts report acreage based on March through Febnruary. The data reported represents the most accurate data available. In order to standardized the reporting of information, some of the crops were grouped together. For example, carrots might be separated by the individual districts but would combined with other crops in the "vegetable" category.

BROADVIEW WATER DISTRICT: IRRIGATED ACREAGE

Table 25 is a summary of the acreages of the various crops for the years studied. Acreage data is recorded by the district based on a water year format (October through September). There was no reported acreage for the following crops; corn, vegetables, pasture, stonefruit, walnut/apple, or sorghum. Note the fallow acreage increases in 1991 and 1992 due to the drought. Note the substantial decrease in the cotton acreage in 1983 due to the PIC program.

Table 25
Acreage's of Crops for BWD: 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	0	334	3,790	95	345	854	1,128	531	452	799	3,460	4,602
Misc.	290	300	0	140	150	140	75	0	147	0	50	148
Cotton	5,669	5,283	2,035	4,905	4,037	4,231	3,721	4,348	4,649	4,416	3,828	2,257
Alfalfa	0	0	160	160	150	147	0	0	0	0	41	0
Wheat	1,046	1,149	835	900	983	968	1,160	689	708	903	304	0
Melons	0	455	450	300	790	670	1,080	1,535	1,279	814	198	448
Process Tom.	220	0	300	150	750	750	450	680	840	850	662	1,080
Sugar Beets	0	300	300	1,355	750	425	300	454	150	300	0	0
Barley	547	741	250	190	425	113	54	150	41	292	0	0
Beans	623	40	745	300	0	20	0	175	0	0	0	0
Seed Alf.	630	560	435	560	630	705	1,030	705	694	585	456	550
Rice	0	0	0	0	0	0	0	0	178	0	0	
Corn	0	0	0	0	0	0	0	0	0	0	0	0
Vegetable	0	0	0	0	0	0	0	0	0	0	0	0
Pasture	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	9,025	8,828	5,510	8,960	8,665	8,169	7,870	8,736	8,686	8,160	5,539	4,483

CCID-CAMP13: IRRIGATED ACREAGE

Approximately 5000 acres of a portion of the Central California Irrigation District was included in this study. This area is refered to as the Camp 13 area. This area was isolated due to low water quality being pumped from the tile drain systems.

Table 26 is a summary of the acreages of the various crops for the years studied. Acreage data is recorded by the district based on a water year format (October through September). There was no reported acreage for the following crops; processing tomatos, beans, seed alfalfa, vegetables, pasture, stonefruit, walnut/apple, or sorghum. In 1981 through 1984, data was not available from the district. Average values were used for these years.

Table 26
Acreages of Crops for CCID-Camp 13: 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	161	161	161	161	318	729	677	146	58	0	0	0
Misc.	0	0	0	0	0	0	0	0	0	0	0	0
Cotton	1,049	1,049	1,049	1,049	1,675	1,431	1,537	1,389	1,547	1,443	1,835	1,733
Alfalfa	288	288	288	288	0	0	340	485	551	551	745	784
Wheat	391	391	391	391	1,073	497	925	790	322	601	0	487
Melons	54	54	54	54	251	0	132	46	46	117	0	61
Process Tom.	0	0	0	0	0	0	0	0	0	0	0	0
Sugar Beets	764	764	764	764	1,970	1,485	556	1,462	1,245	806	863	782
Barley	56	56	56	56	0	0	0	0	0	0	319	351
Beans	0	0	0	0	0	0	0	0	0	0	0	0
Seed Alf.	0	0	0	0	0	0	0	0	0	0	0	0
Rice	540	540	540	540	442	1,039	1,452	1,047	355	720	793	630
Corn	41	41	41	41	0	88	130	0	0	198	0	72
Vegetable	0	0	0	0	0	0	0	0	0	0	0	0
Pasture	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3,183	3,183	3,183	3,183	5,411	4,540	5,072	5,219	4,066	4,436	4,555	4,900

CHARLESTON DRAINAGE DISTRICT: IRRIGATED ACREAGE

Approximately 5000 acres of a portion of the Central California Irrigation District was included in this study. This area is refered to as the Camp 13 area. This area was isolated due to low water quality being pumped from the tile drain systems.

Table 27 is a summary of the acreages of the various crops for the years studied. Acreage data is recorded by the district based on a water year format (October through September). There was no reported acreage for the following crops; wheat, seed alfalfa, rice, stonefruit, walnut/apple, or sorghum.

Table 27
Acreages of Various Crops for CDD: 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	140	115	146	281	526	861	34	171	151	812	416	416
Misc.	0	0	0	0	228	0	0	0	0	0	0	0
Cotton	669	318	1,604	1,998	1,206	1,964	2,453	1,671	2,408	2,544	2,595	2,595
Alfalfa	1,003	557	606	143	278	218	92	1,009	878	573	330	330
Wheat	0	0	0	0	0	0	0	0	0	0	0	0
Melons	490	367	346	1,256	677	515	1,057	514	53	257	525	525
Process Tom.	218	460	104	0	0	0	0	74	114	60	280	280
Sugar Beets	776	649	692	80	0	200	108	69	149	60	80	80
Barley	153	0	0	0	293	0	0	0	0	0	0	0
Beans	0	0	0	0	0	0	0	44	0	0	0	0
Seed Alf.	0	0	0	0	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0
Corn	279	902	260	0	0	0	0	90	0	0	80	80
Vegetable	30	390	0	0	550	0	14	0	0	0	0	0
Pasture	0	0	0	0	0	0	0	111	0	0	0	0
Stonefruit	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3,618	3,643	3,612	3,477	3,232	2,897	3,724	3,582	3,602	3,494	3,890	3,890

FIREBAUGH CANAL WATER DISTRICT: IRRIGATED ACREAGE

Table 28 is a summary of the acreages of the various crops for the years studied. Acreage data is recorded by the district based on a calendar year format (January through December). This may cause some differences in the irrigated acreage values for crops grown and irrigated during the October through December time frame. However, the differences would be small in the accounting of the acreage. The reported acreage for major crops such as cotton are not affected by the different time frames. There was no reported acreage for the following crops; barley, beans, seed alfalfa, pasture, stonefruit. FCWD accounts for cover crops grown in the district. The acreage for cover crops was placed in the sorghum category to account for the water use.

Table 28
Acreages of Various Crops for FCWD: 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	0	0	0	0	0	0	0	0	0	0	0	0
Misc.	0	0	0	0	0	0	0	0	0	0	0	0
Cotton	10,314	9,536	4,989	11,671	10,699	7,371	8,983	11,851	10,112	11,074	13,779	13,387
Alfalfa	1,611	522	935	964	992	1,218	1,692	1,834	2,119	2,298	2,550	2,600
Wheat	3,425	3,921	3,481	3,823	2,941	3,587	3,083	2,311	3,969	3,347	2,760	4,448
Melons	1,336	0	0	0	942	1,269	1,378	1,607	1,953	3,075	2,638	1,833
Process Tom.	558	0	0	0	0	0	0	710	968	1,594	1,534	1,336
Sugar Beets	2,119	1,951	1,674	1,459	2,759	2,823	3,463	2,499	3,115	2,564	832	168
Barley	0	0	0	0	0	0	0	0	0	0	0	0
Beans	0	0	0	0	0	0	0	0	0	0	0	0
Seed Alf.	0	0	0	0	0	0	0	0	0	0	0	0
Rice	1,101	1,946	3,057	1,691	649	1,240	1,143	1,287	601	302	88	111
Corn	141	125	157	0	0	1,269	0	0	0	0	0	0
Vegetable	793	2,208	1,763	1,083	749	811	565	66	515	303	312	353
Pasture	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	22	0	0	0	0	0	40	40	40	40	40	40
Sorghum	517	35	728	0	0	237	634	1,077	1,354	861	145	618
TOTAL	21,938	20,244	16,784	20,691	19,731	19,825	20,981	23,282	24,746	25,458	24,678	24,894

PACHECO WATER DISTRICT: IRRIGATED ACREAGE

Table 29 is a summary of the acreages of the various crops for the years studied. Acreage data is recorded by the district based on a water year format (October through September). There was no reported acreage for the following crops; sugar beets, rice, pasture, walnut/apple, or sorghum.

Table 29
Acreages of Various Crops for PWD: 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	0	0	714	622	1,120	720	802	321	739	0	0	0
Misc.	0	0	0	0	0	207	440	140	243	0	0	0
Cotton	2,663	1,727	2,271	2,271	2,263	2,076	2,194	2,320	2,080	2,011	2,138	2,373
Alfalfa	0	0	0	165	162	160	320	160	178	104	487	267
Wheat	734	271	60	60	0	0	20	139	257	370	0	0
Melons	37	0	0	0	675	1,057	823	966	516	1,363	747	423
Process Tom.	0	0	0	0	0	0	0	311	210	318	472	395
Sugar Beets	0	0	0	0	0	0	0	0	0	0	0	0
Barley	189	0	0	0	0	0	0	143	127	7	0	0
Beans	153	517	702	702	0	0	0	0	37	0	110	127
Seed Alf.	234	1,330	0	0	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0
Corn	0	165	165	0	0	0	0	0	0	0	0	0
Vegetable	0	0	98	98	0	0	231	0	0	81	415	120
Pasture	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit	400	400	400	400	0	0	0	0	0	0	0	0
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4,410	4,410	3,696	3,696	3,100	3,500	4,028	4,179	3,648	4,254	4,369	3,705

PANOCHE DRAINAGE DISTRICT: IRRIGATED ACREAGE

Table 30 is a summary of the acreages of the various crops for the years studied. Acreage data is recorded by the district based on a water year format (October through September). There was no reported acreage for rice in the district. Note the signicant increase in fallow acreage in the 1991 and 1992 drought years. Note the significant irrigated acreage decrease in 1982.

Table 30
Acreage's of Various Crops for Panoche DD: 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	1,165	1,218	4,703	869	869	1,468	798	852	1,029	4,235	7,916	8,566
Misc.	0	0	0	0	188	0	0	277	0	0	0	809
Cotton	18,036	10,282	13,529	17,057	15,331	14,924	14,895	18,560	15,239	14,601	13,056	12,477
Alfalfa	1,454	550	872	1,543	1,543	2,464	2,439	2,853	2,999	3,548	2,712	2,867
Wheat	4,419	1,059	2,524	3,593	2,823	2,115	3,622	837	3,451	1,825	0	298
Melons	2,712	1,552	2,507	819	3,984	2,215	1,193	1,504	3,282	3,485	1,966	2,238
Process Tom.	1,927	2,077	4,440	3,804	3,804	4,283	2,550	5,478	5,401	4,731	5,938	3,710
Sugar Beets	200	380	977	826	1,027	719	1,528	219	220	171	0	0
Barley	1,433	468	130	230	230	926	130	0	0	0	0	0
Beans	551	1,091	1,410	1,689	1,339	2,285	302	0	2,712	2,468	2,730	2,633
Seed Alf.	232	144	55	0	0	300	300	155	0	0	0	0
Rice	0	0	266	0	0	0	0	0	0	0	0	0
Corn	296	0	889	150	150	949	2,576	545	699	189	240	609
Vegetable	1,847	959	1,402	554	1,017	335	2,074	1,935	1,188	285	1,056	1,499
Pasture	111	111	111	0	680	45	0	1,122	26	0	0	0
Stonefruit	301	301	301	301	301	317	273	58	217	117	35	226
Walnut/Apple	0	0	0	32	32	250	253	252	252	379	393	376
Sorghum	632	1,012	290	156	926	1,026	73	0	0	0	0	0
TOTAL	34,151	19,986	29,703	30,754	33,375	33,153	32,208	33,795	35,686	31,799	28,126	27,742

STUDY AREA: IRRIGATED ACREAGE

Table 31 is a summary of the acreages of the various crops for the years studied for all six of the districts. Acreage data is recorded by the district based on a water year format (October through September).Note the signicant increase in fallow acreage in the 1991 and 1992 drought years.

Table 31
Acreage's of Various Crops for Entire Study Area: 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	1,466	1,828	9,514	2,028	3,178	4,632	3,439	2,021	2,429	5,846	11,792	13,584
Misc.	290	300	0	140	566	347	515	417	390	0	50	957
Cotton	38,400	28,195	25,477	38,951	35,211	31,997	33,783	40,139	36,035	36,089	37,231	34,822
Alfalfa	4,356	1,917	2,861	3,263	3,125	4,207	4,883	6,341	6,725	7,074	6,865	6,848
Wheat	10,015	6,791	7,291	8,767	7,820	7,167	8,810	4,766	8,707	7,046	3,064	5,233
Melons	4,629	2,428	3,357	2,429	7,319	5,726	5,663	6,172	7,129	9,111	6,074	5,528
Process Tom.	2,923	2,537	4,844	3,954	4,554	5,033	3,000	7,253	7,533	7,553	8,886	6,801
Sugar Beets	3,859	4,044	4,407	4,484	6,506	5,652	5,955	4,703	4,879	3,901	1,775	1,030
Barley	2,378	1,265	436	476	948	1,039	184	293	168	299	319	351
Beans	1,327	1,648	2,857	2,691	1,339	2,305	302	219	2,749	2,468	2,840	2,760
Seed Alf.	1,096	2,034	490	560	630	1,005	1,330	860	694	585	456	550
Rice	1,641	2,486	3,863	2,231	1,091	2,279	2,595	2,334	1,134	1,022	881	741
Corn	757	1,233	1,512	191	150	2,306	2,706	635	699	387	320	761
Vegetable	2,670	3,557	3,263	1,735	2,316	1,146	2,884	2,001	1,703	669	1,783	1,972
Pasture	111	111	111	0	680	45	0	1,233	26	0	0	0
Stonefruit	701	701	701	701	301	317	273	58	217	117	35	226
Walnut/Apple	22	0	0	32	32	250	293	292	292	419	433	416
Sorghum	1,149	1,047	1,018	156	926	1,263	707	1,077	1,354	861	145	618
TOTAL	76,325	60,294	62,488	70,761	73,514	72,084	73,883	78,793	80,434	77,601	71,157	69,614

STEP 5: Crop Water Use

Calculate crop water use

The estimate of the crop water use is determine by multiplying the ETc of the crops by the irrigated acreage for the different districts. The previous studies incorporated an estimate of the shallow ground water upflux component from water sources outside of the district. This was not used for this study. It was felt that uncertainties in the estimates of lateral subsurface flows did not justify the estimate of a nearly insignificant value. For example, inorder to determine the crop water use for Broadview Water District in 1981; multiply the total ETc for each crop (last column) from **Table 13** by the acreage for 1981 in Broadview (second column) listed in **Table 25**. Tables 13 through 24 are used for the ETc of the crops. Tables 25 through 30 are used for the irrigated acreage of each of the districts.

Table 32 is a summary of the crop water use for the Broadview Water District. Some of the values may be different from other reports do to combining acreages, conservative estimates of ETc, or other factors. **Table 33** through **Table 37** reflect the crop water use for the other districts. **Table 38** is the summary table of the crop water use for the study area.

Table 32
Crop Water Use (in AF) for Broadview Water District: 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	285	298	1,178	219	215	345	197	205	250	1,029	1,904	2,060
Misc.	0	0	0	0	220	0	0	311	0	0	0	914
Cotton	35,527	20,253	28,840	34,704	30,070	28,372	29,001	34,661	30,783	28,516	24,951	24,232
Alfalfa	4,925	1,863	3,056	5,448	5,259	8,029	8,371	9,375	10,146	11,928	8,922	9,598
Wheat	5,376	1,288	2,747	4,751	3,564	2,468	4,561	1,093	4,169	2,220	0	339
Melons	2,728	1,561	2,786	864	4,037	2,129	1,197	1,380	3,365	3,444	1,923	2,153
Process Tom.	3,815	4,112	9,533	7,728	7,515	8,176	5,006	10,213	11,055	9,268	11,416	7,145
Sugar Beets	558	1,060	2,798	2,313	2,878	1,926	4,240	609	602	475	0	0
Barley	1,560	510	124	271	261	966	147	0	0	0	0	0
Beans	841	1,665	2,393	2,717	2,037	3,324	457	0	4,240	3,675	4,033	3,865
Seed Alf.	410	255	98	0	0	508	541	268	0	0	0	0
Rice	0	0	871	0	0	0	0	0	0	0	0	0
Corn	601	0	1,964	314	303	1,856	5,164	1,043	1,462	379	473	1,209
Vegetable	2,102	1,091	1,547	697	1,193	369	2,482	2,175	1,358	319	1,083	1,693
Pasture	407	407	417	0	2,523	159	0	4,043	95	0	0	0
Stonefruit	981	981	1,032	1,029	984	998	898	181	711	378	110	730
Walnut/Apple	0	0	0	112	107	802	848	801	850	1,249	1,254	1,234
Sorghum	1,104	1,767	548	282	1,604	1,726	126	0	0	0	0	0
TOTAL	61,219	37,112	59,932	61,448	62,771	62,151	63,235	66,358	69,086	62,882	56,069	55,172

Table 33
Crop Water Use (in AF) for CCID (Camp 13): 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	39	39	40	41	79	171	167	35	14	0	0	0
Misc.	0	0	0	0	0	0	0	0	0	0	0	0
Cotton	2,067	2,067	2,237	2,135	3,285	2,720	2,993	2,594	3,125	2,818	3,507	3,366
Alfalfa	975	975	1,009	1,017	0	0	1,167	1,594	1,864	1,852	2,451	2,625
Wheat	476	476	426	517	1,355	580	1,165	1,032	389	731	0	554
Melons	55	55	60	57	254	0	132	42	47	116	0	59
Process Tom.	0	0	0	0	0	0	0	0	0	0	0	0
Sugar Beets	2,131	2,131	2,188	2,140	5,521	3,977	1,543	4,068	3,407	2,239	2,442	2,158
Barley	61	61	53	66	0	0	0	0	0	0	320	353
Beans	0	0	0	0	0	0	0	0	0	0	0	0
Seed Alf.	0	0	0	0	0	0	0	0	0	0	0	0
Rice	1,655	1,655	1,767	1,726	1,365	3,077	4,486	3,006	1,119	2,179	2,326	1,899
Corn	83	83	90	85	0	172	261	0	0	397	0	143
Vegetable	0	0	0	0	0	0	0	0	0	0	0	0
Pasture	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	7,541	7,541	7,870	7,783	11,859	10,698	11,914	12,370	9,964	10,334	11,046	11,155

Table 34
Crop Water Use (in AF) for Charleston Drainage District: 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	34	28	37	71	130	202	8	41	37	197	100	100
Misc.	0	0	0	0	267	0	0	0	0	0	0	0
Cotton	1,318	626	3,419	4,065	2,365	3,734	4,776	3,121	4,864	4,969	4,959	5,040
Alfalfa	3,397	1,887	2,124	505	947	710	316	3,316	2,970	1,926	1,086	1,105
Wheat	0	0	0	0	0	0	0	0	0	0	0	0
Melons	493	369	385	1,325	686	495	1,061	472	54	254	514	505
Process Tom.	432	911	223	0	0	0	0	138	233	118	538	539
Sugar Beets	2,164	1,810	1,982	224	0	536	300	192	408	167	226	221
Barley	167	0	0	0	332	0	0	0	0	0	0	0
Beans	0	0	0	0	0	0	0	62	0	0	0	0
Seed Alf.	0	0	0	0	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0
Corn	566	1,830	574	0	0	0	0	172	0	0	158	159
Vegetable	34	444	0	0	645	0	17	0	0	0	0	0
Pasture	0	0	0	0	0	0	0	400	0	0	0	0
Stonefruit	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	8,604	7,905	8,744	6,190	5,374	5,677	6,477	7,913	8,567	7,630	7,581	7,669

Table 35
Crop Water Use (in AF) for Firebaugh Canal Water District: 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	0	0	0	0	0	0	0	0	0	0	0	0
Misc.	0	0	0	0	0	0	0	0	0	0	0	0
Cotton	20,316	18,784	10,635	23,746	20,985	14,013	17,490	22,132	20,426	21,628	26,333	26,000
Alfalfa	5,457	1,768	3,277	3,403	3,381	3,969	5,807	6,026	7,169	7,726	8,389	8,704
Wheat	4,166	4,770	3,789	5,055	3,713	4,186	3,882	3,018	4,795	4,072	3,082	5,057
Melons	1,344	0	0	0	955	1,220	1,383	1,475	2,003	3,039	2,581	1,764
Process Tom.	1,105	0	0	0	0	0	0	1,324	1,981	3,123	2,949	2,573
Sugar Beets	5,908	5,440	4,794	4,085	7,732	7,560	9,609	6,953	8,524	7,124	2,354	464
Barley	0	0	0	0	0	0	0	0	0	0	0	0
Beans	0	0	0	0	0	0	0	0	0	0	0	0
Seed Alf.	0	0	0	0	0	0	0	0	0	0	0	0
Rice	3,377	5,966	10,006	5,405	2,004	3,673	3,531	3,695	1,894	914	258	335
Corn	286	254	347	0	0	2,482	0	0	0	0	0	0
Vegetable	903	2,513	1,945	1,362	878	892	676	74	589	339	320	399
Pasture	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	73	0	0	0	0	0	134	127	135	132	128	131
Sorghum	903	61	1,377	0	0	399	1,091	1,795	2,429	1,490	245	1,065
TOTAL	43,838	39,555	36,169	43,057	39,648	38,393	43,604	46,619	49,943	49,586	46,639	46,490

Table 36
Crop Water Use (in AF) for Pacheco Water District: 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	0	0	179	157	277	169	198	77	180	0	0	0
Misc.	0	0	0	0	0	228	527	157	278	0	0	0
Cotton	5,245	3,402	4,841	4,621	4,439	3,947	4,272	4,333	4,202	4,062	4,176	4,609
Alfalfa	0	0	0	583	552	521	1,098	526	602	352	1,637	894
Wheat	893	330	65	79	0	0	25	182	310	447	0	0
Melons	37	0	0	0	684	1,016	826	887	529	1,398	738	407
Process Tom.	0	0	0	0	0	0	0	580	430	651	925	761
Sugar Beets	0	0	0	0	0	0	0	0	0	0	0	0
Barley	206	0	0	0	0	0	0	169	137	8	0	0
Beans	234	789	1,192	1,129	0	0	0	0	58	0	164	186
Seed Alf.	414	2,351	0	0	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0
Corn	0	335	365	0	0	0	0	0	0	0	0	0
Vegetable	0	0	108	123	0	0	276	0	0	93	464	136
Pasture	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit	1,304	1,304	1,371	1,367	0	0	0	0	0	0	0	0
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	8,332	8,510	8,121	8,059	5,952	5,881	7,222	6,910	6,725	7,010	8,104	6,992

Table 37
Crop Water Use (in AF) for Panoche Drainage District: 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	285	298	1,178	219	215	345	197	205	250	1,029	1,904	2,060
Misc.	0	0	0	0	220	0	0	311	0	0	0	914
Cotton	35,527	20,253	28,840	34,704	30,070	28,372	29,001	34,661	30,783	28,516	24,951	24,232
Alfalfa	4,925	1,863	3,056	5,448	5,259	8,029	8,371	9,375	10,146	11,928	8,922	9,598
Wheat	5,376	1,288	2,747	4,751	3,564	2,468	4,561	1,093	4,169	2,220	0	339
Melons	2,728	1,561	2,786	864	4,037	2,129	1,197	1,380	3,365	3,444	1,923	2,153
Process Tom.	3,815	4,112	9,533	7,728	7,515	8,176	5,006	10,213	11,055	9,268	11,416	7,145
Sugar Beets	558	1,060	2,798	2,313	2,878	1,926	4,240	609	602	475	0	0
Barley	1,560	510	124	271	261	966	147	0	0	0	0	0
Beans	841	1,665	2,393	2,717	2,037	3,324	457	0	4,240	3,675	4,033	3,865
Seed Alf.	410	255	98	0	0	508	541	268	0	0	0	0
Rice	0	0	871	0	0	0	0	0	0	0	0	0
Corn	601	0	1,964	314	303	1,856	5,164	1,043	1,462	379	473	1,209
Vegetable	2,102	1,091	1,547	697	1,193	369	2,482	2,175	1,358	319	1,083	1,693
Pasture	407	407	417	0	2,523	159	0	4,043	95	0	0	0
Stonefruit	981	981	1,032	1,029	984	998	898	181	711	378	110	730
Walnut/Apple	0	0	0	112	107	802	848	801	850	1,249	1,254	1,234
Sorghum	1,104	1,767	548	282	1,604	1,726	126	0	0	0	0	0
TOTAL	61,219	37,112	59,932	61,448	62,771	62,151	63,235	66,358	69,086	62,882	56,069	55,172

Table 38
Crop Water Use (in AF) for Entire Study Area: 1981-1992

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Fallow	359	447	2,382	512	786	1,088	850	485	590	1,421	2,836	3,268
Misc.	330	341	0	176	664	382	616	469	446	0	51	1,081
Cotton	75,639	55,538	54,310	79,250	69,061	60,829	65,776	74,960	72,791	70,618	71,241	67,630
Alfalfa	14,754	6,493	10,026	11,520	10,650	13,708	16,760	20,836	22,751	23,785	22,621	22,926
Wheat	12,183	8,261	7,936	11,592	9,873	8,363	11,094	6,224	10,518	8,568	3,421	5,949
Melons	4,657	2,443	3,732	2,563	7,417	5,503	5,683	5,665	7,310	9,054	5,950	5,319
Process Tom.	5,788	5,023	10,400	8,033	8,997	9,607	5,890	13,522	15,419	14,825	17,101	13,097
Sugar Beets	10,760	11,277	12,621	12,556	18,233	15,136	16,524	13,085	13,350	10,839	5,022	2,843
Barley	2,589	1,377	415	561	1,075	1,084	208	347	181	327	320	353
Beans	2,025	2,515	4,850	4,329	2,037	3,353	457	309	4,298	3,675	4,197	4,051
Seed Alf.	1,937	3,595	876	1,064	1,138	1,701	2,400	1,489	1,237	1,019	756	937
Rice	5,032	7,621	12,644	7,131	3,370	6,750	8,018	6,701	3,573	3,094	2,584	2,233
Corn	1,535	2,501	3,340	399	303	4,511	5,424	1,215	1,462	777	630	1,511
Vegetable	3,039	4,048	3,600	2,182	2,716	1,261	3,451	2,249	1,947	750	1,867	2,227
Pasture	407	407	417	0	2,523	159	0	4,442	95	0	0	0
Stonefruit	2,285	2,285	2,403	2,396	984	998	898	181	711	378	110	730
Walnut/Apple	73	0	0	112	107	802	982	928	985	1,381	1,381	1,365
Sorghum	2,007	1,829	1,925	282	1,604	2,125	1,216	1,795	2,429	1,490	245	1,065
TOTAL	145,399	116,002	131,877	144,657	141,539	137,360	146,246	154,904	160,093	152,001	140,335	136,584

STEP 6: Effective Rainfall

Calculation of the effective rainfall.

The estimate of the effective rainfall was made by estimating the amount of water that is available for crop use or aids in the leaching of salts. There are numerous approaches to determine the effective precipitation. This report uses an estimate based on multiplying the total rainfall occuring during October through March by 50%. This value is based on published estimates by DWR. Based on discussions with irrigation engineers in the area, this estimate may slightly overestimate the amount of rain that is effective. The timing of the events is critical. A grower has to be absolutely ready to take advantage of a rain event. Theoretical calculations of the amount of rain that is effective do not apply to the grower who was not able to prepare the furrows for planting. A pre-irrigation event will still be required to ensure adequate moisture for germination.

Precipitation events in the time period between harvest and planting play a large part in determining the amount of irrigation water needed for pre-plant irrigation. The amount of the total rainfall that actually infiltrates into the soil, and is available for use by the plant must be estimated and will vary widely depending on geographic, soil, and surface conditions. Rainfall for each of the districts was assumed to be equal to values recorded with a rain gage placed at Mendota Dam.

Effective rainfall is defined as that rain which infiltrates and either;

- stays in the effective rootzone of the crop, available for ETc
- is effective in satisfying maintenance (net) or reclamation leaching.

Monthly rainfall records were obtained for the weather station at Mendota Dam and are shown in **Table 39**. Rainfall records from CIMIS Station #7 were not used due to poor site conditions.

Table 39
Gross Monthly Rainfall (in Inches) Reported at Mendota Dam

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Average
Oct	0.00	0.37	0.60	0.59	0.55	0.49	0.00	0.83	0.00	0.64	0.04	0.24	0.36
Nov	0.11	2.25	1.91	1.14	1.05	3.11	0.00	0.59	0.67	0.31	0.27	0.07	0.96
Dec	0.30	0.27	1.03	1.54	2.67	0.97	0.35	1.23	2.13	0.00	0.41	0.87	0.98
Jan	1.61	0.70	3.53	0.10	0.60	0.11	1.14	1.18	0.29	2.05	0.07	1.45	1.07
Feb	0.78	0.66	1.80	1.38	0.09	2.92	1.90	0.46	1.15	0.92	1.01	2.46	1.29
Mar	3.57	2.77	4.57	0.49	0.62	2.44	2.15	0.18	0.88	0.45	3.12	2.24	1.96
Apr	1.32	1.81	0.84	0.03	0.14	0.51	0.00	1.13	0.13	0.39	0.11	0.00	0.53
May	0.00	0.00	0.45	0.00	0.00	0.12	0.12	0.29	0.09	1.20	0.00	0.05	0.19
Jun	0.00	0.12	0.00	0.08	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Jul	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01
Aug	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Sep	0.00	0.78	0.77	0.00	0.00	0.36	0.00	0.00	1.36	0.09	0.00	0.00	0.28
Oct-Mar Only	6.37	7.02	13.44	5.24	5.58	10.04	5.54	4.47	5.12	4.37	4.92	7.33	
Totals	7.69	9.73	15.50	5.35	5.77	11.03	5.66	5.89	6.70	6.05	5.05	7.45	7.66

To determine the effective rainfall, the annual rainfall values were multiplied by the cropped acreage (excluding fallow land) and multiplied by the effective rain factor (50%). **Table 40** summarizes the amount of rainfall that was assumed to be effective.

Table 40
Effective Rainfall (in AF)

District	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Avg.
BWD	2,395	2,582	3,086	1,956	2,015	3,417	1,817	1,627	1,853	1,486	1,135	1,369	2,062
CCID-13	845	931	1,783	695	1,258	1,899	1,171	972	867	808	934	1,497	1,138
CDD	960	1,066	2,023	759	751	1,212	860	667	768	636	797	1,188	974
FCWD	5,823	5,921	9,399	4,518	4,587	8,293	4,843	4,336	5,279	4,635	5,059	7,603	5,858
PoWD	1,170	1,290	2,070	807	721	1,464	930	778	778	775	896	1,132	1,068
PDD	9,064	5,846	16,634	6,715	7,760	13,869	7,435	6,294	7,613	5,790	5,766	8,473	8,438
TOTAL	20,258	17,636	34,993	15,450	17,092	30,155	17,055	14,675	17,159	14,130	14,587	21,261	19,538

Note the wet years in 1983 and 1986. These years tend to show up as poor irrigation efficiencies since so much rain water is accounted for as effective rain. This basically means that the rains were efficient and not the irrigations which may not be true. Growers can not "plan" on receiving adequate rain. Therefore, they irrigate to maximize economic gain and ensure adequate germination.

STEP 7: Water Delivered

Report of the water delivered.

The water delivery records proved to be the most difficult of the data collection tasks. The original stuies had requested information in a calendar year format based on deliveries to the district. None of the districts had this information readily available for all of the years in this format. Water delivery records from the DMC and SLC did not correlate to the district records. Most districts tracked water deliveries on different time lines. The results of the data collection effort represent numerous references. Since most of the districts do not track water in the format requested, values were obtained from personal communications rather than using published reports. The following table is an estimate of the actual water delivered to the district or water supplied from another source outside of the study boundaries (such as a deep well).

Table 41
Annual Water Delivered (in AF)

District	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
BWD	28,932	25,211	15,690	31,911	28,240	24,628	23,308	25,891	25,200	20,582	12,902	9,086
CCID	15,251	15,251	15,251	15,251	18,914	15,072	16,255	16,738	11,049	13,081	16,351	14,546
CDD	14,030	11,973	11,591	13,691	12,119	10,264	13,891	14,428	12,263	11,127	10,218	9,630
FCWD	75,645	66,132	47,400	80,268	75,432	62,966	79,545	75,106	70,326	63,903	57,141	59,569
PoWD	12,653	9,763	9,751	10,775	9,000	7,770	9,756	10,217	13,063	11,569	11,572	8,107
PDD	97,344	89,155	75,306	109,511	98,241	92,487	98,119	97,196	91,300	81,258	69,706	63,416
		215,562		259,342		211,467		237,425		199,661		162,676
TOTAL	241,675		173,087		239,864		238,800		221,310		175,907	

Broadview Water District water supply data were from the district. They have good delivery records in a monthly format. The records are primarily delivered water from the USBR.

CCID-Camp 13 water supply data was from the district from water delivery "tags." A conveyance loss (6.7%) needed to be added to the water delivered values for this district subarea since the only records were for water delivered to the grower.

Charleston Drainage District water supply data was from the San Luis Water District which supplies water to this drainage subarea. In 1991 and 1992, there was a significant "shortage" of water that could not be explained. Rather than have irrigation efficiencies that reflected unrealistic values, an estimate of the water made available was made to account for the acreage of crops grown. An additional 4,188 AF and 2,804 AF was added to 1991 and 1992, respectively to account for the irrigated acreage.

Firebaugh Canal Water District water supply data were taken from two sources which differed considerably. The USBR's DMC supply water dumps into the Mendota Pool where it is delivered to four districts (FCWD, CCID, CCC, and SLCC) under a single contract. The division of water among the four districts is an internal agreement and the USBR only checks FCWD's main intake weir periodically. FCWD's manager states that some reported FCWD water deliveries account for water twice. There are some tailwater systems in the district and field tailwater will go back into the district's supply for use by other farmers. Also, although significant only since 1990, some tilewater has been recycled, if water quality is sufficiently good.

Pacheco Water District water supply data were from two sources for water supplies which differed considerably. PoWD's supply comes from a Federal Contract and an agreement with CCID. PoWD's records were used, except in 1988 (incomplete data set). Water deliveries as reported by the USBR were used for 1988. The water supply for 1990 through 1992 came from PoWD directly (Dermer, 1991). From 1985 to 1988, PoWD was required to release portions of the delivered water directly into the Grassland Water District system for dilution. The amounts released were 2,337 AF in 1985, 3,772 AF in 1986, 3,231 in 1987, and 655 in 1988.

Panoche Drainage District water supply was from the district records. A sub-task was the determination of the volume of pumped irrigation water from private irrigation wells to individual farms in the Panoche Water District. Contact was made with most of the growers who maintain and operate about 42 wells in the Panoche area. Rick Shoneman of the ARS in Fresno met individually with the growers in the field. Growers were asked to estimate the amount of groundwater pumping. In most cases, the wells do not have meters and the data was roughly

estimated. The irrigation efficiency calculations include an estimate for the groundwater pumping. However, the estimates of the private pumping did not appear to account for all of the water required to irrigate the crops grown. In 1991 and 1992, there was a significant "shortage" of water that could not be explained. Rather than have irrigation efficiencies that reflected unrealistic values, an estimate of the water made available was made to account for the acreage of crops grown. An additional 26,387 AF and 25,865 AF was added to 1991 and 1992, respectively to account for the irrigated acreage from groundwater pumping. These values were determined by evaluating a minimum reasonable water dellivered to meet ETc. In 1990 an estimated 3,000 AF was pumped. Panoche is the only district with reported pumped water volumes.

STEP 8: Leaching Required

Calculation of the amount of water required for leaching of salts.

Irrigation water quality measurements were obtained from the districts at the location they felt was most representative of the average quality of the water delivered. Where no yearly ECw values were available (Pacheco and Panoche) the values were estimates supplied by the districts. ECw values for Firebaugh and Charleston for 1982 and 1983 were estimated. The leaching requirement used in finding the PIE was based on maintaining a maximum salt level of 2.5 dS/m in the rootzone. It was assumed that all leaching was done during pre-plant irrigations, and that the necessary leaching to maintain maximum salt levels was done yearly. In actual practice, it is possible to defer leaching for more salt tolerant crops, and irrigation water earmarked for beneficial use as leaching may be actually used for other purposes within the district. In all likelihood, during years when there is less water delivered to the district, much of the leaching is deferred, to be taken care of during years with high rainfall or more available water. This appears in the data for 1990-1992, where the water applied is less than the potential beneficial water use. In 1993, it is expected that the districts would increase the water applied during the pre-plant time frame to account for unsatisfied leaching requirements from 1990-1992.

Table 41 summarizes the water quality values for the districts. Note the high values in 1981 and 1982 for Broadview Water District. These values reflect the water quality of 100% recycling. The remaining years are also high which reflect a large percentage of recycling occuring within the district. They did not have an outlet for the drainage water until 1983. Pacheco Water District also has high values. This reflects a higher amount of recycling within the district. Pacheco reports that alsmost all of the tailwater within the district is recycled and about 50% of the tile water. Recycling of all of the tailwater is feasible for all of the districts. However, recycling all of the tile water leads to very high water salinities of the delivered water. The expected salinities for

100% tile water recycling could be as high as 3 dS/m. 50% tilewater recycling could result in salinities of about 1.5 dS/m. This would have a negative impact on those districts currently discharging the tile water.

Table 42
Water Quality of District Delivered Water (in dS/m)

District	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
BWD	3.21	2.89	0.89	0.74	0.65	0.67	0.56	0.87	0.75	1.06	1.25	1.00
CCID-13	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
FCWD	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
CDD	0.54	0.54	0.54	0.38	0.50	0.39	0.59	0.62	0.53	0.60	0.59	0.62
PoWD	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.54	1.54	1.54	1.54
PDD	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.70	0.70
Ave.	1.09	1.03	0.70	0.65	0.65	0.64	0.65	0.71	0.74	0.80	0.86	0.82

The calculation for the water required for leaching is the product of the delivered water times the fraction required for leaching. The fraction of water required for leaching is from the equation:

$$LR = \frac{ECw}{(5 \times ECe) - ECw}$$

Where; LR = fraction of water required for leaching

ECw = Salinity of the delivered water in dS/m

ECe = Threshold soil salinity (2.5 dS/m)

Table 43 is a summary of the water required for leaching for the districts. Note the fluctuating amounts in some of the districts caused by a high amount of recycling of tile water.

Table 43
Water Required for Leaching (in AF)

District	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Avg.
BWD	9,997	7,582	1,203	2,008	1,549	1,395	1,093	1,937	1,609	1,907	1,434	790	2,709
CCID-13	689	689	689	689	854	681	734	756	499	591	738	657	689
CDD	633	541	523	429	505	331	688	753	543	561	506	503	543
FCWD	3,415	2,986	2,140	3,624	3,406	2,843	3,592	3,391	3,175	2,885	2,580	2,690	3,061
PoWD	1,282	989	988	1,092	912	787	988	1,035	1,835	1,626	1,626	1,139	1,192
PDD	4,395	4,025	3,400	4,944	4,436	4,176	4,430	4,388	4,122	3,669	4,135	3,762	4,157
Total	20,412	16,811	8,943	12,786	11,661	10,212	11,525	12,260	11,783	11,238	11,019	9,540	12,349

STEP 9: District Irrigation Efficiency

Calculation of the district irrigation efficiency.

Water rights are generally based on some combined measure of the need for beneficial use and reasonableness of use. Water allocation decisions require an opinion on how much of the non-beneficially used irrigation water can be classified as "reasonable" use. All non-beneficial uses decrease the Irrigation Efficiency (IE) below its maximum possible value of 100%. Irrigation Efficiency is defined as:

$$IE = \frac{\text{Irrigation Water Beneficially Used}}{\text{Irrigation Water Applied}} \times 100$$

Beneficially used irrigation water has traditionally included the following:

- Crop transpiration; the major component.
- Water needed for leaching requirement (LR), which is typically 3-10% of the gross applied.
- Climate control, such as evaporative cooling or frost protection with sprinklers (not accounted for in this study).
- Use of water for germination of weeds (limited to 1 inch or so per year), so that the weeds can be killed either mechanically or with herbicides (not accounted for in this study).
- Minimal amounts needed for cultural practices such as packing the soil for harvest of some crops or "freshening" of some vegetables before harvest (not accounted for in this study).

These beneficial uses all occur at the farm level. On the district level, less contaminated water which is required for blending of drainage water in order to meet drainage discharge standards (ie., San Joaquin River water quality standards) may also be considered as "beneficial use" since it is necessary to maintain aquatic habitat standards.

Non-beneficial uses of irrigation water on-farm include:

- Canal and ditch seepage and evaporation.
- Evaporation from the field, unless it offsets transpiration requirements.
- Deep percolation in excess of the leaching requirement. Causes of this deep percolation are:
  - Excess duration of irrigations.
  - Nonuniformity of irrigation water infiltration into the soil.
- Uncollected tailwater, except for the small fraction of it which contributes to a beneficial salt balance due to pickup of surface salts. Such a salt pickup is minor in areas of the San Joaquin Valley, but can be important in very hot areas with heavy soils such as the Imperial Valley.
- Spray losses from sprinklers.

Some evaporation and nonuniformity always exist with irrigations, regardless of the method. The exception regarding evaporation might be row crop drip, but during seed germination the soil surface has to be wet somehow, at which time evaporation will occur. Imprecise irrigation timing is also inevitable, due to uncertainties regarding water deliveries, evapotranspiration rates, soil intake rates, soil water depletions, and precise rooting depths.

The values are reported as District Irrigation Efficiencies. The DIE includes water lost from operational discharges and seepage losses from supply canals. The irrigation efficiency is calculated with the following equation:

$$DIE = \frac{(\text{ETc with adjustment} + \text{Leaching required for salt control} - \text{Effective Rain})}{\text{Irrigation Water Applied}} \times 100$$

Where; DIE = District Irrigation Efficiency (%)

ETc = Adjusted ETc values from Tables 13 - 25

Leaching = Water applied for leaching of salts (Table 41)

Effective Rain = Rain used by crops or for salt control (Table 39)

Table 44 summarizes the revised data. Note the low irrigation efficiency values in 1983 and 1986. These years were high rainfall amount years. Note Broadview Water District's high values in 1981 and 1982 and then decreasing in 1983 when they obtained an outlet to the San Joaquin River. The 80% efficiency represented a very high efficiency with 100% recycling of tailwater and tilewater. Since the water quality degraded to a unsatisfactory value, the 80% may well represent a maximum attainable irrigation efficiency. Note that after several years of high irrigation efficiency, the DIE drops in value significantly in Broadview. This can be partially explained by the result of leaching done in subsequent years to make up for water short years. This means that the highest values on the table may reflect levels that are not maintainable.

The trend is definitely one of increasing irrigation efficiency over the 12 years of the study. This reflects a necessary reaction by growers and districts to respond to decreasing water supplies and increasing environmental, political, and social concerns of drainage.

Table 44
District Irrigation Efficiency
ETc Approach

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Broadview	81%	81%	58%	57%	55%	51%	56%	58%	62%	73%	87%	94%
CCID	48%	48%	44%	51%	61%	63%	71%	73%	87%	77%	66%	71%
Charleston	59%	62%	62%	43%	42%	47%	45%	55%	68%	68%	71%	73%
Firebaugh	55%	55%	61%	53%	51%	52%	53%	61%	68%	75%	77%	70%
Pacheco	67%	84%	72%	77%	68%	67%	75%	70%	60%	68%	76%	86%
Panoche	58%	40%	62%	54%	61%	57%	61%	66%	72%	75%	78%	80%
Regional IE	**60%**	**53%**	**61%**	**55%**	**57%**	**56%**	**59%**	**64%**	**70%**	**75%**	**78%**	**77%**

Figure 16 is a graphical representation of the data from Table 44. The trends are quite apparent on the graph. Note the erratic numbers of some of the smaller districts. This is most likely due to potential problems in the data rather the significant data points that can be explained.

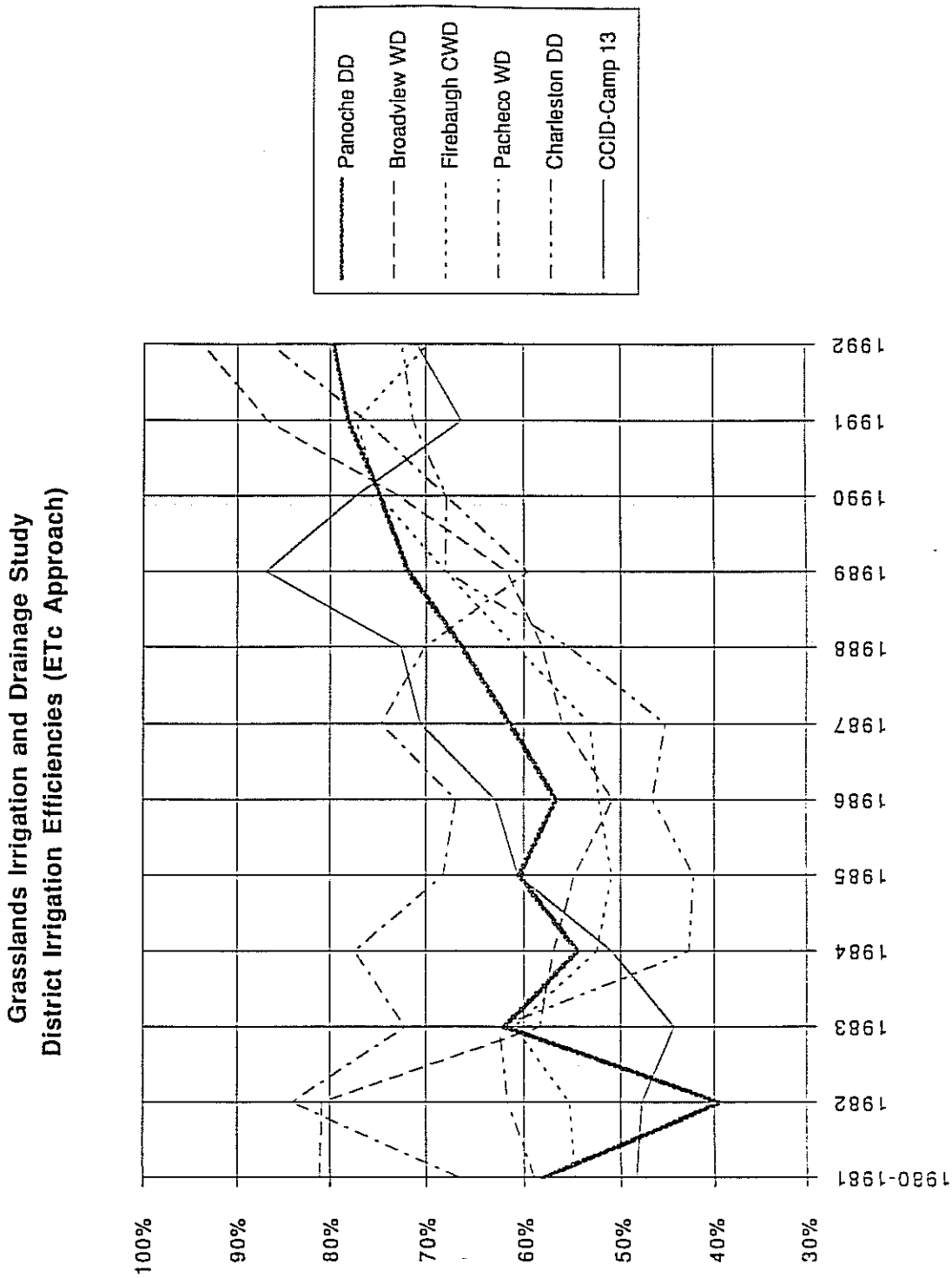
Grasslands Irrigation and Drainage Study
District Irrigation Efficiencies (ETc Approach)
Panoche DD
Broadview WD
Firebaugh CWD
Pacheco WD
Charleston DD
CCID-Camp 13
100%
90%
80%
70%
60%
50%
40%
30%
1980-1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

Figure 16

PROBLEMS WITH VERIFYING DIE ESTIMATES

Using the ETc approach to estimate the DIE has several limitations. Some of the problems are discussed below.

DIFFERENT REPORTING AREAS

One of the major problems is that the areas providing information on the acreage of the various crops grown and water supply are many times not the same area providing reported drainage. For example, PoWD also provides drainage for approximately 640 acres of land outside of it. BWD provides drainage for the FDA, which consists of BWD and 3000 acres that are within WWD.

CROP ETc

There are two major problems in calculating crop ETc:

1. There must be accurate estimates of which crops are being grown.

2. There must be accurate estimates of individual seasonal crop ETc.

The problems of calculating ETc are discussed in detail in the 1991 DIE Report (Burt et al, 1991).

WATER SUPPLY

There are at least two reasons why the estimates for water supply will be inaccurate:

1. The USBR reports that they attempt to maintain a +/- 3% accuracy in the flow meters on the DMC. (Note the effect of this inaccuracy on the comparison of estimated drainage versus Reported Drainage). Looking at PDD, the water supply is in the range of 94,000 acre-feet/year. Three percent of this would be about 2,800 acre-feet/year. PeWD drainage through measuring point PE-14 has ranged from 25,000 acre-feet to 33,700 acre-feet from 1986 to 1989. 2,800 acre-feet is from 8 to 11% of their reported drainage. Thus, due to inaccuracies in measuring the water supply alone, a drainage estimate could be in the range of +/- 10% from the reported drainage.

2. In addition, pumping from farmer-owned deep wells must be accounted for. They are rarely, if ever, metered and reported to the district.

LATERAL INFLOWS

There are two types of lateral inflows to the district that are not regulated or measured:

1. Subsurface lateral inflows are a point of contention among many of the districts in the area. Subsurface flows are said to cause a "base flow" in the tile drainage systems. That is, regardless of irrigation on the land, the tile drains will collect a certain amount of deep percolation that is moving laterally from upslope lands. BWD, in a 1985 report, estimated that 27% of their tile drainage originated on lands upslope of their district. It is also claimed that selenium and other heavy metals are carried with these inflows.

2. There may also be surface inflows to a district that will be picked up and used on an "if and when available" basis by farmers.

REPORTING PERIODS

A major problem is the number of different time periods that will be used by those reporting totals for irrigation water deliveries, drainage, tile sump flows, etc. At least three different periods are in common use:

1. There is the "water year", which generally runs from March of one year through February of the next. This coincides with the length of USBR and SWP delivery contracts.

2. There is the calendar year, from January through December.

3. There have been some reports that refer to water use during a "crop year", which was reported to run from October of one year to September of the next. The starting month of October was chosen because it usually is the start of pre-plant irrigations and/or grain planting for the next growing season.

SECTION 4

PRE-PLANT IRRIGATION EFFICIENCY

INTRODUCTION

Examination of pre-plant irrigation efficiencies for five of the Grassland Basin districts was completed in order to determine the potential for reduction of drainage water from the area during the period of time when pre-plant irrigation events occur (December through March). In theory, the time frame for the poorest irrigation efficiencies occurs during the pre-plant irrigations since irrigations are required for germination but the soil moisture deficit may not warrant the quantity of water applied. The pre-plant efficiency analysis was completed during the summer of 1993. Some of the assumptions are slightly different than the assumptions used in the DIE analysis due to the timing of the analysis. The differences are discussed later in this section.

The five districts examined were Panoche, Firebaugh, Broadview, Pacheco, and Charleston. CCID was not evaluated due to lack of monthly water delivery data. Pre-plant irrigation efficiencies were determined by calculating the potential beneficial uses of irrigation water during the time period, and comparing that to the amount of water delivered to the district on a monthly basis during the same time period.

DATA ANALYSIS

The variables involved in the examination of pre-plant irrigation efficiencies (hereafter known as PIE) are as follows:

- District monthly water delivery figures.
- Estimates of irrigation water quality and leaching requirements.
- Estimates of harvest SMD, soil type, crop root zone depths at harvest, the effects of tiling and ground water levels on SMD, and calculations of the amount of irrigation water needed to fill up the SMD prior to planting time.
- Effectiveness of post-harvest precipitation in filling SMD.

- Crop acreage.
- Crop rotation patterns.
- Distribution uniformity of the irrigation events.
- Crop ETc requirements.

Of these categories, the first four are the most significant in effecting the final PIE values. Each of the categories will be evaluated individually.

DISTRICT MONTHLY WATER DELIVERY

The monthly values given by the water districts are thought to be reasonably accurate for Panoche, Firebaugh, and Broadview. The monthly water supply values for Pacheco are numbers obtained from the Bureau and are inconsistent with yearly delivery values reported by the district. The monthly values for Charleston are also suspect, being reported numbers from the San Luis Canal and also inconsistent with yearly values reported by the district. The monthly values used in the examination do not include irrigation water from well pumping, which is thought to be significant only for Panoche Water District. Obtaining an estimate of well water pumping in Panoche would involve an audit of the PG&E records for the area and permission of the land owners to conduct such an audit, a task which proved beyond the scope of this project. Monthly water delivery values represent the water delivered to the district and do not reflect losses due to seepage, evaporation, or spillage, which can be an estimated 7-10 percent of the water delivered. Losses were not included in the calculation of the PIE since there was doubt about the actual values involved. Monthly values were obtained from the districts and from the Bureau.

ESTIMATES OF WATER QUALITY AND LEACHING REQUIREMENTS

Irrigation water quality measurements were obtained from the districts at the location they felt was most representative of the average quality of the water delivered. Where no yearly ECw values were available (Pacheco and Panoche) the values were estimates supplied by the districts. ECw values for Firebaugh and Charleston for 1982 and 1983 were estimated. The leaching requirement used in finding the PIE was based on maintaining a maximum salt level of 2.5 dS/m. It was assumed that all leaching was done during pre-plant irrigation's, and that the necessary leaching to maintain maximum salt levels was done yearly. In actual practice, it is possible to defer leaching for more salt tolerant crops, and irrigation water earmarked for beneficial use as

leaching may be actually used for other purposes within the district. In all likelihood, during years when there is less water delivered to the district, much of the leaching is deferred, to be taken care of during years with high rainfall or more available water. This appears in the data for 1990-1992, where the water applied is less than the potential beneficial water use. In 1993, it was expected that the districts would increase the water applied during the pre-plant time frame to account for leaching requirements from 1990-1992. The calculated PIE does not take this into account.

ESTIMATES OF HARVEST SMD, SOIL TYPE, CROP ROOTZONE DEPTHS

In order to estimate the SMD at the time of year when pre-plant irrigation events occur, it was necessary to find the SMD at harvest time, which is usually determined by crop and harvesting requirements. Estimates were made for rootzone depths, soil characteristics, contribution from ground water (which is affected by the percent of tiled acreage), and the amount of rainfall infiltrated in the months preceding the pre-plant irrigation events. Since there was no information on site- or crop-specific water deliveries, all of the influencing factors except for crop related information had to be generalized over the water district, which can lead to inaccuracies in finding the amount of irrigation water beneficially used for the SMD. The assumptions in this area were felt to be reasonable, although the crop root zone depths play a large part in determining the final values, and are at best, rough estimates since they can vary widely.

EFFECTIVENESS OF POST-HARVEST RAIN IN REPLENISHING SMD

Precipitation events in the time period between harvest and planting play a large part in determining the amount of irrigation water needed for pre-plant irrigation. The amount of the total rainfall that actually infiltrates into the soil, and is available for use by the plant must be estimated and will vary widely depending on geographic, soil, and surface conditions. Rainfall for each of the districts was assumed to be equal to values recorded with a rain gage placed at Mendota Dam. All of the rainfall calculated as infiltrating was assumed to be beneficial, either meeting the leaching requirement, or satisfying the SMD. During years of heavy rainfall, such as 1983, this assumption may not be correct, since the water could simply deep percolate after the leaching requirement has been met. Fallow acreage was included in the calculation of the total rainfall contribution, since those acres may be planted in the following year. This is not a completely correct assumption, since some of the acreage previously in crops might also become

fallow in the following year, yet the infiltrated rain on those acres will be counted as beneficially used in the PIE calculations. However, there is no practical way to take that into account in this study. Some rainfall events that occur during the months just prior to planting may also not fulfill pre-irrigation needs for the soil surface depth if the field has not been previously prepared, or the rainfall event occurs significantly before water is required for germination, so that the soil surface has time to dry out. The calculated value for rainfall contribution to SMD and the net leaching fraction (NLF) represents rainfall that has infiltrated, less the water that has been calculated as effective precipitation for the crops growing December through March. To be consistent, effective precipitation for the crops growing October through November should also be subtracted from the final rainfall contribution value, but was neglected due to the relative insignificance of the amount of rain involved for the additional work in determining it.

CROP ACREAGE

Crop acreage's are supplied by the districts and are assumed to be accurate. There are minor inconsistencies in the total number of cropped and fallow acres reported each year within the districts. There is some problem with the acreage figures being reported for water year versus crop year. This report uses the water year approach (Oct. 1- Sept. 31).

CROP ROTATION PATTERNS

A significant limitation on the final accuracy of the PIE numbers is the lack of data on the rotation pattern for specific acreage. The type of crop previously on the field has a large impact on the SMD at harvest, and subsequently on the amount of water needed for pre-plant irrigation. Also, since the leaching requirement is based on water quality, the irrigation requirements of the crop previously on the field will significantly impact the necessary leaching requirement. It is assumed in this study that these parameters can be generalized across the district and still produce valid results.

DISTRIBUTION UNIFORMITY OF THE IRRIGATION EVENTS

The study assumed that the affects of distribution uniformity during pre-irrigation events could be neglected since the water applied was significantly greater than that required (i.e. low PIE values) and therefore each portion of the field received at least the needed depth of irrigation water. Since the results indicate some years of high PIE values, the amount of beneficially used water during those years may need to be adjusted to reflect the effects of distribution uniformity.

CROP ETC REQUIREMENTS

Crop ETc requirements were determined based on the results of a previous 1992 DIE Report study, and were adjusted to reflect uneven cropping patterns. The adjusted values were used in this study.

POTENTIAL FUTURE WORK

- Calendar for infiltrated rainfall is September-March, should be October-March.
- Infiltrated rainfall based on estimating need to be verified.
- Effective precipitation for crops growing October-November is not removed from the total rainfall contribution as it should be.

DISCUSSION OF DISTRICT PRE-PLANT IE

Figures 17 through 21 represent the values determined by the pre-plant irrigation efficiency analysis. A detailed description of the Spreadsheets used to calculate the PIE is included in Approach A. In order to visually recognize the need for leaching in the districts, the figures show a graph of the potential beneficial water use and the actual water delivered during the PIE time frame.

PACHECO

Water delivery values for Pacheco are suspect. The values were supplied by the Bureau of Reclamation and the extreme variability of the numbers, particularly the low numbers in 1985 and 1986, indicate the reported values are not correct. In addition, the Bureau numbers are inconsistent with the yearly values reported by the district.

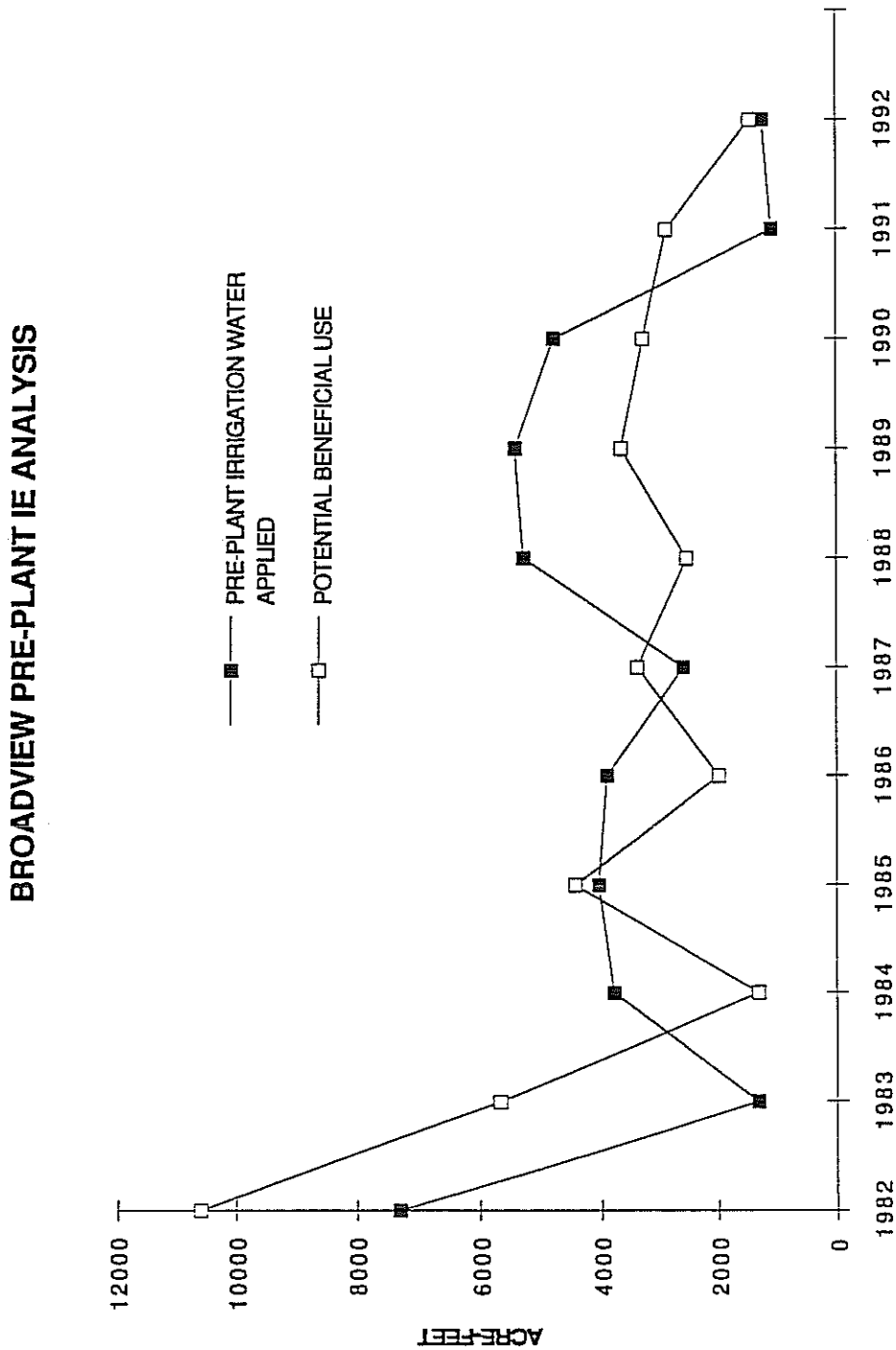
BROADVIEW PRE-PLANT IE ANALYSIS
PRE-PLANT IRRIGATION WATER APPLIED
POTENTIAL BENEFICIAL USE
ACRE-FEET
12000
10000
8000
6000
4000
2000
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

Figure 17

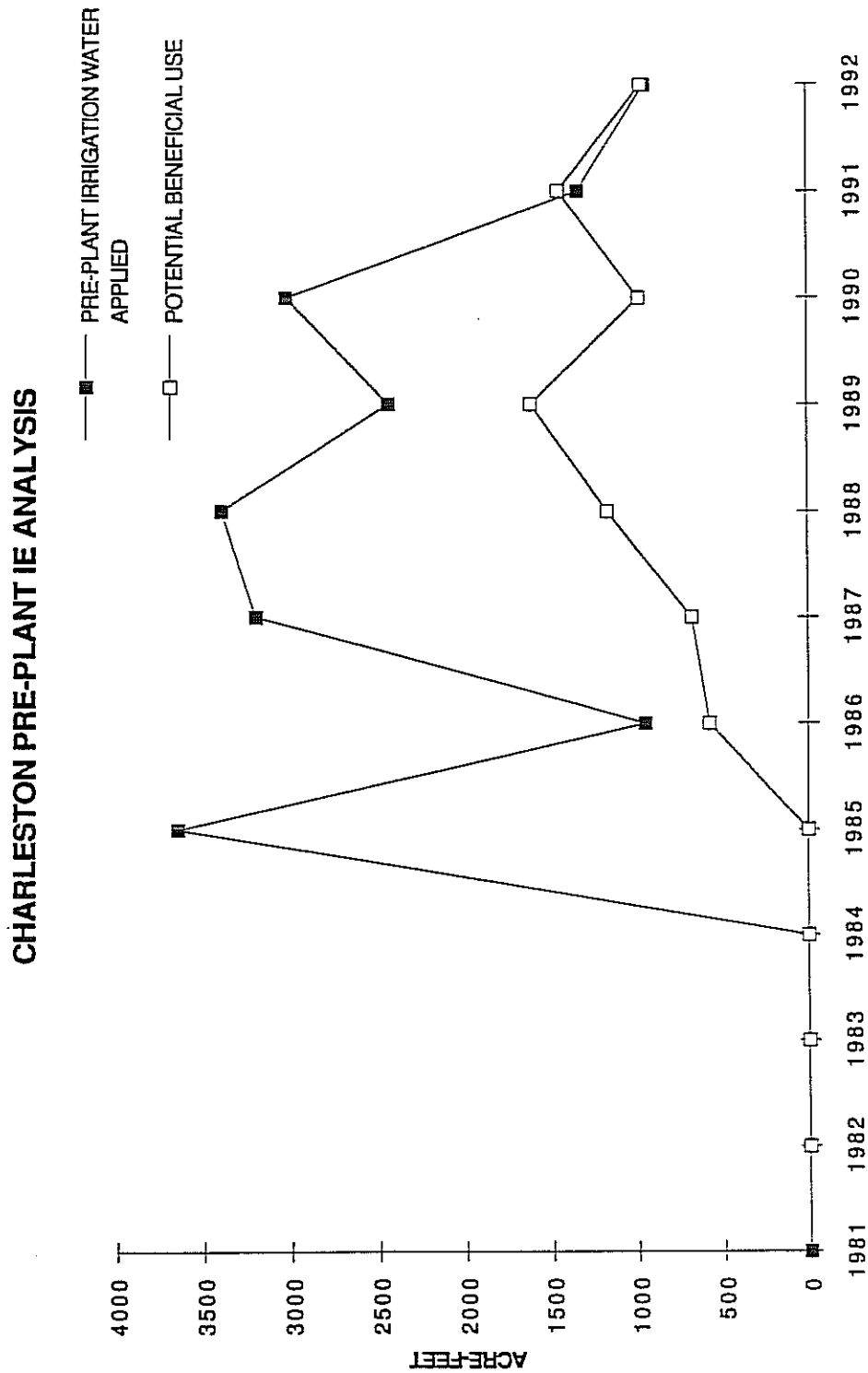
CHARLESTON PRE-PLANT IE ANALYSIS
PRE-PLANT IRRIGATION WATER APPLIED
POTENTIAL BENEFICIAL USE
ACRE-FEET
4000
3500
3000
2500
2000
1500
1000
500
0
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

Figure 18

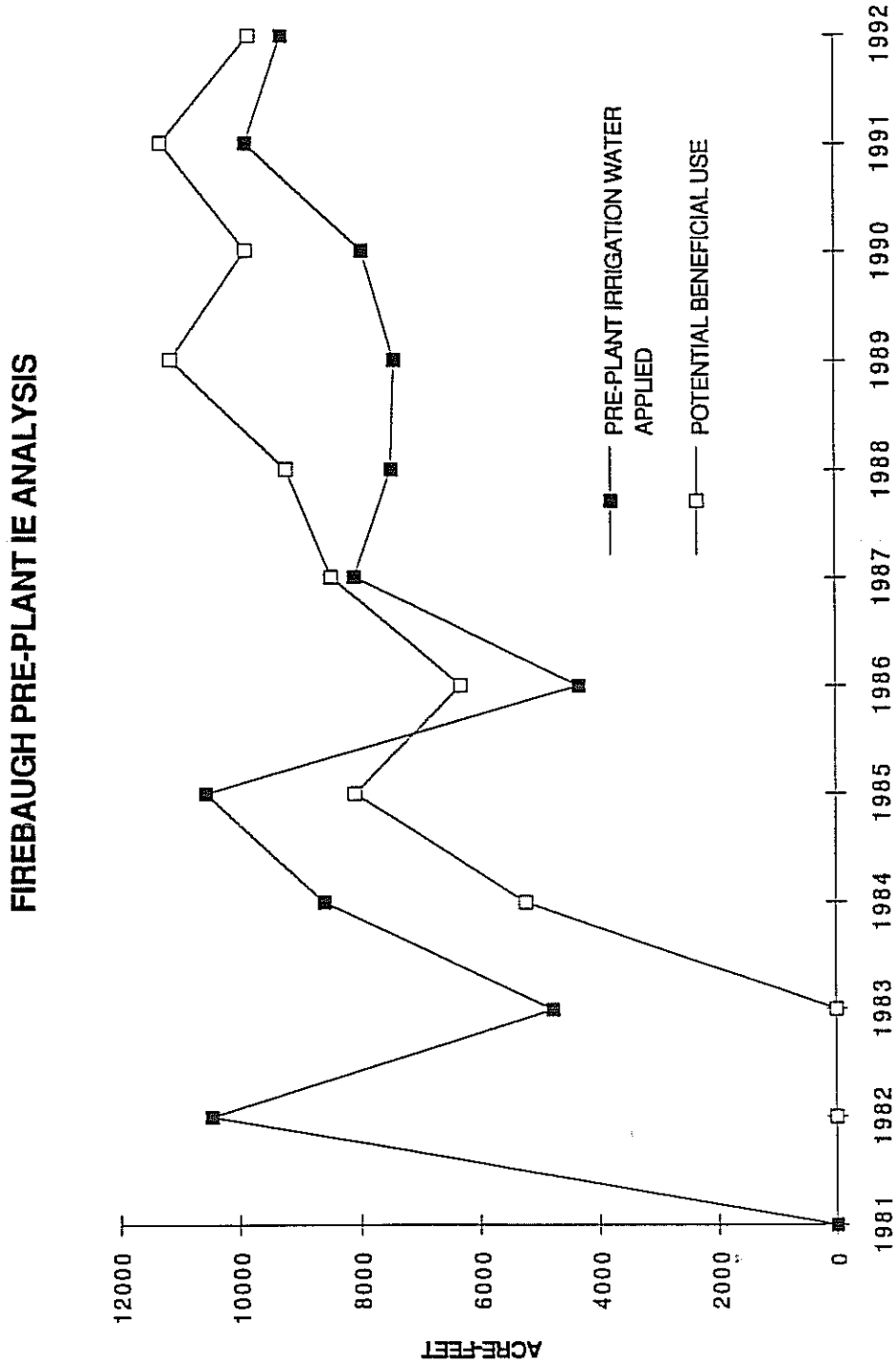
FIREBAUGH PRE-PLANT IE ANALYSIS
ACRE-FEET
12000
10000
8000
6000
4000
2000
0
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
PRE-PLANT IRRIGATION WATER APPLIED
POTENTIAL BENEFICIAL USE

Figure 19

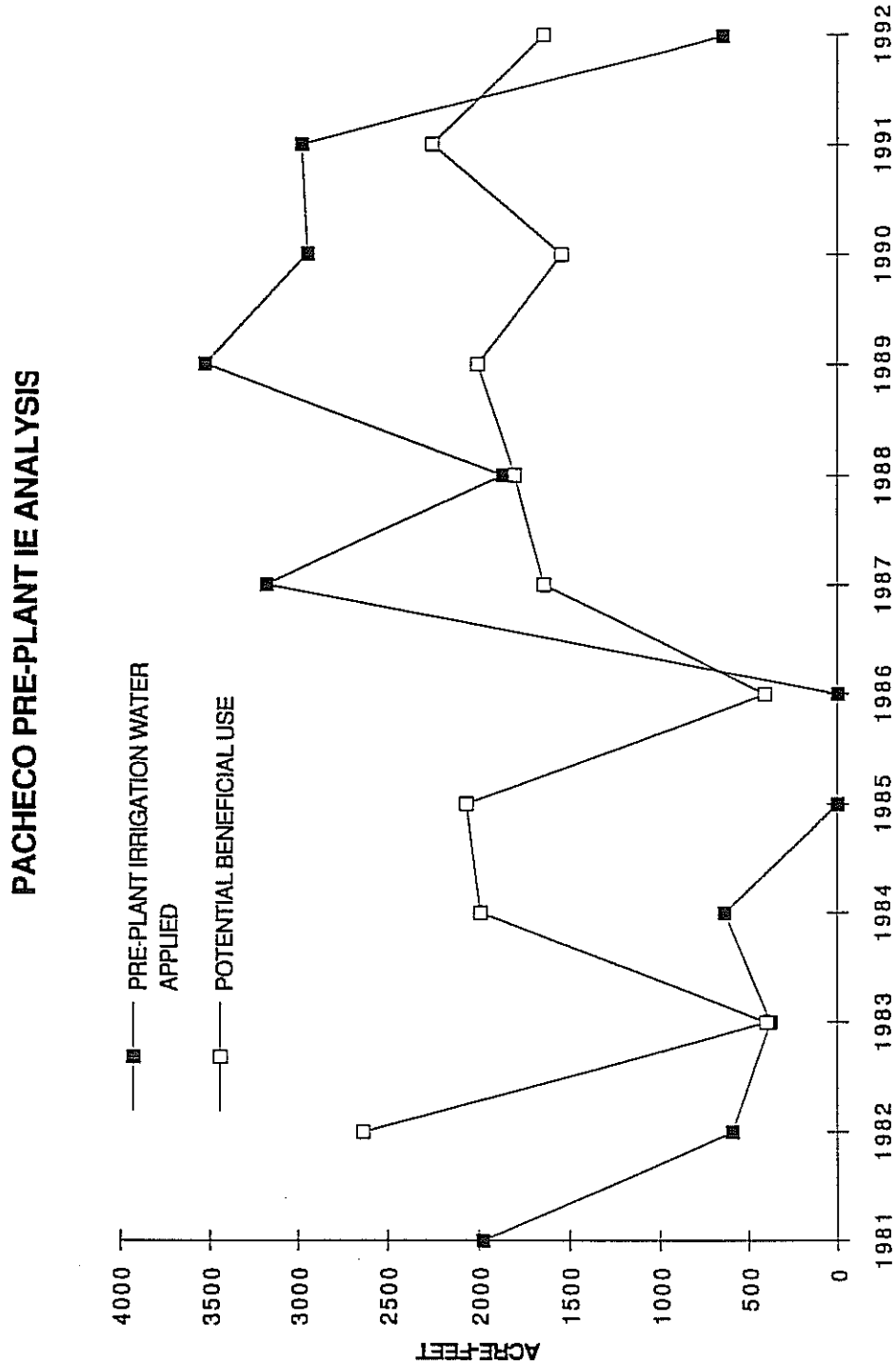
PACHECO PRE-PLANT IE ANALYSIS
PRE-PLANT IRRIGATION WATER APPLIED
POTENTIAL BENEFICIAL USE
ACRE-FEET
4000
3500
3000
2500
2000
1500
1000
500
0
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

Figure 20

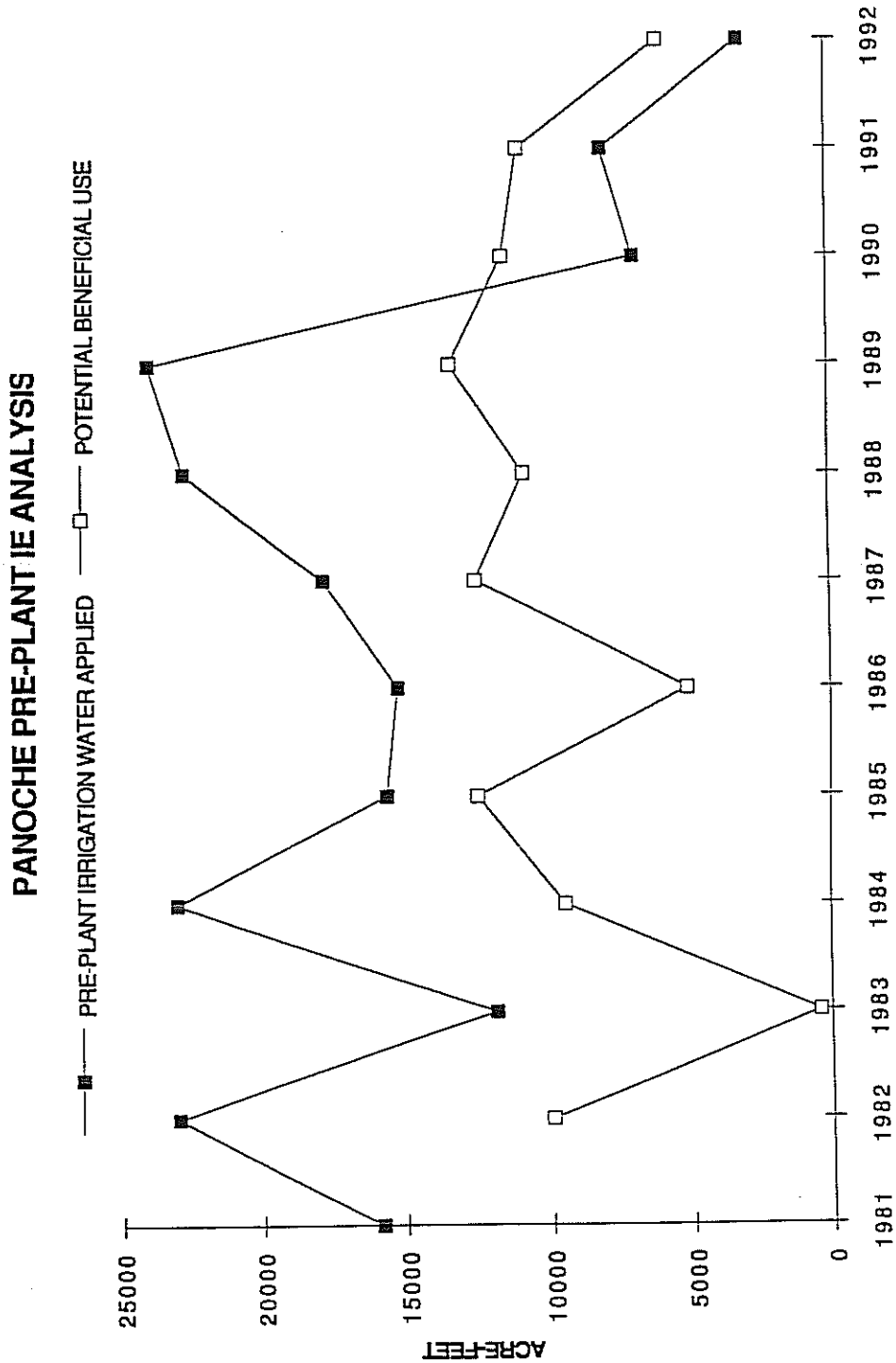
PANOCHE PRE-PLANT IE ANALYSIS
PRE-PLANT IRRIGATION WATER APPLIED
POTENTIAL BENEFICIAL USE
ACRE-FEET
25000
20000
15000
10000
5000
0
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

Figure 21

FIREBAUGH

Water delivery in 1983 and 1986 is significantly less than in other years. Low rainwater contribution in 1987 is due to the amount of rain that occurred in February and March of that year which was counted as effective rainfall for crops growing during that time period (mostly wheat), and was subtracted from the amount of rainfall contributing to SMD and NLF. No crop acreage values for 1982 and 1983 were available.

BROADVIEW

Very high ECw values drive the PIE for 1982 and 1983. A low value of 35% in 1984 is most likely due to making up for leaching requirement from previous years.

CHARLESTON

No crop acreages for 1981-1985 were available. Low water supply in 1986 is coincident with increased rainfall during that year. Monthly water supply values reported by the Bureau are inconsistent with the yearly values reported by the districts; with district values generally considered more accurate.

PANOCHE

Low PIE in 1983 coincide with high rainfall, a trend which is also apparent in most of the other districts since potential beneficial use drops markedly.

ANALYSIS

Useful trends can be read from the figures generated for Panoche, Firebaugh, and Broadview, while Pacheco and Charleston appear less reliable.

High pre-plant irrigation efficiencies in 1990-1992 may be unrealistic since the water applied is less than that theoretically needed for crop requirements and leaching. Deferral of leaching will lead to a need for large irrigation events in future years to compensate; driving down the PIE.

Water use does indicate a compensation for years of high and low rainfall during pre-irrigation. During years of high rainfall, less pre-plant irrigation water is applied, and when the rainfall is less, pre-plant irrigation water increases. The last few years indicate that rainfall has had less effect on

the amount of irrigation water applied, perhaps since leaching requirements are not being taken care of, so pre-plant irrigation water needed to account for low annual rainfall is not being applied. This is shown graphically for Panoche, Firebaugh, and Broadview in **Figures 22 through 24.**

Trends indicate that leaching requirements are met during high rainfall years, when water is abundant.

CONCLUSIONS

The study of the pre-plant irrigation efficiencies in the Grassland Basin Irrigation and Drainage Study depends on the application of broad-based and theoretical assumptions about agricultural practices to highly variable and site specific cropping and irrigation patterns. Furthermore, the information available from the water districts involved is general in nature and at times questionable in its accuracy. Given these limitations, quantifying the data and arriving at specific numbers for district-wide irrigation efficiencies for a certain portion of the cropping season is a task which requires a certain amount of professional skill to evaluate the results. The intention in this portion of the study was to obtain numbers which would reflect trends in pre-plant irrigation efficiencies and indicate the degree of need for modifying irrigation practices during the time of year when pre-plant irrigation occurs. The conclusions which result from this examination show trends which are expected, supporting the validity of the conclusions which may be drawn.

- The data indicate that growers are adjusting water deliveries in response to the quantity of effective rainfall.
- Low PIE values can generally be explained where growers are applying excess water in one year to satisfy leaching requirements from previous years.
- High PIE values from 1990-1992 in some of the districts reflect inadequate water supplied for leaching.
- 1993 can be expected to be a low PIE year if water was available.

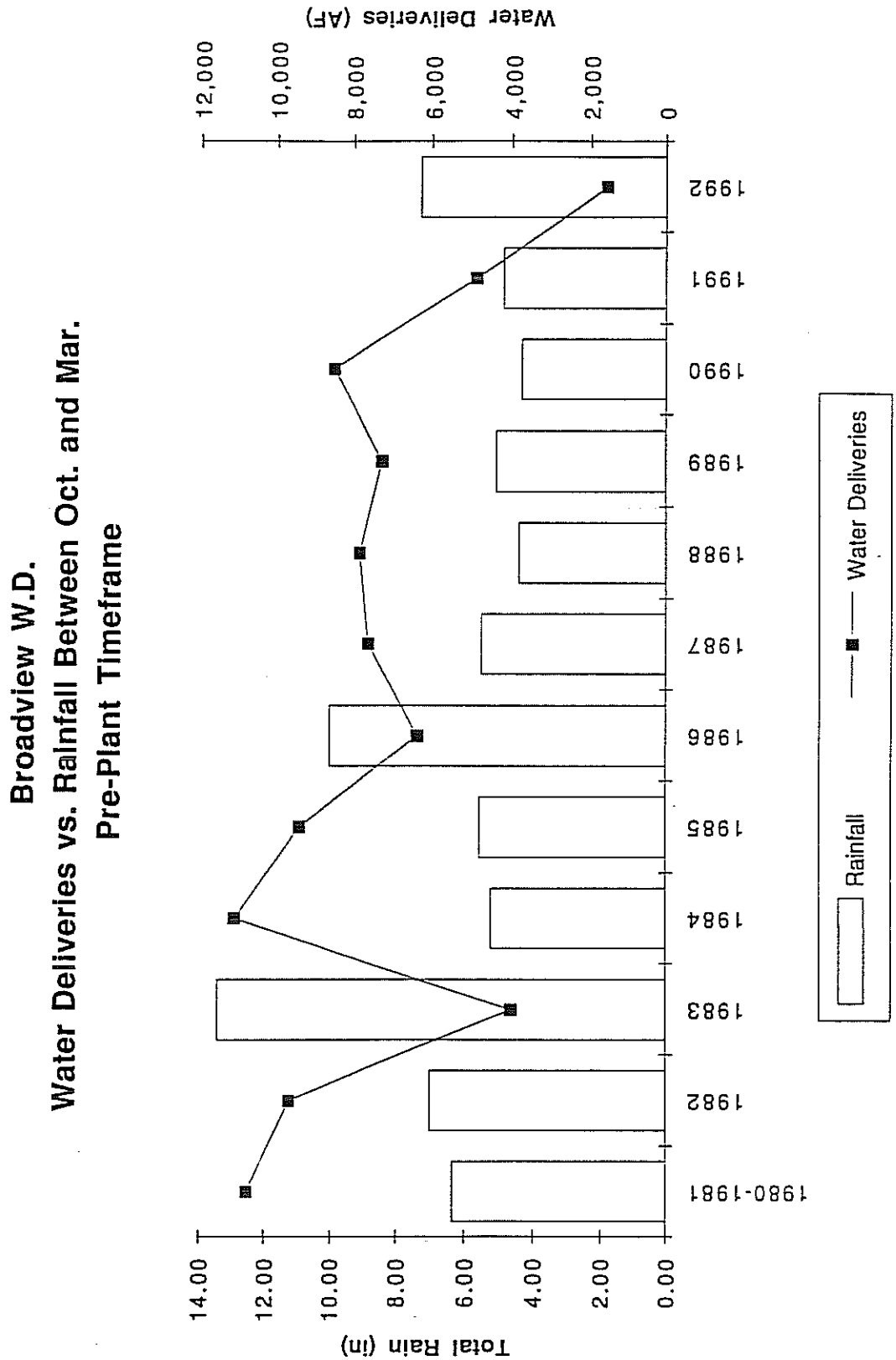
Broadview W.D.
Water Deliveries vs. Rainfall Between Oct. and Mar.
Pre-Plant Timeframe
Total Rain (in)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Water Deliveries (AF)
12,000
10,000
8,000
6,000
4,000
2,000
0
1980-1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
Rainfall
Water Deliveries

Figure 22

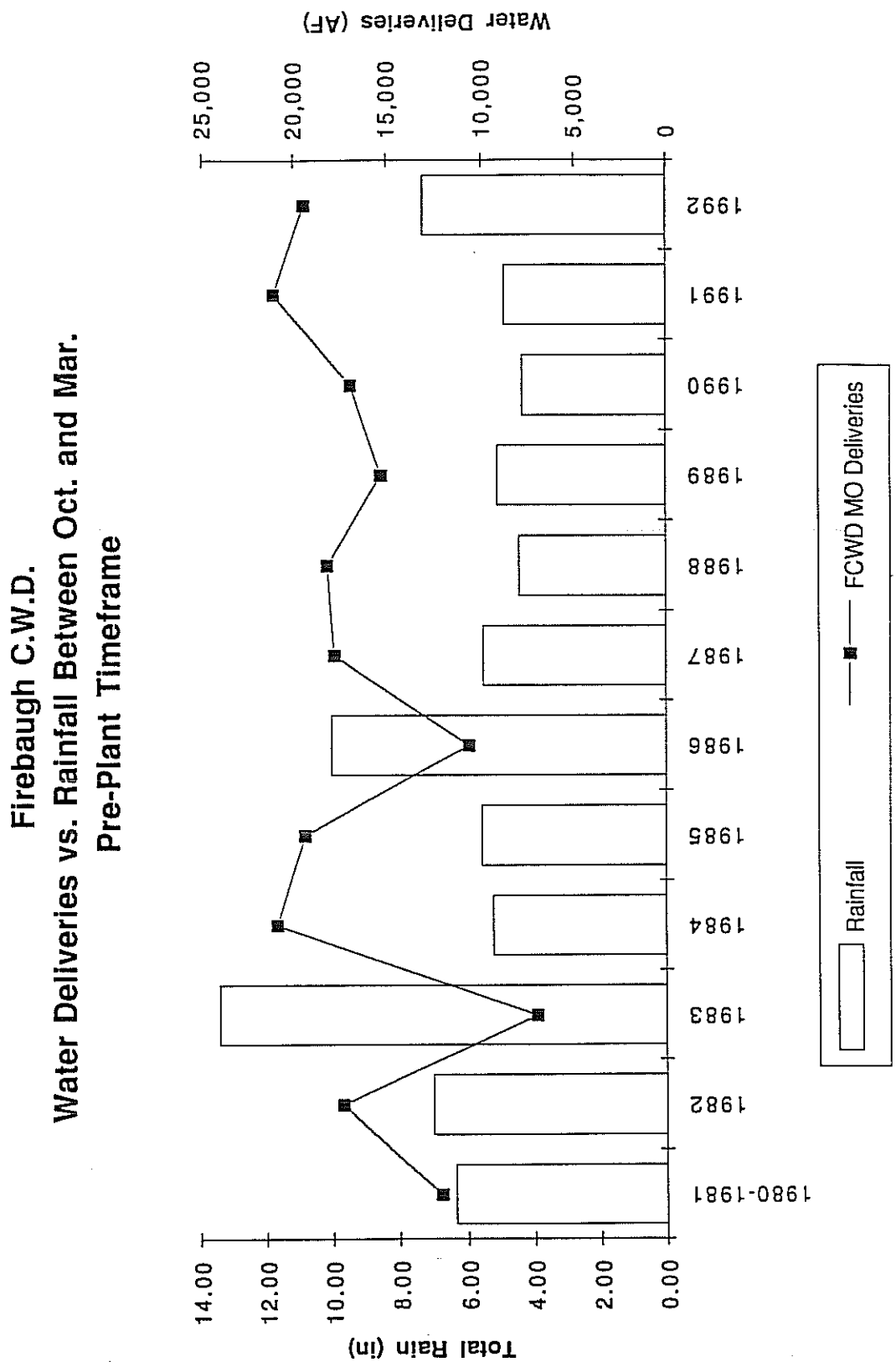
Firebaugh C.W.D.
Water Deliveries vs. Rainfall Between Oct. and Mar.
Pre-Plant Timeframe
Water Deliveries (AF)
25,000
20,000
15,000
10,000
5,000
0
Total Rain (in)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1980-1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
Rainfall
FCWD MO Deliveries

Figure 23

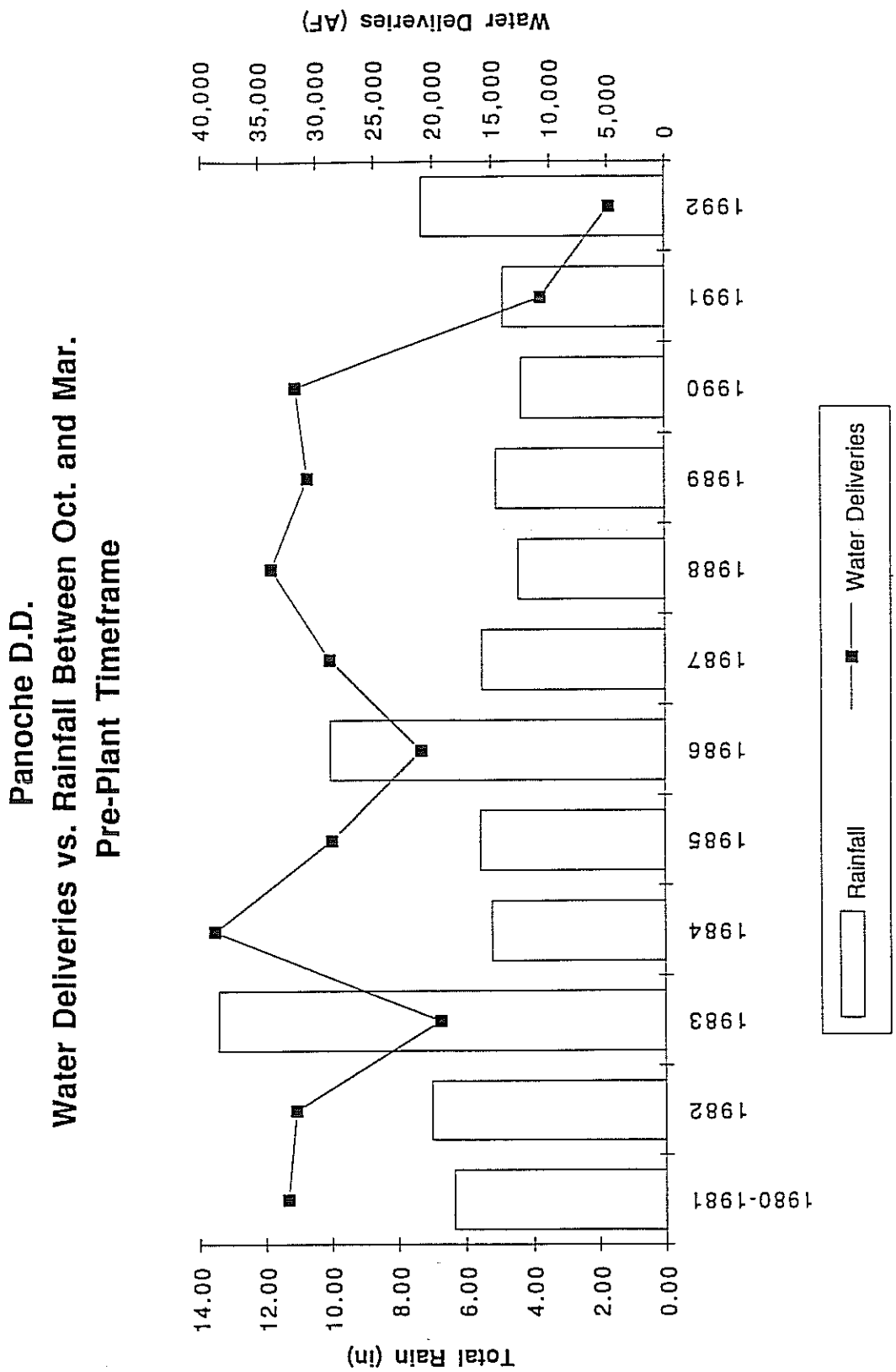
Panoche D.D.
Water Deliveries vs. Rainfall Between Oct. and Mar.
Pre-Plant Timeframe
Water Deliveries (AF)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Total Rain (in)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1980-1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
Rainfall
Water Deliveries

Figure 24

SECTION 5

DISTRICT IRRIGATION EFFICIENCY: WATER BALANCE APPROACH

OVERVIEW

The following section of the study was designed to be a check against the DIE using the ETc approach. The Water Balance approach used the reported district drainage (and its quality) to determine the DIE and to compare it with the ETc approach. If a district acts hydrologically as a "bathtub", this is a reasonable approach.

Since 1985, additional data has been collected and reported for the drainage volumes discharged by the districts. Using this data and some assumptions regarding subsurface water flows, an estimate of the irrigation efficiency using a "bathtub" or water balance approach was completed in order to verify the validity of the values generated by the theoretical ETc approach. The water balance approach is described in this section of the report.

The DIE values were determined for water years 1986 to 1992 depending on what information was available. In this report, 1986 refers to the water year October 1, 1985 through September 30, 1986. The goal was to verify the relative values of the DIE estimates using the ETc approach.

This section represents **Level VI**, from the section on the ETc approach where a check of irrigation efficiency is made using the bathtub approach. Irrigation Efficiency is defined as:

$$IE = \frac{\text{Irrigation Water Beneficially Used}}{\text{Irrigation Water Applied}} \times 100$$

This section calculates the irrigation water beneficially used based on a water balance. Where the amount of water delivered to the fields is known and the drainage volumes are known, estimates of the subsurface components were made to find the beneficial use component. **Figure 25** shows the model used to describe the water balance.

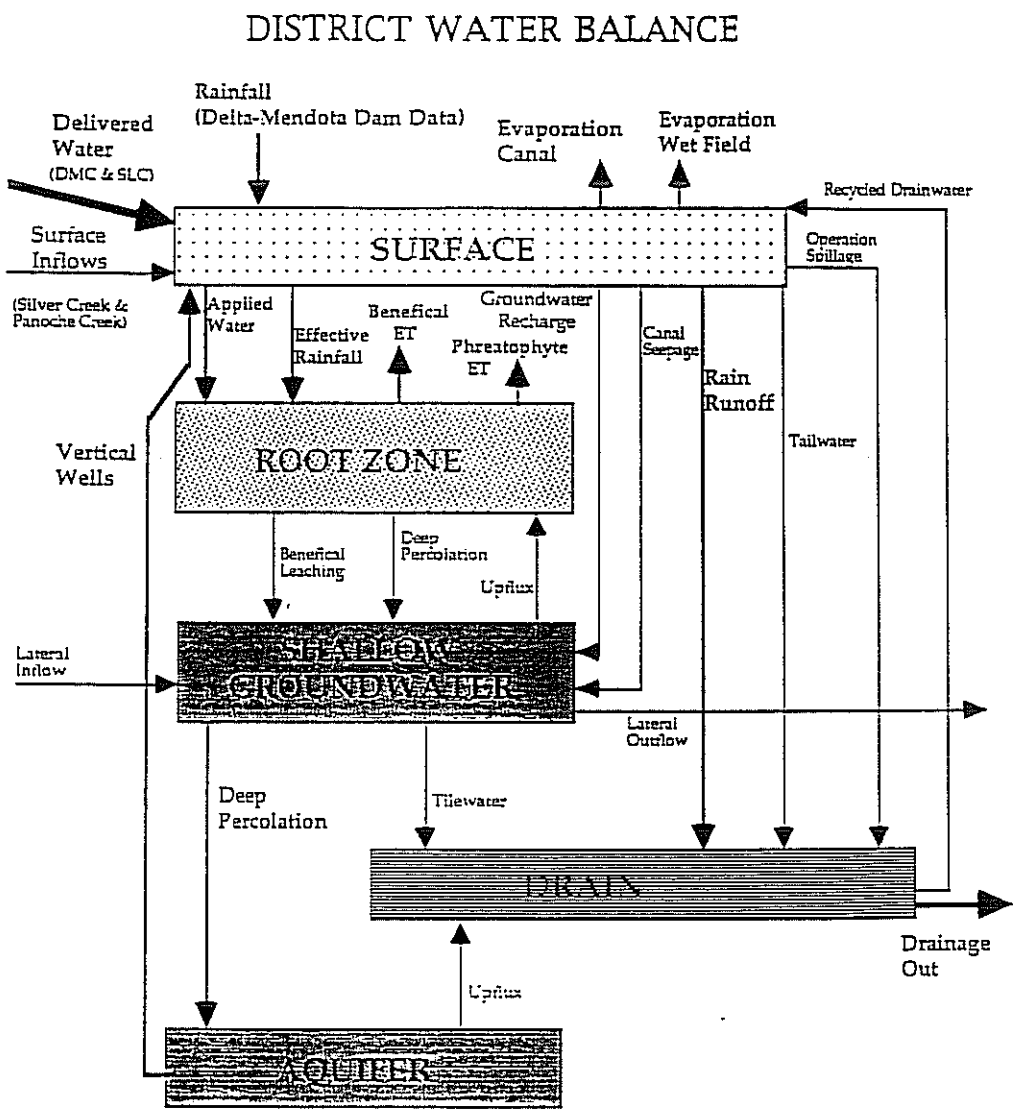
DISTRICT WATER BALANCE
Rainfall
(Delta-Mendota Dam Data)
Delivered
Water
(DMC & SLC)
Evaporation
Canal
Evaporation
Wet Field
Recycled Drainwater
Surface
Inflows
SURFACE
Operation
Spillage
(Silver Creek &
Panoche Creek)
Applied
Water
Effective
Rainfall
Beneficial
ET
Groundwater
Recharge
Phreatophyte
ET
Canal
Seepage
Rain
Runoff
Tailwater
Vertical
Wells
ROOT ZONE
Beneficial
Leaching
Deep
Percolation
Upflux
Lateral
Inflow
SHALLOW
GROUNDWATER
Lateral
Outflow
Deep
Percolation
Tilewater
DRAIN
Drainage
Out
Upflux
AQUIFER

Figure 25

PROCEDURE

A single spreadsheet was developed for the entire study area using the Water Balance approach. The spreadsheet is available in PC-Compatible format or Macintosh format. The entire spreadsheet in its original format is included in **Appendix F.**

The following tables represent the calculation of the amount of water that is beneficially used. Only 1986 through 1992 is included because drainage data collection and recording started in 1985 for most of the districts.

Table 45 shows the total amount of water delivered to the districts including the water from the Delta Mendota Canal, the San Luis Canal, pumps and any surface water that may have entered the canal systems.

Table 45
Water Delivery (IN)
Values in AF

		Variable	1986	1987	1988	1989	1990	1991	1992
Panoche		W1: PeDD	92,487	98,119	97,196	91,300	81,258	69,706	63,416
Pacheco		W2: PaWD	7,770	9,756	10,217	13,063	11,569	11,572	8,107
Charleston		W3: SLWD	10,264	13,891	14,428	12,263	11,127	10,218	9,630
Eastside Districts		W4=W5+W6+W7	102,667	119,108	117,735	106,574	97,567	86,394	83,201
	FCWD	W5: FCWD	62,966	79,545	75,106	70,326	63,903	57,141	59,569
	BWD	W6: BWD	24,628	23,308	25,891	25,200	20,582	12,902	9,086
	CCID	W7: CCID	15,072	16,255	16,738	11,049	13,081	16,351	14,546
Total Vol. (AF)		W8=W1+W2+W3 +W4	213,188	240,874	239,576	223,200	201,521	177,890	164,354

Note the water delivered for the districts decreased from a high of 241,000 AF in 1987 to 164,000 AF in 1992 due to the drought conditions.

Table 46 shows the weather data for the study area. The rain was from the Mendota Dam site. The effective rain was based on 50% of the rain. The runoff from rain events was estimated to be 15%. The ETo data is from CIMIS #7 at Firebaugh, **Table 47** is the acreage data reported by the districts.

Table 46
Rain and ETo Data

			1986	1987	1988	1989	1990	1991	1992
Total Rain	(in)	P1	11.0	5.7	5.9	6.7	6.1	5.1	7.5
Effective Rain	(in)	P2: Est. of 50%	5.5	2.8	2.9	3.4	3.0	2.5	3.7
Rain Runoff	(in)	P3: Est. of 15%	1.7	0.8	0.9	1.0	0.9	0.8	1.1
ETo	(in)	R1: CIMIS	55	57	56	57	57	56	56

Table 47
Acreage (Ac)

			1986	1987	1988	1989	1990	1991	1992
Panoche		A1: PeDD	33,153	32,208	33,795	35,686	31,799	28,126	27,742
Pacheco		A2: PaWD	3,500	4,028	4,179	3,648	4,254	4,369	3,705
Charleston		A3: SLWD	2,897	3,724	3,582	3,602	3,494	3,890	3,890
Eastside Districts		A4=A5+A6+A7	32,534	33,923	37,237	37,498	38,054	34,772	34,277
	FCWD	A5: FCWD	19,825	20,981	23,282	24,746	25,458	24,678	24,894
	BWD	A6: BWD	8,169	7,870	8,736	8,686	8,160	5,539	4,483
	CCID	A7: CCID	4,540	5,072	5,219	4,066	4,436	4,555	4,900
Total Acreage		**A8=A1+A2+ A3+A4**	72,084	73,883	78,793	80,434	77,601	71,157	69,614
Fallow Ac		**A9**	4,632	3,439	2,021	2,429	5,846	11,792	13,584

Table 48 shows the estimated evaporation by the canals in the districts. A base value was estimated based on the miles of canals and the size of the canals. The annual amount was varied by the ETo. **Table 49** shows the estimated evaporation from canals and fields. Both these tables represent non-beneficial water losses for the DIE calculation.

Table 48
Canal Evaporation
Values in AF

			1986	1987	1988	1989	1990	1991	1992
Panoche		E1: Est. 200 AF Vary by ETo	192	202	196	199	199	197	197
Pacheco		E2: Est. 100 AF Vary by ETo	96	101	98	99	99	98	98
Charleston		E3: Est. 100 AF Vary by ETo	96	101	98	99	99	98	98
Eastside		E4=E5+E6+E7	384	404	393	397	397	393	393
Districts									
	FCWD	E5: Est. 150 AF Vary by ETo	144	151	147	149	149	147	147
	BWD	E6: Est. 100 AF Vary by ETo	96	101	98	99	99	98	98
	CCID	E7: Est. 100 AF Vary by ETo	96	101	98	99	99	98	98
Total (AF)		**E8=E1+E2+E3+E4**	768	808	785	795	795	787	787

Table 49
Evaporation - Phreatophytes, Fields, Head Ditches
Values in AF

			1986	1987	1988	1989	1990	1991	1992
Panoche		E11: Est. 3% of Delivered	2,775	2,944	2,916	2,739	2,438	2,091	1,902
Pacheco		E12: Est. 3% of Delivered	233	293	307	392	347	347	243
Charleston		E13: Est. 3% of Delivered	308	417	433	368	334	307	289
Eastside		E14=E15+E16+E17	3,080	3,573	3,532	3,197	2,927	2,592	2,496
Districts									
	FCWD	E14: Est. 3% of Delivered	1,889	2,386	2,253	2,110	1,917	1,714	1,787
	BWD	E15: Est. 3% of Delivered	739	699	777	756	617	387	273
	CCID	E16: Est. 3% of Delivered	452	488	502	331	392	491	436
Total Vol. (AF)		**E18=E11+E12+E13+E14**	6,396	7,226	7,187	6,696	6,046	5,337	4,931

Table 50 shows the estimated amount of applied water that will be accounted for by infiltration or losses to the drains. This includes losses such as operational discharges to the drains. The calculation is simply the total water delivered less the evaporation estimates.

Table 50
Total Infiltrated or in Drains
Values in AF

			1986	1987	1988	1989	1990	1991	1992
Panoche		IN1=W1-E1-E11	89,520	94,973	94,084	88,362	78,622	67,418	61,317
Pacheco		IN2=W2-E2-E12	7,441	9,362	9,812	12,572	11,123	11,127	7,765
Charleston		IN3=W3-E3-E13	9,860	13,373	13,897	11,796	10,694	9,813	9,243
Eastside		IN4=W4-E4-E14	99,203	115,131	113,810	102,980	94,243	83,409	80,312
Districts									
	FCWD	IN5=W5-E5-E15	60,933	77,007	72,705	68,067	61,837	55,279	57,634
	BWD	IN6=W6-E6-E16	23,793	22,508	25,016	24,345	19,865	12,417	8,715
	CCID	IN7=W7-E7-E17	14,524	15,666	16,138	10,618	12,590	15,762	14,012
Total Vol. (AF)		IN8=W8-E8-E18	206,024	232,840	231,603	215,710	194,681	171,766	158,637

Refer to **Figure 26** for the location of the discharge points. **Table 51** shows the amount of drainage flows from the drainage measurement points in the districts. It must be noted that based on visual observation, not all of the measurement sites have the same degree of accuracy. The measurement site at PE-14 is a good measurement site, while the measurement site at PO-1 is a poor measurement site. Future efforts need to focus on improving these measurement sites for accuracy and standardizing the water quality collection process. **Appendix G** contains a selected portion of the graphical analysis of the water quality data. It was determined that due to inconsistencies in the format of the reported data and uncertainties of the water volumes at the times of the water quality measurements, the water quality data was not incorporated into this study of the irrigation efficiency. However, increases in the irrigation efficiency will undoubtedly increase concentrations in the discharges from the districts.

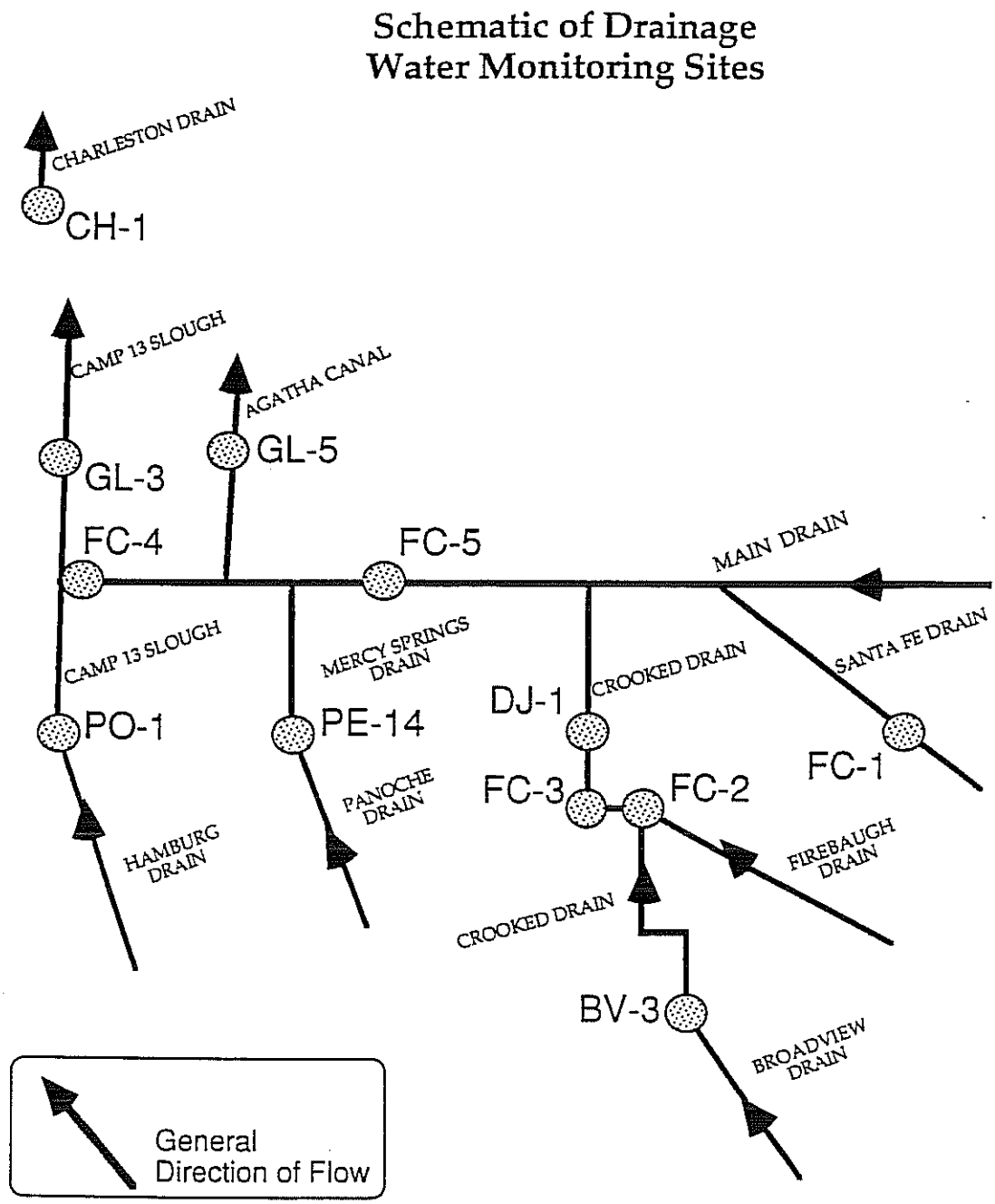
Schematic of Drainage
Water Monitoring Sites
CHARLESTON DRAIN
CH-1
CAMP 13 SLOUGH
AGATHA CANAL
GL-3
GL-5
FC-4
FC-5
MAIN DRAIN
CAMP 13 SLOUGH
MERCY SPRINGS DRAIN
CROOKED DRAIN
SANTA FE DRAIN
DJ-1
PO-1
PE-14
FC-1
FC-3
FC-2
PANOCHE DRAIN
HAMBURG DRAIN
FIREBAUGH DRAIN
CROOKED DRAIN
BV-3
BROADVIEW DRAIN
General
Direction of Flow

Figure 26

Table 51
Water Drainage (OUT)
Values in AF

		1986	1987	1988	1989	1990	1991	1992
Panoche	D1: PE-14	33,257	34,724	30,144	24,875	19,835	13,475	13,532
Pacheco	D2: PO-1	3,884	5,176	2,664	5,122	3,160	2,716	2,716
	(2337,3772,3231,655)							
Charleston	D3: CH-1	3,186	4,769	6,136	2,799	2,126	781	781
Eastside	D4: FC-5	31,191	32,265	26,041	22,626	16,964	13,491	13,491
Districts								
Total Vol.	D5=D1+D2+D3+D4	71,518	76,934	64,985	55,422	42,085	30,463	30,520
(AF)								

Table 52 shows the percentage of the drainage water to the delivered water. This table is deceiving since there can be waters entering the system that are beyond the control of the district. For example, subsurface flows from regions outside of the district boundaries. Or surface runoff from rainfall that enters the drains. Also some of the water may be beneficial by removing harmful salts from the rootzone.

Table 52
Percent of Delivered Water vs. Water in Drains

		1986	1987	1988	1989	1990	1991	1992
Panoche	Water IN/Water OUT	36%	35%	31%	27%	24%	19%	21%
Pacheco	D2/W2	50%	53%	26%	39%	27%	23%	34%
Charleston	D3/W3	31%	34%	43%	23%	19%	8%	8%
Eastside	D4/W4	30%	27%	22%	21%	17%	16%	16%
Districts								
Total Vol.	Calc	34%	32%	27%	25%	21%	17%	19%
(AF)								

Table 53 shows the amount of drain water that is beneficial to the district by removing harmful salts. These values were calculated by using a desired rootzone threshold ECe of 2.5 dS/m.

Table 53
Water For Leaching
Values in AF

			1986	1987	1988	1989	1990	1991	1992
Panoche		L1: From DIE - ETc	4,176	4,430	4,388	4,122	3,669	4,135	3,762
Pacheco		L2: From DIE ETc	787	988	1,035	1,835	1,626	1,626	1,139
Charleston		L3: From DIE ETc	331	688	753	543	561	506	503
Eastside		L4= L5+L6+97	4,918	5,419	6,084	5,283	5,383	4,752	4,136
Districts									
	FCWD	L5: From DIE ETc	2,843	3,592	3,391	3,175	2,885	2,580	2,690
	BWD	L6: From DIE ETc	1,395	1,093	1,937	1,609	1,907	1,434	790
	CCID	L7: From DIE ETc	681	734	756	499	591	738	657
Total Vol.		**L8=L1+L2+L3+L4**	10,212	11,525	12,260	11,783	11,238	11,019	9,540
(AF)									

Table 54 shows the amount of drain water that is estimated from sources outside of the district that are subsurface flows. An estimate was provided from John Fio (personal communication) and the details are included in **Appendix H.**

Table 54
Subsurface Baseflow
Values in AF

			1986	1987	1988	1989	1990	1991	1992
Panoche		B1-B3:From John Fio	4,800	4,300	2,900	3,700	2,000	1,500	906
Pacheco		Personal Communication	544	544	549	605	0	451	575
Charleston			30	30	30	1	0	0	30
Eastside		B4=B5+B6+B7	1,709	1,204	1,198	1,638	1,400	920	961
Districts									
	FCWD	B5-B7:From John Fio	609	438	524	501	509	368	409
	BWD	Personal Communication	600	266	174	637	391	52	52
	CCID		500	500	500	500	500	500	500
Total Vol.		B8=B1+B2+B3+B4	7,083	6,078	4,677	5,944	3,400	2,871	2,472
(AF)									

Table 55 shows the amount of drain water that was from rain runoff. These volumes have not been historically recorded for the districts. Some of the districts could have much larger numbers than were estimated because they might spill water for another district to avoid flooding during rain events. This tended to increase the volumes of drainage flows that did not originate with the districts.

Table 55
Rain Runoff
Values in AF

			1986	1987	1988	1989	1990	1991	1992
Panoche		R1:From DIE ETc	4,571	2,279	2,488	2,989	2,405	1,775	2,583
Pacheco		R2:From DIE ETc	483	285	308	306	322	276	345
Charleston		R3:From DIE ETc	399	263	264	302	264	246	362
Eastside		R4=R5+R6+R7	4,486	2,400	2,742	3,140	2,878	2,195	3,192
Districts									
	FCWD	R5:From DIE ETc	2,733	1,484	1,714	2,072	1,925	1,558	2,318
	BWD	R6:From DIE ETc	1,126	557	643	727	617	350	417
	CCID	R7:From DIE ETc	626	359	384	341	335	288	456
Total Vol.		R8=R1+R2+R3+R4	9,939	5,227	5,801	6,736	5,869	4,492	6,483
(AF)									

Table 56 shows the amount of drain water that was evaporated before reaching the outlet of the district. This value was roughly estimated by the determining the area in drains and factoring in the evaporation rate of an open water body. The evaporation amounts were then varied by month.

Table 56
Drain Evaporation - Phreatophytes & Water Surfaces
Values in AF

			1986	1987	1988	1989	1990	1991	1992
Panoche		E19: Est. 500 AF Vary by ETo	480	505	491	497	497	492	492
Pacheco		E20: Est. 250 AF Vary by ETo	240	252	245	248	248	246	246
Charleston		E21: Est. 250 AF Vary by ETo	240	252	245	248	248	246	246
Eastside		E22=E15+E16+E17	960	1,010	982	993	993	983	983
Districts									
	FCWD	E23: Est. 350 AF Vary by ETo	336	353	344	348	348	344	344
	BWD	E24: Est. 250 AF Vary by ETo	240	252	245	248	248	246	246
	CCID	E25: Est. 250 AF Vary by ETo	240	252	245	248	248	246	246
Total Vol.		**E26=E11+E12+E13+E14**	1,920	2,020	1,964	1,987	1,987	1,966	1,966
(AF)									

Table 57 shows the amount estimated amount of water that leaks to the deep aquifer below the Corcoran Clay. These estimates were provide by John Fio (personal communication) and details are include in **Appendix H.** These values represent drainage from the districts that does not appear in the drains but travels subsurface to the lower aquifer. These values are constant since it is assumed that there is some drainage occuring from the entire area of the districts.

Table 57
Deep Percolation Losses below Corcoran Clay
Values in AF

			1986	1987	1988	1989	1990	1991	1992
Panoche		DP1=.31 AF/A x Acres	10,587	10,587	10,587	10,587	10,587	10,587	10,587
Pacheco		DP2=.31 AF/A x Acres	1,367	1,367	1,367	1,367	1,367	1,367	1,367
Charleston		DP3=.31 AF/A x Acres	1,122	1,122	1,122	1,122	1,122	1,122	1,122
Eastside		DP4=DP5+DP6+DP7	10,019	10,019	10,019	10,019	10,019	10,019	10,019
Districts									
	FCWD	DP5=.21 AF/A x Acres	6,234	6,234	6,234	6,234	6,234	6,234	6,234
	BWD	DP6=.26 AF/A x Acres	2,798	2,798	2,798	2,798	2,798	2,798	2,798
	CCID	DP7=.21 AF/A x Acres	987	987	987	987	987	987	987
Total Vol. (AF)		**DP8=DP1+DP2+DP3+DP4**	23,094	23,094	23,094	23,094	23,094	23,094	23,094

Table 58 shows the calculation of the non-beneficial water from the districts. The equation for the non-beneficial water is as follows:

Non-Beneficial Water
= Drainage - Leaching -Baseflow -Rain Runoff +Drain Evap. +Deep Percolation (Deep Aquifer)
= Table 51 - Table 53 - Table 54 - Table 55 + Table 56 + Table 57

Note that non-beneficial water includes some proportion of tailwater, tile water, and operational spill water. It was felt there was not an easy method to obtain the relative amounts of the individual components. The tile water can be from poor irrigation timing or from the distribution uniformity of the irrigation systems. Note that from 1987 to 1992 the volume of non-beneficial water decreased 50%.

Table 58
Non-Beneficially Used Water
Values in AF

		1986	1987	1988	1989	1990	1991	1992
Panoche	NB1=D1-L1-B1-R1+E19+DP1	30,777	34,807	31,445	25,147	22,845	17,143	17,359
Pacheco	NB2=D2-L2-B2-R2+E20+DP2	3,677	4,978	2,385	3,991	2,828	1,976	2,270
Charleston	NB3=D3-L3-B3-R3+E21+DP3	3,788	5,161	6,456	3,323	2,671	1,397	1,254
Eastside	NB4=D4-L4-B4-R4+E22+DP4	31,057	34,271	27,018	23,577	18,315	16,626	16,203
Districts								
Total Vol.	**NB8=NB1+NB2+NB3**	69,299	79,217	67,304	56,039	46,659	37,142	37,086
(AF)	**+NB4**							

Table 59 shows the calculation of the beneficial water from the districts. The beneficially used water is the difference between the water that was accounted for in the drains (IN1 through IN5) and the non-beneficial component (NB1 through NB5).

Table 59
Beneficially Used Water
Values in AF

		1986	1987	1988	1989	1990	1991	1992
Panoche	B1=IN1-NB1	58,743	60,166	62,639	63,215	55,777	50,275	43,958
Pacheco	B2=IN2-NB2	3,764	4,384	7,428	8,580	8,294	9,150	5,496
Charleston	B3=IN3-NB3	6,072	8,212	7,441	8,473	8,023	8,416	7,989
Eastside	B4=IN4-NB4	68,146	80,860	86,792	79,403	75,928	66,783	64,109
Districts								
Total Vol.	B5=B1+B2+B3+B4	136,725	153,622	164,299	159,671	148,022	134,625	121,552
(AF)								

Table 60 shows the calculation of the district irrigation efficiency based on the following equation:

$$IE = \frac{\text{Irrigation Water Beneficially Used}}{\text{Irrigation Water Applied}} \times 100$$

Also shown on this table is the comparison to the Regional IE estimate from the ETc approach. The values trend similar to each other indicating increasing irrigation efficiencies as the drought continued into the 6th year (1992). **Figure 27** shows the graphical relationship between the two approaches of determining the irrigation efficiency. This graph shows that the water balance approach verifies the assumptions of the DIE analysis using the ETc approach. The differences in the early years probably reflect poor water volume measurements at the beginning of the water masurement efforts. The values are 5% or less difference starting in 1987. The values are within 3% in the years 1989 through 1992.

Table 60
Regional Irrigation Efficiency - Water Balance Approach

		1986	1987	1988	1989	1990	1991	1992
Panoche (DIE)	IE1=B1/W1	64%	61%	64%	69%	69%	72%	69%
Pacheco (DIE)	IE2=B2/W2	48%	45%	73%	66%	72%	79%	68%
Charleston (DIE)	IE3=B3/W3	59%	59%	52%	69%	72%	82%	83%
Eastside Districts	IE4=B4/W4	66%	68%	74%	75%	78%	77%	77%
Regional IE	IE8=B8/W8	**64%**	**64%**	**69%**	**72%**	**73%**	**76%**	**74%**
Regional IE	ETc Approach	**56%**	**59%**	**64%**	**70%**	**75%**	**78%**	**77%**

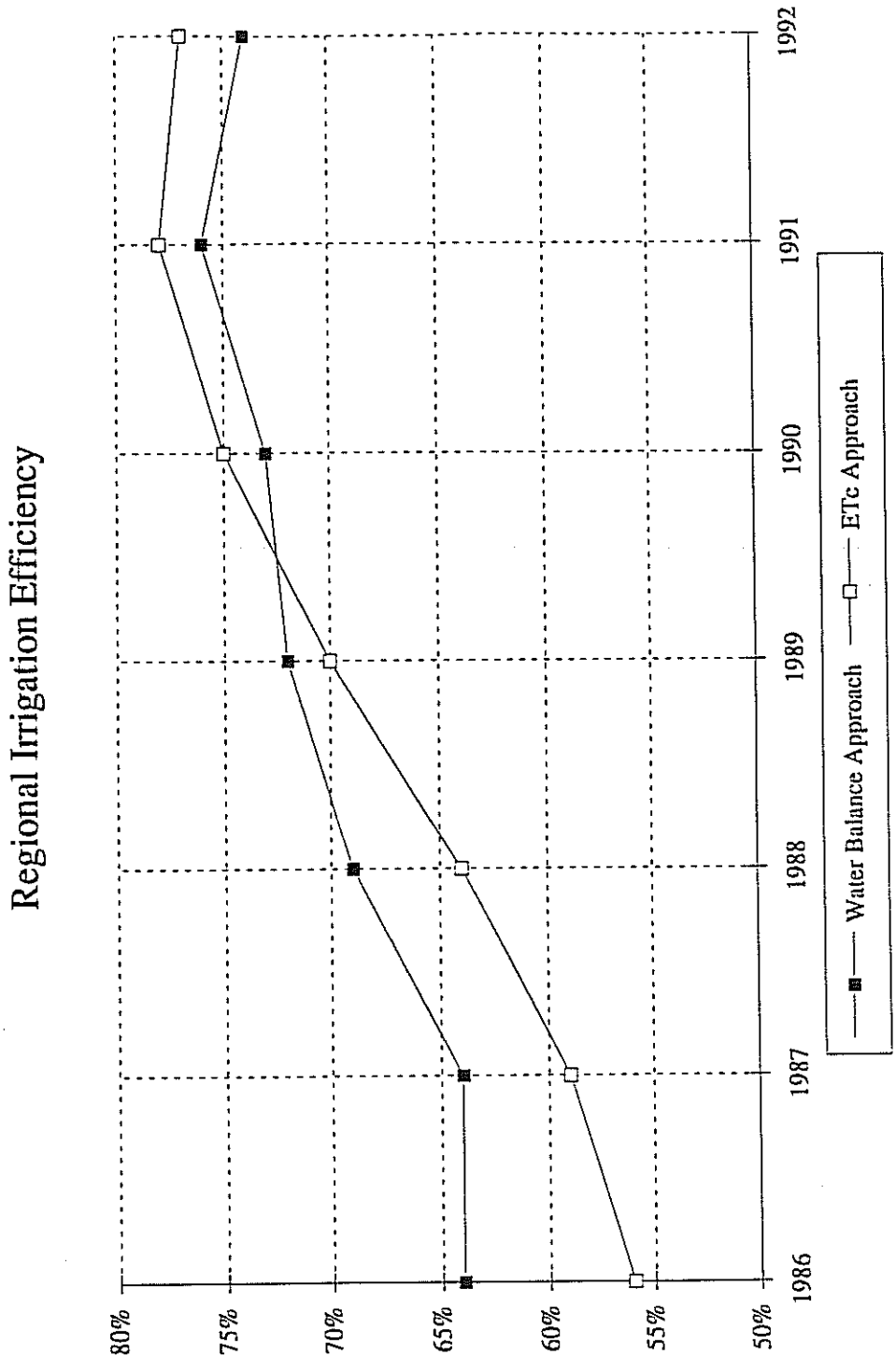
Regional Irrigation Efficiency
80%
75%
70%
65%
60%
55%
50%
1986
1987
1988
1989
1990
1991
1992
Water Balance Approach
ETc Approach

Figure 27

SECTION 6

RESULTS AND CONCLUSIONS

SUMMARY

There are several important concerns for the study area: the drought, increasing concerns over the quality of the San Joaquin River, and increasing pressure to reform federal water contracts and reclamation law. It would be impossible to say that the increasing trend is due to any one of these forces. Most likely it was an initial response to the water quality concerns brought out by the Kesterson Reservoir situation. Although pressure has remained to improve drainage quality, the overriding problem of the drought has become the main impetus for improved irrigation efficiency.

One effect of the drought may well be a reduction in the ETc adjustment factor as farmers stress crops. Another factor might be farmers planting more acreage than prudent; hoping for extra water to appear in mid-season. Without the additional water, some acreage will be abandoned. These abandoned acreages would have to be considered separately if performing further analyses in the same manner as this study.

The results of this study indicate that most of the districts were able to improve DIE. The main problem is whether they can maintain the high levels of irrigation efficiency without being impacted by increasing salinity in the rootzones. Based on the pre-plant analysis, the data indicated that significant underirrigation was being practiced due to the limited irrigation water supplies. If the trend were to continue, excessive levels of salts in the rootzone would be expected.

The results also indicate a basic need for better coordination among the districts in the data collection and recording efforts. The districts might invest in a common spreadsheet and word processing format to aid in information transfer. There has been much data collected for this study area. However, most of the data is not readily accessible for data analysis. Some of the data monitoring sites need to be improved. For example, wells and drainage sumps must be fitted with flowmeters. Other suggestions include standardized procedures for the collection of water quality data, improved drainage discharge point measuring stations, standardized format for reporting irrigated acreage and water delivery data (suggest the September through October format).

An important assumption made in this study was adjusting the ETc downwards to account for nonuniformity and bare spots. This tended to decrease DIE using the ETc approach because it decreases beneficial use for the same amount of applied irrigation water. But, even allowing that crop uniformity is variable throughout a field, and that bare spots do exist, there might be nothing a farmer could do about the perceived low DIE. That is, he cannot micro-manage irrigation within a field to prevent or reduce water application to poor or bare spots in any one field.

Other Significant Results:

- The water balance approach has identified several destinations of water that have not been used in previous reports. These include an estimate of the amount of rainfall runoff that enters the drains. The total amount ranged from about **4,500 AF to 10,000 AF** for the entire study area. Another estimated value was the amount of deep percolation losses below the Corcoran Clay layer. This report estimated losses of about **23,100 AF** per year for the study area. This is compared to the measured drainage volume in 1992 of **30,500 AF**. This is significant because a salt balance of this region needs to include an estimate of the salt removed with the water passing through the Corcoran Clay.

- Due to the fluctuating characteristics of the water quality data from the sumps and the district drains, it was felt it was not possible to draw conclusions regarding the expected selenium, salinity, or boron levels with additional recycling. Future data collection efforts need to focus on consistant water quality measurements and accurate flow measurement devices. Reported water quality measurements appear to use averaging techniques that may not accurately reflect the water quality in the drains. Some of the drainage discharge measurement sites need improvements to ensure accurate water measurement. Concentrations and loads analysis was graphically performed in **Appendix G**. Included in this section are EC, Se, B versus time of year, EC versus Drainage Volume, and EC versus Se ratios.

- In addition, special analysis were made of the sumps in Panoche Drainage District. It was found that 50% of the reported load of Se into the discharge of the district comes from 5 of 61 sumps. 80% of the loading comes from 10 of the sumps. These sumps are located close to each other on the eastern side of the district. If flows from these sumps could be minimized, the impact on the drain Se loading would be significant. Future studies may want to focus on water table control in these areas to minimize drainage volumes. For example, maintaining higher water tables could force additional upflux from the shallow water table. It is recognized

that these regions may be draining significant flows from upslope water users. PDD has also been at the forefront in researching methods to remove harmful salts from the drainage water.

- It was found that the water quality from individual sumps varies significantly and that this is due to variations in the timing of the water quality samples. Apparently, water samples are drawn when convenient and cost concerns do not allow consideration for the timing of irrigation events. However, the data indicates that reductions in the drainage volumes will definitely reduce the EC, Se, and B loadings in the drains with the tradeoff of some increase in the concentrations.

There are two reasonable approaches available towards increasing the DIE in this area.

- The first is the classical approach of improved water management on both district and on-farm levels.
  - Improved <u>on-farm</u> irrigation efficiency implies improved timing of irrigations (in the sense of shutting off the water at the correct time) and better DU of water applications, plus recycling of tailwater on-farm. This improved on-farm irrigation reduces the two main on-farm water losses: deep percolation and uncollected tailwater.
  - Improved <u>district</u> level management involves recycling of reasonable quality tail and tile water, plus improved flexibility in water deliveries to the farms. Most of the districts have some capability of recycling tailwater. Firebaugh Canal Water District has just begun a study to evaluate the potential construction and blending requirements for recycling tailwater and higher quality tile water.
- The second path is a relatively new idea. This approach is an integrated approach which attempts to maximize the ratio of crop yield to the unit-water applied. Through improved management of the soil fertility, planting, irrigation, and other agronomic factors, the zones in a field which have weak or bare crop growth will be eliminated or minimized. Therefore, with a stronger crop, the field ET will increase because there are more and healthier plants. The applied water would remain about the same. The net result is less deep percolation and a higher IE.

Sustainable District Irrigation Efficiencies

There are two important and related questions which the ITRC has addressed in this study:

- What is the highest District Irrigation Efficiency (DIE) which can be sustained in this
- How much tile water recycling can be done?

The evidence to date indicates that the answers are three-fold:

- If there is under-irrigation on fields (caused by a combination of short durations and non-uniformity), any tile water recycling appears to be unsustainable in that some portions of the fields will accumulate unacceptably high and toxic salt levels.
- If there is no under-irrigation on fields (ie, all non-uniformity is compensated for with extra water application, and irrigation scheduling is sufficient to have no stress anywhere), about 30% of the deep percolation through the root zone can be recycled without raising the average root zone ECe to more than about 2.5 dS/m. The remaining 70% of the root zone deep percolation will either exit through the Corcoran Clay layer or be discharged (via tiles and then surface drains) from the district. Because of the uncertainties of the magnitude of the flow rate downward through the Corcoran Clay layer, it is impossible to predict the precise amount of tile water that must be discharged from the district via surface drains.
- The maximum sustainable DIE is about 80% in this region.

These conclusions are based upon the following:

1. All on-farm irrigation has non-uniformity (Distribution Uniformity, DU, of less than 100%) of water distribution across a field. Typical well-managed and well-designed irrigation systems have a DU of about 75-80%.

2. To avoid under-irrigation, with a DU of 75% and about 5% non-beneficial evaporation loss, the Irrigation Efficiency (IE) of a farm with no recycling is about 70%

$$IE = DU \times (1 - \frac{\%\ evap\ loss}{100})$$

$$= 75 \times (1 - \frac{5}{100})$$

$$= 71\%$$

3. A simple spread sheet was developed to examine soil salinities across a field with a linear DU pattern and varying percentages of tile recycling. A 30% recycling of root zone deep percolation, accomplished through blending tile water with supply water, indicated that the drainwater EC and blended water EC stabilize within a couple of years. This assumes **no under-irrigation** (a key assumption, as explained below). Estimated stabilized values were:

   EC of source water = 0.6 dS/m (assumed)
   ECe at "worst spot" in the field = 2.6 dS/m
   ECe at "best spot" in the field = 0.5 dS/m

   ECiw (blended) = 0.8 dS/m

   ECdw = 2.5 dS/m

4. The numbers in item (3) above do not match what is actually seen in field. In particular, Broadview Water District has excellent data since about 1980. That data shows the following:

   - Before BWD had an outlet for its tile drain water, the EC of the blended irrigation water was about 3.0 dS/m, higher than predicted in (3).

   - This report has estimated that the present annual DIE values and pre-irrigation DIE values are in the range of 90%.

- Soil salinities measured throughout BWD by Lesch and Rhoades in 1991 are much higher than the ECe's predicted.

- The high DIE values in BWD are indicative of under-irrigation on parts of fields. That under-irrigation leads to salt build-up (due to no leaching) in some parts of fields, and very concentrated tile drain water in the areas with some leaching. That concentrated tile drain water is then recirculated on all the field, compounding the problem.

5. The district farmers see processing tomatoes as a key crop in their economic rotation. Tomatoes have a threshold (critical maximum) ECe of about 2.5 dS/m for soil salinity. Therefore, this discussion of sustainability revolves around the objective of maintaining a soil salinity distribution such that there is no yield decline of tomatoes anywhere in the field due to salt buildup.

In summary, the evidence indicates that the best strategy for soil productivity sustainability requires all three of the following:

- Have high irrigation DU's.

- Have excellent irrigation scheduling and water depth control, and avoid under-irrigation

- Recycle no more than about 30% of the root zone deep percolation, which may be equivalent to 40-60% of the tile water.

SECTION 7

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GRASSLAND BASIN IRRIGATION AND DRAINAGE STUDY

VOLUME 2 - TECHNICAL APPENDICES

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CAL POLY

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TECHNICAL APPENDIX A
Geographical Information System (GIS) Application

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UNDERSTANDING GIS

A Geographic Information System (GIS) is an organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information. Simply put, the GIS is a computer system capable of holding and using data describing places on the earth's surface. Data that a GIS can store and use can be represented as related data layers including, hydrology, topography, land use, utilities, soils, streets, districts, and parcels.

A GIS differs from other computer programs, such as, spreadsheets, statistics packages, or drafting programs in that a GIS allows spatial operations to be done on the data. Other program packages are only capable of answering aspatial queries, or questions not requiring the stored value of latitude and longitude or describing where places are in relation to each other. A GIS readily answers spatial queries.

A GIS is also able to link different sets of data. By accessing a database, a GIS can link data in different files by exact matching or by non-exact matching, including hierarchical matching and fuzzy matching. Exact matching occurs when information about a set of geographic features, stored in multiple files, is joined and stored in another file. To bring the two sets of information together, a key (such as a district name)common to both files is used. The data stored in each separate file with the same district name is extracted and joined for storage in a new file. Information is sometimes gathered at different scales with differing frequency. To relate these

types of data, a hierarchical matching can be used. If a group of smaller areas fit exactly within a larger area, the data gathered about the small areas can be added up and then an exact match can be done with the information about the larger area. On many occasions, however, the smaller areas do not fit exactly within the larger area or their total area does not exactly match that of the larger area. To compare these types of data sets, one can use fuzzy matching. In principle, it is like laying one area map over another and relating and comparing the combined information. A GIS can do this because it uses geography, or space, as the common key between the data sets. In fuzzy matching, information is linked only if it relates to the same geographical area. Data linkage allows one to relate separate sets of information and to add to the database.

A GIS is able to carry out spatial operations, link data, and can also answer questions relating to location, condition, trends, patterns, and modeling. It can find out what exists at a particular location, or find a location where certain conditions are satisfied. It can answer what has changed over time about a location or what patterns can be identified as remaining constant or progressing. A GIS can also be used to determine what happens given a hypothetical situation for a given area. In general, a Geographic Information System can be used for many diverse applications.

GEOGRAPHIC INFORMATION SYSTEM ACTIVITIES

An ARC/INFO database has been developed for this project to manage all of the map data. Although initial maps were down-loaded from the Bureau of Reclamation's computer in Sacramento at the start of the project, many changes to the existing data were found to be necessary. Therefore, data was re-digitized from existing map sources and field checking using a USGS 7.5 minute quad series as the base. The quads are as follows:

Charleston School	Mendota Dam	Laguna Seca
Dos Palos	Firebaugh	
Oxalis	Broadview Farms	
Poso Farm	Hammonds Ranch	

These maps were supplemented with field information and other map bases received from various agencies.

The database is stored as a nine-quad coverage except for the drainage district boundaries. The maps produced were based on the individual boundaries and/or quad boundaries. The database includes the following list of ARC/INFO coverages:

Table 1: ARC/INFO Coverages

Coverage Name	Description
sect	Coverage of sections of the nine quads (polygon coverage)
firebaugh	Firebaugh drainage district boundary (polygon coverage)
sect2	Coverage of label points for each section polygon (point coverage)
sjv.tics	Tics for nine quads making up the database
broad	Broadview drainage district boundary (polygon coverage)
wats	Water supply lines for the nine quads (line coverage)
c.c.i.d.	C.C.I.D drainage district boundary (polygon coverage)
wells	Coverage of wells in nine quads (point coverage)
pacheco	Pacheco drainage district boundary (polygon coverage)
panoche	Panoche drainage district boundary (polygon coverage)
charleston	Charleston drainage district boundary (polygon coverage)
dist	All drainage district boundaries in a single coverage (poly)
drains	Coverage of on-farm and main drains (line coverage)
ponds	Coverage of ponds (polygon coverage)
quads	USGS quad boundaries as single coverage (polygon coverage)
rds	Roads for the nine quads (line coverage)

This data resides on a Sun workstation running ARC/INFO 6.0.1 at Cal Poly. Maps were produced by "cutting" the quads out of the larger base. In this way the relationships between all of the districts can be maintained for future use.

1:24000 scale maps were produced with an eight pen CalComp plotter, while the maps included within the report were generated with ARC/INFO and saved on a Macintosh computer.

The GIS was set up using ARCINFO. The master file currently resides on a SUN Computer Workstation in the Landscape Architecture Department at Cal Poly. Dr. Walt Bremer has aided the effort of creating the mapping and database linkages for the project. The maps were sent to the individual districts and revisions were made to accurately reflect the physical conditions of the study area. The revised maps (a total of 9) are transmitted separately. The maps correlate to the USGS 7-1/2 Minute Quadrangle Maps for Charleston School, Dos Palos, Oxalis, Poso Farm, Laguna Seca, Mendota Dam, Firebaugh, Broadview Farms, and Hammonds Ranch. As additional GIS data is generated and added to the database, the master file will be maintained and updated at Cal Poly.

The file is now capable of being used by other entities for GIS analysis. The database has been transmitted to the USBR (through Internet), USSL in Riverside (tape file), and to the USGS in Sacramento (tape file). Copies of the file can be made for other entities wishing to perform analysis of the study area using GIS.

John Fio, with the USGS in Sacramento, used the GIS to perform an analysis of the base flow for the study area. The sump discharge data for all of the sumps in the study area was being analyzed for the study period. Low flows have been assumed to reflect the most accurate determination of the base flow. John has defined the base flow for this project as the net groundwater inflow to the region from outside of the study area boundaries measured in the surface discharge measurements. There are still questions as to whether or not the low flow assumption is valid.

Groundwater moves into the study area from upslope sources (in general, from the San Luis Canal to the study area). Groundwater may be used in transpiration (an estimate of 0.25 acre-feet/acre was used to estimate the contribution to ETc for those areas with a high water table). Groundwater has some component of deep percolation and seepage from the districts in the study area (which shows up in the drainage sumps.) Groundwater also moves, subsurface, out of the study area boundaries (going to downslope users or the San Joaquin River). By analyzing the low flow data, an estimate can be made of the quantity of water from sources collected by district drainage systems outside of the district boundaries. This data is being added to the GIS database and the results plotted to determine if the assumption is valid.

The GIS database presently contains basic information. The location data has been used extensively to generate maps and determine the physical interrelationships between districts. Parameters have been assigned to each of the input points and segments (such as the length and direction of flow). However, detailed information has not been incorporated into the database. For example, the monthly solute loadings for each sump for the 12 year study period are available in computer spreadsheet files. These files contain a tremendous amount of data that has not been filtered nor added to the ARCINFO database. As other entities utilize the database to expand the analysis of the study area, that data will be retrieved and used to update (and expand) the master files maintained at Cal Poly.

An example of other entities using the GIS database, that is not a part of this project, is the work being done by the USSL. The USSL has been involved with the detailed analysis of a portion of the BWD. The area has been studied for purposes of modeling the vertical transport of various solutes into the root zone (0 - 1.2 meters depth.) The USSL utilized the GIS database to create input data files for running a salinity model. A computer model, TETrans, developed by the USSL to calculate profiles of soil moisture and salinity in the vadose zone during a sequence of irrigations, has been adapted as a stand-alone program. The new version of TETrans, is called TETransgeo. The GIS database was integrated with TETransgeo in order to compute salinity profiles and solute-loading to the groundwater over selected geographic areas. When the program is run, TETransgeo accesses the database and generates a formatted text file of data required for a complete TETransgeo calculation at a selected set of point locations. Output files are then created and plots generated. This work is on-going and results have not been published at this time.

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District Drain Pumps Data Summary

Drainage District	Type of Water	Linkage Line	Water Quality	Other Inf		Comments
				hp	Flow, cfs	
Firebaugh	100	0	0	95	5	
Panoche	100	100	0	100	100	
Broadview	100	100	0	100	100	
Pacheco						none
Charleston						none
CCID						none

District Lift Pumps Data Summary

Drainage District	Lift, feet	Horsepower	Efficiency	Flow Rate, cfs	Linkage to Line	Comments
Firebaugh	0	100	0	100	100	
Panoche	100	100	95	95	100	
Broadview	100	95	0	100	100	
Pacheco	0	100	100	100	100	
Charleston						None
CCID						None

Drainage Channel Data Summary

Drainage District	Constr Material	Lining	Diam	Type of Water	Maint	Comments
Firebaugh	100	100	100	100	100	
Panoche	100	100	100	100	100	
Broadview	100	100	100	100	100	
Pacheco	90	90	90	100	100	
Charleston	100	100	100	100	100	
CCID	100	100	100	100	100	

Tile Outlet Data Summary

Drainage District	Exit Type	Owner	Maint	Linkage to line	Water Quality	Other Info		Comments
						hp	Flow, cfs	
Firebaugh	100	99	99	95	50	100	0	
Panoche	100	25	25	95	100	100	100	
Broadview	100	100	100	95	100	100	100	
Pacheco	100	100	100	100	0	10	0	
Charleston	100	10	10	100	100	0	0	
CCID	100	100	0	100	100	0	0	

Wells Data Summary

Drainage District	Owner	In use?	Owner ship	Dest of water	Linkage to Dist. line	Water Quality	Other Info		Comments
							hp	Flow, cfs	
Firebaugh	0	100	100	100	100	50	100	0	
Panoche	95	100	100	95	100	40	0	95	
Broadview	0	100	100	100	100	0	0	0	
Pacheco	10	100	100	100	100	20	100	100	
Charleston									None
CCID									Wells on maps are inactive farmer-owned

Panoche District Drain Pumps

(recycle point - must be linked to two lines)

Designation	Type of Water				Linkage to Line		General Info (By Month or Year)						Other Inf		Ref
Name or ID #	Ti	Ta	W	Source	Destin 1	Destin 2	Vol, AF	Selen	EC salin	TDS ppm	Boron	kW-hrs	hp	Flow, cfs	
RL1	X	X		Russ Lift	Russ Lift	-							50	20	
RL2	X	X		Russ Lift	Russ Lift	-							50	20	

Panoche District Lift Pumps

SHT 1 OF 2

Designation	Pump Unit	Lift feet	Horse power	Effic %	Flow Rate, cfs	Linkage to Line		Reference
						in	out	
STA #1	M-1	7.2	75	53.7	73.1	DMC	Main	WCP, '86 (p 11)
	M-50	-	60	25.2	23.6	DMC	Main	
	M-3	-	75	49.0	73.9	DMC	Main	
STA #2	M-4	17.5	125	35.3	25.4	Main	Main	
	M-5	-	125	62.0	39.6	Main	Main	
	M-6	-	100	47.5	30.3	Main	Main	
	M-7	-	125	56.7	36.6	Main	Main	
	M-8	-	250			Main	Main	
STA #3	M-9	18.7	100	54.3	35.3	Main	Main	
	M-10	-	125	33.3	30.5	Main	Main	
	M-11	-	125	58.6	42.7	Main	Main	
	M-12	-	150	60.4	54.3	Main	Main	
	M-13	-	200	53.5	76.6	Main	Main	
STA #4	M-14	19.2	75	52.3	22.4	Main	Main	
	M-15	-	125	56.8	41.4	Main	Main	
	M-16	-	125	66.5	43.1	Main	Main	
	M-17	-	150	55.3	61.6	Main	Main	
	M-18	-	250	59.4	79.1	Main	Main	
STA #5	M-19	13.9	75	70.2	38.8	Main	Cont/Main	
	M-20	-	75	67.0	36.5	Main	Cont/Main	
	M-21	-	75	62.5	38.7	Main	Cont/Main	
	M-22	-	150			Main	Cont/Main	

Panoche District Lift Pumps

SHT 2 OF 2

Designation	Pump Unit	Lift feet	Horse power	Effic %	Flow Rate, cfs	Linkage to Line in	Linkage to Line out	Reference
STA #6W	M-23	19.8	75	59.7	19.9	10W TO	Main	WCP, '86 (p 11)
	M-24	-	60	50.8	13.0	10W TO	Main	
STA #7	M-40		60	59.5	17.1	10W TO	10W TO	
STA #T-1	M-28	14.5	100	61.4	44.8	DMC	T	
	M-29	-	75	55.1	26.3	DMC	T	
		-	40					
STA #T-2	M-30	12.4	60	62.9	29.2	T	T	
	M-31	-	60	63.5	34.3	T	T	
STA #T-3	M-32	12.2	40	54.4	15.9	T	T	
	M-33	-	60	62.7	33.0	T	T	
STA #T-4	M-34	12.3	50	74.2	40.4	T	T	
STA #T-5	M-35	12.4	60	57.9	28.3	T	T	
STA #T-6	M-36	12.7	40	66.5	19.3	T	Contour	
STA #10 E3	M-43		7.5			10E2S	-	
	M-44		7.5			10E2S	-	

Panoche Drainage Channel

SHT 1 OF 1

Designation	Const Mat	Lining or type	Diam in	Type of Water Ta	Type of Water Ti	Type of Water Other	Maint	Reference
Northside Drain	E			X	X		D	
Courtney Drain	E			X	X		D	
Russell Ave. Drain N.	C			X	X		D	
Hammond Drain	E			X	X		D	
Shaw Drain	E			X	X		D	
Russell Ave. Drain S.	E			X	X		D	
Millux Drain	C			X	X		?	Farmer Owned
Davidson Drain				X	X		D	
Russell Lift	E			X	X		D	
Althea Drain				X	X		D	
11-12 Drain				X	X		D	
Oxford Ave. Drain	P		12"	X	X		D	

Panoche Tile Outlets (recycle point - must be linked to a line) SHT 1 OF 3

Name or ID #	Exit Type	Owner	Maint	Linkage to line	General Info (By Month or Year) (REF #41) Vol, AF	Selen	EC salin	ppm sal	Boron	kW-hrs	Other Inf hp	Flow, afy	Ref Other
DP1	Pu			N/S							5.0	91	USDA/PDM
DP2	Pu			N/S	Ref #41						7.5	188	
DP3	Pu			N/S	Panoche Drainage District Drainage Operation Plan						7.5	254	
DP4	Pu				Summers Eng. Sept 1991						5.0	214	
DP5	Pu										7.5	59	
DP6	Pu										10.0	815	
DP7	Pu										7.5	293	
DP8	Pu										5.0	72	
DP9	Pu										5.0	96	
DP10	G												
DP11	Pu												
DP12	G												
DP13	G			CD									
DP14	Pu			CD							5.0	121	
DP15	Pu										7.5	163	
DP16	Pu										5.0	225	
DP17	Pu												
DP18M	Pu			CD							7.5	723	
DP18W	G			CD									
DP19	G			CD									
DP20	G			CD									

Exit Type
G=Gravity
Pu=Pumped from Sump

Ownership
D = District
F = Farmer

Maintenance
D = District
F = Farmer

Link
N/SD=Northside Drain
SD=Shaw Drain
CD=Courtney Drain
MD=Millux Drain
RADN=Russell Ave. Drain N.
DRD=Davidson Drain
HD=Hammond Drain
OD=Oxford Drain

Panoche Tile Outlets (recycle point - must be linked to a line) SHT 2 OF 3

Name or ID #	Exit Type	Owner	Maint	Linkage to line	General Info (By Month or Year) (REF #41) Vol, AF	Selen	EC salin	ppm sal	Boron	kW-hrs	Other Info hp	Flow, afy	Ref Other
DP21	G			CD									
DP22	G			CD									
DP23	G												
DP24	G			RADN									
DP25	Pu			HD							15.0	512	
DP26	G			RADN									
DP27	Pu			MD							15.0	399	
DP28	G												
DP29	Pu			N/SD									
DP30	Pu			RADN							7.5	627	
DP31	Pu			HD							7.5	363	
DP32	Pu	F	F	-		DOES NOT DISCHARGE INTO DISTRICT					7.5	337	
DP33	Pu			MD							7.5	189	
DP34	Pu												
DP35	Pu			DRD							7.5	67	
DP36	G			DRD									
DP37	G												
DP38	Pu			RADN							7.5	613	
DP39	Pu			RADN							7.5	614	
DP40	Pu			HD							5.0	543	
DP41	Pu			HD							5.0	149	

Panoche Tile Outlets (recycle point - must be linked to a line) SHT 3 OF 3

Name or ID #	Exit Type	Owner	Maint	Linkage to line	General Info (By Month or Year) (REF #41) Vol, AF	Selen	EC	salin	ppm sal	Boron	kW-hrs	Other Info ap	Flow, afy	Ref Other
DP42	Pu			MD								5.0	149	
DP43	Pu											7.5	2	
DP44	Pu		D	RADN								7.5	426	
DP45	Pu			DRD								15.0	18	
DP46	G			HD										
DP47	G			HD										
DP48	Pu	D	D	SD								5.0	76	
DP49	Pu			SD								5.0	217	
DP50	Pu											7.5	129	
DP51	Pu			RADN								7.5	362	
DP52	Pu			MD								15.0	380	
DP53	G													
DP54	G			N/SD										
DP55	G													
DP56	G													
DP57	G			CD										
DP58	Pu			HD										
DP59	Pu													
DP60	Pu			RADN										

Panoche Water Supply SHT 1 OF 1

Designation	Const Mat	Lining or type	Diam in	Type of Water Ta	Ti	W	DMC	SLC	Other	Max Flow Rate, cfs	Length mi	ft	Reference
Main Canal	E	-	-			X	X			170	6		WCP, '86 (pg 10)
T-Canal	E	-	-	X	X	X	X			100	3.75		
Contour Canal	E	-	-			X	X			120	4.25		
Lateral #1	C	-	-			X	X			22	1		
Lateral #2	C	-	-				X			45	3		
	E	-	-				X			45	1.9		
Lateral #3	C	-	-			X	X			45	3		
	E	-	-				X			45	1.1		
Lateral #5	P	Stl	24			X		X		20		2,100	
	C	-	-					X		20	2		
#304	C	-	-					X		15	0.75		
10W T.O. Canal	C	-	-			X		X		52	1.5		
	P	ACP	42					X		52		2,100	
10E2 T.O. Canal	C	-	-			X		X		42	2.1		
10E2 South	E	-	-					X		42	0.4		
	P	PVC	24					X		20		2,600	
Russell Lateral	C	-	-					X		57	2		
Lateral 11-E						X		X					
G-1	C		48					X					
G-2	P	ACP	12				--	X					
G								X					

Construction Material

P = Pipeline
C = Conc Lined
E = Earthen

Type of Water

Ta = Tail Water
Ti = Tile Water
W = Well
DMC = DMC Supply
SLC = SLC Supply
OC = Outside Canal

Panoche Wells SHT 1 OF 2

Name or ID#	Owner	In use?	Ownership	Dest of water	Linkage to Dist. line	General Info (By Month or Year) (91 WDS) Vol, af	Salen	EC salin	TDS ppm	Boron	Other Info kW-hrs	hp	Flow, cfs	Ref. Other
W1		Y	F	D & F	DMC				1382	1.88			4.5	91 WDS
W2		Y	F	D & F	DMC				1269	1.79			5.0	
W3		Y	F	D & F	Main				1308	2.02			3.5	
W4		Y	F	F	-				1765	3.43			4.5	
W5		Y	F	F	-								2.0	
W6		Y	F	D & F	Main				1300	2.42			4.5	
W7		Y	F	D & F	Contour				1124	1.98			3.4	
W8		N	F	F	-									
W9		Y	F	D & F									3.5	
W10		Y	F	D & F	T				1292	1.83			4.0	
W11		Y	F	D & F	Contour								4.5	
W12		Y	F	D & F	10E2 TO				1125	1.69			3.6	
W13		Y	F	D & F	10E2 TO				1392	2.38			3.5	
W14		Y	F	D & F	L5				1399	1.80			2.5	
W15		Y	F	F	-				1332	1.68			3.0	
W16		Y	F	D & F	11-E				1432	2.11			3.5	
W17		Y	F	F	-								3.0	
W18		Y	F	D & F					out of district				3.0	
W19		Y	F	F	-				1774	1.92			4.5	
W20		Y	F	F	-				1427	1.82			3.5	
W21		Y	F	F	-				1468	1.81			3.7	

Ownership
D = District
F = Farmer

Destination of Water
D = District
F = Farmer

Panoche Wells SHT 2 OF 2

Name or ID#	Owner	In use?	Ownership	Dest of water	Linkage to Dist. line	General Info (By Month or Year) (91 WDS) Vol, af	Salen	EC salin	TDS ppm	Boron	Other Info kW-hrs	hp	Flow, cfs	Ref. Other
W22		Y	F	D & F	Main				1276	1.77			5.0	91 WDS
W23		Y	F	F	-				1671	2.10			3.0	
W24		Y	F	F	-				3240	3.59			4.5	
W25		N	F	F	-								4.0	
W26		Y	F	F	-								1.0	
W27		Y	F	D & F	Main				1260	1.90			1.0	
W28		Y	F	D & F	TD 10W				1913	2.67			2.5	
W29		Y	F	F	-				965	1.57			3.0	
W30		Y	F	F	-				1898	2.56			1.5	
W31		N	F	D & F	L5									
W32		Y	F	D & F	L3				1608	2.73			2.5	
W33		N	F	F	-									
W34		Y	F	F	-				1529	2.81			6.6	
W35		Y	F	F	DMC				1831	1.74			3.0	
W36		Y	F	D & F					2150	3.23			4.5	
W37		N	F	D & F	L3									
W38		N	F	F	L3				NOT IN SERVICE					
W39		Y	F	D & F	L3				1005	2.29			3.5	
W40		Y	F	D & F	L1				1102	2.48			0.5	
W41		Y	F	F	-				1918	2.03			4.5	

Broadview District Drain Pumps

(recycle point - must be linked to two lines)

Designation Name or ID #	Type of Water Ti	Ta	W	Source	Linkage to Line Destin 1	Destin 2	General Info (By Month or Year) Flow, cfs	Selen	EC sat	TDS ppm	Boron	kW-hrs	Other Info hp	Flow, cfs	Ref
Ness Station	X	X		FCWD	Frix Dr	Main									
1	X	X		No longer pump drain outlet											
2	X	X		FCWD	Frix Dr	Main							15.0	7.0	
3	X	X		FCWD	Frix Dr	Main							20.0	12.0	
4	X	X		FCWD	Frix Dr	Main							30.0	20.0	
5	X	X		FCWD	Frix Dr	Main							40.0	25.0	
Comfort Sta.	X	X		FCWD	FCWD	-									
1	X	X		FCWD	FCWD	-							15.0	7.0	
2	X	X		FCWD	FCWD	-							60.0	30.0	
3	X	X		FCWD	FCWD	-							40.0	25.0	
Johnston Sta.	X	X		FCWD	FCWD	-									
1	X	X		FCWD	FCWD	-							20.0	12.0	
2	X	X		FCWD	FCWD	-							20.0	12.0	

Water Type

Ti = Tile Water W = Well

Ta = Tail Water

Broadview District Lift Pumps

SHT 1 OF2

Designation	Pump Unit	Lift feet	Horse power	Effic %	Flow Rate, cfs	Linkage to Line in	out	Reference
Sta #1		25.6						
	1 - 1	-	150		23.5	DMC	Main Lift	
	1 - 2	-	250		38.6	DMC	Main Lift	
	1 - 3	-	250		42.6	DMC	Main Lift	
	1 - 4	-	250		41.0	DMC	Main Lift	
Sta #2		10.7						
	2 - 1	-	15		8.1	Main Lift	Main Lift	
	2 - 2	-	50		29.3	Main Lift	Main Lift	
	2 - 3	-	40		23.5	Main Lift	Main Lift	
	2 - 4	-	60		29.2	Main Lift	Main Lift	
	2 - 5	-	60		29.6	Main Lift	Main Lift	
	2 - 6	-	100		44.2	Main Lift	Main Lift	
Sta #3		8.6						
	3 - 1	-	40		11.3	Main Lift	Main Lift	
	3 - 2	-	40		17.3	Main Lift	Main Lift	
	3 - 3	-	40		23.9	Main Lift	Main Lift	
	3 - 4	-	60		29.1	Main Lift	Main Lift	
	3 - 5	-	30		16.9	Main Lift	Main Lift	
	3 - 6	-	100		46.2	Main Lift	Main Lift	

Broadview District Lift Pumps

Designation	Pump Unit	Lift feet	Horse power	Effic %	Flow Rate, cfs	Linkage to Line in	Linkage to Line out	Reference
Sta #4		11.7						
	4-1	-	100		24.5	Main Lift	Main Lift	
	4-2	-	100		19.0	Main Lift	Main Lift	
	4-3	-	100		24.5	Main Lift	Main Lift	
	4-4	-	15		9.5	Main Lift	Main Lift	
	4-5	-	100		30.4	Main Lift	Main Lift	
	4-6	-	15		13.7	Main Lift	Main Lift	
Sta #5		6.6						
	5-1	-	15		7.4	Main Lift	Main Lift	
	5-2	-	30		21.6	Main Lift	Main Lift	
	5-3	-	40		17.8	Main Lift	Main Lift	
	5-4	-	100		52.4	Main Lift	Main Lift	
Sta #6		6.0						
	6-1	-	75		14.8	Main Lift	Main Lift	
	6-2	-	125		23.5	Main Lift	Main Lift	
	6-3	-	125		25.1	Main Lift	Main Lift	
	6-4	-	30		20.2	Main Lift	Main Lift	
	6-5	-	40		14.7	Main Lift	Main Lift	

Broadview Drainage Channel

Designation	Const Mat	Lining or type	Diam in	Ta	Ti	Other	Maint	Reference
Fairfax Drain	P	STL	36.0	X	X		D	As-Built Map
Hudson Drain	E	-	-	X	X		D	
Jerrold Drain	E	-	-	X	X		D	
Newcomb Drain	E	-	-	X	X		D	
Douglas Drain	E	-	-	X	X		D	
Shaw Drain	E	-	-	X	X		D	
FCWD Main Drain	E	-	-	X	X		D	

Construction Material
P = Pipeline
C = Concrete Lined
E = Earthen

Type of Water
Ta = Tail Water
Ti = Tile Water

Maintenance
D = District
F = Farmer

Designation Name or ID #	Owner	Fields Drained		Tiles		Density	Year	Reference
		Name	Acreage	Spacing, ft	Tot Length, ft	ft/acre	Installed	
S2-1		F2-1A	160	200	34850	218	77-78	BWDTDS, 1991
		F2-1B	72	75-200	23800	331	77-78	
		F2-3A	160	425	15600	98	89	
		F2-3B	160	200	34850	218	77-78	
		F2-3C	35	75-200	11070	316	77-78	
S3-2		F3-2	155.5	275	26370	170	64-77	
		F3-4	155.5	275	26370	170		
S4-1		F4-1	145.4	Main	5200	36	1975?	
		F4-3	147.6	Main	5200	35	1975?	
S4-2		F4-2	145.5	Main	5200	36	1975?	
		F4-4	147.7	Main	5200	35	1975?	
S7-1		F7-1,2	146.9	300	26930	183	1975	
S7-4		F7-3,4	136.7	300	25050	183	1975	
S8-2			610.2	500-518	54340	89		
		F8-1	156.3	5 tiles		0		
		F8-2	155.4			0		
		F8-3	149.7	3 tiles		0		
		F8-4	148.8	6 tiles		0		
S9-2		F9-1	153.9	750	8960	58	1979	
		F9-2	154	260	23240	151	79	
S9-4		F9-4	152	500	13242	87	79-82	
S10-2		F10-1	153.9	750	9590	62	71-74	
		F10-2	154	260	25630	166	71-74	

Designation Name or ID #	Owner	Fields Drained Name	Fields Drained Acreage	Tiles Spacing, ft	Tiles Tot Length, ft	Density ft/acre	Year Installed	Reference
S10-4		F10-3	150.1	250	9590	64	71-74	
		F10-4	150	745	25620	171	71-74	
S11-4		F11-4	151.4	300	21980	145	1976	
S12-1		F12-1:4	552.8	300	80270	145	1976	
S13-2		F13-1,2	306.2	405	36710	120	1977	
		F13-3,4	306.2	270	54390	178	1977	
S14-2		F14-1	154.3	660	10180	66	1976	
		F14-2	153.3	660	10180	66	1976	
S15-1		F15-1	152.9	300	22200	145	1974	
		F15-3	160	300	4800	30	1988	
S15-2		F15-2	152.9	300	22500	147		
S16-2		F16-1	151.7	main	2450	16	1975	
		F16-2	151.8	390	17570	116	1975	
S18-1		F18-1,3	311.3	330	41090	132	1976	
S18-2		F18-2,4	311.3	330	41090	132	1976	
					7800		1988	
S33-1		F33-1,3	284.2	220	59500	209	1971	
S33-2		F33-2,4	273.2	main	4750	17	1971?	
				300/600	30120		1988	
S34-1		F34-3A	75	200	22000	293	1980	
S34-2		F34-1B,C	141	300	20470	145	63-65	
S35-1		F34-1A	35	150-310	7400	211	63-65	

Broadview Tile Outlets (recycle point - must be linked to a line) Sht 1 of 1

Name or ID #	Exit Type	Sump no.	Owner	Maint	Linkage to line	General Info (By Month or Year) Flow, cfs	Selen	EC salin	TDS ppm	Boronk	W - hrs	Other Inf Q, cfs	hp	Pipe, in	Rel Other
T2-1	P	S2-1	F	D	FCWD							1.61	7.5	8	Pond 7
T3-2	P	S3-2	F	D	J							2.42	7.5	8	
T4-1	P	S4-1	F	D								1.09	5	6	
T4-2	P	S4-2	F	D	H							1.00	5	6	
T7-1	P	S7-1	F	D	FCWD							0.87	5	6	
T7-4	P	S7-4	F	D	FCWD							0.87	5	6	
T8-2	P	S8-2	F	D	H							0.73	5	6	
T9-2	P	S9-2	F	D	H							3.11	15	10	
T9-4	P	S9-4	F	D	H							1.68	15	10	
T10-2	P	S10-2F		D	J							2.08	15	8	
T10-4	P	S10-4F		D	J							2.56	15	8	
T11-4	P	S11-4F		D	N							0.87	5	6	
T12-1	P	S12-1F		D	FCWD							2.56	7.5	8	Reset
T13-2	P	S13-2F		D	D							2.56	7.5	8	
T14-2	P	S14-2F		D	N							0.90	5	6	
T15-1	P	S15-1F		D								1.74	7.5	6	
T15-2	P	S15-2F		D	J							0.66	5	6	
T16-2	P	S16-2F		D	H							0.87	5	6	
T18-1	P	S18-1F		D	S							0.90	5	6	

Exit Type
G = Gravity
P = Pumped From Sump

Ownership
D = District
F = Farmer

Maintenance
D = District
F = Farmer

Linkage
FCWD = FCWD Main Drain
F = Fairfax Drair
H = Hudson Drain
J = Jerrold
N = Newcomb Drain
D = Douglas Drain
S = Shaw Drain

Broadview — Water Supply

SHT 1 OF 1

Designation	Const Mat	Lining or type	Diam in	Type of Water: Ta	Ti	W	DMC	SLC	Other	Max Flow Rate, cfs	Length mi	ft	Reference
Main Lift - Pond 2	E			X	X		X			125		5,280	Fig 1, '87 WCP
Main Lift - Pond 3	E			X	X		X					690	
Main Lift - Pond 4	E			X	X		X					2,750	
	E			X	X		X					2,640	
Main Lift - Pond 5	P	Stl	36/30	X	X		X					1,320	
	E			X	X		X					1,320	
	E			X	X		X					2,640	
Main Lift - Pond 6	E			X	X		X					2,640	
	P	Stl	26	X	X		X			28		2,640	
Chuck Lateral	E			X	X		X			10		8,080	Q: BV Fax 5/12/92
Lateral 4-1	E			X	X		X			20		10,560	Q: BV Fax 5/12/92
Lateral 4-3	E			X	X		X			20		15,840	Q: BV Fax 5/12/92
Lateral 9-1	E			X	X		X			25		21,130	Q: BV Fax 5/12/92
Lateral 9-3	E			X	X		X			30		23,760	Q: BV Fax 5/12/92
Lateral 8-1	E			X	X		X					10,560	
Lateral 16-1	E			X	X		X			30		23,760	Q: BV Fax 5/12/92
Lateral 16-3	E			X	X		X			25		23,760	Q: BV Fax 5/12/92
Lateral 33-3										10			Q: BV Fax 5/12/92
Main Lift - Pond 1	P	RGRCP	60				X			125	1.8	9,504	DOP Map

Construction Material

P = Pipeline
C = Concrete Lined
E = Earthen

Type of Water

Ta = Tail Water
Ti = Tile Water
W = Well
DMC = DMC Supply
SLC = SLC Supply
OC = Outside Canal

Broadview — Wells

SHT 1 OF 1

Name or ID#	Owner	In use?	Ownership	Dest of water	Linkage to Dist. line	General Info (By Month or Year): Vol, af	Selen	EC salin	TDS ppm	Boron	kW-hrs	Other Info: hp	Flow, cfs	Rel. Other
Well		Y	F	F	No									

Firebaugh District Drain Pumps

(recycle point - must be linked to two lines)

Designation Name or ID #	Type of Water				Linkage to Line		General Info (By Month or Year)						Other Inf		Ref
	Ti	Ta	W	Source	Destin 1	Destin 2	Flow, cfs	Selen	EC salin	TDS ppm	Boron	kW-hrs	hp	Flow, cfs	
D-1	X	X											15.0		
D-2	X	X											7.5		
D-3	X	X											50.0		
D-4	X	X											20.0		
D-5	X	X											10.0		
D-6	X	X													
D-7	X	X											15.0		
D-8	X	X											10.0		
D-9	X	X											5.0		
D-10	X	X											5.0		
D-11	X	X											7.5		
D-13	X	X											50.0		
DT-1	X	X												15.0	
DT-2	X	X												3.0	

Water Type
Ti = Tile Water
Ta = Tail Water
W = Well

Firebaugh District Lift Pumps

SHT 1 OF 1

Designation	Pump Unit	Lift feet	Horse power	Effic %	Flow Rate, cfs	Linkage to Line in	Linkage to Line out	Reference
Pump Station #1	1		50		23.0	Intake	1st Lift	Fax 5/1/92
	2		100		48.0			
	3		50		22.0			
	4		100		32.0			
	5		150		77.0			
	6		150		77.0			
Pump Station #2	7		40		20.0	Intake	2nd Lift	
	8		150		85.0			
	9		40		22.0			
	10		125		65.0			
	11		40		22.0			
	12		100		35.0			
Pump Station #3	13		40		20.0	Intake	3rd Lift	
	14		40		20.0			
	15		40		20.0			
	16		125		75.0			

Firebaugh Tile Outlets (recycle point - must be linked to a line) SHT 1 OF 2

Name or ID #	Exit Type	Sump no.	Owner	Main	Linkage to line	General Info (By Month or Year) Vol, afSeen		EC salin	ppm TDS	Boron	kW-hrs	Other Inf hp	Flow, cfs	Rel Other
T-1	P	S-1	F	D	1L2							3.0		
T-2	P	S-2	F	D	1L1							5.0		
T-3	P	S-3	F	D								5.0		DISCON.
T-4	P	S-4	F	D	S32							5.0		
T-5	P	S-5	F	D	SF3							3.0		
T-6	P	S-6	F	D	SF3							5.0		
T-7	P	S-7	F	D	2L6							3.0		
T-8	P	S-8										5.0		
T-9	P	S-9	F	D	CC2							7.5		
T-10	P	S-10	F	D	CC1							5.0		
T-11	P	S-11	F	D	2L1							5.0		
T-12	P	S-12	F	D	SF1							5.0		
T-13	P	S-13	F	D	SX1							5.0		
T-14	P	S-14	F	D	2L2							5.0		
T-15	P	S-15	F	D	2L2							5.0		
T-16	P	S-16	F	D	2L3							10.0		
T-17	P	S-17	F	D	2L3							20.0		
T-18	P	S-18	F	D	2L4							5.0		
T-19	P	S-19	F	D								15.0		
T-20	P	S-20	F	D								5.0		DISCON.
T-21	P	S-21	F	D	2L5							7.5		
T-22	P	S-22	F	D	2L5							7.5		

Exit Type
G = Gravity
P = Pumped From Sump

Ownership
D = District
F = Farmer

Maintenance
D = District
F = Farmer

Firebaugh Tile Outlets (recycle point - must be linked to a line) SHT 2 OF 2

Name or ID #	Exit Type	Sump no.	Owner	Main	Linkage to line	General Info (By Month or Year) Vol, afSeen		EC salin	ppm TDS	Boron	kW-hrs	Other Inf hp	Flow, cfs	Rel Other
T-23	P	S-23	F	D	2L5							10.0		
T-24	P	S-24	F	D	2L5							5.0		
T-25	P	S-25	F	D	2L6							5.0		
T-26	P	S-26	F	D	DMC2							5.0		
T-27	P	S-27	F	D								3.0		
T-28	P	S-28	F	D	2L9							5.0		
T-29	P	S-29	F	D	2L10							5.0		
T-30	P	S-30	F	D	DMC3							7.0		
TR1	P	S-TR1	F	D	2L10									
TR2	P	S-TR2	F	D	TR									
TR3	P	S-TR3	F	D	TR									
TR4	P	S-TR4	F	D	TR									
TR5	P	S-TR5	F	D	TR									
T-2B	P	S-T-2B	F	F										
T-1C/D7	P	S-T-1C/D7												

Firebaugh On-Farm Tile System

SHEET 1 OF 2

Designation Name or ID #	Owner	Fields Drained		Tiles		Density ft/acre	Year Installed	Reference DWR Maps
		Name	Acreage	Spacing, ft	Tot Length, ft			
S-1							1969	Concrete
S-2							1971	Plastic
S-4							1962	Concrete
S-5								
S-6							1961	
S-7							1980	Plastic
S-8								
S-9								
S-10							1963	Concrete
S-11								Plastic
S-12							1959 & '65	Concrete
S-13								
S-14								
S-15							1965 & '68	Concrete
S-16							1956	Concrete
S-17							1967	
S-18							1950 & '58	Concrete
S-19								
S-20								
S-21							1962	Concrete
S-22							1957 & '74	Conc/Plastic
S-23							1958	Concrete
S-24								

Firebaugh On-Farm Tile System

SHEET 2 OF 2

Designation Name or ID #	Owner	Fields Drained		Tiles		Density ft/acre	Year Installed	Reference
		Name	Acreage	Spacing, ft	Tot Length, ft			
S-25							'56, '68, '80	Plastic
S-26							1956	
S-27							'56, '63, '65	
S-28							1978	Plastic
S-29							1968	Concrete
S-30								
S-31								
S-T-1C/D7							1958	Concrete
S-T-2B							1980	Plastic
S-TR1							1979	Plastic
S-TR2							1980	Plastic
S-TR3							1978	Plastic
S-TR4								

Firebaugh Drainage Channel

SHT 1 OF 2

Designation	Const Mat	Lining or type	Diam in	Type of Water Ta	Ti	Other	Maint	Reference
Main Drain	E	-	-	X	X		D	
Crooked Drain	E	-	-	X	X		D	
1L1 Drain	E	-	-	X	X		D	
1L2 Drain	E	-	-	X	X		D	
1L3 Drain	E	-	-	X	X		D	
1L4 Drain	E	-	-	X	X		D	
1L5 Drain	E	-	-	X	X		D	
DMC 1	E	-	-	X	X		D	
DMC 2	E	-	-	X	X		D	
DMC 3	E	-	-	X	X		D	
SF1	E	-	-	X	X		D	
SF2	E	-	-	X	X		D	
SF3	E	-	-	X	X		D	
SP1	E	-	-	X	X		D	
SP2	E	-	-	X	X		D	
2X1	E	-	-	X	X		D	
CC1	E	-	-	X	X		D	
CC2	E	-	-	X	X		D	
2L1	E	-	-	X	X		D	
2L2	E	-	-	X	X		D	
2L3	E	-	-	X	X		D	

Construction Material
P = Pipeline
C = Concrete Lined
E = Earthen

Type of Water
Ta = Tail Water
Ti = Tile Water

Maintenance
D = District
F = Farmer

Firebaugh Drainage Channel

SHT 2 OF 2

Designation	Const Mat	Lining or type	Diam in	Type of Water Ta	Ti	Other	Maint	Reference
2L4	E	-	-	X	X		D	
2L5	E	-	-	X	X		D	
2L6	E	-	-	X	X		D	
2L7	E	-	-	X	X		D	
2L8	E	-	-	X	X		D	
2L9	E	-	-	X	X		D	
2L10	E	-	-	X	X		D	

Firebaugh — Water Supply

SHT 1 OF 1

Designation	Const Mat	Lining or type	Diam in	Type of Water						Max Flow Rate, cfs	Length		Reference
				Ta	Ti	W	DMC	SLC	Other		mi	ft	
Intake Canal	C	-	-			X	X						
First Lift Canal	E	-	-	X	X		X						
Second Lift Canal	E	-	-	X	X		X						
Third Lift Canal	E	-	-	X	X		X						
Lorenzetti Lateral	E	-	-	X	X		X						
Comfort Lateral	E	-	-	X	X		X						
Santa Fe Grade Ditch	E	-	-	X	X		X						

Construction Material
P = Pipeline
C = Conc Lined
E = Earthen

Type of Water
Ta = Tail Water
Ti = Tile Water
W = Well
DMC = DMC Supply (Mendota Pool)
SLC = SLC Supply
OC = Outside Canal

Firebaugh — Wells

SHT 1 OF 1

Name or ID#	Owner	In use?	Owner ship	Dest of water	Linkage to Dist. line	General Info (By Month or Year)						Other Inf		Rel, Other
						Vol, afSe	en	EC salin	TDS ppm	Boron	kW-hrs	hp	Flow, cfs	
3		Y	D	D	Intake				700			4.0		
5		Y	D	D	Intake				1700			4.0		

Pacheco District Lift Pumps

Designation	Pump Unit	Lift feet	Horse power	Effic %	Flow Rate, cfs	Linkage to Line in	Linkage to Line out	Reference
LIFT #1	1		50	50.0	12.8	⊗	MAIN LIFT	WCD 1986
	3		75	67.0	21.9	⊗	MAIN LIFT	
LIFT #2	5		125	65.0	33.4	MAIN LIFT	#2 LATERAL	
	6		100	73.0	24.2	MAIN LIFT	#2 LATERAL	
	7		100	N/A	25.6	MAIN LIFT	#2 LATERAL	
LIFT #3	8		100	58.0	26.8	MAIN LIFT	#3 LATERAL	
	9		50	42.0	9.7	MAIN LIFT	#3 LATERAL	
	10		50	54.0	10.9	MAIN LIFT	#3 LATERAL	
	11		50	42.0	8.4	MAIN LIFT	#3 LATERAL	
LIFT #4	12		50	38.0	9.0	MAIN LIFT	#4 LATERAL	
	13		50	28.0	7.2	MAIN LIFT	#4 LATERAL	
	14		50	60.0	12.5	MAIN LIFT	#4 LATERAL	
	15		100	69.0	28.8	MAIN LIFT	#4 LATERAL	
LIFT #5	16		50	N/A	12.0	MAIN LIFT	#5 LATERAL	
	17		50	60.0	14.5	MAIN LIFT	#5 LATERAL	
	18		50	N/A	11.6	MAIN LIFT	#5 LATERAL	
	19		50	60.0	13.0	MAIN LIFT	#5 LATERAL	
LIFT #6	6-1		30	N/A	13.6	MAIN LIFT	#6 LATERAL	
	6-2		20	N/A	10.8	MAIN LIFT	#6 LATERAL	

Pacheco Drainage Channel

Designation	Const Mat	Lining or type	Diam in	Type of Water Ta	Type of Water Ti	Type of Water Other	Maint	Reference
Westside Drain				X	X		D	
SIS-10 Drain	E	-	-	X			D	
DMC Drain	E	-	-	X	X		D	
S4 Drain	P	-	-	X	X		D	
DMCN Drain	C	-	-	X	X		D	
DMCS Drain	C	-	-		X		D	
OC Drain	E	-	-	X	X		D	
T8-2	E				X		D	
202 Drain	P	-	-		X		D	

Construction Material
P = Pipeline
C = Concrete Lined
E = Earthen

Type of Water
Ta = Tail Water
Ti = Tile Water

Maintenance
D = District
F = Farmer

Pacheco Tile Outlets (recycle point - must be linked to a line)

SHT 1 of 1

Name or ID #	Exit Type	Owner	Maint	Linkage to drain	General Info (By Month or Year) Vol, ac-ft	Salen	EC salin	TDS ppm	Boron	kW-hrs	Other Info hp	Flow, cfs	Other
101	P	D	D	OC									
104	P	F	F	OC									
110	P	F	F	W/S									
201	P	D	D	DMCN							15.0		REW
202	P	D	D	202.0							50.0		REW
208	P	D	D	DMCS									
308	P	D	D	W/S									
312	P	D	D	W/S									
314M	P	D	D	W/S									
314S	P	D	D	W/S									
D & M	P	D	D	W/S									
310	P	D	D	W/S									
108	P	D	D	W/S									

Exit Type
G = Gravity
P = Pumped From Sump

Ownership
D = District
F = Farmer

Maintenance
D = District
F = Farmer

Pacheco Water Supply

SHT 1 OF 1

Designation	Const Mat	Lining or type	Diam in	Type of Water (Estimated) Ta	Ti	W	DMC	SLC	OC	Max Flow Rate, cfs	Length mi	ft	Reference
Main Lift	E	-	-	X	X	X			X		-	16,300	
#2 Lateral	C	-	-	X	X		X		X		-	15,200	
#3 Lateral	E	-	-	X	X		X		X		-	16,000	
#4 Lateral	C	-	-	X	X		X		X		-	5,800	
	E	-	-	X	X		X		X		-	12,000	
#5 Lateral	C	-	-	X	X		X	X	X		-	3,900	
	E	-	-	X	X		X	X	X		-	15,800	
#6 Lateral	E	-	-	X	X			X			-	18,000	
#7 Lateral	C	-	-					X			-	24,700	
Lift #6 Pipe	P	ASB/C	24.0								-	1,750	
	P	RGRCP	24.0								-	1,750	

Construction Mat'l
P = Pipeline
C = Conc Lined
E = Earthen

Type of Water
Ta = Tail Water
Ti = Tile Water
W = Well
DMC = DMC Supply
SLC = SLC Supply
OC = Outside Canal

Name or ID#	Owner	In use?	Ownership	Dest of water	Linkage to Dist. line	General Info (By Month or Year)						Other Inf		Ref. Other
						Vol, AF	Selen	EC salin	TDS ppm	Boronk	V - hrs	hp	Flow, cfs	
101-1		Y	F	F	-			1650				125.0	2.65	PWD LET '85
101-2		Y	F	F	-			2200				125.0	3.21	
101-3		N	D	D	Main Lift			-				-	-	Dist. Pulled
101-4		Y	F	F	-			1870				125.0	3.95	
102-2		Y	F	F	-			1900				125.0	2.71	
103-1		Y	F	F	-			2500				100.0	2.85	
104-2		Y	F	F	-			1440				200.0	4.83	
110-1		Y	F	F	-			1170				125.0	3.18	
110-2		N	F	-	-			-				-	-	Not in oper.
202-1		Y	F	F	-			2600				100.0	1.46	Not in oper.
102-1		Y	F	F	-			1670				200.0	2.31	
104-1		Y	F	F	-			1470				200.0	3.01	

Charleston Drainage Channel

Sht 1 of 1

Designation	Const Mat	Lining or type	Diam in	Type of Water Ta	Ti	Other	Maint	Reference
DMCS Drain	E	-	-	X	X	.	D	
OC Drain	E	-	-	X	X		D	
Woo Drain	E	-	-	X	X		D	
DMCN Drain	C	-	-	X	X		D	
S33 Drain	E	-	-	X	X		D	
DMC-OC Drain	C	-	-	X	X		D	
S36 Drain	E	-	-	X	X		D	

Construction Material
P = Pipeline
C = Concrete Lined
E = Earthen

Type of Water
Ta = Tail Water
Ti = Tile Water

Maintenance
D = District
F = Farmer

Charleston Tile Outlets

(recycle point - must be linked to a line)

SHT 1OF 1

Name or ID #	Exit Type	Sump no.	Owner	Maint	Linkage to drain	General Info (By Month or Year)(DOP '89 (p.2)) Vol, AF	Selen	EC salin	TDS ppm	Boron	kW-hrs	Other Inf hp	Flow, cfs	Ref Other
T-1	P				DMCN									REW
SL-1	P				DMCS									Map'91
L1	P				DMCS									
L2	P				DMCS									
L3	P				S33									
L4	P				S33									
ATL-1	G		CCID		DMCN									
LG-1	G				DMCS									

Exit Type
G = Gravity
P = Pumped From Sump

Ownership
D = District
F = Farmer

Maintenance
D = District
F = Farmer

Charleston Water Supply

SHT 1 OF 1

Designation	Const Mat	Lining or type	Diam in	Type of Water Ta	Ti	W	DMC	SLC	OC	Max Flow Rate, cfs	Length mi	ft	Other, Reference
TO8 (Farmer)	N/A	N/A	N/A					X		8.0			SLOwn, map, 1991
TO32 (Farmer)	N/A	N/A	N/A				X			10.0			SLOwn, map, 1991
TO33 (Farmer)	N/A	N/A	N/A				X						SLOwn, map, 1991
TO34 (Farmer)	N/A	N/A	N/A				X						SLOwn, map, 1991
TO35 (Farmer)	N/A	N/A	N/A				X			150.0			SLOwn, map, 1991
TO36 (Farmer)	N/A	N/A	N/A				X						SLOwn, map, 1991
TO37 (Farmer)	N/A	N/A	N/A				X			30.0			SLOwn, map, 1991
TO38 (Farmer)	N/A	N/A	N/A				X						SLOwn, map, 1991
TO39 (Farmer)	N/A	N/A	N/A				X						SLOwn, map, 1991
Cotton Gin Canal	C	-	-				X		X				
Murray Springs	C	-	-						X				

Construction Mat'l
P = Pipeline
C = Concrete Lined
E = Earthen

Type of Water
Ta = Tail Water
Ti = Tile Water
W = Well
DMC = DMC Supply
SLC = SLC Supply
OC = Outside Canal Supply

CCID

Drainage Channel

Sht 1 of 2

Designation	Const Mat	Lining or type	Diam in	Type of Water						Maint	Reference
				Ta	Ti				Other		
Main Drain	E	-	-	X	X					D	
Santa Fe Drain	E	-	-	X	X					D	
Sect 8 Drain	E	-	-	X	X					D	
Newcomb Drain	E	-	-	X	X					D	

Construction Material
P = Pipeline
C = Conc Lined
E = Earthen

Type of Water
Ta = Tail Water
Ti = Tile Water

Maintenance
D = District
F = Farmer

CCID

On-Farm Tile System

SHEET 1 OF 1

Designation Name or ID #	Owner	Fields Drained		Tiles		Density ft/acre	Year Installed	Reference
		Name	Acreage	Spacing, ft	Tot Length, ft			
TS-1		-	63.4					CCID Map 1987
TS-2		-	97.8					
TS-3		-	53.4					
TS-4		-	116.1					
TS-5		-	195.6					
TS-6		-	4.11					
TS-7		-	111.87					
TS-8		-	111.84					
TS-9		-	197.3					
TS-14		-	103.8					
TS-15		-	57.7					

CCID

Tile Outlets

(recycle point - must be linked to a line)

SHT 1OF 1

Name or ID #	Exit Type	Sump no.	Owner	Maint	Linkage to line	General Info (By Month or Year)						Other Inf		Ref Other
						Vol, ac-ft	Selen	EC salin	TDS ppm	Boron	kW-hrs	np	Flow, cfs	
CDS-1	P	TS-1	F		Main									
CDS-2	P	TS-2	F		Main									
CDS-3	P	TS-3	F		Outside									
CDS-4	P	TS-4	F		Main									
CDS-5	P	TS-5	F		Santa Fe									
CDS-6	P	TS-6	F		Sect 8									
CDS-7	P	TS-7	F		Main									
CDS-8	P	TS-8	F		Main									
CDS-9	P	TS-9	F		Main									
CDS-15P		TS-14F			Main									
CDS-14P		TS-15F			Main									

Exit Type
G = Gravity
P = Pumped From Sump

Ownership
D = District
F = Farmer

Maintenance
D = District
F = Farmer

CCID

Water Supply

SHT 1 OF 1

Designation	Const Mat	Lining or type	Diam in	Type of Water						Max Flow Rate, cfs	Length		Reference
				Ta	Ti	W	DMC	SLC	Other		mi	ft	
All Farmer Turnouts on Outside Canal													

Name or ID#	Owner	In use?	Owner ship	Dest of water	Linkage to Dist. line	General Info (By Month or Year)						Other Inf		Ref, Other
						Vol, ac-ft	Selen	EC salin	TDS ppm	Boron	kW-hrs	hp	Flow, cfs	
278		N	F											REW
279		N	F											REW
325		N	F											REW

TECHNICAL APPENDIX B
Crop Coefficients (Kc)

TABLE OF CONTENTS
TECHNICAL APPENDIX B

Calculation of Kcs Table B3

Graph of the Kcs Used in the Study Area B4

Daily Kcs for all the crops in the study B5

Crops included:

Alfalfa
Barley
Beans
Corn
Cotton
Melons
Pasture
Process Tom.
Rice
Seed Alf.
Sorghum
Stonefruit
Sugar Beets
Vegetable
Walnut/Apple
Wheat

Pivot Kc's and Dates Used to Determine Monthly Crop Kc's

CROP	Kc 1	Kc 2	Kc 3	A	B	C	D	E	DECLINE
	|--PIVOT Ks--|			|----------PIVOT DATES----------|				
ALFALFA	0.25	0.90	0.25	01/01	02/15	03/15	10/01	12/31	85 %
BARLEY	0.22	1.25	0.10	12/01	12/24	03/02	04/11	05/25	75 %
DRY BEANS	0.14	1.15	0.30	04/01	04/30	05/25	06/29	07/25	4 %
COTTON	0.14	1.04	0.10	04/10	05/12	07/06	08/17	10/09	69 %
CORN	0.18	1.10	0.45	04/16	05/07	06/28	08/06	09/15	74 %
MELON	0.18	1.10	0.10	04/01	05/06	06/14	06/18	07/15	75 %
RICE	0.95	1.25	0.95	04/01	04/26	05/28	06/29	08/31	59 %
SEED ALFALFA	0.20	1.00	0.30	12/01	01/15	04/15	05/19	07/15	75 %
SORGHUM	0.16	1.05	0.45	05/01	06/04	07/04	08/04	09/30	63 %
STONEFRUIT/ ALMOND	0.65	0.98	0.85	03/10	03/10	06/09	09/14	11/01	80 %
SUGARBEETS - NORTH	0.23	1.10	0.95	05/20	06/10	07/20	01/26	03/15	84 %
SUGARBEETS - SOUTH	0.24	1.13	0.70	02/01	03/27	05/13	06/28	08/31	70 %
TOMATO	0.24	1.12	0.70	04/01	05/08	06/28	07/19	08/31	72 %
VEGETABLE	0.30	1.05	0.80	02/01	02/28	04/12	05/01	05/31	75 %
WALNUT/ APPLE	0.70	1.14	0.15	03/10	03/10	07/07	08/15	11/09	65 %
WHEAT	0.22	1.17	0.38	12/01	12/24	03/02	04/11	05/25	75 %

Monthly Crop Kc Values

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Fallow	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Misc.	0.00	0.00	0.00	0.06	0.30	0.59	1.02	0.92	0.00	0.00	0.00	0.00
Cotton	0.05	0.00	0.00	0.00	0.00	0.00	0.10	0.23	0.70	1.03	1.02	0.56
Alfalfa	0.79	0.57	0.36	0.25	0.32	0.82	0.90	0.90	0.90	0.90	0.90	0.90
Wheat	0.00	0.04	0.23	0.54	0.95	1.17	1.04	0.47	0.00	0.00	0.00	0.00
Melons	0.00	0.00	0.00	0.00	0.00	0.04	0.18	0.43	0.94	0.18	0.00	0.00
Process Tom.	0.00	0.00	0.00	0.00	0.00	0.05	0.24	0.40	0.90	1.10	0.85	0.00
Sugar Beets	1.10	1.10	1.10	1.10	1.04	0.44	0.00	0.13	0.38	0.96	1.10	1.10
Barley	0.00	0.03	0.23	0.53	0.93	1.15	0.98	0.30	0.00	0.00	0.00	0.00
Beans	0.00	0.00	0.00	0.00	0.00	0.03	0.14	0.78	1.14	0.56	0.00	0.00
Seed Alf.	0.00	0.03	0.20	0.24	0.47	0.74	0.97	0.97	0.66	0.19	0.00	0.00
Rice	0.00	0.00	0.00	0.00	0.00	0.19	0.95	1.14	1.25	1.17	1.02	0.00
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.36	0.88	1.10	0.93	0.27
Vegetable	0.00	0.00	0.00	0.06	0.30	0.59	1.02	0.92	0.00	0.00	0.00	0.00
Pasture	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Stonefruit	0.89	0.00	0.00	0.00	0.00	0.50	0.78	0.89	0.98	0.98	0.98	0.97
Walnut/Apple	0.42	0.06	0.00	0.00	0.00	0.54	0.84	0.95	1.06	1.14	1.09	0.77
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.16	0.51	1.04	0.93	0.59

Alfalfa

% SMD	70.00
RTZN	6
AWHC	2
SMD	8.4
crop'd Kc	0.15
Maturity %	0.75

	Dates			Kcs	
Start	01/01/92	33604	33604	0	0.25
Planting	01/01/92	33604	33604	0.25	0.25
Date A	01/01/92	33604	33649	0.25	0.25
Date B	02/15/92	33649	33678	0.25	0.9
Date C	03/15/92	33678	33878	0.9	0.9
Date D	30-Sep	33878	33969	0.9	0.25
Date E	12/31/92	33969	33969	0.25	0
End	12/31/92	33969		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-9	0	0.25	33604	33604	0.25	
04-Jan	0.25	0.25	33604	33649	0.25	
07-Jan	0.25	0.25	33604	33649	0.25	
10-Jan	0.25	0.25	33604	33649	0.25	
13-Jan	0.25	0.25	33604	33649	0.25	
16-Jan	0.25	0.25	33604	33649	0.25	
19-Jan	0.25	0.25	33604	33649	0.25	
22-Jan	0.25	0.25	33604	33649	0.25	
25-Jan	0.25	0.25	33604	33649	0.25	
28-Jan	0.25	0.25	33604	33649	0.25	
31-Jan	0.25	0.25	33604	33649	0.25	0.25
03-Feb	0.25	0.25	33604	33649	0.25	
06-Feb	0.25	0.25	33604	33649	0.25	
09-Feb	0.25	0.25	33604	33649	0.25	
12-Feb	0.25	0.25	33604	33649	0.25	
15-Feb	0.25	0.9	33649	33678	0.25	
18-Feb	0.25	0.9	33649	33678	0.3172414	
21-Feb	0.25	0.9	33649	33678	0.3844828	
24-Feb	0.25	0.9	33649	33678	0.4517241	
27-Feb	0.25	0.9	33649	33678	0.5189655	0.3247126
01-Mar	0.25	0.9	33649	33678	0.5862069	
04-Mar	0.25	0.9	33649	33678	0.6534483	
07-Mar	0.25	0.9	33649	33678	0.7206897	
10-Mar	0.25	0.9	33649	33678	0.787931	
13-Mar	0.25	0.9	33649	33678	0.8551724	
16-Mar	0.9	0.9	33678	33878	0.9	
19-Mar	0.9	0.9	33678	33878	0.9	
22-Mar	0.9	0.9	33678	33878	0.9	
25-Mar	0.9	0.9	33678	33878	0.9	
28-Mar	0.9	0.9	33678	33878	0.9	
31-Mar	0.9	0.9	33678	33878	0.9	0.8184953
03-Apr	0.9	0.9	33678	33878	0.9	
06-Apr	0.9	0.9	33678	33878	0.9	

09-Apr	0.9	0.9	33678	33878	0.9	
12-Apr	0.9	0.9	33678	33878	0.9	
15-Apr	0.9	0.9	33678	33878	0.9	
18-Apr	0.9	0.9	33678	33878	0.9	
21-Apr	0.9	0.9	33678	33878	0.9	
24-Apr	0.9	0.9	33678	33878	0.9	
27-Apr	0.9	0.9	33678	33878	0.9	
30-Apr	0.9	0.9	33678	33878	0.9	0.9
03-May	0.9	0.9	33678	33878	0.9	
06-May	0.9	0.9	33678	33878	0.9	
09-May	0.9	0.9	33678	33878	0.9	
12-May	0.9	0.9	33678	33878	0.9	
15-May	0.9	0.9	33678	33878	0.9	
18-May	0.9	0.9	33678	33878	0.9	
21-May	0.9	0.9	33678	33878	0.9	
24-May	0.9	0.9	33678	33878	0.9	
27-May	0.9	0.9	33678	33878	0.9	
30-May	0.9	0.9	33678	33878	0.9	0.9
02-Jun	0.9	0.9	33678	33878	0.9	
05-Jun	0.9	0.9	33678	33878	0.9	
08-Jun	0.9	0.9	33678	33878	0.9	
11-Jun	0.9	0.9	33678	33878	0.9	
14-Jun	0.9	0.9	33678	33878	0.9	
17-Jun	0.9	0.9	33678	33878	0.9	
20-Jun	0.9	0.9	33678	33878	0.9	
23-Jun	0.9	0.9	33678	33878	0.9	
26-Jun	0.9	0.9	33678	33878	0.9	
29-Jun	0.9	0.9	33678	33878	0.9	0.9
02-Jul	0.9	0.9	33678	33878	0.9	
05-Jul	0.9	0.9	33678	33878	0.9	
08-Jul	0.9	0.9	33678	33878	0.9	
11-Jul	0.9	0.9	33678	33878	0.9	
14-Jul	0.9	0.9	33678	33878	0.9	
17-Jul	0.9	0.9	33678	33878	0.9	
20-Jul	0.9	0.9	33678	33878	0.9	
23-Jul	0.9	0.9	33678	33878	0.9	
26-Jul	0.9	0.9	33678	33878	0.9	
29-Jul	0.9	0.9	33678	33878	0.9	0.9
01-Aug	0.9	0.9	33678	33878	0.9	
04-Aug	0.9	0.9	33678	33878	0.9	
07-Aug	0.9	0.9	33678	33878	0.9	
10-Aug	0.9	0.9	33678	33878	0.9	
13-Aug	0.9	0.9	33678	33878	0.9	
16-Aug	0.9	0.9	33678	33878	0.9	
19-Aug	0.9	0.9	33678	33878	0.9	
22-Aug	0.9	0.9	33678	33878	0.9	
25-Aug	0.9	0.9	33678	33878	0.9	
28-Aug	0.9	0.9	33678	33878	0.9	
31-Aug	0.9	0.9	33678	33878	0.9	0.9
03-Sep	0.9	0.9	33678	33878	0.9	
06-Sep	0.9	0.9	33678	33878	0.9	
09-Sep	0.9	0.9	33678	33878	0.9	

12-Sep	0.9	0.9	33678	33878	0.9	
15-Sep	0.9	0.9	33678	33878	0.9	
18-Sep	0.9	0.9	33678	33878	0.9	
21-Sep	0.9	0.9	33678	33878	0.9	
24-Sep	0.9	0.9	33678	33878	0.9	
27-Sep	0.9	0.9	33678	33878	0.9	
30-Sep	0.9	0.9	33678	33878	0.9	0.9
03-Oct	0.9	0.25	33878	33969	0.8839726	
06-Oct	0.9	0.25	33878	33969	0.8626027	
09-Oct	0.9	0.25	33878	33969	0.8412329	
12-Oct	0.9	0.25	33878	33969	0.819863	
15-Oct	0.9	0.25	33878	33969	0.7984932	
18-Oct	0.9	0.25	33878	33969	0.7771233	
21-Oct	0.9	0.25	33878	33969	0.7557534	
24-Oct	0.9	0.25	33878	33969	0.7343836	
27-Oct	0.9	0.25	33878	33969	0.7130137	
30-Oct	0.9	0.25	33878	33969	0.6916438	0.7878082
02-Nov	0.9	0.25	33878	33969	0.670274	
05-Nov	0.9	0.25	33878	33969	0.6489041	
08-Nov	0.9	0.25	33878	33969	0.6275342	
11-Nov	0.9	0.25	33878	33969	0.6061644	
14-Nov	0.9	0.25	33878	33969	0.5847945	
17-Nov	0.9	0.25	33878	33969	0.5634247	
20-Nov	0.9	0.25	33878	33969	0.5420548	
23-Nov	0.9	0.25	33878	33969	0.5206849	
26-Nov	0.9	0.25	33878	33969	0.4993151	
29-Nov	0.9	0.25	33878	33969	0.4779452	0.5741096
02-Dec	0.9	0.25	33878	33969	0.4565753	
05-Dec	0.9	0.25	33878	33969	0.4352055	
08-Dec	0.9	0.25	33878	33969	0.4138356	
11-Dec	0.9	0.25	33878	33969	0.3924658	
14-Dec	0.9	0.25	33878	33969	0.3710959	
17-Dec	0.9	0.25	33878	33969	0.349726	
20-Dec	0.9	0.25	33878	33969	0.3283562	
23-Dec	0.9	0.25	33878	33969	0.3069863	
26-Dec	0.9	0.25	33878	33969	0.2856164	
29-Dec	0.9	0.25	33878	33969	0.2642466	0.360411

Barley

% SMD	50.00
RTZN	6
AWHC	2
SMD	6
crop'd Kc	0.15
Maturity %	0.75

	Dates			Kcs	
Start	06/01/91	33390	33563	0	0
Planting	11/21/91	33563	33573	0	0.22
Date A	12/01/91	33573	33596	0.22	0.22
Date B	12/24/91	33596	33665	0.22	1.15
Date C	03/02/92	33665	33705	1.15	1.15
Date D	11-Apr	33705	33749	1.15	0.1
Date E	05/25/92	33749	33750	0.1	0
End	05/26/92	33750		0	0

	KcA	KcB	Date A	Date B	Kc = A+(B-A)*(D-Da/Db-Da)	
01-jan-92	0.22	1.15	33596	33665	0.3278261	
04-Jan	0.22	1.15	33596	33665	0.3682609	
07-Jan	0.22	1.15	33596	33665	0.4086957	
10-Jan	0.22	1.15	33596	33665	0.4491304	
13-Jan	0.22	1.15	33596	33665	0.4895652	
16-Jan	0.22	1.15	33596	33665	0.53	
19-Jan	0.22	1.15	33596	33665	0.5704348	
22-Jan	0.22	1.15	33596	33665	0.6108696	
25-Jan	0.22	1.15	33596	33665	0.6513043	
28-Jan	0.22	1.15	33596	33665	0.6917391	
31-Jan	0.22	1.15	33596	33665	0.7321739	0.53
03-Feb	0.22	1.15	33596	33665	0.7726087	
06-Feb	0.22	1.15	33596	33665	0.8130435	
09-Feb	0.22	1.15	33596	33665	0.8534783	
12-Feb	0.22	1.15	33596	33665	0.893913	
15-Feb	0.22	1.15	33596	33665	0.9343478	
18-Feb	0.22	1.15	33596	33665	0.9747826	
21-Feb	0.22	1.15	33596	33665	1.0152174	
24-Feb	0.22	1.15	33596	33665	1.0556522	
27-Feb	0.22	1.15	33596	33665	1.096087	0.9343478
01-Mar	0.22	1.15	33596	33665	1.1365217	
04-Mar	1.15	1.15	33665	33705	1.15	
07-Mar	1.15	1.15	33665	33705	1.15	
10-Mar	1.15	1.15	33665	33705	1.15	
13-Mar	1.15	1.15	33665	33705	1.15	
16-Mar	1.15	1.15	33665	33705	1.15	
19-Mar	1.15	1.15	33665	33705	1.15	
22-Mar	1.15	1.15	33665	33705	1.15	
25-Mar	1.15	1.15	33665	33705	1.15	
28-Mar	1.15	1.15	33665	33705	1.15	
31-Mar	1.15	1.15	33665	33705	1.15	1.1487747
03-Apr	1.15	1.15	33665	33705	1.15	
06-Apr	1.15	1.15	33665	33705	1.15	
09-Apr	1.15	1.15	33665	33705	1.15	
12-Apr	1.15	0.1	33705	33749	1.1261364	
15-Apr	1.15	0.1	33705	33749	1.0545455	
18-Apr	1.15	0.1	33705	33749	0.9829545	
21-Apr	1.15	0.1	33705	33749	0.9113636	
24-Apr	1.15	0.1	33705	33749	0.8397727	
27-Apr	1.15	0.1	33705	33749	0.7681818	
30-Apr	1.15	0.1	33705	33749	0.6965909	0.9829545
03-May	1.15	0.1	33705	33749	0.625	
06-May	1.15	0.1	33705	33749	0.5534091	
09-May	1.15	0.1	33705	33749	0.4818182	
12-May	1.15	0.1	33705	33749	0.4102273	
15-May	1.15	0.1	33705	33749	0.3386364	

18-May	1.15	0.1	33705	33749	0.2670455	
21-May	1.15	0.1	33705	33749	0.1954545	
24-May	1.15	0.1	33705	33749	0.1238636	
27-May	0	0	33750	0	0	
30-May	0	0	33750	0	0	0.2995455
02-jun-91	0	0	33390	33563	0	
05-Jun	0	0	33390	33563	0	
08-Jun	0	0	33390	33563	0	
11-Jun	0	0	33390	33563	0	
14-Jun	0	0	33390	33563	0	
17-Jun	0	0	33390	33563	0	
20-Jun	0	0	33390	33563	0	
23-Jun	0	0	33390	33563	0	
26-Jun	0	0	33390	33563	0	
29-Jun	0	0	33390	33563	0	0
02-Jul	0	0	33390	33563	0	
05-Jul	0	0	33390	33563	0	
08-Jul	0	0	33390	33563	0	
11-Jul	0	0	33390	33563	0	
14-Jul	0	0	33390	33563	0	
17-Jul	0	0	33390	33563	0	
20-Jul	0	0	33390	33563	0	
23-Jul	0	0	33390	33563	0	
26-Jul	0	0	33390	33563	0	
29-Jul	0	0	33390	33563	0	0
01-Aug	0	0	33390	33563	0	
04-Aug	0	0	33390	33563	0	
07-Aug	0	0	33390	33563	0	
10-Aug	0	0	33390	33563	0	
13-Aug	0	0	33390	33563	0	
16-Aug	0	0	33390	33563	0	
19-Aug	0	0	33390	33563	0	
22-Aug	0	0	33390	33563	0	
25-Aug	0	0	33390	33563	0	
28-Aug	0	0	33390	33563	0	
31-Aug	0	0	33390	33563	0	0
03-Sep	0	0	33390	33563	0	
06-Sep	0	0	33390	33563	0	
09-Sep	0	0	33390	33563	0	
12-Sep	0	0	33390	33563	0	
15-Sep	0	0	33390	33563	0	
18-Sep	0	0	33390	33563	0	
21-Sep	0	0	33390	33563	0	
24-Sep	0	0	33390	33563	0	
27-Sep	0	0	33390	33563	0	
30-Sep	0	0	33390	33563	0	0
03-Oct	0	0	33390	33563	0	
06-Oct	0	0	33390	33563	0	
09-Oct	0	0	33390	33563	0	
12-Oct	0	0	33390	33563	0	
15-Oct	0	0	33390	33563	0	
18-Oct	0	0	33390	33563	0	
21-Oct	0	0	33390	33563	0	
24-Oct	0	0	33390	33563	0	
27-Oct	0	0	33390	33563	0	
30-Oct	0	0	33390	33563	0	0
02-Nov	0	0	33390	33563	0	
05-Nov	0	0	33390	33563	0	
08-Nov	0	0	33390	33563	0	
11-Nov	0	0	33390	33563	0	
14-Nov	0	0	33390	33563	0	
17-Nov	0	0	33390	33563	0	
20-Nov	0	0	33390	33563	0	
23-Nov	0	0.22	33563	33573	0.044	
26-Nov	0	0.22	33563	33573	0.11	

29-Nov	0	0.22	33563	33573	0.176	0.033
02-Dec	0.22	0.22	33573	33596	0.22	
05-Dec	0.22	0.22	33573	33596	0.22	
08-Dec	0.22	0.22	33573	33596	0.22	
11-Dec	0.22	0.22	33573	33596	0.22	
14-Dec	0.22	0.22	33573	33596	0.22	
17-Dec	0.22	0.22	33573	33596	0.22	
20-Dec	0.22	0.22	33573	33596	0.22	
23-Dec	0.22	0.22	33573	33596	0.22	
26-Dec	0.22	1.15	33596	33665	0.2469565	
29-Dec	0.22	1.15	33596	33665	0.2873913	0.2294348

Bean

% SMD	50.00
RTZN	4
AWHC	2
SMD	4
crop'd Kc	0.15
Maturity %	0.74

	Dates			Kcs	
Start	01/01/92	33604	33683	0	0
Planting	03/20/92	33683	33695	0	0.14
Date A	04/01/92	33695	33724	0.14	0.14
Date B	04/30/92	33724	33749	0.14	1.15
Date C	05/25/92	33749	33780.1	1.15	1.15
Date D	25-Jun	33780.1	33810	1.15	0.3
Date E	07/25/92	33810	33817	0.3	0
End	08/01/92	33817		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0	0	33604	33683	0	
04-Jan	0	0	33604	33683	0	
07-Jan	0	0	33604	33683	0	
10-Jan	0	0	33604	33683	0	
13-Jan	0	0	33604	33683	0	
16-Jan	0	0	33604	33683	0	
19-Jan	0	0	33604	33683	0	
22-Jan	0	0	33604	33683	0	
25-Jan	0	0	33604	33683	0	
28-Jan	0	0	33604	33683	0	
31-Jan	0	0	33604	33683	0	0
03-Feb	0	0	33604	33683	0	
06-Feb	0	0	33604	33683	0	
09-Feb	0	0	33604	33683	0	
12-Feb	0	0	33604	33683	0	
15-Feb	0	0	33604	33683	0	
18-Feb	0	0	33604	33683	0	
21-Feb	0	0	33604	33683	0	
24-Feb	0	0	33604	33683	0	
27-Feb	0	0	33604	33683	0	0
01-Mar	0	0	33604	33683	0	
04-Mar	0	0	33604	33683	0	
07-Mar	0	0	33604	33683	0	
10-Mar	0	0	33604	33683	0	
13-Mar	0	0	33604	33683	0	
16-Mar	0	0	33604	33683	0	
19-Mar	0	0	33604	33683	0	
22-Mar	0	0.14	33683	33695	0.02333333	
25-Mar	0	0.14	33683	33695	0.05833333	
28-Mar	0	0.14	33683	33695	0.09333333	
31-Mar	0	0.14	33683	33695	0.12833333	0.02757576
03-Apr	0.14	0.14	33695	33724	0.14	
06-Apr	0.14	0.14	33695	33724	0.14	

09-Apr	0.14	0.14	33695	33724	0.14	
12-Apr	0.14	0.14	33695	33724	0.14	
15-Apr	0.14	0.14	33695	33724	0.14	
18-Apr	0.14	0.14	33695	33724	0.14	
21-Apr	0.14	0.14	33695	33724	0.14	
24-Apr	0.14	0.14	33695	33724	0.14	
27-Apr	0.14	0.14	33695	33724	0.14	
30-Apr	0.14	1.15	33724	33749	0.14	0.14
03-May	0.14	1.15	33724	33749	0.2612	
06-May	0.14	1.15	33724	33749	0.3824	
09-May	0.14	1.15	33724	33749	0.5036	
12-May	0.14	1.15	33724	33749	0.6248	
15-May	0.14	1.15	33724	33749	0.746	
18-May	0.14	1.15	33724	33749	0.8672	
21-May	0.14	1.15	33724	33749	0.9884	
24-May	0.14	1.15	33724	33749	1.1096	
27-May	1.15	1.15	33749	33780.1	1.15	
30-May	1.15	1.15	33749	33780.1	1.15	0.77832
02-Jun	1.15	1.15	33749	33780.1	1.15	
05-Jun	1.15	1.15	33749	33780.1	1.15	
08-Jun	1.15	1.15	33749	33780.1	1.15	
11-Jun	1.15	1.15	33749	33780.1	1.15	
14-Jun	1.15	1.15	33749	33780.1	1.15	
17-Jun	1.15	1.15	33749	33780.1	1.15	
20-Jun	1.15	1.15	33749	33780.1	1.15	
23-Jun	1.15	1.15	33749	33780.1	1.15	
26-Jun	1.15	0.3	33780.1	33810	1.12441472	
29-Jun	1.15	0.3	33780.1	33810	1.03913043	1.13635452
02-Jul	1.15	0.3	33780.1	33810	0.95384615	
05-Jul	1.15	0.3	33780.1	33810	0.86856187	
08-Jul	1.15	0.3	33780.1	33810	0.78327759	
11-Jul	1.15	0.3	33780.1	33810	0.69799331	
14-Jul	1.15	0.3	33780.1	33810	0.61270903	
17-Jul	1.15	0.3	33780.1	33810	0.52742475	
20-Jul	1.15	0.3	33780.1	33810	0.44214047	
23-Jul	1.15	0.3	33780.1	33810	0.35685619	
26-Jul	0.3	0	33810	33817	0.25714286	
29-Jul	0.3	0	33810	33817	0.12857143	0.56285237
01-Aug	0	0	33817	0	0	
04-Aug	0	0	33817	0	0	
07-Aug	0	0	33817	0	0	
10-Aug	0	0	33817	0	0	
13-Aug	0	0	33817	0	0	
16-Aug	0	0	33817	0	0	
19-Aug	0	0	33817	0	0	
22-Aug	0	0	33817	0	0	
25-Aug	0	0	33817	0	0	
28-Aug	0	0	33817	0	0	
31-Aug	0	0	33817	0	0	0
03-Sep	0	0	33817	0	0	
06-Sep	0	0	33817	0	0	
09-Sep	0	0	33817	0	0	

12-Sep	0	0	33817	0	0	
15-Sep	0	0	33817	0	0	
18-Sep	0	0	33817	0	0	
21-Sep	0	0	33817	0	0	
24-Sep	0	0	33817	0	0	
27-Sep	0	0	33817	0	0	
30-Sep	0	0	33817	0	0	0
03-Oct	0	0	33817	0	0	
06-Oct	0	0	33817	0	0	
09-Oct	0	0	33817	0	0	
12-Oct	0	0	33817	0	0	
15-Oct	0	0	33817	0	0	
18-Oct	0	0	33817	0	0	
21-Oct	0	0	33817	0	0	
24-Oct	0	0	33817	0	0	
27-Oct	0	0	33817	0	0	
30-Oct	0	0	33817	0	0	0
02-Nov	0	0	33817	0	0	
05-Nov	0	0	33817	0	0	
08-Nov	0	0	33817	0	0	
11-Nov	0	0	33817	0	0	
14-Nov	0	0	33817	0	0	
17-Nov	0	0	33817	0	0	
20-Nov	0	0	33817	0	0	
23-Nov	0	0	33817	0	0	
26-Nov	0	0	33817	0	0	
29-Nov	0	0	33817	0	0	0
02-Dec	0	0	33817	0	0	
05-Dec	0	0	33817	0	0	
08-Dec	0	0	33817	0	0	
11-Dec	0	0	33817	0	0	
14-Dec	0	0	33817	0	0	
17-Dec	0	0	33817	0	0	
20-Dec	0	0	33817	0	0	
23-Dec	0	0	33817	0	0	
26-Dec	0	0	33817	0	0	
29-Dec	0	0	33817	0	0	0

Cotton

% SMD	60.00
RTZN	6
AWHC	2
SMD	7.2
crop'd Kc	0.15
Maturity %	0.75

	Dates			Kcs	
Start	01/01/92	33604	33695	0	0
Planting	04/01/92	33695	33704	0	0.12
Date A	04/10/92	33704	33736	0.12	0.12
Date B	05/12/92	33736	33791	0.12	1.04
Date C	07/06/92	33791	33840.5	1.04	1.04
Date D	24-Aug	33840.5	33886	1.04	0.1
Date E	10/09/92	33886	33887	0.1	0
End	10/10/92	33887		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0	0	33604	33695	0	
04-Jan	0	0	33604	33695	0	
07-Jan	0	0	33604	33695	0	
10-Jan	0	0	33604	33695	0	
13-Jan	0	0	33604	33695	0	
16-Jan	0	0	33604	33695	0	
19-Jan	0	0	33604	33695	0	
22-Jan	0	0	33604	33695	0	
25-Jan	0	0	33604	33695	0	
28-Jan	0	0	33604	33695	0	
31-Jan	0	0	33604	33695	0	0
03-Feb	0	0	33604	33695	0	
06-Feb	0	0	33604	33695	0	
09-Feb	0	0	33604	33695	0	
12-Feb	0	0	33604	33695	0	
15-Feb	0	0	33604	33695	0	
18-Feb	0	0	33604	33695	0	
21-Feb	0	0	33604	33695	0	
24-Feb	0	0	33604	33695	0	
27-Feb	0	0	33604	33695	0	0
01-Mar	0	0	33604	33695	0	
04-Mar	0	0	33604	33695	0	
07-Mar	0	0	33604	33695	0	
10-Mar	0	0	33604	33695	0	
13-Mar	0	0	33604	33695	0	
16-Mar	0	0	33604	33695	0	
19-Mar	0	0	33604	33695	0	
22-Mar	0	0	33604	33695	0	
25-Mar	0	0	33604	33695	0	
28-Mar	0	0	33604	33695	0	
31-Mar	0	0	33604	33695	0	0
03-Apr	0	0.12	33695	33704	0.02666667	
06-Apr	0	0.12	33695	33704	0.06666667	

09-Apr	0	0.12	33695	33704	0.10666667	
12-Apr	0.12	0.12	33704	33736	0.12	
15-Apr	0.12	0.12	33704	33736	0.12	
18-Apr	0.12	0.12	33704	33736	0.12	
21-Apr	0.12	0.12	33704	33736	0.12	
24-Apr	0.12	0.12	33704	33736	0.12	
27-Apr	0.12	0.12	33704	33736	0.12	
30-Apr	0.12	0.12	33704	33736	0.12	0.104
03-May	0.12	0.12	33704	33736	0.12	
06-May	0.12	0.12	33704	33736	0.12	
09-May	0.12	0.12	33704	33736	0.12	
12-May	0.12	1.04	33736	33791	0.12	
15-May	0.12	1.04	33736	33791	0.17018182	
18-May	0.12	1.04	33736	33791	0.22036364	
21-May	0.12	1.04	33736	33791	0.27054545	
24-May	0.12	1.04	33736	33791	0.32072727	
27-May	0.12	1.04	33736	33791	0.37090909	
30-May	0.12	1.04	33736	33791	0.42109091	0.22538182
02-Jun	0.12	1.04	33736	33791	0.47127273	
05-Jun	0.12	1.04	33736	33791	0.52145455	
08-Jun	0.12	1.04	33736	33791	0.57163636	
11-Jun	0.12	1.04	33736	33791	0.62181818	
14-Jun	0.12	1.04	33736	33791	0.672	
17-Jun	0.12	1.04	33736	33791	0.72218182	
20-Jun	0.12	1.04	33736	33791	0.77236364	
23-Jun	0.12	1.04	33736	33791	0.82254545	
26-Jun	0.12	1.04	33736	33791	0.87272727	
29-Jun	0.12	1.04	33736	33791	0.92290909	0.69709091
02-Jul	0.12	1.04	33736	33791	0.97309091	
05-Jul	0.12	1.04	33736	33791	1.02327273	
08-Jul	1.04	1.04	33791	33840.5	1.04	
11-Jul	1.04	1.04	33791	33840.5	1.04	
14-Jul	1.04	1.04	33791	33840.5	1.04	
17-Jul	1.04	1.04	33791	33840.5	1.04	
20-Jul	1.04	1.04	33791	33840.5	1.04	
23-Jul	1.04	1.04	33791	33840.5	1.04	
26-Jul	1.04	1.04	33791	33840.5	1.04	
29-Jul	1.04	1.04	33791	33840.5	1.04	1.03163636
01-Aug	1.04	1.04	33791	33840.5	1.04	
04-Aug	1.04	1.04	33791	33840.5	1.04	
07-Aug	1.04	1.04	33791	33840.5	1.04	
10-Aug	1.04	1.04	33791	33840.5	1.04	
13-Aug	1.04	1.04	33791	33840.5	1.04	
16-Aug	1.04	1.04	33791	33840.5	1.04	
19-Aug	1.04	1.04	33791	33840.5	1.04	
22-Aug	1.04	1.04	33791	33840.5	1.04	
25-Aug	1.04	0.1	33840.5	33886	1.02967033	
28-Aug	1.04	0.1	33840.5	33886	0.96769231	
31-Aug	1.04	0.1	33840.5	33886	0.90571429	1.02027972
03-Sep	1.04	0.1	33840.5	33886	0.84373626	
06-Sep	1.04	0.1	33840.5	33886	0.78175824	
09-Sep	1.04	0.1	33840.5	33886	0.71978022	

12-Sep	1.04	0.1	33840.5	33886	0.6578022	
15-Sep	1.04	0.1	33840.5	33886	0.59582418	
18-Sep	1.04	0.1	33840.5	33886	0.53384615	
21-Sep	1.04	0.1	33840.5	33886	0.47186813	
24-Sep	1.04	0.1	33840.5	33886	0.40989011	
27-Sep	1.04	0.1	33840.5	33886	0.34791209	
30-Sep	1.04	0.1	33840.5	33886	0.28593407	0.56483516
03-Oct	1.04	0.1	33840.5	33886	0.22395604	
06-Oct	1.04	0.1	33840.5	33886	0.16197802	
09-Oct	0.1	0	33886	33887	0.1	
12-Oct	0	0	33887	0	0	
15-Oct	0	0	33887	0	0	
18-Oct	0	0	33887	0	0	
21-Oct	0	0	33887	0	0	
24-Oct	0	0	33887	0	0	
27-Oct	0	0	33887	0	0	
30-Oct	0	0	33887	0	0	0.04859341
02-Nov	0	0	33887	0	0	
05-Nov	0	0	33887	0	0	
08-Nov	0	0	33887	0	0	
11-Nov	0	0	33887	0	0	
14-Nov	0	0	33887	0	0	
17-Nov	0	0	33887	0	0	
20-Nov	0	0	33887	0	0	
23-Nov	0	0	33887	0	0	
26-Nov	0	0	33887	0	0	
29-Nov	0	0	33887	0	0	0
02-Dec	0	0	33887	0	0	
05-Dec	0	0	33887	0	0	
08-Dec	0	0	33887	0	0	
11-Dec	0	0	33887	0	0	
14-Dec	0	0	33887	0	0	
17-Dec	0	0	33887	0	0	
20-Dec	0	0	33887	0	0	
23-Dec	0	0	33887	0	0	
26-Dec	0	0	33887	0	0	
29-Dec	0	0	33887	0	0	0

Corn

% SMD	50.00
RTZN	6
AWHC	2
SMD	6
crop'd Kc	0.15
Maturity %	0.74

	Dates			Kcs	
Start	01/01/92	33604	33700	0	0
Planting	04/06/92	33700	33710	0	0.18
Date A	04/16/92	33710	33731	0.18	0.18
Date B	05/07/92	33731	33783	0.18	1.1
Date C	06/28/92	33783	33822.48	1.1	1.1
Date D	06-Aug	33822.48	33862	1.1	0.45
Date E	09/15/92	33862	33863	0.45	0
End	09/16/92	33863		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0	0	33604	33700	0	
04-Jan	0	0	33604	33700	0	
07-Jan	0	0	33604	33700	0	
10-Jan	0	0	33604	33700	0	
13-Jan	0	0	33604	33700	0	
16-Jan	0	0	33604	33700	0	
19-Jan	0	0	33604	33700	0	
22-Jan	0	0	33604	33700	0	
25-Jan	0	0	33604	33700	0	
28-Jan	0	0	33604	33700	0	
31-Jan	0	0	33604	33700	0	0
03-Feb	0	0	33604	33700	0	
06-Feb	0	0	33604	33700	0	
09-Feb	0	0	33604	33700	0	
12-Feb	0	0	33604	33700	0	
15-Feb	0	0	33604	33700	0	
18-Feb	0	0	33604	33700	0	
21-Feb	0	0	33604	33700	0	
24-Feb	0	0	33604	33700	0	
27-Feb	0	0	33604	33700	0	0
01-Mar	0	0	33604	33700	0	
04-Mar	0	0	33604	33700	0	
07-Mar	0	0	33604	33700	0	
10-Mar	0	0	33604	33700	0	
13-Mar	0	0	33604	33700	0	
16-Mar	0	0	33604	33700	0	
19-Mar	0	0	33604	33700	0	
22-Mar	0	0	33604	33700	0	
25-Mar	0	0	33604	33700	0	
28-Mar	0	0	33604	33700	0	
31-Mar	0	0	33604	33700	0	0
03-Apr	0	0	33604	33700	0	
06-Apr	0	0.18	33700	33710	0	

09-Apr	0	0.18	33700	33710	0.054	
12-Apr	0	0.18	33700	33710	0.108	
15-Apr	0	0.18	33700	33710	0.162	
18-Apr	0.18	0.18	33710	33731	0.18	
21-Apr	0.18	0.18	33710	33731	0.18	
24-Apr	0.18	0.18	33710	33731	0.18	
27-Apr	0.18	0.18	33710	33731	0.18	
30-Apr	0.18	0.18	33710	33731	0.18	0.1224
03-May	0.18	0.18	33710	33731	0.18	
06-May	0.18	0.18	33710	33731	0.18	
09-May	0.18	1.1	33731	33783	0.21538462	
12-May	0.18	1.1	33731	33783	0.26846154	
15-May	0.18	1.1	33731	33783	0.32153846	
18-May	0.18	1.1	33731	33783	0.37461538	
21-May	0.18	1.1	33731	33783	0.42769231	
24-May	0.18	1.1	33731	33783	0.48076923	
27-May	0.18	1.1	33731	33783	0.53384615	
30-May	0.18	1.1	33731	33783	0.58692308	0.35692308
02-Jun	0.18	1.1	33731	33783	0.64	
05-Jun	0.18	1.1	33731	33783	0.69307692	
08-Jun	0.18	1.1	33731	33783	0.74615385	
11-Jun	0.18	1.1	33731	33783	0.79923077	
14-Jun	0.18	1.1	33731	33783	0.85230769	
17-Jun	0.18	1.1	33731	33783	0.90538462	
20-Jun	0.18	1.1	33731	33783	0.95846154	
23-Jun	0.18	1.1	33731	33783	1.01153846	
26-Jun	0.18	1.1	33731	33783	1.06461538	
29-Jun	1.1	1.1	33783	33822.48	1.1	0.87707692
02-Jul	1.1	1.1	33783	33822.48	1.1	
05-Jul	1.1	1.1	33783	33822.48	1.1	
08-Jul	1.1	1.1	33783	33822.48	1.1	
11-Jul	1.1	1.1	33783	33822.48	1.1	
14-Jul	1.1	1.1	33783	33822.48	1.1	
17-Jul	1.1	1.1	33783	33822.48	1.1	
20-Jul	1.1	1.1	33783	33822.48	1.1	
23-Jul	1.1	1.1	33783	33822.48	1.1	
26-Jul	1.1	1.1	33783	33822.48	1.1	
29-Jul	1.1	1.1	33783	33822.48	1.1	1.1
01-Aug	1.1	1.1	33783	33822.48	1.1	
04-Aug	1.1	1.1	33783	33822.48	1.1	
07-Aug	1.1	0.45	33822.48	33862	1.09144737	
10-Aug	1.1	0.45	33822.48	33862	1.04210526	
13-Aug	1.1	0.45	33822.48	33862	0.99276316	
16-Aug	1.1	0.45	33822.48	33862	0.94342105	
19-Aug	1.1	0.45	33822.48	33862	0.89407895	
22-Aug	1.1	0.45	33822.48	33862	0.84473684	
25-Aug	1.1	0.45	33822.48	33862	0.79539474	
28-Aug	1.1	0.45	33822.48	33862	0.74605263	
31-Aug	1.1	0.45	33822.48	33862	0.69671053	0.93151914
03-Sep	1.1	0.45	33822.48	33862	0.64736842	
06-Sep	1.1	0.45	33822.48	33862	0.59802632	
09-Sep	1.1	0.45	33822.48	33862	0.54868421	

12-Sep	1.1	0.45	33822.48	33862	0.49934211	
15-Sep	0.45	0	33862	33863	0.45	
18-Sep	0	0	33863	0	0	
21-Sep	0	0	33863	0	0	
24-Sep	0	0	33863	0	0	
27-Sep	0	0	33863	0	0	
30-Sep	0	0	33863	0	0	0.27434211
03-Oct	0	0	33863	0	0	
06-Oct	0	0	33863	0	0	
09-Oct	0	0	33863	0	0	
12-Oct	0	0	33863	0	0	
15-Oct	0	0	33863	0	0	
18-Oct	0	0	33863	0	0	
21-Oct	0	0	33863	0	0	
24-Oct	0	0	33863	0	0	
27-Oct	0	0	33863	0	0	
30-Oct	0	0	33863	0	0	0
02-Nov	0	0	33863	0	0	
05-Nov	0	0	33863	0	0	
08-Nov	0	0	33863	0	0	
11-Nov	0	0	33863	0	0	
14-Nov	0	0	33863	0	0	
17-Nov	0	0	33863	0	0	
20-Nov	0	0	33863	0	0	
23-Nov	0	0	33863	0	0	
26-Nov	0	0	33863	0	0	
29-Nov	0	0	33863	0	0	0
02-Dec	0	0	33863	0	0	
05-Dec	0	0	33863	0	0	
08-Dec	0	0	33863	0	0	
11-Dec	0	0	33863	0	0	
14-Dec	0	0	33863	0	0	
17-Dec	0	0	33863	0	0	
20-Dec	0	0	33863	0	0	
23-Dec	0	0	33863	0	0	
26-Dec	0	0	33863	0	0	
29-Dec	0	0	33863	0	0	0

Fallow

% SMD	50.00
RTZN	6
AWHC	2
SMD	6
crop'd Kc	0.15
Maturity %	0.9

	Dates			Kcs	
Start	01/01/92	33604	33604	0	0
Planting	01/01/92	33604	33605	0	0.06
Date A	01/02/92	33605	33606	0.06	0.06
Date B	01/03/92	33606	33607	0.06	0.06
Date C	01/04/92	33607	33608.6	0.06	0.06
Date D	05-Jan	33608.6	33609	0.06	0.06
Date E	01/06/92	33609	33969	0.06	0.06
End	12/31/92	33969		0.06	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0	0	33604	33604	0.06	
04-Jan	0.06	0.06	33607	33608.6	0.06	
07-Jan	0.06	0.06	33609	33969	0.06	
10-Jan	0.06	0.06	33609	33969	0.06	
13-Jan	0.06	0.06	33609	33969	0.06	
16-Jan	0.06	0.06	33609	33969	0.06	
19-Jan	0.06	0.06	33609	33969	0.06	
22-Jan	0.06	0.06	33609	33969	0.06	
25-Jan	0.06	0.06	33609	33969	0.06	
28-Jan	0.06	0.06	33609	33969	0.06	
31-Jan	0.06	0.06	33609	33969	0.06	0.06
03-Feb	0.06	0.06	33609	33969	0.06	
06-Feb	0.06	0.06	33609	33969	0.06	
09-Feb	0.06	0.06	33609	33969	0.06	
12-Feb	0.06	0.06	33609	33969	0.06	
15-Feb	0.06	0.06	33609	33969	0.06	
18-Feb	0.06	0.06	33609	33969	0.06	
21-Feb	0.06	0.06	33609	33969	0.06	
24-Feb	0.06	0.06	33609	33969	0.06	
27-Feb	0.06	0.06	33609	33969	0.06	0.06
01-Mar	0.06	0.06	33609	33969	0.06	
04-Mar	0.06	0.06	33609	33969	0.06	
07-Mar	0.06	0.06	33609	33969	0.06	
10-Mar	0.06	0.06	33609	33969	0.06	
13-Mar	0.06	0.06	33609	33969	0.06	
16-Mar	0.06	0.06	33609	33969	0.06	
19-Mar	0.06	0.06	33609	33969	0.06	
22-Mar	0.06	0.06	33609	33969	0.06	
25-Mar	0.06	0.06	33609	33969	0.06	
28-Mar	0.06	0.06	33609	33969	0.06	
31-Mar	0.06	0.06	33609	33969	0.06	0.06
03-Apr	0.06	0.06	33609	33969	0.06	
06-Apr	0.06	0.06	33609	33969	0.06	

09-Apr	0.06	0.06	33609	33969	0.06	
12-Apr	0.06	0.06	33609	33969	0.06	
15-Apr	0.06	0.06	33609	33969	0.06	
18-Apr	0.06	0.06	33609	33969	0.06	
21-Apr	0.06	0.06	33609	33969	0.06	
24-Apr	0.06	0.06	33609	33969	0.06	
27-Apr	0.06	0.06	33609	33969	0.06	
30-Apr	0.06	0.06	33609	33969	0.06	0.06
03-May	0.06	0.06	33609	33969	0.06	
06-May	0.06	0.06	33609	33969	0.06	
09-May	0.06	0.06	33609	33969	0.06	
12-May	0.06	0.06	33609	33969	0.06	
15-May	0.06	0.06	33609	33969	0.06	
18-May	0.06	0.06	33609	33969	0.06	
21-May	0.06	0.06	33609	33969	0.06	
24-May	0.06	0.06	33609	33969	0.06	
27-May	0.06	0.06	33609	33969	0.06	
30-May	0.06	0.06	33609	33969	0.06	0.06
02-Jun	0.06	0.06	33609	33969	0.06	
05-Jun	0.06	0.06	33609	33969	0.06	
08-Jun	0.06	0.06	33609	33969	0.06	
11-Jun	0.06	0.06	33609	33969	0.06	
14-Jun	0.06	0.06	33609	33969	0.06	
17-Jun	0.06	0.06	33609	33969	0.06	
20-Jun	0.06	0.06	33609	33969	0.06	
23-Jun	0.06	0.06	33609	33969	0.06	
26-Jun	0.06	0.06	33609	33969	0.06	
29-Jun	0.06	0.06	33609	33969	0.06	0.06
02-Jul	0.06	0.06	33609	33969	0.06	
05-Jul	0.06	0.06	33609	33969	0.06	
08-Jul	0.06	0.06	33609	33969	0.06	
11-Jul	0.06	0.06	33609	33969	0.06	
14-Jul	0.06	0.06	33609	33969	0.06	
17-Jul	0.06	0.06	33609	33969	0.06	
20-Jul	0.06	0.06	33609	33969	0.06	
23-Jul	0.06	0.06	33609	33969	0.06	
26-Jul	0.06	0.06	33609	33969	0.06	
29-Jul	0.06	0.06	33609	33969	0.06	0.06
01-Aug	0.06	0.06	33609	33969	0.06	
04-Aug	0.06	0.06	33609	33969	0.06	
07-Aug	0.06	0.06	33609	33969	0.06	
10-Aug	0.06	0.06	33609	33969	0.06	
13-Aug	0.06	0.06	33609	33969	0.06	
16-Aug	0.06	0.06	33609	33969	0.06	
19-Aug	0.06	0.06	33609	33969	0.06	
22-Aug	0.06	0.06	33609	33969	0.06	
25-Aug	0.06	0.06	33609	33969	0.06	
28-Aug	0.06	0.06	33609	33969	0.06	
31-Aug	0.06	0.06	33609	33969	0.06	0.06
03-Sep	0.06	0.06	33609	33969	0.06	
06-Sep	0.06	0.06	33609	33969	0.06	
09-Sep	0.06	0.06	33609	33969	0.06	

12-Sep	0.06	0.06	33609	33969	0.06	
15-Sep	0.06	0.06	33609	33969	0.06	
18-Sep	0.06	0.06	33609	33969	0.06	
21-Sep	0.06	0.06	33609	33969	0.06	
24-Sep	0.06	0.06	33609	33969	0.06	
27-Sep	0.06	0.06	33609	33969	0.06	
30-Sep	0.06	0.06	33609	33969	0.06	0.06
03-Oct	0.06	0.06	33609	33969	0.06	
06-Oct	0.06	0.06	33609	33969	0.06	
09-Oct	0.06	0.06	33609	33969	0.06	
12-Oct	0.06	0.06	33609	33969	0.06	
15-Oct	0.06	0.06	33609	33969	0.06	
18-Oct	0.06	0.06	33609	33969	0.06	
21-Oct	0.06	0.06	33609	33969	0.06	
24-Oct	0.06	0.06	33609	33969	0.06	
27-Oct	0.06	0.06	33609	33969	0.06	
30-Oct	0.06	0.06	33609	33969	0.06	0.06
02-Nov	0.06	0.06	33609	33969	0.06	
05-Nov	0.06	0.06	33609	33969	0.06	
08-Nov	0.06	0.06	33609	33969	0.06	
11-Nov	0.06	0.06	33609	33969	0.06	
14-Nov	0.06	0.06	33609	33969	0.06	
17-Nov	0.06	0.06	33609	33969	0.06	
20-Nov	0.06	0.06	33609	33969	0.06	
23-Nov	0.06	0.06	33609	33969	0.06	
26-Nov	0.06	0.06	33609	33969	0.06	
29-Nov	0.06	0.06	33609	33969	0.06	0.06
02-Dec	0.06	0.06	33609	33969	0.06	
05-Dec	0.06	0.06	33609	33969	0.06	
08-Dec	0.06	0.06	33609	33969	0.06	
11-Dec	0.06	0.06	33609	33969	0.06	
14-Dec	0.06	0.06	33609	33969	0.06	
17-Dec	0.06	0.06	33609	33969	0.06	
20-Dec	0.06	0.06	33609	33969	0.06	
23-Dec	0.06	0.06	33609	33969	0.06	
26-Dec	0.06	0.06	33609	33969	0.06	
29-Dec	0.06	0.06	33609	33969	0.06	0.06

Melon

% SMD	50.00
RTZN	4
AWHC	2
SMD	4
crop'd Kc	0.15
Maturity %	0.75

	Dates			Kcs	
Start	01/01/92	33604	33683	0	0
Planting	03/20/92	33683	33695	0	0.18
Date A	04/01/92	33695	33730	0.18	0.18
Date B	05/06/92	33730	33769	0.18	1.1
Date C	06/14/92	33769	33773.75	1.1	1.1
Date D	18-Jun	33773.75	33800	1.1	0.1
Date E	07/15/92	33800	33801	0.1	0
End	07/16/92	33801		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0	0	33604	33683	0	
04-Jan	0	0	33604	33683	0	
07-Jan	0	0	33604	33683	0	
10-Jan	0	0	33604	33683	0	
13-Jan	0	0	33604	33683	0	
16-Jan	0	0	33604	33683	0	
19-Jan	0	0	33604	33683	0	
22-Jan	0	0	33604	33683	0	
25-Jan	0	0	33604	33683	0	
28-Jan	0	0	33604	33683	0	
31-Jan	0	0	33604	33683	0	0
03-Feb	0	0	33604	33683	0	
06-Feb	0	0	33604	33683	0	
09-Feb	0	0	33604	33683	0	
12-Feb	0	0	33604	33683	0	
15-Feb	0	0	33604	33683	0	
18-Feb	0	0	33604	33683	0	
21-Feb	0	0	33604	33683	0	
24-Feb	0	0	33604	33683	0	
27-Feb	0	0	33604	33683	0	0
01-Mar	0	0	33604	33683	0	
04-Mar	0	0	33604	33683	0	
07-Mar	0	0	33604	33683	0	
10-Mar	0	0	33604	33683	0	
13-Mar	0	0	33604	33683	0	
16-Mar	0	0	33604	33683	0	
19-Mar	0	0	33604	33683	0	
22-Mar	0	0.18	33683	33695	0.03	
25-Mar	0	0.18	33683	33695	0.075	
28-Mar	0	0.18	33683	33695	0.12	
31-Mar	0	0.18	33683	33695	0.165	0.03545455
03-Apr	0.18	0.18	33695	33730	0.18	
06-Apr	0.18	0.18	33695	33730	0.18	

09-Apr	0.18	0.18	33695	33730	0.18	
12-Apr	0.18	0.18	33695	33730	0.18	
15-Apr	0.18	0.18	33695	33730	0.18	
18-Apr	0.18	0.18	33695	33730	0.18	
21-Apr	0.18	0.18	33695	33730	0.18	
24-Apr	0.18	0.18	33695	33730	0.18	
27-Apr	0.18	0.18	33695	33730	0.18	
30-Apr	0.18	0.18	33695	33730	0.18	0.18
03-May	0.18	0.18	33695	33730	0.18	
06-May	0.18	1.1	33730	33769	0.18	
09-May	0.18	1.1	33730	33769	0.25076923	
12-May	0.18	1.1	33730	33769	0.32153846	
15-May	0.18	1.1	33730	33769	0.39230769	
18-May	0.18	1.1	33730	33769	0.46307692	
21-May	0.18	1.1	33730	33769	0.53384615	
24-May	0.18	1.1	33730	33769	0.60461538	
27-May	0.18	1.1	33730	33769	0.67538462	
30-May	0.18	1.1	33730	33769	0.74615385	0.43476923
02-Jun	0.18	1.1	33730	33769	0.81692308	
05-Jun	0.18	1.1	33730	33769	0.88769231	
08-Jun	0.18	1.1	33730	33769	0.95846154	
11-Jun	0.18	1.1	33730	33769	1.02923077	
14-Jun	1.1	1.1	33769	33773.75	1.1	
17-Jun	1.1	1.1	33769	33773.75	1.1	
20-Jun	1.1	0.1	33773.75	33800	1.05238095	
23-Jun	1.1	0.1	33773.75	33800	0.93809524	
26-Jun	1.1	0.1	33773.75	33800	0.82380952	
29-Jun	1.1	0.1	33773.75	33800	0.70952381	0.94161172
02-Jul	1.1	0.1	33773.75	33800	0.5952381	
05-Jul	1.1	0.1	33773.75	33800	0.48095238	
08-Jul	1.1	0.1	33773.75	33800	0.36666667	
11-Jul	1.1	0.1	33773.75	33800	0.25238095	
14-Jul	1.1	0.1	33773.75	33800	0.13809524	
17-Jul	0	0	33801	0	0	
20-Jul	0	0	33801	0	0	
23-Jul	0	0	33801	0	0	
26-Jul	0	0	33801	0	0	
29-Jul	0	0	33801	0	0	0.18333333
01-Aug	0	0	33801	0	0	
04-Aug	0	0	33801	0	0	
07-Aug	0	0	33801	0	0	
10-Aug	0	0	33801	0	0	
13-Aug	0	0	33801	0	0	
16-Aug	0	0	33801	0	0	
19-Aug	0	0	33801	0	0	
22-Aug	0	0	33801	0	0	
25-Aug	0	0	33801	0	0	
28-Aug	0	0	33801	0	0	
31-Aug	0	0	33801	0	0	0
03-Sep	0	0	33801	0	0	
06-Sep	0	0	33801	0	0	
09-Sep	0	0	33801	0	0	

12-Sep	0	0	33801	0	0	
15-Sep	0	0	33801	0	0	
18-Sep	0	0	33801	0	0	
21-Sep	0	0	33801	0	0	
24-Sep	0	0	33801	0	0	
27-Sep	0	0	33801	0	0	
30-Sep	0	0	33801	0	0	0
03-Oct	0	0	33801	0	0	
06-Oct	0	0	33801	0	0	
09-Oct	0	0	33801	0	0	
12-Oct	0	0	33801	0	0	
15-Oct	0	0	33801	0	0	
18-Oct	0	0	33801	0	0	
21-Oct	0	0	33801	0	0	
24-Oct	0	0	33801	0	0	
27-Oct	0	0	33801	0	0	
30-Oct	0	0	33801	0	0	0
02-Nov	0	0	33801	0	0	
05-Nov	0	0	33801	0	0	
08-Nov	0	0	33801	0	0	
11-Nov	0	0	33801	0	0	
14-Nov	0	0	33801	0	0	
17-Nov	0	0	33801	0	0	
20-Nov	0	0	33801	0	0	
23-Nov	0	0	33801	0	0	
26-Nov	0	0	33801	0	0	
29-Nov	0	0	33801	0	0	0
02-Dec	0	0	33801	0	0	
05-Dec	0	0	33801	0	0	
08-Dec	0	0	33801	0	0	
11-Dec	0	0	33801	0	0	
14-Dec	0	0	33801	0	0	
17-Dec	0	0	33801	0	0	
20-Dec	0	0	33801	0	0	
23-Dec	0	0	33801	0	0	
26-Dec	0	0	33801	0	0	
29-Dec	0	0	33801	0	0	0

Pasture

% SMD	50.00
RTZN	6
AWHC	2
SMD	6
crop'd Kc	0.15
Maturity %	0.75

	Dates			Kcs	
Start	01/01/92	33604	33604	0	0
Planting	01/01/92	33604	33604	0	0.9
Date A	01/01/92	33604	33605	0.9	0.9
Date B	01/02/92	33605	33606	0.9	0.9
Date C	01/03/92	33606	33606.25	0.9	0.9
Date D	03-Jan	33606.25	33607	0.9	0.9
Date E	01/04/92	33607	33969	0.9	0.9
End	12/31/92	33969		0.9	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0	0	33604	33604	0.9	
04-Jan	0.9	0.9	33607	33969	0.9	
07-Jan	0.9	0.9	33607	33969	0.9	
10-Jan	0.9	0.9	33607	33969	0.9	
13-Jan	0.9	0.9	33607	33969	0.9	
16-Jan	0.9	0.9	33607	33969	0.9	
19-Jan	0.9	0.9	33607	33969	0.9	
22-Jan	0.9	0.9	33607	33969	0.9	
25-Jan	0.9	0.9	33607	33969	0.9	
28-Jan	0.9	0.9	33607	33969	0.9	
31-Jan	0.9	0.9	33607	33969	0.9	0.9
03-Feb	0.9	0.9	33607	33969	0.9	
06-Feb	0.9	0.9	33607	33969	0.9	
09-Feb	0.9	0.9	33607	33969	0.9	
12-Feb	0.9	0.9	33607	33969	0.9	
15-Feb	0.9	0.9	33607	33969	0.9	
18-Feb	0.9	0.9	33607	33969	0.9	
21-Feb	0.9	0.9	33607	33969	0.9	
24-Feb	0.9	0.9	33607	33969	0.9	
27-Feb	0.9	0.9	33607	33969	0.9	0.9
01-Mar	0.9	0.9	33607	33969	0.9	
04-Mar	0.9	0.9	33607	33969	0.9	
07-Mar	0.9	0.9	33607	33969	0.9	
10-Mar	0.9	0.9	33607	33969	0.9	
13-Mar	0.9	0.9	33607	33969	0.9	
16-Mar	0.9	0.9	33607	33969	0.9	
19-Mar	0.9	0.9	33607	33969	0.9	
22-Mar	0.9	0.9	33607	33969	0.9	
25-Mar	0.9	0.9	33607	33969	0.9	
28-Mar	0.9	0.9	33607	33969	0.9	
31-Mar	0.9	0.9	33607	33969	0.9	0.9
03-Apr	0.9	0.9	33607	33969	0.9	
06-Apr	0.9	0.9	33607	33969	0.9	

09-Apr	0.9	0.9	33607	33969	0.9	
12-Apr	0.9	0.9	33607	33969	0.9	
15-Apr	0.9	0.9	33607	33969	0.9	
18-Apr	0.9	0.9	33607	33969	0.9	
21-Apr	0.9	0.9	33607	33969	0.9	
24-Apr	0.9	0.9	33607	33969	0.9	
27-Apr	0.9	0.9	33607	33969	0.9	
30-Apr	0.9	0.9	33607	33969	0.9	0.9
03-May	0.9	0.9	33607	33969	0.9	
06-May	0.9	0.9	33607	33969	0.9	
09-May	0.9	0.9	33607	33969	0.9	
12-May	0.9	0.9	33607	33969	0.9	
15-May	0.9	0.9	33607	33969	0.9	
18-May	0.9	0.9	33607	33969	0.9	
21-May	0.9	0.9	33607	33969	0.9	
24-May	0.9	0.9	33607	33969	0.9	
27-May	0.9	0.9	33607	33969	0.9	
30-May	0.9	0.9	33607	33969	0.9	0.9
02-Jun	0.9	0.9	33607	33969	0.9	
05-Jun	0.9	0.9	33607	33969	0.9	
08-Jun	0.9	0.9	33607	33969	0.9	
11-Jun	0.9	0.9	33607	33969	0.9	
14-Jun	0.9	0.9	33607	33969	0.9	
17-Jun	0.9	0.9	33607	33969	0.9	
20-Jun	0.9	0.9	33607	33969	0.9	
23-Jun	0.9	0.9	33607	33969	0.9	
26-Jun	0.9	0.9	33607	33969	0.9	
29-Jun	0.9	0.9	33607	33969	0.9	0.9
02-Jul	0.9	0.9	33607	33969	0.9	
05-Jul	0.9	0.9	33607	33969	0.9	
08-Jul	0.9	0.9	33607	33969	0.9	
11-Jul	0.9	0.9	33607	33969	0.9	
14-Jul	0.9	0.9	33607	33969	0.9	
17-Jul	0.9	0.9	33607	33969	0.9	
20-Jul	0.9	0.9	33607	33969	0.9	
23-Jul	0.9	0.9	33607	33969	0.9	
26-Jul	0.9	0.9	33607	33969	0.9	
29-Jul	0.9	0.9	33607	33969	0.9	0.9
01-Aug	0.9	0.9	33607	33969	0.9	
04-Aug	0.9	0.9	33607	33969	0.9	
07-Aug	0.9	0.9	33607	33969	0.9	
10-Aug	0.9	0.9	33607	33969	0.9	
13-Aug	0.9	0.9	33607	33969	0.9	
16-Aug	0.9	0.9	33607	33969	0.9	
19-Aug	0.9	0.9	33607	33969	0.9	
22-Aug	0.9	0.9	33607	33969	0.9	
25-Aug	0.9	0.9	33607	33969	0.9	
28-Aug	0.9	0.9	33607	33969	0.9	
31-Aug	0.9	0.9	33607	33969	0.9	0.9
03-Sep	0.9	0.9	33607	33969	0.9	
06-Sep	0.9	0.9	33607	33969	0.9	
09-Sep	0.9	0.9	33607	33969	0.9	

12-Sep	0.9	0.9	33607	33969	0.9	
15-Sep	0.9	0.9	33607	33969	0.9	
18-Sep	0.9	0.9	33607	33969	0.9	
21-Sep	0.9	0.9	33607	33969	0.9	
24-Sep	0.9	0.9	33607	33969	0.9	
27-Sep	0.9	0.9	33607	33969	0.9	
30-Sep	0.9	0.9	33607	33969	0.9	0.9
03-Oct	0.9	0.9	33607	33969	0.9	
06-Oct	0.9	0.9	33607	33969	0.9	
09-Oct	0.9	0.9	33607	33969	0.9	
12-Oct	0.9	0.9	33607	33969	0.9	
15-Oct	0.9	0.9	33607	33969	0.9	
18-Oct	0.9	0.9	33607	33969	0.9	
21-Oct	0.9	0.9	33607	33969	0.9	
24-Oct	0.9	0.9	33607	33969	0.9	
27-Oct	0.9	0.9	33607	33969	0.9	
30-Oct	0.9	0.9	33607	33969	0.9	0.9
02-Nov	0.9	0.9	33607	33969	0.9	
05-Nov	0.9	0.9	33607	33969	0.9	
08-Nov	0.9	0.9	33607	33969	0.9	
11-Nov	0.9	0.9	33607	33969	0.9	
14-Nov	0.9	0.9	33607	33969	0.9	
17-Nov	0.9	0.9	33607	33969	0.9	
20-Nov	0.9	0.9	33607	33969	0.9	
23-Nov	0.9	0.9	33607	33969	0.9	
26-Nov	0.9	0.9	33607	33969	0.9	
29-Nov	0.9	0.9	33607	33969	0.9	0.9
02-Dec	0.9	0.9	33607	33969	0.9	
05-Dec	0.9	0.9	33607	33969	0.9	
08-Dec	0.9	0.9	33607	33969	0.9	
11-Dec	0.9	0.9	33607	33969	0.9	
14-Dec	0.9	0.9	33607	33969	0.9	
17-Dec	0.9	0.9	33607	33969	0.9	
20-Dec	0.9	0.9	33607	33969	0.9	
23-Dec	0.9	0.9	33607	33969	0.9	
26-Dec	0.9	0.9	33607	33969	0.9	
29-Dec	0.9	0.9	33607	33969	0.9	0.9

Rice

% SMD	50.00
RTZN	6
AWHC	2
SMD	6
crop'd Kc	0.15
Maturity %	0.59

	Dates			Kcs	
Start	01/01/92	33604	33683	0	0
Planting	03/20/92	33683	33695	0	0.95
Date A	04/01/92	33695	33720	0.95	0.95
Date B	04/26/92	33720	33752	0.95	1.25
Date C	05/28/92	33752	33784.68	1.25	1.25
Date D	29-Jun	33784.68	33847	1.25	0.95
Date E	08/31/92	33847	33848	0.95	0
End	09/01/92	33848		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0	0	33604	33683	0	
04-Jan	0	0	33604	33683	0	
07-Jan	0	0	33604	33683	0	
10-Jan	0	0	33604	33683	0	
13-Jan	0	0	33604	33683	0	
16-Jan	0	0	33604	33683	0	
19-Jan	0	0	33604	33683	0	
22-Jan	0	0	33604	33683	0	
25-Jan	0	0	33604	33683	0	
28-Jan	0	0	33604	33683	0	
31-Jan	0	0	33604	33683	0	0
03-Feb	0	0	33604	33683	0	
06-Feb	0	0	33604	33683	0	
09-Feb	0	0	33604	33683	0	
12-Feb	0	0	33604	33683	0	
15-Feb	0	0	33604	33683	0	
18-Feb	0	0	33604	33683	0	
21-Feb	0	0	33604	33683	0	
24-Feb	0	0	33604	33683	0	
27-Feb	0	0	33604	33683	0	0
01-Mar	0	0	33604	33683	0	
04-Mar	0	0	33604	33683	0	
07-Mar	0	0	33604	33683	0	
10-Mar	0	0	33604	33683	0	
13-Mar	0	0	33604	33683	0	
16-Mar	0	0	33604	33683	0	
19-Mar	0	0	33604	33683	0	
22-Mar	0	0.95	33683	33695	0.15833333	
25-Mar	0	0.95	33683	33695	0.39583333	
28-Mar	0	0.95	33683	33695	0.63333333	
31-Mar	0	0.95	33683	33695	0.87083333	0.18712121
03-Apr	0.95	0.95	33695	33720	0.95	
06-Apr	0.95	0.95	33695	33720	0.95	

09-Apr	0.95	0.95	33695	33720	0.95	
12-Apr	0.95	0.95	33695	33720	0.95	
15-Apr	0.95	0.95	33695	33720	0.95	
18-Apr	0.95	0.95	33695	33720	0.95	
21-Apr	0.95	0.95	33695	33720	0.95	
24-Apr	0.95	0.95	33695	33720	0.95	
27-Apr	0.95	1.25	33720	33752	0.959375	
30-Apr	0.95	1.25	33720	33752	0.9875	0.9546875
03-May	0.95	1.25	33720	33752	1.015625	
06-May	0.95	1.25	33720	33752	1.04375	
09-May	0.95	1.25	33720	33752	1.071875	
12-May	0.95	1.25	33720	33752	1.1	
15-May	0.95	1.25	33720	33752	1.128125	
18-May	0.95	1.25	33720	33752	1.15625	
21-May	0.95	1.25	33720	33752	1.184375	
24-May	0.95	1.25	33720	33752	1.2125	
27-May	0.95	1.25	33720	33752	1.240625	
30-May	1.25	1.25	33752	33784.68	1.25	1.1403125
02-Jun	1.25	1.25	33752	33784.68	1.25	
05-Jun	1.25	1.25	33752	33784.68	1.25	
08-Jun	1.25	1.25	33752	33784.68	1.25	
11-Jun	1.25	1.25	33752	33784.68	1.25	
14-Jun	1.25	1.25	33752	33784.68	1.25	
17-Jun	1.25	1.25	33752	33784.68	1.25	
20-Jun	1.25	1.25	33752	33784.68	1.25	
23-Jun	1.25	1.25	33752	33784.68	1.25	
26-Jun	1.25	1.25	33752	33784.68	1.25	
29-Jun	1.25	1.25	33752	33784.68	1.25	1.25
02-Jul	1.25	0.95	33784.68	33847	1.23883184	
05-Jul	1.25	0.95	33784.68	33847	1.22439024	
08-Jul	1.25	0.95	33784.68	33847	1.20994865	
11-Jul	1.25	0.95	33784.68	33847	1.19550706	
14-Jul	1.25	0.95	33784.68	33847	1.18106547	
17-Jul	1.25	0.95	33784.68	33847	1.16662388	
20-Jul	1.25	0.95	33784.68	33847	1.15218228	
23-Jul	1.25	0.95	33784.68	33847	1.13774069	
26-Jul	1.25	0.95	33784.68	33847	1.1232991	
29-Jul	1.25	0.95	33784.68	33847	1.10885751	1.17384467
01-Aug	1.25	0.95	33784.68	33847	1.09441592	
04-Aug	1.25	0.95	33784.68	33847	1.07997433	
07-Aug	1.25	0.95	33784.68	33847	1.06553273	
10-Aug	1.25	0.95	33784.68	33847	1.05109114	
13-Aug	1.25	0.95	33784.68	33847	1.03664955	
16-Aug	1.25	0.95	33784.68	33847	1.02220796	
19-Aug	1.25	0.95	33784.68	33847	1.00776637	
22-Aug	1.25	0.95	33784.68	33847	0.99332478	
25-Aug	1.25	0.95	33784.68	33847	0.97888318	
28-Aug	1.25	0.95	33784.68	33847	0.96444159	
31-Aug	0.95	0	33847	33848	0.95	1.02220796
03-Sep	0	0	33848	0	0	
06-Sep	0	0	33848	0	0	
09-Sep	0	0	33848	0	0	

12-Sep	0	0	33848	0	0	
15-Sep	0	0	33848	0	0	
18-Sep	0	0	33848	0	0	
21-Sep	0	0	33848	0	0	
24-Sep	0	0	33848	0	0	
27-Sep	0	0	33848	0	0	
30-Sep	0	0	33848	0	0	0
03-Oct	0	0	33848	0	0	
06-Oct	0	0	33848	0	0	
09-Oct	0	0	33848	0	0	
12-Oct	0	0	33848	0	0	
15-Oct	0	0	33848	0	0	
18-Oct	0	0	33848	0	0	
21-Oct	0	0	33848	0	0	
24-Oct	0	0	33848	0	0	
27-Oct	0	0	33848	0	0	
30-Oct	0	0	33848	0	0	0
02-Nov	0	0	33848	0	0	
05-Nov	0	0	33848	0	0	
08-Nov	0	0	33848	0	0	
11-Nov	0	0	33848	0	0	
14-Nov	0	0	33848	0	0	
17-Nov	0	0	33848	0	0	
20-Nov	0	0	33848	0	0	
23-Nov	0	0	33848	0	0	
26-Nov	0	0	33848	0	0	
29-Nov	0	0	33848	0	0	0
02-Dec	0	0	33848	0	0	
05-Dec	0	0	33848	0	0	
08-Dec	0	0	33848	0	0	
11-Dec	0	0	33848	0	0	
14-Dec	0	0	33848	0	0	
17-Dec	0	0	33848	0	0	
20-Dec	0	0	33848	0	0	
23-Dec	0	0	33848	0	0	
26-Dec	0	0	33848	0	0	
29-Dec	0	0	33848	0	0	0

Seed alfalfa

% SMD	50.00
RTZN	6
AWHC	2
SMD	6
crop'd Kc	0.15
Maturity %	0.75

	Dates			Kcs	
Start	01/01/91	33239	33562	0	0
Planting	11/20/91	33562	33573	0	0.2
Date A	12/01/91	33573	33618	0.2	0.2
Date B	01/15/92	33618	33709	0.2	1
Date C	04/15/92	33709	33743.25	1	1
Date D	19-May	33743.25	33800	1	0.3
Date E	07/15/92	33800	33801	0.3	0
End	07/16/92	33801		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0.2	0.2	33573	33618	0.2	
04-Jan	0.2	0.2	33573	33618	0.2	
07-Jan	0.2	0.2	33573	33618	0.2	
10-Jan	0.2	0.2	33573	33618	0.2	
13-Jan	0.2	0.2	33573	33618	0.2	
16-Jan	0.2	1	33618	33709	0.20879121	
19-Jan	0.2	1	33618	33709	0.23516484	
22-Jan	0.2	1	33618	33709	0.26153846	
25-Jan	0.2	1	33618	33709	0.28791209	
28-Jan	0.2	1	33618	33709	0.31428571	
31-Jan	0.2	1	33618	33709	0.34065934	0.24075924
03-Feb	0.2	1	33618	33709	0.36703297	
06-Feb	0.2	1	33618	33709	0.39340659	
09-Feb	0.2	1	33618	33709	0.41978022	
12-Feb	0.2	1	33618	33709	0.44615385	
15-Feb	0.2	1	33618	33709	0.47252747	
18-Feb	0.2	1	33618	33709	0.4989011	
21-Feb	0.2	1	33618	33709	0.52527473	
24-Feb	0.2	1	33618	33709	0.55164835	
27-Feb	0.2	1	33618	33709	0.57802198	0.47252747
01-Mar	0.2	1	33618	33709	0.6043956	
04-Mar	0.2	1	33618	33709	0.63076923	
07-Mar	0.2	1	33618	33709	0.65714286	
10-Mar	0.2	1	33618	33709	0.68351648	
13-Mar	0.2	1	33618	33709	0.70989011	
16-Mar	0.2	1	33618	33709	0.73626374	
19-Mar	0.2	1	33618	33709	0.76263736	
22-Mar	0.2	1	33618	33709	0.78901099	
25-Mar	0.2	1	33618	33709	0.81538462	
28-Mar	0.2	1	33618	33709	0.84175824	
31-Mar	0.2	1	33618	33709	0.86813187	0.73626374
03-Apr	0.2	1	33618	33709	0.89450549	
06-Apr	0.2	1	33618	33709	0.92087912	

09-Apr	0.2	1	33618	33709	0.94725275	
12-Apr	0.2	1	33618	33709	0.97362637	
15-Apr	1	1	33709	33743.25	1	
18-Apr	1	1	33709	33743.25	1	
21-Apr	1	1	33709	33743.25	1	
24-Apr	1	1	33709	33743.25	1	
27-Apr	1	1	33709	33743.25	1	
30-Apr	1	1	33709	33743.25	1	0.97362637
03-May	1	1	33709	33743.25	1	
06-May	1	1	33709	33743.25	1	
09-May	1	1	33709	33743.25	1	
12-May	1	1	33709	33743.25	1	
15-May	1	1	33709	33743.25	1	
18-May	1	1	33709	33743.25	1	
21-May	1	0.3	33743.25	33800	0.9784141	
24-May	1	0.3	33743.25	33800	0.94140969	
27-May	1	0.3	33743.25	33800	0.90440529	
30-May	1	0.3	33743.25	33800	0.86740088	0.969163
02-Jun	1	0.3	33743.25	33800	0.83039648	
05-Jun	1	0.3	33743.25	33800	0.79339207	
08-Jun	1	0.3	33743.25	33800	0.75638767	
11-Jun	1	0.3	33743.25	33800	0.71938326	
14-Jun	1	0.3	33743.25	33800	0.68237885	
17-Jun	1	0.3	33743.25	33800	0.64537445	
20-Jun	1	0.3	33743.25	33800	0.60837004	
23-Jun	1	0.3	33743.25	33800	0.57136564	
26-Jun	1	0.3	33743.25	33800	0.53436123	
29-Jun	1	0.3	33743.25	33800	0.49735683	0.66387665
02-Jul	1	0.3	33743.25	33800	0.46035242	
05-Jul	1	0.3	33743.25	33800	0.42334802	
08-Jul	1	0.3	33743.25	33800	0.38634361	
11-Jul	1	0.3	33743.25	33800	0.34933921	
14-Jul	1	0.3	33743.25	33800	0.3123348	
17-jul-91	0	0	33239	33562	0	
20-Jul	0	0	33239	33562	0	
23-Jul	0	0	33239	33562	0	
26-Jul	0	0	33239	33562	0	
29-Jul	0	0	33239	33562	0	0.19317181
01-Aug	0	0	33239	33562	0	
04-Aug	0	0	33239	33562	0	
07-Aug	0	0	33239	33562	0	
10-Aug	0	0	33239	33562	0	
13-Aug	0	0	33239	33562	0	
16-Aug	0	0	33239	33562	0	
19-Aug	0	0	33239	33562	0	
22-Aug	0	0	33239	33562	0	
25-Aug	0	0	33239	33562	0	
28-Aug	0	0	33239	33562	0	
31-Aug	0	0	33239	33562	0	0
03-Sep	0	0	33239	33562	0	
06-Sep	0	0	33239	33562	0	
09-Sep	0	0	33239	33562	0	

12-Sep	0	0	33239	33562	0	
15-Sep	0	0	33239	33562	0	
18-Sep	0	0	33239	33562	0	
21-Sep	0	0	33239	33562	0	
24-Sep	0	0	33239	33562	0	
27-Sep	0	0	33239	33562	0	
30-Sep	0	0	33239	33562	0	0
03-Oct	0	0	33239	33562	0	
06-Oct	0	0	33239	33562	0	
09-Oct	0	0	33239	33562	0	
12-Oct	0	0	33239	33562	0	
15-Oct	0	0	33239	33562	0	
18-Oct	0	0	33239	33562	0	
21-Oct	0	0	33239	33562	0	
24-Oct	0	0	33239	33562	0	
27-Oct	0	0	33239	33562	0	
30-Oct	0	0	33239	33562	0	0
02-Nov	0	0	33239	33562	0	
05-Nov	0	0	33239	33562	0	
08-Nov	0	0	33239	33562	0	
11-Nov	0	0	33239	33562	0	
14-Nov	0	0	33239	33562	0	
17-Nov	0	0	33239	33562	0	
20-Nov	0	0.2	33562	33573	0	
23-Nov	0	0.2	33562	33573	0.05454545	
26-Nov	0	0.2	33562	33573	0.10909091	
29-Nov	0	0.2	33562	33573	0.16363636	0.03272727
02-Dec	0.2	0.2	33573	33618	0.2	
05-Dec	0.2	0.2	33573	33618	0.2	
08-Dec	0.2	0.2	33573	33618	0.2	
11-Dec	0.2	0.2	33573	33618	0.2	
14-Dec	0.2	0.2	33573	33618	0.2	
17-Dec	0.2	0.2	33573	33618	0.2	
20-Dec	0.2	0.2	33573	33618	0.2	
23-Dec	0.2	0.2	33573	33618	0.2	
26-Dec	0.2	0.2	33573	33618	0.2	
29-Dec	0.2	0.2	33573	33618	0.2	0.2

Sugar beets - north of Nees

% SMD	50.00
RTZN	6
AWHC	2
SMD	6
crop'd Kc	0.15
Maturity %	0.84

	Dates			Kcs	
Start	01/01/91	33239	33368	0	0
Planting	05/10/91	33368	33378	0	0.23
Date A	05/20/91	33378	33399	0.23	0.23
Date B	06/10/91	33399	33439	0.23	1.1
Date C	07/20/91	33439	33630	1.1	1.1
Date D	27-Jan	33630	33678	1.1	0.95
Date E	03/15/92	33678	33678	0.95	0
End	03/15/92	33678		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	1.1	1.1	33439	33630	1.1	
04-Jan	1.1	1.1	33439	33630	1.1	
07-Jan	1.1	1.1	33439	33630	1.1	
10-Jan	1.1	1.1	33439	33630	1.1	
13-Jan	1.1	1.1	33439	33630	1.1	
16-Jan	1.1	1.1	33439	33630	1.1	
19-Jan	1.1	1.1	33439	33630	1.1	
22-Jan	1.1	1.1	33439	33630	1.1	
25-Jan	1.1	1.1	33439	33630	1.1	
28-Jan	1.1	0.95	33630	33678	1.096875	
31-Jan	1.1	0.95	33630	33678	1.0875	1.09857955
03-Feb	1.1	0.95	33630	33678	1.078125	
06-Feb	1.1	0.95	33630	33678	1.06875	
09-Feb	1.1	0.95	33630	33678	1.059375	
12-Feb	1.1	0.95	33630	33678	1.05	
15-Feb	1.1	0.95	33630	33678	1.040625	
18-Feb	1.1	0.95	33630	33678	1.03125	
21-Feb	1.1	0.95	33630	33678	1.021875	
24-Feb	1.1	0.95	33630	33678	1.0125	
27-Feb	1.1	0.95	33630	33678	1.003125	1.040625
01-Mar	1.1	0.95	33630	33678	0.99375	
04-Mar	1.1	0.95	33630	33678	0.984375	
07-Mar	1.1	0.95	33630	33678	0.975	
10-Mar	1.1	0.95	33630	33678	0.965625	
13-Mar	1.1	0.95	33630	33678	0.95625	
16-Mar	0	0	33678	0	0	
19-Mar	0	0	33678	0	0	
22-Mar	0	0	33678	0	0	
25-Mar	0	0	33678	0	0	
28-Mar	0	0	33678	0	0	
31-Mar	0	0	33678	0	0	0.44318182
03-Apr	0	0	33678	0	0	
06-Apr	0	0	33678	0	0	

09-Apr	0	0	33678	0	0	
12-Apr	0	0	33678	0	0	
15-Apr	0	0	33678	0	0	
18-Apr	0	0	33678	0	0	
21-Apr	0	0	33678	0	0	
24-Apr	0	0	33678	0	0	
27-Apr	0	0	33678	0	0	
30-Apr	0	0	33678	0	0	0
03-MAY-91	0	0	33239	33368	0	
06-May	0	0	33239	33368	0	
09-May	0	0	33239	33368	0	
12-May	0	0.23	33368	33378	0.046	
15-May	0	0.23	33368	33378	0.115	
18-May	0	0.23	33368	33378	0.184	
21-May	0.23	0.23	33378	33399	0.23	
24-May	0.23	0.23	33378	33399	0.23	
27-May	0.23	0.23	33378	33399	0.23	
30-May	0.23	0.23	33378	33399	0.23	0.1265
02-Jun	0.23	0.23	33378	33399	0.23	
05-Jun	0.23	0.23	33378	33399	0.23	
08-Jun	0.23	0.23	33378	33399	0.23	
11-Jun	0.23	1.1	33399	33439	0.25175	
14-Jun	0.23	1.1	33399	33439	0.317	
17-Jun	0.23	1.1	33399	33439	0.38225	
20-Jun	0.23	1.1	33399	33439	0.4475	
23-Jun	0.23	1.1	33399	33439	0.51275	
26-Jun	0.23	1.1	33399	33439	0.578	
29-Jun	0.23	1.1	33399	33439	0.64325	0.38225
02-Jul	0.23	1.1	33399	33439	0.7085	
05-Jul	0.23	1.1	33399	33439	0.77375	
08-Jul	0.23	1.1	33399	33439	0.839	
11-Jul	0.23	1.1	33399	33439	0.90425	
14-Jul	0.23	1.1	33399	33439	0.9695	
17-Jul	0.23	1.1	33399	33439	1.03475	
20-Jul	1.1	1.1	33439	33630	1.1	
23-Jul	1.1	1.1	33439	33630	1.1	
26-Jul	1.1	1.1	33439	33630	1.1	
29-Jul	1.1	1.1	33439	33630	1.1	0.962975
01-Aug	1.1	1.1	33439	33630	1.1	
04-Aug	1.1	1.1	33439	33630	1.1	
07-Aug	1.1	1.1	33439	33630	1.1	
10-Aug	1.1	1.1	33439	33630	1.1	
13-Aug	1.1	1.1	33439	33630	1.1	
16-Aug	1.1	1.1	33439	33630	1.1	
19-Aug	1.1	1.1	33439	33630	1.1	
22-Aug	1.1	1.1	33439	33630	1.1	
25-Aug	1.1	1.1	33439	33630	1.1	
28-Aug	1.1	1.1	33439	33630	1.1	
31-Aug	1.1	1.1	33439	33630	1.1	1.1
03-Sep	1.1	1.1	33439	33630	1.1	
06-Sep	1.1	1.1	33439	33630	1.1	
09-Sep	1.1	1.1	33439	33630	1.1	

12-Sep	1.1	1.1	33439	33630	1.1	
15-Sep	1.1	1.1	33439	33630	1.1	
18-Sep	1.1	1.1	33439	33630	1.1	
21-Sep	1.1	1.1	33439	33630	1.1	
24-Sep	1.1	1.1	33439	33630	1.1	
27-Sep	1.1	1.1	33439	33630	1.1	
30-Sep	1.1	1.1	33439	33630	1.1	1.1
03-Oct	1.1	1.1	33439	33630	1.1	
06-Oct	1.1	1.1	33439	33630	1.1	
09-Oct	1.1	1.1	33439	33630	1.1	
12-Oct	1.1	1.1	33439	33630	1.1	
15-Oct	1.1	1.1	33439	33630	1.1	
18-Oct	1.1	1.1	33439	33630	1.1	
21-Oct	1.1	1.1	33439	33630	1.1	
24-Oct	1.1	1.1	33439	33630	1.1	
27-Oct	1.1	1.1	33439	33630	1.1	
30-Oct	1.1	1.1	33439	33630	1.1	1.1
02-Nov	1.1	1.1	33439	33630	1.1	
05-Nov	1.1	1.1	33439	33630	1.1	
08-Nov	1.1	1.1	33439	33630	1.1	
11-Nov	1.1	1.1	33439	33630	1.1	
14-Nov	1.1	1.1	33439	33630	1.1	
17-Nov	1.1	1.1	33439	33630	1.1	
20-Nov	1.1	1.1	33439	33630	1.1	
23-Nov	1.1	1.1	33439	33630	1.1	
26-Nov	1.1	1.1	33439	33630	1.1	
29-Nov	1.1	1.1	33439	33630	1.1	1.1
02-Dec	1.1	1.1	33439	33630	1.1	
05-Dec	1.1	1.1	33439	33630	1.1	
08-Dec	1.1	1.1	33439	33630	1.1	
11-Dec	1.1	1.1	33439	33630	1.1	
14-Dec	1.1	1.1	33439	33630	1.1	
17-Dec	1.1	1.1	33439	33630	1.1	
20-Dec	1.1	1.1	33439	33630	1.1	
23-Dec	1.1	1.1	33439	33630	1.1	
26-Dec	1.1	1.1	33439	33630	1.1	
29-Dec	1.1	1.1	33439	33630	1.1	1.1

Sorghum

% SMD	50.00
RTZN	4
AWHC	2
SMD	4
crop'd Kc	0.15
Maturity %	0.63

	Dates			Kcs	
Start	01/01/92	33604	33714	0	0
Planting	04/20/92	33714	33725	0	0.16
Date A	05/01/92	33725	33759	0.16	0.16
Date B	06/04/92	33759	33789	0.16	1.05
Date C	07/04/92	33789	33820.76	1.05	1.05
Date D	04-Aug	33820.76	33877	1.05	0.45
Date E	09/30/92	33877	33878	0.45	0
End	10/01/92	33878		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0	0	33604	33714	0	
04-Jan	0	0	33604	33714	0	
07-Jan	0	0	33604	33714	0	
10-Jan	0	0	33604	33714	0	
13-Jan	0	0	33604	33714	0	
16-Jan	0	0	33604	33714	0	
19-Jan	0	0	33604	33714	0	
22-Jan	0	0	33604	33714	0	
25-Jan	0	0	33604	33714	0	
28-Jan	0	0	33604	33714	0	
31-Jan	0	0	33604	33714	0	0
03-Feb	0	0	33604	33714	0	
06-Feb	0	0	33604	33714	0	
09-Feb	0	0	33604	33714	0	
12-Feb	0	0	33604	33714	0	
15-Feb	0	0	33604	33714	0	
18-Feb	0	0	33604	33714	0	
21-Feb	0	0	33604	33714	0	
24-Feb	0	0	33604	33714	0	
27-Feb	0	0	33604	33714	0	0
01-Mar	0	0	33604	33714	0	
04-Mar	0	0	33604	33714	0	
07-Mar	0	0	33604	33714	0	
10-Mar	0	0	33604	33714	0	
13-Mar	0	0	33604	33714	0	
16-Mar	0	0	33604	33714	0	
19-Mar	0	0	33604	33714	0	
22-Mar	0	0	33604	33714	0	
25-Mar	0	0	33604	33714	0	
28-Mar	0	0	33604	33714	0	
31-Mar	0	0	33604	33714	0	0
03-Apr	0	0	33604	33714	0	
06-Apr	0	0	33604	33714	0	

09-Apr	0	0	33604	33714	0	
12-Apr	0	0	33604	33714	0	
15-Apr	0	0	33604	33714	0	
18-Apr	0	0	33604	33714	0	
21-Apr	0	0.16	33714	33725	0.01454545	
24-Apr	0	0.16	33714	33725	0.05818182	
27-Apr	0	0.16	33714	33725	0.10181818	
30-Apr	0	0.16	33714	33725	0.14545455	0.032
03-May	0.16	0.16	33725	33759	0.16	
06-May	0.16	0.16	33725	33759	0.16	
09-May	0.16	0.16	33725	33759	0.16	
12-May	0.16	0.16	33725	33759	0.16	
15-May	0.16	0.16	33725	33759	0.16	
18-May	0.16	0.16	33725	33759	0.16	
21-May	0.16	0.16	33725	33759	0.16	
24-May	0.16	0.16	33725	33759	0.16	
27-May	0.16	0.16	33725	33759	0.16	
30-May	0.16	0.16	33725	33759	0.16	0.16
02-Jun	0.16	0.16	33725	33759	0.16	
05-Jun	0.16	1.05	33759	33789	0.18966667	
08-Jun	0.16	1.05	33759	33789	0.27866667	
11-Jun	0.16	1.05	33759	33789	0.36766667	
14-Jun	0.16	1.05	33759	33789	0.45666667	
17-Jun	0.16	1.05	33759	33789	0.54566667	
20-Jun	0.16	1.05	33759	33789	0.63466667	
23-Jun	0.16	1.05	33759	33789	0.72366667	
26-Jun	0.16	1.05	33759	33789	0.81266667	
29-Jun	0.16	1.05	33759	33789	0.90166667	0.5071
02-Jul	0.16	1.05	33759	33789	0.99066667	
05-Jul	1.05	1.05	33789	33820.76	1.05	
08-Jul	1.05	1.05	33789	33820.76	1.05	
11-Jul	1.05	1.05	33789	33820.76	1.05	
14-Jul	1.05	1.05	33789	33820.76	1.05	
17-Jul	1.05	1.05	33789	33820.76	1.05	
20-Jul	1.05	1.05	33789	33820.76	1.05	
23-Jul	1.05	1.05	33789	33820.76	1.05	
26-Jul	1.05	1.05	33789	33820.76	1.05	
29-Jul	1.05	1.05	33789	33820.76	1.05	1.04406667
01-Aug	1.05	1.05	33789	33820.76	1.05	
04-Aug	1.05	1.05	33789	33820.76	1.05	
07-Aug	1.05	0.45	33820.76	33877	1.02610242	
10-Aug	1.05	0.45	33820.76	33877	0.99409673	
13-Aug	1.05	0.45	33820.76	33877	0.96209104	
16-Aug	1.05	0.45	33820.76	33877	0.93008535	
19-Aug	1.05	0.45	33820.76	33877	0.89807966	
22-Aug	1.05	0.45	33820.76	33877	0.86607397	
25-Aug	1.05	0.45	33820.76	33877	0.83406828	
28-Aug	1.05	0.45	33820.76	33877	0.80206259	
31-Aug	1.05	0.45	33820.76	33877	0.7700569	0.92570154
03-Sep	1.05	0.45	33820.76	33877	0.73805121	
06-Sep	1.05	0.45	33820.76	33877	0.70604552	
09-Sep	1.05	0.45	33820.76	33877	0.67403983	

12-Sep	1.05	0.45	33820.76	33877	0.64203414	
15-Sep	1.05	0.45	33820.76	33877	0.61002845	
18-Sep	1.05	0.45	33820.76	33877	0.57802276	
21-Sep	1.05	0.45	33820.76	33877	0.54601707	
24-Sep	1.05	0.45	33820.76	33877	0.51401138	
27-Sep	1.05	0.45	33820.76	33877	0.48200569	
30-Sep	0.45	0	33877	33878	0.45	0.5940256
03-Oct	0	0	33878	0	0	
06-Oct	0	0	33878	0	0	
09-Oct	0	0	33878	0	0	
12-Oct	0	0	33878	0	0	
15-Oct	0	0	33878	0	0	
18-Oct	0	0	33878	0	0	
21-Oct	0	0	33878	0	0	
24-Oct	0	0	33878	0	0	
27-Oct	0	0	33878	0	0	
30-Oct	0	0	33878	0	0	0
02-Nov	0	0	33878	0	0	
05-Nov	0	0	33878	0	0	
08-Nov	0	0	33878	0	0	
11-Nov	0	0	33878	0	0	
14-Nov	0	0	33878	0	0	
17-Nov	0	0	33878	0	0	
20-Nov	0	0	33878	0	0	
23-Nov	0	0	33878	0	0	
26-Nov	0	0	33878	0	0	
29-Nov	0	0	33878	0	0	0
02-Dec	0	0	33878	0	0	
05-Dec	0	0	33878	0	0	
08-Dec	0	0	33878	0	0	
11-Dec	0	0	33878	0	0	
14-Dec	0	0	33878	0	0	
17-Dec	0	0	33878	0	0	
20-Dec	0	0	33878	0	0	
23-Dec	0	0	33878	0	0	
26-Dec	0	0	33878	0	0	
29-Dec	0	0	33878	0	0	0

Stonefruit/almonds

% SMD	50.00
RTZN	6
AWHC	2
SMD	6
crop'd Kc	0.15
Maturity %	0.8

	Dates			Kcs	
Start	01/01/92	33604	33672	0	0
Planting	03/09/92	33672	33673	0	0.65
Date A	03/10/92	33673	33674	0.65	0.65
Date B	03/11/92	33674	33764	0.65	0.98
Date C	06/09/92	33764	33861.8	0.98	0.98
Date D	14-Sep	33861.8	33909	0.98	0.85
Date E	11/01/92	33909	33910	0.85	0
End	11/02/92	33910		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0	0	33604	33672	0	
04-Jan	0	0	33604	33672	0	
07-Jan	0	0	33604	33672	0	
10-Jan	0	0	33604	33672	0	
13-Jan	0	0	33604	33672	0	
16-Jan	0	0	33604	33672	0	
19-Jan	0	0	33604	33672	0	
22-Jan	0	0	33604	33672	0	
25-Jan	0	0	33604	33672	0	
28-Jan	0	0	33604	33672	0	
31-Jan	0	0	33604	33672	0	0
03-Feb	0	0	33604	33672	0	
06-Feb	0	0	33604	33672	0	
09-Feb	0	0	33604	33672	0	
12-Feb	0	0	33604	33672	0	
15-Feb	0	0	33604	33672	0	
18-Feb	0	0	33604	33672	0	
21-Feb	0	0	33604	33672	0	
24-Feb	0	0	33604	33672	0	
27-Feb	0	0	33604	33672	0	0
01-Mar	0	0	33604	33672	0	
04-Mar	0	0	33604	33672	0	
07-Mar	0	0	33604	33672	0	
10-Mar	0.65	0.65	33673	33674	0.65	
13-Mar	0.65	0.98	33674	33764	0.65733333	
16-Mar	0.65	0.98	33674	33764	0.66833333	
19-Mar	0.65	0.98	33674	33764	0.67933333	
22-Mar	0.65	0.98	33674	33764	0.69033333	
25-Mar	0.65	0.98	33674	33764	0.70133333	
28-Mar	0.65	0.98	33674	33764	0.71233333	
31-Mar	0.65	0.98	33674	33764	0.72333333	0.49839394
03-Apr	0.65	0.98	33674	33764	0.73433333	
06-Apr	0.65	0.98	33674	33764	0.74533333	

09-Apr	0.65	0.98	33674	33764	0.75633333	
12-Apr	0.65	0.98	33674	33764	0.76733333	
15-Apr	0.65	0.98	33674	33764	0.77833333	
18-Apr	0.65	0.98	33674	33764	0.78933333	
21-Apr	0.65	0.98	33674	33764	0.80033333	
24-Apr	0.65	0.98	33674	33764	0.81133333	
27-Apr	0.65	0.98	33674	33764	0.82233333	
30-Apr	0.65	0.98	33674	33764	0.83333333	0.78383333
03-May	0.65	0.98	33674	33764	0.84433333	
06-May	0.65	0.98	33674	33764	0.85533333	
09-May	0.65	0.98	33674	33764	0.86633333	
12-May	0.65	0.98	33674	33764	0.87733333	
15-May	0.65	0.98	33674	33764	0.88833333	
18-May	0.65	0.98	33674	33764	0.89933333	
21-May	0.65	0.98	33674	33764	0.91033333	
24-May	0.65	0.98	33674	33764	0.92133333	
27-May	0.65	0.98	33674	33764	0.93233333	
30-May	0.65	0.98	33674	33764	0.94333333	0.89383333
02-Jun	0.65	0.98	33674	33764	0.95433333	
05-Jun	0.65	0.98	33674	33764	0.96533333	
08-Jun	0.65	0.98	33674	33764	0.97633333	
11-Jun	0.98	0.98	33764	33861.8	0.98	
14-Jun	0.98	0.98	33764	33861.8	0.98	
17-Jun	0.98	0.98	33764	33861.8	0.98	
20-Jun	0.98	0.98	33764	33861.8	0.98	
23-Jun	0.98	0.98	33764	33861.8	0.98	
26-Jun	0.98	0.98	33764	33861.8	0.98	
29-Jun	0.98	0.98	33764	33861.8	0.98	0.9756
02-Jul	0.98	0.98	33764	33861.8	0.98	
05-Jul	0.98	0.98	33764	33861.8	0.98	
08-Jul	0.98	0.98	33764	33861.8	0.98	
11-Jul	0.98	0.98	33764	33861.8	0.98	
14-Jul	0.98	0.98	33764	33861.8	0.98	
17-Jul	0.98	0.98	33764	33861.8	0.98	
20-Jul	0.98	0.98	33764	33861.8	0.98	
23-Jul	0.98	0.98	33764	33861.8	0.98	
26-Jul	0.98	0.98	33764	33861.8	0.98	
29-Jul	0.98	0.98	33764	33861.8	0.98	0.98
01-Aug	0.98	0.98	33764	33861.8	0.98	
04-Aug	0.98	0.98	33764	33861.8	0.98	
07-Aug	0.98	0.98	33764	33861.8	0.98	
10-Aug	0.98	0.98	33764	33861.8	0.98	
13-Aug	0.98	0.98	33764	33861.8	0.98	
16-Aug	0.98	0.98	33764	33861.8	0.98	
19-Aug	0.98	0.98	33764	33861.8	0.98	
22-Aug	0.98	0.98	33764	33861.8	0.98	
25-Aug	0.98	0.98	33764	33861.8	0.98	
28-Aug	0.98	0.98	33764	33861.8	0.98	
31-Aug	0.98	0.98	33764	33861.8	0.98	0.98
03-Sep	0.98	0.98	33764	33861.8	0.98	
06-Sep	0.98	0.98	33764	33861.8	0.98	
09-Sep	0.98	0.98	33764	33861.8	0.98	

12-Sep	0.98	0.98	33764	33861.8	0.98	
15-Sep	0.98	0.85	33861.8	33909	0.97944915	
18-Sep	0.98	0.85	33861.8	33909	0.97118644	
21-Sep	0.98	0.85	33861.8	33909	0.96292373	
24-Sep	0.98	0.85	33861.8	33909	0.95466102	
27-Sep	0.98	0.85	33861.8	33909	0.94639831	
30-Sep	0.98	0.85	33861.8	33909	0.93813559	0.96727542
03-Oct	0.98	0.85	33861.8	33909	0.92987288	
06-Oct	0.98	0.85	33861.8	33909	0.92161017	
09-Oct	0.98	0.85	33861.8	33909	0.91334746	
12-Oct	0.98	0.85	33861.8	33909	0.90508475	
15-Oct	0.98	0.85	33861.8	33909	0.89682203	
18-Oct	0.98	0.85	33861.8	33909	0.88855932	
21-Oct	0.98	0.85	33861.8	33909	0.88029661	
24-Oct	0.98	0.85	33861.8	33909	0.8720339	
27-Oct	0.98	0.85	33861.8	33909	0.86377119	
30-Oct	0.98	0.85	33861.8	33909	0.85550847	0.89269068
02-Nov	0	0	33910	0	0	
05-Nov	0	0	33910	0	0	
08-Nov	0	0	33910	0	0	
11-Nov	0	0	33910	0	0	
14-Nov	0	0	33910	0	0	
17-Nov	0	0	33910	0	0	
20-Nov	0	0	33910	0	0	
23-Nov	0	0	33910	0	0	
26-Nov	0	0	33910	0	0	
29-Nov	0	0	33910	0	0	0
02-Dec	0	0	33910	0	0	
05-Dec	0	0	33910	0	0	
08-Dec	0	0	33910	0	0	
11-Dec	0	0	33910	0	0	
14-Dec	0	0	33910	0	0	
17-Dec	0	0	33910	0	0	
20-Dec	0	0	33910	0	0	
23-Dec	0	0	33910	0	0	
26-Dec	0	0	33910	0	0	
29-Dec	0	0	33910	0	0	0

Tomato - processing

% SMD	50.00
RTZN	6
AWHC	2
SMD	6
crop'd Kc	0.15
Maturity %	0.72

	Dates			Kcs	
Start	01/01/92	33604	33683	0	0
Planting	03/20/92	33683	33695	0	0.24
Date A	04/01/92	33695	33732	0.24	0.24
Date B	05/08/92	33732	33783	0.24	1.12
Date C	06/28/92	33783	33804.44	1.12	1.12
Date D	19-Jul	33804.44	33847	1.12	0.7
Date E	08/31/92	33847	33848	0.7	0
End	09/01/92	33848		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0	0	33604	33683	0	
04-Jan	0	0	33604	33683	0	
07-Jan	0	0	33604	33683	0	
10-Jan	0	0	33604	33683	0	
13-Jan	0	0	33604	33683	0	
16-Jan	0	0	33604	33683	0	
19-Jan	0	0	33604	33683	0	
22-Jan	0	0	33604	33683	0	
25-Jan	0	0	33604	33683	0	
28-Jan	0	0	33604	33683	0	
31-Jan	0	0	33604	33683	0	0
03-Feb	0	0	33604	33683	0	
06-Feb	0	0	33604	33683	0	
09-Feb	0	0	33604	33683	0	
12-Feb	0	0	33604	33683	0	
15-Feb	0	0	33604	33683	0	
18-Feb	0	0	33604	33683	0	
21-Feb	0	0	33604	33683	0	
24-Feb	0	0	33604	33683	0	
27-Feb	0	0	33604	33683	0	0
01-Mar	0	0	33604	33683	0	
04-Mar	0	0	33604	33683	0	
07-Mar	0	0	33604	33683	0	
10-Mar	0	0	33604	33683	0	
13-Mar	0	0	33604	33683	0	
16-Mar	0	0	33604	33683	0	
19-Mar	0	0	33604	33683	0	
22-Mar	0	0.24	33683	33695	0.04	
25-Mar	0	0.24	33683	33695	0.1	
28-Mar	0	0.24	33683	33695	0.16	
31-Mar	0	0.24	33683	33695	0.22	0.04727273
03-Apr	0.24	0.24	33695	33732	0.24	
06-Apr	0.24	0.24	33695	33732	0.24	

09-Apr	0.24	0.24	33695	33732	0.24	
12-Apr	0.24	0.24	33695	33732	0.24	
15-Apr	0.24	0.24	33695	33732	0.24	
18-Apr	0.24	0.24	33695	33732	0.24	
21-Apr	0.24	0.24	33695	33732	0.24	
24-Apr	0.24	0.24	33695	33732	0.24	
27-Apr	0.24	0.24	33695	33732	0.24	
30-Apr	0.24	0.24	33695	33732	0.24	0.24
03-May	0.24	0.24	33695	33732	0.24	
06-May	0.24	0.24	33695	33732	0.24	
09-May	0.24	1.12	33732	33783	0.2572549	
12-May	0.24	1.12	33732	33783	0.30901961	
15-May	0.24	1.12	33732	33783	0.36078431	
18-May	0.24	1.12	33732	33783	0.41254902	
21-May	0.24	1.12	33732	33783	0.46431373	
24-May	0.24	1.12	33732	33783	0.51607843	
27-May	0.24	1.12	33732	33783	0.56784314	
30-May	0.24	1.12	33732	33783	0.61960784	0.3987451
02-Jun	0.24	1.12	33732	33783	0.67137255	
05-Jun	0.24	1.12	33732	33783	0.72313725	
08-Jun	0.24	1.12	33732	33783	0.77490196	
11-Jun	0.24	1.12	33732	33783	0.82666667	
14-Jun	0.24	1.12	33732	33783	0.87843137	
17-Jun	0.24	1.12	33732	33783	0.93019608	
20-Jun	0.24	1.12	33732	33783	0.98196078	
23-Jun	0.24	1.12	33732	33783	1.03372549	
26-Jun	0.24	1.12	33732	33783	1.0854902	
29-Jun	1.12	1.12	33783	33804.44	1.12	0.90258824
02-Jul	1.12	1.12	33783	33804.44	1.12	
05-Jul	1.12	1.12	33783	33804.44	1.12	
08-Jul	1.12	1.12	33783	33804.44	1.12	
11-Jul	1.12	1.12	33783	33804.44	1.12	
14-Jul	1.12	1.12	33783	33804.44	1.12	
17-Jul	1.12	1.12	33783	33804.44	1.12	
20-Jul	1.12	0.7	33804.44	33847	1.11447368	
23-Jul	1.12	0.7	33804.44	33847	1.08486842	
26-Jul	1.12	0.7	33804.44	33847	1.05526316	
29-Jul	1.12	0.7	33804.44	33847	1.02565789	1.10002632
01-Aug	1.12	0.7	33804.44	33847	0.99605263	
04-Aug	1.12	0.7	33804.44	33847	0.96644737	
07-Aug	1.12	0.7	33804.44	33847	0.93684211	
10-Aug	1.12	0.7	33804.44	33847	0.90723684	
13-Aug	1.12	0.7	33804.44	33847	0.87763158	
16-Aug	1.12	0.7	33804.44	33847	0.84802632	
19-Aug	1.12	0.7	33804.44	33847	0.81842105	
22-Aug	1.12	0.7	33804.44	33847	0.78881579	
25-Aug	1.12	0.7	33804.44	33847	0.75921053	
28-Aug	1.12	0.7	33804.44	33847	0.72960526	
31-Aug	0.7	0	33847	33848	0.7	0.84802632
03-Sep	0	0	33848	0	0	
06-Sep	0	0	33848	0	0	
09-Sep	0	0	33848	0	0	

12-Sep	0	0	33848	0	0	
15-Sep	0	0	33848	0	0	
18-Sep	0	0	33848	0	0	
21-Sep	0	0	33848	0	0	
24-Sep	0	0	33848	0	0	
27-Sep	0	0	33848	0	0	
30-Sep	0	0	33848	0	0	0
03-Oct	0	0	33848	0	0	
06-Oct	0	0	33848	0	0	
09-Oct	0	0	33848	0	0	
12-Oct	0	0	33848	0	0	
15-Oct	0	0	33848	0	0	
18-Oct	0	0	33848	0	0	
21-Oct	0	0	33848	0	0	
24-Oct	0	0	33848	0	0	
27-Oct	0	0	33848	0	0	
30-Oct	0	0	33848	0	0	0
02-Nov	0	0	33848	0	0	
05-Nov	0	0	33848	0	0	
08-Nov	0	0	33848	0	0	
11-Nov	0	0	33848	0	0	
14-Nov	0	0	33848	0	0	
17-Nov	0	0	33848	0	0	
20-Nov	0	0	33848	0	0	
23-Nov	0	0	33848	0	0	
26-Nov	0	0	33848	0	0	
29-Nov	0	0	33848	0	0	0
02-Dec	0	0	33848	0	0	
05-Dec	0	0	33848	0	0	
08-Dec	0	0	33848	0	0	
11-Dec	0	0	33848	0	0	
14-Dec	0	0	33848	0	0	
17-Dec	0	0	33848	0	0	
20-Dec	0	0	33848	0	0	
23-Dec	0	0	33848	0	0	
26-Dec	0	0	33848	0	0	
29-Dec	0	0	33848	0	0	0

Vegetable

% SMD	50.00
RTZN	4
AWHC	2
SMD	4
crop'd Kc	0.15
Maturity %	0.75

	Dates			Kcs	
Start	01/01/92	33604	33623	0	0
Planting	01/20/92	33623	33635	0	0.3
Date A	02/01/92	33635	33662	0.3	0.3
Date B	02/28/92	33662	33706	0.3	1.05
Date C	04/12/92	33706	33725	1.05	1.05
Date D	01-May	33725	33755	1.05	0.8
Date E	05/31/92	33755	33756	0.8	0
End	06/01/92	33756		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0	0	33604	33623	0	
04-Jan	0	0	33604	33623	0	
07-Jan	0	0	33604	33623	0	
10-Jan	0	0	33604	33623	0	
13-Jan	0	0	33604	33623	0	
16-Jan	0	0	33604	33623	0	
19-Jan	0	0	33604	33623	0	
22-Jan	0	0.3	33623	33635	0.05	
25-Jan	0	0.3	33623	33635	0.125	
28-Jan	0	0.3	33623	33635	0.2	
31-Jan	0	0.3	33623	33635	0.275	0.05909091
03-Feb	0.3	0.3	33635	33662	0.3	
06-Feb	0.3	0.3	33635	33662	0.3	
09-Feb	0.3	0.3	33635	33662	0.3	
12-Feb	0.3	0.3	33635	33662	0.3	
15-Feb	0.3	0.3	33635	33662	0.3	
18-Feb	0.3	0.3	33635	33662	0.3	
21-Feb	0.3	0.3	33635	33662	0.3	
24-Feb	0.3	0.3	33635	33662	0.3	
27-Feb	0.3	0.3	33635	33662	0.3	0.3
01-Mar	0.3	1.05	33662	33706	0.33409091	
04-Mar	0.3	1.05	33662	33706	0.38522727	
07-Mar	0.3	1.05	33662	33706	0.43636364	
10-Mar	0.3	1.05	33662	33706	0.4875	
13-Mar	0.3	1.05	33662	33706	0.53863636	
16-Mar	0.3	1.05	33662	33706	0.58977273	
19-Mar	0.3	1.05	33662	33706	0.64090909	
22-Mar	0.3	1.05	33662	33706	0.69204545	
25-Mar	0.3	1.05	33662	33706	0.74318182	
28-Mar	0.3	1.05	33662	33706	0.79431818	
31-Mar	0.3	1.05	33662	33706	0.84545455	0.58977273
03-Apr	0.3	1.05	33662	33706	0.89659091	
06-Apr	0.3	1.05	33662	33706	0.94772727	

09-Apr	0.3	1.05	33662	33706	0.99886364	
12-Apr	1.05	1.05	33706	33725	1.05	
15-Apr	1.05	1.05	33706	33725	1.05	
18-Apr	1.05	1.05	33706	33725	1.05	
21-Apr	1.05	1.05	33706	33725	1.05	
24-Apr	1.05	1.05	33706	33725	1.05	
27-Apr	1.05	1.05	33706	33725	1.05	
30-Apr	1.05	1.05	33706	33725	1.05	1.01931818
03-May	1.05	0.8	33725	33755	1.03333333	
06-May	1.05	0.8	33725	33755	1.00833333	
09-May	1.05	0.8	33725	33755	0.98333333	
12-May	1.05	0.8	33725	33755	0.95833333	
15-May	1.05	0.8	33725	33755	0.93333333	
18-May	1.05	0.8	33725	33755	0.90833333	
21-May	1.05	0.8	33725	33755	0.88333333	
24-May	1.05	0.8	33725	33755	0.85833333	
27-May	1.05	0.8	33725	33755	0.83333333	
30-May	1.05	0.8	33725	33755	0.80833333	0.92083333
02-Jun	0	0	33756	0	0	
05-Jun	0	0	33756	0	0	
08-Jun	0	0	33756	0	0	
11-Jun	0	0	33756	0	0	
14-Jun	0	0	33756	0	0	
17-Jun	0	0	33756	0	0	
20-Jun	0	0	33756	0	0	
23-Jun	0	0	33756	0	0	
26-Jun	0	0	33756	0	0	
29-Jun	0	0	33756	0	0	0
02-Jul	0	0	33756	0	0	
05-Jul	0	0	33756	0	0	
08-Jul	0	0	33756	0	0	
11-Jul	0	0	33756	0	0	
14-Jul	0	0	33756	0	0	
17-Jul	0	0	33756	0	0	
20-Jul	0	0	33756	0	0	
23-Jul	0	0	33756	0	0	
26-Jul	0	0	33756	0	0	
29-Jul	0	0	33756	0	0	0
01-Aug	0	0	33756	0	0	
04-Aug	0	0	33756	0	0	
07-Aug	0	0	33756	0	0	
10-Aug	0	0	33756	0	0	
13-Aug	0	0	33756	0	0	
16-Aug	0	0	33756	0	0	
19-Aug	0	0	33756	0	0	
22-Aug	0	0	33756	0	0	
25-Aug	0	0	33756	0	0	
28-Aug	0	0	33756	0	0	
31-Aug	0	0	33756	0	0	0
03-Sep	0	0	33756	0	0	
06-Sep	0	0	33756	0	0	
09-Sep	0	0	33756	0	0	

12-Sep	0	0	33756	0	0	
15-Sep	0	0	33756	0	0	
18-Sep	0	0	33756	0	0	
21-Sep	0	0	33756	0	0	
24-Sep	0	0	33756	0	0	
27-Sep	0	0	33756	0	0	
30-Sep	0	0	33756	0	0	0
03-Oct	0	0	33756	0	0	
06-Oct	0	0	33756	0	0	
09-Oct	0	0	33756	0	0	
12-Oct	0	0	33756	0	0	
15-Oct	0	0	33756	0	0	
18-Oct	0	0	33756	0	0	
21-Oct	0	0	33756	0	0	
24-Oct	0	0	33756	0	0	
27-Oct	0	0	33756	0	0	
30-Oct	0	0	33756	0	0	0
02-Nov	0	0	33756	0	0	
05-Nov	0	0	33756	0	0	
08-Nov	0	0	33756	0	0	
11-Nov	0	0	33756	0	0	
14-Nov	0	0	33756	0	0	
17-Nov	0	0	33756	0	0	
20-Nov	0	0	33756	0	0	
23-Nov	0	0	33756	0	0	
26-Nov	0	0	33756	0	0	
29-Nov	0	0	33756	0	0	0
02-Dec	0	0	33756	0	0	
05-Dec	0	0	33756	0	0	
08-Dec	0	0	33756	0	0	
11-Dec	0	0	33756	0	0	
14-Dec	0	0	33756	0	0	
17-Dec	0	0	33756	0	0	
20-Dec	0	0	33756	0	0	
23-Dec	0	0	33756	0	0	
26-Dec	0	0	33756	0	0	
29-Dec	0	0	33756	0	0	0

Walnut/apple - with cover

% SMD	50.00
RTZN	6
AWHC	2
SMD	6
crop'd Kc	0.15
Maturity %	0.65

	Dates			Kcs	
Start	01/01/92	33604	33672	0	0
Planting	03/09/92	33672	33673	0	0.7
Date A	03/10/92	33673	33674	0.7	0.7
Date B	03/11/92	33674	33792	0.7	1.14
Date C	07/07/92	33792	33831.6	1.14	1.14
Date D	15-Aug	33831.6	33917	1.14	0.15
Date E	11/09/92	33917	33918	0.15	0
End	11/10/92	33918		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0	0	33604	33672	0	
04-Jan	0	0	33604	33672	0	
07-Jan	0	0	33604	33672	0	
10-Jan	0	0	33604	33672	0	
13-Jan	0	0	33604	33672	0	
16-Jan	0	0	33604	33672	0	
19-Jan	0	0	33604	33672	0	
22-Jan	0	0	33604	33672	0	
25-Jan	0	0	33604	33672	0	
28-Jan	0	0	33604	33672	0	
31-Jan	0	0	33604	33672	0	0
03-Feb	0	0	33604	33672	0	
06-Feb	0	0	33604	33672	0	
09-Feb	0	0	33604	33672	0	
12-Feb	0	0	33604	33672	0	
15-Feb	0	0	33604	33672	0	
18-Feb	0	0	33604	33672	0	
21-Feb	0	0	33604	33672	0	
24-Feb	0	0	33604	33672	0	
27-Feb	0	0	33604	33672	0	0
01-Mar	0	0	33604	33672	0	
04-Mar	0	0	33604	33672	0	
07-Mar	0	0	33604	33672	0	
10-Mar	0.7	0.7	33673	33674	0.7	
13-Mar	0.7	1.14	33674	33792	0.70745763	
16-Mar	0.7	1.14	33674	33792	0.71864407	
19-Mar	0.7	1.14	33674	33792	0.72983051	
22-Mar	0.7	1.14	33674	33792	0.74101695	
25-Mar	0.7	1.14	33674	33792	0.75220339	
28-Mar	0.7	1.14	33674	33792	0.76338983	
31-Mar	0.7	1.14	33674	33792	0.77457627	0.5351926
03-Apr	0.7	1.14	33674	33792	0.78576271	
06-Apr	0.7	1.14	33674	33792	0.79694915	

09-Apr	0.7	1.14	33674	33792	0.80813559	
12-Apr	0.7	1.14	33674	33792	0.81932203	
15-Apr	0.7	1.14	33674	33792	0.83050847	
18-Apr	0.7	1.14	33674	33792	0.84169492	
21-Apr	0.7	1.14	33674	33792	0.85288136	
24-Apr	0.7	1.14	33674	33792	0.8640678	
27-Apr	0.7	1.14	33674	33792	0.87525424	
30-Apr	0.7	1.14	33674	33792	0.88644068	0.83610169
03-May	0.7	1.14	33674	33792	0.89762712	
06-May	0.7	1.14	33674	33792	0.90881356	
09-May	0.7	1.14	33674	33792	0.92	
12-May	0.7	1.14	33674	33792	0.93118644	
15-May	0.7	1.14	33674	33792	0.94237288	
18-May	0.7	1.14	33674	33792	0.95355932	
21-May	0.7	1.14	33674	33792	0.96474576	
24-May	0.7	1.14	33674	33792	0.9759322	
27-May	0.7	1.14	33674	33792	0.98711864	
30-May	0.7	1.14	33674	33792	0.99830508	0.9479661
02-Jun	0.7	1.14	33674	33792	1.00949153	
05-Jun	0.7	1.14	33674	33792	1.02067797	
08-Jun	0.7	1.14	33674	33792	1.03186441	
11-Jun	0.7	1.14	33674	33792	1.04305085	
14-Jun	0.7	1.14	33674	33792	1.05423729	
17-Jun	0.7	1.14	33674	33792	1.06542373	
20-Jun	0.7	1.14	33674	33792	1.07661017	
23-Jun	0.7	1.14	33674	33792	1.08779661	
26-Jun	0.7	1.14	33674	33792	1.09898305	
29-Jun	0.7	1.14	33674	33792	1.11016949	1.05983051
02-Jul	0.7	1.14	33674	33792	1.12135593	
05-Jul	0.7	1.14	33674	33792	1.13254237	
08-Jul	1.14	1.14	33792	33831.6	1.14	
11-Jul	1.14	1.14	33792	33831.6	1.14	
14-Jul	1.14	1.14	33792	33831.6	1.14	
17-Jul	1.14	1.14	33792	33831.6	1.14	
20-Jul	1.14	1.14	33792	33831.6	1.14	
23-Jul	1.14	1.14	33792	33831.6	1.14	
26-Jul	1.14	1.14	33792	33831.6	1.14	
29-Jul	1.14	1.14	33792	33831.6	1.14	1.13738983
01-Aug	1.14	1.14	33792	33831.6	1.14	
04-Aug	1.14	1.14	33792	33831.6	1.14	
07-Aug	1.14	1.14	33792	33831.6	1.14	
10-Aug	1.14	1.14	33792	33831.6	1.14	
13-Aug	1.14	1.14	33792	33831.6	1.14	
16-Aug	1.14	0.15	33831.6	33917	1.135363	
19-Aug	1.14	0.15	33831.6	33917	1.10058548	
22-Aug	1.14	0.15	33831.6	33917	1.06580796	
25-Aug	1.14	0.15	33831.6	33917	1.03103044	
28-Aug	1.14	0.15	33831.6	33917	0.99625293	
31-Aug	1.14	0.15	33831.6	33917	0.96147541	1.09004684
03-Sep	1.14	0.15	33831.6	33917	0.92669789	
06-Sep	1.14	0.15	33831.6	33917	0.89192037	
09-Sep	1.14	0.15	33831.6	33917	0.85714286	

12-Sep	1.14	0.15	33831.6	33917	0.82236534	
15-Sep	1.14	0.15	33831.6	33917	0.78758782	
18-Sep	1.14	0.15	33831.6	33917	0.7528103	
21-Sep	1.14	0.15	33831.6	33917	0.71803279	
24-Sep	1.14	0.15	33831.6	33917	0.68325527	
27-Sep	1.14	0.15	33831.6	33917	0.64847775	
30-Sep	1.14	0.15	33831.6	33917	0.61370023	0.77019906
03-Oct	1.14	0.15	33831.6	33917	0.57892272	
06-Oct	1.14	0.15	33831.6	33917	0.5441452	
09-Oct	1.14	0.15	33831.6	33917	0.50936768	
12-Oct	1.14	0.15	33831.6	33917	0.47459016	
15-Oct	1.14	0.15	33831.6	33917	0.43981265	
18-Oct	1.14	0.15	33831.6	33917	0.40503513	
21-Oct	1.14	0.15	33831.6	33917	0.37025761	
24-Oct	1.14	0.15	33831.6	33917	0.33548009	
27-Oct	1.14	0.15	33831.6	33917	0.30070258	
30-Oct	1.14	0.15	33831.6	33917	0.26592506	0.42242389
02-Nov	1.14	0.15	33831.6	33917	0.23114754	
05-Nov	1.14	0.15	33831.6	33917	0.19637002	
08-Nov	1.14	0.15	33831.6	33917	0.16159251	
11-Nov	0	0	33918	0	0	
14-Nov	0	0	33918	0	0	
17-Nov	0	0	33918	0	0	
20-Nov	0	0	33918	0	0	
23-Nov	0	0	33918	0	0	
26-Nov	0	0	33918	0	0	
29-Nov	0	0	33918	0	0	0.05891101
02-Dec	0	0	33918	0	0	
05-Dec	0	0	33918	0	0	
08-Dec	0	0	33918	0	0	
11-Dec	0	0	33918	0	0	
14-Dec	0	0	33918	0	0	
17-Dec	0	0	33918	0	0	
20-Dec	0	0	33918	0	0	
23-Dec	0	0	33918	0	0	
26-Dec	0	0	33918	0	0	
29-Dec	0	0	33918	0	0	0

Wheat

% SMD	50.00
RTZN	6
AWHC	2
SMD	6
crop'd Kc	0.15
Maturity %	0.75

	Dates			Kcs	
Start	01/01/91	33239	33562	0	0
Planting	11/20/91	33562	33573	0	0.22
Date A	12/01/91	33573	33596	0.22	0.22
Date B	12/24/91	33596	33665	0.22	1.17
Date C	03/02/92	33665	33705	1.17	1.17
Date D	11-Apr	33705	33749	1.17	0.38
Date E	05/25/92	33749	33750	0.38	0
End	05/26/92	33750		0	0

	Kc1	Kc2	date 1	date 2	Kc	
01-jan-92	0.22	1.17	33596	33665	0.33014493	
04-Jan	0.22	1.17	33596	33665	0.37144928	
07-Jan	0.22	1.17	33596	33665	0.41275362	
10-Jan	0.22	1.17	33596	33665	0.45405797	
13-Jan	0.22	1.17	33596	33665	0.49536232	
16-Jan	0.22	1.17	33596	33665	0.53666667	
19-Jan	0.22	1.17	33596	33665	0.57797101	
22-Jan	0.22	1.17	33596	33665	0.61927536	
25-Jan	0.22	1.17	33596	33665	0.66057971	
28-Jan	0.22	1.17	33596	33665	0.70188406	
31-Jan	0.22	1.17	33596	33665	0.74318841	0.53666667
03-Feb	0.22	1.17	33596	33665	0.78449275	
06-Feb	0.22	1.17	33596	33665	0.8257971	
09-Feb	0.22	1.17	33596	33665	0.86710145	
12-Feb	0.22	1.17	33596	33665	0.9084058	
15-Feb	0.22	1.17	33596	33665	0.94971014	
18-Feb	0.22	1.17	33596	33665	0.99101449	
21-Feb	0.22	1.17	33596	33665	1.03231884	
24-Feb	0.22	1.17	33596	33665	1.07362319	
27-Feb	0.22	1.17	33596	33665	1.11492754	0.94971014
01-Mar	0.22	1.17	33596	33665	1.15623188	
04-Mar	1.17	1.17	33665	33705	1.17	
07-Mar	1.17	1.17	33665	33705	1.17	
10-Mar	1.17	1.17	33665	33705	1.17	
13-Mar	1.17	1.17	33665	33705	1.17	
16-Mar	1.17	1.17	33665	33705	1.17	
19-Mar	1.17	1.17	33665	33705	1.17	
22-Mar	1.17	1.17	33665	33705	1.17	
25-Mar	1.17	1.17	33665	33705	1.17	
28-Mar	1.17	1.17	33665	33705	1.17	
31-Mar	1.17	1.17	33665	33705	1.17	1.16874835
03-Apr	1.17	1.17	33665	33705	1.17	
06-Apr	1.17	1.17	33665	33705	1.17	

09-Apr	1.17	1.17	33665	33705	1.17	
12-Apr	1.17	0.38	33705	33749	1.15204545	
15-Apr	1.17	0.38	33705	33749	1.09818182	
18-Apr	1.17	0.38	33705	33749	1.04431818	
21-Apr	1.17	0.38	33705	33749	0.99045455	
24-Apr	1.17	0.38	33705	33749	0.93659091	
27-Apr	1.17	0.38	33705	33749	0.88272727	
30-Apr	1.17	0.38	33705	33749	0.82886364	1.04431818
03-May	1.17	0.38	33705	33749	0.775	
06-May	1.17	0.38	33705	33749	0.72113636	
09-May	1.17	0.38	33705	33749	0.66727273	
12-May	1.17	0.38	33705	33749	0.61340909	
15-May	1.17	0.38	33705	33749	0.55954545	
18-May	1.17	0.38	33705	33749	0.50568182	
21-May	1.17	0.38	33705	33749	0.45181818	
24-May	1.17	0.38	33705	33749	0.39795455	
27-May	0	0	33750	0	0	
30-May	0	0	33750	0	0	0.46918182
02-jun-91	0	0	33239	33562	0	
05-Jun	0	0	33239	33562	0	
08-Jun	0	0	33239	33562	0	
11-Jun	0	0	33239	33562	0	
14-Jun	0	0	33239	33562	0	
17-Jun	0	0	33239	33562	0	
20-Jun	0	0	33239	33562	0	
23-Jun	0	0	33239	33562	0	
26-Jun	0	0	33239	33562	0	
29-Jun	0	0	33239	33562	0	0
02-Jul	0	0	33239	33562	0	
05-Jul	0	0	33239	33562	0	
08-Jul	0	0	33239	33562	0	
11-Jul	0	0	33239	33562	0	
14-Jul	0	0	33239	33562	0	
17-Jul	0	0	33239	33562	0	
20-Jul	0	0	33239	33562	0	
23-Jul	0	0	33239	33562	0	
26-Jul	0	0	33239	33562	0	
29-Jul	0	0	33239	33562	0	0
01-Aug	0	0	33239	33562	0	
04-Aug	0	0	33239	33562	0	
07-Aug	0	0	33239	33562	0	
10-Aug	0	0	33239	33562	0	
13-Aug	0	0	33239	33562	0	
16-Aug	0	0	33239	33562	0	
19-Aug	0	0	33239	33562	0	
22-Aug	0	0	33239	33562	0	
25-Aug	0	0	33239	33562	0	
28-Aug	0	0	33239	33562	0	
31-Aug	0	0	33239	33562	0	0
03-Sep	0	0	33239	33562	0	
06-Sep	0	0	33239	33562	0	
09-Sep	0	0	33239	33562	0	

12-Sep	0	0	33239	33562	0	
15-Sep	0	0	33239	33562	0	
18-Sep	0	0	33239	33562	0	
21-Sep	0	0	33239	33562	0	
24-Sep	0	0	33239	33562	0	
27-Sep	0	0	33239	33562	0	
30-Sep	0	0	33239	33562	0	0
03-Oct	0	0	33239	33562	0	
06-Oct	0	0	33239	33562	0	
09-Oct	0	0	33239	33562	0	
12-Oct	0	0	33239	33562	0	
15-Oct	0	0	33239	33562	0	
18-Oct	0	0	33239	33562	0	
21-Oct	0	0	33239	33562	0	
24-Oct	0	0	33239	33562	0	
27-Oct	0	0	33239	33562	0	
30-Oct	0	0	33239	33562	0	0
02-Nov	0	0	33239	33562	0	
05-Nov	0	0	33239	33562	0	
08-Nov	0	0	33239	33562	0	
11-Nov	0	0	33239	33562	0	
14-Nov	0	0	33239	33562	0	
17-Nov	0	0	33239	33562	0	
20-Nov	0	0.22	33562	33573	0	
23-Nov	0	0.22	33562	33573	0.06	
26-Nov	0	0.22	33562	33573	0.12	
29-Nov	0	0.22	33562	33573	0.18	0.036
02-Dec	0.22	0.22	33573	33596	0.22	
05-Dec	0.22	0.22	33573	33596	0.22	
08-Dec	0.22	0.22	33573	33596	0.22	
11-Dec	0.22	0.22	33573	33596	0.22	
14-Dec	0.22	0.22	33573	33596	0.22	
17-Dec	0.22	0.22	33573	33596	0.22	
20-Dec	0.22	0.22	33573	33596	0.22	
23-Dec	0.22	0.22	33573	33596	0.22	
26-Dec	0.22	1.17	33596	33665	0.24753623	
29-Dec	0.22	1.17	33596	33665	0.28884058	0.22963768

TECHNICAL APPENDIX C
Rainfall Data

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TECHNICAL APPENDIX C

Effective Rainfall and Runoff Calculations C3

Graph of Rainfall during Pre-Plant Months C4

Rainfall Spreadsheet C6

Monthly Rainfall Graphs C7

Effective Precipitation and Runoff

References:

Rainfall information provided by Jeff Bryant at the San Joaquin River Exchange Contractor's Water Authority. Rainfall data read from a rain gage placed by the CCID at the Mendota Dam.

Method:

Evaporation, runoff and infiltration was calculated for use in determining the amount of rainfall contributing the soil moisture deficit (SMD) and net leaching fraction (NLF) for water districts in the Grasslands Basin Irrigation Area. The amount of rainfall in each category was determined according to the following table.

	Evap	Infilt.	Runoff
R < 0.2 in	100%	0	0
0.2 < R < 0.5	0.2 in	R-0.2	0
0.5 in < R	0.2 in	.3+(.7*(R-.5))	.3*(R-.5)

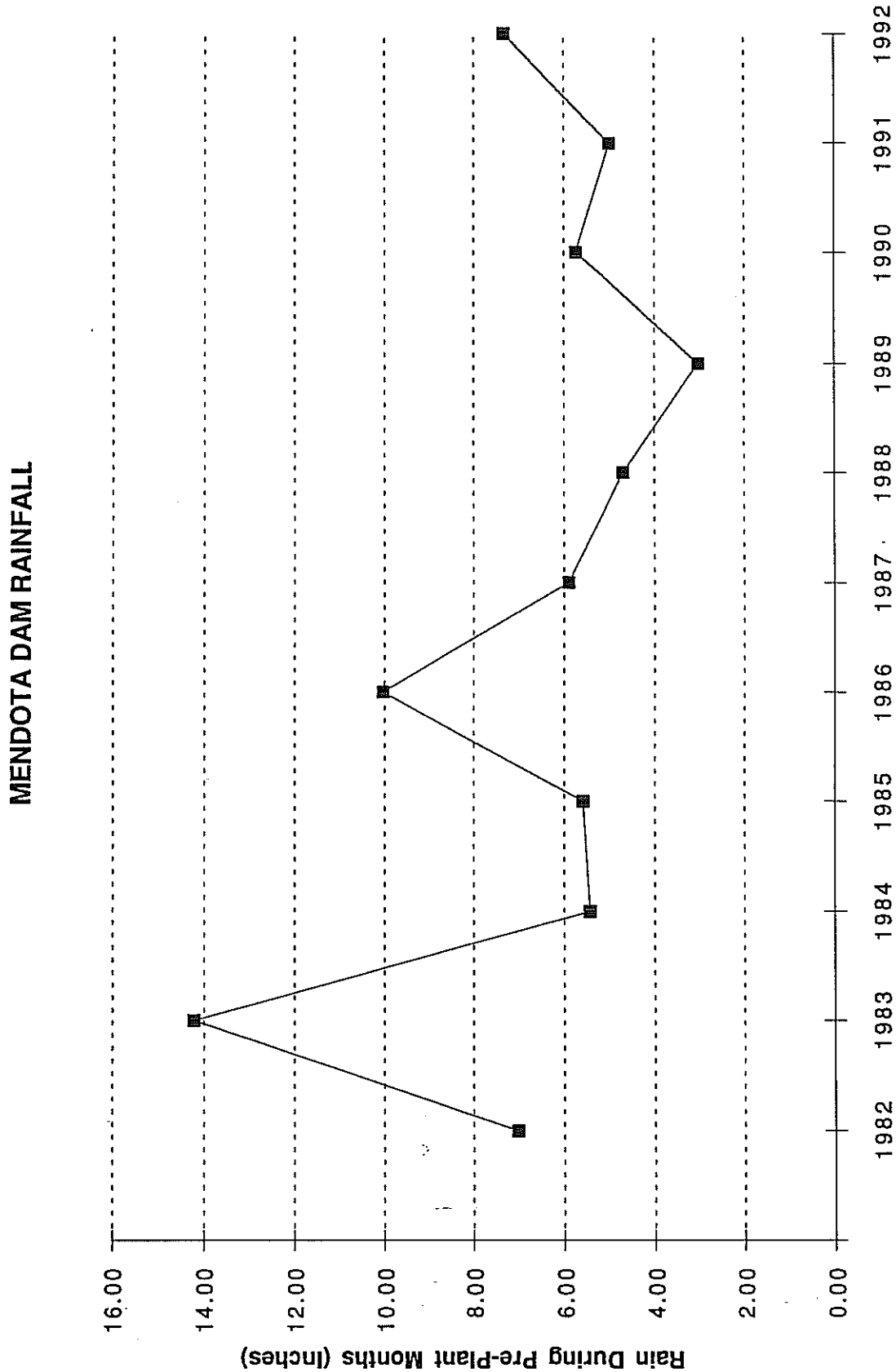
R = Rainfall

Each daily precipitation event was separately analyzed. If rain occurred over 3 or more consecutive days, then the sum of the rain over those days was used in the calculation. The resulting infiltration was used along with acreage data to provide acre-feet of water available to potentially satisfy SMD and NLF requirements.

Mendota Dam Effective Precipitation Summary indicates that 51% of the total annual rainfall is infiltrated, according to the procedure outlined above. Based on the results of the analysis, the effective precipitation used in calculating the Annual District IE is 50% of the total annual rainfall.

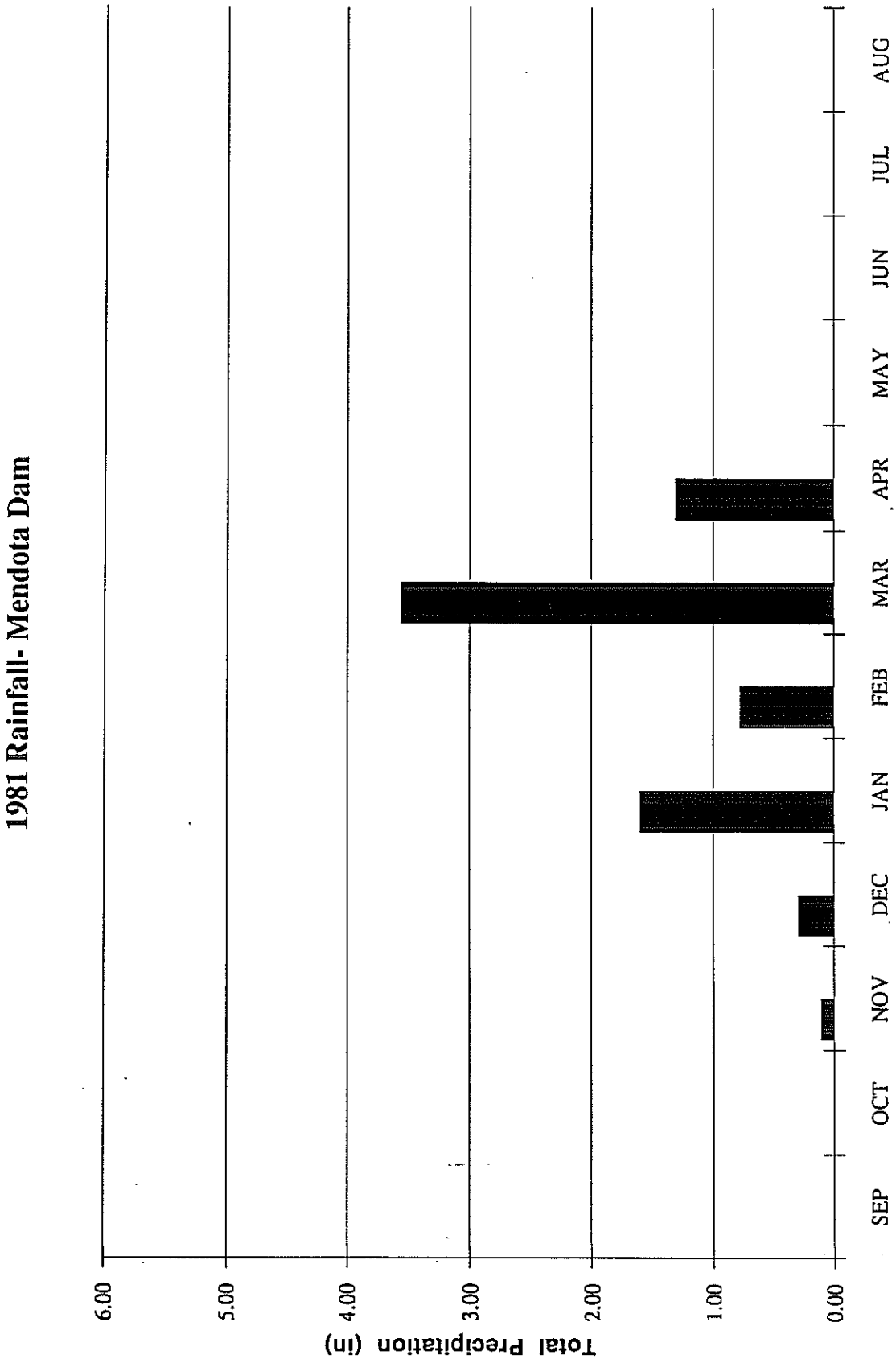
MENDOTA DAM EFFECTIVE PRECIPITATION SUMMARY

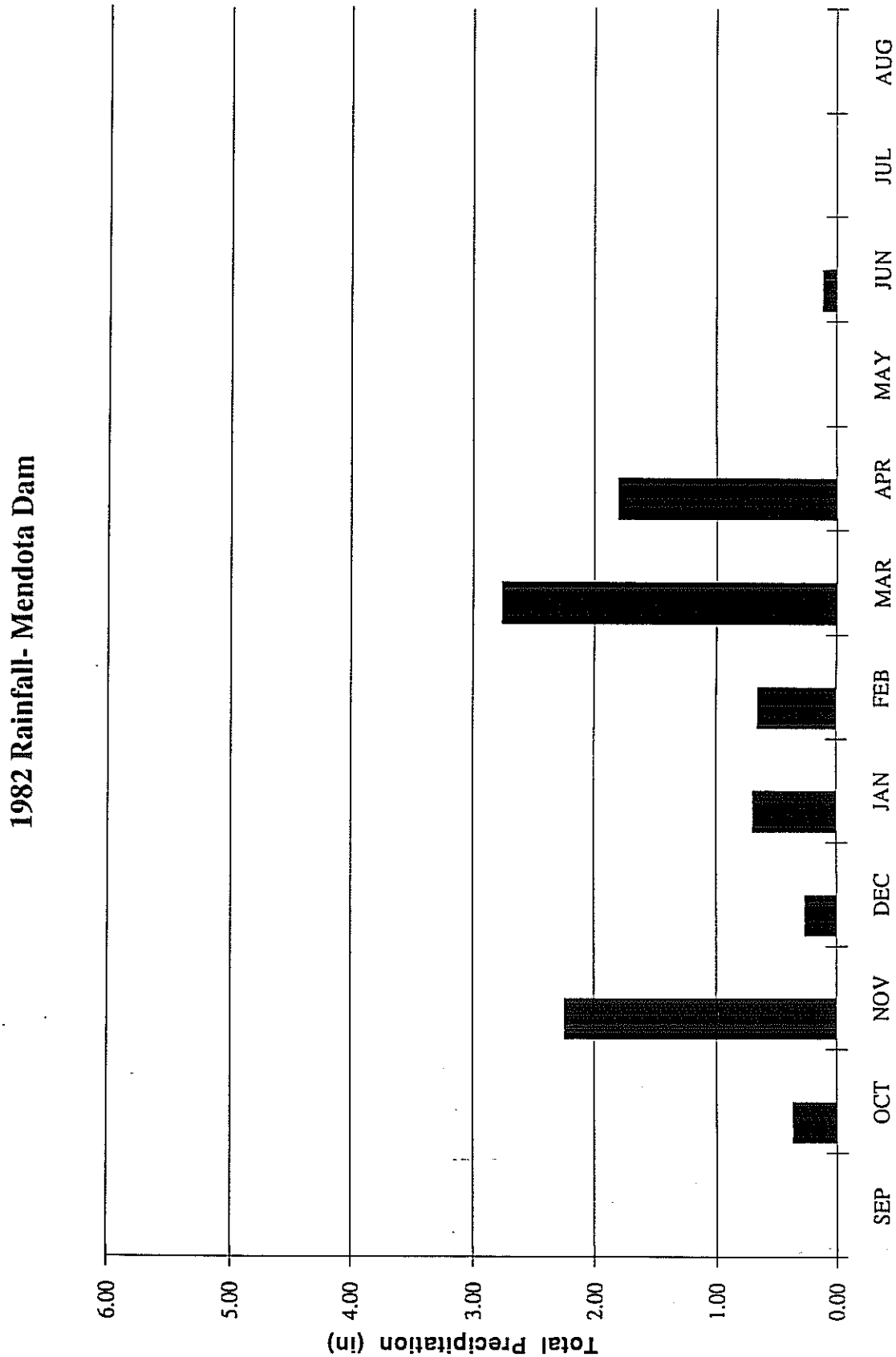
	Precip. Annual (in)	% Infilt. of Annual (%)	Precip. Sept-Mar (in)	September - March Only					
				Infilt. (in)	% Infilt. (%)	Evap. (in)	% Evap. (%)	Runoff (in)	% Runoff (%)
1980-1981	7.69	47%	6.2	3.6	58%	1.6	26%	1.0	17%
1982	8.95	43%	7.0	3.9	55%	2.4	35%	0.7	11%
1983	15.51	56%	14.2	8.6	61%	2.8	19%	2.5	18%
1984	6.12	51%	6.0	3.2	52%	2.5	42%	0.3	5%
1985	5.77	47%	5.6	2.7	49%	2.3	42%	0.5	9%
1986	10.75	59%	10.0	6.3	63%	2.1	21%	1.6	16%
1987	6.02	52%	5.9	3.1	53%	2.1	36%	0.7	12%
1988	5.87	42%	4.7	2.5	53%	2.0	43%	0.2	5%
1989	5.35	52%	5.1	2.8	54%	1.8	35%	0.6	12%
1990	7.32	44%	5.7	3.2	56%	2.0	35%	0.5	9%
1991	5.14	55%	5.0	2.8	56%	1.7	34%	0.5	10%
1992	7.45	57%	7.3	4.2	57%	1.9	26%	1.2	16%
AVERAGE	**7.7**	**51%**	**6.9**	**3.9**	**57%**	**2.1**	**30%**	**0.9**	**13%**


MENDOTA DAM RAINFALL
Rain During Pre-Plant Months (Inches)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

Rainfall Data at Mendota Dam (in)

	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	Total
1980-1981	0.00	0.00	0.11	0.30	1.61	0.78	3.57	1.32	0.00	0.00	0.00	0.00	7.69
1982	0.00	0.37	2.25	0.27	0.70	0.66	2.77	1.81	0.00	0.12	0.00	0.00	8.95
1983	0.78	0.60	1.91	1.03	3.53	1.80	4.57	0.84	0.45	0.00	0.00	0.00	15.51
1984	0.77	0.59	1.14	1.54	0.10	1.38	0.49	0.03	0.00	0.08	0.00	0.00	6.12
1985	0.00	0.55	1.05	2.67	0.60	0.09	0.62	0.14	0.00	0.05	0.00	0.00	5.77
1986	0.00	0.49	3.11	0.97	0.11	2.92	2.44	0.51	0.12	0.00	0.08	0.00	10.75
1987	0.36	0.00	0.00	0.35	1.14	1.90	2.15	0.00	0.12	0.00	0.00	0.00	6.02
1988	0.00	1.18	0.52	1.23	1.18	0.50	0.10	0.94	0.22	0.00	0.00	0.00	5.87
1989	0.00	0.00	0.67	2.13	0.29	1.15	0.89	0.13	0.09	0.00	0.00	0.00	5.35
1990	1.36	0.64	0.31	0.00	2.05	0.92	0.45	0.39	1.20	0.00	0.00	0.00	7.32
1991	0.09	0.04	0.27	0.41	0.07	1.01	3.12	0.11	0.00	0.00	0.00	0.02	5.14
1992	0.00	0.24	0.07	0.87	1.45	2.46	2.24	0.00	0.05	0.00	0.07	0.00	7.45
Average	**0.28**	**0.39**	**0.95**	**0.98**	**1.07**	**1.30**	**1.95**	**0.52**	**0.19**	**0.02**	**0.01**	**0.00**	


1981 Rainfall- Mendota Dam
Total Precipitation (in)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG


1982 Rainfall- Mendota Dam
Total Precipitation (in)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SEP
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DEC
JAN
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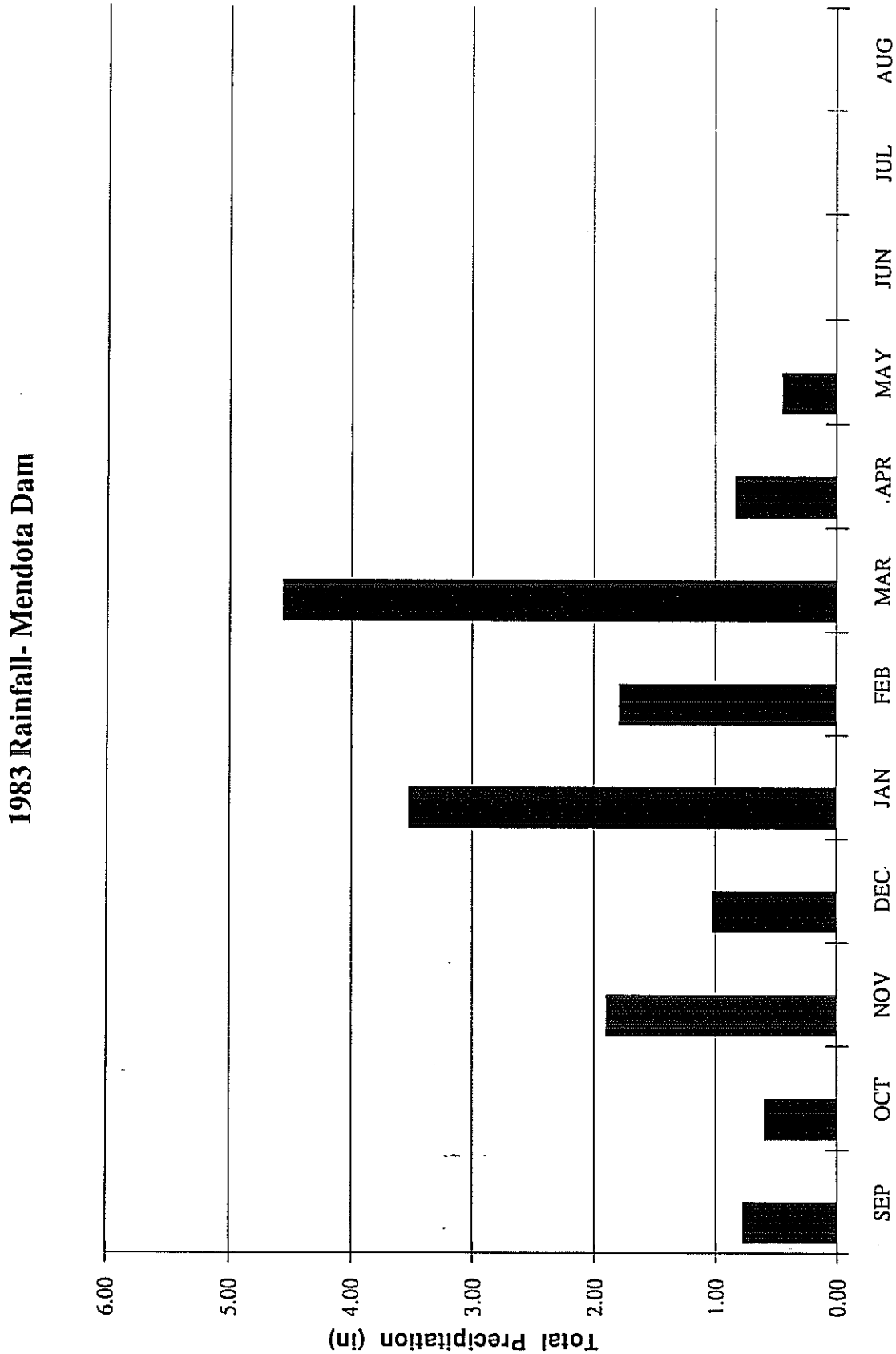
1983 Rainfall- Mendota Dam
Total Precipitation (in)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SEP
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NOV
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JAN
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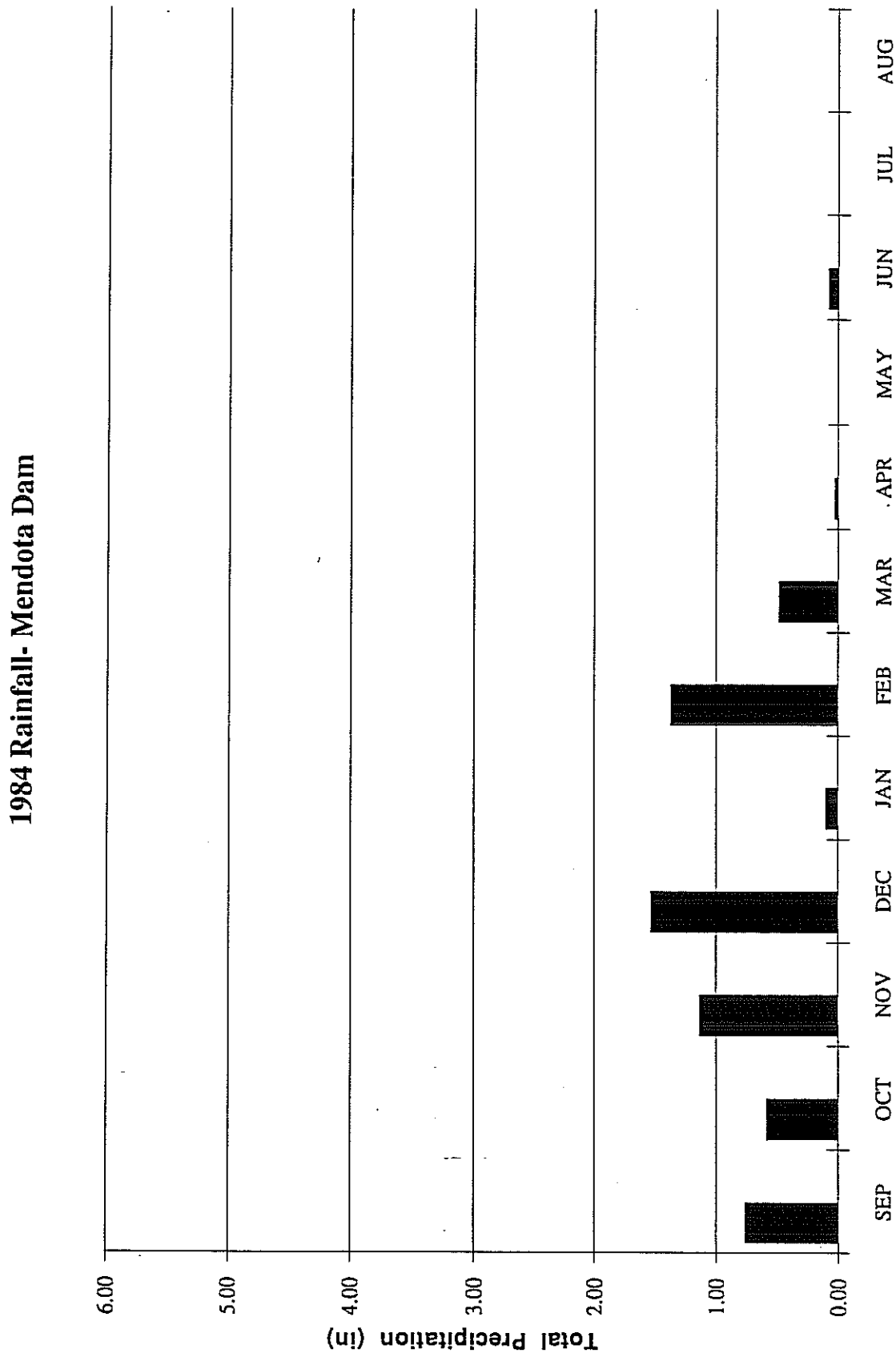
JUL
AUG


1984 Rainfall- Mendota Dam
Total Precipitation (in)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SEP
OCT
NOV
DEC
JAN
FEB
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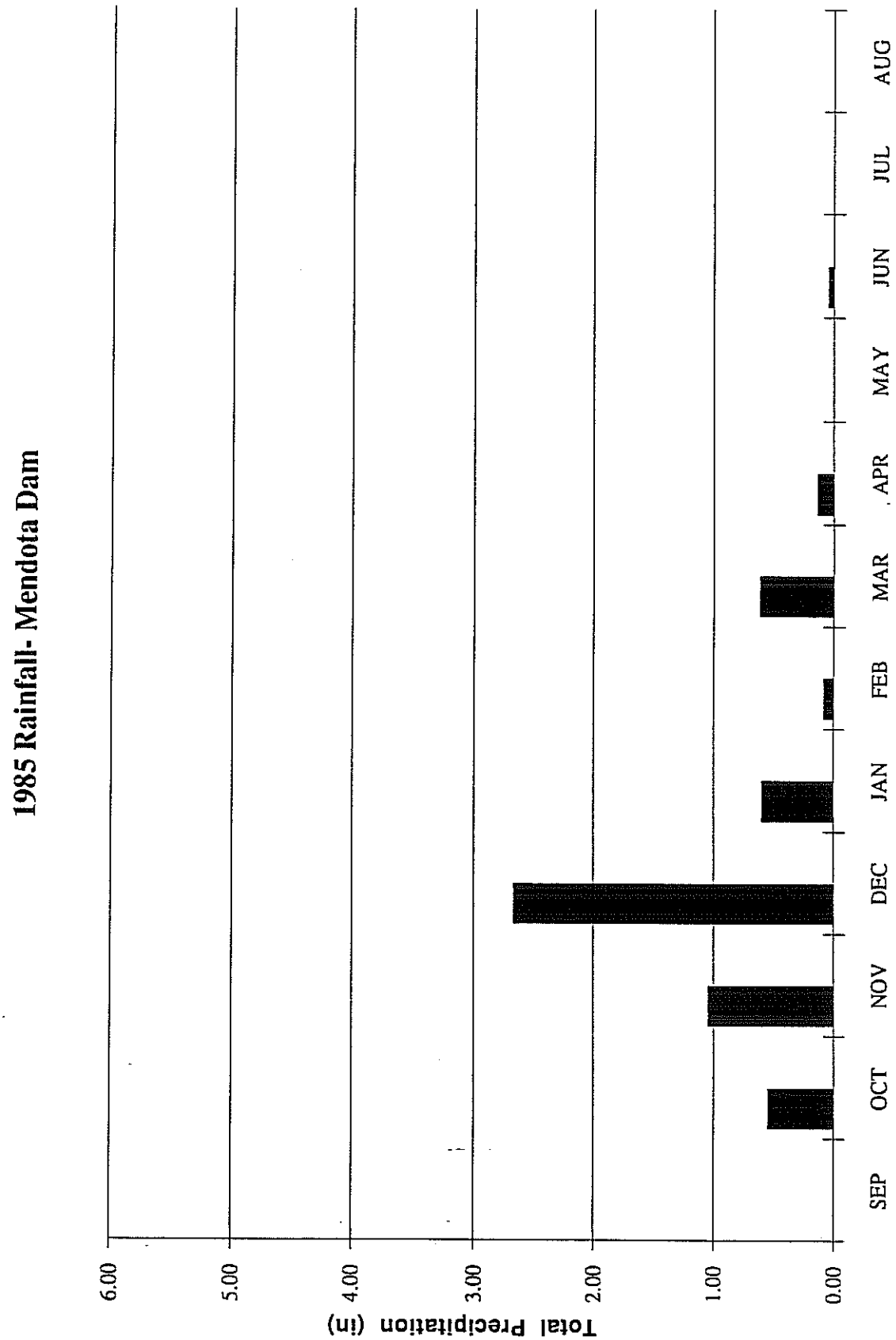
JUN
JUL
AUG


1985 Rainfall- Mendota Dam
Total Precipitation (in)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SEP
OCT
NOV
DEC
JAN
FEB
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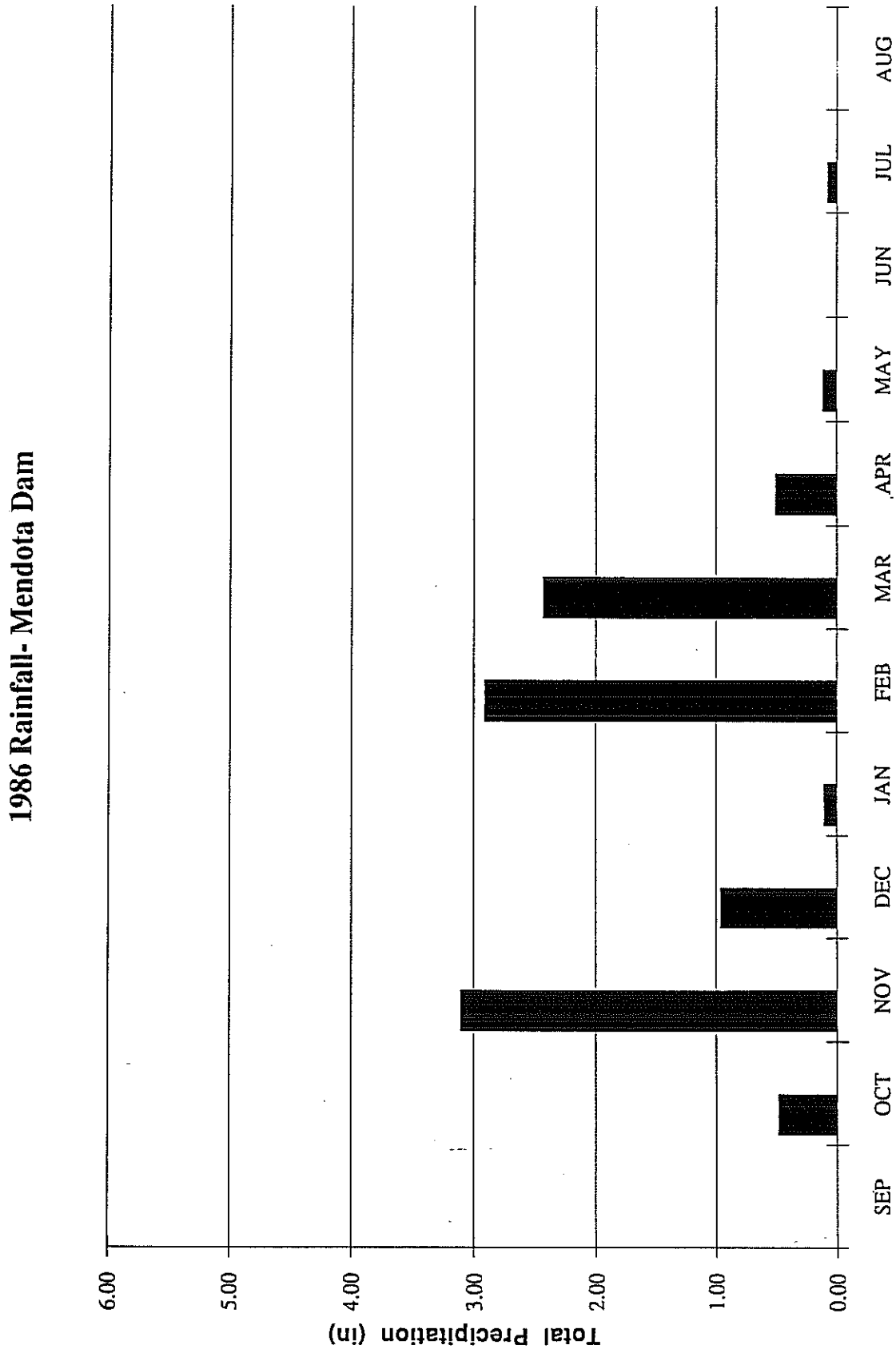
JUL
AUG


1986 Rainfall- Mendota Dam
Total Precipitation (in)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SEP
OCT
NOV
DEC
JAN
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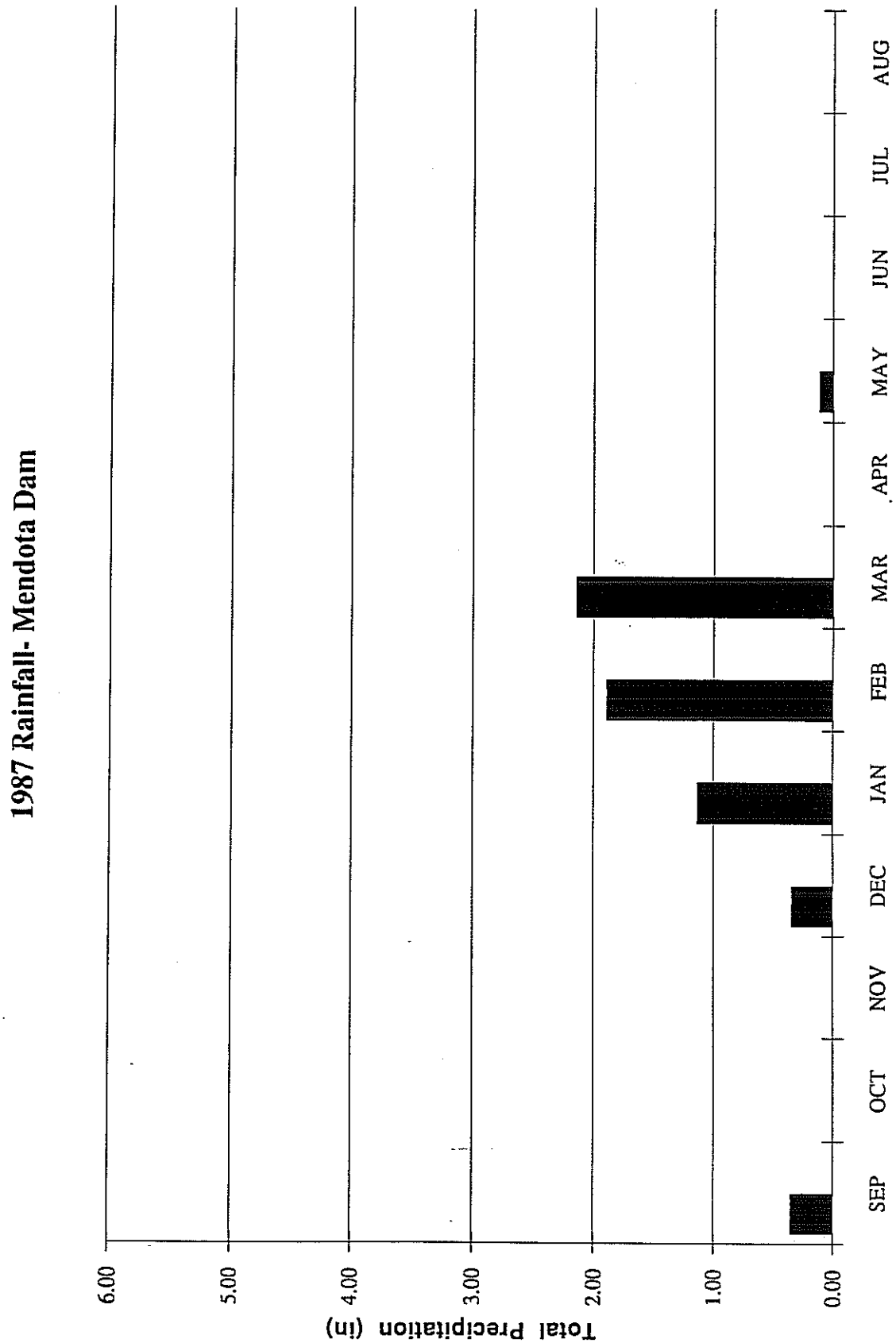
JUN
JUL
AUG


1987 Rainfall- Mendota Dam
Total Precipitation (in)
6.00
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4.00
3.00
2.00
1.00
0.00
SEP
OCT
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DEC
JAN
FEB
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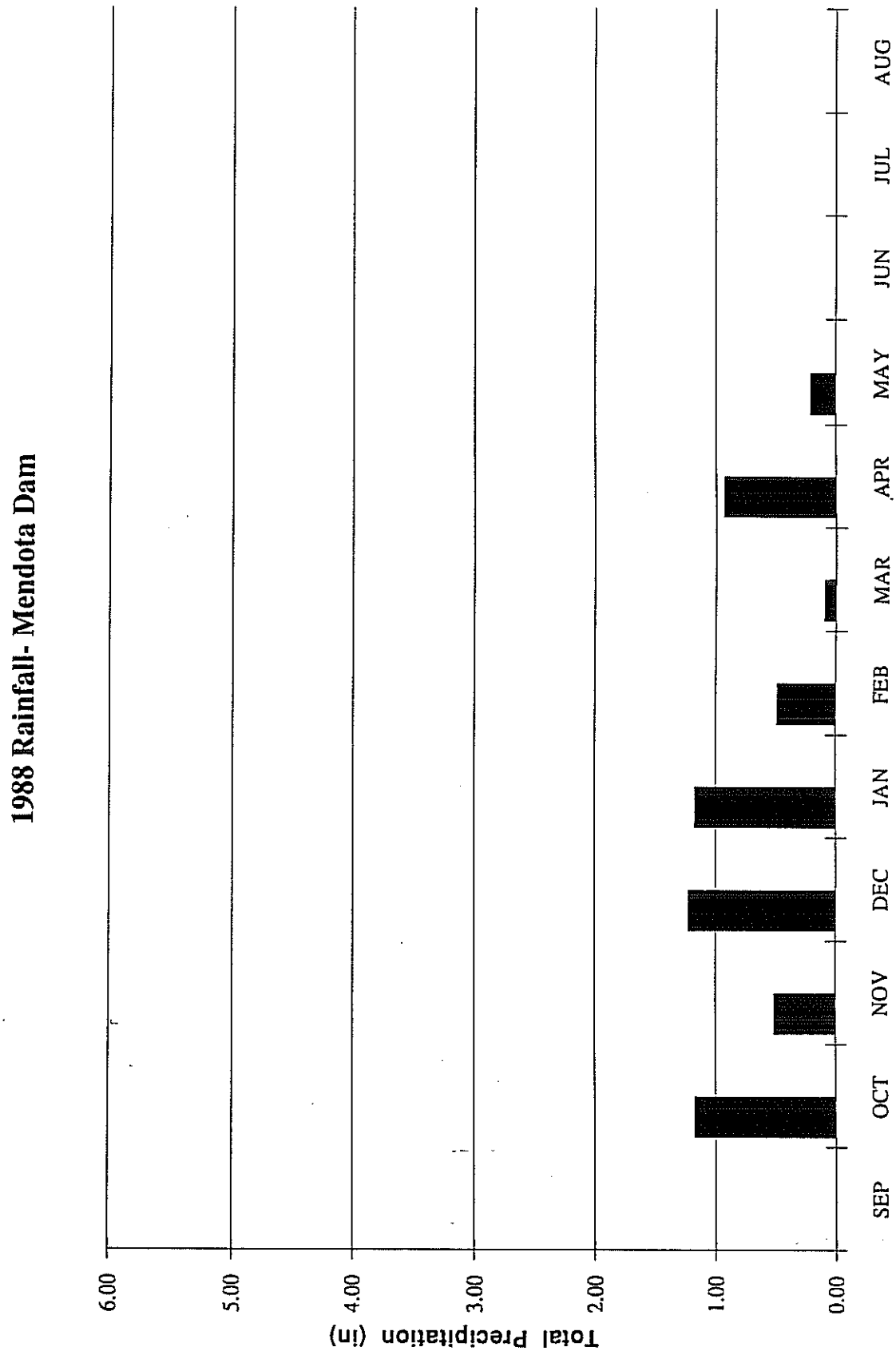
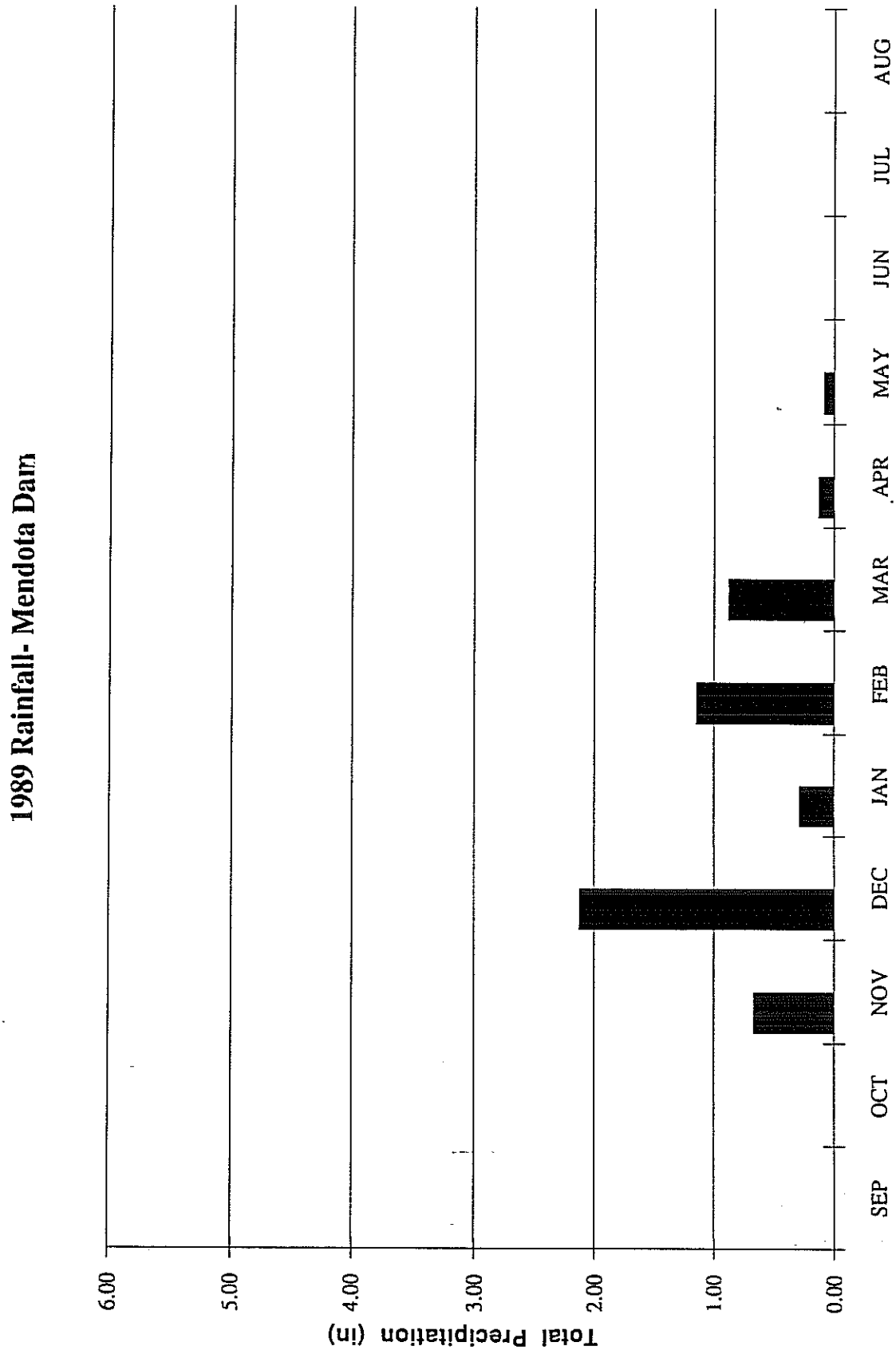
JUN
JUL
AUG


1988 Rainfall- Mendota Dam
Total Precipitation (in)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG


1989 Rainfall- Mendota Dam
Total Precipitation (in)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SEP
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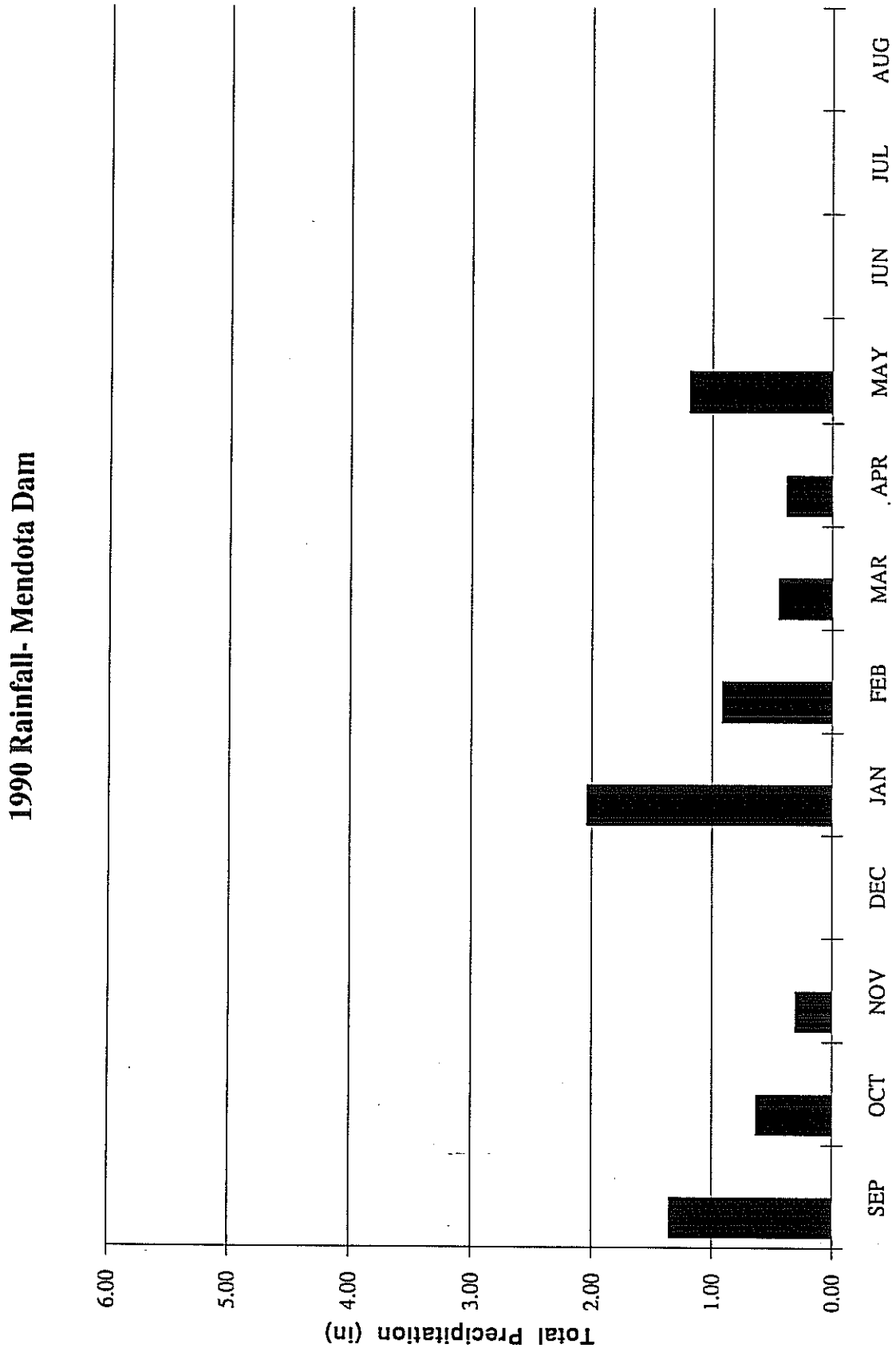
1990 Rainfall- Mendota Dam
Total Precipitation (in)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SEP
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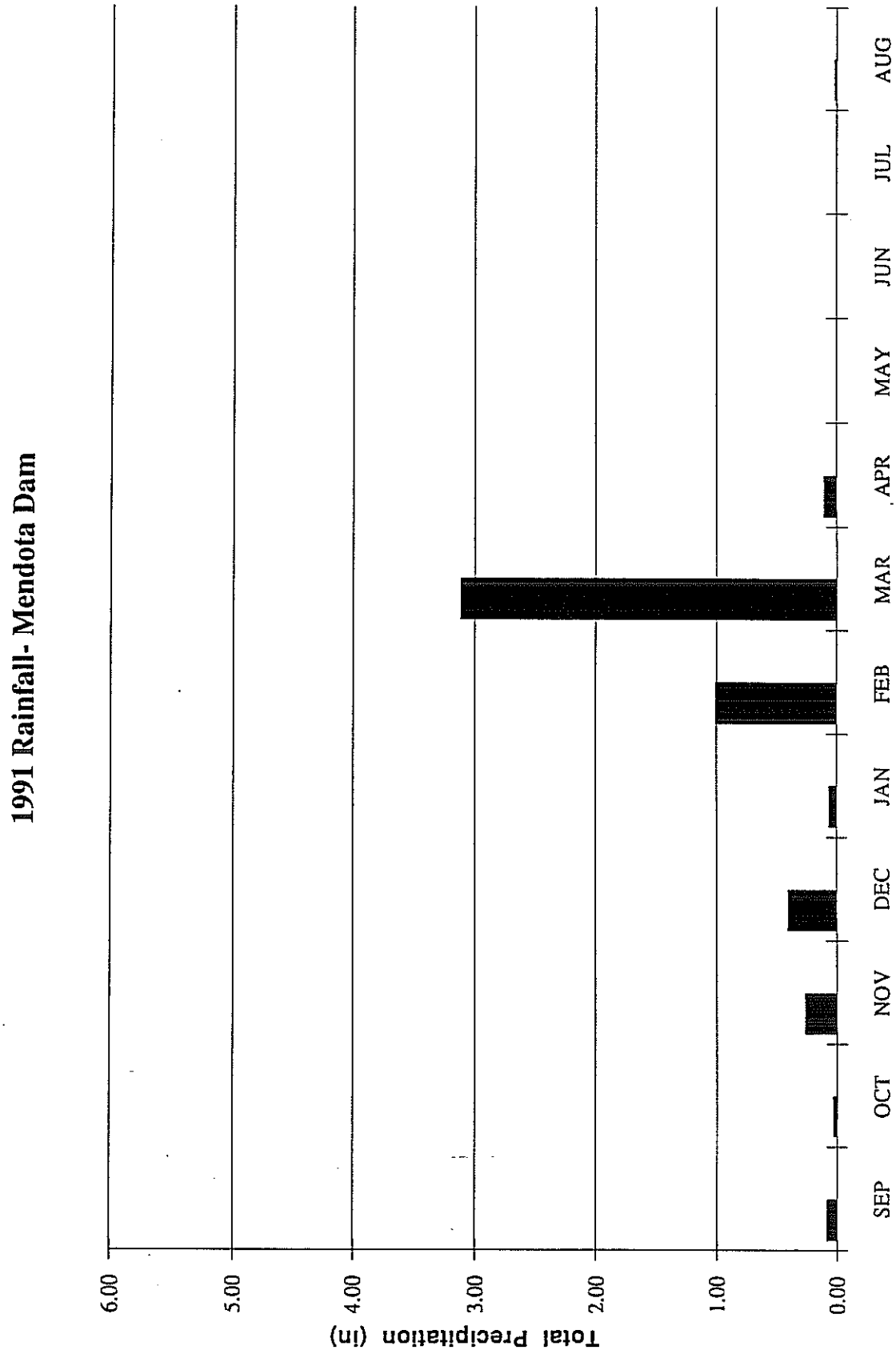
AUG


1991 Rainfall- Mendota Dam
Total Precipitation (in)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SEP
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APR
MAY
JUN
JUL
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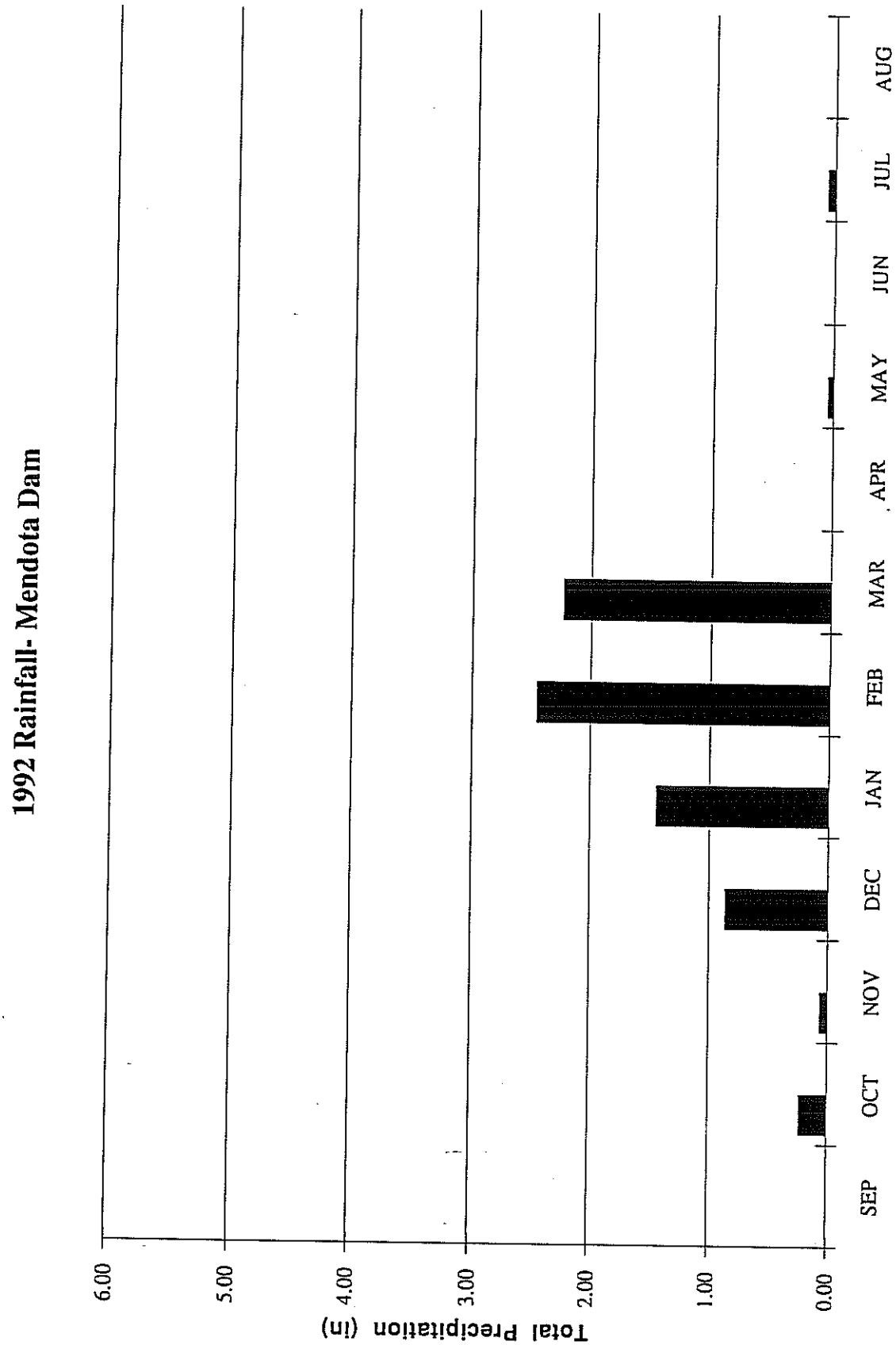
1992 Rainfall- Mendota Dam
Total Precipitation (in)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG

TECHNICAL APPENDIX D
IRRIGATION EFFICIENCY Spreadsheet
ETc Approach

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TECHNICAL APPENDIX D

Spreadsheet Output D3

Grasslands Basin Irrigation and Drainage Study
Cal Poly - ITRC

Kc Calc

Kc Values Used for the ETc Analysis

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Fallow	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Misc.	0.00	0.00	0.00	0.06	0.30	0.59	1.02	0.92	0.00	0.00	0.00	0.00
Cotton	0.05	0.00	0.00	0.00	0.00	0.00	0.10	0.23	0.70	1.03	1.02	0.56
Alfalfa	0.79	0.57	0.36	0.25	0.32	0.82	0.90	0.90	0.90	0.90	0.90	0.90
Wheat	0.00	0.04	0.23	0.54	0.95	1.17	1.04	0.47	0.00	0.00	0.00	0.00
Melons	0.00	0.00	0.00	0.00	0.00	0.04	0.18	0.43	0.94	0.16	0.00	0.00
Processing	0.00	0.00	0.00	0.00	0.00	0.05	0.24	0.40	0.90	1.10	0.85	0.00
Sugar Beets	1.10	1.10	1.10	1.10	1.04	0.44	0.00	0.13	0.38	0.96	1.10	1.10
Barley	0.00	0.03	0.23	0.53	0.93	1.15	0.96	0.30	0.00	0.00	0.00	0.00
Beans	0.00	0.00	0.00	0.00	0.00	0.03	0.14	0.78	1.14	0.56	0.00	0.00
Seed Alf.	0.00	0.03	0.20	0.24	0.47	0.74	0.97	0.97	0.66	0.19	0.00	0.00
Rice	0.00	0.00	0.00	0.00	0.00	0.19	0.95	1.14	1.25	1.17	1.02	0.00
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.36	0.88	1.10	0.93	0.27
Vegetable	0.00	0.00	0.00	0.06	0.30	0.59	1.02	0.92	0.00	0.00	0.00	0.00
Pasture	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Stonefruit/	0.89	0.00	0.00	0.00	0.00	0.50	0.76	0.89	0.98	0.98	0.98	0.97
Walnut/Apple	0.42	0.06	0.00	0.00	0.00	0.54	0.84	0.95	1.06	1.14	1.09	0.77
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.16	0.51	1.04	0.93	0.59

Kc Values Used for the ETc Analysis

Adjustment to account for poor stands = 88%

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Fallow	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Misc.	0.00	0.00	0.00	0.05	0.26	0.51	0.88	0.79	0.00	0.00	0.00	0.00
Cotton	0.04	0.00	0.00	0.00	0.00	0.00	0.09	0.19	0.60	0.89	0.88	0.49
Alfalfa	0.68	0.49	0.31	0.22	0.28	0.70	0.77	0.77	0.77	0.77	0.77	0.77
Wheat	0.00	0.03	0.20	0.46	0.82	1.01	0.90	0.40	0.00	0.00	0.00	0.00
Melons	0.00	0.00	0.00	0.00	0.00	0.03	0.15	0.37	0.81	0.16	0.00	0.00
Processing	0.00	0.00	0.00	0.00	0.00	0.04	0.21	0.34	0.78	0.95	0.73	0.00
Sugar Beets	0.95	0.95	0.95	0.94	0.89	0.38	0.00	0.11	0.33	0.83	0.95	0.95
Barley	0.00	0.03	0.20	0.46	0.80	0.99	0.85	0.26	0.00	0.00	0.00	0.00
Beans	0.00	0.00	0.00	0.00	0.00	0.03	0.12	0.67	0.98	0.48	0.00	0.00
Seed Alf.	0.00	0.03	0.17	0.21	0.41	0.63	0.84	0.83	0.57	0.17	0.00	0.00
Rice	0.00	0.00	0.00	0.00	0.00	0.16	0.82	0.98	1.08	1.01	0.88	0.00
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.31	0.75	0.95	0.80	0.24
Vegetable	0.00	0.00	0.00	0.05	0.26	0.51	0.88	0.79	0.00	0.00	0.00	0.00
Pasture	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Stonefruit/	0.77	0.00	0.00	0.00	0.00	0.43	0.67	0.77	0.84	0.84	0.84	0.83
Walnut/Apple	0.36	0.05	0.00	0.00	0.00	0.46	0.72	0.82	0.91	0.98	0.94	0.66
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.14	0.44	0.90	0.80	0.51

File: DIE - ETo Approach
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Grasslands Basin Irrigation and Drainage Study
Cal Poly - ITRC

ETo Calc

ETo @ CIMIS #7 - inches

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1981*	3.83	1.96	1.14	1.19	2.05	3.80	5.75	7.70	8.45	8.50	7.09	5.43	57
1982*	3.83	1.96	1.14	1.19	2.05	3.80	5.75	7.70	8.45	8.50	7.09	5.43	57
1983	3.83	1.96	1.14	0.85	1.80	3.00	4.84	8.80	9.57	9.24	7.48	5.73	58
1984	3.45	1.55	0.95	0.88	2.16	4.60	5.77	8.96	8.55	8.57	7.11	6.28	59
1985	3.83	1.75	1.74	0.96	2.37	3.53	6.43	7.56	8.57	8.19	7.19	5.40	58
1986	3.88	1.81	0.77	1.24	2.03	3.50	5.59	7.50	8.04	7.90	7.30	5.07	55
1987	4.01	2.54	0.73	1.32	1.71	3.78	6.65	7.71	8.29	8.25	7.06	5.40	57
1988	3.66	1.62	1.39	1.21	2.65	5.20	4.98	7.25	7.47	8.40	6.72	5.31	56
1989	3.30	1.59	0.94	1.49	1.70	3.83	5.75	7.86	8.58	8.95	7.40	5.12	57
1990	3.94	1.98	1.05	1.34	1.94	3.76	6.14	7.02	8.44	8.46	7.03	5.41	57
1991	4.44	2.55	1.51	1.31	2.09	2.97	5.61	6.66	8.57	8.57	6.51	5.15	56
1992	3.96	2.44	1.17	0.73	1.81	3.01	5.81	8.12	7.74	7.94	7.32	5.69	56
Average	3.83	1.96	1.14	1.15	2.03	3.73	5.76	7.74	8.39	8.46	7.13	5.45	56.74
Std Dev													

ETc Calc

1981 ETc = ETo * Kc adj.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total, Inches
Fallow	0.20	0.10	0.06	0.06	0.11	0.20	0.30	0.40	0.44	0.44	0.37	0.26	3
Misc.	0.00	0.00	0.00	0.06	0.53	1.93	5.04	6.10	0.00	0.00	0.00	0.00	14
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.51	1.49	5.07	7.54	6.22	2.64	24
Alfalfa	2.60	0.97	0.35	0.26	0.57	2.67	4.45	5.96	6.54	6.58	5.49	4.20	41
Wheat	0.00	0.06	0.22	0.55	1.67	3.82	5.17	3.11	0.00	0.00	0.00	0.00	15
Melons	0.00	0.00	0.00	0.00	0.00	0.12	0.89	2.88	6.85	1.34	0.00	0.00	12
Processing	0.00	0.00	0.00	0.00	0.00	0.15	1.19	2.64	6.56	8.04	5.17	0.00	24
Sugar Beets	3.62	1.85	1.06	1.12	1.83	1.45	0.00	0.84	2.78	7.04	6.71	5.14	33
Barley	0.00	0.06	0.22	0.54	1.65	3.75	4.86	1.98	0.00	0.00	0.00	0.00	13
Beans	0.00	0.00	0.00	0.00	0.00	0.09	0.69	3.16	8.26	4.12	0.00	0.00	18
Seed Alf.	0.00	0.06	0.20	0.25	0.85	2.40	4.82	6.42	4.83	1.41	0.00	0.00	25
Rice	0.00	0.00	0.00	0.00	0.00	0.61	4.72	7.55	9.09	8.58	6.25	0.00	37
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.61	2.36	6.38	8.04	5.68	1.28	24
Vegetable	0.00	0.00	0.00	0.06	0.53	1.93	5.04	6.10	0.00	0.00	0.00	0.00	14
Pasture	2.97	1.52	0.88	0.92	1.59	2.94	4.45	5.96	6.54	6.58	5.49	4.30	44
Stonefruit/	2.94	0.00	0.00	0.00	0.00	1.63	3.86	5.92	7.09	7.17	5.97	4.52	39
Walnut/Apple	1.39	0.10	0.00	0.00	0.00	1.75	4.14	6.26	7.70	8.32	6.65	3.60	48
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.16	1.06	3.69	7.64	5.64	2.77	21

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Grasslands Basin Irrigation and Drainage Study
Cal Poly - ITRC

1982 ETc

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total, Inches
Fallow	0.20	0.10	0.06	0.06	0.11	0.20	0.30	0.40	0.44	0.44	0.37	0.28	3
Misc.	0.00	0.00	0.00	0.06	0.53	1.93	5.04	6.10	0.00	0.00	0.00	0.00	14
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.51	1.49	5.07	7.54	6.22	2.64	24
Alfalfa	2.60	0.97	0.35	0.26	0.57	2.67	4.45	5.96	6.54	6.58	5.49	4.20	41
Wheat	0.00	0.06	0.22	0.55	1.67	3.82	5.17	3.11	0.00	0.00	0.00	0.00	15
Melons	0.00	0.00	0.00	0.00	0.00	0.12	0.89	2.68	6.65	1.34	0.00	0.00	12
Processing	0.00	0.00	0.00	0.00	0.00	0.15	1.19	2.64	6.56	8.04	5.17	0.00	24
Sugar Beets	3.62	1.85	1.08	1.12	1.83	1.45	0.00	0.84	2.78	7.04	6.71	5.14	33
Barley	0.00	0.06	0.22	0.54	1.65	3.75	4.86	1.98	0.00	0.00	0.00	0.00	13
Beans	0.00	0.00	0.00	0.00	0.00	0.09	0.69	5.16	8.26	4.12	0.00	0.00	18
Seed Alf.	0.00	0.06	0.20	0.25	0.83	2.40	4.82	6.42	4.83	1.41	0.00	0.00	21
Rice	0.00	0.00	0.00	0.00	0.00	0.61	4.72	7.55	9.09	8.58	6.23	0.00	37
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.61	2.36	6.36	8.04	5.68	1.28	24
Vegetable	0.00	0.00	0.00	0.06	0.53	1.93	5.04	6.10	0.00	0.00	0.00	0.00	14
Pasture	2.97	1.52	0.88	0.92	1.59	2.94	4.45	5.96	6.54	6.58	5.49	4.20	44
Stonefruit/	2.94	0.00	0.00	0.00	0.00	1.63	3.88	5.92	7.09	7.17	5.97	4.52	38
Walnut/Apple	1.39	0.10	0.00	0.00	0.00	1.75	4.14	6.28	7.70	8.32	6.65	3.60	40
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.16	1.06	3.88	7.64	5.64	2.77	21

1983 ETc

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total, Inches
Fallow	0.20	0.10	0.06	0.04	0.09	0.15	0.25	0.45	0.49	0.48	0.39	0.30	3
Misc.	0.00	0.00	0.00	0.04	0.46	1.52	4.24	6.97	0.00	0.00	0.00	0.00	13
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.43	1.71	5.74	8.20	6.56	2.78	24
Alfalfa	2.60	0.97	0.35	0.18	0.50	2.11	3.75	6.81	7.41	7.15	5.79	4.44	42
Wheat	0.00	0.06	0.22	0.39	1.47	3.02	4.35	3.55	0.00	0.00	0.00	0.00	13
Melons	0.00	0.00	0.00	0.00	0.00	0.09	0.75	3.29	7.75	1.46	0.00	0.00	13
Processing	0.00	0.00	0.00	0.00	0.00	0.12	1.00	3.02	7.43	8.74	5.46	0.00	26
Sugar Beets	3.62	1.85	1.08	0.60	1.61	1.14	0.00	0.96	3.15	7.65	7.06	5.42	34
Barley	0.00	0.06	0.22	0.39	1.45	2.96	4.09	2.27	0.00	0.00	0.00	0.00	11
Beans	0.00	0.00	0.00	0.00	0.00	0.07	0.56	5.89	9.35	4.47	0.00	0.00	20
Seed Alf.	0.00	0.06	0.20	0.18	0.73	1.90	4.05	7.33	5.46	1.54	0.00	0.00	21
Rice	0.00	0.00	0.00	0.00	0.00	0.48	3.97	8.63	10.29	9.33	6.58	0.00	39
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.51	2.70	7.22	8.74	5.98	1.55	27
Vegetable	0.00	0.00	0.00	0.04	0.46	1.52	4.24	6.97	0.00	0.00	0.00	0.00	13
Pasture	2.97	1.52	0.88	0.66	1.39	2.32	3.75	6.81	7.41	7.15	5.79	4.44	45
Stonefruit/	2.94	0.00	0.00	0.00	0.00	1.28	3.26	6.76	8.03	7.79	6.30	4.77	41
Walnut/Apple	1.39	0.10	0.00	0.00	0.00	1.38	3.48	7.17	8.72	9.04	7.01	3.80	42
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.13	1.21	4.17	8.30	5.95	2.93	23

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Grasslands Basin Irrigation and Drainage Study
Cal Poly - ITRC

1984 ETc

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total, Inches
Fallow	0.18	0.07	0.05	0.05	0.11	0.24	0.30	0.46	0.44	0.44	0.37	0.32	3
Misc.	0.00	0.00	0.00	0.05	0.56	2.33	5.06	7.10	0.00	0.00	0.00	0.00	15
Cotton	0.14	0.00	0.00	0.00	0.00	0.00	0.52	1.74	5.13	7.60	6.24	3.05	24
Alfalfa	2.34	0.67	0.39	0.31	0.60	3.24	4.47	6.94	6.62	6.63	5.50	4.86	42
Wheat	0.00	0.04	0.19	0.45	1.76	4.62	5.18	3.62	0.00	0.00	0.00	0.00	16
Melons	0.00	0.00	0.00	0.00	0.00	0.14	0.89	3.35	6.92	1.33	0.00	0.00	13
Processing	0.00	0.00	0.00	0.00	0.00	0.19	1.19	3.07	6.64	6.11	5.19	0.00	24
Sugar Beets	3.26	1.28	0.90	0.93	1.93	1.75	0.00	0.97	2.81	7.10	6.73	5.94	34
Barley	0.00	0.04	0.19	0.45	1.74	4.54	4.88	2.31	0.00	0.00	0.00	0.00	14
Beans	0.00	0.00	0.00	0.00	0.00	0.11	0.69	6.00	8.36	4.15	0.00	0.00	19
Seed Alf.	0.00	0.04	0.16	0.20	0.88	2.91	4.83	7.47	4.88	1.42	0.00	0.00	23
Rice	0.00	0.00	0.00	0.00	0.00	0.74	4.74	8.79	9.19	8.63	6.25	0.00	38
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.61	2.75	6.45	8.11	5.70	1.45	25
Vegetable	0.00	0.00	0.00	0.05	0.56	2.33	5.06	7.10	0.00	0.00	0.00	0.00	15
Pasture	2.67	1.04	0.74	0.76	1.67	3.56	4.47	6.94	6.62	6.63	5.50	4.86	43
Stonefruit/	2.65	0.00	0.00	0.00	0.00	1.97	3.89	6.69	7.17	7.22	5.99	5.22	41
Walnut/Apple	1.25	0.07	0.00	0.00	0.00	2.12	4.15	7.30	7.79	8.38	6.67	4.16	42
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.16	1.23	3.73	7.68	5.68	3.21	23

1985 ETc

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total, Inches
Fallow	0.20	0.09	0.09	0.05	0.12	0.18	0.35	0.39	0.44	0.42	0.37	0.26	3
Misc.	0.00	0.00	0.00	0.05	0.61	1.79	5.64	5.89	0.00	0.00	0.00	0.00	14
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.58	1.47	5.14	7.27	6.31	2.62	24
Alfalfa	2.59	0.86	0.54	0.21	0.66	3.48	4.96	5.85	6.63	6.34	5.57	4.16	41
Wheat	0.00	0.05	0.34	0.44	1.94	3.55	5.77	3.05	0.00	0.00	0.00	0.00	15
Melons	0.00	0.00	0.00	0.00	0.00	0.11	1.00	2.83	6.94	1.29	0.00	0.00	13
Processing	0.00	0.00	0.00	0.00	0.00	0.14	1.33	2.59	6.65	7.75	5.24	0.00	24
Sugar Beets	3.62	1.66	1.65	0.91	2.12	1.35	0.00	0.82	2.82	6.78	6.60	5.11	34
Barley	0.00	0.05	0.34	0.44	1.90	3.49	5.44	1.95	0.00	0.00	0.00	0.00	14
Beans	0.00	0.00	0.00	0.00	0.00	0.08	0.77	5.06	8.38	3.96	0.00	0.00	18
Seed Alf.	0.00	0.05	0.30	0.20	0.96	2.24	5.38	6.30	4.89	1.36	0.00	0.00	22
Rice	0.00	0.00	0.00	0.00	0.00	0.57	5.28	7.41	9.21	8.27	6.32	0.00	37
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.68	2.32	6.46	7.75	5.76	1.37	24
Vegetable	0.00	0.00	0.00	0.05	0.61	1.79	5.64	5.89	0.00	0.00	0.00	0.00	14
Pasture	2.96	1.35	1.35	0.74	1.83	2.73	4.96	5.85	6.63	6.34	5.57	4.16	45
Stonefruit/	2.94	0.00	0.00	0.00	0.00	1.51	4.33	5.61	7.19	6.90	6.06	4.49	39
Walnut/Apple	1.39	0.09	0.00	0.00	0.00	1.62	4.62	6.16	7.81	8.01	6.74	3.58	40
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.18	1.04	3.74	7.35	5.72	2.76	21

File: OIE - ETo Approach
Date: 2/23/94

Grasslands Basin Irrigation and Drainage Study
Cal Poly - ITRC

1986 ETc

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total, Inches
Fallow	0.20	0.09	0.04	0.06	0.10	0.16	0.29	0.39	0.41	0.41	0.36	0.26	3
Misc.	0.00	0.00	0.00	0.06	0.52	1.78	4.90	5.94	0.00	0.00	0.00	0.00	13
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.50	1.45	4.82	7.01	6.41	2.46	23
Alfalfa	3.63	0.89	0.24	0.27	0.57	2.46	4.53	5.81	6.22	6.11	5.65	3.92	39
Wheat	0.00	0.06	0.15	0.57	1.66	3.52	3.02	3.03	0.00	0.00	0.00	0.00	14
Melons	0.00	0.00	0.00	0.00	0.00	0.11	0.67	2.80	6.51	1.25	0.00	0.00	12
Processing	0.00	0.00	0.00	0.00	0.00	0.14	1.15	2.57	6.24	7.47	5.32	0.00	23
Sugar Beets	3.67	1.71	0.73	1.17	1.82	1.33	0.00	0.82	2.64	6.54	6.91	4.80	32
Barley	0.00	0.05	0.15	0.57	1.63	3.46	4.73	1.93	0.00	0.00	0.00	0.00	13
Beans	0.00	0.00	0.00	0.00	0.00	0.08	0.67	3.02	7.86	3.82	0.00	0.00	17
Seed Alf.	0.00	0.05	0.13	0.26	0.82	2.22	4.68	6.25	4.59	1.31	0.00	0.00	20
Rice	0.00	0.00	0.00	0.00	0.00	0.56	4.59	7.36	8.64	7.98	6.42	0.00	36
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.59	2.30	6.06	7.47	5.85	1.20	23
Vegetable	0.00	0.00	0.00	0.06	0.52	1.78	4.90	5.94	0.00	0.00	0.00	0.00	13
Pasture	3.00	1.40	0.60	0.96	1.57	2.71	4.33	5.81	6.22	6.11	5.65	3.92	42
Stonefruit/	2.98	0.00	0.00	0.00	0.00	1.50	3.77	5.77	6.75	6.46	6.15	4.22	38
Walnut/Apple	1.41	0.09	0.00	0.00	0.00	1.61	4.02	6.11	7.33	7.73	6.84	3.36	38
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.15	1.03	3.51	7.09	5.81	2.59	20

1987 ETc

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total, Inches
Fallow	0.21	0.13	0.04	0.07	0.09	0.20	0.34	0.40	0.43	0.43	0.36	0.28	3
Misc.	0.00	0.00	0.00	0.07	0.44	1.92	5.83	6.11	0.00	0.00	0.00	0.00	14
Cotton	0.17	0.00	0.00	0.00	0.00	0.00	0.59	1.49	4.97	7.32	6.19	2.62	23
Alfalfa	2.72	1.25	0.23	0.26	0.48	2.66	5.15	5.97	6.42	6.39	5.46	4.16	41
Wheat	0.00	0.08	0.14	0.61	1.40	3.80	3.97	3.11	0.00	0.00	0.00	0.00	15
Melons	0.00	0.00	0.00	0.00	0.00	0.12	1.03	2.88	6.71	1.30	0.00	0.00	12
Processing	0.00	0.00	0.00	0.00	0.00	0.15	1.37	2.64	6.43	7.80	5.13	0.00	24
Sugar Beets	3.80	2.40	0.69	1.23	1.53	1.44	0.00	0.84	2.73	6.83	6.68	5.11	33
Barley	0.00	0.07	0.14	0.60	1.37	3.73	5.62	1.99	0.00	0.00	0.00	0.00	14
Beans	0.00	0.00	0.00	0.00	0.00	0.09	0.80	5.16	8.10	3.99	0.00	0.00	18
Seed Alf.	0.00	0.07	0.13	0.27	0.69	2.39	5.57	6.43	4.73	1.37	0.00	0.00	22
Rice	0.00	0.00	0.00	0.00	0.00	0.61	5.46	7.56	8.91	8.33	6.21	0.00	37
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.70	2.37	6.25	7.80	5.66	1.27	24
Vegetable	0.00	0.00	0.00	0.07	0.44	1.92	5.83	6.11	0.00	0.00	0.00	0.00	14
Pasture	3.11	1.97	0.57	1.02	1.32	2.93	5.15	5.97	6.42	6.39	5.46	4.16	44
Stonefruit/	3.09	0.00	0.00	0.00	0.00	1.62	4.48	5.93	6.96	6.85	5.93	4.49	39
Walnut/Apple	1.46	0.13	0.00	0.00	0.00	1.74	4.76	6.29	7.56	8.07	6.62	3.58	40
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.18	1.06	3.62	7.41	5.62	2.74	21

File: DIE - ETc Approach
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Grasslands Basin Irrigation and Drainage Study
Cal Poly - ITRC

1988 ETc

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total, Inches
Fallow	0.19	0.06	0.07	0.06	0.14	0.27	0.26	0.37	0.39	0.43	0.35	0.27	3
Misc.	0.00	0.00	0.00	0.06	0.66	2.64	4.37	5.74	0.00	0.00	0.00	0.00	13
Cotton	0.15	0.00	0.00	0.00	0.00	0.00	0.45	1.41	4.48	7.45	5.90	2.58	22
Alfalfa	2.46	0.60	0.43	0.26	0.74	3.66	3.85	5.61	5.78	6.50	5.20	4.11	39
Wheat	0.00	0.05	0.27	0.56	2.16	5.23	4.47	2.97	0.00	0.00	0.00	0.00	16
Melons	0.00	0.00	0.00	0.00	0.00	0.16	0.77	2.71	6.05	1.32	0.00	0.00	11
Processing	0.00	0.00	0.00	0.00	0.00	0.21	1.03	2.49	5.60	7.95	4.90	0.00	22
Sugar Beets	3.46	1.33	1.31	1.14	2.37	1.96	0.00	0.79	2.46	6.96	6.56	5.02	33
Barley	0.00	0.05	0.27	0.55	2.13	5.14	4.21	1.87	0.00	0.00	0.00	0.00	14
Beans	0.00	0.00	0.00	0.00	0.00	0.12	0.60	4.85	7.30	4.07	0.00	0.00	17
Seed Alf.	0.00	0.05	0.24	0.25	1.08	3.29	4.17	6.04	4.26	1.40	0.00	0.00	21
Rice	0.00	0.00	0.00	0.00	0.00	0.84	4.09	7.11	8.03	8.48	5.91	0.00	34
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.52	2.23	5.63	7.95	5.38	1.25	23
Vegetable	0.00	0.00	0.00	0.06	0.66	2.64	4.37	5.74	0.00	0.00	0.00	0.00	13
Pasture	2.63	1.25	1.08	0.94	2.05	4.02	3.85	5.61	5.78	6.50	5.20	4.11	43
Stonefruit/	2.81	0.00	0.00	0.00	0.00	2.23	3.36	5.57	6.27	7.08	5.66	4.42	37
Walnut/Apple	1.33	0.08	0.00	0.00	0.00	2.39	3.58	5.81	6.81	6.22	6.30	3.52	38
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.14	1.00	3.26	7.54	5.35	2.71	20

1989 ETc

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total, Inches
Fallow	0.17	0.06	0.05	0.06	0.09	0.20	0.30	0.41	0.44	0.46	0.38	0.26	3
Misc.	0.00	0.00	0.00	0.06	0.44	1.94	5.04	6.22	0.00	0.00	0.00	0.00	14
Cotton	0.14	0.00	0.00	0.00	0.00	0.00	0.51	1.52	5.14	7.94	6.49	2.49	24
Alfalfa	2.24	0.79	0.29	0.32	0.47	2.70	4.45	6.08	6.64	6.93	5.73	3.96	41
Wheat	0.00	0.05	0.19	0.69	1.38	3.65	5.16	3.17	0.00	0.00	0.00	0.00	14
Melons	0.00	0.00	0.00	0.00	0.00	0.12	0.89	2.94	6.95	1.41	0.00	0.00	12
Processing	0.00	0.00	0.00	0.00	0.00	0.16	1.19	2.70	6.66	8.47	5.40	0.00	25
Sugar Beets	3.12	1.50	0.89	1.41	1.52	1.44	0.00	0.86	2.82	7.41	7.00	4.84	33
Barley	0.00	0.05	0.19	0.66	1.37	3.78	4.86	2.02	0.00	0.00	0.00	0.00	13
Beans	0.00	0.00	0.00	0.00	0.00	0.09	0.69	5.26	8.38	4.33	0.00	0.00	18
Seed Alf.	0.00	0.04	0.16	0.31	0.69	2.43	4.81	6.55	4.90	1.49	0.00	0.00	21
Rice	0.00	0.00	0.00	0.00	0.00	0.62	4.72	7.71	9.22	9.04	6.51	0.00	38
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.61	2.41	6.47	8.47	5.93	1.21	25
Vegetable	0.00	0.00	0.00	0.06	0.44	1.94	5.04	6.22	0.00	0.00	0.00	0.00	14
Pasture	2.55	1.23	0.73	1.15	1.32	2.96	4.45	6.08	6.64	6.93	5.73	3.96	44
Stonefruit/	2.53	0.00	0.00	0.00	0.00	1.64	3.88	6.04	7.20	7.54	6.24	4.26	39
Walnut/Apple	1.20	0.08	0.00	0.00	0.00	1.76	4.13	6.41	7.62	8.73	6.94	3.38	40
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.16	1.08	3.74	8.04	5.89	2.62	22

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Grasslands Basin Irrigation and Drainage Study
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1990 ETc

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total, Inches
Fallow	0.20	0.10	0.05	0.07	0.10	0.19	0.32	0.36	0.44	0.44	0.36	0.26	3
Misc.	0.00	0.00	0.00	0.07	0.50	1.91	5.38	5.56	0.00	0.00	0.00	0.00	13
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.55	1.36	5.06	7.51	6.17	2.63	23
Alfalfa	2.67	0.98	0.33	0.29	0.54	2.65	4.75	5.43	6.53	6.55	5.44	4.19	40
Wheat	0.00	0.06	0.21	0.62	1.58	3.78	5.51	2.83	0.00	0.00	0.00	0.00	15
Melons	0.00	0.00	0.00	0.00	0.00	0.11	0.95	2.62	6.63	1.33	0.00	0.00	12
Processing	0.00	0.00	0.00	0.00	0.00	0.15	1.27	2.41	6.55	8.00	5.13	0.00	24
Sugar Beets	3.73	1.87	0.99	1.27	1.74	1.43	0.00	0.76	2.77	7.01	6.65	5.12	33
Barley	0.00	0.06	0.21	0.61	1.56	3.71	5.19	1.81	0.00	0.00	0.00	0.00	13
Beans	0.00	0.00	0.00	0.00	0.00	0.09	0.74	4.70	6.25	4.10	0.00	0.00	18
Seed Alf.	0.00	0.06	0.16	0.28	0.79	2.36	5.14	5.85	4.62	1.41	0.00	0.00	21
Rice	0.00	0.00	0.00	0.00	0.00	0.61	5.04	6.88	5.07	8.54	6.18	0.00	36
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.65	2.15	6.37	8.00	5.63	1.38	24
Vegetable	0.00	0.00	0.00	0.07	0.50	1.91	5.38	5.56	0.00	0.00	0.00	0.00	13
Pasture	3.05	1.53	0.81	1.04	1.50	2.91	4.75	5.43	6.53	6.55	5.44	4.19	44
Stonefruit/	3.02	0.00	0.00	0.00	0.00	1.61	4.14	5.40	7.08	7.13	5.92	4.50	39
Walnut/Apple	1.43	0.10	0.00	0.00	0.00	1.73	4.41	5.72	7.69	8.28	6.59	3.58	40
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.97	3.68	7.60	5.60	3.76	21

1991 ETc

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total, Inches
Fallow	0.23	0.13	0.08	0.07	0.11	0.15	0.29	0.34	0.44	0.44	0.34	0.27	3
Misc.	0.00	0.00	0.00	0.07	0.54	1.51	4.92	5.27	0.00	0.00	0.00	0.00	12
Cotton	0.19	0.00	0.00	0.00	0.00	0.00	0.50	1.29	5.14	7.60	5.71	2.50	23
Alfalfa	3.01	1.26	0.47	0.28	0.58	2.09	4.34	5.15	6.63	6.63	5.04	3.99	39
Wheat	0.00	0.08	0.30	0.60	1.71	2.99	5.04	2.69	0.00	0.00	0.00	0.00	13
Melons	0.00	0.00	0.00	0.00	0.00	0.09	0.87	2.49	6.94	1.35	0.00	0.00	12
Processing	0.00	0.00	0.00	0.00	0.00	0.12	1.16	2.28	6.65	8.11	4.75	0.00	23
Sugar Beets	4.20	2.41	1.43	1.24	1.87	1.13	0.00	0.72	2.82	7.10	6.16	4.87	34
Barley	0.00	0.07	0.30	0.60	1.68	2.93	4.74	1.72	0.00	0.00	0.00	0.00	12
Beans	0.00	0.00	0.00	0.00	0.00	0.07	0.68	4.46	6.38	4.15	0.00	0.00	18
Seed Alf.	0.00	0.07	0.26	0.27	0.85	1.86	4.70	5.55	4.89	1.42	0.00	0.00	20
Rice	0.00	0.00	0.00	0.00	0.00	0.48	4.61	6.53	9.21	6.65	5.72	0.00	33
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.59	2.04	6.46	8.11	5.22	1.22	24
Vegetable	0.00	0.00	0.00	0.07	0.54	1.51	4.92	5.27	0.00	0.00	0.00	0.00	12
Pasture	3.44	1.97	1.17	1.01	1.62	2.30	4.34	5.15	6.63	6.63	5.04	3.99	43
Stonefruit/	3.41	0.00	0.00	0.00	0.00	1.27	3.78	5.12	7.19	7.22	5.49	4.26	38
Walnut/Apple	1.61	0.13	0.00	0.00	0.00	1.37	4.03	5.43	7.81	8.38	6.10	3.41	38
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.92	3.74	7.69	5.18	3.63	20

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Grasslands Basin Irrigation and Drainage Study
Cal Poly - ITRC

1992 ETc

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total, Inches
Fallow	0.20	0.13	0.06	0.04	0.09	0.16	0.30	0.42	0.40	0.41	0.38	0.29	3
Misc.	0.00	0.00	0.00	0.04	0.47	1.53	5.08	6.43	0.00	0.00	0.00	0.00	14
Cotton	0.17	0.00	0.00	0.00	0.00	0.00	0.52	1.57	4.64	7.04	6.60	2.76	23
Alfalfa	2.68	1.20	0.36	0.16	0.51	2.12	4.50	6.28	5.89	6.15	5.82	4.40	40
Wheat	0.00	0.08	0.23	0.34	1.48	3.03	5.22	3.28	0.00	0.00	0.00	0.00	14
Melons	0.00	0.00	0.00	0.00	0.00	0.09	0.90	3.04	6.27	1.25	0.00	0.00	12
Processing	0.00	0.00	0.00	0.00	0.00	0.12	1.20	2.76	6.01	7.51	5.48	0.00	23
Sugar Beets	3.75	2.31	1.11	0.69	1.62	1.15	0.00	0.88	2.54	6.56	7.11	5.38	33
Barley	0.00	0.07	0.33	0.33	1.45	2.97	4.91	2.09	0.00	0.00	0.00	0.00	12
Beans	0.00	0.00	0.00	0.00	0.00	0.07	0.70	5.44	7.56	3.84	0.00	0.00	18
Seed Alf.	0.00	0.07	0.20	0.15	0.74	1.91	4.86	6.77	4.42	1.32	0.00	0.00	20
Rice	0.00	0.00	0.00	0.00	0.00	0.48	4.77	7.96	8.32	8.02	6.41	0.00	36
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.61	2.49	5.84	7.51	6.02	1.34	24
Vegetable	0.00	0.00	0.00	0.04	0.47	1.53	5.09	6.43	0.00	0.00	0.00	0.00	14
Pasture	3.07	1.69	0.91	0.57	1.40	2.33	4.50	6.28	5.99	6.15	5.82	4.40	43
Stonefruit/	3.04	0.00	0.00	0.00	0.00	1.28	3.93	6.24	6.49	6.69	6.34	4.73	38
Walnut/Apple	1.44	0.12	0.00	0.00	0.00	1.39	4.18	6.62	7.05	7.77	7.05	3.77	38
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.16	1.12	3.38	7.13	5.99	2.91	21

1980 -1992 Average ETc

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total, Inches
Fallow	0.20	0.10	0.06	0.06	0.10	0.19	0.30	0.40	0.43	0.44	0.37	0.28	3
Misc.	0.00	0.00	0.00	0.06	0.52	1.89	5.05	6.13	0.00	0.00	0.00	0.00	14
Cotton	0.16	0.00	0.00	0.00	0.00	0.00	0.51	1.50	5.03	7.50	6.25	2.65	24
Alfalfa	2.60	0.97	0.35	0.25	0.57	2.63	4.46	5.99	6.50	6.55	5.51	4.22	41
Wheat	0.00	0.06	0.22	0.53	1.66	3.75	5.17	3.12	0.00	0.00	0.00	0.00	15
Melons	0.00	0.00	0.00	0.00	0.00	0.11	0.89	2.89	6.80	1.35	0.00	0.00	12
Processing	0.00	0.00	0.00	0.00	0.00	0.15	1.19	2.65	6.52	8.00	5.20	0.00	24
Sugar Beets	3.62	1.85	1.08	1.05	1.82	1.42	0.00	0.84	2.76	7.00	6.74	5.16	33
Barley	0.00	0.06	0.22	0.52	1.63	3.69	4.67	1.99	0.00	0.00	0.00	0.00	13
Beans	0.00	0.00	0.00	0.00	0.00	0.09	0.68	5.18	8.20	4.09	0.00	0.00	18
Seed Alf.	0.00	0.06	0.20	0.24	0.82	2.36	4.82	6.45	4.79	1.40	0.00	0.00	21
Rice	0.00	0.00	0.00	0.00	0.00	0.60	4.73	7.59	9.02	8.54	6.26	0.00	37
Corn	0.00	0.00	0.00	0.00	0.00	0.00	0.61	2.37	6.33	8.00	5.71	1.29	24
Vegetable	0.00	0.00	0.00	0.06	0.52	1.89	5.05	6.13	0.00	0.00	0.00	0.00	14
Pasture	2.97	1.52	0.88	0.89	1.57	2.89	4.46	5.99	6.50	6.55	5.51	4.22	44
Stonefruit/	2.94	0.00	0.00	0.00	0.00	1.60	3.86	5.95	7.04	7.13	6.00	4.54	39
Walnut/Apple	1.39	0.10	0.00	0.00	0.00	1.72	4.14	6.31	7.65	8.27	6.68	3.61	40
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.16	1.06	3.66	7.59	5.67	2.79	21

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Grasslands Basin Irrigation and Drainage Study
Cal Poly - ITRC

Acreage

Panoche Drainage District

Acreage

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	1,165	1,216	4,703	869	869	1,468	798	852	1,028	4,235	7,916	8,566	2,407
Misc.	0	0	0	0	188	0	0	277	0	0	0	809	106
Cotton	18,036	10,262	13,529	17,057	15,331	14,924	14,895	18,560	15,239	14,601	13,056	12,477	14,632
Alfalfa	1,454	550	872	1,543	1,543	2,464	2,439	2,853	2,999	3,546	2,712	2,867	2,154
Wheat	4,419	1,059	2,524	3,593	2,823	2,115	3,622	837	3,451	1,825	0	398	2,214
Melons	2,712	1,352	2,507	819	3,984	2,215	1,193	1,304	3,382	3,485	1,966	2,238	2,288
Processing	1,927	2,077	4,440	3,804	3,804	4,283	2,550	5,478	5,401	4,731	5,938	3,710	4,012
Sugar Beets	200	380	977	826	1,027	719	1,528	219	220	171	0	0	522
Barley	1,433	468	130	230	230	926	130	0	0	0	0	0	296
Beans	551	1,091	1,410	1,669	1,339	2,265	302	0	2,712	2,468	2,730	2,633	1,601
Seed Alf.	232	144	55	0	0	300	300	155	0	0	0	0	99
Rice	0	0	266	0	0	0	0	0	0	0	0	0	22
Corn	296	0	889	150	150	849	2,576	545	699	189	240	609	608
Vegetable	1,847	959	1,402	554	1,017	335	2,074	1,935	1,188	285	1,056	1,499	1,179
Pasture	111	111	111	0	680	45	0	1,122	26	0	0	0	184
Stonefruit/	301	301	301	301	301	317	273	58	217	117	33	226	229
Walnut/Apple	0	0	0	32	32	250	253	252	252	379	393	376	165
Sorghum	632	1,012	290	156	926	1,026	73	0	0	0	0	0	343
TOTAL (less fallow)	34,151	19,966	29,703	30,754	33,375	33,153	32,208	33,795	35,686	31,799	28,126	27,742	30,873

Broadview Water District

Acreage

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	0	334	3,790	95	345	854	1,128	531	452	799	3,460	4602	1,366
Misc.	290	300	0	140	150	140	75	0	147	0	50	148	120
Cotton	5,669	5,263	2,035	4,905	4,037	4,231	3,721	4,348	4,649	4,416	3,626	2257	4,115
Alfalfa	0	0	160	160	150	147	0	0	0	0	41	0	55
Wheat	1,046	1,149	835	900	983	968	1,160	689	708	903	304	0	804
Melons	0	455	450	300	790	670	1,080	1,535	1,279	814	198	446	668
Processing	220	0	300	150	750	750	450	680	840	850	682	1080	561
Sugar Beets	0	300	300	1,355	750	425	300	454	150	300	0	0	361
Barley	547	741	250	190	425	113	54	150	41	292	0	0	234
Beans	623	40	745	300	0	20	0	175	0	0	0	0	159
Seed Alf.	630	560	435	560	630	705	1,030	705	694	585	456	550	628
Rice	0	0	0	0	0	0	0	0	178	0	0		16
Corn	0	0	0	0	0	0	0	0	0	0	0	0	0
Vegetable	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture	0	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit/	0	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL (less fallow)	9,025	8,828	5,510	8,960	8,865	8,169	7,870	8,736	8,686	8,160	5,539	4,483	7,721

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Firebaugh Canal Water District

Acreage

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc.	0	0	0	0	0	0	0	0	0	0	0	0	0
Cotton	10,314	9,536	4,989	11,671	10,659	7,371	8,983	11,851	10,112	11,074	13,779	13,367	10,314
Alfalfa	1,611	522	935	964	992	1,218	1,692	1,834	2,119	2,298	2,550	2,600	1,611
Wheat	3,425	3,921	3,461	3,823	2,941	3,587	3,063	2,311	3,969	3,347	2,760	4,448	3,425
Melons	1,336	0	0	0	542	1,249	1,378	1,607	1,953	3,075	2,638	1,833	1,336
Processing	555	0	0	0	0	0	0	710	968	1,594	1,534	1,336	555
Sugar Beets	2,119	1,351	1,674	1,459	2,759	2,823	3,463	2,489	3,115	2,564	832	168	2,119
Barley	0	0	0	0	0	0	0	0	0	0	0	0	0
Beans	0	0	0	0	0	0	0	0	0	0	0	0	0
Seed Alf.	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice	1,101	1,946	3,057	1,691	649	1,240	1,143	1,387	601	302	88	111	1,101
Corn	141	125	157	0	0	1,269	0	0	0	0	0	0	141
Vegetable	793	2,208	1,763	1,083	749	811	565	66	515	303	312	353	793
Pasture	0	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit/	0	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	22	0	0	0	0	0	40	40	40	40	40	40	22
Sorghum (Cover)	517	35	726	0	0	237	634	1,077	1,354	861	145	418	517
TOTAL (less fallow)	21,938	20,244	18,784	20,691	19,731	19,825	20,981	23,282	24,746	25,458	24,676	24,894	21,936

Note: 1981 are average values.

Pacheco Water District

Acreage

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	0	0	714	622	1,120	720	802	321	739	0	0	0	420
Misc.	0	0	0	0	0	207	440	140	243	0	0	0	86
Cotton	2,663	1,727	2,271	2,271	2,263	2,076	2,194	2,320	2,080	2,011	2,138	2,373	2,189
Alfalfa	0	0	0	165	162	160	320	160	178	104	487	267	167
Wheat	734	271	60	60	0	0	20	139	257	370	0	0	139
Melons	37	0	0	0	675	1,057	823	966	516	1,363	747	433	551
Processing	0	0	0	0	0	0	0	311	210	318	472	395	142
Sugar Beets	0	0	0	0	0	0	0	0	0	0	0	0	0
Barley	169	0	0	0	0	0	0	143	127	7	0	0	39
Beans	153	517	702	702	0	0	0	0	37	0	110	127	196
Seed Alf.	234	1,330	0	0	0	0	0	0	0	0	0	0	130
Rice	0	0	0	0	0	0	0	0	0	0	0	0	0
Corn	0	165	165	0	0	0	0	0	0	0	0	0	28
Vegetable	0	0	98	98	0	0	231	0	0	81	415	120	87
Pasture	0	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit/	400	400	400	400	0	0	0	0	0	0	0	0	133
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL (less fallow)	4,410	4,410	3,696	3,696	3,100	3,500	4,026	4,179	3,648	4,254	4,369	3,705	3,916

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Charleston Drainage District
Acreage

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	140	115	146	261	526	861	34	171	151	612	416	416	339
Misc.	0	0	0	0	228	0	0	0	0	0	0	0	19
Cotton	669	318	1,604	1,996	1,206	1,864	2,453	1,671	2,408	2,544	2,595	2,595	1,835
Alfalfa	1,003	537	606	143	278	218	92	1,009	878	573	330	330	501
Wheat	0	0	0	0	0	0	0	0	0	0	0	0	0
Melons	490	367	346	1,256	677	515	1,057	514	53	257	525	525	549
Processing	218	460	104	0	0	0	0	74	114	60	280	280	133
Sugar Beets	776	649	692	80	0	200	108	69	149	60	80	80	245
Barley	153	0	0	0	293	0	0	0	0	0	0	0	37
Beans	0	0	0	0	0	0	0	44	0	0	0	0	4
Seed Alf.	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0	0
Corn	379	902	260	0	0	0	0	90	0	0	80	80	141
Vegetable	30	350	0	0	550	0	14	0	0	0	0	0	82
Pasture	0	0	0	0	0	0	0	111	0	0	0	0	9
Stonefruit/	0	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL (less fallow)	3,618	3,643	3,612	3,477	3,232	2,897	3,724	3,582	3,602	3,494	3,890	3,880	3,555

CCID - Comp13
Acreage

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	161	161	161	161	318	729	677	146	58	0	0	0	214
Misc.	0	0	0	0	0	0	0	0	0	0	0	0	0
Cotton	1,049	1,049	1,049	1,049	1,675	1,431	1,537	1,389	1,547	1,443	1,835	1,733	1,399
Alfalfa	288	288	288	288	0	0	340	485	551	551	745	784	384
Wheat	391	391	391	391	1,073	497	925	790	522	601	0	487	522
Melons	54	54	54	54	251	0	132	46	46	117	0	61	73
Processing	0	0	0	0	0	0	0	0	0	0	0	0	0
Sugar Beets	764	764	764	764	1,970	1,483	556	1,462	1,245	806	863	782	1,019
Barley	56	56	56	56	0	0	0	0	0	0	318	351	74
Beans	0	0	0	0	0	0	0	0	0	0	0	0	0
Seed Alf.	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice	540	540	540	540	442	1,039	1,452	1,047	355	720	793	630	720
Corn	41	41	41	41	0	88	130	0	0	198	0	72	54
Vegetable	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture	0	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit/	0	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL (less fallow)	3,183	3,183	3,183	3,183	5,411	4,540	5,072	5,219	4,066	4,436	4,555	4,900	4,244

1981-1984 are average values.

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Summary - Grasslands Study Area

Acreage

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	1,466	1,828	9,514	2,028	3,178	4,632	3,439	2,021	2,429	5,846	11,792	13,564	5,146
Misc.	280	300	0	140	566	347	515	417	390	0	50	957	331
Cotton	38,400	28,195	25,477	38,951	35,211	31,997	33,785	40,139	36,035	36,069	37,231	34,622	34,694
Alfalfa	4,356	1,917	2,661	3,263	3,125	4,207	4,883	6,341	6,725	7,074	6,865	6,848	4,872
Wheat	10,015	6,791	7,291	8,767	7,820	7,167	8,810	4,766	8,707	7,046	3,064	5,233	7,123
Melons	4,639	2,428	3,357	2,439	7,319	5,726	5,663	6,172	7,128	9,111	6,074	5,526	5,464
Processing	2,923	2,537	4,844	3,954	4,554	5,033	3,000	7,253	7,533	7,553	8,886	6,801	5,406
Sugar Beets	3,859	4,044	6,407	4,484	6,306	5,632	5,955	4,703	4,679	3,901	1,775	1,030	4,266
Barley	2,378	1,265	436	476	948	1,039	184	293	168	299	319	331	680
Beans	1,327	1,648	2,857	2,691	1,339	2,305	302	219	2,749	2,468	2,840	2,760	1,959
Seed Alf.	1,096	2,034	490	560	630	1,005	1,330	860	494	585	456	550	858
Rice	1,641	2,486	3,863	2,231	1,091	2,279	2,595	2,334	1,134	1,022	681	741	1,856
Corn	757	1,233	1,512	191	150	2,306	2,706	655	699	367	320	761	971
Vegetable	2,670	3,557	3,263	1,735	2,316	1,146	2,684	2,001	1,703	669	1,783	1,972	2,142
Pasture	111	111	111	0	680	45	0	1,233	26	0	0	0	193
Stonefruit/	701	701	701	701	301	317	273	58	217	117	35	226	362
Walnut/Apple	22	0	0	32	32	250	293	292	292	419	433	416	207
Sorghum	1,149	1,047	1,018	156	936	1,269	707	1,077	1,354	861	145	618	660
TOTAL (less fallow)	74,325	60,294	62,488	70,761	73,514	72,064	73,883	78,793	80,434	77,601	71,157	69,614	72,246

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Water Supply

Panoche Drainage District
Water Supply

Month	1980-1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Average
Oct	2,565	2,565	2,805	3,636	1,556	833	2,860	1,506	865	315	507	138	1,708
Nov	3,331	3,331	3,501	4,662	3,311	2,026	5,770	3,216	945	3,524	1,366	350	3,117
Dec	6,032	6,032	6,165	9,935	3,866	1,539	3,182	6,015	4,430	5,973	540	374	4,510
Jan	10,278	4,045	3,371	5,856	1,217	8,387	5,086	5,618	6,806	8,357	2,371	1,251	5,063
Feb	6,585	8,412	2,678	7,128	7,341	5,759	7,654	11,416	15,325	9,108	4,765	957	7,256
Mar	3,598	7,266	867	7,282	9,169	4,355	4,075	6,190	2,222	4,507	1,354	1,697	4,374
Dec-Mar	26,493	25,755	12,981	30,201	21,693	18,050	19,997	29,241	28,883	27,945	8,930	4,279	
Apr	7,563	3,563	5,018	8,212	7,557	11,195	6,804	3,385	5,781	4,155	1,303	2,603	5,612
May	8,673	8,376	7,667	12,412	10,612	9,861	8,724	5,243	6,056	5,752	4,097	4,416	7,657
Jun	13,400	13,395	13,117	13,376	15,262	15,783	18,956	15,137	15,275	13,174	8,518	8,820	13,484
Jul	18,699	15,549	14,074	20,191	21,316	18,419	19,031	20,781	17,607	17,365	11,492	9,586	17,004
Aug	13,436	14,030	12,526	13,449	12,901	13,731	13,066	15,616	10,868	7,920	5,906	6,624	11,672
Sep	3,364	2,583	3,583	3,170	2,231	2,589	2,811	3,061	2,016	1,108	656	685	2,322
Other									3,000		26,387	25,865	18,417
Total	97,344	89,155	75,306	109,511	98,241	92,487	98,119	97,196	91,300	81,258	69,706	63,416	88,587
AF/A	2.9	4.6	2.6	3.6	2.9	2.8	3.0	2.8	2.6	2.6	2.6	2.3	2.8

Broadview Water District
Water Supply

Month	1980-1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Average
Oct	0	1,386	1,734	2,746	1,231	562	869	775	530	102	2,561	0	1,041
Nov	0	32	244	2,773	1,737	1,253	3,339	280	401	2,428	693	0	1,117
Dec	3,534	0	0	1,812	1,322	1,315	687	0	266	2,421	0	0	948
Jan	5,640	3,395	626	776	238	1,392	1,419	2,961	2,751	1,050	541	123	1,734
Feb	897	4,461	1,380	903	2,086	1,151	653	2,756	2,596	1,446	705	385	1,818
Mar	691	362	0	2,069	2,766	769	620	1,047	680	1,040	176	1,066	941
Dec-Mar	10,762	8,218	3,006	5,560	6,412	4,527	3,379	6,764	6,315	5,957	1,424	1,574	
Apr	1,038	1,197	1,488	2,459	2,638	1,659	2,511	2,018	2,181	1,031	312	594	1,611
May	1,784	2,094	1,982	3,426	2,845	2,490	2,121	2,245	1,745	939	327	1,503	1,938
Jun	4,793	3,605	2,754	5,168	5,127	4,787	4,367	4,462	4,906	3,543	2,083	2,011	3,948
Jul	5,895	4,602	3,167	5,944	5,351	5,311	4,132	5,812	5,980	4,286	2,962	1,681	4,594
Aug	4,196	3,963	2,174	3,523	2,812	3,575	2,453	3,439	3,980	2,067	1,478	739	2,763
Sep	462	94	141	312	87	254	137	96	162	0	0	0	145
Other										238	862	984	695
Total	28,932	25,211	15,690	31,911	28,240	24,626	23,308	25,691	25,200	20,582	12,902	9,016	22,632
AF/A	3.2	2.8	2.8	3.6	3.3	3.0	3.0	3.0	2.8	2.5	2.3	2.0	2.9

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Pinebaugh Canal Water District

Water Supply

Month	1980-1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Average
Oct	2,764	2,764	1,513	4,778	3,097	2,551	3,649	3,605	2,359	1,882	6,290	4,400	3,208
Nov	619	619	510	648	984	1,329	3,508	948	846	2,588	3,536	4,140	1,737
Dec	0	0	0	0	0	0	0	0	0	0	0	0	0
Jan	3,198	4,840	1,010	6,149	3,861	2,170	4,361	4,624	4,489	4,210	5,521	3,727	3,948
Feb	3,959	6,864	4,219	5,328	6,618	2,624	4,190	6,746	4,536	3,554	3,180	3,751	4,947
Mar	1,337	1,980	64	4,148	6,804	1,964	1,862	2,029	3,012	2,579	543	3,431	2,479
Dec-Mar	8,493	13,684	5,303	15,425	16,283	6,757	10,613	13,399	12,046	12,343	11,245	10,909	11,375
Apr	6,796	2,374	2,537	4,862	5,740	6,267	7,742	3,466	6,608	3,627	1,655	3,548	4,603
May	10,038	6,281	6,191	10,093	7,705	7,196	8,330	8,054	6,695	5,349	4,092	4,855	7,340
Jun	12,137	6,756	8,333	11,086	11,906	11,869	12,728	11,559	12,287	10,730	4,092	10,092	10,470
Jul	16,164	13,363	9,877	15,151	14,774	12,330	14,950	16,360	15,402	13,837	13,332	12,116	13,982
Aug	14,136	13,701	9,570	14,327	12,390	10,898	13,608	14,320	11,540	11,302	11,144	8,126	12,069
Sep	4,276	2,349	3,797	3,897	3,553	3,781	4,417	3,255	2,592	1,866	1,755	1,386	3,082
Other													
Total	75,645	64,132	47,400	80,268	75,432	62,966	79,545	75,106	70,326	63,903	57,141	59,569	
AF/A	3.4	3.3	2.8	3.8	3.8	3.2	3.8	3.2	2.8	2.5	2.3	2.4	3.1

Water Supply

	1980-1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Average
Pachecho Water District	12,653	9,763	9,751	10,775	9,000	7,770	9,736	10,217	13,063	11,569	11,572	8,107	10,333
Charlaston Drainage District	14,030	11,973	11,591	13,691	12,119	10,264	13,881	14,428	12,263	11,127	10,218	9,830	12,102
CCID Camp 13	15,251	15,251	15,251	15,251	16,914	15,072	16,255	16,736	11,049	13,081	16,351	14,546	15,251

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Grasslands Basin Irrigation and Drainage Study
Cal Poly - ITRC

Combined - Pacheco, Chadestea, and CCID Camp 13

Assumed Monthly Water Supply

Month	1980-1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Average
Oct	808	713	705	766	772	638	769	798	701	690	735	622	727
Nov	1,476	1,302	1,288	1,398	1,409	1,165	1,404	1,456	1,280	1,259	1,342	1,136	1,326
Dec	2,135	1,883	1,863	2,022	2,038	1,686	2,032	2,107	1,852	1,822	1,942	1,644	1,919
Jan	2,397	2,114	2,091	2,270	2,288	1,892	2,280	2,365	2,079	2,045	2,180	1,845	2,154
Feb	3,435	3,030	2,998	3,254	3,280	2,712	3,269	3,390	2,980	2,931	3,125	2,645	3,087
Mar	2,076	1,826	1,807	1,961	1,976	1,634	1,970	2,043	1,796	1,766	1,883	1,594	1,861
Dec-Mar	10,037	8,853	8,759	9,507	9,582	7,924	9,551	9,905	8,707	8,564	9,129	7,727	9,020
Apr	2,657	2,343	2,318	2,516	2,536	2,097	2,528	2,622	2,305	2,267	2,416	2,045	2,388
May	3,625	3,197	3,163	3,433	3,460	2,862	3,449	3,577	3,144	3,093	3,297	2,791	3,258
Jun	6,478	5,713	5,653	6,135	6,184	5,114	6,164	6,393	5,619	5,527	5,892	4,987	5,821
Jul	8,048	7,100	7,024	7,624	7,684	6,355	7,659	7,943	6,982	6,867	7,321	6,197	7,234
Aug	5,525	4,873	4,822	5,233	5,275	4,362	5,258	5,453	4,793	4,714	5,025	4,254	4,866
Sep	1,099	970	959	1,041	1,050	868	1,046	1,085	954	936	1,000	846	988
Other													
Total	39,754	35,065	34,691	37,653	37,952	31,386	37,826	39,232	34,484	33,918	36,158	30,605	35,727

Based on Pacheco DD water delivery distribution percentages by month.

Summary - Grasslands Study Area

Water Supply

Month	1980-1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Average
Oct	6,178	7,468	6,357	12,127	5,658	4,584	8,248	6,884	4,453	2,989	10,094	5,160	6,683
Nov	5,625	5,503	5,643	9,481	9,440	5,773	14,021	5,900	3,475	9,500	7,139	5,666	7,297
Dec	11,701	7,915	7,568	13,768	7,326	4,540	5,901	8,122	6,568	10,216	2,482	2,018	7,377
Jan	21,512	14,393	7,108	15,031	6,404	11,751	13,346	15,568	16,235	15,662	10,613	6,946	12,699
Feb	14,876	22,767	11,235	16,413	19,324	12,246	15,766	24,310	25,438	19,039	13,774	7,738	16,911
Mar	7,496	11,434	2,737	15,460	20,716	8,722	8,527	11,309	7,709	9,882	3,858	7,787	9,654
Apr	17,653	9,476	11,361	18,049	18,271	21,416	19,565	11,521	16,874	11,079	6,266	6,788	14,214
May	24,119	21,946	19,003	29,365	24,623	22,409	23,624	19,119	17,641	15,123	11,813	13,564	20,113
Jun	36,807	31,466	29,857	35,765	38,479	37,563	42,215	37,551	38,097	33,093	20,585	23,910	33,944
Jul	46,808	40,635	34,142	48,910	49,125	42,405	45,772	50,916	45,971	42,456	35,047	29,560	42,814
Aug	37,295	36,537	29,193	36,533	33,377	32,566	34,365	38,728	30,182	26,003	23,555	19,742	31,510
Sep	9,201	5,995	6,482	8,421	6,921	7,491	8,411	7,497	5,664	4,032	3,411	2,927	31,510
Other	0	0	0	0	0	0	0	0	3,000	258	27,249	26,849	6,538
Total	241,675	215,562	173,087	259,343	239,664	211,467	238,800	237,425	221,310	199,661	175,907	162,676	

File: DIE - ETc Approach
Date: 2/23/94

Rain Calc

Total Rainfall at Mendota Dam, inches

	1980-1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Average
Oct	0.00	0.37	0.60	0.59	0.55	0.49	0.00	0.63	0.00	0.64	0.04	0.24	0.36
Nov	0.11	2.25	1.91	1.14	1.05	3.11	0.00	0.59	0.67	0.31	0.27	0.07	0.86
Dec	0.30	0.27	1.03	1.54	2.67	0.97	0.35	1.23	2.13	0.00	0.41	0.67	0.88
Jan	1.61	0.70	3.53	0.10	0.60	0.11	1.14	1.18	0.39	2.05	0.07	1.45	1.07
Feb	0.75	0.66	1.80	1.38	0.09	2.92	1.90	0.46	1.15	0.92	1.01	2.46	1.28
Mar	3.57	2.77	4.57	0.49	0.62	2.44	2.15	0.11	0.88	0.45	3.12	2.24	1.86
Apr	1.32	1.81	0.84	0.03	0.14	0.51	0.00	1.13	0.13	0.39	0.11	0.00	0.52
May	0.00	0.00	0.45	0.00	0.00	0.12	0.12	0.29	0.09	1.20	0.00	0.05	0.19
Jun	0.00	0.12	0.00	0.08	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Jul	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01
Aug	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Sep	0.00	0.78	0.77	0.00	0.00	0.36	0.00	0.00	1.36	0.09	0.00	0.00	0.28
Oct-Mar Only	6.37	7.02	13.44	5.24	5.56	10.04	5.54	4.47	5.12	4.37	4.92	7.33	
Totals	7.88	9.73	16.50	6.36	6.77	11.03	6.66	5.89	6.70	6.06	6.06	7.46	7.86

Effective Precipitation

District	1980-1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Average
Panoche DD	9,064	5,846	16,634	6,715	7,760	13,869	7,435	6,294	7,613	5,790	5,766	8,473	8,436
Broadview WD	2,385	2,582	3,086	1,956	2,015	3,417	1,617	1,627	1,853	1,486	1,135	1,369	2,062
Firebaugh CWD	5,823	5,921	9,399	4,518	4,587	8,293	4,643	4,336	5,279	4,635	5,059	7,603	5,858
Pachece WD	1,170	1,290	2,070	807	721	1,464	930	776	778	775	896	1,132	1,068
Charleston DD	960	1,066	2,023	759	751	1,212	860	667	768	636	797	1,168	974
CCID-Camp 13	845	931	1,783	695	1,258	1,899	1,171	972	867	806	934	1,497	1,138
Total-Grasslands Study Area	20,258	17,636	34,993	15,450	17,092	30,155	17,055	14,675	17,159	14,130	14,587	21,261	19,538

Assumed Effective precipitation = 50% Only for Oct-Mar.

References: Pre plant IE analysis and DWR Report date 2/89 "Effective Precipitation".

Calculation = Acreage x Precipitation x Effective Precipitation Percent

File: DIE - ETc Approach
Date: 2/23/94

Leaching

Water Quality, ECw in dS/m

District	1980-1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Panoche DD	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.70	0.70
Broadview WD	3.21	2.89	0.89	0.74	0.65	0.67	0.56	0.87	0.75	1.06	1.25	1.00
Firebaugh CWD	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Pachece WD	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.54	1.54	1.54	1.54
Charleston DD	0.54	0.54	0.54	0.38	0.50	0.39	0.59	0.62	0.53	0.60	0.59	0.62
CCID-Camp 13	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Ave.-Grasslands Study Area	1.09	1.03	0.70	0.65	0.65	0.64	0.65	0.71	0.74	0.80	0.86	0.82

Water Per Leaching

District	1980-1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	Average
Panoche DD	4,395	4,025	3,400	4,944	4,436	4,176	4,430	4,388	4,122	3,669	4,135	3,742	4,157
Broadview WD	9,997	7,582	1,203	2,008	1,549	1,395	1,093	1,937	1,609	1,907	1,434	790	2,709
Firebaugh CWD	3,415	2,986	2,140	3,624	3,406	2,843	3,592	3,391	3,175	2,885	2,580	2,690	3,061
Pachece WD	1,282	989	988	1,092	912	787	988	1,035	1,855	1,626	1,626	1,139	1,192
Charleston DD	633	541	523	429	505	331	688	753	543	561	506	503	543
CCID-Camp 13	689	689	689	688	854	681	734	756	499	591	736	657	689
Total-Grasslands Study Area	20,412	16,811	8,943	12,766	11,661	10,212	11,525	12,260	11,783	11,238	11,019	9,540	12,349

Assumed Threshold Salinity (ECe in dS/m) = 2.50

Calculation: Water for Leaching = Water Delivered x LR

LR = ECw/((5*ECe) ECw)

File: DIE - ETo Approach
Date: 2/23/94

Grasslands Basin Irrigation and Drainage Study
Cal Poly - ITRC

Firebaugh Canal Water District

Crop Water Requirement (Adj. ETo * Acres)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc.	0	0	0	0	0	0	0	0	0	0	0	0	0
Cotton	20,316	18,784	10,635	23,746	20,885	14,013	17,490	22,132	20,426	21,628	26,333	26,000	20,207
Alfalfa	5,457	1,768	3,377	3,403	3,381	3,969	5,807	6,026	7,168	7,726	8,389	8,704	5,423
Wheat	4,166	4,770	3,789	5,055	3,713	4,116	3,682	3,016	4,795	4,072	3,082	5,057	4,132
Melons	1,344	0	0	0	955	1,320	1,363	1,475	2,003	3,039	2,581	1,764	1,313
Processing	1,105	0	0	0	0	0	0	1,324	1,981	3,123	2,949	3,573	1,088
Sugar Beets	5,908	5,440	4,794	4,085	7,732	7,560	9,609	6,953	8,324	7,124	2,354	-464	5,879
Barley	0	0	0	0	0	0	0	0	0	0	0	0	0
Beans	0	0	0	0	0	0	0	0	0	0	0	0	0
Seed Alf.	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice	3,377	5,966	10,006	5,405	2,004	3,673	3,531	3,695	1,894	914	256	335	3,422
Corn	286	254	347	0	0	2,462	0	0	0	0	0	0	281
Vegetable	903	2,513	1,945	1,362	878	692	676	74	589	339	320	389	906
Pasture	0	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit/	0	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	73	0	0	0	0	0	134	127	135	132	128	131	72
Sorghum	903	61	1,377	0	0	399	1,091	1,755	2,429	1,490	245	1,065	903
TOTAL	43,838	39,555	36,169	43,057	39,646	38,393	43,604	46,619	49,943	49,586	46,639	46,490	43,629

Pacheco Water District

Crop Water Requirement (Adj. ETo * Acres)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	0	0	179	157	277	169	196	77	180	0	0	0	103
Misc.	0	0	0	0	0	228	527	157	276	0	0	0	99
Cotton	5,245	3,402	4,841	4,621	4,439	3,847	4,272	4,333	4,202	4,082	4,176	4,609	4,346
Alfalfa	0	0	0	563	552	521	1,098	526	602	352	1,637	894	564
Wheat	893	330	65	79	0	0	25	182	310	447	0	0	194
Melons	37	0	0	0	684	1,016	626	867	529	1,398	738	407	543
Processing	0	0	0	0	0	0	0	560	430	651	925	761	279
Sugar Beets	0	0	0	0	0	0	0	0	0	0	0	0	0
Barley	206	0	0	0	0	0	0	169	137	5	0	0	43
Beans	234	789	1,192	1,129	0	0	0	0	58	0	164	166	313
Seed Alf.	414	2,351	0	0	0	0	0	0	0	0	0	0	230
Rice	0	0	0	0	0	0	0	0	0	0	0	0	0
Corn	0	335	365	0	0	0	0	0	0	0	0	0	58
Vegetable	0	0	108	123	0	0	276	0	0	93	464	136	100
Pasture	0	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit/	1,304	1,304	1,371	1,367	0	0	0	0	0	0	0	0	444
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	8,332	8,310	8,121	8,039	5,952	5,881	7,222	6,910	6,725	7,010	8,104	6,892	7,314

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Grasslands Basin Irrigation and Drainage Study
Cal Poly - ITRC

Charleston Drainage District

Crop Water Requirement (Adj. ETo * Acres)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	34	28	37	71	130	202	9	41	37	197	100	100	82
Misc.	0	0	0	0	267	0	0	0	0	0	0	0	22
Cotton	1,316	626	3,419	4,065	2,365	3,734	4,776	3,121	4,864	4,969	4,959	5,040	3,605
Alfalfa	3,387	1,887	2,124	505	947	710	316	3,316	2,970	1,926	1,086	1,105	1,691
Wheat	0	0	0	0	0	0	0	0	0	0	0	0	0
Melons	495	369	385	1,325	686	495	1,061	472	54	254	514	505	551
Processing	432	911	223	0	0	0	0	138	233	118	538	539	261
Sugar Beets	2,184	1,610	1,982	224	0	536	300	192	408	167	226	221	686
Barley	167	0	0	0	332	0	0	0	0	0	0	0	42
Beans	0	0	0	0	0	0	0	62	0	0	0	0	5
Seed Alf.	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0	0
Corn	566	1,630	574	0	0	0	0	172	0	0	158	159	286
Vegetable	34	444	0	0	645	0	17	0	0	0	0	0	93
Pasture	0	0	0	0	0	0	0	400	0	0	0	0	33
Stonefruit/	0	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	8,604	7,505	8,744	6,190	5,374	5,677	6,477	7,913	8,567	7,630	7,581	7,669	7,361

CCID - Camp13

Crop Water Requirement (Adj. ETo * Acres)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	38	39	40	41	79	171	167	35	14	0	0	0	52
Misc.	0	0	0	0	0	0	0	0	0	0	0	0	0
Cotton	2,067	2,067	2,237	2,135	3,385	2,720	2,993	2,594	3,125	2,818	3,507	3,366	2,743
Alfalfa	975	975	1,009	1,017	0	0	1,167	1,594	1,864	1,852	2,431	2,625	1,394
Wheat	476	476	426	517	1,355	580	1,165	1,032	389	731	0	554	642
Melons	55	55	60	57	254	0	132	42	47	116	0	59	73
Processing	0	0	0	0	0	0	0	0	0	0	0	0	0
Sugar Beets	2,131	2,131	2,168	2,140	5,521	3,977	1,543	4,068	3,407	2,239	2,442	2,136	2,829
Barley	61	61	53	66	0	0	0	0	0	0	320	353	76
Beans	0	0	0	0	0	0	0	0	0	0	0	0	0
Seed Alf.	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice	1,655	1,655	1,767	1,726	1,365	3,077	4,486	3,006	1,119	2,179	2,326	1,899	2,186
Corn	53	53	90	85	0	172	261	0	0	397	0	143	109
Vegetable	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture	0	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit/	0	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	7,541	7,541	7,870	7,783	11,659	10,696	11,914	12,370	9,964	10,334	11,046	11,155	10,006

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Grasslands Basin Irrigation and Drainage Study
Cal Poly - ITRC

Summary - Grasslands Study Area

Crop Water Requirement (Adj. ETc * Acres)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	359	447	2,382	512	766	1,088	850	485	590	1,421	2,836	3,266	1,252
Misc.	330	341	0	176	664	382	616	469	446	0	51	1,081	380
Cotton	73,639	55,538	54,310	79,250	69,061	60,829	65,776	74,960	72,791	70,616	71,241	67,630	68,137
Alfalfa	14,754	6,493	10,026	11,520	10,650	13,708	16,760	20,836	22,751	23,785	22,621	22,926	16,403
Wheat	12,183	8,261	7,936	11,592	9,873	8,363	11,094	6,224	10,518	8,568	3,421	5,949	8,665
Melons	4,657	2,443	3,732	2,563	7,417	5,503	5,683	5,665	7,310	9,054	5,950	5,319	5,441
Processing	5,788	5,023	10,400	8,033	8,997	9,607	5,890	13,522	15,419	14,823	17,101	13,097	10,642
Sugar Beets	10,760	11,277	12,621	12,556	18,233	15,136	16,524	13,085	13,350	10,839	5,022	2,843	11,854
Barley	2,589	1,377	415	561	1,075	1,084	206	347	181	327	320	353	736
Beans	2,025	2,515	4,850	4,329	2,037	3,333	457	309	4,296	3,675	4,197	4,051	3,008
Seed Alf.	1,937	3,595	876	1,064	1,136	1,701	2,400	1,489	1,237	1,019	756	937	1,312
Rice	5,032	7,621	12,644	7,131	3,370	6,750	8,018	6,701	3,573	3,094	2,564	2,233	5,729
Corn	1,535	2,501	3,340	399	303	4,511	5,424	1,215	1,462	777	630	1,511	1,867
Vegetable	3,039	4,048	3,600	2,182	2,716	1,261	3,431	2,249	1,947	750	1,867	2,227	2,445
Pasture	407	407	417	0	2,523	159	0	4,442	95	0	0	0	704
Stonefruit/	2,285	2,285	2,403	2,396	884	998	898	181	711	376	110	730	1,197
Walnut/Apple	71	0	0	112	107	802	982	928	985	1,381	1,381	1,363	676
Sorghum	2,007	1,829	1,925	282	1,604	2,125	1,216	1,795	2,429	1,490	245	1,065	1,501
TOTAL	145,399	116,002	131,877	144,657	141,538	137,360	146,246	154,904	160,093	152,001	140,335	136,584	142,250

Irrigation Efficiency

Irrigation Efficiency = Adj. Crop Water Requirement - Effective Precipitation + Water For Leaching) / Water Delivered

District	1980-1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Panoche DD	58%	40%	62%	54%	61%	57%	61%	66%	72%	75%	78%	80%
Broadview WD	81%	81%	58%	57%	55%	51%	56%	58%	62%	73%	87%	94%
Firebaugh CWD	55%	55%	61%	53%	51%	52%	53%	61%	68%	75%	77%	70%
Pacheco WD	67%	84%	72%	77%	68%	67%	75%	70%	60%	68%	76%	86%
Charleston DD	39%	62%	62%	43%	42%	47%	43%	55%	66%	65%	71%	73%
CCID Camp 13	46%	46%	44%	31%	61%	63%	71%	73%	67%	77%	66%	71%
Total-Grasslands Study Area	60%	53%	61%	53%	57%	56%	59%	64%	70%	75%	76%	77%

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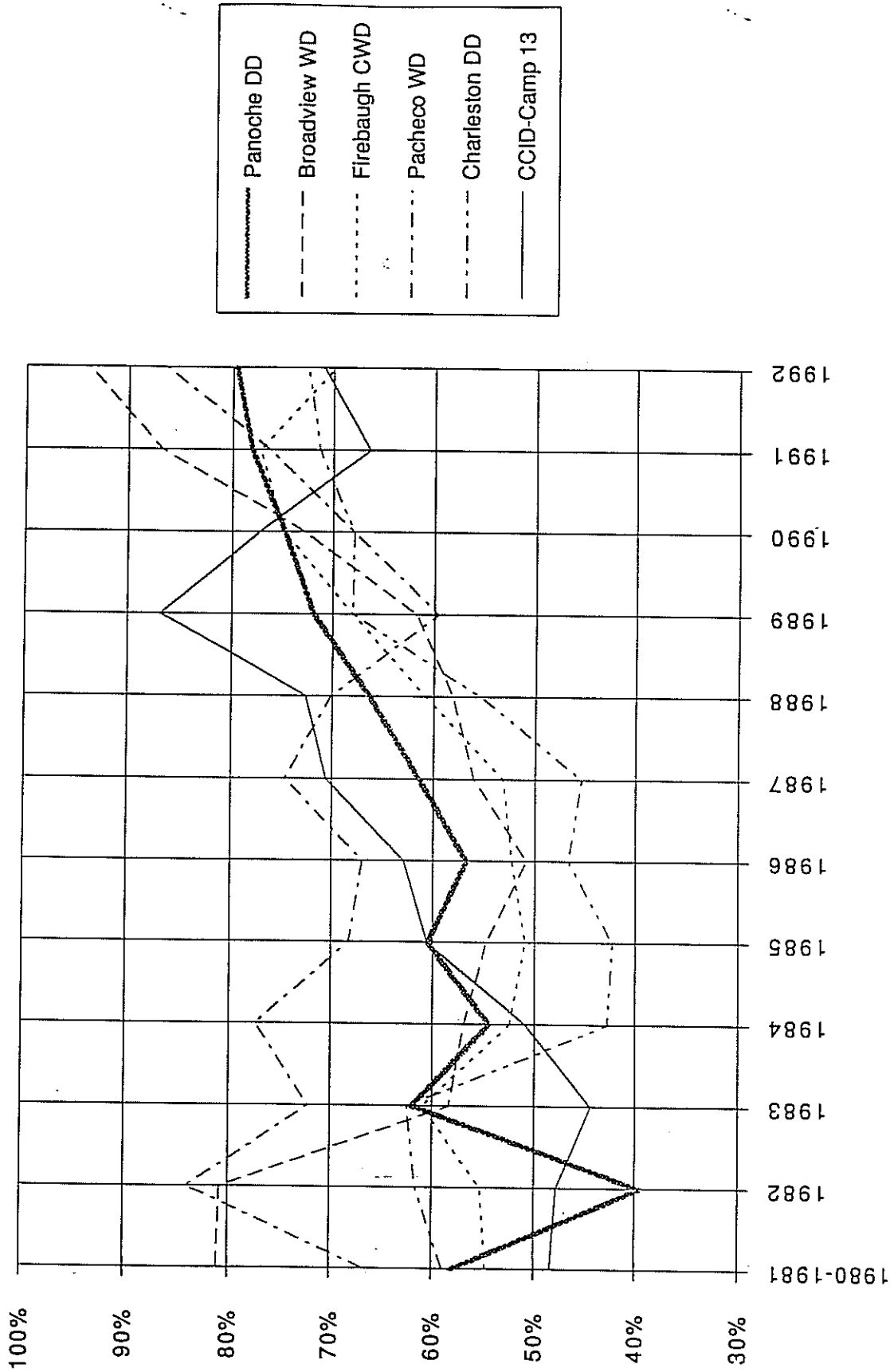
Date: 2/23/94

Grasslands Irrigation and Drainage Study
District Irrigation Efficiencies (ETc Approach)



Grasslands Basin Irrigation and Drainage Study
Cal Poly - ITRC

Crop Water Requirement

Panoche Drainage District

Crop Water Requirement (Adj. ETc * Acres)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	285	298	1,178	219	215	345	197	205	250	1,029	1,904	2,060	682
Misc.	0	0	0	0	220	0	0	311	0	0	0	814	120
Cotton	35,537	20,253	28,840	34,704	30,070	28,372	28,001	34,661	30,783	26,316	24,931	24,232	28,159
Alfalfa	4,925	1,863	3,056	5,448	5,259	8,029	8,371	9,375	10,146	11,928	8,822	9,598	7,243
Wheat	5,376	1,288	2,747	4,751	3,564	2,468	4,561	1,093	4,169	2,220	0	339	2,715
Melons	2,728	1,561	2,786	864	4,037	2,129	1,197	1,360	3,365	3,444	1,923	2,153	2,297
Processing	3,815	4,112	9,533	7,728	7,515	8,176	5,006	10,213	11,055	9,268	11,416	7,143	7,915
Sugar Beets	558	1,060	2,798	2,313	2,878	1,926	4,240	609	602	475	0	0	1,455
Barley	1,560	510	124	271	261	966	147	0	0	0	0	0	320
Beans	841	1,665	2,393	2,717	2,037	3,324	457	0	4,240	3,675	4,033	3,865	2,437
Seed Alf.	410	255	96	0	0	508	541	268	0	0	0	0	173
Rice	0	0	871	0	0	0	0	0	0	0	0	0	73
Corn	601	0	1,964	314	303	1,856	5,164	1,043	1,462	379	473	1,209	1,231
Vegetable	2,102	1,091	1,547	697	1,193	369	2,482	2,175	1,356	319	1,083	1,693	1,342
Pasture	407	407	417	0	2,523	159	0	4,043	95	0	0	0	471
Stonefruit/	981	981	1,032	1,029	984	998	896	181	711	378	110	730	751
Walnut/Apple	0	0	0	112	107	802	848	801	850	1,248	1,254	1,254	605
Sorghum	1,104	1,767	548	282	1,604	1,726	126	0	0	0	0	0	596
TOTAL	61,219	37,112	59,932	61,448	62,771	62,151	63,235	66,358	69,016	62,862	56,069	55,172	59,786

Broadview Water District

Crop Water Requirement (Adj. ETc * Acres)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	AVERAGE
Fallow	0	82	949	24	85	201	279	128	110	194	832	1,107	333
Misc.	330	341	0	176	178	154	90	0	168	0	51	167	138
Cotton	11,167	10,406	4,338	9,980	7,918	8,043	7,245	8,120	9,391	8,635	7,316	4,383	8,078
Alfalfa	0	0	561	565	511	479	0	0	0	0	135	0	186
Wheat	1,272	1,396	909	1,180	1,241	1,130	1,461	900	855	1,098	339	0	983
Melons	0	458	500	316	801	644	1,084	1,409	1,311	804	194	431	663
Processing	436	0	644	305	1,482	1,432	883	1,268	1,719	1,665	1,273	2,080	1,099
Sugar Beets	0	837	859	3,794	3,102	1,136	832	1,263	410	834	0	0	1,006
Barley	596	807	238	224	482	118	61	178	44	320	0	0	256
Beans	951	61	1,265	483	0	28	0	347	0	0	0	0	253
Seed Alf.	1,113	990	777	1,064	1,138	1,194	1,859	1,221	1,237	1,019	756	937	1,109
Rice	0	0	0	0	0	0	0	0	561	0	0	0	47
Corn	0	0	0	0	0	0	0	0	0	0	0	0	0
Vegetable	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture	0	0	0	0	0	0	0	0	0	0	0	0	0
Stonefruit/	0	0	0	0	0	0	0	0	0	0	0	0	0
Walnut/Apple	0	0	0	0	0	0	0	0	0	0	0	0	0
Sorghum	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	15,864	15,378	11,040	18,121	15,936	14,561	13,793	14,733	15,607	14,559	10,896	9,105	14,150

File: DIE - ETc Approach
Date: 2/23/94

TECHNICAL APPENDIX E

PRE-PLANT IRRIGATION EFFICIENCIES

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TECHNICAL APPENDIX E

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INTRODUCTION

Examination of pre-plant irrigation efficiencies for five of the Grassland Basin districts was completed in order to determine the potential for reduction of drainage water from the area during the period of time when pre-plant irrigation events occur (December through March). In theory, the timeframe for the poorest irrigation efficiencies occurs during the pre-plant irrigations since irrigations are required for germination but the soil moisture deficit may not warrant the quantity of water applied. The pre-plant efficiency analysis was completed during the summer of 1993. Some of the assumptions are slightly different than the assumptions used in the DIE analysis due to the timing of the analysis. The differences are discussed later in this section.

The five districts examined were Panoche, Firebaugh, Broadview, Pacheco, and Charleston. CCID was not evaluated due to lack of monthly water delivery data. Pre-plant irrigation efficiencies were determined by calculating the potential beneficial uses of irrigation water during the time period, and comparing that to the amount of water delivered to the district on a monthly basis during the same time period.

RESULTS

Table 1 shows the results of this analysis. The main problem with this analysis is when the irrigation water applied is less than the amount required. Using the traditional irrigation efficiency equation below, the IE appears to be larger than 100% which is not possible.

$$IE = \frac{\text{Irrigation Water Beneficially Used}}{\text{Irrigation Water Applied}} \times 100$$

Therefore, the emphasis in this report was with the differences between the identified water beneficially used and the water applied. Values calculated above 100% are shown as 100%.

Table 1

Pre-Plant Irrigation Efficiency (in percent)

YEAR	PANOCHE	PACHECO	FIREBAUGH	BROADVIEW	CHARLESTON
1982	43	100		100	
1983	4	100		100	
1984	41	100	61	35	
1985	80		77	100	
1986	34		100	51	61
1987	71	52	100	100	21
1988	48	97	100	48	35
1989	56	57	100	67	66
1990	100	52	100	69	33
1991	100	76	100	100	100
1992	100	100	100	100	100

Figure 1 is a graph of the summary results. Note the dark line for Panoche.

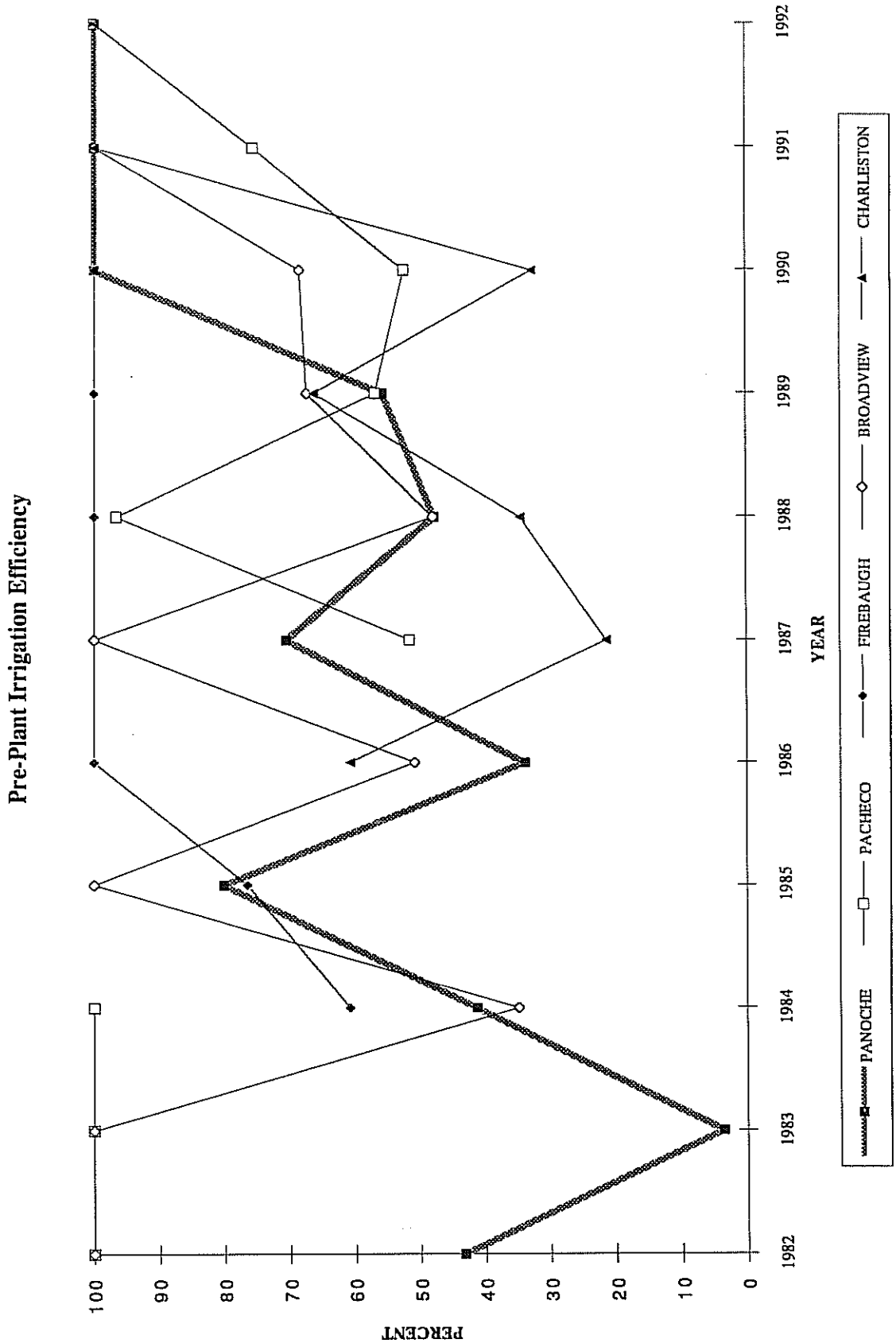
Pre-Plant Irrigation Efficiency
PERCENT
100
90
80
70
60
50
40
30
20
10
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
YEAR
PANOCHE
PACHECO
FIREBAUGH
BROADVIEW
CHARLESTON

Figure 1

CALCULATION STEPS

The following is a step by step breakdown of the steps taken in calculating district pre-plant irrigation efficiencies for the irrigation districts in the Grasslands Basin Irrigation and Drainage Study. The districts in the study include Broadview, Firebaugh, Panoche, and Pacheco Water Districts, and Charleston Drainage District. The Central California Irrigation District (Camp 13) is not included in the study due to the difficulty in obtaining needed water supply information.

STEP 1:

Determine the time period during the year when most of the pre-plant irrigation events occur.

Pre-plant irrigation water is by definition applied prior to or just after planting. In estimating the district pre-plant irrigation efficiencies it was necessary to choose the time of year when pre-plant irrigation usually occurs. The time period chosen was December to March. This time period was chosen due to the lack of significant increases in monthly water deliveries prior to that period, which would be expected if there were many pre-plant irrigation events occurring. In the months following the time period, there was an insignificant amount of uncropped acreage in the districts, meaning the time for pre-plant irrigation had largely passed.

The various crops were separated into three categories during the period December-March.

a. Crops growing during the entire time period.

b. Crops not grown during the time period.

c. Crops growing during part of the time period.

STEP 2:

For the four months of the time period, determine the total *regular* irrigation requirements of crops in groups a and c.

The regular irrigation requirement takes into account the water required to meet the plant's evapotranspiration (ETc) needs, the rainwater that is available for ETc (effective rainfall), and the efficiency of the application of irrigation water.

$$\text{Gross Irrigation Water Requirement} = \frac{(\text{Monthly ETc - Eff. Rain})}{(\text{Annual IE} * 0.8)}$$

Annual IE values are from spreadsheets in the 1992 D.I.E. Report using (ADJ. ETc-GW/AVAIL) values, with the exception of BWD where the (ADJ. ETc + RECL/AVAIL) figures where used in order to take into account the reclamation leaching in the district. The leaching requirement is left out because it is typically done once a year in the area, when there are no crops in the field. The calculated annual district IE figures were multiplied by about 80 % as an adjustment to the results from the previous study for inconsistent crop growth.

Determine the rain contribution to soil moisture deficit (SMD) and leaching fraction (NLF).

The calculation for rain contribution to SMD and NLF based on an infiltration of 50 % is

Rain Contribution = Infiltrated Rain - Eff. Rain Contribution to ETc

STEP 3:

Find the amount of water available during the four months for pre-plant irrigations.

This represents the theoretical water available for pre-plant irrigation once the ETc of the growing crops had been met.

Pre-Plant Irrigation Water = Total Supply - Gross Irrigation for ETc

STEP 4:

Find the SMD for each month in the time period of interest (on a per district basis) for uncropped acreage.

In order to find the amount of pre-plant irrigation water beneficially applied, it was necessary to estimate how dry the soil was after crops were harvested in the previous year using the following procedure.

A. Develop a calendar of crop life spans.

B. Estimate the SMD of fields with particular crops grown in the previous year.

1. Estimate the SMD at harvest for each crop.
   a. Estimate the MAD of the crops at harvest.
   b. Estimate the root zone depth of the crops at harvest.
   c. Calculate a value for SMD from the MAD values using soil maps of the area to assign a proportionate amount of the crops to the equivalent proportion of the soil type on a per district basis.

C. Multiply the SMD by the total number of acres of a particular crop.

STEP 5:

Find the annual NLF for the acreage not being cropped during the time period.

It is assumed that the majority of the annual leaching occurs during the time between harvest and planting, which is usually during the time period being considered.

$$NLF = \frac{(\text{Ann. ETc - Rainfall ET Contrib.})}{(1 - LR)} - (\text{Ann. ETc - Rainfall ET Contrib.})$$

$$LR = \frac{ECw}{(5 \times ECe) - ECw}$$

where,

ECe = 2.5 dS/m, threshold value for tomatoes.

LR = based on a critical crop of tomatoes for all fields.

Rainfall ET Contribution = effective rain available for crop ET.

NLF = net inches of water required to maintain a salt balance at the critical point (driest point) in the field. See pg. 3 of Leaching Requirement Summary in the 1991 D.I.E. Report (Burt, 1991) for more information.

STEP 6:

Determine the amount of irrigation water needed to satisfy the SMD and NLF of the b and c crops.

This represents the amount of irrigation water that in theory could be used beneficially for pre-plant irrigation.

Assumption: The annual NLF is satisfied during the time period. Total neglects the impact of DU, which is small since there is typically overirrigation at this point in the year.

Theoretical Water Requirement = (Prev. Year SMD + Prev. Year NLF) x (Prev. Year Acres)

STEP 7:

Calculate the irrigation efficiency of the pre-plant irrigation water.

$$\text{Pre-Plant Irrigation Efficiencies} = \frac{\text{(Beneficially Used Pre-Plant Irrigation Water)}}{\text{(Total Pre-Plant Irrigation Water Applied)}}$$

Beneficially used pre-plant irrigation water is the irrigation water that has gone to satisfy the SMD in the root zone and the net leaching fraction needed to maintain a salt balance in the soil minus the contribution from rain.

Total pre-plant irrigation water applied is the difference between the total water supplied to the districts during December through March and the water used for regular irrigations on crops grown during that same time period.

DETAILED EXPLANATION OF SPREADSHEET CALCULATIONS

Pre-plant irrigation efficiencies for Broadview, Firebaugh, Panoche and Pacheco Water Districts, and Charleston Drainage District were calculated using the following spreadsheets.

Unless indicated, the values used in spreadsheet columns were obtained from information included in the 1991 D.I.E. Report (Burt, 1991), and the 1992 D.I.E. Report (Burt, 1992). Values from sources other than the two mentioned reports include soil type percentages, total irrigation water supply figures, water quality figures, root zone depth values for particular crops, and soil moisture deficit values at harvest for particular crops. The source is cited under the column heading in which the values are used.

Four different spreadsheets were developed in determining district pre-plant irrigation efficiencies. The first spreadsheet was developed to answer STEPS 2 and 3 of the calculation of district pre-plant irrigation efficiencies. It calculates the amount of irrigation water available annually for pre-plant irrigation in each district from December through March. The spreadsheet also calculates how much of the total rain is available to satisfy the SMD and NLF.

The second spreadsheet is used to calculate values used in answering STEP 4, i.e., the soil moisture deficit in the district prior to pre-plant irrigation for each year.

The third spreadsheet is used to calculate the NLF required for each crop on an annual basis for STEP 5.

The fourth spreadsheet calculates the theoretical water required to satisfy the prior year SMD and NLF requirements needed for STEP 6. District pre-plant irrigation efficiencies are calculated in spreadsheet 5 for STEP 7.

Spreadsheet	Step Number	Calculated Values
1	2 and 3	Water available for pre-plant irrigation.
2	4	Soil Moisture Deficit (SMD).
3	5	Net Leaching Fraction (NLF).
4	6	Theoretical water needed to satisfy SMD and NLF.
5	7	District Pre-Plant Irrigation Efficiencies.

SPREADSHEET 1:

Answer Steps 2 and 3 of calculation of district pre-plant irrigation efficiencies. Spreadsheet 1 calculates the theoretical amount of water available for pre-plant irrigation in each district on an annual basis and the rain contribution to SMD and NLF.

COLUMN A: GROUP

This column indicates the placement of crops into one of three categories. Group "a" indicates crops that are grown continuously in the period December-March, group "c" crops are grown only during a part of that time period.

COLUMN B: CROP

This column lists crops grown in the district. The values for MISC are the same as those for VEGETABLE. MILO values are the same as for SORGHUM.

COLUMNS C-F : ADJUSTED ETc VALUES (in)

This column lists calculated, monthly ETc values that are adjusted to reflect a lack of uniformity in crop growth in the planted acreage (bare spots and stunted plant growth). For more information on the procedure used in calculating adjusted ETc values, see page 8 of D.I.E. Report, (Burt, 1991). December values are from the year indicated on the spreadsheet and do not chronologically precede January-March. The calculated ETc values are the same regardless of the irrigation district being considered.

COLUMN G-J : CROPPED PPT <= ETc (IN), EFF RAIN

This column lists effective rainfall (rainfall that infiltrates into the ground and is available for crop ET) on cropped ground that is less than or equal to adjusted ETc. For more information, see page 4 of D.I.E. Report, (Burt, 1991).

COLUMN K: ANNUAL I.E. (ADJ ET-GW/AVAIL)

This column lists the annual DIEs. The DIEs values include the effects of ground water and adjustments for uneven crop growth. See pages 87-91 of D.I.E. Report, (Burt, 1992) for further explanation. Some of the values have been updated to reflect new information and are taken from the October 1993 D.I.E. Progress Report for the Grassland Basin Irrigation

and Study Area. The annual DIEs include water lost from operational discharges and seepage losses from supply canals.

Broadview Water District

DIE values used for BWD differ from those used for the other districts. The values include provision for reclamation leaching during the years studied. (The values are from the column heading ADJ ET + RECL/AVAIL on page 85 of the D.I.E. Report for one year values, (Burt, 1992)).

COLUMN L: CROP ACRES PLANTED

This column lists the total acres planted to the crop for a particular year.

COLUMN M-P: REG. WATER REQRD (AC-FT)

This column lists the calculated values for the amount of water required for irrigation of crops that are grown during the period December-March, taking into account effective rainfall. The DIEs are adjusted by a factor of about 0.8 to reflect uneven crop growth in the districts, and represents a subjective adjustment based on examination of aerial photos of the districts revealing uneven growth and bare spots within fields. For more information, see page 87 of D.I.E. Report, (Burt, 1992).

$$\text{Reg. water reqd.} = \frac{\text{ADJ. ETc - EFF. RAIN}}{\text{ANNUAL I.E./100} * 0.8} * \frac{\text{FT}}{\text{12IN}} * \text{CROP ACRES}$$

$$\text{COLUMN M} = \frac{\text{COLUMN C - COLUMN G}}{\text{COLUMN K/100} * 0.8} * \frac{1}{12} * \text{COLUMN L}$$

$$\text{COLUMN N} = \frac{\text{COLUMN D - COLUMN H}}{\text{COLUMN K/100} * 0.8} * \frac{1}{12} * \text{COLUMN M}$$

$$\text{COLUMN O} = \frac{\text{COLUMN E - COLUMN I}}{\text{COLUMN K/100} * 0.8} * \frac{1}{12} * \text{COLUMN N}$$

$$\text{COLUMN P} = \frac{\text{COLUMN F - COLUMN J}}{\text{COLUMN K/100} * 0.8} * \frac{1}{12} * \text{COLUMN O}$$

COLUMN Q: TOTAL REQ. REG WATER, GROSS (AC-FT)

This column lists the sum of the monthly water requirements for crops grown during December-March.

TOTAL REQ. REG WATER= REG. WATER REQRD (DEC + JAN + FEB + MARCH)

COLUMN Q = COLUMN M + COLUMN N + COLUMN O + COLUMN P

COLUMN R: TOTAL SUPPLY

This column lists the amount of water supplied to the farmer by the irrigation district and from private well pumping.

Charleston Drainage District

The water supply values for 1991 and 1992 are questionable. The water supply values do not include the water supplied to CDD by CCID.

Panoche Water District

The water supply values for PeWD do not include water from private well pumping.

COLUMN S: PRE-IRR AVAILABLE (AC-FT)

This column lists the calculated value for the amount of water available for use in pre-plant irrigations on fields that were previously fallow or have been harvested.

AVAIL FOR PRE = TOTAL SUPPLY- SUM OF TOTAL REQ. REG WATER, GROSS

COLUMN S = COLUMN R - SUM OF COLUMN Q

COLUMN T: TOTAL EFFECTIVE RAIN WATER (AC-FT)

This column lists the total rain water that satisfies ETc during the time period December through March.

TOTAL EFF. RAIN = EFF. RAIN (DEC + JAN + FEB + MARCH) * $\frac{1}{12}$ * CROP ACRES

COLUMN T = (COL. G + COL. H + COL. I + COL. J) * $\frac{1}{12}$ * COLUMN L

COLUMN U: TOTAL RAIN WATER CONTRIBUTION TO SMD AND NLF (AC-FT)

TOTAL CONTRIBUTION = (50 % RAIN * CROP ACRES) - RAIN TO SATISFY ETc

COLUMN U = [COLUMN U * ACRES (FROM STEP 6)] - SUM OF COLUMN T

SPREADSHEET 2:

Answer Step 4 of calculation of district pre-plant irrigation efficiencies. Spreadsheet 2 calculates the SMD in the district after crop harvest.

COLUMN A: CROP

This column lists the crops currently grown in the district.

COLUMN B: ACRES PLANTED

This column lists the number of acres of each crop planted within the district.

COLUMN C: HARVEST MAD (%)

This column lists the estimated management allowable deficit (MAD) for a particular crop at harvest time. These numbers are approximate values based on the experience of Jerry Robb of Westlands Water District and Dr. Charles Burt of the ITRC at California State Polytechnic University.

COLUMN D: RZD (FT)

This column lists the approximate root zone depth of the crop at harvest.

COLUMN E-G: SOIL TYPE (%)

This column lists the percentage of soil in the district that falls into one of three broad textural categories. The soil within the district was broken down into three categories to improve the estimate of the available water holding capacity (AWHC). The values were estimated based on soil survey maps of the districts. The AWHC values are 0.5 in., 1.5 in. and 2 in. for the light, medium and heavy soil categories respectively.

COLUMN H: AWHC (IN)

This column lists the calculated values which represent the amount of water held in one foot of soil when the soil is at field capacity. Available water holding capacities are based on estimates in CIM-AG (Burt, 1992). The accuracy of these estimated values have a significant impact on the calculated district pre-plant irrigation efficiencies.

$$AWHC = \frac{\%LIGHT}{100} * 0.5 + \frac{\%MED}{100} * 1.5 + \frac{\%HEAVY}{100} * 2$$

$$COLUMN\ H = \frac{COLUMN\ E}{100} * 0.5 + \frac{COLUMN\ F}{100} * 1.5 + \frac{COLUMN\ G}{100} * 2$$

COLUMN I: ADJUSTMENT TO RZD>6 FT DUE TO % TILED AREA

This column lists the percentage of cropped land that has been tiled in the district. The percentage figures used were based on values for tiled acreage reported in the State Water Resources Control Board Technical Report: Regulation of Agricultural Drainage to the San Joaquin River (1987)

COLUMN J: ADJUSTED HARVEST SMD FOR TILED AREA (FT)

This column lists the calculated values for the SMD in the acreage tiled. The figures are based on the assumption that the root zone depth is restricted to a maximum depth of 5 feet in the tiled area. This assumption is based on a typical tile spacing of 300 ft buried 6 ft below the soil surface according to David Cone of BWD. 1987 values for total cropped or fallow acreage in the district was used as a base value for the calculation

$$ADJUSTED\ HARVEST\ SMD = AWHC\ (IN) * 5\ FT\ OF\ RZD * \frac{MAD\ (\%)}{100} * \frac{1\ FT}{12\ IN}$$

$$COLUMN\ J = COLUMN\ H * 5\ FT * COLUMN\ C * 1\ FT/12\ IN$$

COLUMN K: HARVEST SMD (FT)

This column lists the calculated values representing the SMD of the root zone at harvest.

$$HARVEST\ SMD = AWHC\ (IN) * RZD\ (FT) * \frac{MAD\ (\%)}{100} * \frac{1\ FT}{12\ IN}$$

$$COLUMN\ I = COLUMN\ H * COLUMN\ D * COLUMN\ C / 1200$$

COLUMN L: TOTAL WATER NEEDED FOR SMD FOR EACH CROP (AC-FT)

This column lists the calculated value for the amount of water needed to fill the root zone to field capacity for the planted acreage. Rows without an adjusted harvest SMD are calculated according to equation A, those with the adjusted value according to equation B.

A. TOTAL FOR SMD= SMD * ACRES PLANTED

COLUMN L= COLUMN K * COLUMN B

B. TOTAL FOR SMD= ACRES PLANTED*((TILED AREA(%)/100*

ADJ. HARVEST SMD)+((1- TILED AREA(%)/100)*HARVEST SMD))

COLUMN L= COLUMN B*((COLUMN I/100*COLUMN J)+((1- COLUMN I/

100)*COLUMN K)

SUMMARY VALUES - SPREADSHEET 2

A) TOTAL ACRES

This row lists the amount of planted or fallow acreage in the district.

TOTAL ACRES= SUM OF COLUMN B

B) TOTAL WATER

This row lists the calculated values of the total water needed in the district to fill the soil to field capacity after crop harvest.

TOTAL WATER= SUM OF COLUMN J

SPREADSHEET 3:

Answer Step 5 of calculation of district pre-plant irrigation efficiencies. Spreadsheet 3 calculates the net leaching fraction required during the year to prevent soil salt build-up.

COLUMN A: CROP

This column lists the crops grown in the district.

COLUMN B: ADJUSTED ANNUAL ETc (IN)

This column lists the annual, calculated ETc.

COLUMN C: ANNUAL EFF PPT <= ETc (IN)

This column lists effective rainfall (rainfall that infiltrates into the ground and is available for crop ET) on cropped ground that is less than or equal to adjusted ETc. For more information, see page 4 of D.I.E. Report, (Burt, 1991).

COLUMN D: ECw (dS/M)

This column lists the ECw values for the districts.

COLUMN E: LR (%)

This column lists the calculated values for the fraction of infiltrated water required to maintain desirable root zone salinity levels in the soil. See page 1-6 of Leaching Requirement Summary in the D.I.E. Report, (Burt, 1991). ECe values are based on the most salt sensitive crop, in this case tomatoes. Tomatoes have a threshold ECe of 2.5 dS/M.

$$LR = \frac{ECw}{(5 \times ECe) - ECw}$$

COLUMN E = COLUMN D/(5 * 2.5 - COLUMN D)

COLUMN F: NLF (IN)

This column lists the calculated values representing the amount of water required for deep percolation below the root zone to fulfill the leaching requirement. See pages 1-6 of Leaching Requirement Summary in D.I.E. Report, (Burt, 1991) for more information.

NLF = (ANNUAL ETc - EFF PPT)/(1-LR) - (ANNUAL ETc - EFF PPT)

COLUMN F= (COLUMN B - COLUMN C)/(1-LR) - (COLUMN B - COLUMN C)

SPREADSHEET 4:

Answer Step 6 of calculation of district pre-plant irrigation efficiencies. Spreadsheet 4 calculates the theoretical water (rain and irrigation) needed to satisfy the SMD and NLF for crops planted after or sometime during the period December through March. Previous year figures are used for the SMD and NLF values to estimate current year pre-plant irrigation requirements.

COLUMN A: b AND c CROPS

This column lists crops grown in the district that are planted during or after the time period December through March. Group "b" indicates crops planted after the time period. Group "c" indicates crops planted during the time period, but not before.

COLUMN B: PREVIOUS YEAR SMD (FT)

This column lists previous year SMD values from STEP 4, Spreadsheet 2.

COLUMN C: PREVIOUS YEAR ANNUAL NLF (IN)

This column lists previous year annual NLF values from STEP 5, Spreadsheet 3.

COLUMN D: PREVIOUS YEAR CROP ACRES

This column lists the number of acres grown in the crop in the previous year.

COLUMN E: THEORETICAL WATER TO SATISFY SMD + NLF (AC-FT)

This column indicates the calculated values for the amount of theoretical water (irrigation and rain) required to fill the soil to field capacity (equal to the SMD for the root zone) and satisfy the leaching requirements for the previous year's crops.

TOTAL = (SMD(FT) + NLF(IN) *1 FT/12 IN) * PREV YR CROP ACRES

COLUMN E = (COLUMN B + COLUMN C/12)*COLUMN D

TOTAL WATER FOR LISTED CROPS

This column lists the calculated values for the total theoretical water required annually to satisfy both the SMD and the NLF for the previous year's crops.

TOTAL WATER = SUM OF COLUMN E (which are associated with a listed crop)

REFERENCES

1. Burt, C.M., P. Canessa, and J. Parrish. 1991. Irrigation Efficiencies in parts of the Selenium Drainage area on the West Side of the San Joaquin Valley, with a focus on Water District Irrigation Efficiencies. Irrigation and Research Training Center, California Polytechnic State University, San Luis Obispo, CA.

2. Burt, C.M., R.E. Walker, P. Canessa, and K. Robinson. 1992. Final Report, Irrigation and Drainage in the Grassland Area of the Westside of the San Joaquin Valley. Irrigation Research and Training Center, California Polytechnic State University, San Luis Obispo, CA.

3. Burt, C.M. 1992. CIM-AG. Irrigation Research and Training Center, California Polytechnic State University, San Luis Obispo, CA.

4. Cone, D. 1993. Personal communication. Broadview Water District, Firebaugh, CA.

5. Robb, J. 1993. Personal communication. Westlands Water District, Fresno County, CA.

6. State Water Resources Control Board Technical Report. 1987. Regulation of Agricultural Drainage to the San Joaquin River.

PANOCHE WATER DISTRICT
Steps 1, 2, and 3

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
	1981	ADJUSTED ETc VALUES (IN)				CROPPED PPT (IN) <= ETc, EFF. RAIN				DISTRICT ANNUAL IE ADJ	ACRES	REG.WATER REQRD. (AC-FT)				TOTAL REQ. REG WATER	TOTAL	PRE-IRR	EFFECTIVE	TOTAL RAIN
Group	CROP	DEC	JAN	FEB	MARCH	DEC	JAN	FEB	MARCH	ET-GW/AVAIL (%)	PLANTED	DEC	JAN	FEB	MARCH	GROSS (AC-FT)	SUPPLY (AC-FT)	AVAILABLE (AC-FT)	RAIN WATER (AC-FT)	CONTRIBUTION TO SMD AND NLF LESS EFF. PRECIP. CONTRIBUTION
a	FALLOW	0.07	0.07	0.12	0.23	0.00	0.00	0.00	0.00	47	1,165	18	18	32	59	127	20,461		0	
b	COTTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47	18,038	0	0	0	0	0	20,461		0	
a	ALFALFA	0.41	0.30	0.87	3.11	0.24	0.30	0.87	2.68	47	1,454	54	0	0	139	193	20,461		471	
a	WHEAT	0.26	0.64	1.95	4.44	0.24	0.64	0.70	2.68	47	4,419	18	0	1,219	1,724	2,961	20,461		1,569	
c	MELONS	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	47	2,712	0	0	0	81	81	20,461		0	
c	TOMATOES	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	47	1,927	0	0	0	77	77	20,461		0	
a	SUGARBEET(N)	1.25	1.31	2.13	1.68	0.24	1.31	0.70	1.68	47	200	45	0	63	0	108	20,461		68	
a	BARLEY	0.26	0.63	1.92	4.36	0.24	0.63	0.70	2.68	47	1,433	6	0	385	535	926	20,461		508	
c	BEANS	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	47	551	0	0	0	13	13	20,461		0	
a	SD ALFALFA	0.23	0.29	0.97	2.80	0.23	0.29	0.70	2.68	47	232	0	0	14	6	20	20,461		75	
c	RICE	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.71	47	0	0	0	0	0	0	20,461		0	
b	CORN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47	298	0	0	0	0	0	20,461		0	
c	VEGETABLE	0.00	0.07	0.62	2.24	0.00	0.00	0.62	2.24	47	1,847	0	29	0	0	29	20,461		439	
a	PASTURE	1.03	1.07	1.85	3.42	0.24	1.07	0.70	2.68	47	111	19	0	28	18	66	20,461		43	
c	ALMOND-STONE	0.00	0.00	0.00	1.89	0.00	0.00	0.00	1.89	47	301	0	0	0	0	0	20,461		47	
c	WALNUT	0.00	0.00	0.00	2.03	0.00	0.00	0.00	2.03	47	0	0	0	0	0	0	20,461		0	
b	MILO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47	632	0	0	0	0	0	20,461		0	
																	RAIN WATER TO SATISFY ET=		3,219	
																			EFF RAIN	3.60
															SUM OF GROSS=	4,599	AVAIL FOR PRE=	15,862		#VALUE!

	1982	ADJUSTED ETc VALUES (IN)				CROPPED PPT (IN) <= ETc, EFF. RAIN				DISTRICT ANNUAL IE ADJ	ACRES	REG.WATER REQRD. (AC-FT)				TOTAL REQ. REG WATER	TOTAL SUPPLY	PRE-IRR	EFFECTIVE	TOTAL RAIN
Group	CROP	DEC	JAN	FEB	MARCH	DEC	JAN	FEB	MARCH	ET-GW/AVAIL	PLANTED	DEC	JAN	FEB	MARCH	GROSS (AC-FT)	(AC-FT)	AVAILABLE (AC-FT)	RAIN WATER (AC-FT)	CONTRIBUTION TO SMD AND NLF LESS EFF. PRECIP. TO ETc
										32.00										
c	MISC	0.00	0.07	0.62	2.24	0.00	0.00	0.59	2.24	32.00	0	0	0	0	0	0			0	
b	COTTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.00	10,282	0	0	0	0	0			0	
a	ALFALFA	0.41	0.30	0.87	3.11	0.41	0.30	0.59	2.31	32.00	550	0	0	13	143	156			186	
a	WHEAT	0.26	0.64	1.95	4.44	0.26	0.63	0.59	2.31	32.00	1,059	0	3	466	734	1,203			335	
c	MELONS	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	32.00	1,552	0	0	0	68	68			0	
c	TOMATOES	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	32.00	2,077	0	0	0	121	121			0	
a	SUGARBEET(N)	0.90	1.31	2.13	1.68	0.90	0.63	0.59	1.68	32.00	380	0	84	190	0	274			121	
a	BARLEY	0.26	0.63	1.92	4.36	0.26	0.63	0.59	2.31	32.00	468	0	0	201	313	514			148	
c	BEANS	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	32.00	1,091	0	0	0	37	37			0	
a	SD ALFALFA	0.23	0.29	0.97	2.80	0.23	0.29	0.59	2.31	32.00	144	0	0	18	23	41			41	
c	RICE	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.71	32.00	0	0	0	0	0	0			0	
b	CORN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.00	0	0	0	0	0	0			0	
c	VEGETABLE	0.00	0.07	0.62	2.24	0.00	0.00	0.59	2.24	32.00	959	0	22	7	0	28			226	
a	PASTURE	1.03	1.07	1.85	3.42	0.90	0.63	0.59	2.31	32.00	111	4	18	45	40	106			41	
c	ALMOND-STONE	0.00	0.00	0.00	1.89	0.00	0.00	0.00	1.89	32.00	301	0	0	0	0	0			47	
c	WALNUT	0.00	0.00	0.00	2.03	0.00	0.00	0.00	2.03	32.00	0	0	0	0	0	0			0	
b	MILO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.00	1,012	0	0	0	0	0	25,755		0	
																	RAIN WATER TO SATIFY ET=		1,125	
																			EFF RAIN	3.90
															SUM OF GROSS=	2,743	AVAIL FOR PRE=	23,012		7,802

PANOCHE WATER DISTRICT
Steps 1, 2, and 3

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
	1983																			
		ADJUSTED ETo VALUES (IN)				CROPPED PPT (IN) <= ETo , EFF. RAIN				DISTRICT ANNUAL IE ADJ ET-GW/AVAIL	ACRES PLANTED	REQ WATER REQRD. (AC-FT)				TOTAL REQ REQ WATER GROSS (AC-FT)	TOTAL SUPPLY (AC-FT)	PRE-RR AVAILABLE (AC-FT)	EFFECTIVE RAIN WATER (AC-FT)	TOTAL RAIN CONTRIBUTION TO SMD AND NLF LESS EFF. PRECIP. CONTRIBUTION TO ETo
Group	CROP	DEC	JAN	FEB	MARCH	DEC	JAN	FEB	MARCH			DEC	JAN	FEB	MARCH					
a	FALLOW	0.06	0.05	0.11	0.18	0.00	0.00	0.00	0.00	47.00	4,703	59	53	113	188	413			0	
c	MISC	0.00	0.05	0.54	1.77	0.00	0.00	0.54	1.77	47.00	0	0	0	0	0	0			0	
b	COTTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	13,529	0	0	0	0	0			0	
a	ALFALFA	0.34	0.21	0.56	2.46	0.34	0.21	0.56	2.46	47.00	872	0	0	1	0	2			261	
a	WHEAT	0.22	0.46	1.71	3.51	0.22	0.46	1.58	3.02	47.00	2,524	0	0	75	274	349			1,106	
c	MELONS	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	47.00	2,507	0	0	0	59	59			0	
c	TOMATOES	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	47.00	4,440	0	0	0	140	140			0	
a	SUGARBEET(N)	1.05	0.93	1.87	1.33	1.05	0.93	1.56	1.33	47.00	977	0	0	65	0	65			398	
a	BARLEY	0.22	0.45	1.68	3.45	0.22	0.45	1.58	3.02	47.00	130	0	0	3	12	15			57	
c	BEANS	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	47.00	1,410	0	0	0	26	26			0	
a	SD ALFALFA	0.19	0.20	0.85	2.21	0.19	0.20	0.85	2.21	47.00	55	0	0	0	0	0			16	
c	RICE	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.56	47.00	266	0	0	0	0	0			12	
b	CORN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	889	0	0	0	0	0			0	
c	VEGETABLE	0.00	0.05	0.54	1.77	0.00	0.00	0.54	1.77	47.00	1,402	0	16	0	0	16			270	
a	PASTURE	0.86	0.77	1.62	2.70	0.86	0.77	1.56	2.70	47.00	111	0	0	1	0	1			55	
c	ALMOND-STONE	0.00	0.00	0.00	1.50	0.00	0.00	0.00	1.50	47.00	301	0	0	0	0	0			38	
c	WALNUT	0.00	0.00	0.00	1.61	0.00	0.00	0.00	1.61	47.00	0	0	0	0	0	0			0	
b	MILO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	290	0	0	0	0	0	12,981		0	
																	RAIN WATER TO SATIFY ET=		2,213	
																			EFF RAIN	8.60
															SUM OF GROSS=	1,085	AVAIL FOR PRE=	11,898		11,040

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
	1984																			
		ADJUSTED ETo VALUES (IN)				CROPPED PPT (IN) <= ETo , EFF. RAIN				DISTRICT ANNUAL IE ADJ ET-GW/AVAIL	ACRES PLANTED	REQ WATER REQRD. (AC-FT)				TOTAL REQ REQ WATER GROSS (AC-FT)	TOTAL SUPPLY (AC-FT)	PRE-RR AVAILABLE (AC-FT)	EFFECTIVE RAIN WATER (AC-FT)	TOTAL RAIN CONTRIBUTION TO SMD AND NLF LESS EFF. PRECIP. CONTRIBUTION TO ETo
Group	CROP	DEC	JAN	FEB	MARCH	DEC	JAN	FEB	MARCH			DEC	JAN	FEB	MARCH					
a	FALLOW	0.10	0.06	0.13	0.28	0.00	0.00	0.00	0.00	52.00	869	18	10	23	48	99			0	
c	MISC	0.00	0.06	0.65	2.71	0.00	0.00	0.65	0.44	52.00	0	0	0	0	0	0			0	
b	COTTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.00	17,057	0	0	0	0	0			0	
a	ALFALFA	0.63	0.25	0.70	3.77	0.63	0.09	0.70	0.44	52.00	1,543	0	48	0	1,027	1,076			239	
a	WHEAT	0.40	0.53	2.05	5.38	0.40	0.09	1.21	0.44	52.00	3,593	0	314	607	3,552	4,473			840	
c	MELONS	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	52.00	819	0	0	0	27	27			0	
c	TOMATOES	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	52.00	3,804	0	0	0	166	166			0	
a	SUGARBEET(N)	1.91	1.08	2.25	2.04	1.91	0.09	1.21	0.44	52.00	826	0	163	172	264	600			251	
a	BARLEY	0.40	0.52	2.02	5.28	0.40	0.09	1.21	0.44	52.00	230	0	20	37	223	280			41	
c	BEANS	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	52.00	1,689	0	0	0	43	43			0	
a	SD ALFALFA	0.35	0.24	1.02	3.39	0.35	0.09	1.02	0.44	52.00	0	0	0	0	0	0			0	
c	RICE	0.00	0.00	0.00	0.86	0.00	0.00	0.00	0.44	52.00	0	0	0	0	0	0			0	
b	CORN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.00	150	0	0	0	0	0			0	
c	VEGETABLE	0.00	0.06	0.65	2.71	0.00	0.00	0.65	0.44	52.00	554	0	6	0	252	259			50	
a	PASTURE	1.57	0.88	1.94	4.14	1.57	0.09	1.21	0.44	52.00	0	0	0	0	0	0			0	
c	ALMOND-STONE	0.00	0.00	0.00	2.29	0.00	0.00	0.00	0.44	52.00	301	0	0	0	112	112			11	
c	WALNUT	0.00	0.00	0.00	2.46	0.00	0.00	0.00	0.44	52.00	32	0	0	0	13	13			1	
b	MILO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.00	156	0	0	0	0	0	30,201		0	
																	RAIN WATER TO SATIFY ET=		1,234	
																			EFF RAIN	3.20
															SUM OF GROSS=	7,147	AVAIL FOR PRE=	23,054		6,696

PANOCHE WATER DISTRICT
Steps 1, 2, and 3

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
	1985																			
Group	CROP	ADJUSTED ETc VALUES (IN)				CROPPED PPT (IN) <= ETc, EFF. RAIN				DISTRICT ANNUAL IE ADJ ET-GW/AVAIL	ACRES PLANTED	REQ.WATER REQRD. (AC-FT)				TOTAL REQ. REQ WATER GROSS (AC-FT)	TOTAL SUPPLY (AC-FT)	PRE-RR AVAILABLE (AC-FT)	EFFECTIVE RAIN WATER (AC-FT)	TOTAL RAIN CONTRIBUTION TO SMD AND NLF LESS EFF. PRECIP. CONTRIBUTION TO ETc
		DEC	JAN	FEB	MARCH	DEC	JAN	FEB	MARCH			DEC	JAN	FEB	MARCH					
a	FALLOW	0.05	0.06	0.14	0.21	0.00	0.00	0.00	0.00	59.00	869	7	9	22	32	70			0	
c	MISC	0.00	0.06	0.71	2.06	0.00	0.00	0.08	0.56	59.00	168	0	2	21	51	73			10	
b	COTTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.00	15,331	0	0	0	0	0			0	
a	ALFALFA	0.28	0.24	0.77	2.89	0.28	0.24	0.08	0.56	59.00	1,543	0	0	186	635	823			149	
a	WHEAT	0.18	0.52	2.25	4.13	0.18	0.52	0.08	0.56	59.00	2,823	0	0	1,081	1,778	2,860			313	
c	MELONS	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	59.00	3,984	0	0	0	88	88			0	
c	TOMATOES	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	59.00	3,804	0	0	0	112	112			0	
a	SUGARBEET(N)	0.85	1.05	2.47	1.56	0.85	0.54	0.08	0.56	59.00	1,027	0	93	433	182	708			173	
a	BARLEY	0.18	0.51	2.21	4.06	0.18	0.51	0.08	0.56	59.00	230	0	0	87	142	228			25	
c	BEANS	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	59.00	1,339	0	0	0	23	23			0	
a	SD ALFALFA	0.15	0.23	1.12	2.80	0.15	0.23	0.08	0.56	59.00	0	0	0	0	0	0			0	
c	RICE	0.00	0.00	0.00	0.66	0.00	0.00	0.00	0.56	59.00	0	0	0	0	0	0			0	
b	CORN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.00	150	0	0	0	0	0			0	
c	VEGETABLE	0.00	0.06	0.71	2.06	0.00	0.00	0.08	0.56	59.00	1,017	0	10	113	274	397			54	
a	PASTURE	0.69	0.66	2.13	3.18	0.69	0.54	0.08	0.56	59.00	680	0	39	246	314	600			106	
c	ALMOND-STONE	0.00	0.00	0.00	1.76	0.00	0.00	0.00	0.56	59.00	301	0	0	0	64	64			14	
c	WALNUT	0.00	0.00	0.00	1.89	0.00	0.00	0.00	0.56	59.00	32	0	0	0	8	8			1	
b	MILO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.00	926	0	0	0	0	0	21,893		0	
																	RAIN WATER TO SATIFY ET=		846	
																			EFF RAIN	2.70
															SUM OF GROSS=	8,054	AVAIL FOR PRE=	15,639		4,876

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
	1986																			
Group	CROP	ADJUSTED ETc VALUES (IN)				CROPPED PPT (IN) <= ETc, EFF. RAIN				DISTRICT ANNUAL IE ADJ ET-GW/AVAIL	ACRES PLANTED	REQ.WATER REQRD. (AC-FT)				TOTAL REQ. REQ WATER GROSS (AC-FT)	TOTAL SUPPLY (AC-FT)	PRE-RR AVAILABLE (AC-FT)	EFFECTIVE RAIN WATER (AC-FT)	TOTAL RAIN CONTRIBUTION TO SMD AND NLF LESS EFF. PRECIP. CONTRIBUTION TO ETc
		DEC	JAN	FEB	MARCH	DEC	JAN	FEB	MARCH			DEC	JAN	FEB	MARCH					
a	FALLOW	0.04	0.07	0.12	0.21	0.00	0.00	0.00	0.00	52.00	1,468	13	22	36	62	132			0	
c	MISC	0.00	0.07	0.61	2.06	0.00	0.00	0.61	2.03	52.00	0	0	0	0	0	0			0	
b	COTTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.00	14,924	0	0	0	0	0			0	
a	ALFALFA	0.26	0.31	0.66	2.86	0.26	0.10	0.66	2.03	52.00	2,464	2	104	0	411	516			627	
a	WHEAT	0.17	0.67	1.93	4.09	0.17	0.10	1.93	2.03	52.00	2,115	0	240	0	872	1,112			745	
c	MELONS	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	52.00	2,215	0	0	0	55	55			0	
c	TOMATOES	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	52.00	4,283	0	0	0	142	142			0	
a	SUGARBEET(N)	0.80	1.36	2.11	1.55	0.32	0.10	2.11	1.55	52.00	719	70	182	0	0	252			244	
a	BARLEY	0.17	0.66	1.90	4.02	0.17	0.10	1.90	2.03	52.00	926	0	104	0	368	472			324	
c	BEANS	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	52.00	2,285	0	0	0	44	44			0	
a	SD ALFALFA	0.15	0.30	0.96	2.56	0.15	0.10	0.96	2.03	52.00	300	0	12	0	33	45			81	
c	RICE	0.00	0.00	0.00	0.65	0.00	0.00	0.00	0.65	52.00	0	0	0	0	0	0			0	
b	CORN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.00	949	0	0	0	0	0			0	
c	VEGETABLE	0.00	0.07	0.61	2.06	0.00	0.00	0.61	2.03	52.00	335	0	5	0	2	7			0	
a	PASTURE	0.66	1.12	1.83	3.15	0.32	0.10	1.83	2.03	52.00	45	3	9	0	10	22			74	
c	ALMOND-STONE	0.00	0.00	0.00	1.74	0.00	0.00	0.00	1.74	52.00	317	0	0	0	0	0			16	
c	WALNUT	0.00	0.00	0.00	1.87	0.00	0.00	0.00	1.87	52.00	250	0	0	0	0	0			46	
b	MILO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.00	1,026	0	0	0	0	0	18,050		39	
																			0	
																	RAIN WATER TO SATIFY ET=		2,195	
																			EFF RAIN	6.30
															SUM OF GROSS=	2,800	AVAIL FOR PRE=	15,250		12,474

PANOCHE
PAGE 3

PANOCHE WATER DISTRICT
Steps 1, 2, and 3

1987

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Group	CROP	ADJUSTED ETc VALUES (IN)				CROPPED PPT (IN) <= ETc, EFF. RAIN				DISTRICT ANNUAL IE ADJ ET-GW/AVAIL	ACRES PLANTED	REQ WATER REQRD. (AC-FT)				TOTAL REQ REQ WATER GROSS (AC-FT)	TOTAL SUPPLY (AC-FT)	PRE-RR AVAILABLE (AC-FT)	EFFECTIVE RAIN WATER (AC-FT)	TOTAL RAIN CONTRIBUTION TO SMD AND NLF LESS EFF. PRECIP. CONTRIBUTION TO ETc
		DEC	JAN	FEB	MARCH	DEC	JAN	FEB	MARCH			DEC	JAN	FEB	MARCH					
a	FALLOW	0.08	0.08	0.10	0.23	0.00	0.00	0.00	0.00	54.00	852	14	13	17	37	81			0	
c	MISC	0.00	0.08	0.51	2.23	0.00	0.00	0.51	1.79	54.00	277	0	4	0	23	28			53	
b	COTTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.00	18,560	0	0	0	0	0			0	
a	ALFALFA	0.50	0.33	0.56	3.09	0.50	0.33	0.56	1.79	54.00	2,853	1	0	0	717	718			755	
a	WHEAT	0.32	0.71	1.62	4.42	0.32	0.71	1.62	1.79	54.00	837	0	0	0	424	424			310	
c	MELONS	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	54.00	1,504	0	0	0	39	39			0	
c	TOMATOES	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	54.00	5,478	0	0	0	189	189			0	
a	SUGARBEET(N)	1.53	1.45	1.78	1.68	1.08	1.00	1.68	1.68	54.00	219	19	19	5	0	43			99	
a	BARLEY	0.32	0.70	1.60	4.34	0.32	0.70	1.60	1.79	54.00	0	0	0	0	0	0			0	
c	BEANS	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	54.00	0	0	0	0	0	0			0	
a	SD ALFALFA	0.28	0.32	0.81	2.78	0.28	0.32	0.81	1.79	54.00	155	0	0	0	30	30			41	
c	RICE	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.71	54.00	0	0	0	0	0	0			0	
b	CORN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.00	545	0	0	0	0	0			0	
c	VEGETABLE	0.00	0.08	0.51	2.23	0.00	0.00	0.51	1.79	54.00	1,935	0	29	0	164	193			372	
a	PASTURE	1.25	1.19	1.54	3.40	1.08	1.00	1.54	1.79	54.00	1,122	38	41	0	349	428			505	
c	ALMOND-STONE	0.00	0.00	0.00	1.68	0.00	0.00	0.00	1.79	54.00	58	0	0	0	1	1			9	
c	WALNUT	0.00	0.00	0.00	2.02	0.00	0.00	0.00	1.79	54.00	252	0	0	0	11	11			38	
b	MILO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.00	0	0	0	0	0	0	19,997		0	
																	RAIN WATER TO SATIFY ET=		2,181	
																			EFF RAIN	3.10
															SUM OF GROSS=	2,184	AVAIL FOR PRE=	17,813		5,086

1988

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Group	CROP	ADJUSTED ETc VALUES (IN)				CROPPED PPT (IN) <= ETc, EFF. RAIN				DISTRICT ANNUAL IE ADJ ET-GW/AVAIL	ACRES PLANTED	REQ WATER REQRD. (AC-FT)				TOTAL REQ REQ WATER GROSS (AC-FT)	TOTAL SUPPLY (AC-FT)	PRE-RR AVAILABLE (AC-FT)	EFFECTIVE RAIN WATER (AC-FT)	TOTAL RAIN CONTRIBUTION TO SMD AND NLF LESS EFF. PRECIP. CONTRIBUTION TO ETc
		DEC	JAN	FEB	MARCH	DEC	JAN	FEB	MARCH			DEC	JAN	FEB	MARCH					
a	FALLOW	0.08	0.07	0.18	0.31	0.00	0.00	0.00	0.00	63.00	852	8	10	22	44	85			0	
c	MISC	0.00	0.07	0.60	3.07	0.00	0.00	0.41	0.16	63.00	277	0	3	17	133	154			13	
b	COTTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.00	18,560	0	0	0	0	0			0	
a	ALFALFA	0.34	0.30	0.86	4.26	0.34	0.30	0.41	0.16	63.00	2,853	0	1	211	1,931	2,143			269	
a	WHEAT	0.22	0.65	2.52	6.08	0.22	0.65	0.41	0.16	63.00	837	0	0	291	819	1,110			101	
c	MELONS	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	63.00	1,504	0	0	0	46	46			0	
c	TOMATOES	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	63.00	5,478	0	0	0	223	223			0	
a	SUGARBEET(N)	1.03	1.33	2.76	2.30	1.03	1.03	0.41	0.16	63.00	219	0	11	85	78	173			46	
a	BARLEY	0.22	0.64	2.46	5.97	0.22	0.64	0.41	0.16	63.00	0	0	0	0	0	0			0	
c	BEANS	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	63.00	0	0	0	0	0	0			0	
a	SD ALFALFA	0.19	0.29	1.25	3.83	0.19	0.29	0.41	0.16	63.00	155	0	0	21	94	115			14	
c	RICE	0.00	0.00	0.00	0.97	0.00	0.00	0.00	0.16	63.00	0	0	0	0	0	0			0	
b	CORN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.00	545	0	0	0	0	0			0	
c	VEGETABLE	0.00	0.07	0.60	3.07	0.00	0.00	0.41	0.16	63.00	1,935	0	23	122	929	1,074			83	
a	PASTURE	0.85	1.09	2.39	4.68	0.85	1.03	0.41	0.16	63.00	1,122	0	10	360	838	1,214			229	
c	ALMOND-STONE	0.00	0.00	0.00	2.59	0.00	0.00	0.00	0.16	63.00	58	0	0	0	23	23			1	
c	WALNUT	0.00	0.00	0.00	2.78	0.00	0.00	0.00	0.16	63.00	252	0	0	0	109	109			3	
b	MILO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.00	0	0	0	0	0	0	29,241		0	
																	RAIN WATER TO SATIFY ET=		791	
																			EFF RAIN	2.50
															SUM OF GROSS=	6,469	AVAIL FOR PRE=	22,772		5,347

PANOCHE WATER DISTRICT
Steps 1, 2, and 3

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
	1989																			
		ADJUSTED ETc VALUES (IN)				CROPPED PPT (IN) <= ETc, EFF. RAIN				DISTRICT ANNUAL IE ADJ ET-GW/AVAIL	ACRES PLANTED	REQ WATER REQRD. (AC-FT)				TOTAL REQ. REQ WATER GROSS (AC-FT)	TOTAL SUPPLY (AC-FT)	PRE-RR AVAILABLE (AC-FT)	EFFECTIVE RAIN WATER (AC-FT)	TOTAL RAIN CONTRIBUTION TO SMD AND NLF LESS EFF. PRECIP. CONTRIBUTION TO ETc
Group	CROP	DEC	JAN	FEB	MARCH	DEC	JAN	FEB	MARCH			DEC	JAN	FEB	MARCH					
a	FALLOW	0.06	0.09	0.10	0.23	0.00	0.00	0.00	0.00	68.00	1,029	10	14	16	36	76			0	
c	MISC	0.00	0.09	0.51	2.26	0.00	0.00	0.51	0.79	68.00	0	0	0	0	0	0			0	
b	COTTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	68.00	15,239	0	0	0	0	0			0	
a	ALFALFA	0.38	0.37	0.55	3.13	0.00	0.26	0.55	0.79	68.00	2,999	174	51	1	1,076	1,302			401	
a	WHEAT	0.24	0.80	1.61	4.48	0.00	0.26	1.01	0.79	68.00	3,451	127	285	322	1,948	2,681			502	
c	MELONS	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	68.00	3,282	0	0	0	68	68			0	
c	TOMATOES	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	68.00	5,401	0	0	0	150	150			0	
a	SUGARBEET(N)	1.16	1.64	1.77	1.70	0.00	0.26	1.01	0.79	68.00	220	39	48	26	31	142			38	
a	BARLEY	0.24	0.79	1.59	4.40	0.00	0.26	1.01	0.79	68.00	0	0	0	0	0	0			0	
c	BEANS	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	68.00	2,712	0	0	0	44	44			0	
a	SD ALFALFA	0.21	0.36	0.80	2.82	0.00	0.26	0.80	0.79	68.00	0	0	0	0	0	0			0	
c	RICE	0.00	0.00	0.00	0.72	0.00	0.00	0.00	0.72	68.00	0	0	0	0	0	0			0	
b	CORN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	68.00	699	0	0	0	0	0			0	
c	VEGETABLE	0.00	0.09	0.51	2.26	0.00	0.00	0.51	0.79	68.00	1,188	0	16	0	267	283			129	
a	PASTURE	0.95	1.34	1.53	3.45	0.00	0.26	1.01	0.79	68.00	26	4	4	2	11	21			4	
c	ALMOND-STONE	0.00	0.00	0.00	1.91	0.00	0.00	0.00	0.79	68.00	217	0	0	0	37	37			14	
c	WALNUT	0.00	0.00	0.00	2.05	0.00	0.00	0.00	0.79	68.00	252	0	0	0	49	49			17	
b	MILO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	68.00	0	0	0	0	0	0	28,883		0	
																	RAIN WATER TO SATIFY ET=		1,195	
																			EFF RAIN	2.80
															SUM OF GROSS=	4,853	AVAIL FOR PRE=	24,030		5679.34

	1990																			
		ADJUSTED ETc VALUES (IN)				CROPPED PPT (IN) <= ETc, EFF. RAIN				DISTRICT ANNUAL IE ADJ ET-GW/AVAIL	ACRES PLANTED	REQ WATER REQRD. (AC-FT)				TOTAL REQ. REQ WATER GROSS (AC-FT)	TOTAL SUPPLY (AC-FT)	PRE-RR AVAILABLE (AC-FT)	EFFECTIVE RAIN WATER (AC-FT)	TOTAL RAIN CONTRIBUTION TO SMD AND NLF LESS EFF. PRECIP. CONTRIBUTION TO ETc
Group	CROP	DEC	JAN	FEB	MARCH	DEC	JAN	FEB	MARCH			DEC	JAN	FEB	MARCH					
a	FALLOW	0.09	0.08	0.12	0.23	0.00	0.00	0.00	0.00	74	4,235	54	48	69	134	306			0	
c	MISC	0.00	0.08	0.58	2.22	0.00	0.00	0.58	0.41	74	0	0	0	0	0	0			0	
b	COTTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	74	14,801	0	0	0	0	0			0	
a	ALFALFA	0.54	0.34	0.63	3.06	0.37	0.34	0.63	0.41	74	3,548	88	0	0	1,335	1,422			514	
a	WHEAT	0.35	0.72	1.84	4.39	0.35	0.72	0.83	0.41	74	1,625	0	0	281	1,025	1,285			350	
c	MELONS	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	74	3,485	0	0	0	65	65			0	
c	TOMATOES	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	74	4,731	0	0	0	118	118			0	
a	SUGARBEET(N)	1.66	1.47	2.02	1.67	0.37	1.47	0.83	0.41	74	171	31	0	29	30	90			44	
a	BARLEY	0.35	0.71	1.81	4.32	0.35	0.71	0.83	0.41	74	0	0	0	0	0	0			0	
c	BEANS	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	74	2,468	0	0	0	36	36			0	
a	SD ALFALFA	0.30	0.32	0.92	2.77	0.30	0.32	0.83	0.41	74	0	0	0	0	0	0			0	
c	RICE	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.41	74	0	0	0	0	0	0			0	
b	CORN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	74	189	0	0	0	0	0			0	
c	VEGETABLE	0.00	0.08	0.58	2.22	0.00	0.00	0.58	0.41	74	285	0	3	0	73	76			23	
a	PASTURE	1.36	1.21	1.75	3.36	0.37	1.21	0.83	0.41	74	0	0	0	0	0	0			0	
c	ALMOND-STONE	0.00	0.00	0.00	1.87	0.00	0.00	0.00	0.41	74	117	0	0	0	24	24			4	
c	WALNUT	0.00	0.00	0.00	2.01	0.00	0.00	0.00	0.41	74	379	0	0	0	86	86			13	
b	MILO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	74	0	0	0	0	0	0	10,480		0	
																	RAIN WATER TO SATIFY ET=		948	
																			EFF RAIN	3.20
															SUM OF GROSS=	3,509	AVAIL FOR PRE=	6,871		7,057

PANOCHE WATER DISTRICT
Steps 1, 2, and 3

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1991																				
Group	CROP	ADJUSTED ETc VALUES (IN)				CROPPED PPT (IN) <= ETo, EFF. RAIN				DISTRICT ANNUAL IE ADJ ET-GW/AVAIL	ACRES PLANTED	REQ WATER REQRD. (AC-FT)				TOTAL REQ REQ WATER GROSS (AC-FT)	TOTAL SUPPLY (AC-FT)	PRE-RR AVAILABLE (AC-FT)	EFFECTIVE RAIN WATER (AC-FT)	TOTAL RAIN CONTRIBUTION TO SMD AND NLF LESS EFF. PRECIP. CONTRIBUTION TO ETc
		DEC	JAN	FEB	MARCH	DEC	JAN	FEB	MARCH			DEC	JAN	FEB	MARCH					
a																				
c	FALLOW	0.07	0.08	0.13	0.18	0.00	0.00	0.00	0.00	72	7,916	80	90	144	204	518			0	
b	MISC	0.00	0.08	0.63	1.75	0.00	0.00	0.63	1.75	72	0	0	0	0	0	0			0	
a	COTTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	72	13,056	0	0	0	0	0			0	
a	ALFALFA	0.42	0.33	0.88	2.43	0.42	0.06	0.88	2.34	72	2,712	1	104	-1	36	140			792	
c	WHEAT	0.27	0.70	1.98	3.47	0.27	0.06	0.88	2.34	72	0	0	0	0	0	0			0	
c	MELONS	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	72	1,966	0	0	0	30	30			0	
a	TOMATOES	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	72	5,938	0	0	0	121	121			0	
a	SUGARBEET(N)	1.29	1.44	2.17	1.32	0.78	0.06	0.86	1.32	72	0	0	0	0	0	0			0	
c	BARLEY	0.27	0.69	1.95	3.41	0.27	0.06	0.88	2.34	72	0	0	0	0	0	0			0	
a	BEANS	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	72	2,730	0	0	0	32	32			0	
c	SD ALFALFA	0.23	0.32	0.99	2.19	0.23	0.06	0.86	2.19	72	0	0	0	0	0	0			0	
b	RICE	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.56	72	0	0	0	0	0	0			0	
c	CORN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	72	240	0	0	0	0	0			0	
a	VEGETABLE	0.00	0.08	0.63	1.75	0.00	0.00	0.63	1.75	72	1,056	0	12	0	0	12			209	
c	PASTURE	1.05	1.16	1.88	2.67	0.78	0.06	0.88	2.34	72	0	0	0	0	0	0			0	
c	ALMOND-STONE	0.00	0.00	0.00	1.48	0.00	0.00	0.00	1.48	72	35	0	0	0	0	0			4	
b	WALNUT	0.00	0.00	0.00	1.59	0.00	0.00	0.00	1.59	72	393	0	0	0	0	0			52	
	MILO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	72	0	0	0	0	0	0	8,930		0	
																	RAIN WATER TO SATIFY ET=		1,057	
																			EFF RAIN	2.80
															SUM OF GROSS=	852	AVAIL FOR PRE=	8,078		8,057

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1992																				
Group	CROP	ADJUSTED ETc VALUES (IN)				CROPPED PPT (IN) <= ETo, EFF. RAIN				DISTRICT ANNUAL IE ADJ ET-GW/AVAIL	ACRES PLANTED	REQ WATER REQRD. (AC-FT)				TOTAL REQ REQ WATER GROSS (AC-FT)	TOTAL SUPPLY (AC-FT)	PRE-RR AVAILABLE (AC-FT)	EFFECTIVE RAIN WATER (AC-FT)	TOTAL RAIN CONTRIBUTION TO SMD AND NLF LESS EFF. PRECIP. CONTRIBUTION TO ETo
		DEC	JAN	FEB	MARCH	DEC	JAN	FEB	MARCH			DEC	JAN	FEB	MARCH					
a																				
c	FALLOW	0.06	0.04	0.11	0.16	0.00	0.00	0.00	0.00	63	8,566	92	62	154	256	563			0	
b	MISC	0.00	0.04	0.54	1.78	0.00	0.00	0.54	1.78	63	809	0	6	0	0	6			156	
a	COTTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63	12,477	0	0	0	0	0			0	
a	ALFALFA	0.39	0.18	0.59	2.46	0.39	0.16	0.59	1.87	63	2,867	0	1	-1	283	283			723	
c	WHEAT	0.25	0.39	1.72	3.52	0.25	0.39	1.72	1.87	63	298	0	0	0	81	81			105	
c	MELONS	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	63	2,238	0	0	0	39	39			0	
a	TOMATOES	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	63	3,710	0	0	0	87	87			0	
a	SUGARBEET(N)	1.19	0.60	1.86	1.33	1.09	0.60	1.68	1.33	63	0	0	0	0	0	0			0	
c	BARLEY	0.25	0.39	1.69	3.46	0.25	0.39	1.69	1.87	63	0	0	0	0	0	0			0	
a	BEANS	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	63	2,633	0	0	0	36	36			0	
c	SD ALFALFA	0.22	0.16	0.86	2.22	0.22	0.16	0.86	1.87	63	0	0	0	0	0	0			0	
b	RICE	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.56	63	0	0	0	0	0	0			0	
c	CORN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63	609	0	0	0	0	0			0	
a	VEGETABLE	0.00	0.04	0.54	1.78	0.00	0.00	0.54	1.78	63	1,499	0	11	0	0	11			290	
c	PASTURE	0.97	0.66	1.63	2.71	0.97	0.66	1.63	1.87	63	0	0	0	0	0	0			0	
c	ALMOND-STONE	0.00	0.00	0.00	1.50	0.00	0.00	0.00	1.50	63	226	0	0	0	0	0			28	
b	WALNUT	0.00	0.00	0.00	1.61	0.00	0.00	0.00	1.61	63	376	0	0	0	0	0			50	
	MILO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63	0	0	0	0	0	0	4,261		0	
																	RAIN WATER TO SATIFY ET=		1,352	
																			EFF RAIN	4.20
															SUM OF GROSS=	1,107	AVAIL FOR PRE=	3,154		10,313

PANOCHE WATER DISTRICT
Step 4

1981 AVERAGE SMD FOR PANOCHE WATER DISTRICT

A	B	C	D	E	F	G	H	I	J	K	L
CROP	ACRES PLANTED	HARVEST MAD (%)	RZD (FT)	SOIL TYPE (%) LIGHT	MED	HEAVY	AWHC (IN)	ADJUSTMENT TO RZD > 6 FT DUE TO % TILED AREA	ADJUSTED HARVEST SMD FOR TILED AREA (FT)	HARVEST SMD (FT)	TOTAL WATER BY CROP NEEDED FOR SMD (AC-FT)
FALLOW	1,165	N/A	N/A	0	21	79	1.89			#VALUE!	
COTTON	16,036	80	6	0	21	79	1.89	60	0.63	0.76	12290.82
ALFALFA	1,454	N/A	N/A	0	21	79	1.89			#VALUE!	
WHEAT	4,419	70	4	0	21	79	1.89			0.44	
MELONS	2,712	50	4	0	21	79	1.89			0.32	855.61
TOMATOES	1,927	60	5	0	21	79	1.89			0.47	911.93
SUGARBEET N	200	80	5	0	21	79	1.89			0.63	
BARLEY	1,433	70	4	0	21	79	1.89			0.44	
BEANS	551	60	5	0	21	79	1.89			0.47	260.75
SD ALFALFA	232	80	6	0	21	79	1.89	60	0.63	0.76	
RICE	0	20	3	0	21	79	1.89			0.00	0.00
CORN	296	50	5	0	21	79	1.89			0.39	116.73
VEGETABLE	1,847	40	3	0	21	79	1.89			0.19	349.63
PASTURE	111	N/A	N/A	0	21	79	1.89			#VALUE!	
ALMOND-STONE	301	N/A	N/A	0	21	79	1.89			#VALUE!	
WALNUT	0	N/A	N/A	0	21	79	1.89			#VALUE!	
MILO	632	80	5	0	21	79	1.89			0.63	398.76
TOTAL ACRES =	35,316									TOTAL WATER =	15164.25

TOTAL WATER/TOTAL ACRES (AVE SMD (FT)) = 0.43

PANOCHE WATER DISTRICT
Step 5

1981

A	B	C	D	E	F
CROP	ADJUSTED ANNUAL ET (IN)	ANNUAL EFF PPT <= ETc (IN)	ECw (dS/M)	LR (%)	NLF (IN)
FALLOW	3.41	0.00	0.54	0.05	0.18
COTTON	27.49	0.00	0.54	0.05	1.30
ALFALFA	47.26	6.50	0.54	0.05	1.93
WHEAT	16.97	5.42	0.54	0.05	0.55
MELONS	14.04	1.04	0.54	0.05	0.61
TOMATOES	27.63	1.16	0.54	0.05	1.25
SUGARBEET N	38.91	6.14	0.54	0.05	1.55
BARLEY	15.19	5.41	0.54	0.05	0.46
BEANS	21.30	0.00	0.54	0.05	1.01
SD ALFALFA	24.66	5.05	0.54	0.05	0.93
RICE	42.78	1.87	0.54	0.05	1.93
CORN	28.31	0.00	0.54	0.05	1.34
VEGETABLE	15.88	4.01	0.54	0.05	0.56
PASTURE	51.20	7.94	0.54	0.05	2.05
ALMOND-STONE	45.48	3.38	0.54	0.05	1.99
WALNUT	46.42	3.52	0.54	0.05	2.03
MILO	24.37	0.00	0.54	0.05	1.15

1982 AVERAGE SMD FOR PANOCHE WATER DISTRICT

CROP	ACRES PLANTED	HARVEST MAD (%)	RZD (FT)	LIGHT	MED	HEAVY	AWHC (IN)	ADJUSTMENT TO RZD > 6 FT % TILED AREA	ADJUSTED HARVEST SMD (FT)	(FT)	TOTAL WATER BY CROP SMD (AC-FT)
FALLOW	1,218	N/A	N/A	0	21	79	1.89			#VALUE!	
MISC	0	40	3	0	21	79	1.89			0.19	0.00
COTTON	10,282	80	6	0	21	79	1.89	60	0.63	0.76	7006.78
ALFALFA	550	N/A	N/A	0	21	79	1.89			#VALUE!	
WHEAT	1,059	70	4	0	21	79	1.89			0.44	
MELONS	1,552	50	4	0	21	79	1.89			0.32	489.64
TOMATOES	2,077	60	5	0	21	79	1.89			0.47	982.91
SUGARBEET N	380	80	5	0	21	79	1.89			0.63	
BARLEY	468	70	4	0	21	79	1.89			0.44	
BEANS	1,091	60	5	0	21	79	1.89			0.47	516.30
SD ALFALFA	144	80	6	0	21	79	1.89	60	0.63	0.76	
RICE	0	20	3	0	21	79	1.89			0.00	0.00
CORN	0	50	5	0	21	79	1.89			0.39	0.00
VEGETABLE	959	40	3	0	21	79	1.89			0.19	181.53
PASTURE	111	N/A	N/A	0	21	79	1.89			#VALUE!	
ALMOND-STONE	301	N/A	N/A	0	21	79	1.89			#VALUE!	
WALNUT	0	N/A	N/A	0	21	79	1.89			#VALUE!	
MILO	1,012	80	5	0	21	79	1.89			0.63	638.55
TOTAL ACRES =	21,204									TOTAL WATER =	9815.72

TOTAL WATER/TOTAL ACRES (AVE SMD (FT)) = 0

1982

CROP	ANNUAL ET (IN)	ANNUAL (IN)	ECw (dS/M)	LR (%)	NLF (IN)
FALLOW	3.41	0.00	0.54	0.05	0.18
MISC	15.88	4.42	0.54	0.05	0.54
COTTON	27.49	0.61	0.54	0.05	1.28
ALFALFA	47.26	7.67	0.54	0.05	1.67
WHEAT	16.97	5.38	0.54	0.05	0.55
MELONS	14.04	1.14	0.54	0.05	0.61
TOMATOES	27.63	1.49	0.54	0.05	1.24
SUGARBEET N	38.91	6.83	0.54	0.05	1.52
BARLEY	15.19	5.38	0.54	0.05	0.46
BEANS	21.30	0.11	0.54	0.05	1.00
SD ALFALFA	24.66	5.11	0.54	0.05	0.92
RICE	42.78	2.40	0.54	0.05	1.91
CORN	28.31	0.81	0.54	0.05	1.30
VEGETABLE	15.88	4.42	0.54	0.05	0.54
PASTURE	51.20	9.04	0.54	0.05	1.99
ALMOND-STONE	45.48	4.63	0.54	0.05	1.92
WALNUT	46.42	4.97	0.54	0.05	1.96
MILO	24.37	0.61	0.54	0.05	1.11

PANOCHE WATER DISTRICT
Step 4

1983 AVERAGE SMD FOR PANOCHE WATER DISTRICT

A	B	C	D	E	F	G	H	I	J	K	L
CROP	ACRES PLANTED	HARVEST MAD (%)	RZD (FT)	SOIL TYPE (%) LIGHT	MED	HEAVY	AWHC (IN)	ADJUSTMENT TO RZD > 6 FT DUE TO % TILED AREA	ADJUSTED HARVEST SMD FOR TILED AREA (FT)	HARVEST SMD (FT)	TOTAL WATER BY CROP NEEDED FOR SMD (AC-FT)
FALLOW	4,703	N/A	N/A	0	21	79	1.89			#VALUE!	
MSC	0	40	3	0	21	79	1.89			0.19	0.00
COTTON	13,529	80	6	0	21	79	1.89	60	0.83	0.76	9219.48
ALFALFA	872	N/A	N/A	0	21	79	1.89			#VALUE!	
WHEAT	2,524	70	4	0	21	79	1.89			0.44	
MELONS	2,507	50	4	0	21	79	1.89			0.32	700.94
TOMATOES	4,440	60	5	0	21	79	1.89			0.47	2101.17
SUGARBEET N	977	80	5	0	21	79	1.89			0.63	
BARLEY	130	70	4	0	21	79	1.89			0.44	
BEANS	1,410	60	5	0	21	79	1.89			0.47	667.26
SD ALFALFA	55	80	6	0	21	79	1.89	60	0.83	0.76	
RICE	266	20	3	0	21	79	1.89			0.09	25.18
CORN	889	50	5	0	21	79	1.89			0.39	350.59
VEGETABLE	1,402	40	3	0	21	79	1.89			0.19	265.39
PASTURE	111	N/A	N/A	0	21	79	1.89			#VALUE!	
ALMOND-STONE	301	N/A	N/A	0	21	79	1.89			#VALUE!	
WALNUT	0	N/A	N/A	0	21	79	1.89			#VALUE!	
MILO	290	80	5	0	21	79	1.89			0.63	182.98
TOTAL ACRES =	34,406									TOTAL WATER =	13602.99

TOTAL WATER/TOTAL ACRES (AVE SMD (FT)) = 0

1984 AVERAGE SMD FOR PANOCHE WATER DISTRICT

CROP	ACRES PLANTED	HARVEST MAD (%)	RZD (FT)	SOIL TYPE (%) LIGHT	MED	HEAVY	AWHC (IN)	ADJUSTMENT TO RZD > 6 FT DUE TO % TILED AREA	ADJUSTED HARVEST SMD FOR TILED AREA (FT)	HARVEST SMD (FT)	TOTAL WATER BY CROP NEEDED FOR SMD (AC-FT)
FALLOW	889	N/A	N/A	0	21	79	1.89			#VALUE!	
MSC	0	40	3	0	21	79	1.89			0.19	0.00
COTTON	17,057	80	6	0	21	79	1.89	60	0.83	0.76	11623.67
ALFALFA	1,543	N/A	N/A	0	21	79	1.89			#VALUE!	
WHEAT	3,593	70	4	0	21	79	1.89			0.44	
MELONS	819	50	4	0	21	79	1.89			0.32	258.39
TOMATOES	3,804	60	5	0	21	79	1.89			0.47	1800.19
SUGARBEET N	826	80	5	0	21	79	1.89			0.63	
BARLEY	230	70	4	0	21	79	1.89			0.44	
BEANS	1,669	60	5	0	21	79	1.89			0.47	799.30
SD ALFALFA	0	80	6	0	21	79	1.89	60	0.63	0.76	
RICE	0	20	3	0	21	79	1.89			0.09	0.00
CORN	150	50	5	0	21	79	1.89			0.39	59.15
VEGETABLE	554	40	3	0	21	79	1.89			0.19	104.87
PASTURE	0	N/A	N/A	0	21	79	1.89			#VALUE!	
ALMOND-STONE	301	N/A	N/A	0	21	79	1.89			#VALUE!	
WALNUT	32	N/A	N/A	0	21	79	1.89			#VALUE!	
MILO	156	80	5	0	21	79	1.89			0.63	98.43
TOTAL ACRES =	31,623									TOTAL WATER =	14744.00

TOTAL WATER/TOTAL ACRES (AVE SMD (FT)) = 0

PANOCHE WATER DISTRICT
Step 5

1983

A	B	C	D	E	F
CROP	ADJUSTED ANNUAL ET (IN)	ANNUAL EFF PPT<=ETc (IN)	ECw (dS/M)	LR (%)	NLF (IN)
FALLOW	3.42	0.00	0.54	0.05	0.16
MSC	15.40	3.47	0.54	0.05	0.56
COTTON	29.73	1.10	0.54	0.05	1.35
ALFALFA	46.16	6.75	0.54	0.05	1.96
WHEAT	15.12	6.43	0.54	0.05	0.41
MELONS	15.51	1.16	0.54	0.05	0.68
TOMATOES	29.06	1.16	0.54	0.05	1.36
SUGARBEET N	38.66	7.10	0.54	0.05	1.49
BARLEY	13.23	6.42	0.54	0.05	0.32
BEANS	23.69	0.41	0.54	0.05	1.10
SD ALFALFA	24.88	4.81	0.54	0.05	0.96
RICE	45.67	1.72	0.54	0.05	2.08
CORN	30.83	1.10	0.54	0.05	1.41
VEGETABLE	15.40	3.47	0.54	0.05	0.56
PASTURE	51.35	9.28	0.54	0.05	1.99
ALMOND-STONE	47.50	3.68	0.54	0.05	2.06
WALNUT	48.75	3.99	0.54	0.05	2.12
MILO	26.39	1.10	0.54	0.05	1.20

1984

CROP	ADJUSTED ANNUAL ET (IN)	ANNUAL EFF PPT<=ETc (IN)	ECw (dS/M)	LR (%)	NLF (IN)
FALLOW	3.62	0.00	0.54	0.05	0.17
MSC	17.55	1.12	0.54	0.05	0.78
COTTON	28.41	0.07	0.54	0.05	1.34
ALFALFA	50.08	3.37	0.54	0.05	2.21
WHEAT	18.65	2.17	0.54	0.05	0.78
MELONS	14.72	0.10	0.54	0.05	0.69
TOMATOES	28.35	0.10	0.54	0.05	1.34
SUGARBEET N	40.80	5.14	0.54	0.05	1.89
BARLEY	16.83	2.16	0.54	0.05	0.68
BEANS	22.45	0.07	0.54	0.05	1.06
SD ALFALFA	26.68	2.00	0.54	0.05	1.17
RICE	44.60	0.54	0.54	0.05	2.08
CORN	29.18	0.07	0.54	0.05	1.38
VEGETABLE	17.55	1.12	0.54	0.05	0.78
PASTURE	54.27	4.62	0.54	0.05	2.34
ALMOND-STONE	48.03	1.04	0.54	0.05	2.22
WALNUT	48.90	1.04	0.54	0.05	2.26
MILO	25.21	0.07	0.54	0.05	1.19

PANOCHE WATER DISTRICT
Step 4

1985 AVERAGE SMD FOR PANOCHE WATER DISTRICT

A	B	C	D	E	F	G	H	I	J	K	L
CROP	ACRES PLANTED	HARVEST MAD (%)	RZD (FT)	SOIL TYPE (%) LIGHT	MED	HEAVY	AWHC (IN)	ADJUSTMENT TO RZD > 6 FT DUE TO % TILED AREA	ADJUSTED HARVEST SMD FOR TILED AREA (FT)	HARVEST SMD (FT)	TOTAL WATER BY CROP NEEDED FOR SMD (AC-FT)
FALLOW	869	N/A	N/A	0	21	79	1.89			#VALUE!	
MSC	188	40	3	0	21	79	1.89			0.19	35.59
COTTON	15,331	80	6	0	21	79	1.89	60	0.63	0.76	10447.47
ALFALFA	1,543	N/A	N/A	0	21	79	1.89			#VALUE!	
WHEAT	2,623	70	4	0	21	79	1.89			0.44	
MELONS	3,984	50	4	0	21	79	1.89			0.32	1258.92
TOMATOES	3,804	60	5	0	21	79	1.89			0.47	1800.19
SUGARBEET N	1,027	80	5	0	21	79	1.89			0.63	
BARLEY	230	70	4	0	21	79	1.89			0.44	
BEANS	1,339	60	5	0	21	79	1.89			0.47	633.66
SD ALFALFA	0	80	6	0	21	79	1.89	60	0.63	0.76	
RICE	0	20	3	0	21	79	1.89			0.09	0.00
CORN	150	50	5	0	21	79	1.89			0.39	59.15
VEGETABLE	1,017	40	3	0	21	79	1.89			0.19	192.51
PASTURE	680	N/A	N/A	0	21	79	1.89			#VALUE!	
ALMOND-STONE	301	N/A	N/A	0	21	79	1.89			#VALUE!	
WALNUT	32	N/A	N/A	0	21	79	1.89			#VALUE!	
MLO	928	80	5	0	21	79	1.89			0.63	584.29

TOTAL ACRES = 34,244

TOTAL WATER = 15009.78

TOTAL WATER/TOTAL ACRES (AVE SMD (FT)) = 0

PANOCHE WATER DISTRICT
Step 5

1985

A	B	C	D	E	F
CROP	ADJUSTED ANNUAL ET (IN)	ANNUAL EFF PPT<=ETc (IN)	ECw (dS/M)	LR (%)	NLF (IN)
FALLOW	3.40	0.00	0.54	0.05	0.16
MSC	16.37	0.77	0.54	0.05	0.74
COTTON	27.37	0.05	0.54	0.05	1.29
ALFALFA	47.28	2.61	0.54	0.05	2.10
WHEAT	17.40	1.40	0.54	0.05	0.75
MELONS	14.14	0.17	0.54	0.05	0.66
TOMATOES	27.57	0.17	0.54	0.05	1.30
SUGARBEET N	36.16	4.50	0.54	0.05	1.59
BARLEY	15.60	1.45	0.54	0.05	0.67
BEANS	21.23	0.05	0.54	0.05	1.00
SD ALFALFA	25.02	1.20	0.54	0.05	1.13
RICE	43.10	0.73	0.54	0.05	2.00
CORN	26.19	0.05	0.54	0.05	1.33
VEGETABLE	16.37	0.77	0.54	0.05	0.74
PASTURE	50.99	4.11	0.54	0.05	2.22
ALMOND-STONE	45.68	1.17	0.54	0.05	2.10
WALNUT	46.57	1.17	0.54	0.05	2.15
MLO	24.18	0.05	0.54	0.05	1.14

1986 AVERAGE SMD FOR PANOCHE WATER DISTRICT

CROP	ACRES PLANTED	HARVEST MAD (%)	RZD (FT)	SOIL TYPE (%) LIGHT	MED	HEAVY	AWHC (IN)	ADJUSTMENT TO RZD > 6 FT DUE TO % TILED AREA	ADJUSTED HARVEST SMD FOR TILED AREA (FT)	HARVEST SMD (FT)	TOTAL WATER BY CROP NEEDED FOR SMD (AC-FT)
FALLOW	1,468	N/A	N/A	0	21	79	1.89			#VALUE!	
MSC	0	40	3	0	21	79	1.89			0.19	0.00
COTTON	14,924	80	6	0	21	79	1.89	60	0.63	0.76	10170.11
ALFALFA	2,464	N/A	N/A	0	21	79	1.89			#VALUE!	
WHEAT	2,115	70	4	0	21	79	1.89			0.44	
MELONS	2,215	50	4	0	21	79	1.89			0.32	698.61
TOMATOES	4,283	60	5	0	21	79	1.89			0.47	2026.87
SUGARBEET N	719	80	5	0	21	79	1.89			0.63	
BARLEY	928	70	4	0	21	79	1.89			0.44	
BEANS	2,285	60	5	0	21	79	1.89			0.47	1081.35
SD ALFALFA	300	80	6	0	21	79	1.89	60	0.63	0.76	
RICE	0	20	3	0	21	79	1.89			0.09	0.00
CORN	949	50	5	0	21	79	1.89			0.39	374.25
VEGETABLE	335	40	3	0	21	79	1.89			0.19	63.41
PASTURE	45	N/A	N/A	0	21	79	1.89			#VALUE!	
ALMOND-STONE	317	N/A	N/A	0	21	79	1.89			#VALUE!	
WALNUT	250	N/A	N/A	0	21	79	1.89			#VALUE!	
MLO	1,028	80	5	0	21	79	1.89			0.63	647.39

TOTAL ACRES = 34,621

TOTAL WATER = 15062.20

TOTAL WATER/TOTAL ACRES (AVE SMD (FT)) = 0

1986

CROP	ADJUSTED ANNUAL ET (IN)	ANNUAL EFF PPT<=ETc (IN)	ECw (dS/M)	LR (%)	NLF (IN)
FALLOW	3.33	0.00	0.54	0.05	0.16
MSC	15.35	3.21	0.54	0.05	0.57
COTTON	26.53	0.43	0.54	0.05	1.23
ALFALFA	45.98	3.84	0.54	0.05	1.99
WHEAT	16.30	4.79	0.54	0.05	0.54
MELONS	13.41	0.57	0.54	0.05	0.61
TOMATOES	26.64	0.57	0.54	0.05	1.23
SUGARBEET N	38.28	4.40	0.54	0.05	1.60
BARLEY	14.57	4.76	0.54	0.05	0.46
BEANS	20.30	0.11	0.54	0.05	0.95
SD ALFALFA	23.84	3.80	0.54	0.05	0.94
RICE	41.33	1.22	0.54	0.05	1.90
CORN	27.29	0.43	0.54	0.05	1.27
VEGETABLE	15.35	3.21	0.54	0.05	0.57
PASTURE	49.91	5.16	0.54	0.05	2.12
ALMOND-STONE	44.06	2.64	0.54	0.05	1.96
WALNUT	44.87	2.76	0.54	0.05	1.99
MLO	23.47	0.43	0.54	0.05	1.09

PANOCHE WATER DISTRICT
Step 4

1985 AVERAGE SMD FOR PANOCHE WATER DISTRICT

A	B	C	D	E	F	G	H	I	J	K	L
CROP	ACRES PLANTED	HARVEST MAD (%)	RZD (FT)	SOIL TYPE (%) LIGHT	MED	HEAVY	AWHC (IN)	ADJUSTMENT TO RZD > 6 FT DUE TO % TILED AREA	ADJUSTED HARVEST SMD FOR TILED AREA (FT)	HARVEST SMD (FT)	TOTAL WATER BY CROP NEEDED FOR SMD (AC-FT)
FALLOW	869	N/A	N/A	0	21	79	1.89			#VALUE!	
MSC	168	40	3	0	21	79	1.89			0.19	35.59
COTTON	15,331	80	6	0	21	79	1.89	60	0.63	0.76	10447.47
ALFALFA	1,543	N/A	N/A	0	21	79	1.89			#VALUE!	
WHEAT	2,823	70	4	0	21	79	1.89			0.44	
MELONS	3,984	50	4	0	21	79	1.89			0.32	1258.92
TOMATOES	3,804	60	5	0	21	79	1.89			0.47	1800.19
SUGARBEET N	1,027	80	5	0	21	79	1.89			0.63	
BARLEY	230	70	4	0	21	79	1.89			0.44	
BEANS	1,339	60	5	0	21	79	1.89			0.47	633.06
SD ALFALFA	0	80	6	0	21	79	1.89	60	0.63	0.76	
RICE	0	20	3	0	21	79	1.89			0.09	0.00
CORN	150	50	5	0	21	79	1.89			0.39	59.15
VEGETABLE	1,017	40	3	0	21	79	1.89			0.19	192.51
PASTURE	880	N/A	N/A	0	21	79	1.89			#VALUE!	
ALMOND-STONE	301	N/A	N/A	0	21	79	1.89			#VALUE!	
WALNUT	32	N/A	N/A	0	21	79	1.89			#VALUE!	
MILO	926	60	5	0	21	79	1.89			0.63	584.29
TOTAL ACRES =	34,244									TOTAL WATER =	15009.78

TOTAL WATER/TOTAL ACRES (AVE SMD (FT)) = 0

PANOCHE WATER DISTRICT
Step 5

A	B	C	D	E	F
1985					
CROP	ADJUSTED ANNUAL ET (IN)	ANNUAL EFF PPT<=ETc (IN)	ECw (dS/M)	LR (%)	NLF (IN)
FALLOW	3.40	0.00	0.54	0.05	0.16
MSC	16.37	0.77	0.54	0.05	0.74
COTTON	27.37	0.05	0.54	0.05	1.29
ALFALFA	47.28	2.81	0.54	0.05	2.10
WHEAT	17.40	1.46	0.54	0.05	0.75
MELONS	14.14	0.17	0.54	0.05	0.66
TOMATOES	27.57	0.17	0.54	0.05	1.30
SUGARBEET N	36.16	4.50	0.54	0.05	1.59
BARLEY	15.80	1.45	0.54	0.05	0.67
BEANS	21.23	0.05	0.54	0.05	1.00
SD ALFALFA	25.02	1.20	0.54	0.05	1.13
RICE	43.10	0.73	0.54	0.05	2.00
CORN	28.19	0.05	0.54	0.05	1.33
VEGETABLE	16.37	0.77	0.54	0.05	0.74
PASTURE	50.99	4.11	0.54	0.05	2.22
ALMOND-STONE	45.66	1.17	0.54	0.05	2.10
WALNUT	46.57	1.17	0.54	0.05	2.15
MILO	24.16	0.05	0.54	0.05	1.14

1986 AVERAGE SMD FOR PANOCHE WATER DISTRICT

A	B	C	D	E	F	G	H	I	J	K	L
CROP	ACRES PLANTED	HARVEST MAD (%)	RZD (FT)	SOIL TYPE (%) LIGHT	MED	HEAVY	AWHC (IN)	ADJUSTMENT TO RZD > 6 FT DUE TO % TILED AREA	ADJUSTED HARVEST SMD FOR TILED AREA (FT)	HARVEST SMD (FT)	TOTAL WATER BY CROP NEEDED FOR SMD (AC-FT)
FALLOW	1,468	N/A	N/A	0	21	79	1.89			#VALUE!	
MSC	0	40	3	0	21	79	1.89			0.19	0.00
COTTON	14,924	80	6	0	21	79	1.89	60	0.63	0.76	10170.11
ALFALFA	2,464	N/A	N/A	0	21	79	1.89			#VALUE!	
WHEAT	2,115	70	4	0	21	79	1.89			0.44	
MELONS	2,215	50	4	0	21	79	1.89			0.32	698.81
TOMATOES	4,263	60	5	0	21	79	1.89			0.47	2026.87
SUGARBEET N	719	80	5	0	21	79	1.89			0.63	
BARLEY	928	70	4	0	21	79	1.89			0.44	
BEANS	2,265	60	5	0	21	79	1.89			0.47	1081.35
SD ALFALFA	300	80	6	0	21	79	1.89	60	0.63	0.76	
RICE	0	20	3	0	21	79	1.89			0.09	0.00
CORN	949	50	5	0	21	79	1.89			0.39	374.25
VEGETABLE	335	40	3	0	21	79	1.89			0.19	63.41
PASTURE	45	N/A	N/A	0	21	79	1.89			#VALUE!	
ALMOND-STONE	317	N/A	N/A	0	21	79	1.89			#VALUE!	
WALNUT	250	N/A	N/A	0	21	79	1.89			#VALUE!	
MILO	1,026	80	5	0	21	79	1.89			0.63	647.39
TOTAL ACRES =	34,821									TOTAL WATER =	15062.20

TOTAL WATER/TOTAL ACRES (AVE SMD (FT)) = 0

A	B	C	D	E	F
1986					
CROP	ADJUSTED ANNUAL ET (IN)	ANNUAL EFF PPT<=ETc (IN)	ECw (dS/M)	LR (%)	NLF (IN)
FALLOW	3.33	0.00	0.54	0.05	0.16
MSC	15.35	3.21	0.54	0.05	0.57
COTTON	26.53	0.43	0.54	0.05	1.23
ALFALFA	45.96	3.94	0.54	0.05	1.99
WHEAT	16.30	4.79	0.54	0.05	0.54
MELONS	13.41	0.57	0.54	0.05	0.61
TOMATOES	26.64	0.57	0.54	0.05	1.23
SUGARBEET N	36.28	4.40	0.54	0.05	1.60
BARLEY	14.57	4.76	0.54	0.05	0.46
BEANS	20.30	0.11	0.54	0.05	0.95
SD ALFALFA	23.64	3.80	0.54	0.05	0.94
RICE	41.33	1.22	0.54	0.05	1.90
CORN	27.29	0.43	0.54	0.05	1.27
VEGETABLE	15.35	3.21	0.54	0.05	0.57
PASTURE	49.01	5.16	0.54	0.05	2.12
ALMOND-STONE	44.06	2.64	0.54	0.05	1.96
WALNUT	44.87	2.76	0.54	0.05	1.99
MILO	23.47	0.43	0.54	0.05	1.09

PANOCHE WATER DISTRICT
Step 4

1989 AVERAGE SMD FOR PANOCHE WATER DISTRICT

A	B	C	D	E	F	G	H	I	J	K	L
CROP	ACRES PLANTED	HARVEST MAD (%)	RZD (FT)	SOIL TYPE (%) LIGHT	MED	HEAVY	AWHC (IN)	ADJUSTMENT TO RZD > 6 FT DUE TO % TILED AREA	ADJUSTED HARVEST SMD FOR TILED AREA (FT)	HARVEST SMD (FT)	TOTAL WATER BY CROP NEEDED FOR SMD (AC-FT)
FALLOW	1,029	N/A	N/A	0	21	79	1.89			#VALUE!	
MSC	0	40	3	0	21	79	1.89			0.19	0.00
COTTON	15,239	60	6	0	21	79	1.89	60	0.63	0.76	10384.77
ALFALFA	2,999	N/A	N/A	0	21	79	1.89			#VALUE!	
WHEAT	3,451	70	4	0	21	79	1.89			0.44	
MELONS	3,282	50	4	0	21	79	1.89			0.32	1035.44
TOMATOES	5,401	60	5	0	21	79	1.89			0.47	2555.05
SUGARBEET N	220	60	5	0	21	79	1.89			0.63	
BARLEY	0	70	4	0	21	79	1.89			0.44	
BEANS	2,712	60	5	0	21	79	1.89			0.47	1283.42
SD ALFALFA	0	80	6	0	21	79	1.89	60	0.63	0.76	
RICE	0	20	3	0	21	79	1.89			0.09	0.00
CORN	699	50	5	0	21	79	1.89			0.39	275.66
VEGETABLE	1,186	40	3	0	21	79	1.89			0.19	224.88
PASTURE	26	N/A	N/A	0	21	79	1.89			#VALUE!	
ALMOND-STONE	217	N/A	N/A	0	21	79	1.89			#VALUE!	
WALNUT	252	N/A	N/A	0	21	79	1.89			#VALUE!	
MILO	0	60	5	0	21	79	1.89			0.63	0.00
TOTAL ACRES =	36,715									TOTAL WATER =	15750.12

TOTAL WATER/TOTAL ACRES (AVE SMD (FT)) = 0

PANOCHE WATER DISTRICT
Step 5

1989

A	B	C	D	E	F
CROP	ADJUSTED ANNUAL ET (IN)	ANNUAL EFF PPT<=ETc (IN)	ECw (dS/M)	LR (%)	NLF (IN)
FALLOW	3.43	0.00	0.54	0.05	0.16
MSC	15.06	1.50	0.54	0.05	0.88
COTTON	28.22	1.27	0.54	0.05	1.27
ALFALFA	47.67	3.85	0.54	0.05	2.09
WHEAT	16.10	2.26	0.54	0.05	0.69
MELONS	14.31	0.20	0.54	0.05	0.67
TOMATOES	28.56	0.20	0.54	0.05	1.34
SUGARBEET N	39.43	4.10	0.54	0.05	1.67
BARLEY	15.09	2.26	0.54	0.05	0.61
BEANS	21.62	0.08	0.54	0.05	1.03
SD ALFALFA	24.90	2.05	0.54	0.05	1.06
RICE	43.96	0.91	0.54	0.05	2.04
CORN	29.18	1.27	0.54	0.05	1.32
VEGETABLE	15.96	1.50	0.54	0.05	0.68
PASTURE	51.89	4.30	0.54	0.05	2.25
ALMOND-STONE	46.30	2.76	0.54	0.05	2.06
WALNUT	47.37	2.76	0.54	0.05	2.11
MILO	25.03	1.27	0.54	0.05	1.12

1990 AVERAGE SMD FOR PANOCHE WATER DISTRICT

CROP	ACRES PLANTED	HARVEST MAD (%)	RZD (FT)	SOIL TYPE (%) LIGHT	MED	HEAVY	AWHC (IN)	ADJUSTMENT TO RZD > 6 FT DUE TO % TILED AREA	ADJUSTED HARVEST SMD FOR TILED AREA (FT)	HARVEST SMD (FT)	TOTAL WATER BY CROP NEEDED FOR SMD (AC-FT)
FALLOW	4,235	N/A	N/A	0	21	79	1.89			#VALUE!	
MSC	0	40	3	0	21	79	1.89			0.19	0.00
COTTON	14,601	80	6	0	21	79	1.89	60	0.63	0.76	9050.00
ALFALFA	3,548	N/A	N/A	0	21	79	1.89			#VALUE!	
WHEAT	1,825	70	4	0	21	79	1.89			0.44	
MELONS	3,485	50	4	0	21	79	1.89			0.32	1099.49
TOMATOES	4,731	60	5	0	21	79	1.89			0.47	2236.88
SUGARBEET N	171	80	5	0	21	79	1.89			0.63	
BARLEY	0	70	4	0	21	79	1.89			0.44	
BEANS	2,468	60	5	0	21	79	1.89			0.47	1167.95
SD ALFALFA	0	80	6	0	21	79	1.89	60	0.63	0.76	
RICE	0	20	3	0	21	79	1.89			0.09	0.00
CORN	189	50	5	0	21	79	1.89			0.39	74.53
VEGETABLE	285	40	3	0	21	79	1.89			0.19	53.95
PASTURE	0	N/A	N/A	0	21	79	1.89			#VALUE!	
ALMOND-STONE	117	N/A	N/A	0	21	79	1.89			#VALUE!	
WALNUT	379	N/A	N/A	0	21	79	1.89			#VALUE!	
MILO	0	80	5	0	21	79	1.89			0.63	0.00
TOTAL ACRES =	36,034									TOTAL WATER =	14584.80

TOTAL WATER/TOTAL ACRES (AVE SMD (FT)) = 0

1990

CROP	ADJUSTED ANNUAL ET (IN)	ANNUAL EFF PPT<=ETc (IN)	ECw (dS/M)	LR (%)	NLF (IN)
FALLOW	3.48	0.00	0.54	0.05	0.16
MSC	15.60	2.39	0.54	0.05	0.82
COTTON	27.28	1.13	0.54	0.05	1.24
ALFALFA	47.80	3.50	0.54	0.05	2.09
WHEAT	17.10	3.70	0.54	0.05	0.83
MELONS	13.79	1.40	0.54	0.05	0.59
TOMATOES	27.34	1.40	0.54	0.05	1.23
SUGARBEET N	40.45	3.43	0.54	0.05	1.75
BARLEY	15.41	3.89	0.54	0.05	0.55
BEANS	20.78	1.05	0.54	0.05	0.93
SD ALFALFA	24.41	3.26	0.54	0.05	1.00
RICE	42.24	1.81	0.54	0.05	1.91
CORN	28.00	1.13	0.54	0.05	1.27
VEGETABLE	15.60	2.39	0.54	0.05	0.62
PASTURE	52.24	4.57	0.54	0.05	2.25
ALMOND-STONE	45.57	1.92	0.54	0.05	2.06
WALNUT	46.22	1.92	0.54	0.05	2.09
MILO	24.15	1.13	0.54	0.05	1.09

PANOCHE WATER DISTRICT
Step 4

1991 AVERAGE SMD FOR PANOCHE WATER DISTRICT

A	B	C	D	E	F	G	H	I	J	K	L
CROP	ACRES PLANTED	HARVEST MAD (%)	RZD (FT)	SOIL TYPE (%) LIGHT	MED	HEAVY	AWHC (IN)	ADJUSTMENT TO RZD > 6 FT DUE TO % TILED AREA	ADJUSTED HARVEST SMD FOR TILED AREA (FT)	HARVEST SMD (FT)	TOTAL WATER BY CROP NEEDED FOR SMD (AC-FT)
FALLOW	7,916	N/A	N/A	0	21	79	1.89			#VALUE!	
MSC	0	40	3	0	21	79	1.89			0.19	0.00
COTTON	13,056	80	6	0	21	79	1.89	60	0.63	0.76	8807.15
ALFALFA	2,712	N/A	N/A	0	21	79	1.89			#VALUE!	
WHEAT	0	70	4	0	21	79	1.89			0.44	
MELONS	1,966	50	4	0	21	79	1.89			0.32	620.26
TOMATOES	5,938	80	5	0	21	79	1.89			0.47	2810.06
SUGARBEET N	0	80	5	0	21	79	1.89			0.53	
BARLEY	0	70	4	0	21	79	1.89			0.44	
BEANS	2,730	60	5	0	21	79	1.89			0.47	1291.94
SD ALFALFA	0	80	6	0	21	79	1.89	60	0.63	0.76	
RICE	0	20	3	0	21	79	1.89			0.09	0.00
CORN	240	50	5	0	21	79	1.89			0.33	94.65
VEGETABLE	1,056	40	3	0	21	79	1.89			0.19	199.90
PASTURE	0	N/A	N/A	0	21	79	1.89			#VALUE!	
ALMOND-STONE	35	N/A	N/A	0	21	79	1.89			#VALUE!	
WALNUT	393	N/A	N/A	0	21	79	1.89			#VALUE!	
MILO	0	80	5	0	21	79	1.89			0.63	0.00

TOTAL ACRES = 36,042

TOTAL WATER = 13913.96

TOTAL WATER/TOTAL ACRES (AVE SMD (FT)) = 0

PANOCHE WATER DISTRICT
Step 5

1991

A	B	C	D	E	F
CROP	ADJUSTED ANNUAL ET (IN)	ANNUAL EFF PPT <= ETc (IN)	ECw (dS/M)	LR (%)	NLF (IN)
FALLOW	3.30	0.00	0.54	0.05	0.16
MSC	14.31	2.46	0.54	0.05	0.56
COTTON	26.64	0.02	0.54	0.05	1.26
ALFALFA	45.34	3.90	0.54	0.05	1.96
WHEAT	15.50	3.65	0.54	0.05	0.56
MELONS	13.65	0.10	0.54	0.05	0.64
TOMATOES	26.83	0.12	0.54	0.05	1.26
SUGARBEET N	36.45	3.34	0.54	0.05	1.66
BARLEY	13.92	3.65	0.54	0.05	0.49
BEANS	20.61	0.00	0.54	0.05	0.97
SD ALFALFA	23.07	3.47	0.54	0.05	0.93
RICE	40.93	0.67	0.54	0.05	1.90
CORN	27.48	0.02	0.54	0.05	1.30
VEGETABLE	14.31	2.46	0.54	0.05	0.56
PASTURE	49.51	4.47	0.54	0.05	2.13
ALMOND-STONE	43.49	1.81	0.54	0.05	1.97
WALNUT	44.30	1.92	0.54	0.05	2.00
MILO	23.62	0.02	0.54	0.05	1.12

1992 AVERAGE SMD FOR PANOCHE WATER DISTRICT

A	B	C	D	E	F	G	H	I	J	K	L
CROP	ACRES PLANTED	HARVEST MAD (%)	RZD (FT)	SOIL TYPE (%) LIGHT	MED	HEAVY	AWHC (IN)	ADJUSTMENT TO RZD > 6 FT DUE TO % TILED AREA	ADJUSTED HARVEST SMD FOR TILED AREA (FT)	HARVEST SMD (FT)	TOTAL WATER BY CROP NEEDED FOR SMD (AC-FT)
FALLOW	8,566	N/A	N/A	0	21	79	1.89			#VALUE!	
MSC	809	40	3	0	21	79	1.89			0.19	153.14
COTTON	12,477	80	6	0	21	79	1.89	60	0.63	0.76	8502.58
ALFALFA	2,867	N/A	N/A	0	21	79	1.89			#VALUE!	
WHEAT	298	70	4	0	21	79	1.89			0.44	
MELONS	2,238	50	4	0	21	79	1.89			0.32	706.07
TOMATOES	3,710	80	5	0	21	79	1.89			0.47	1755.71
SUGARBEET N	0	80	5	0	21	79	1.89			0.63	
BARLEY	0	70	4	0	21	79	1.89			0.44	
BEANS	2,633	60	5	0	21	79	1.89			0.47	1246.03
SD ALFALFA	0	80	6	0	21	79	1.89	60	0.63	0.76	
RICE	0	20	3	0	21	79	1.89			0.09	0.00
CORN	609	50	5	0	21	79	1.89			0.39	240.17
VEGETABLE	1,499	40	3	0	21	79	1.89			0.19	283.75
PASTURE	0	N/A	N/A	0	21	79	1.89			#VALUE!	
ALMOND-STONE	226	N/A	N/A	0	21	79	1.89			#VALUE!	
WALNUT	376	N/A	N/A	0	21	79	1.89			#VALUE!	
MILO	0	80	5	0	21	79	1.89			0.63	0.00

TOTAL ACRES = 36,308

TOTAL WATER = 12887.45

TOTAL WATER/TOTAL ACRES (AVE SMD (FT)) = 0

1992

A	B	C	D	E	F
CROP	ADJUSTED ANNUAL ET (IN)	ANNUAL EFF PPT <= ETc (IN)	ECw (dS/M)	LR (%)	NLF (IN)
FALLOW	3.33	0.00	0.54	0.05	0.16
MSC	15.76	2.36	0.54	0.05	0.63
COTTON	27.09	0.11	0.54	0.05	1.28
ALFALFA	46.45	4.25	0.54	0.05	2.00
WHEAT	15.84	4.27	0.54	0.05	0.55
MELONS	13.43	0.11	0.54	0.05	0.63
TOMATOES	26.87	0.11	0.54	0.05	1.27
SUGARBEET N	38.06	6.29	0.54	0.05	1.50
BARLEY	14.00	4.24	0.54	0.05	0.48
BEANS	20.46	0.11	0.54	0.05	0.96
SD ALFALFA	23.74	3.22	0.54	0.05	0.97
RICE	42.05	0.67	0.54	0.05	1.96
CORN	27.70	0.11	0.54	0.05	1.30
VEGETABLE	15.76	2.36	0.54	0.05	0.63
PASTURE	49.98	6.35	0.54	0.05	2.08
ALMOND-STONE	44.65	2.73	0.54	0.05	1.99
WALNUT	45.69	2.84	0.54	0.05	2.03
MILO	24.04	0.11	0.54	0.05	1.13

PANOCHE WATER DISTRICT
Step 6

A	B	C	D	E
1981 b AND c CROPS	PREVIOUS YEAR SMD (AC-FT)	PREVIOUS YEAR ANNUAL NLF (IN)	PREVIOUS YR CROP ACRES	SATISFY SMD + NLF (AC-FT)
	N/A	N/A	N/A	#VALUE!
COTTON	N/A	N/A	N/A	#VALUE!
	N/A	N/A	N/A	#VALUE!
	N/A	N/A	N/A	#VALUE!
MELONS	N/A	N/A	N/A	#VALUE!
TOMATOES	N/A	N/A	N/A	#VALUE!
	N/A	N/A	N/A	#VALUE!
	N/A	N/A	N/A	#VALUE!
BEANS	N/A	N/A	N/A	#VALUE!
	N/A	N/A	N/A	#VALUE!
RICE	N/A	N/A	N/A	#VALUE!
CORN	N/A	N/A	N/A	#VALUE!
VEGETABLE	N/A	N/A	N/A	#VALUE!
	N/A	N/A	N/A	#VALUE!
ALMOND-STONE	N/A	N/A	N/A	#VALUE!
WALNUT	N/A	N/A	N/A	#VALUE!
MILO	N/A	N/A	N/A	#VALUE!
		TOTAL WATER FOR LISTED CROP		#VALUE!

ACREAGE OF LISTED CROPS+ FALLOW= #VALUE!

1982 b AND c CROPS	SMD (AC-FT)	ANNUAL NLF (IN)	PREVIOUS YR	SATISFY (AC-FT)
	0.00	0.16	1,165	16
MISC	0.00	0.56	0	0
COTTON	12290.82	1.30	18,036	14,244
	0.00	1.93	1,454	234
	0.00	0.55	4,410	201
MELONS	855.61	0.61	2,712	995
TOMATOES	911.93	1.25	1,927	1,113
	0.00	1.55	200	26
	0.00	0.46	1,433	55
BEANS	260.75	1.01	551	307
	0.00	0.93	232	18
RICE	0.00	1.93	0	0
CORN	116.73	1.34	296	150
VEGETABLE	349.63	0.56	1,847	436
	0.00	2.05	111	19
ALMOND-STONE	0.00	1.99	301	50
WALNUT	0.00	2.03	0	0
MILO	398.78	1.15	632	459
		TOTAL WATER FOR LISTED CROP		17,754

ACREAGE OF LISTED CROPS+ FALLOW= 27,467

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PAGE 13

PANOCHE WATER DISTRICT
Step 6

A 1983 b AND c CROPS	B PREVIOUS YEAR SMD (AC-FT)	C PREVIOUS YEAR ANNUAL NLF (IN)	D PREVIOUS YR CROP ACRES	E SATISFY SMD + NLF (AC-FT)
	0.00	0.16	1,2 8	16
MISC	0.00	0.54	0	0
COTTON	7006.78	1.26	10,282	8,088
	0.00	1.87	550	86
	0.00	0.55	1,059	48
MELONS	489.64	0.61	1,552	588
TOMATOES	982.91	1.24	2,077	1,197
	0.00	1.52	300	48
	0.00	0.46	468	18
BEANS	516.30	1.00	1,091	607
	0.00	0.92	144	11
RICE	0.00	1.91	0	0
CORN	0.00	1.30	0	0
VEGETABLE	181.53	0.54	959	225
	0.00	1.99	111	18
ALMOND-STONE	0.00	1.92	301	48
WALNUT	0.00	1.98	0	0
MILO	638.55	1.11	1,012	733
		TOTAL WATER FOR LISTED CROP!		11,468

ACREAGE OF LISTED CROPS+ FALLOW= 18,402

1984 b AND c CROPS	PREVIOUS YEAR SMD (AC-FT)	PREVIOUS YEAR ANNUAL NLF (IN)	PREVIOUS YR CROP ACRES	SATISFY SMD + NLF (AC-FT)
	0.00	0.16	4,703	63
MISC	0.00	0.56	0	0
COTTON	9219.46	1.35	13,529	10,746
	0.00	1.96	872	142
	0.00	0.41	2,524	86
MELONS	790.94	0.68	2,507	933
TOMATOES	2101.17	1.38	4,440	2,605
	0.00	1.49	977	121
	0.00	0.32	130	3
BEANS	667.26	1.10	1,410	797
	0.00	0.96	55	4
RICE	25.18	2.08	266	71
CORN	350.59	1.41	889	455
VEGETABLE	285.39	0.56	1,402	331
	0.00	1.99	111	18
ALMOND-STONE	0.00	2.06	301	52
WALNUT	0.00	2.12	0	0
MILO	182.98	1.20	290	212
		TOTAL WATER FOR LISTED CROP!		16,201

ACREAGE OF LISTED CROPS+ FALLOW= 29,737

PANOCHE WATER DISTRICT
Step 6

A	B	C	D	E
1985 b AND c CROPS	PREVIOUS YEAR SMD (AC-FT)	PREVIOUS YEAR ANNUAL NLF (IN)	PREVIOUS YR CROP ACRES	SATISFY SMD + NLF (AC-FT)
	0.00	0.17	869	12
MISC	0.00	0.78	0	0
COTTON	11823.67	1.34	17,057	13,528
	0.00	2.21	1,543	284
	0.00	0.78	3,593	233
MELONS	258.39	0.89	819	306
TOMATOES	1800.19	1.34	3,804	2,224
SUGARBEET N	0.00	1.69	826	116
	0.00	0.68	230	13
BEANS	799.30	1.06	1,889	948
	0.00	1.17	0	0
RICE	0.00	2.08	0	0
CORN	59.15	1.38	150	76
VEGETABLE	104.87	0.78	554	141
	0.00	2.34	0	0
ALMOND-STONE	0.00	2.22	301	56
WALNUT	0.00	2.26	32	6
MILO	98.43	1.19	156	114
		TOTAL WATER FOR LISTED CROPS		17,398

ACREAGE OF LISTED CROPS-- FALLOW= 25,431

1986 b AND c CROPS	PREVIOUS YEAR SMD (AC-FT)	PREVIOUS YEAR ANNUAL NLF (IN)	PREVIOUS YR CROP ACRES	SATISFY SMD + NLF (AC-FT)
	0.00	0.16	869	12
MISC	35.59	0.74	188	47
COTTON	10447.47	1.29	15,331	12,098
	0.00	2.10	1,543	270
	0.00	0.75	2,823	177
MELONS	1256.92	0.66	3,984	1,476
TOMATOES	1800.19	1.30	3,804	2,211
	0.00	1.59	1,027	136
	0.00	0.67	230	13
BEANS	633.68	1.00	1,339	745
	0.00	1.13	0	0
RICE	0.00	2.00	0	0
CORN	59.15	1.33	150	76
VEGETABLE	192.51	0.74	1,017	255
	0.00	2.22	680	126
ALMOND-STONE	0.00	2.10	301	53
WALNUT	0.00	2.15	32	6
MILO	584.29	1.14	926	872
		TOTAL WATER FOR LISTED CROPS		17,640

ACREAGE OF LISTED CROPS+ FALLOW= 27,941

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PANOCHE WATER DISTRICT
Step 6

A 1987 b AND c CROPS	B PREVIOUS YEAR SMD (AC-FT)	C PREVIOUS YEAR ANNUAL NLF (IN)	D PREVIOUS YR CROP ACRES	E SATISFY SMD + NLF (AC-FT)
	0.00	0.16	1,468	19
MISC	0.00	0.57	0	0
COTTON	10170.11	1.23	14,924	11,705
	0.00	1.99	2,484	408
	0.00	0.54	2,115	96
MELONS	998.81	0.61	2,215	811
TOMATOES	2026.87	1.23	4,283	2,487
	0.00	1.60	719	96
	0.00	0.48	926	36
BEANS	1081.35	0.95	2,285	1,283
	0.00	0.94	300	23
RICE	0.00	1.90	0	0
CORN	374.25	1.27	949	475
VEGETABLE	63.41	0.57	335	79
	0.00	2.12	45	8
ALMOND-STONE	0.00	1.96	317	52
WALNUT	0.00	1.99	250	41
MILO	647.39	1.09	1,026	741

TOTAL WATER FOR LISTED CROPS 17,634

ACREAGE OF LISTED CROPS + FALLOW= 28,052

1988 b AND c CROPS	PREVIOUS YEAR SMD (AC-FT)	PREVIOUS YEAR ANNUAL NLF (IN)	PREVIOUS YR CROP ACRES	SATISFY SMD + NLF (AC-FT)
	0.00	0.16	852	11
MISC	0.00	0.68	277	16
COTTON	10150.35	1.28	18,560	12,128
	0.00	2.02	2,853	481
	0.00	0.62	837	43
MELONS	376.38	0.66	1,504	459
TOMATOES	1208.75	1.29	5,478	1,798
	0.00	1.48	219	27
	0.00	0.54	0	0
BEANS	142.92	0.99	0	143
	0.00	1.04	155	13
RICE	0.00	2.00	0	0
CORN	1015.88	1.32	545	1,076
VEGETABLE	392.60	0.68	1,935	502
	0.00	2.10	1,122	196
ALMOND-STONE	0.00	2.03	58	10
WALNUT	0.00	2.08	252	44
MILO	46.06	1.13	0	48

TOTAL WATER FOR LISTED CROPS 18,218

ACREAGE OF LISTED CROPS + FALLOW= 29,481

PANOCHE WATER DISTRICT
Step 6

A 1989 b AND c CROPS	B PREVIOUS YEAR SMD (AC-FT)	C PREVIOUS YEAR ANNUAL NLF (IN)	D PREVIOUS YR CROP ACRES	ADJUSTMENT SATISFY SMD + NLF (AC-FT)
	0.00	0.16	852	11
MISC	51.43	0.66	277	68
COTTON	12647.90	1.22	18,580	14,533
	0.00	2.00	2,853	476
	0.00	0.73	837	51
MELONS	474.50	0.55	1,504	544
TOMATOES	2592.39	1.17	5,476	3,127
	0.00	1.64	219	30
	0.00	0.65	0	0
BEANS	0.00	0.92	0	0
	0.00	1.03	155	13
RICE	0.00	1.83	0	0
CORN	214.93	1.25	545	272
VEGETABLE	366.28	0.66	1,935	472
	0.00	2.14	1,122	200
ALMOND-STONE	0.00	1.97	56	10
WALNUT	0.00	2.02	252	42
MILO	0.00	1.09	0	0
		TOTAL WATER FOR LISTED CROPS		19,067

ACREAGE OF LISTED CROPS+ FALLOW= 29,461

1990 b AND c CROPS	PREVIOUS YEAR SMD (AC-FT)	PREVIOUS YEAR ANNUAL NLF (IN)	PREVIOUS YR CROP ACRES	SATISFY SMD + NLF (AC-FT)
	0.00	0.16	1,029	14
MISC	0.00	0.66	0	0
COTTON	10384.77	1.27	15,239	12,003
	0.00	2.09	2,999	521
	0.00	0.69	3,451	199
MELONS	1035.44	0.87	3,282	1,216
TOMATOES	2555.95	1.34	5,401	3,160
	0.00	1.67	220	31
	0.00	0.61	0	0
BEANS	1203.42	1.03	2,712	1,516
	0.00	1.08	0	0
RICE	0.00	2.04	0	0
CORN	275.66	1.32	699	353
VEGETABLE	224.88	0.68	1,188	293
	0.00	2.25	26	5
ALMOND-STONE	0.00	2.06	217	37
WALNUT	0.00	2.11	252	44
MILO	0.00	1.12	0	0
		TOTAL WATER FOR LISTED CROPS		18,823

ACREAGE OF LISTED CROPS+ FALLOW= 30,019

PANOCHE WATER DISTRICT
Step 6

A 1991 b AND c CROPS	B PREVIOUS YEAR SMD (AC-FT)	C PREVIOUS YEAR ANNUAL NLF (IN)	D PREVIOUS YR CROP ACRES	E SATISFY SMD + NLF (AC-FT)
	0.00	0.16	4,235	58
MISC	0.00	0.62	0	0
COTTON	9950.00	1.24	14,601	11,454
	0.00	2.09	3,548	619
	0.00	0.63	1,825	96
MELONS	1009.49	0.59	3,485	1,270
TOMATOES	2238.88	1.23	4,731	2,722
	0.00	1.75	171	25
	0.00	0.55	0	0
BEANS	1167.95	0.93	2,468	1,360
	0.00	1.00	0	0
RICE	0.00	1.91	0	0
CORN	74.53	1.27	189	95
VEGETABLE	53.95	0.62	285	89
	0.00	2.25	0	0
ALMOND-STONE	0.00	2.06	117	20
WALNUT	0.00	2.09	379	66
MILO	0.00	1.09	0	0

TOTAL WATER FOR LISTED CROPS 17,056

ACREAGE OF LISTED CROPS+ FALLOW= 30,490

1992 b AND c CROPS	PREVIOUS YEAR SMD (AC-FT)	PREVIOUS YEAR ANNUAL NLF (IN)	PREVIOUS YR CROP ACRES	SATISFY SMD + NLF (AC-FT)
	0.00	0.16	7,916	103
MISC	0.00	0.56	0	0
COTTON	8897.15	1.26	13,056	10,267
	0.00	1.96	2,712	443
	0.00	0.56	0	0
MELONS	620.26	0.64	1,966	725
TOMATOES	2810.06	1.26	5,936	3,435
	0.00	1.66	0	0
	0.00	0.49	0	0
BEANS	1291.94	0.97	2,730	1,514
	0.00	0.93	0	0
RICE	0.00	1.90	0	0
CORN	94.65	1.30	240	121
VEGETABLE	199.90	0.56	1,056	249
	0.00	2.13	0	0
ALMOND-STONE	0.00	1.97	35	8
WALNUT	0.00	2.00	393	68
MILO	0.00	1.12	0	0

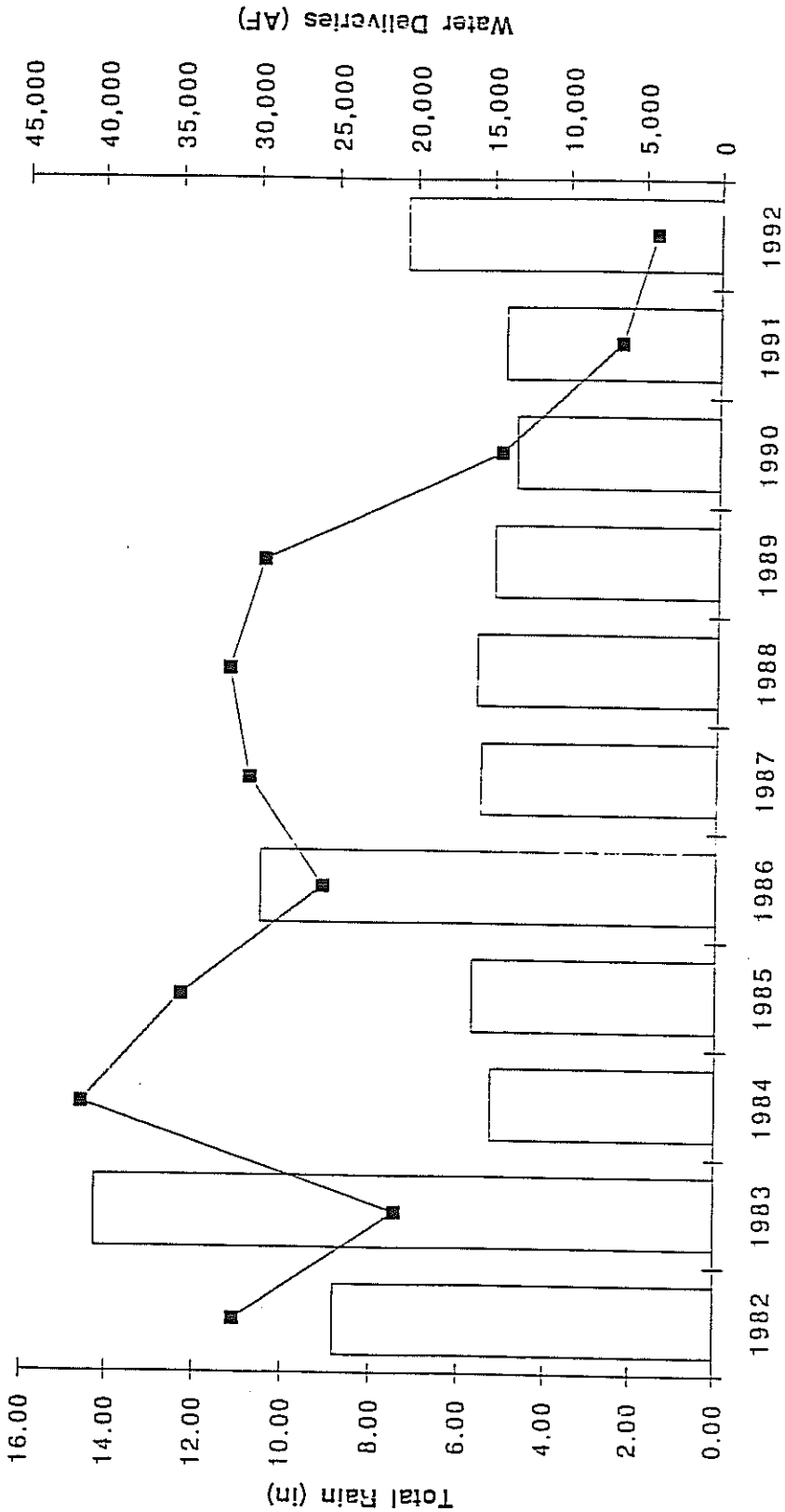
TOTAL WATER FOR LISTED CROPS 16,302

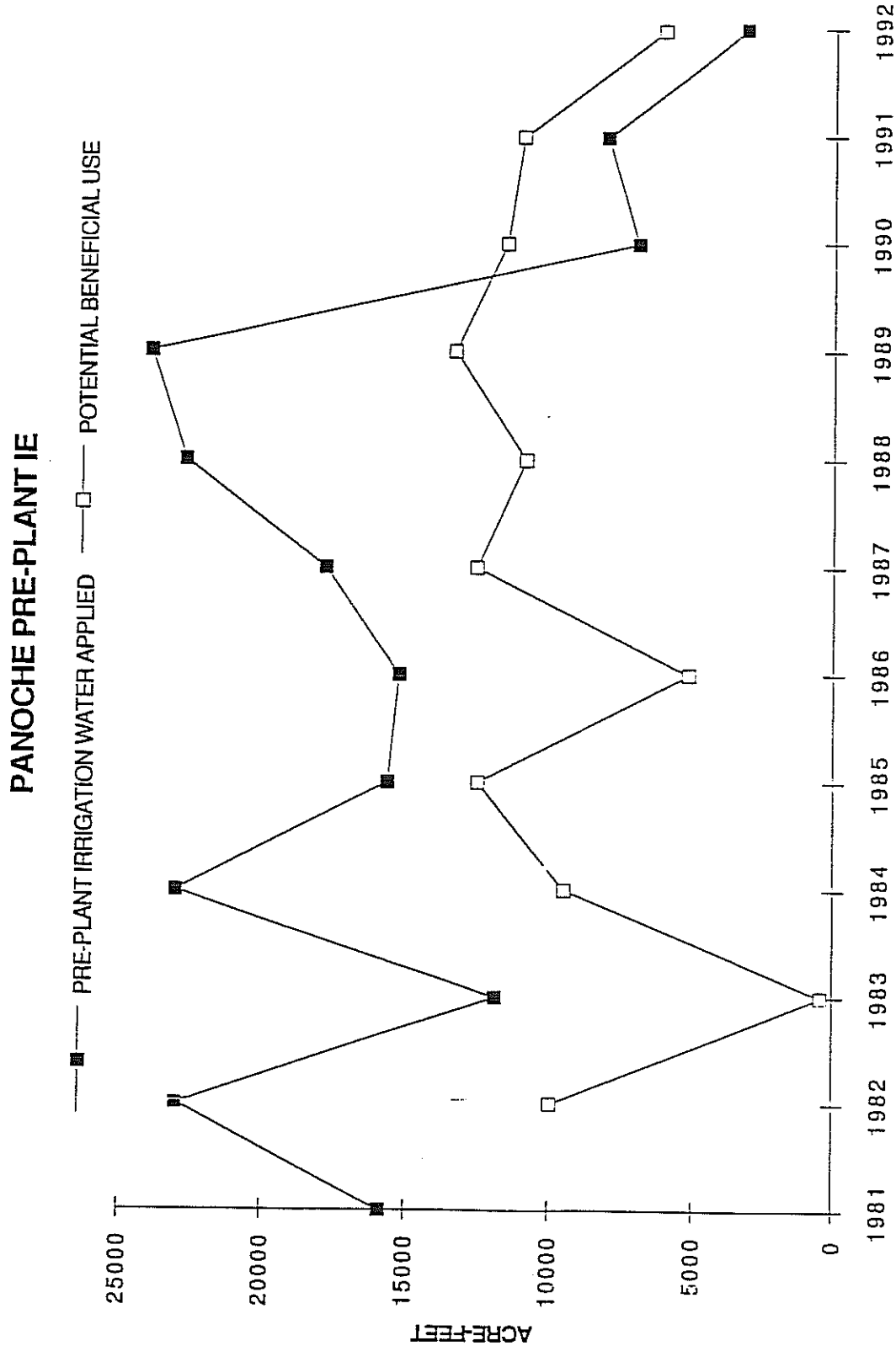
ACREAGE OF LISTED CROPS+ FALLOW= 33,330

PANOCHE WATER DISTRICT

YEAR	TOTAL SUPPLY (AC-FT)	WATER TO MEET ETc (AC-FT)	PRE-PLANT IRRIGATION WATER AVAILABLE (AC-FT)	WATER FOR PREVIOUS YEAR (AC-FT)	WATER FOR PREVIOUS YEAR SMD + NLF (AC-FT)	RAINWATER CONTRIBUTION TO SMD, NLF (AC-FT)	WATER FOR PREVIOUS YEAR SMD + NLF LESS RAINWATER (AC-FT)	NO RAINWATER PRE-PLANT IRRIGATION EFFICIENCY	INCLUDES RAINWATER PRE-PLANT IRRIGATION EFFICIENCY
1981	20461	4599	15862						
1982	25755	2743	23012	15184	17754	7802	9952	77.15	43.25
1983	12981	1085	11896	9816	11466	11040	426	96.38	3.58
1984	30201	7147	23054	13603	16201	6696	9505	70.27	41.23
1985	21693	6054	15639	14744	17398	4876	12523	100.00	80.07
1986	18050	2800	15250	15010	17640	12474	5166	100.00	33.88
1987	19997	2184	17813	15062	17634	5066	12568	98.99	70.56
1988	29241	6469	22772	13331	16218	5347	10871	71.22	47.74
1989	28883	4853	24030	16348	19067	5679	13388	79.35	55.71
1990	10480	3509	6971	15760	18623	7057	11565	100.00	100.00
1991	8930	852	8078	14585	17056	6057	10999	100.00	100.00
1992	4261	1107	3154	13914	16382	10313	6069	100.00	100.00

Panoche MO Deliveries Chart 3

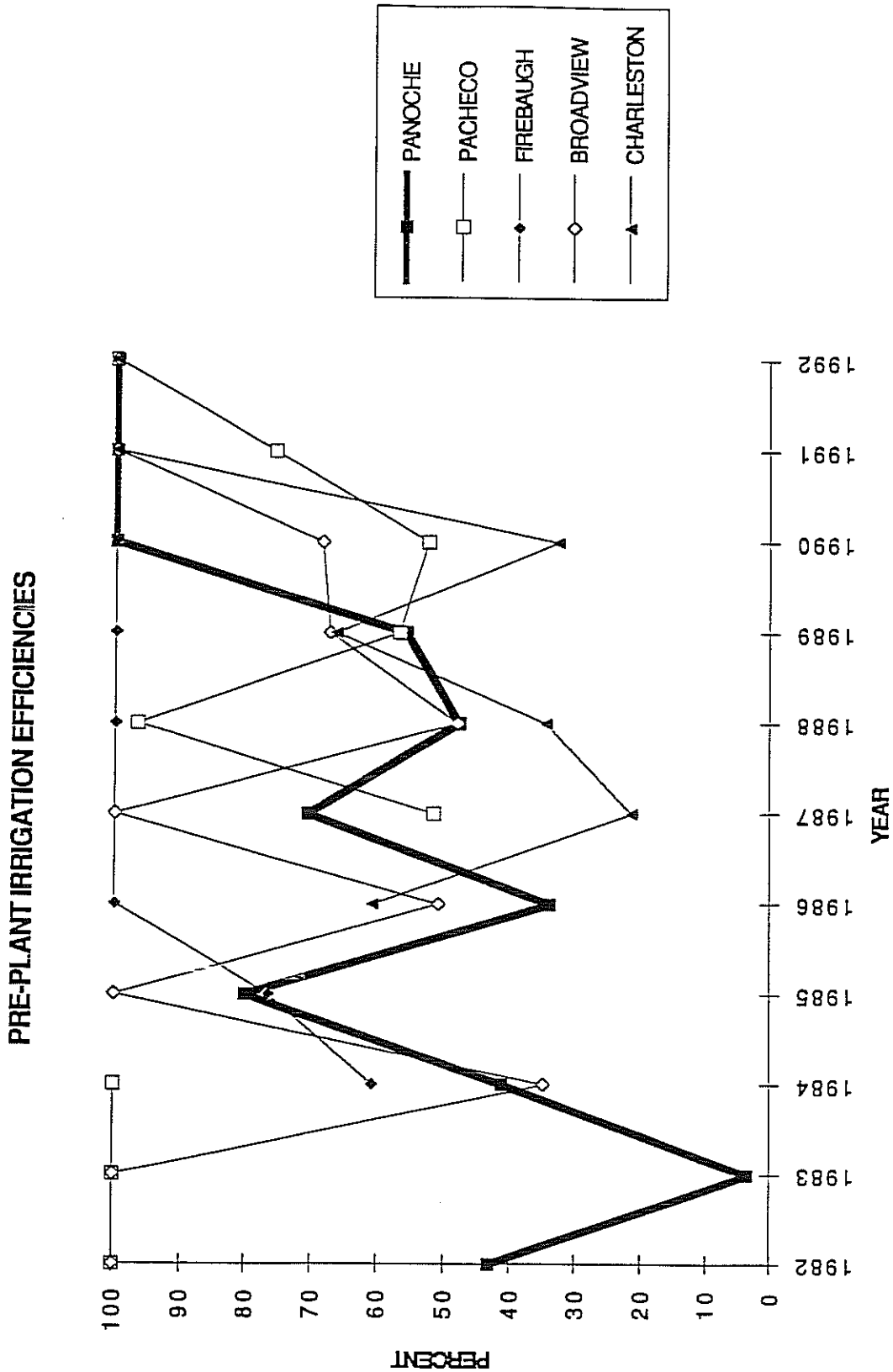



PANOCHE PRE-PLANT IE
PRE-PLANT IRRIGATION WATER APPLIED
POTENTIAL BENEFICIAL USE
ACRE-FEET
25000
20000
15000
10000
5000
0
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992

PRE-PLANT IE SUMMARY CHART

PRE-PLANT IRRIGATION EFFICIENCIES FROM MASTER SPREADSHEETS					
YEAR	PANOCHE	PACHECO	FIREBAUGH	BROADVIEW	CHARLESTON
1982	43	100		100	
1983	4	100		100	
1984	41	100	61	35	
1985	80		77	100	
1986	34		100	51	61
1987	71	52	100	100	21
1988	48	97	100	48	35
1989	56	57	100	67	66
1990	100	52	100	69	33
1991	100	76	100	100	100
1992	100	100	100	100	100

PRE-PLANT IE SUMMARY CHART Chart 2



PRE-PLANT IRRIGATION EFFICIENCIES FOR GRASSLANDS WATER DISTRICTS

TECHNICAL APPENDIX F
IRRIGATION EFFICIENCY Spreadsheet
Water Balance Approach

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TECHNICAL APPENDIX F

Spreadsheet Output F3

Graph of DIE-Water Balance Approach F6

Graphs of Individual Subareas: PE-14, PO-1, CH-1, and FC-5 ..... F7

Grasslands Basin Irrigation and Drainage Study

Water Balance

		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Water Delivery (IN)													
Panoche	W1: PaDD	97,344	89,155	75,306	109,511	98,241	92,487	98,119	97,196	91,300	81,258	69,706	63,416
Pacheco	W2: PaWD	12,653	9,763	9,751	10,775	9,000	7,770	9,756	10,217	13,063	11,569	11,572	8,107
Charleston	W3: SLWD	14,030	11,973	11,591	13,691	12,119	10,264	13,891	14,428	12,263	11,127	10,218	9,630
Eastside Districts	W4=W5+W6+W7	119,828	106,594	78,341	127,430	122,585	102,667	119,108	117,735	106,574	97,567	86,394	83,201
Firebaugh	W5: FCWD	75,645	66,132	47,400	80,268	75,432	62,966	79,545	75,106	70,326	63,903	57,141	59,569
Broadview	W6: BWD	28,932	25,211	15,690	31,911	28,240	24,628	23,308	25,891	25,200	20,582	12,902	9,086
CCID	W7: CCID	15,251	15,251	15,251	15,251	18,914	15,072	16,255	16,738	11,049	13,081	16,351	14,546
Total Volume (AF)	W8=W1+W2+W3+W4	243,855	217,485	174,989	261,407	241,945	213,188	240,874	239,576	223,200	201,521	177,890	164,354
Precipitation													
Total Rain (in)	P1	7.7	9.7	15.5	5.4	5.8	11.0	5.7	5.9	6.7	6.1	5.1	7.5
Effective Rain	P2: Est. of 50%	3.8	4.9	7.8	2.7	2.9	5.5	2.8	2.9	3.4	3.0	2.5	3.7
Rain Runoff	P3: Est. of 15%	1.2	1.5	2.3	0.8	0.9	1.7	0.8	0.9	1.0	0.9	0.8	1.1
Reference Evapotranspiration	R1: CIMIS	57	57	58	59	58	55	57	56	57	57	56	56
Total Acreage													
Panoche	A1: PaDD	34,151	19,986	29,703	30,754	33,375	33,153	32,208	33,795	35,686	31,799	28,126	27,742
Pacheco	A2: PaWD	4,410	4,410	3,696	3,696	3,100	3,500	4,028	4,179	3,648	4,254	4,369	3,705
Charleston	A3: SLWD	3,618	3,643	3,612	3,477	3,232	2,897	3,724	3,582	3,602	3,494	3,890	3,890
Eastside Districts	A4=A5+A6+A7	32,318	32,255	25,477	32,834	33,807	32,534	33,923	37,237	37,498	38,054	34,772	34,277
Firebaugh	A5: FCWD	20,110	20,244	16,784	20,691	19,731	19,825	20,981	23,282	24,746	25,458	24,676	24,894
Broadview	A6: BWD	9,025	8,828	5,510	8,960	8,665	8,169	7,870	8,736	8,686	8,160	5,539	4,483
CCID	A7: CCID	3,183	3,183	3,183	3,183	5,411	4,540	5,072	5,219	4,066	4,436	4,555	4,900
Total Acreage	A8=A1+A2+A3+A4	74,497	60,294	62,488	70,761	73,514	72,084	73,883	78,793	80,434	77,601	71,157	69,614
Fallow Acreage													
Total Acreage	A9	1,466	1,828	9,514	2,028	3,178	4,632	3,439	2,021	2,429	5,846	11,792	13,584
Evaporation - Canals													
Panoche	B1: Est. 200 AF Vary by ETo	200	200	205	206	202	192	202	196	199	199	197	197
Pacheco	B2: Est. 100 AF Vary by ETo	100	100	102	103	101	96	101	98	99	99	98	98
Charleston	B3: Est. 100 AF Vary by ETo	100	100	102	103	101	96	101	98	99	99	98	98
Eastside Districts	B4=B5+B6+B7	400	400	409	413	404	384	404	393	397	397	393	393
Firebaugh	B5: Est. 150 AF Vary by ETo	150	150	154	155	152	144	151	147	149	149	147	147
Broadview	B6: Est. 100 AF Vary by ETo	100	100	102	103	101	96	101	98	99	99	98	98
CCID	B7: Est. 100 AF Vary by ETo	100	100	102	103	101	96	101	98	99	99	98	98
Total Volume (AF)	B8=B1+B2+B3+B4	800	800	819	826	809	768	808	785	795	795	787	787
Evaporation - Phreatophytes, Fields & Head Ditches													
3% Panoche	B11: Est. 3% of Delivered	2,920	2,675	2,259	3,285	2,947	2,775	2,944	2,916	2,739	2,438	2,091	1,902
Pacheco	B12: Est. 3% of Delivered	380	293	293	323	270	233	293	307	392	347	347	243
Charleston	B13: Est. 3% of Delivered	421	359	348	411	364	308	417	433	368	334	307	289
Eastside Districts	B14=B15+B16+B17	3,595	3,198	2,350	3,823	3,678	3,080	3,573	3,532	3,197	2,927	2,592	2,496
Firebaugh	B14: Est. 3% of Delivered	2,269	1,984	1,422	2,408	2,263	1,889	2,386	2,253	2,110	1,917	1,714	1,787
Broadview	B15: Est. 3% of Delivered	868	756	471	957	847	739	699	777	756	617	387	273
CCID	B16: Est. 3% of Delivered	458	458	458	458	567	452	488	502	331	392	491	436
Total Volume (AF)	B18=B11+B12+B13+B14	7,316	6,525	5,250	7,842	7,258	6,396	7,226	7,187	6,696	6,046	5,337	4,931
Total Infiltrated or in Drains													
Panoche	IN1=W1-B1-B11	94,224	86,280	72,842	106,019	95,092	89,520	94,973	94,084	88,362	78,622	67,418	61,317
Pacheco	IN2=W2-B2-B12	12,173	9,370	9,356	10,349	8,629	7,441	9,362	9,812	12,572	11,123	11,127	7,765
Charleston	IN3=W3-B3-B13	13,509	11,514	11,141	13,177	11,654	9,860	13,373	13,897	11,796	10,694	9,813	9,243
Eastside Districts	IN4=W4-B4-B14	115,833	102,996	75,581	123,194	118,503	99,203	115,131	113,810	102,980	94,243	83,409	80,312
Firebaugh	IN5=W5-B5-B15	73,225	63,998	45,825	77,705	73,017	60,933	77,007	72,705	68,067	61,837	55,279	57,634
Broadview	IN6=W6-B6-B16	27,964	24,355	15,117	30,850	27,292	23,793	22,508	25,016	24,345	19,865	12,417	8,715
CCID	IN7=W7-B7-B17	14,693	14,693	14,691	14,690	18,245	14,524	15,666	16,138	10,618	12,590	15,762	14,012
Total Volume (AF)	IN8=W8-B8-B18	235,739	210,160	168,921	252,738	233,878	206,024	232,840	231,603	215,710	194,681	171,766	158,637

Grasslands Basin Irrigation and Drainage Study

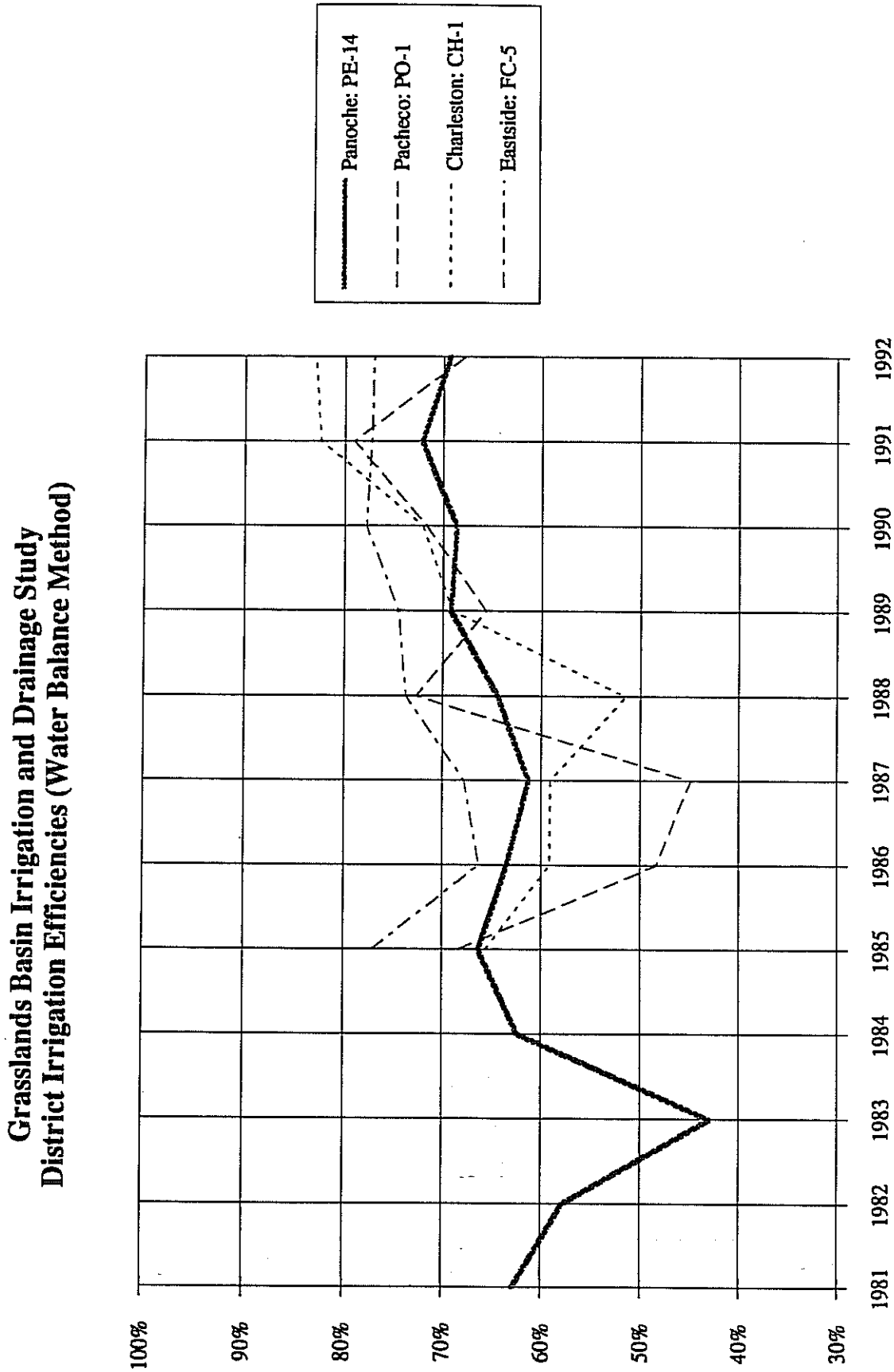
Water Balance

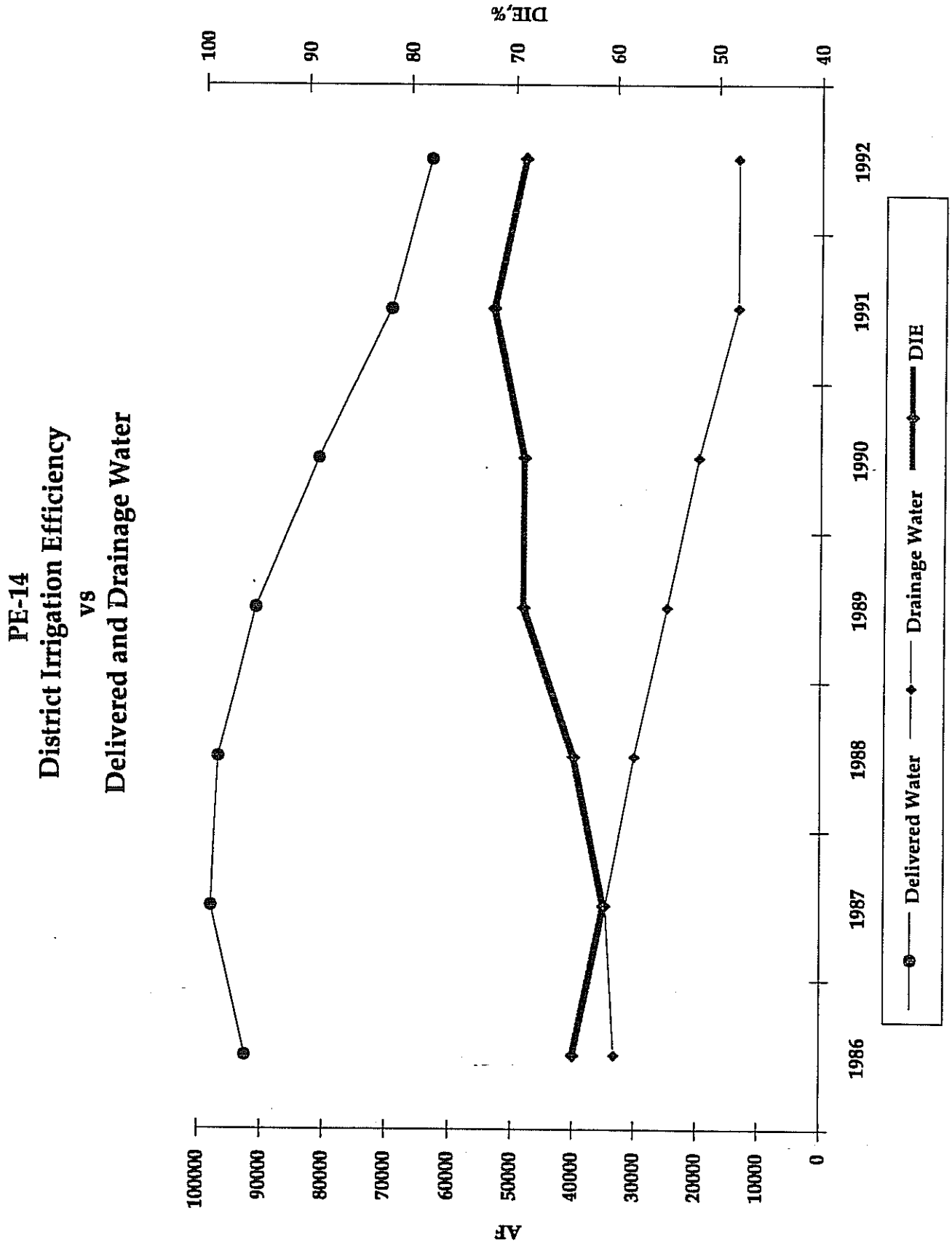
		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Water Drainage (OUT)													
Panoche	D1: PB-14	34,411	34,861	43,278	38,359	30,468	33,257	34,724	30,144	24,875	19,835	13,475	13,532
Pacheco	D2: PD-1/85-2337,3772,3231,655					2,531	3,884	5,176	2,664	5,122	3,160	2,716	2,716
Charleston	D3: CH-1					3,090	3,186	4,769	6,136	2,799	2,126	781	781
Eastside Districts	D4: FC-5					22,907	31,191	32,265	26,041	22,626	16,964	13,491	13,491
Firebaugh													
Broadview													
CCID													
Total Volume (AF)	D5=D1+D2+D3+D4					58,995	71,518	76,934	64,985	55,422	42,085	30,463	30,520
Percent of Delivered													
Panoche	Water Out/ Water In	35%	39%	57%	35%	31%	36%	35%	31%	27%	24%	19%	21%
Pacheco	"					28%	50%	53%	26%	39%	27%	23%	34%
Charleston	"					25%	31%	34%	43%	23%	19%	8%	8%
Eastside Districts	"					19%	30%	27%	22%	21%	17%	16%	16%
Firebaugh													
Broadview													
CCID													
Total	"	0%	0%	0%	0%	24%	34%	32%	27%	25%	21%	17%	19%
Water For Leaching													
Panoche	L1: From DIE Spreadsheet	4,395	4,025	3,400	4,944	4,436	4,176	4,430	4,388	4,122	3,669	4,135	3,762
Pacheco	L2: From DIE Spreadsheet	1,282	989	988	1,092	912	787	988	1,035	1,835	1,626	1,626	1,139
Charleston	L3: From DIE Spreadsheet	633	541	523	429	505	331	688	753	543	561	506	503
Eastside Districts	L4= L5+L6+97	14,101	11,256	4,031	6,321	5,809	4,918	5,419	6,084	5,283	5,383	4,752	4,136
Firebaugh	L5: From DIE Spreadsheet	3,415	2,986	2,140	3,624	3,406	2,843	3,392	3,391	3,175	2,885	2,580	2,690
Broadview	L6: From DIE Spreadsheet	9,997	7,582	1,203	2,008	1,549	1,395	1,093	1,937	1,609	1,907	1,434	790
CCID	L7: From DIE Spreadsheet	689	689	689	689	854	681	734	756	499	591	738	657
Total Volume (AF)	L8=L1+L2+L3+L4	20,412	16,811	8,943	12,786	11,661	10,212	11,525	12,260	11,783	11,238	11,019	9,540
Subsurface Baseflow													
Panoche	B1-B3:From John Pio	4,800	4,800	4,800	4,800	4,800	4,800	4,300	2,900	3,700	2,000	1,600	908
Pacheco	Personal Communication	544	544	544	544	544	544	544	549	605	0	451	575
Charleston		30	30	30	30	30	30	30	30	1	0	0	30
Eastside Districts	B4=B5+B6+B7	1,703	1,703	1,703	1,703	1,703	1,709	1,204	1,198	1,638	1,400	920	961
Firebaugh	B5-B7:From John Pio	609	609	609	609	609	609	438	524	501	509	368	409
Broadview	Personal Communication	594	594	594	594	594	600	266	174	637	391	52	52
CCID		500	500	500	500	500	500	500	500	500	500	500	500
Total Volume (AF)	B8=B1+B2+B3+B4	7,077	7,077	7,077	7,077	7,077	7,083	6,078	4,677	5,944	3,400	2,871	2,472
Rain Runoff													
Panoche	R1:From DIE Spreadsheet	3,283	2,431	5,755	2,057	2,407	4,571	2,279	2,488	2,989	2,405	1,775	2,583
Pacheco	R2:From DIE Spreadsheet	424	536	716	247	224	483	285	308	306	322	276	345
Charleston	R3:From DIE Spreadsheet	348	443	700	233	233	399	263	264	302	264	246	362
Eastside Districts	R4=R5+R6+R7	3,107	3,923	4,936	2,196	2,438	4,486	2,400	2,742	3,140	2,878	2,195	3,192
Firebaugh	R5:From DIE Spreadsheet	1,933	2,462	3,252	1,384	1,423	2,733	1,484	1,714	2,072	1,925	1,558	2,318
Broadview	R6:From DIE Spreadsheet	868	1,074	1,068	599	625	1,126	557	643	727	617	350	417
CCID	R7:From DIE Spreadsheet	306	387	617	213	390	626	359	384	341	335	288	456
Total Volume (AF)	R8=R1+R2+R3+R4	7,161	7,333	12,107	4,732	5,302	9,939	5,227	5,801	6,736	5,869	4,492	6,483

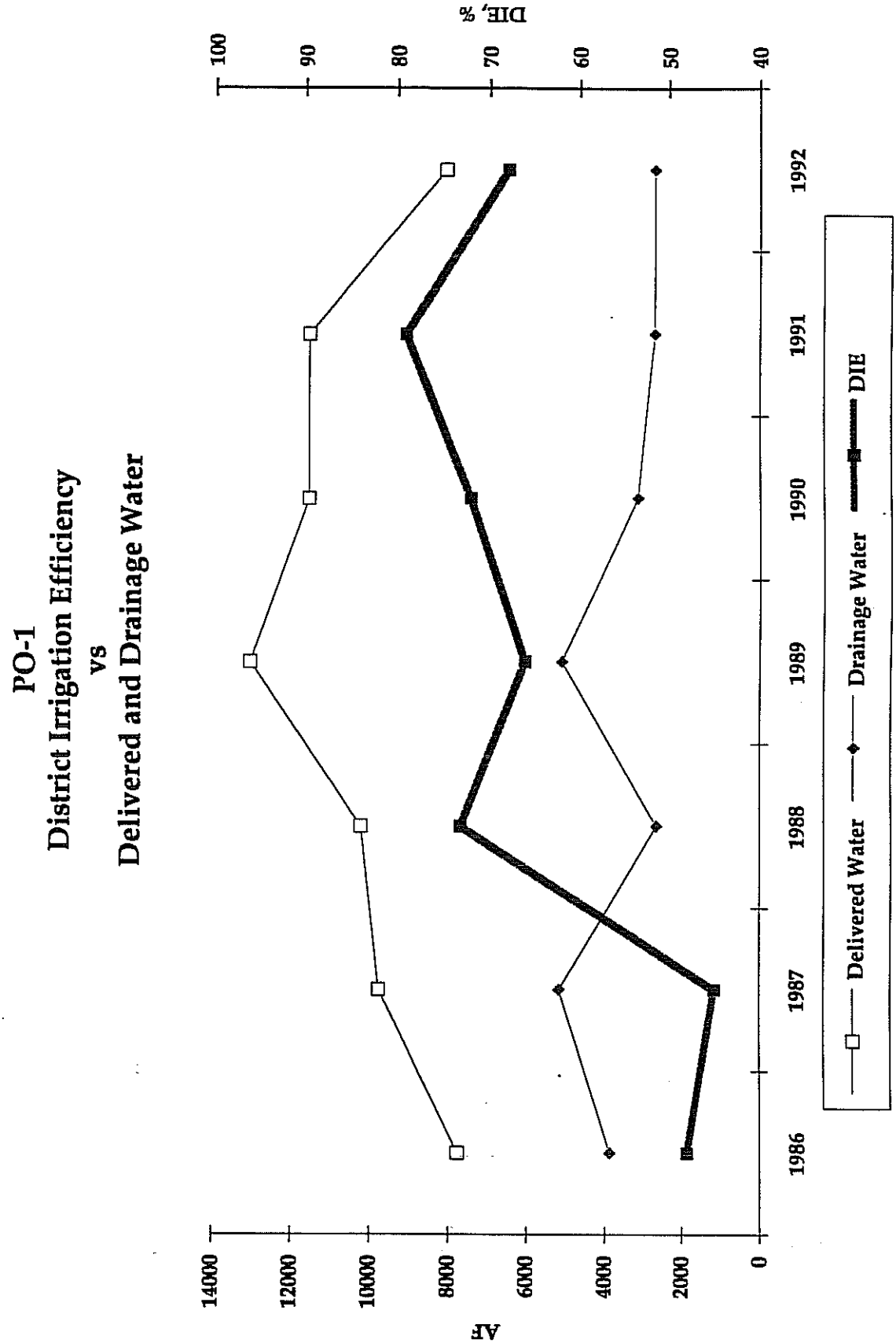
Grasslands Basin Irrigation and Drainage Study

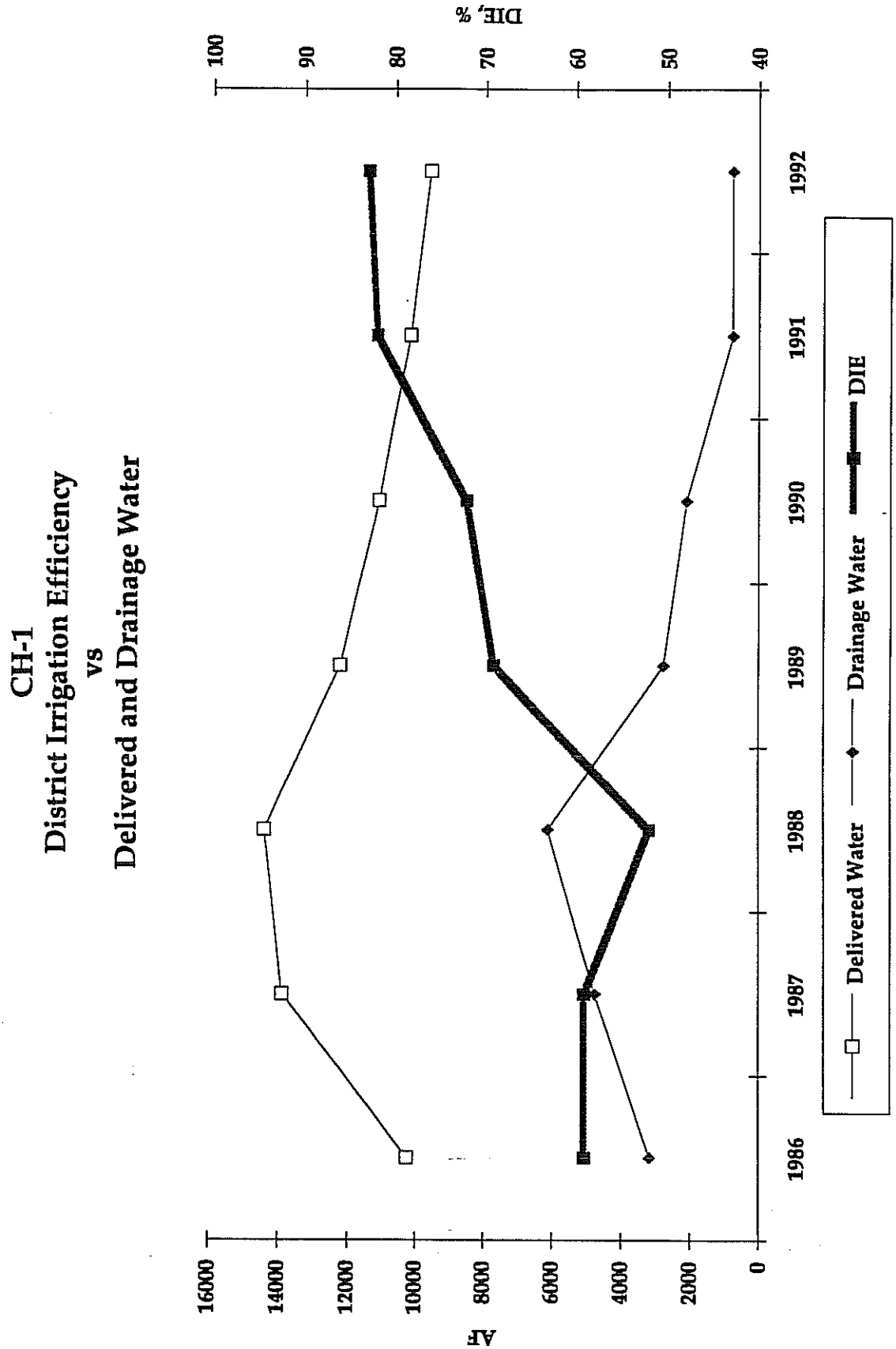
Water Balance

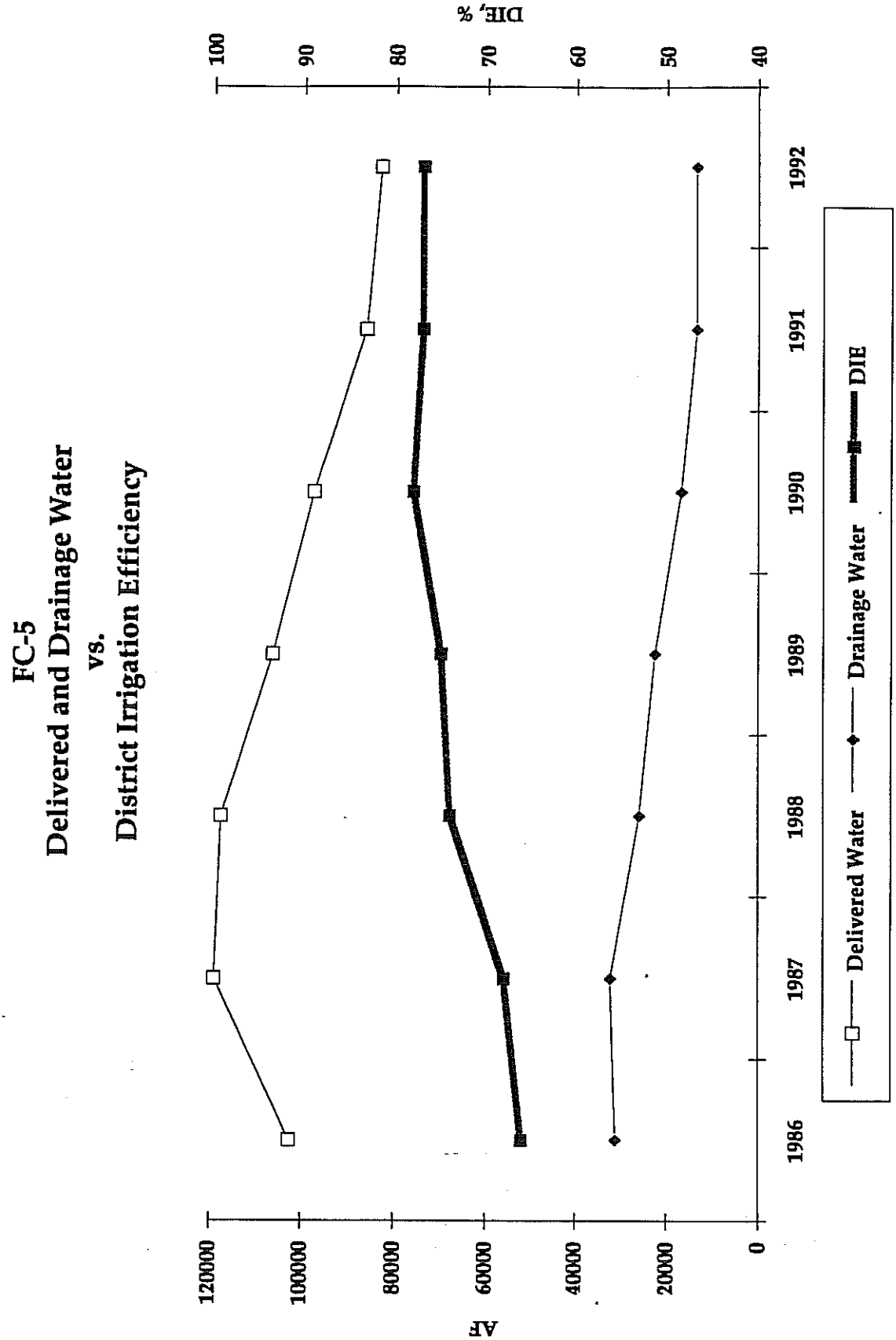
		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Drain Evaporation - Phreatophytes & Water Surfaces													
Panoche	B19: Est. 500 AF Vary by ETo	500	500	512	516	506	480	505	491	497	497	492	492
Pacheco	B20: Est. 250 AF Vary by ETo	250	250	256	258	253	240	252	245	248	248	246	246
Charleston	B21: Est. 250 AF Vary by ETo	250	250	256	258	253	240	252	245	248	248	246	246
Eastside Districts	B22=B15+B16+B17	850	1,000	1,024	1,032	1,011	960	1,010	982	993	993	983	983
Firebaugh	B23: Est. 350 AF Vary by ETo	350	350	358	361	354	336	353	344	348	348	344	344
Broadview	B24: Est. 250 AF Vary by ETo	250	250	256	258	253	240	252	245	248	248	246	246
CCID	B25: Est. 250 AF Vary by ETo	250	250	256	258	253	240	252	245	248	248	246	246
Total Volume (AF)	B26=B11+B12+B13+B14	1,850	2,000	2,047	2,065	2,022	1,920	2,020	1,964	1,987	1,987	1,966	1,966
Deep Percolation Losses below Corcoran Clay													
Panoche	DP1=.31 AF/A x Acres in 1981	10,587	10,587	10,587	10,587	10,587	10,587	10,587	10,587	10,587	10,587	10,587	10,587
Pacheco	DP2=.31 AF/A x Acres	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367
Charleston	DP3=.31 AF/A x Acres	1,122	1,122	1,122	1,122	1,122	1,122	1,122	1,122	1,122	1,122	1,122	1,122
Eastside Districts	DP4=DP5+DP6+DP7	10,019	10,019	10,019	10,019	10,019	10,019	10,019	10,019	10,019	10,019	10,019	10,019
Firebaugh	DP5=.21 AF/A x Acres	6,234	6,234	6,234	6,234	6,234	6,234	6,234	6,234	6,234	6,234	6,234	6,234
Broadview	DP6=.26 AF/A x Acres	2,798	2,798	2,798	2,798	2,798	2,798	2,798	2,798	2,798	2,798	2,798	2,798
CCID	DP7=.21 AF/A x Acres	987	987	987	987	987	987	987	987	987	987	987	987
Total Volume (AF)	DP8=DP1+DP2+DP3+DP4	23,094	23,094	23,094	23,094	23,094	23,094	23,094	23,094	23,094	23,094	23,094	23,094
Non-Beneficially Used Water													
Panoche	NB1=D1-L1-B1-R1+E19+DP1	33,020	34,692	40,422	37,661	29,918	30,777	34,807	31,445	25,147	22,845	17,143	17,359
Pacheco	NB2=D2-L2-B2-R2+E20+DP2					2,471	3,677	4,978	2,385	3,991	2,828	1,976	2,270
Charleston	NB3=D3-L3-B3-R3+E21+DP3					3,696	3,788	5,161	6,456	3,323	2,671	1,397	1,254
Eastside Districts	NB4=D4-L4-B4-R4+E22+DP4					23,986	31,057	34,271	27,018	23,577	18,315	16,626	16,203
Firebaugh													
Broadview													
CCID													
Total Volume (AF)	NB5=NB1+NB2+NB3+NB4	33,020	34,692	40,422	37,661	60,071	69,299	79,217	67,304	56,039	46,659	37,142	37,086
Beneficially Used Water													
Panoche	B1=IN1-NB1	61,204	51,589	32,421	68,358	65,174	58,743	60,166	62,639	63,215	55,777	50,275	43,958
Pacheco	B2=IN2-NB2	12,173	9,370	9,356	10,349	6,158	3,764	4,384	7,428	8,580	8,294	9,150	5,496
Charleston	B3=IN3-NB3	13,509	11,514	11,141	13,177	7,958	6,072	8,212	7,441	8,473	8,023	8,416	7,989
Eastside Districts	B4=IN4-NB4	115,833	102,996	75,581	123,194	94,517	68,146	80,860	86,792	79,403	75,928	66,783	64,109
Firebaugh													
Broadview													
CCID													
Total Volume (AF)	B5=B1+B2+B3+B4	202,719	175,468	128,499	215,078	173,807	136,725	153,622	164,299	159,671	148,022	134,625	121,552
District Irrigation Efficiency		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Panoche	IE1=B1/W1	63%	58%	43%	62%	66%	64%	61%	64%	69%	69%	72%	69%
Pacheco	IE2=B2/W2					68%	48%	45%	73%	66%	72%	79%	68%
Charleston	IE3=B3/W3					66%	59%	59%	52%	69%	72%	82%	83%
Eastside Districts	IE4=B4/W4					77%	66%	68%	74%	75%	78%	77%	77%
Firebaugh													
Broadview													
CCID													
Total	IE5=B5/W5					72%	64%	64%	69%	72%	73%	76%	74%


Grasslands Basin Irrigation and Drainage Study
District Irrigation Efficiencies (Water Balance Method)
Panoche: PE-14
Pacheco: PO-1
Charleston: CH-1
Eastside: FC-5
100%
90%
80%
70%
60%
50%
40%
30%
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992


PE-14
District Irrigation Efficiency
vs
Delivered and Drainage Water
AF
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
DIE,%
100
90
80
70
60
50
40
1986
1987
1988
1989
1990
1991
1992
Delivered Water
Drainage Water
DIE


PO-1
District Irrigation Efficiency
vs
Delivered and Drainage Water
DIE, %
100
90
80
70
60
50
40
AF
14000
12000
10000
8000
6000
4000
2000
0
1986
1987
1988
1989
1990
1991
1992
Delivered Water
Drainage Water
DIE


CH-1
District Irrigation Efficiency
vs
Delivered and Drainage Water
AF
16000
14000
12000
10000
8000
6000
4000
2000
0
DIE, %
100
90
80
70
60
50
40
1986
1987
1988
1989
1990
1991
1992
Delivered Water
Drainage Water
DIE


FC-5
Delivered and Drainage Water
vs.
District Irrigation Efficiency
AF
120000
100000
80000
60000
40000
20000
0
DIE, %
100
90
80
70
60
50
40
1986
1987
1988
1989
1990
1991
1992
Delivered Water
Drainage Water
DIE

TECHNICAL APPENDIX G
Water Quality and Discharge Measurements

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TECHNICAL APPENDIX G

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FC-5: Selected Graphs Of Water Quality Data.....G34

Salinity Model

While extensive analysis has not been completed at this time, researchers recognize the potential for improved analysis using computer salinity models. Such tools may be used to predict drainage water quality, drainage water quantity, and the effect of drainage water reuse on EC_e. Improved knowledge of such information would be useful in determining the appropriate management strategies of salt affected regions.

The programs vary in their capacity, scope, accuracy, and and ease of use--some models may be appropriate in some instances, while others may be better suited for other scenarios.

WATSUIT requires simple inputs: irrigation water quality and leaching fractions. It provides information on soil-water quality with varying leaching fractions. This program also addresses the potential for soil amendments for potential remedial measures: sulphuric acid, gypsum (top dressing), and gypsum (incorporated). Due to the program's simplicity, it has potential applications for management in determining strategies to establish a salt balance in a particular region.

C-HYSM is a conceptual hydro-salinity model which is more detailed than the previous program. The inputs are extensive and the program solves for the entire water and salt balance in an area. Output focuses on predicted drainage volumes and quality of discharge. There are 75 equations in the text: the majority are simple mass balance equations. In the past, this program has been used to predict flows of drainage water in the Panoche Water District. In addition, this program has been used by USBR in analyzing the Westlands Water District.

LEACHM is a leaching estimation and chemistry program. Inputs required are irrigation water compostion, soil physical properties, climate, chemical applications, and soil chemical properties.

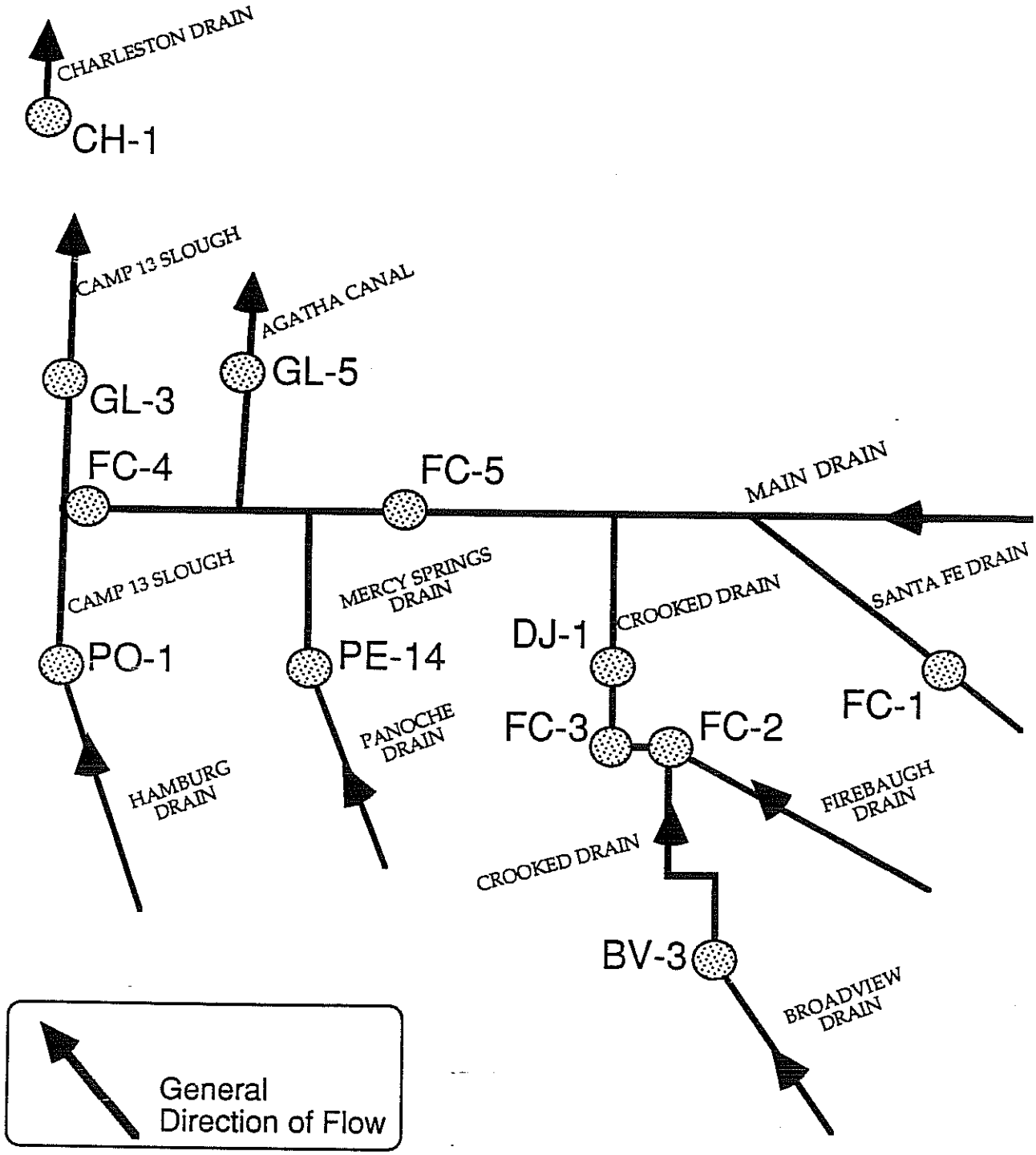
TETrans is a user-friendly functional model of solute transport. Inputs required are soil type, water holding capactiy, crop parameters, chemistry parameters, irrigation water quality, and irrigation scheduling. Output includes information on soil water concentrations at various

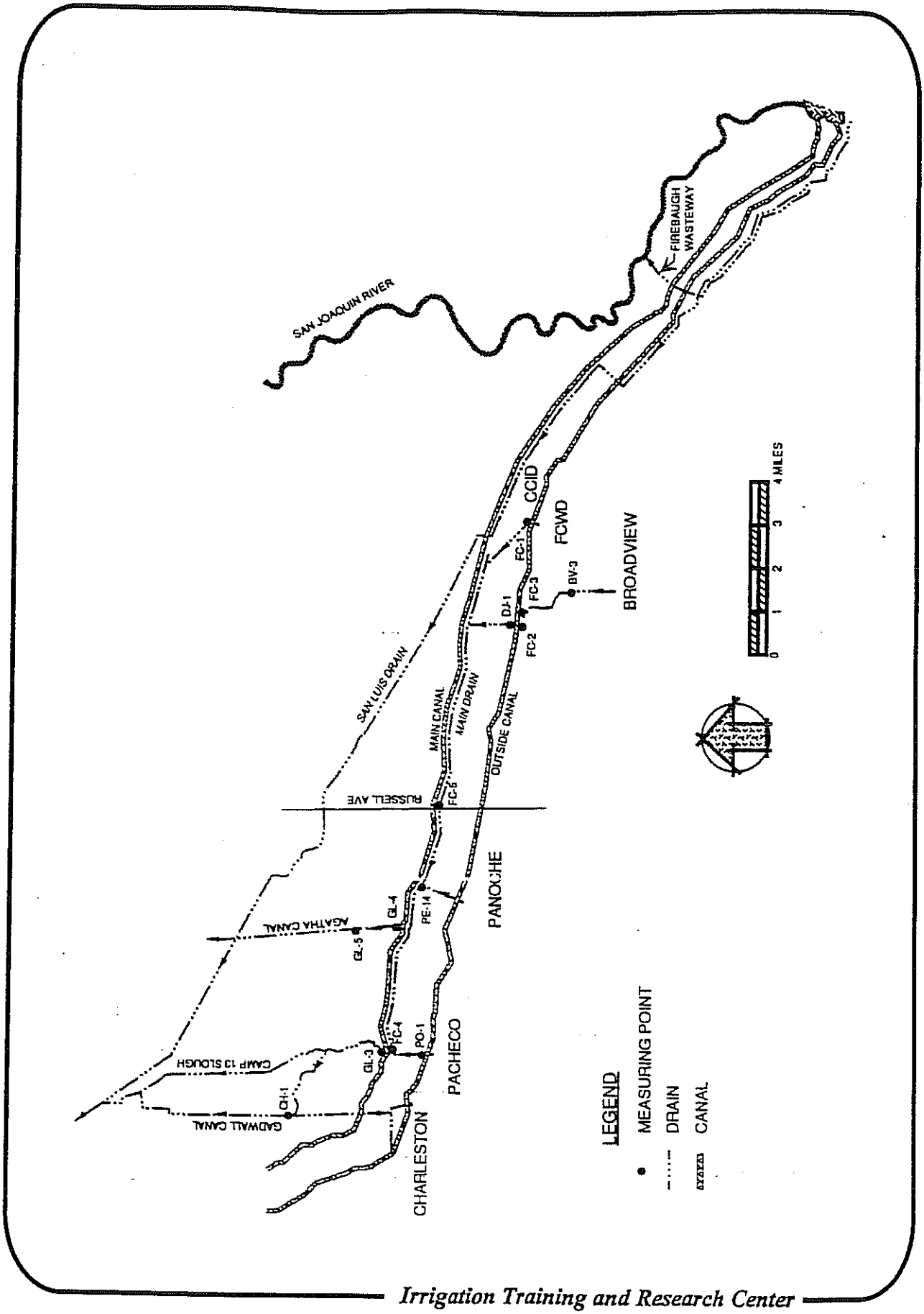
depths for each irrigation interval (before and after irrigations), water and solute balance at each irrigation, leaching fractions, and drainage water volumes.

A new version of TETrans (TETransgeo) has been developed as a standalone program. In this program, GIS is integrated with TETrans in order to compute salinity profiles and solute-loading to groundwater over selected geographic areas. Both the computed results and all input data are stored in the GIS database to allow for spatial representation of the physical variables. The US Salinity Laboratory has compiled a complete data set for 37 quarter-sections in the Broadview Water District.

Although these salinity modeling programs can improve the understanding of vertical solute movement in irrigated lands, it is hoped that they will be expanded to incorporate additional variables necessary for further analysis. For example, input regarding recycling percentages, distribution uniformity, and irrigation efficiency would be helpful in predicting the effects of drainage water reuse on the EC_e. The capability of handling additional variables would be helpful in predicting the effects of various scenarios--such information could be crucial in determining the best management strategies for these areas.

Schematic of Drainage Water Monitoring Sites




SAN JOAQUIN RIVER
FIREBAUGH WASTEWAY
CCID
FCWD
BROADVIEW
FC-1
FC-3
BV-3
DJ-1
FC-2
SAN LUIS DRAIN
MAIN CANAL
MAIN DRAIN
OUTSIDE CANAL
RUSSELL AVE
FC-5
PANOCHE
PE-14
GL-4
AGATHA CANAL
GL-5
CAMP 13 SLOUGH
FC-4
PO-1
GL-3
PACHECO
DH-1
GADWALL CANAL
CHARLESTON
LEGEND
MEASURING POINT
DRAIN
CANAL
0
1
2
3
4 MILES

SELENIUM, BORON, AND SALT LOADS FROM GRASSLANDS DRAINERS

Date	Drain	Flow (Acre-ft)	Se Load (lbs)	Salt Load (tons)	B Load (lbs)
1986	Charleston	3,219	498	11,785	29,510
	Firebaugh	31,191	3,584	74,855	317,680
	Hamburg	8,618	1,218	29,371	90,661
	Panoche	33,257	4,840	106,610	455,825
	Camp 13	*3,549*	*374*	*9,084*	*30,238*
	TOTAL	72,736	9,766	213,537	863,438
1987	Charleston	4,698	947	20,364	49,096
	Firebaugh	30,229	4,213	87,148	302,840
	Hamburg	7,630	1,190	28,519	73,346
	Panoche	34,336	4,832	114,168	537,498
	Camp 13	*4,970*	*595*	*15,680*	*54,934*
	TOTAL	71,923	10,587	234,520	907,847
1988	Charleston	6,144	1,055	29,445	64,136
	Firebaugh	23,899	3,440	71,983	227,947
	Hamburg	3,669	651	16,758	47,254
	Panoche	30,144	4,967	111,521	477,347
	Camp 13	*575*	*63*	*1,933*	*6,723*
	TOTAL	63,281	10,051	227,774	809,961
1989	Charleston	3,021	579	12,542	31,006
	Firebaugh	23,787	3,152	69,625	241,639
	Hamburg	4,647	1,118	24,855	71,914
	Panoche	24,875	4,264	96,755	432,521
	TOTAL	56,330	9,113	203,777	777,080
1990	Charleston	1,924	370	8,494	20,166
	Firebaugh	16,942	3,397	67,360	244,375
	Hamburg	3,186	761	17,676	48,299
	Panoche	19,835	3,503	82,957	413,061
	Camp 13	*3,430*	*655*	*16,141*	*56,723*
	TOTAL	38,457	7,377	160,346	669,178
1991	Charleston	753	221	3,437	8,771
	Firebaugh	10,969	1,779	40,439	170,837
	Hamburg	2,630	694	15,230	41,610
	Panoche	12,028	2,136	52,548	245,003
	Camp 13	*1,253*	*158*	*5,152*	*18,730*
	TOTAL	25,127	4,673	106,502	447,491

CVRWQCB J. Karkoski

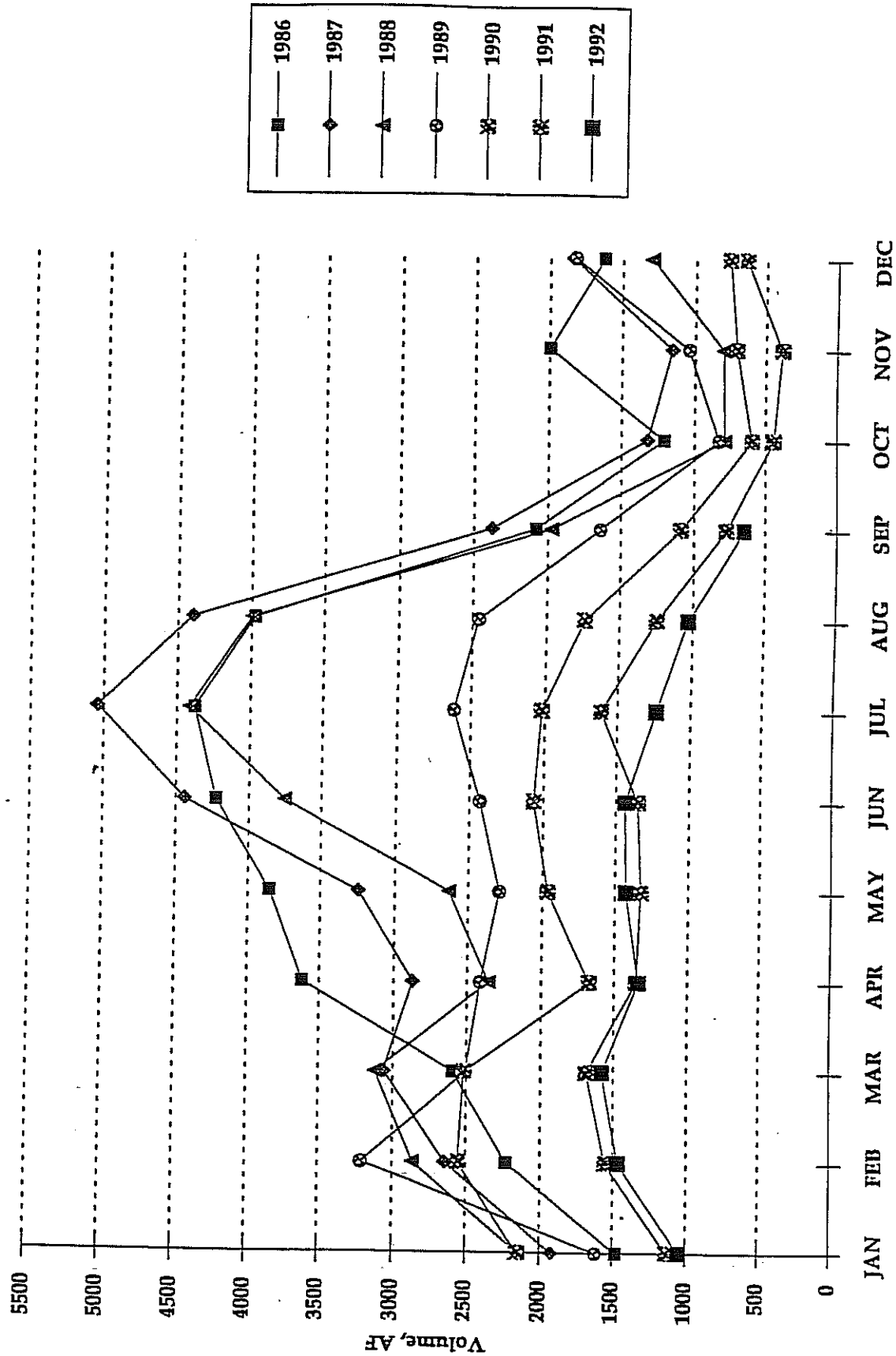
PE-14: Selected Graphs Of Water Quality Data

MONTHLY VOLUMES, Se, B, and EC - PE-14

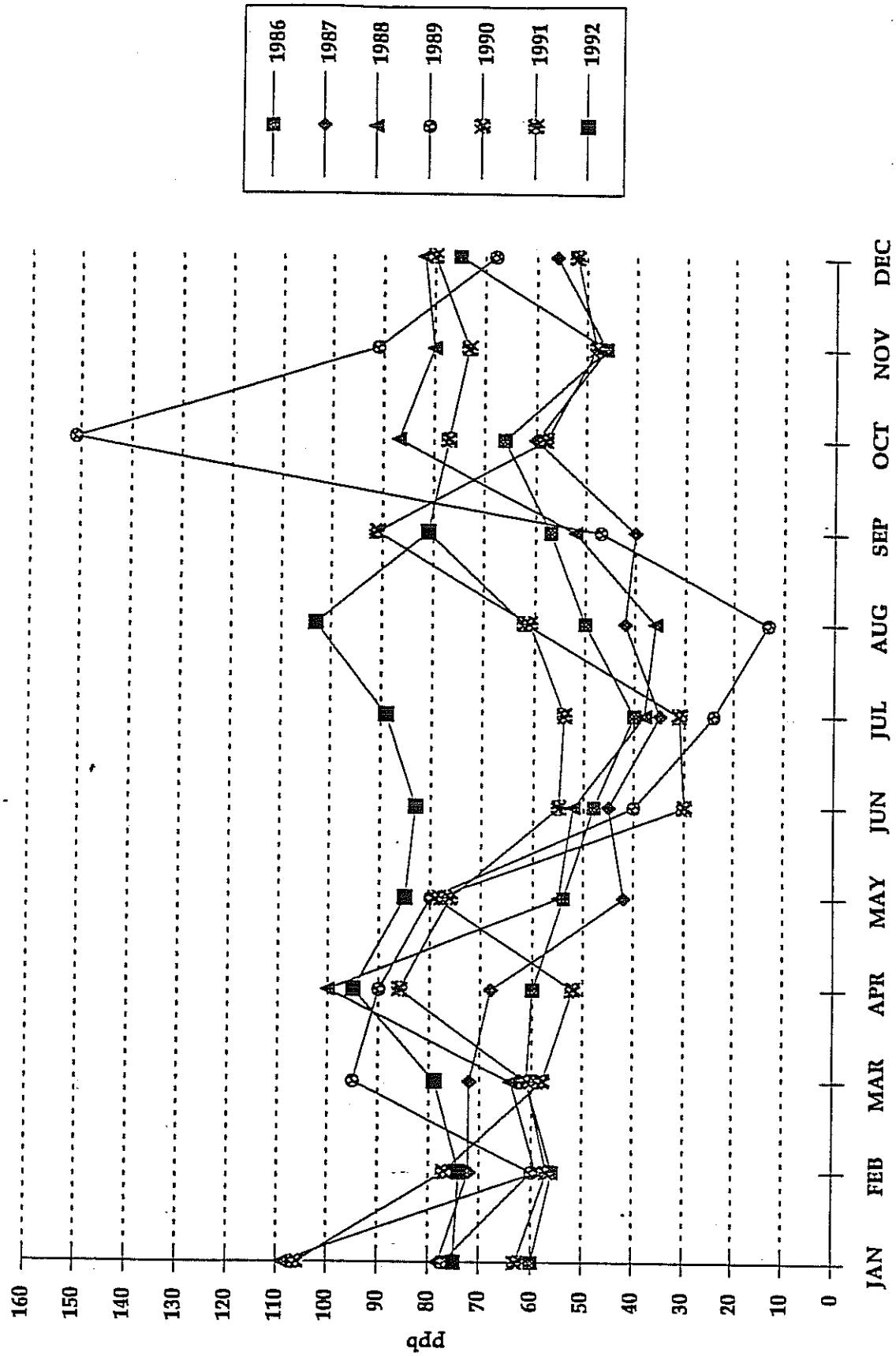
Month	1986 Vol ac-ft	Se ppb	B ppm	EC dS/m	1987 Vol ac-ft	Se ppb	B ppm	EC dS/m	1988 Vol ac-ft	Se ppb	B ppm	EC dS/m	1989 Vol ac-ft	Se ppb	B ppm	EC dS/m	1990 Vol ac-ft	Se ppb	B ppm	EC dS/m	1991 Vol ac-ft	Se ppb	B ppm	EC dS/m	1992 Vol ac-ft	Se ppb	B ppm	EC dS/m
JAN	1478	60	4.8	3.150	1922	78	5.1	3.395	2146	109	8.5	5.300	1617	77	7	4.390	2155	106	6.8	3.960	1132	63	8	4.415	1048	75	7.1	4.607
FEB	2233	56	5.8	3.650	2648	72	7.3	4.245	2866	59	6.3	4.300	3209	60	6.2	3.900	2556	77	8.2	4.200	1556	57	7	4.318	1469	74	5.6	4.635
MAR	2594	61	5.4	3.790	3062	72	8.6	4.140	3120	64	6.7	4.017	2507	95	6.9	4.573	2517	58	7.5	4.525	1687	61	7.5	4.600	1581	79	8.4	4.869
APR	3618	60	6.4	3.533	2874	68	7.2	4.010	2356	100	6.5	4.650	2414	90	7.7	5.100	1670	52	7.2	4.493	1348	86	8.3	4.810	1335	95	8.2	5.046
MAY	3052	54	6	3.59	3244	42	4.8	3.040	2634	55	6.6	3.990	2293	80	7	4.460	1962	79	8.8	4.835	1324	76	7.7	4.730	1425	85	7.6	4.930
JUN	4225	48	5.7	3.205	4443	45	4.6	3.205	3753	52	5.2	3.517	2430	40	5.1	3.400	2066	30	7.9	4.100	1348	55	7.2	4.480	1437	83	8.1	5.014
JUL	4378	40	1.7	3.220	5042	35	4.1	3.047	4413	38	4	2.980	2616	24	5.3	3.020	2018	31	7.1	3.715	1611	54	7.4	4.397	1236	89	7.9	4.933
AUG	3973	50	4.9	2.995	4399	42	4.9	2.900	3991	36	4.6	3.095	2458	13	5.3	3.460	1736	62	7.4	4.765	1246	61	7	4.305	1031	103	8.5	5.034
SEP	2079	57	6.7	3.647	2380	40	6.5	3.120	1974	52	5.2	3.445	1640	47	6.4	3.575	1091	81	8.4	4.300	776	91	7.6	4.757	649	81	9	5.200
OCT	1210	66	5	3.090	1321	60	8.4	4.355	789	87	7	4.310	827	151	9	5.230	596	77	8.7	4.695	442	58	8.5	5.118				
NOV	1993	46	4	2.280	1158	46	7.3	4.185	801	80	7.5	4.250	1042	91	7.5	4.533	707	73	7.1	4.290	384	48	8	4.591				
DEC	1624	75	5	3.520	1843	56	4.6	3.245	1301	82	6.7	4.190	1822	68	6.2	3.825	761	80	7.6	4.560	641	52	7.5	4.663				
TOT.	33357				29766				30144				24875				19835				13495				11211			

Source: Tables supplied by Joe Karkoski at the California Regional Water Quality Control Board on the monitoring points.

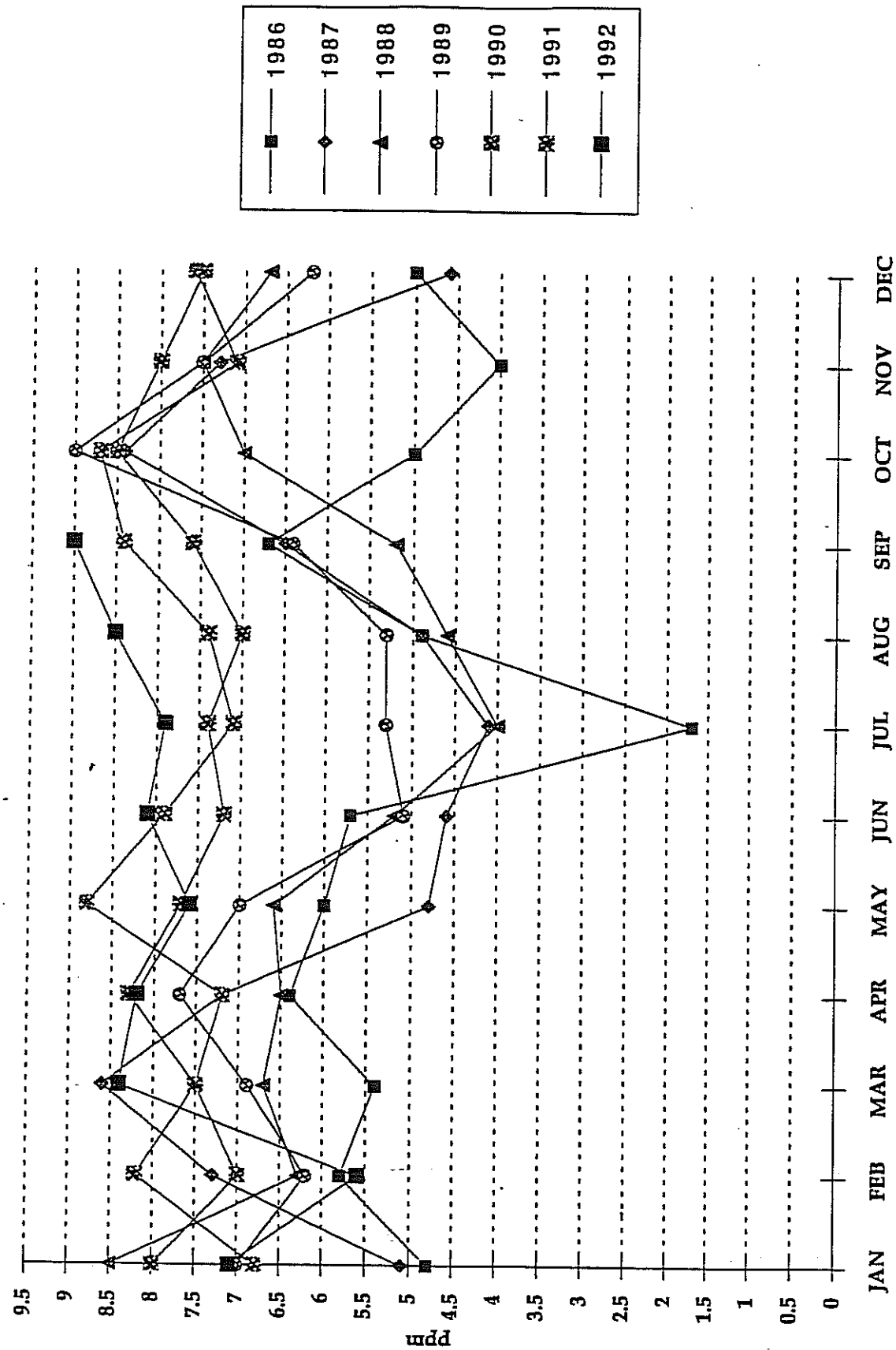
PE-14
Monthly Drainage Volume



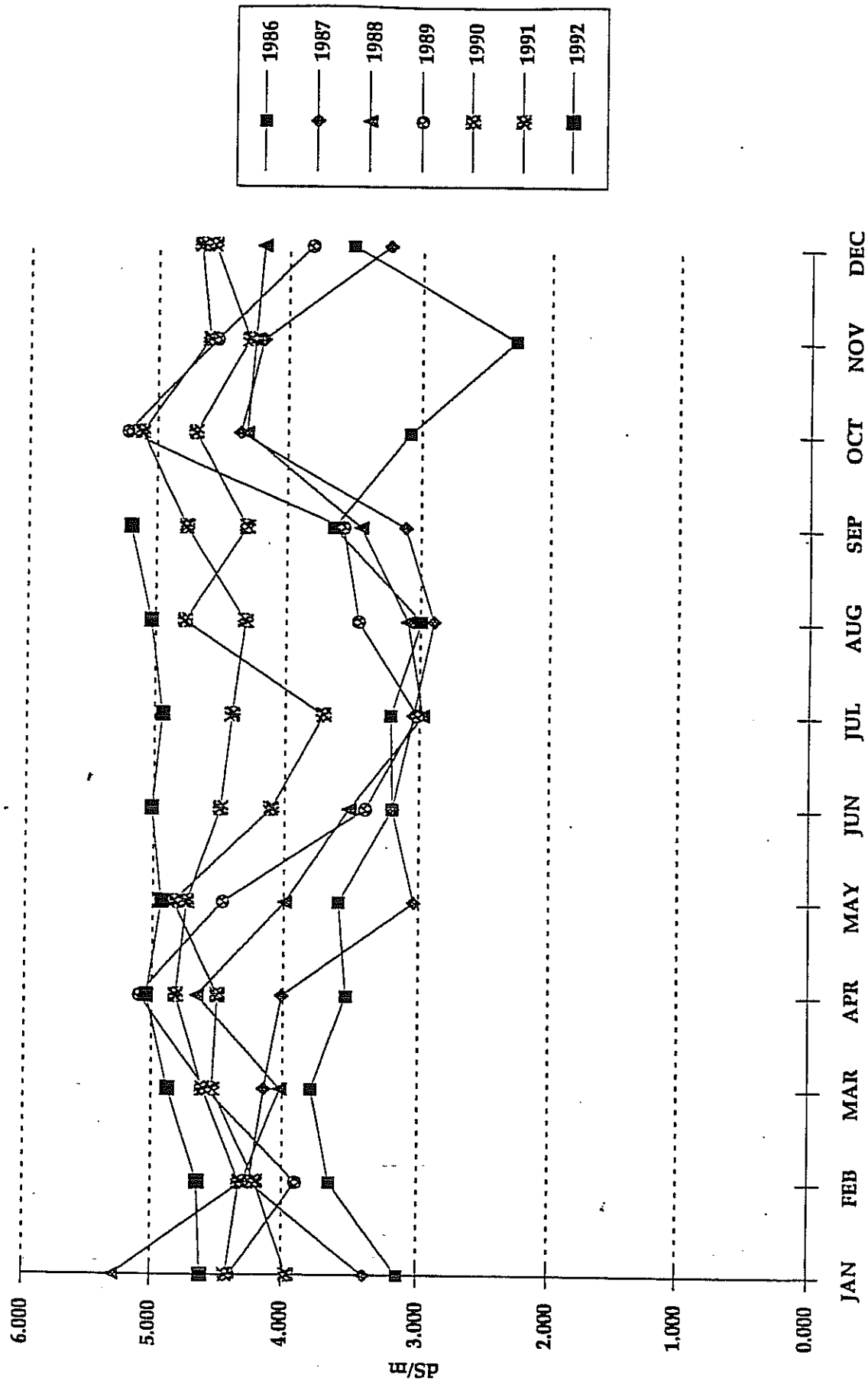
PE-14
Monthly Selenium Concentration

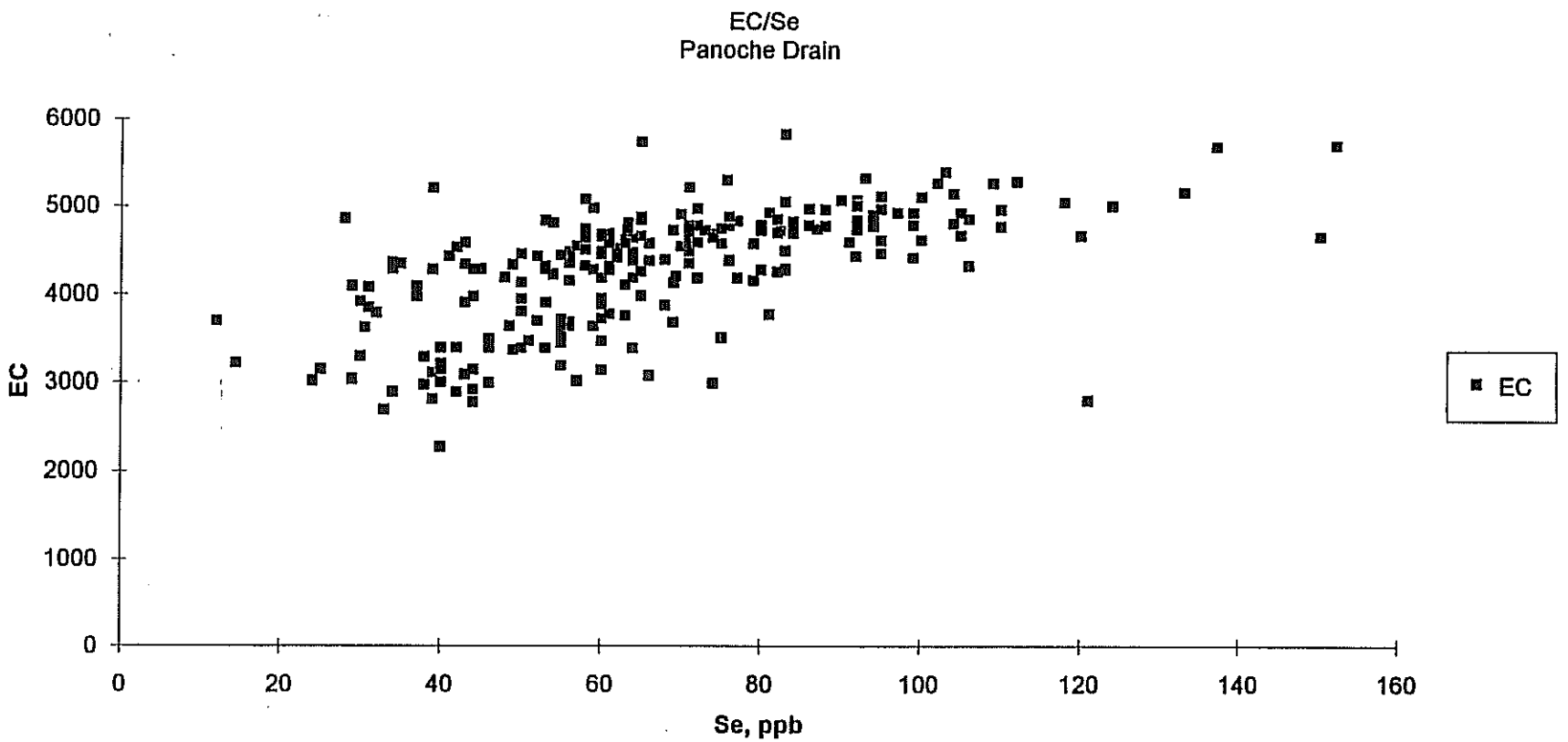


PE-14
Monthly Boron Concentration



PE-14
Monthly Electrical Conductivity Levels



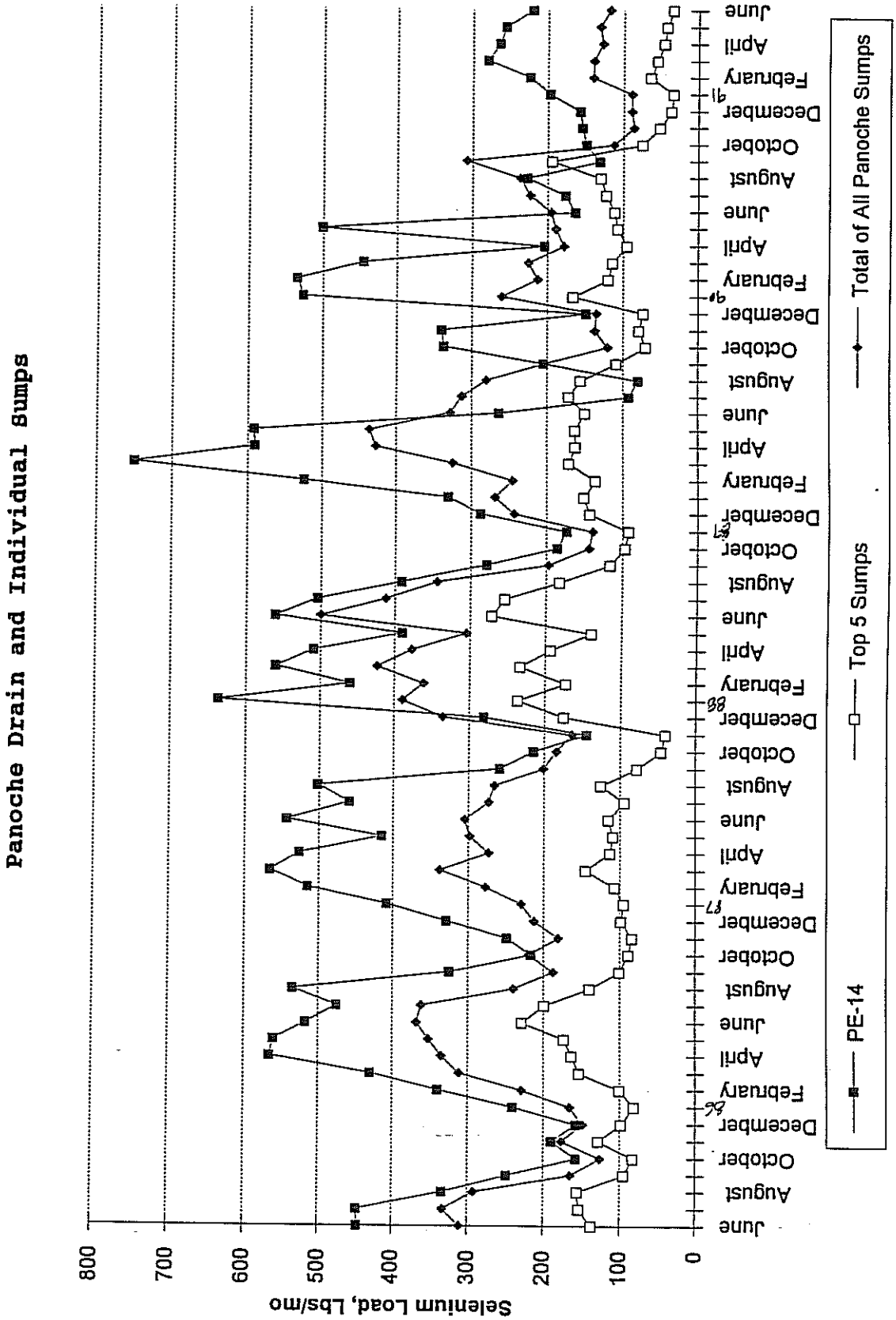

EC/Se
Panoche Drain
6000
5000
4000
3000
2000
1000
0
EC
0
20
40
60
80
100
120
140
160
Se, ppb
EC

PANOCHE DRAINAGE DISTRICT - DISCHARGE POINTS

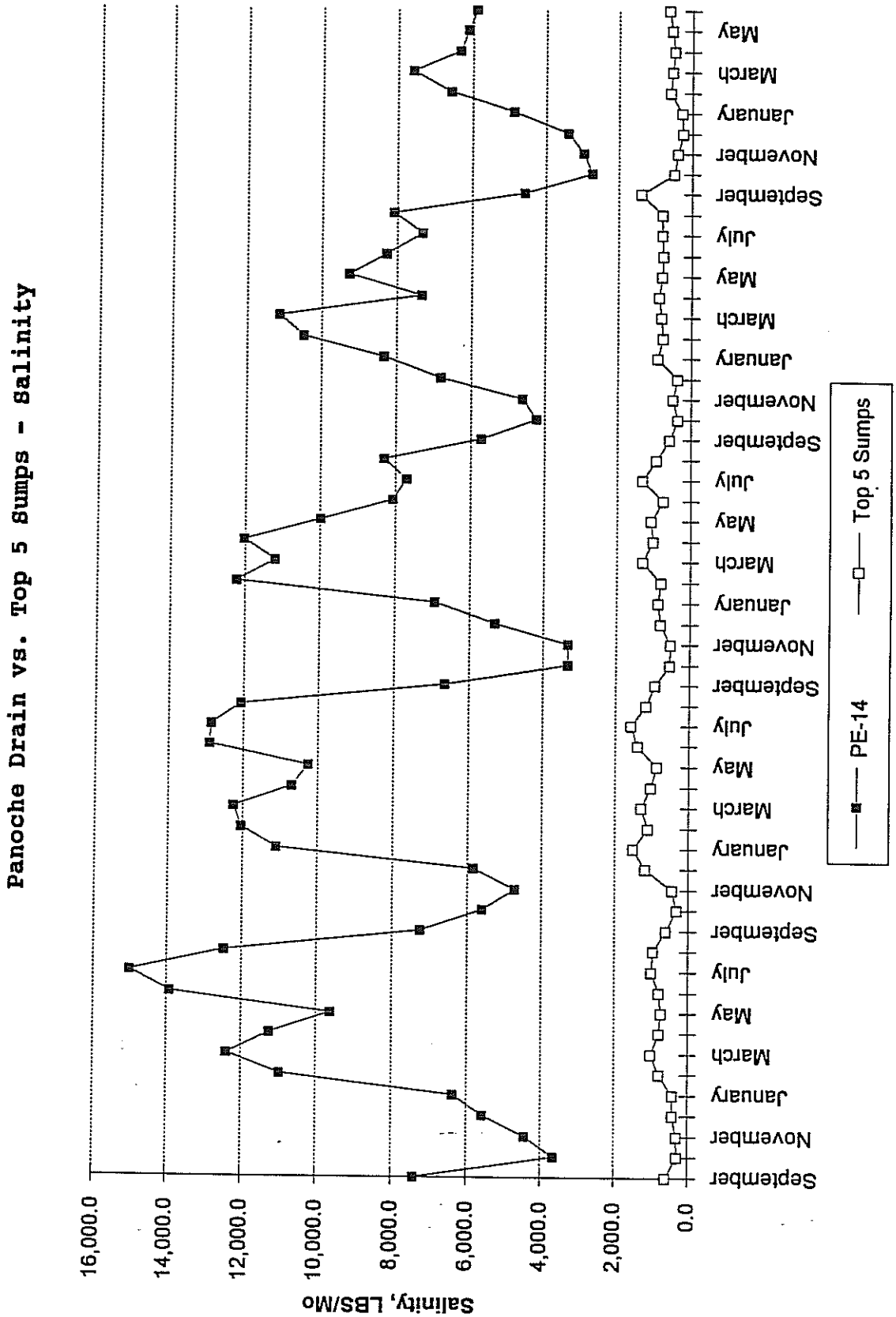
DISCHARGE MEASURED WITH FLOW METERS

	Month	Year	DP - 25			DP - 31			DP - 35			DP - 40			DP - 42			PE-14			Total of Top 5		Total of Panoche Sumps	
			(lbs)	(ac-ft)	(mg/l)	(lbs)	(ac-ft)	(mg/l)	(lbs)	(ac-ft)	(mg/l)	(lbs)	(ac-ft)	(mg/l)	(lbs)	(ac-ft)	(mg/l)	(lbs)	(ac-ft)	(mg/l)	(lbs)	% of PE14		% of Total
Jun-85	June	1985	42.1	42.2	0.36	11	26.9	0.15	17.4	1.9	3.57	45			21.4	23.1	0.34	447	4219	0.039	136.9	31%	311	44%
	July	1985	79.3	39	0.423	17.3	20.9	0.22	16.8	1.6	3.53	26			13.9	16.1	0.34	448	4676	0.036	153.3	34%	333	46%
	August	1985	69	33.1	0.467	21.6	27.4	0.29	16.7	1.8	3.5	34			14.2	15.4	0.34	334	3963	0.031	155.8	47%	293	53%
Sep-85	Septembe	1985	32.5	21.2	0.51	23.7	22.2	0.393	24.6	2.6	3.5	12			2.4	2.5	0.34	249	1960	0.047	95.2	38%	168	68%
	October	1985	19.4	14.9	0.48	20.8	15.4	0.497	13	1.4	3.5	29			0.3	0.3	0.34	158	920	0.063	82.5	52%	126	65%
	November	1985	78.8	55.8	0.5	19.6	12	0.5	9.5	1	3.5	23			0.2	0.2	0.34	190	1158	0.06	128.1	67%	177	72%
Dec-85	December	1985	68.7	67.7	0.445	13.5	12.4	0.4	5.3	0.7	3.35	9			0	0	0.34	158	1058	0.055	98.8	62%	149	66%
	January	1986	41.5	39.1	0.39	10.4	19.1	0.2	23.1	2.7	3.2	6			0	0	0.34	241	1478	0.06	81	34%	156	49%
	February	1986	30	27.8	0.397	16	19.7	0.28	17.9	2.1	3.17	24			13.9	14.9	0.34	340	2233	0.058	100.7	30%	229	44%
Mar-86	March	1986	33.7	30.9	0.403	21	21.4	0.36	38.7	4.6	3.13	60			0.3	0.3	0.34	430	2594	0.061	153.7	36%	312	49%
	April	1986	29.8	26.8	0.41	22.5	18.9	0.44	46.8	5.3	3.1	66			0	0	0.34	566	3618	0.058	163.2	29%	335	49%
	May	1986	28.1	25.6	0.406	21.9	16.7	0.48	35.3	4.4	2.871	74			14.3	16.8	0.34	560	3652	0.053	173.6	31%	382	49%
Jun-86	June	1986	44.7	40.7	0.404	23.8	17.5	0.5	61.8	8	2.843	88			0	0	0.34	617	4225	0.046	228.3	44%	368	62%
	July	1986	75.3	68.8	0.402	26.1	18.4	0.52	2.8	0.4	2.714	85			0	0	0.34	476	4378	0.04	199.2	42%	382	55%
	August	1986	68.1	64.4	0.4	21.3	14.5	0.54	13.6	1.9	2.586	34			11.9	12.9	0.34	635	3973	0.05	139.8	26%	240	58%
Sep-86	Septembe	1986	34	23.4	0.533	15.5	11.9	0.48	30.5	4.6	2.457	17			3.7	4	0.34	325	2078	0.057	100.7	31%	168	64%
	October	1986	17.5	9.7	0.567	10	8.7	0.42	12	1.9	2.329	12			37.8	40.6	0.34	217	1210	0.066	89	41%	220	40%
	November	1986	24	11	0.8	8.2	8.4	0.36	8	1.3	2.2	11			33	35.7	0.34	248	1093	0.046	84.2	34%	181	47%
Dec-86	December	1986	24.8	18.7	0.465	11.8	8	0.485	7.7	1.4	2.05	20			34.1	36.9	0.34	328	1824	0.076	98.8	30%	213	46%
	January	1987	11	31.1	0.13	13.3	8	0.61	7.2	1.4	1.9	33			30.7	33.2	0.34	408	1822	0.076	96.2	23%	230	41%
	February	1987	21.1	36.4	0.213	15.1	9.9	0.56	6.5	1.1	1.9	26			37.5	40.6	0.34	515	2648	0.072	107.2	21%	278	38%
Mar-87	March	1987	26.9	35.8	0.297	21.2	15.3	0.51	14.8	2.9	1.9	30			50.6	54.7	0.34	556	3062	0.068	145.6	26%	338	43%
	April	1987	26.6	25.7	0.38	19.9	15.8	0.46	15.9	3.1	1.9	22			29.8	31.2	0.34	527	2674	0.067	113.1	21%	274	41%
	May	1987	25.3	23.7	0.393	29.5	21.8	0.505	13.7	2.2	2.267	19			21.8	24.8	0.327	415	3832	0.042	109.3	26%	299	37%
Jun-87	June	1987	29.5	26.7	0.406	42.5	26.5	0.649	12.8	1.8	2.533	11			19.2	22.5	0.314	544	4443	0.045	115	21%	305	38%
	July	1987	37.8	36.5	0.28	26.4	32.7	0.32	28.7	3.6	3	2			7.1	21.8	0.12	469	6042	0.033	94	20%	274	34%
	August	1987	22.3	25.3	0.324	44.7	32	0.513	25.5	2.9	3.208	14			18.8	16.4	0.48	502	4389	0.042	126.3	25%	266	47%
Sep-87	Septembe	1987	12.4	12.4	0.369	42.1	21.9	0.707	0.2	0	3.417	15			6.3	3.6	0.84	259	2380	0.04	78	30%	201	39%
	October	1987	7.9	7	0.413	26.1	10.6	0.5	0.7	0.1	3.625	10			1	0.3	1.2	214	1321	0.06	48.7	21%	184	25%
	November	1987	11.1	9	0.457	19.5	8.5	0.849	1.3	0.1	3.269	8			0.3	0.1	0.97	146	1158	0.046	40.3	28%	164	25%
Dec-87	December	1987	44.8	32.9	0.501	37.8	17.4	0.798	0.8	0.1	2.913	33			58.6	29.2	0.74	281	1843	0.056	175	62%	335	52%
	January	1988	67.1	45.2	0.546	37.9	18.7	0.745	2.7	0.4	2.556	57			71.3	51.8	0.61	636	2146	0.109	236	37%	389	61%
	February	1988	45	28.1	0.69	26.1	13.6	0.695	13.5	2.3	2.2	60			27.8	36.5	0.28	460	2066	0.069	172.6	38%	361	48%
Mar-88	March	1988	35.8	22.8	0.578	77.3	36.7	0.735	21.8	3.1	2.668	56			42.8	36.8	0.428	660	3120	0.066	233.7	42%	423	65%
	April	1988	27.4	18.3	0.65	70.9	33.7	0.775	23.8	3	2.935	21			50.3	32.2	0.675	509	2358	0.079	193.4	38%	377	61%
	May	1988	30.8	20.6	0.65	72.1	33.2	0.8	18.7	2.6	2.79	17			1.5	26.4	0.02	390	2634	0.064	140.1	36%	305	45%
Jun-88	June	1988	56.7	37.9	0.65	102.5	45.7	0.825	9.2	1.3	2.645	76			28	27.2	0.378	561	3763	0.066	271.4	48%	500	54%
	July	1988	82.5	65.2	0.55	60.9	29.8	0.65	9.5	1.4	2.5	63			30.4	40	0.28	504	4413	0.042	254.3	50%	412	52%
	August	1988	66.9	35.4	0.592	7.2	3.3	0.808	39.8	6.2	2.8	67			21.7	30.8	0.256	381	3991	0.036	182.6	47%	344	53%
Sep-88	Septembe	1988	38.1	22.2	0.633	6.2	2.5	0.767	28.1	3.3	3.15	36			8.8	13.7	0.237	279	1974	0.052	116.2	42%	197	58%
	October	1988	25.9	14.1	0.676	7.7	3.9	0.725	26.7	2.6	3.5	33			3.2	6.8	0.216	186	789	0.067	96.5	52%	144	67%
	November	1988	21.5	12.8	0.619	9.7	5.1	0.701	19	2.2	3.25	39			2.5	3.6	0.254	173	801	0.079	91.7	53%	139	66%
Dec-88	December	1988	47.4	31	0.563	31.3	17	0.678	21.2	2.6	3	20			23.7	29.9	0.293	288	1301	0.081	143.6	50%	243	59%
	January	1989	49.9	36.3	0.506	33.6	16.8	0.654	20.6	2.9	2.76	16			30.7	34.1	0.331	330	1617	0.076	150.7	46%	269	56%
	February	1989	40.1	32.8	0.45	32	16.7	0.63	17.9	2.6	2.5	11			34.8	34.6	0.37	624	3208	0.06	135.7	26%	246	55%
Mar-89	March	1989	54.8	41.5	0.485	41.8	24.4	0.63	25.7	3.2	2.99	2			46.4	46.7	0.365	760	2507	0.11	170.7	23%	325	53%
	April	1989	33.3	23.6	0.52	51.3	30	0.63	41.6	4.0	3.4	1			35.3	35	0.36	691	3414	0.09	162.4	27%	427	38%
	May	1989	29.7	22.1	0.483	71.1	42.2	0.62	37.6	4.4	3.133				25.1	28.3	0.327	592	2293	0.095	163.4	28%	436	37%
Jun-89	June	1989	27.2	21.4	0.467	67.7	40.9	0.61	33.2	4.3	2.867				21.8	27.4	0.293	364	3430	0.04	149.9	67%	328	46%
	July	1989	61.8	51.7	0.44	58.6	36	0.6	31.2	4.4	2.6				19.8	29	0.26	92	2616	0.013	171.4	186%	313	55%
	August	1989	61.2	38.1	0.877	37.6	23	0.7	36.7	4.6	2.967				20.2	25.7	0.29	80	2460	0.012	165.7	196%	281	55%
Sep-89	Septembe	1989	36	18.8	0.713	25.7	14	0.8	32.3	3.6	3.333				13.7	16.8	0.32	205	1640	0.046	108.7	53%	204	53%
	October	1989	17.8	7.8	0.85	18.4	8.5	0.9	27.8	2.8	3.7				5.8	6.2	0.35	337	827	0.15	70	21%	120	58%
	November	1989	36.2	17.3	0.77	16.9	7.7	0.825	15.1	1.6	3.425				8	8.8	0.335	340	1042	0.12	78.2	23%	137	57%
Dec-89	December	1989	33.5	17.8	0.69	17.9	8	0.75	14.3	1.7	3.16				7.5	8.8	0.32	149	1822	0.03	73.3	49%	135	54%
	January	1990	45	27.1	0.81	41.1	20.2	0.675	43.6	6.6	2.876				36.3	43.7	0.305	627	2158	0.09	186	31%	261	64%
	February	1990	22.9	16.8	0.53	31.8	17.4	0.6	30.2	4.3	2.8				34.4	43.6	0.29	538	2558	0.077	119.3	22%	213	56%
Mar-90	March	1990	21.6	15	0.53	29.4	19	0.6	25.1	3.6	2.8				38	48.3	0.29	445	2517	0.065	114.1	26%	225	61%
	April	1990	25.6	23.8	0.411	8.2	20.3	0.145	25.8	3.4	2.915				33.3	38.1	0.314	204	1670	0.046	84.9	47%	176	63%
	May	1990	30.4	24.6	0.454	12.1	21	0.213	40.7	5.3	2.846				24.3	26.3	0.341	501	1962	0.094	107.6	21%	189	67%
Jun-90	June	1990	32.2	23.8	0.497	15.2	20.3	0.276	38.4	5.1	2.777				25.4	25.4	0.369	183	2065	0.029	111.2	58%	195	67%
	July	1990	36.2	24.6	0.54	19.3	21	0.34	38.7	5.3	2.708				28.3	26.2	0.397	176	2018	0.032	122.5	70%	223	65%
	August	1990	39.1	24.6	0.584	23	21	0.403	37.7	5.3	2.638				30.2	26.2	0.425	227	1736	0.048	130	57%	237	65%
Sep-90	Septembe	1990	104.4	61.3	0.627	22.8	18	0.467	35.5	5.1	2.569				31.2	28.4	0.452	131	1091	0.044	193.9	148%	306	63%
	October	1990	36.2	19.9	0.67	0	0	0.53	18.2	2.7	2.5	18			2	1.5	0.48	149	886	0.062	74.4	50%	113	66%
	November	1990	37.7	22.4	0.62	0	0	0.51	13.1	1.9	2.46				0.6	0.5	0.464	154	707	0.08	51.4	33%	96	60%
Dec-90	December	1990	31.3	20.1	0.67	0	0	0.49	4.5	0.7	2.46				0.3	0.3	0.448	157	761	0.075	36.1	23%	69	41%
	January	1991	28.4	20.1	0.62	0	0	0.47	4.5	0.7	2.44				0.3	0.3	0.432	197	1132	0.064	33.3	17%	69	37%
	February	1991	32.9	25.8	0.47	0	0	0.45	0	0	2.42				30.8	27.2	0.416	224	1556	0.053	63.7	28%	140	46%
Mar-91	March	1991	39.6	34.7	0.42	0	0	0.43	0	0	2.4				15.1	13.9	0.4	280	1687	0.061	54.7	20%	139	39%
	April	1991	33.6	33.6	0.367	0	0	0.407	0	0	2.4				12.2	13.8	0.333	264	1348	0.072	45.7	17%	128	36%
	May	1991	37.3	43.8	0.313			0.383	0	0	2.4				5.4	7.4	0.267	256	1324	0.071	42.7	17%	131	33%
Jun-91	June	1991	30	42.4	0.26			0.35	0	0	2.4				3.9	7.2	0.2	220	1348	0.06	33.9	15%	110	29%
		TOTAL	2781	2121.3	0.482	1870	1245.9	0.552	1452.9	187.7	2.846	1503			1417.1	1505.7	0.346	25604	159081	0.056	9023	35%	17985	60%

092


Panoche Drain and Individual Sumps
Selenium Load, Lbs/mo
800
700
600
500
400
300
200
100
0
June
August
October
December
February
April
June
August
October
December
February
April
June
August
October
December
February
April
June
August
October
December
February
April
June
August
October
December
February
April
June
August
October
December
February
April
June
August
October
December
February
April
June
PE-14
Top 5 Sumps
Total of All Panoche Sumps

MAXLOAD.XLS Chart 1

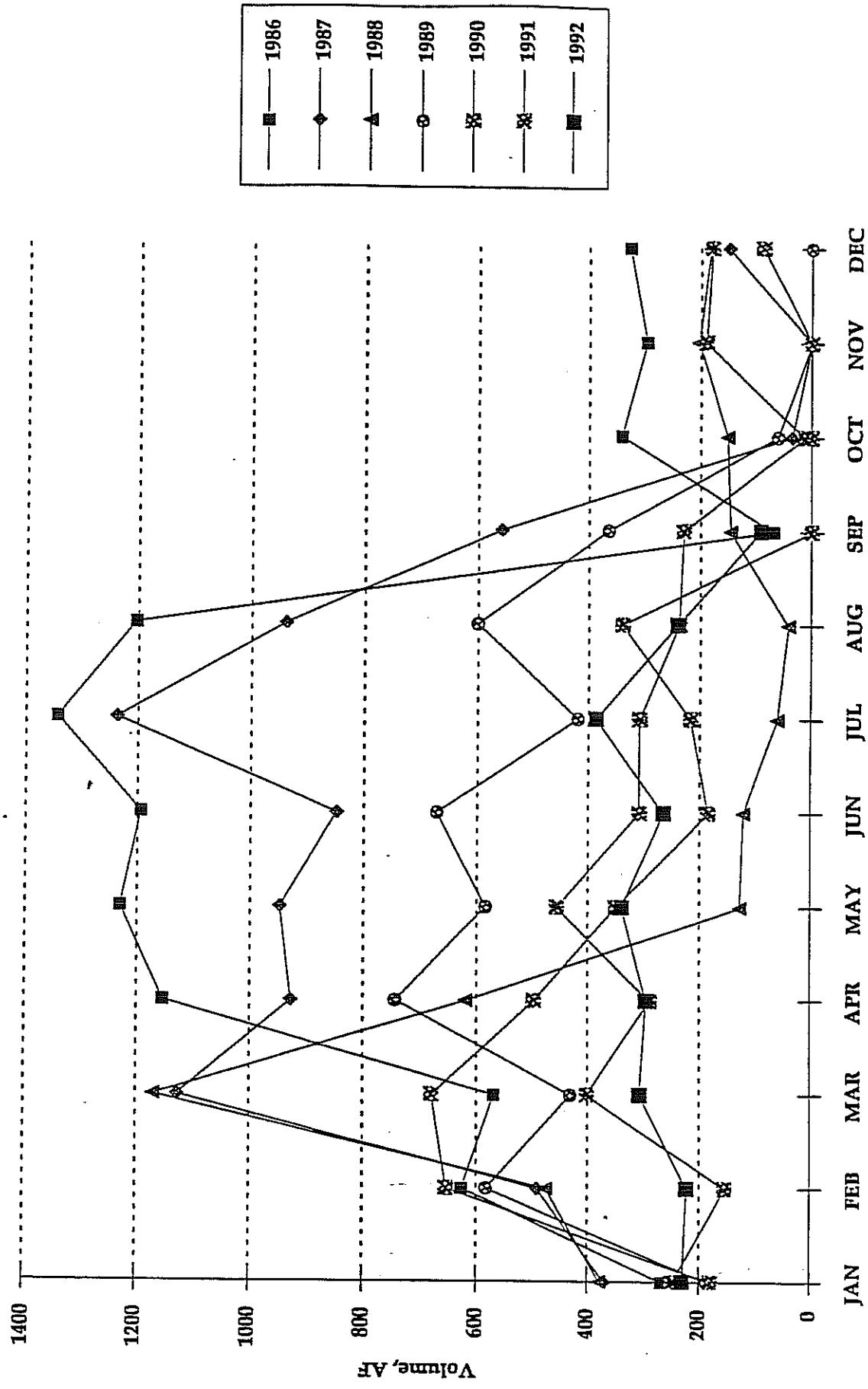


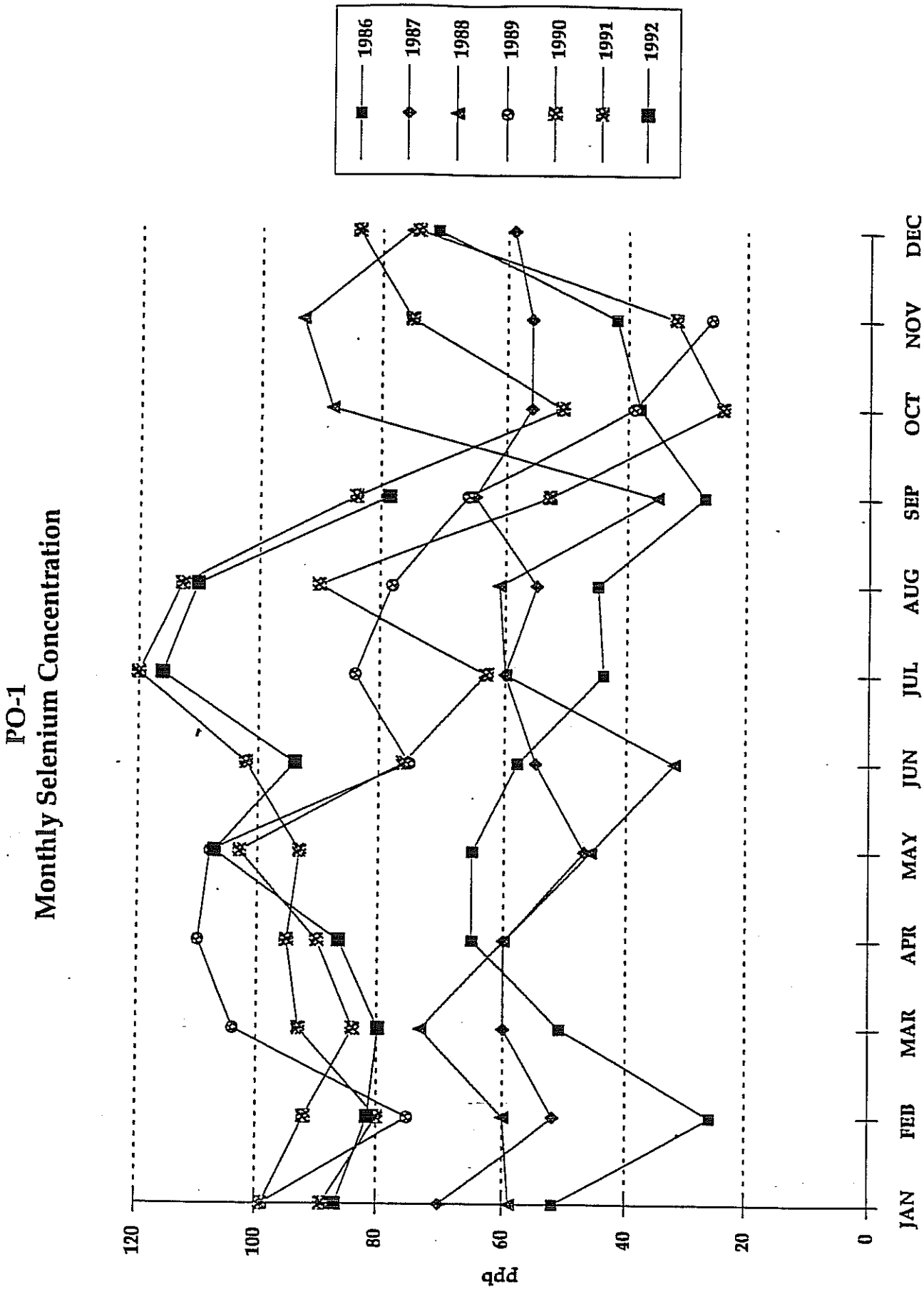
PO-1: Selected Graphs Of Water Quality Data

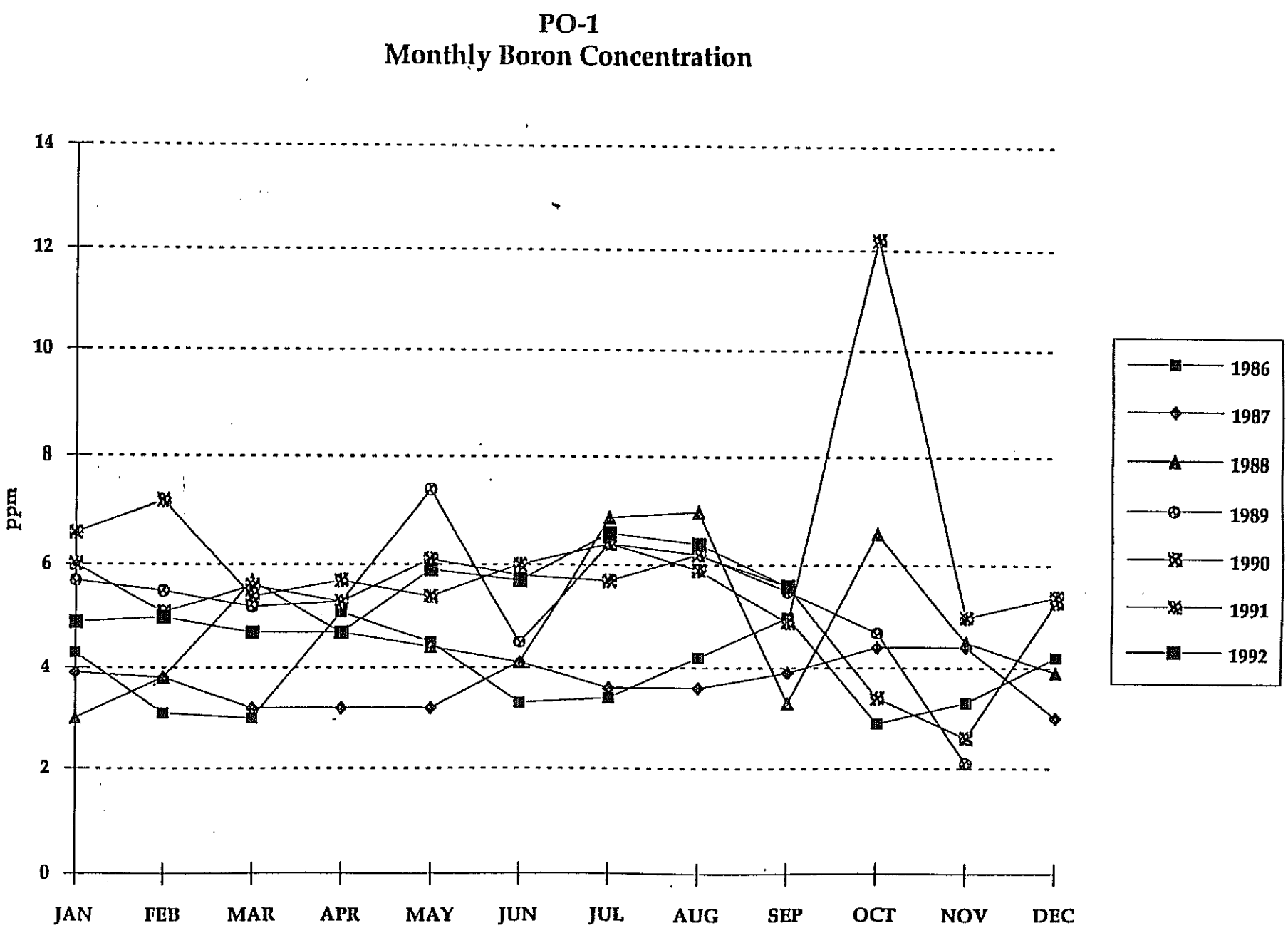
MONTHLY VOLUMES, Se, B, and EC - PO-1

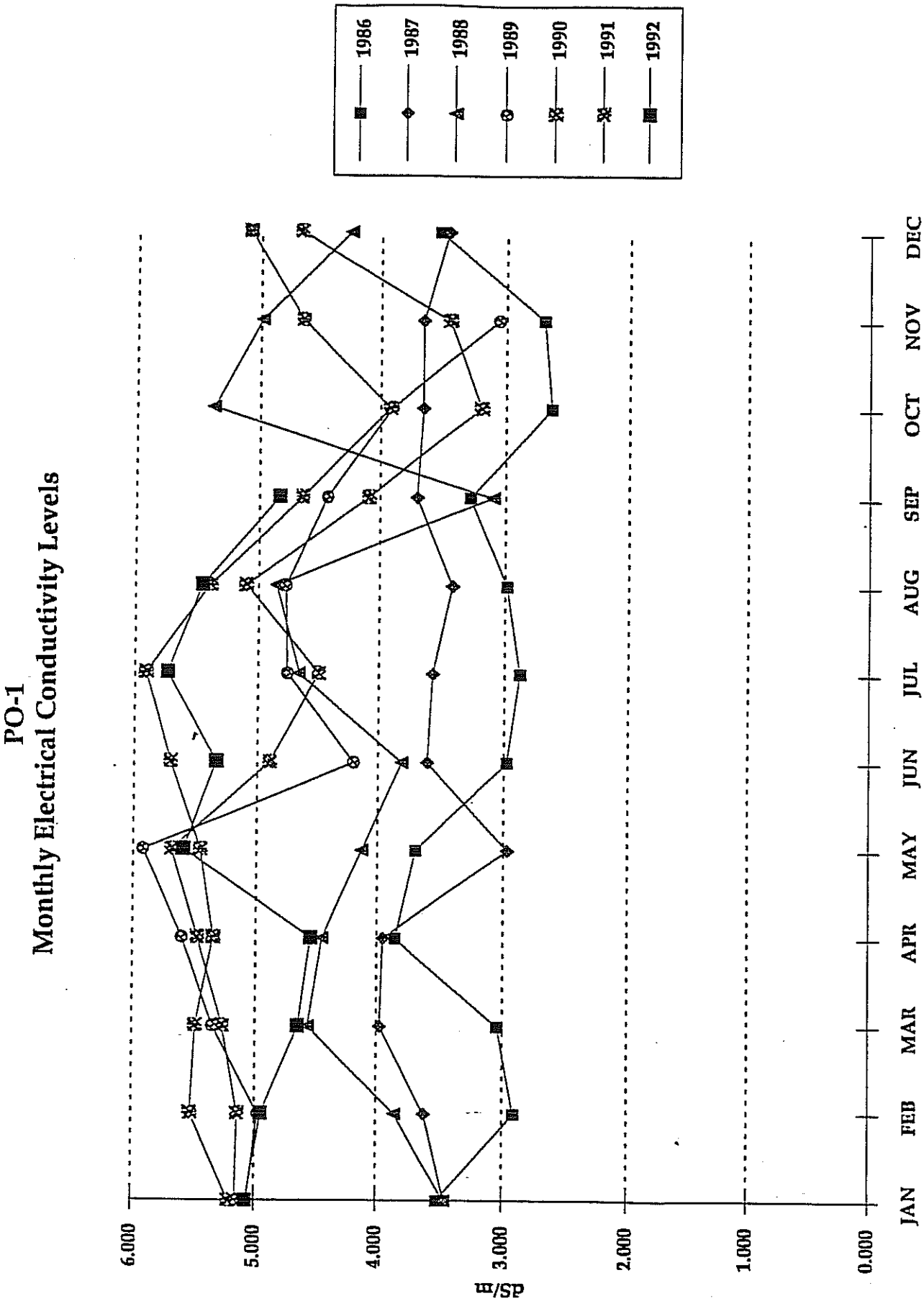
Month	1986 Vol ac-ft	Se ppb	B ppm	EC dS/m	1987 Vol ac-ft	Se ppb	B ppm	EC dS/m	1988 Vol ac-ft	Se ppb	B ppm	EC dS/m	1989 Vol ac-ft	Se ppb	B ppm	EC dS/m	1990 Vol ac-ft	Se ppb	B ppm	EC dS/m	1991 Vol ac-ft	Se ppb	B ppm	EC dS/m	1992 Vol ac-ft	Se ppb	B ppm	EC dS/m
JAN	267	52	4.3	3.507	369	70	3.9	3.445	377	59	3	3.450	186	99	5.7	5.060	180	99	6	5.155	248	89	6.6	5.210	230	86.8	4.9	5.070
FEB	626	26	3.1	2.915	492	52	3.8	3.610	476	60	3.8	3.850	583	75	5.5	4.975	653	92	5.1	5.140	154	80	7.2	5.523	223	81.5	5	4.950
MAR	570	51	3	3.045	1127	60	3.2	3.970	1169	73	5.7	4.563	432	104	5.2	5.347	680	84	5.6	5.270	401	93	5.4	5.485	306	79.8	4.7	4.649
APR	1154	65	5.1	3.850	928	60	3.2	3.950	620	60	4.7	4.450	745	110	5.3	5.600	498	90	5.3	5.473	289	95	5.7	5.345	295	86.4	4.7	4.544
MAY	1230	65	4.5	3.685	948	47	3.2	2.970	126	46	4.4	4.128	585	108	7.4	5.917	349	103	6.1	5.685	456	93	5.4	5.455	338	107	5.9	5.590
JUN	1194	58	3.3	2.978	847	55	4.1	3.600	120	32	4.1	3.805	672	75	4.5	4.200	185	76	5.8	4.895	307	102	6	5.702	265	93.8	5.7	5.332
JUL	1343	44	3.4	2.880	1237	60	3.6	3.560	60	60	6.9	4.660	419	84	6.4	4.760	217	63	5.7	4.495	307	120	6.4	5.908	385	116	6.6	5.732
AUG	1204	45	4.2	2.985	939	55	3.6	3.410	41	61	7	4.850	601	78	6.2	4.775	338	90	6.2	5.100	238	113	5.9	5.390	241	110	6.4	5.456
SEP	68	27	5	3.275	558	65	3.9	3.695	145	35	3.3	3.100	364	66	5.5	4.433	0	53	5.6	4.090	230	84	4.9	4.640	90	78.6	5.6	4.832
OCT	340	38	2.9	2.640	36	56	4.4	3.650	150	88	6.6	5.375	60	39	4.7	3.900	0	24	3.4	3.190	13	51	12.2	3.920				
NOV	296	42	3.3	2.700	0	56	4.4	3.650	203	93	4.5	4.985	0	26	2.1	3.060	0	32	2.6	3.440	190	75	5	4.646				
DEC	326	71	4.2	3.520	149	59	3	3.450	182	75	3.9	4.245	0				86	74	5.3	4.665	180	83.8	5.4	5.086				
TOT.	8618				6769				3669				4647				3186				3013				2373			

Source: Tables supplied by Joe Karkoski at the California Regional Water Quality Control Board on the monitoring points.

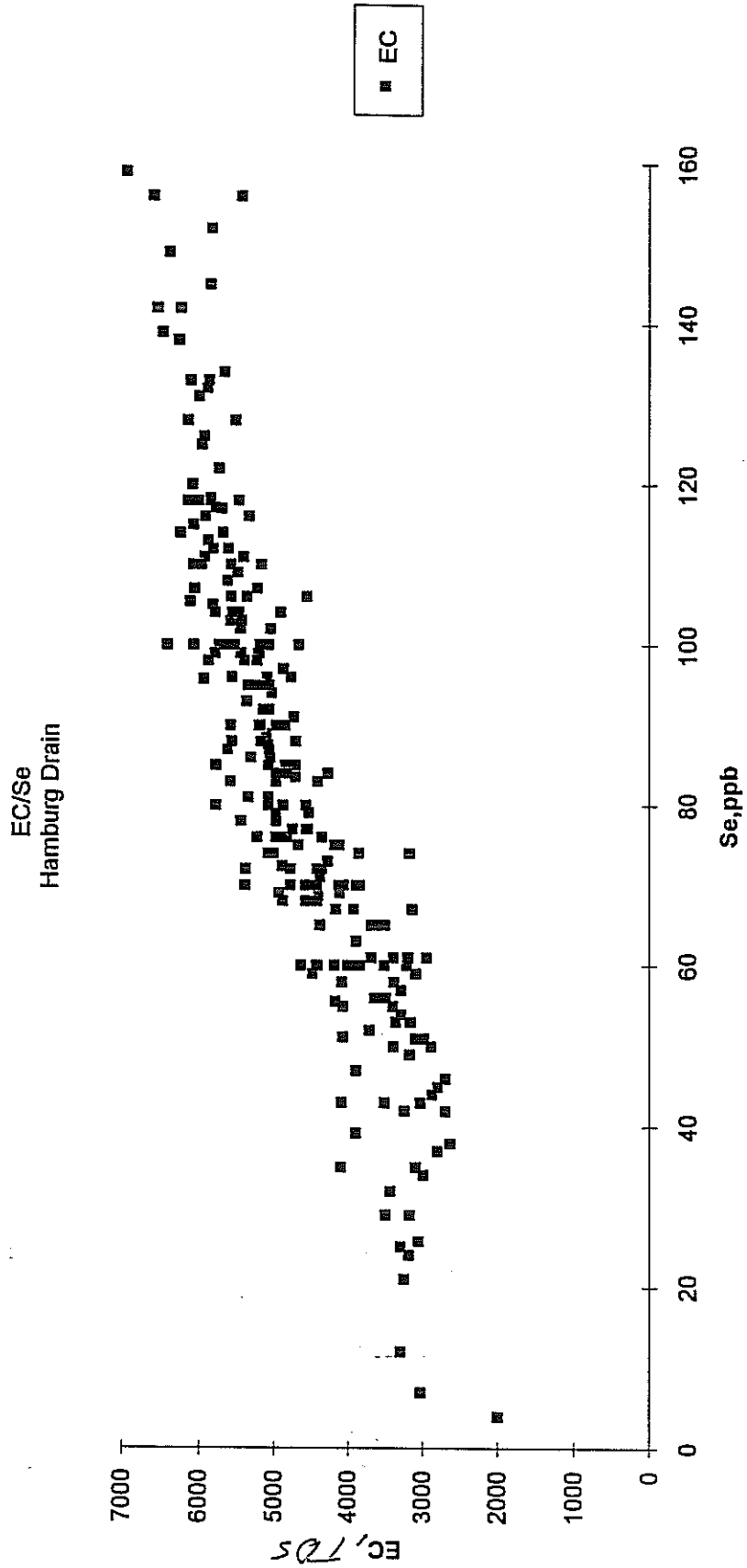

PO-1
Monthly Drainage Volume
1986
1987
1988
1989
1990
1991
1992
Volume, AF
1400
1200
1000
800
600
400
200
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


PO-1
Monthly Selenium Concentration
1986
1987
1988
1989
1990
1991
1992
ppb
120
100
80
60
40
20
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


PO-1
Monthly Boron Concentration
ppm
14
12
10
8
6
4
2
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1986
1987
1988
1989
1990
1991
1992

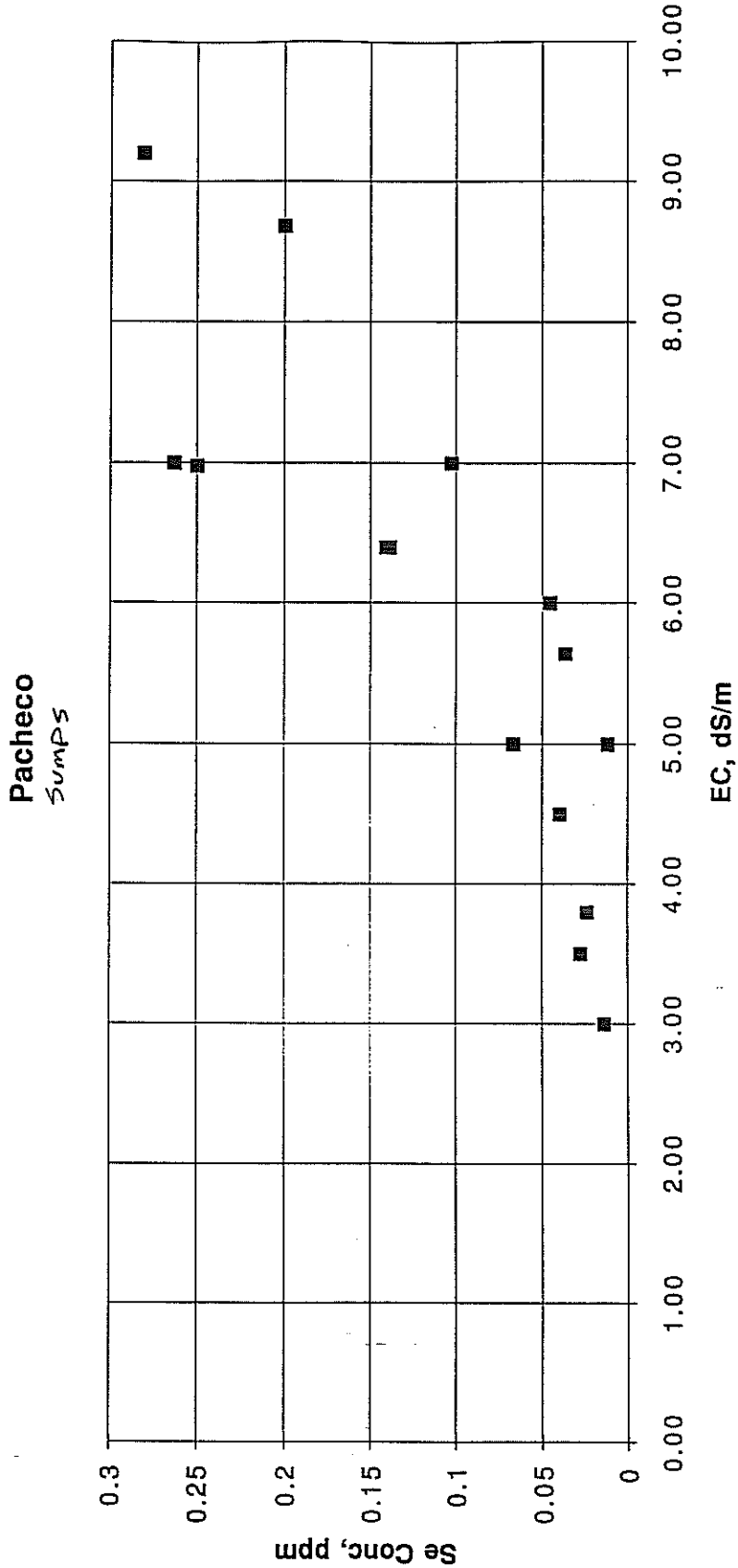

PO-1
Monthly Electrical Conductivity Levels
1986
1987
1988
1989
1990
1991
1992
6.000
5.000
4.000
3.000
2.000
1.000
0.000
dS/m
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

HAMBURGD.XLS Chart 1



Page 1

#2 Chart 1

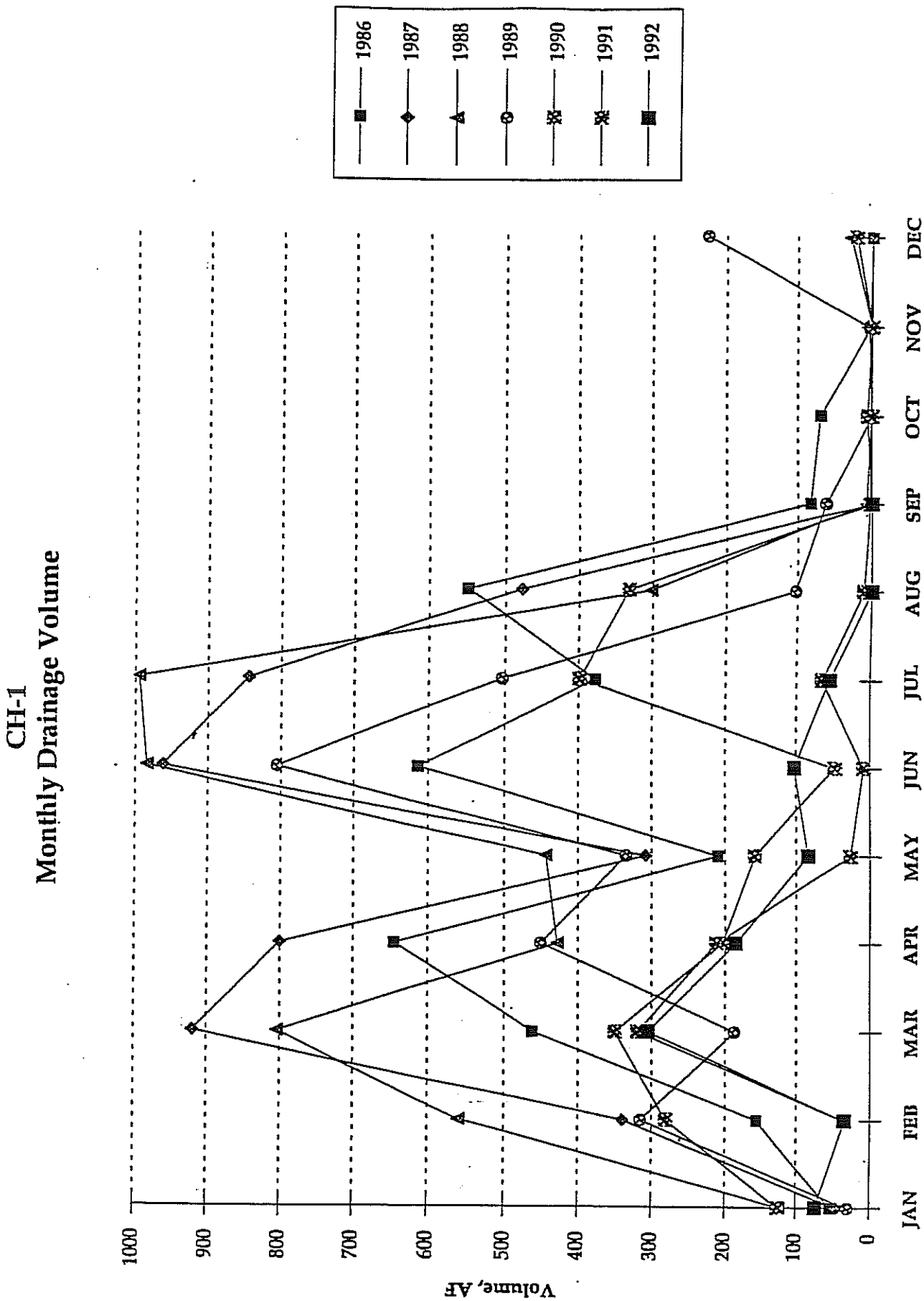

Pacheco
Sumps
Se Conc, ppm
0.3
0.25
0.2
0.15
0.1
0.05
0
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
EC, dS/m

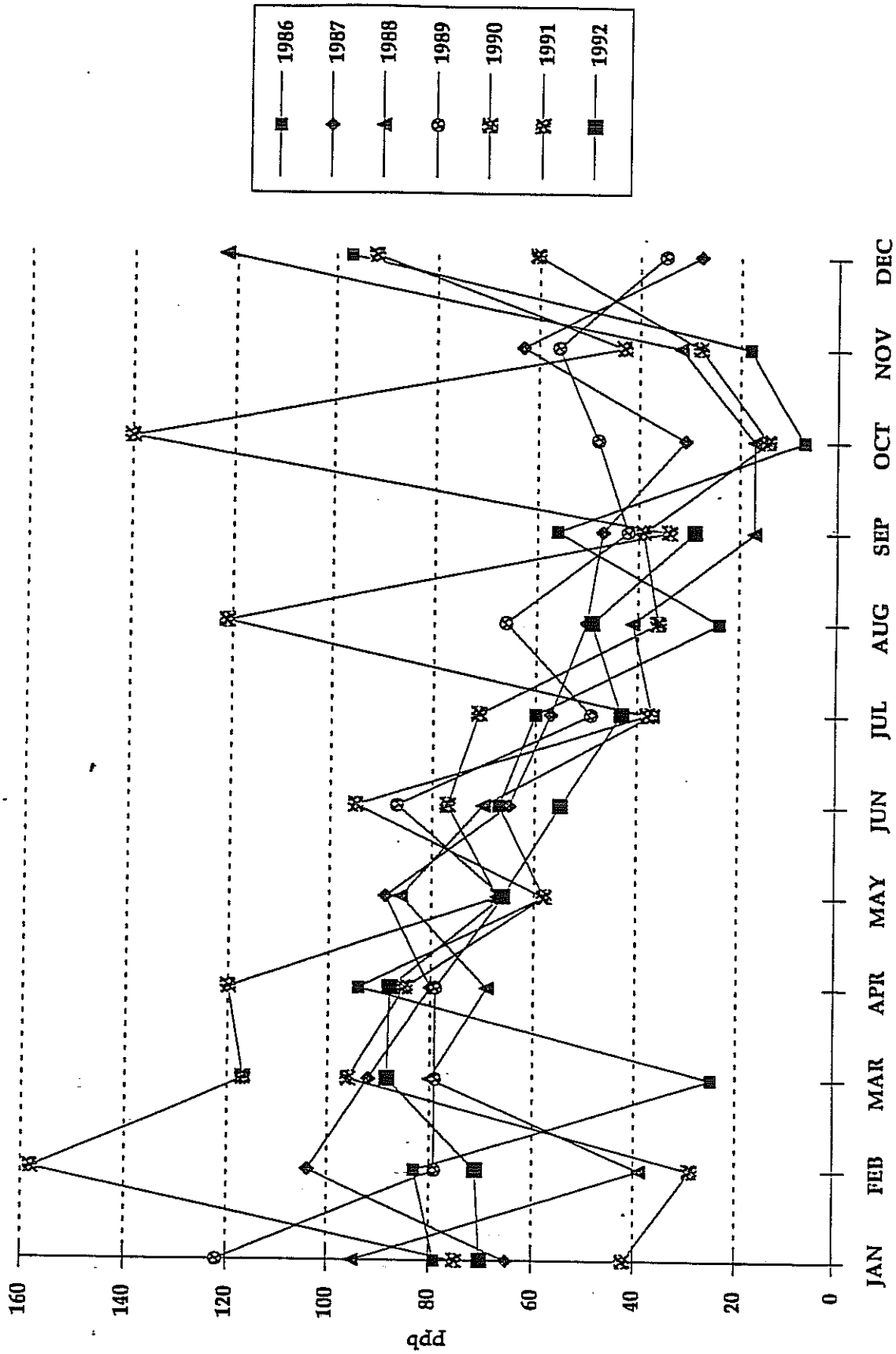
CH-1: Selected Graphs Of Water Quality Data

MONTHLY VOLUMES, Se, B, and EC - CH-1

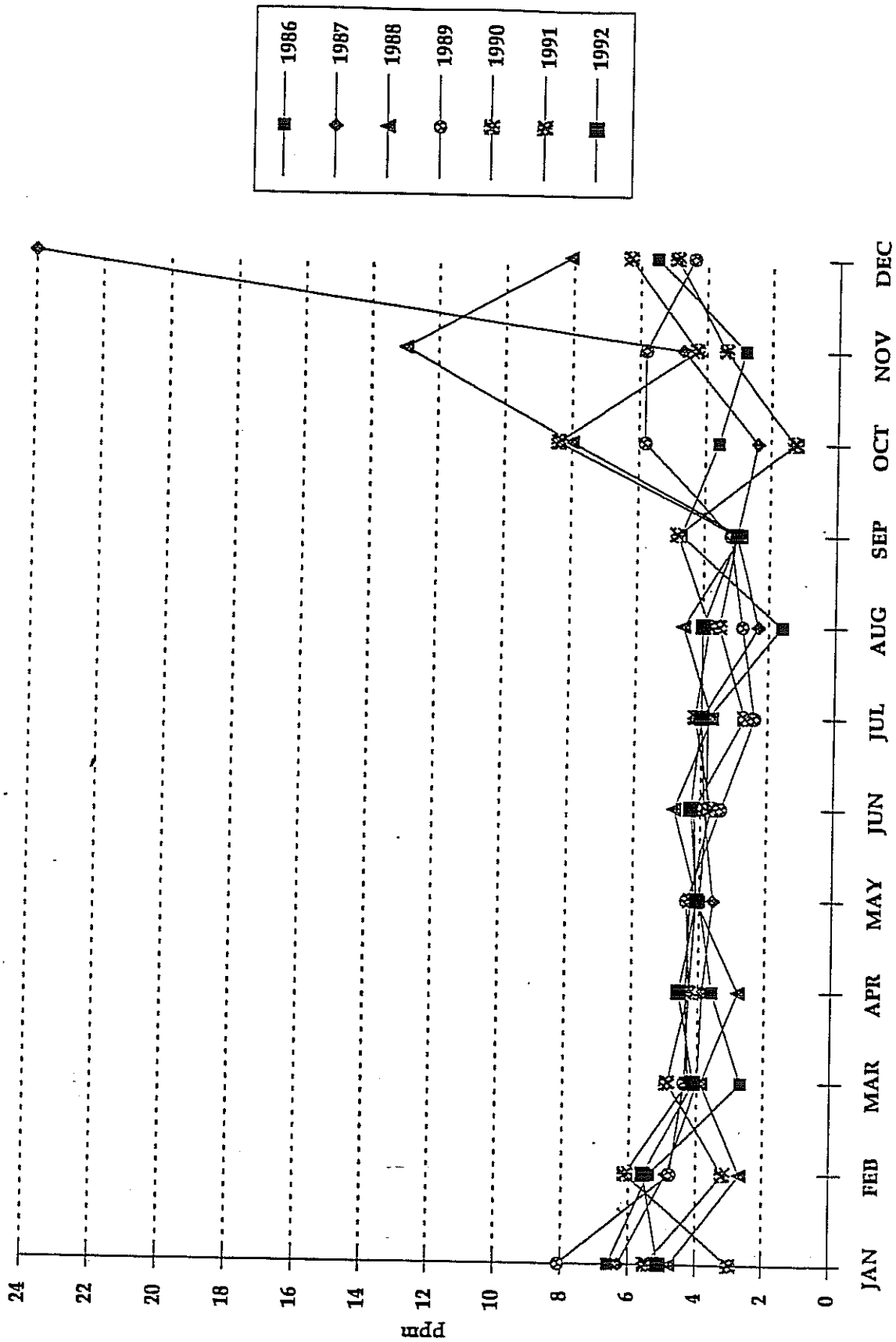
Month	1986 Vol ac-ft	Se ppb	B ppm	EC dS/m	1987 Vol ac-ft	Se ppb	B ppm	EC dS/m	1988 Vol ac-ft	Se ppb	B ppm	EC dS/m	1989 Vol ac-ft	Se ppb	B ppm	EC dS/m	1990 Vol ac-ft	Se ppb	B ppm	EC dS/m	1991 Vol ac-ft	Se ppb	B ppm	EC dS/m	1992 Vol ac-ft	Se ppb	B ppm	EC dS/m
JAN	53	79	6.6	6.090	45	65	6.3	3.58	123	95	4.8	5.815	30	122	8.1	7.045	125	42	5.5	5.23	73	75	3	4.322	73	70	5.1	5.128
FEB	156	83	5.4	5.3	340	104	4.9	5.42	560	39	2.7	3.51	315	79	4.8	4.916	281	29	3.2	3.79	35	158	6.1	5.24	35	71	5.57	5.073
MAR	462	25	2.7	2.82	919	92	4	5.24	804	80	3.9	4.523	187	79	4.4	4.828	350	96	4.9	5.43	319	117	4.3	4.777	305	88.4	4.126	4.968
APR	644	94	3.6	3.983	801	80	3.9	4.66	428	69	2.8	3.683	451	79	4.3	4.633	204	85	4.3	4.95	212	120	4.4	3.877	185	88	4.6	4.882
MAY	210	58	4	4.11	308	89	3.6	4.23	444	86	4.1	4.934	335	66	4.4	4.718	158	58	4.1	4.423	27	67	4.3	4.538	83	66.2	4.1	4.598
JUN	613	67	3.8	4.058	962	65	3.9	3.895	983	70	4.8	5.724	806	87	3.4	4.439	47	95	4.2	5.319	9	77	3.7	4.452	102	55	4.3	4.386
JUL	378	60	3.8	3.71	845	57	4	3.143	994	37	3.7	5.262	504	49	2.4	3.268	399	38	2.7	3.19	64	71	4.2	4.286	55	43	4	3.597
AUG	550	24	1.6	1.965	478	50	2.3	3.13	302	41	4.6	4.131	102	66	2.8	3.76	332	121	3.5	3.667	11	36	3.8	3.512	0	49	4	3.832
SEP	82	56	4.7	4.273	0	47	3	3.32	8	17	2.9	3.086	61	42	3.2	3373	0	34	3	2.69	3	39	4.8	4.538	0	29	3	2.978
OCT	68	7	3.6	3.07	0	31	2.4	2.73	0	17	8	6.098	0	48	5.8	5.149	6	140	8.4	6.883	0	14.1	1.3	1.714				
NOV	3	18	2.8	7.2	0	63	4.7	4.55	0	32	13	9.519	4	56	5.8	4.944	0	43	4.3	4.061	0	28	3.4	3.34				
DEC	0	97	5.5	7.2	0	28	24	10.22	30	122	8.1	7.045	226	35	4.4	4.04	22	92	6.3	5.91	22	60.4	4.92	4.812				
TOT.	3219				4313				4676				3021				1924				775				838			

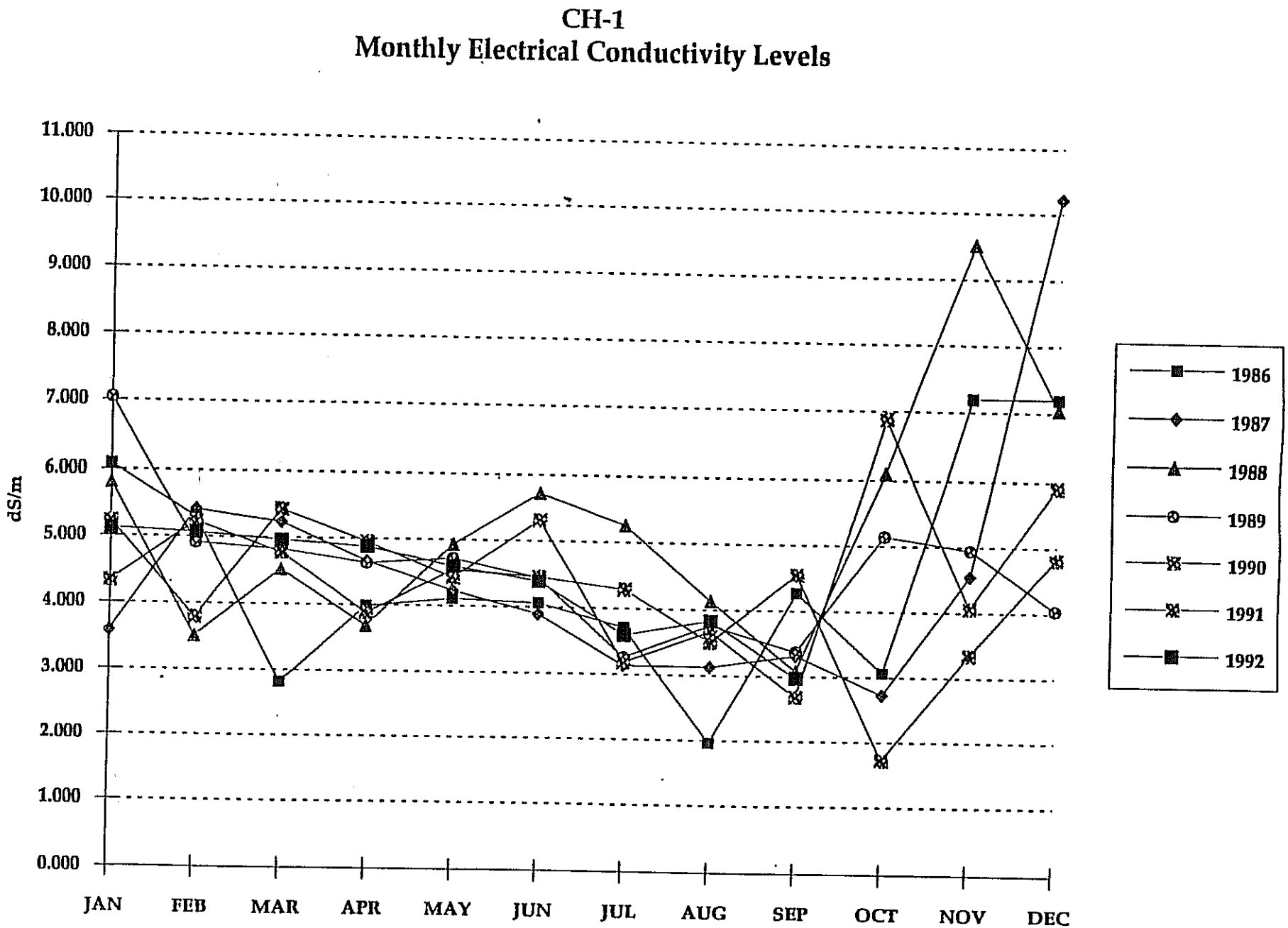
Source: Tables supplied by Joe Karkoski at the California Regional Water Quality Control Board on the monitoring points.


CH-1
Monthly Drainage Volume
1986
1987
1988
1989
1990
1991
1992
Volume, AF
1000
900
800
700
600
500
400
300
200
100
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

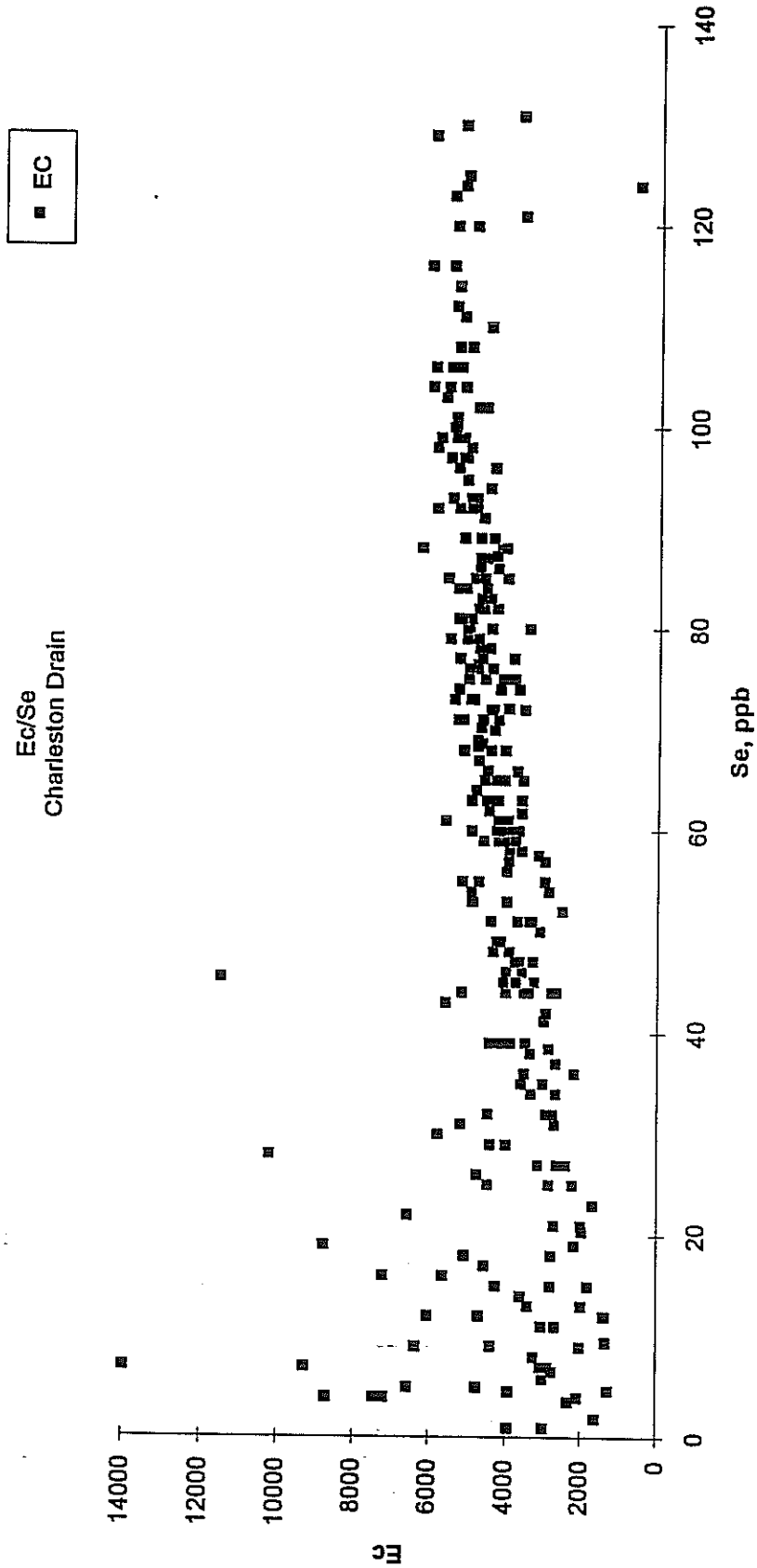

CH-1
Monthly Selenium Concentration
1986
1987
1988
1989
1990
1991
1992
ppb
160
140
120
100
80
60
40
20
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

CH-1
Monthly Boron Concentration

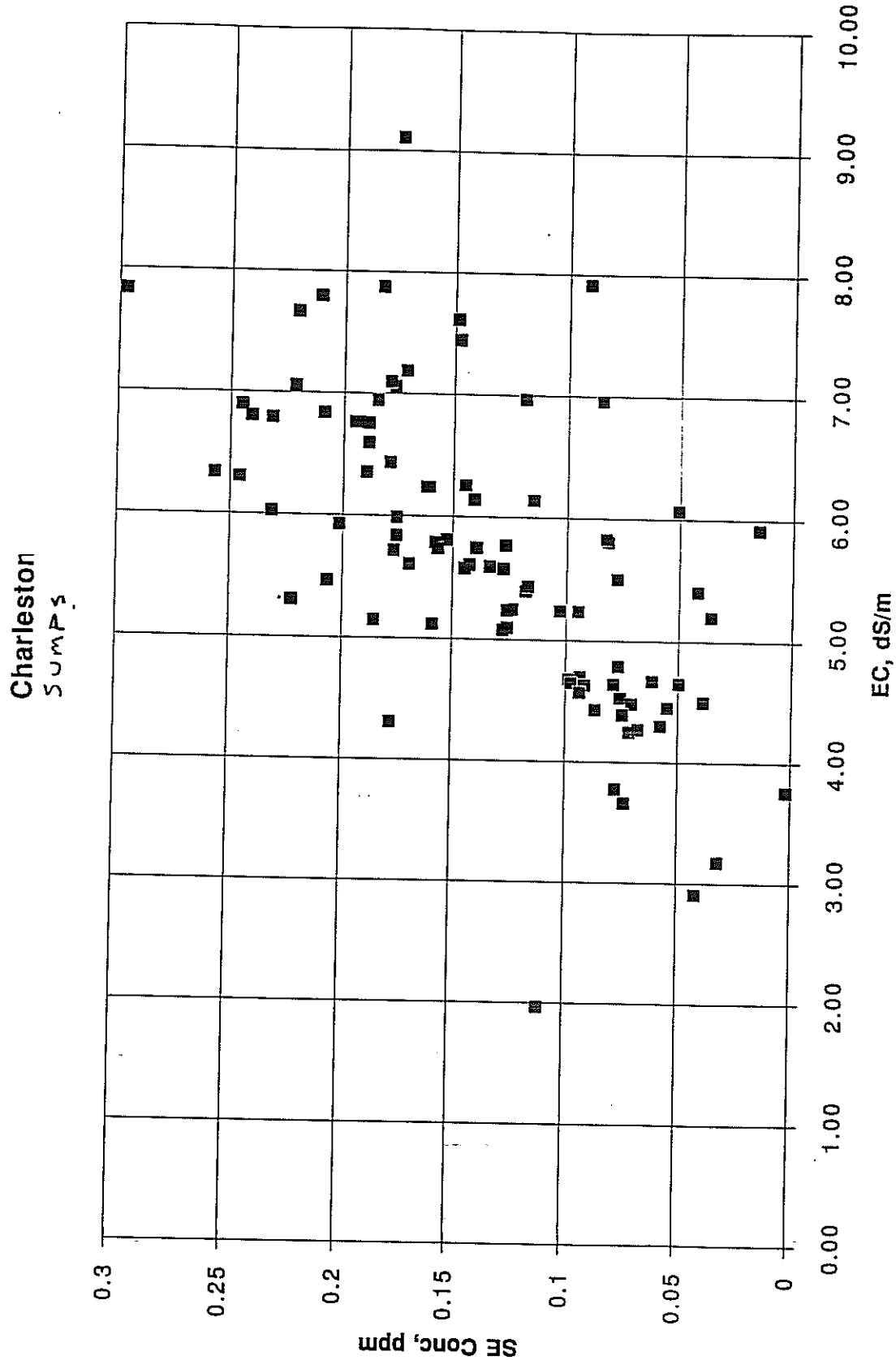



CH-1
Monthly Electrical Conductivity Levels
dS/m
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1986
1987
1988
1989
1990
1991
1992

CHARLESD.XLS Chart 2



#1 Chart 1


Charleston
SUMPS
SE Conc, ppm
0.3
0.25
0.2
0.15
0.1
0.05
0
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
EC, dS/m

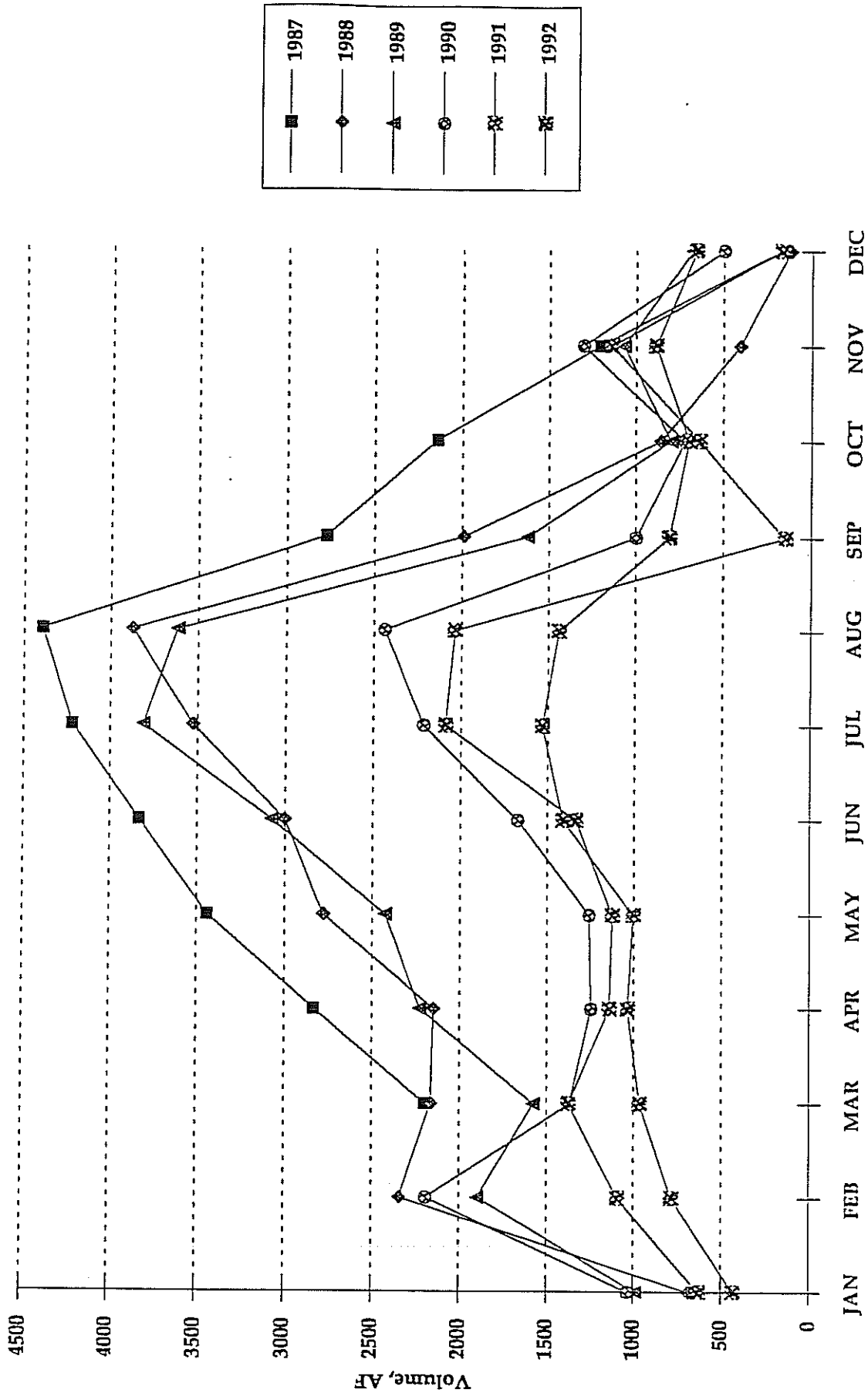
FC-5: Selected Graphs Of Water Quality Data

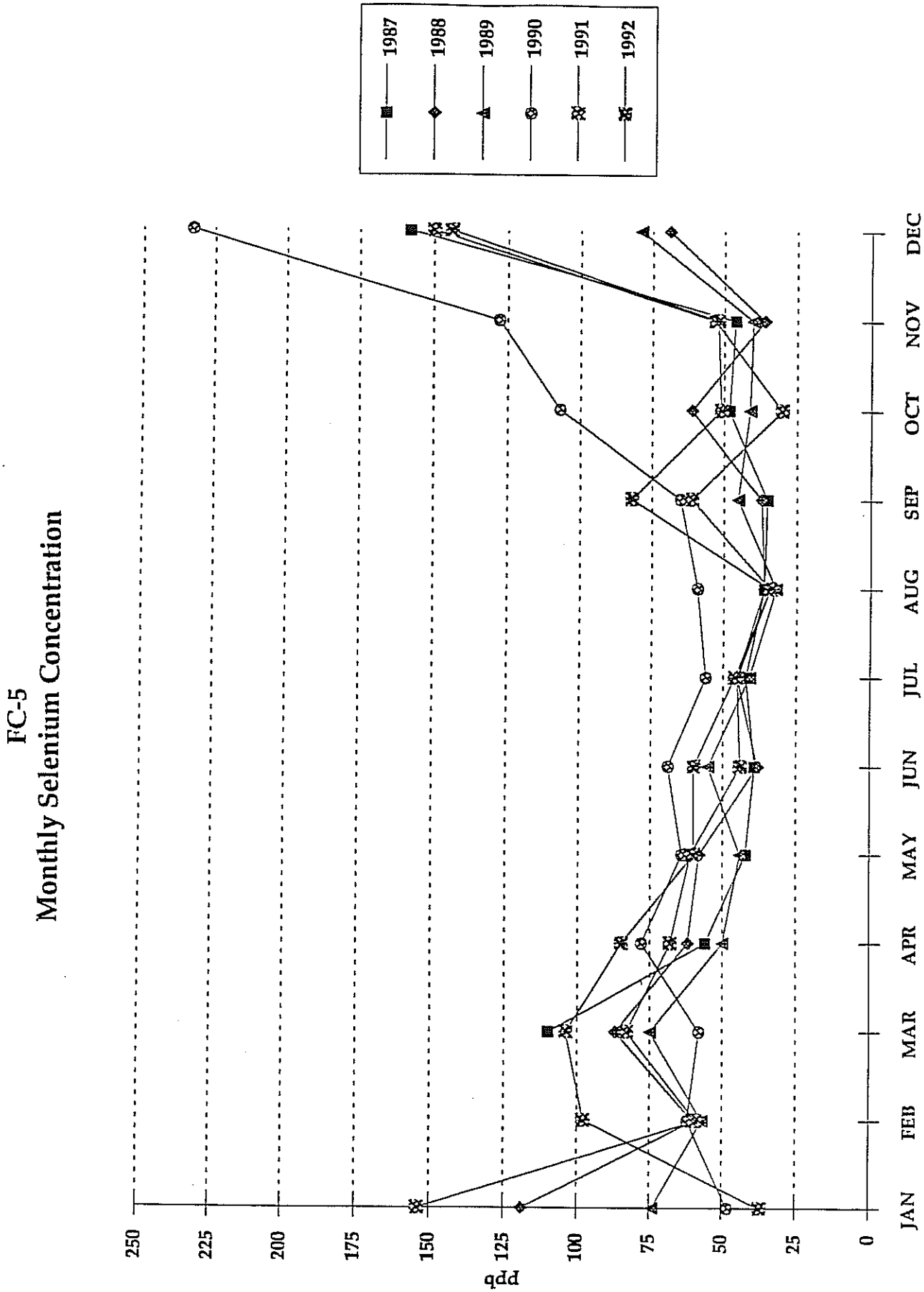
MONTHLY VOLUMES, Se, B, and EC - FC-5

MONTH	1987 Vol ac-ft	Se ppb	B ppm	EC dS/m	1988 Vol ac-ft	Se ppb	B ppm	EC dS/m	1989 Vol ac-ft	Se ppb	B ppm	EC dS/m	1990 Vol ac-ft	Se ppb	B ppm	EC dS/m	1991 Vol ac-ft	Se ppb	B ppm	EC dS/m	1992 Vol ac-ft	Se ppb	B ppm	EC dS/m
JAN					687	119	7	5.747	988	74	4.5	3.400	1033	48	2.9	2.750	631	154	10.6	6.168	432	37	4	3.372
FEB					2344	60	3.3	3.220	1897	57	3	3.300	2194	62	3.7	3.605	1091	59	12.7	4.803	785	98	7	5.053
MAR	2200	110	6	5.15	2165	87	5.1	3.827	1578	75	4.8	3.925	1371	58	4.7	3.695	1376	83	5.1	4.530	965	104	7	4.878
APR	2833	56	3.3	2.975	2151	62	3.6	3.470	2228	50	3.8	3.500	1244	78	4.9	4.333	1140	68	5.1	3.738	1035	85	6	4.185
MAY	3442	42	2.8	2.345	2778	58	3.7	3.390	2429	44	3.9	2.980	1255	64	4.5	6.090	1121	61	5.9	4.000	1003	60	5	3.736
JUN	3832	39	3.4	2.58	3001	38	3.1	2.670	3075	55	4.2	3.200	1672	69	5.4	3.900	1335	44	4	3.351	1409	60	5	3.742
JUL	4219	42	3	2.443	3525	45	3.2	2.920	3809	41	3.7	2.800	2214	56	4.4	2.950	2089	45	4.3	3.215	1532	46	5	3.405
AUG	4390	36	2.6	2.23	3874	36	2.6	2.485	3616	32	2.7	2.080	2440	59	4.5	3.080	2036	34	3.7	2.786	1437	34	4	2.800
SEP	2773	35	4.9	2.37	1991	37	2.9	2.430	1623	45	4.4	2.700	997	65	7.5	5.000	150	61	6.5	4.061	809	82	9	5.052
OCT	2142	48	3	2.685	856	61	4.5	3.325	799	41	4.5	3.173	721	107	9.1	5.235	637	30	4	2.962	697	51	7.3	4.250
NOV	1204	46	3.4	3.335	402	36	2.7	2.575	1067	40	2.8	2.525	1303	128	7.9	5.435	1135	53	4	2.846	884	52	5.3	3.430
DEC	179	158	10.5	7.5	125	69	9.4	5.635	678	79	4.8	4.580	498	233	13.5	8.045	172	150	16	7.704	658	144	10.7	6.520
TOT.	27214				23899				23787				16942				12913				11646			

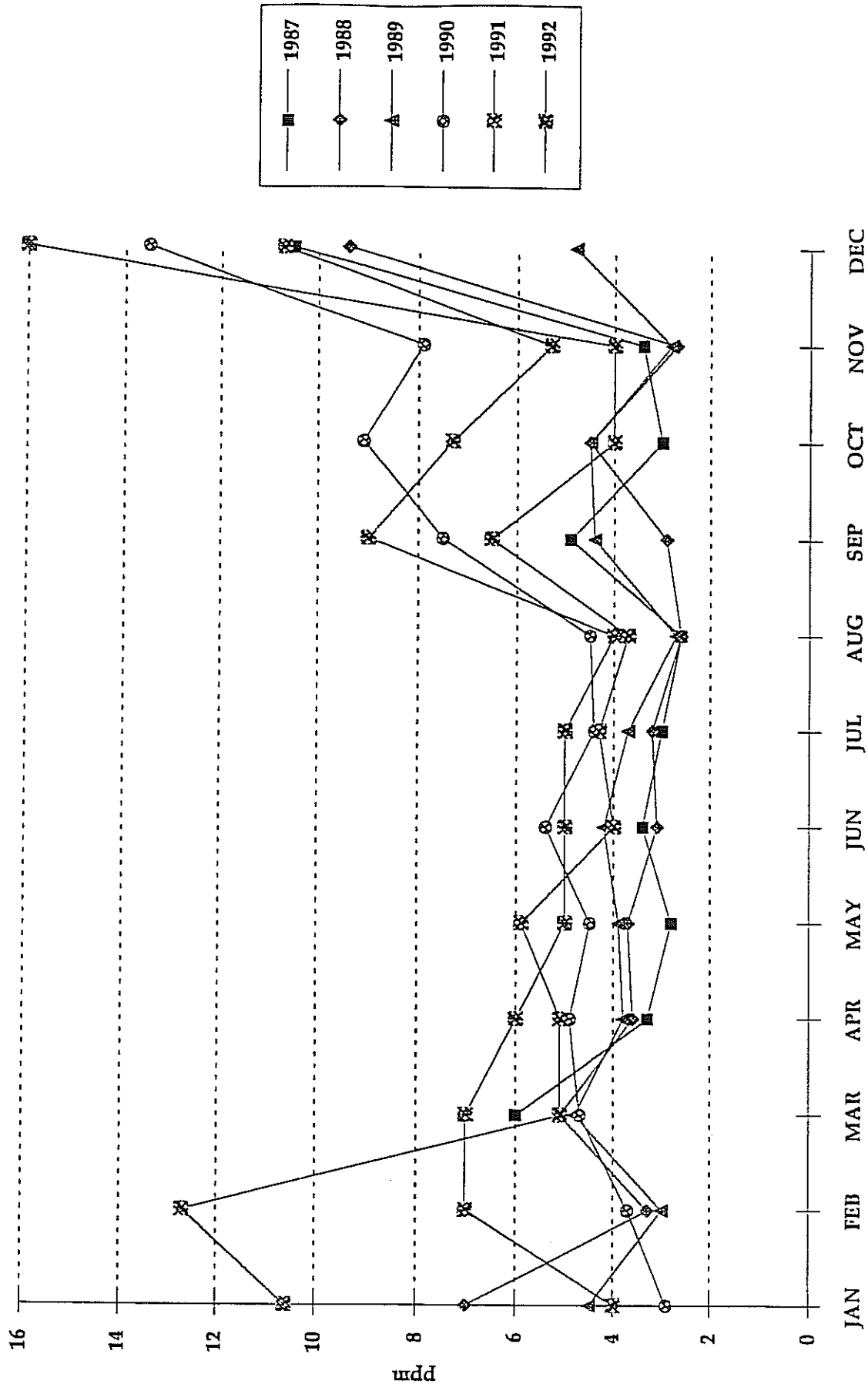
Source: Tables supplied by Joe Karkoski at the California Regional Water Quality Control Board on the monitoring points.

FC-5
Monthly Drainage Volume

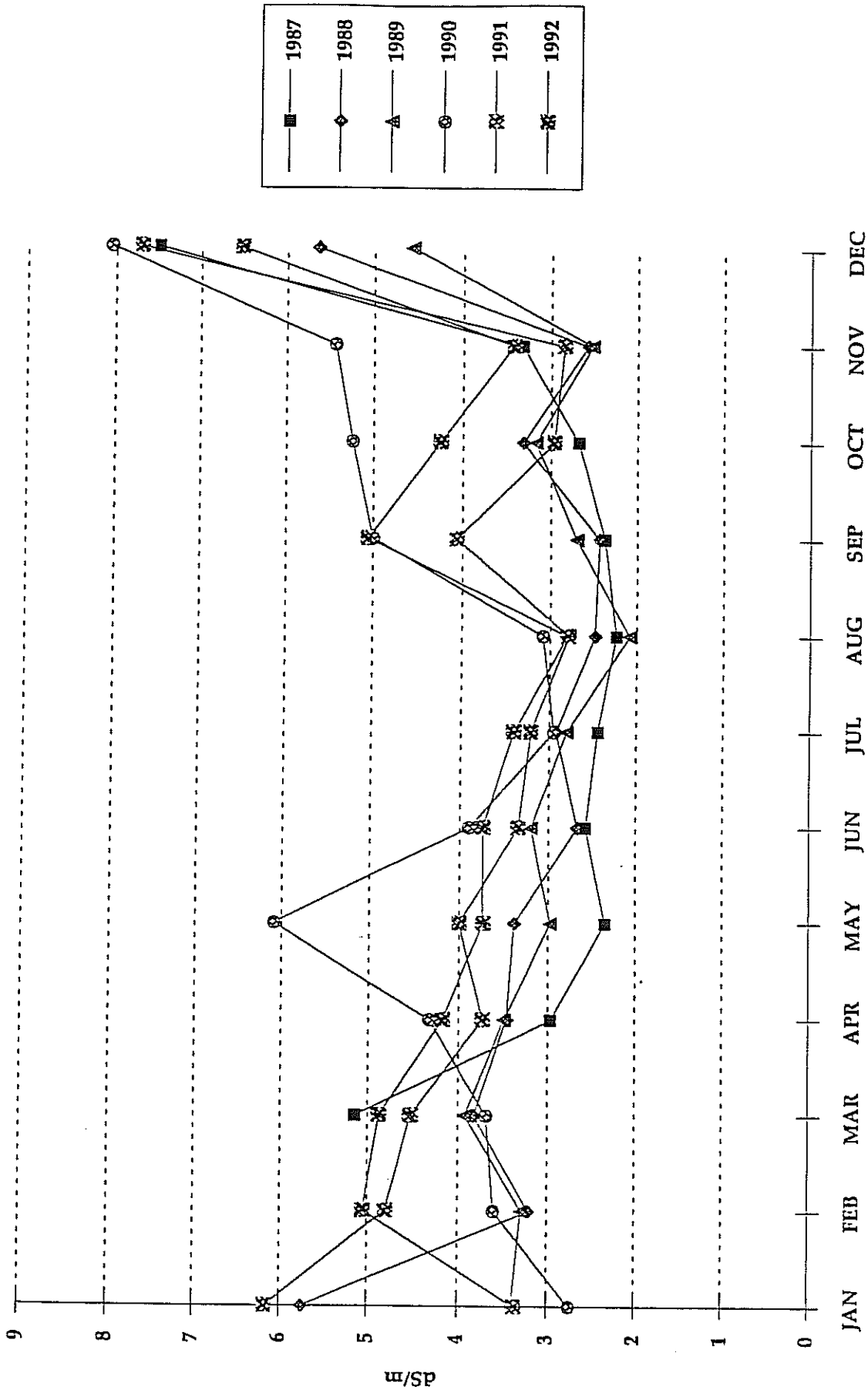


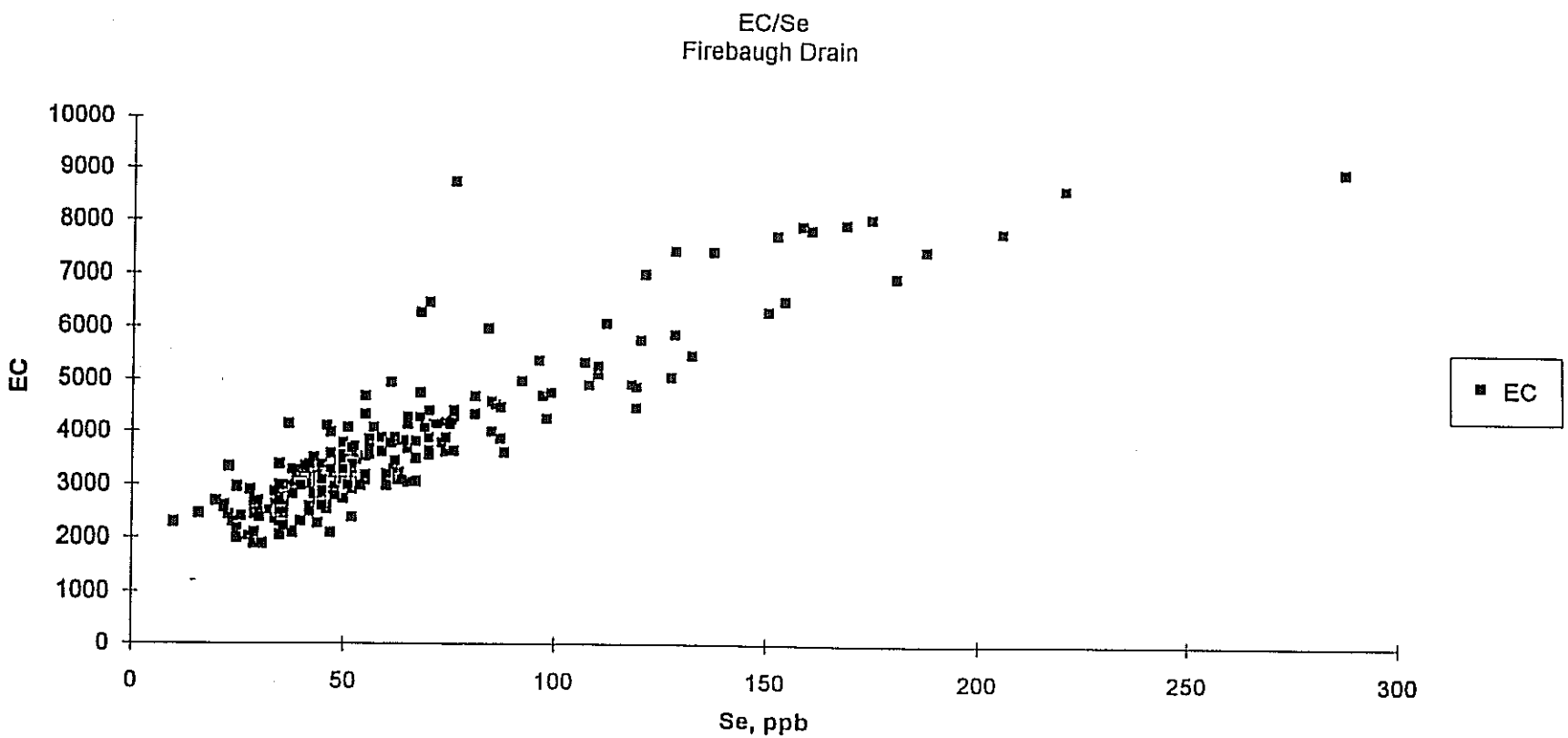

FC-5
Monthly Selenium Concentration
1987
1988
1989
1990
1991
1992
ppb
250
225
200
175
150
125
100
75
50
25
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

FC-5
Monthly Boron Concentration

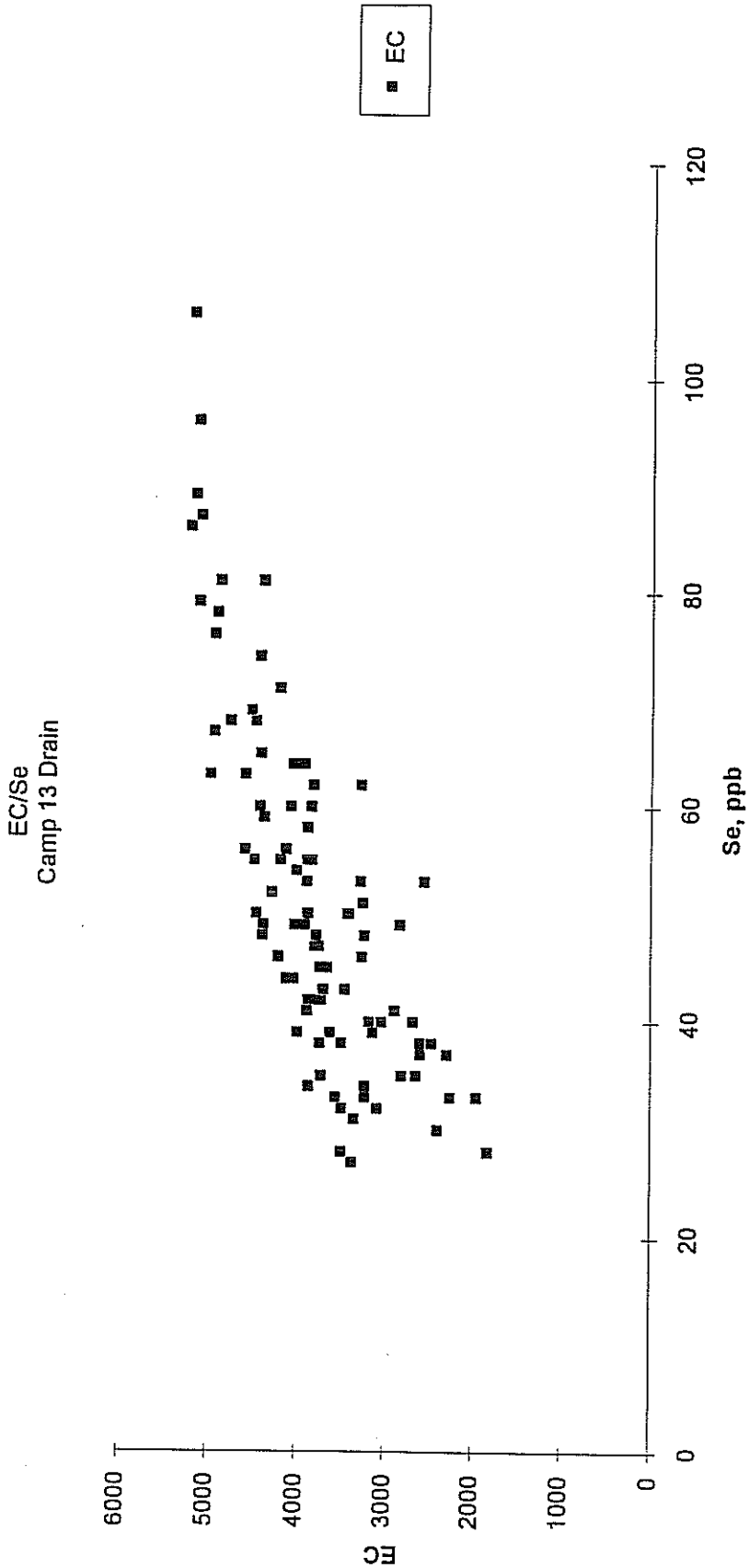


FC-5
Monthly Electrical Conductivity Levels

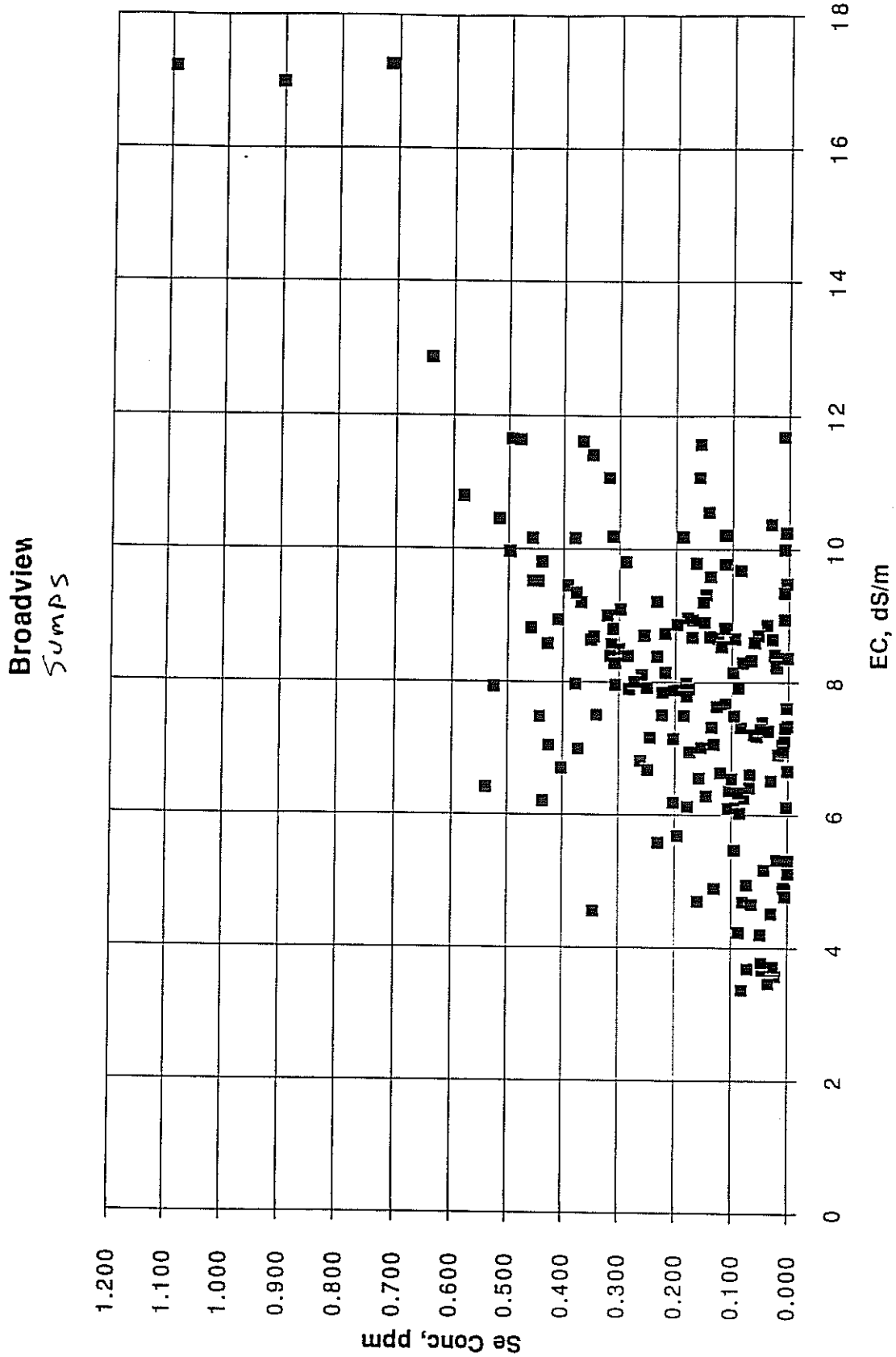



EC/Se
Firebaugh Drain
EC
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
50
100
150
200
250
300
Se, ppb
EC

CAMP13D.XLS Chart 1



SDATA92.FL,SE,ED Chart 2



TECHNICAL APPENDIX H
Subsurface Flow Analysis

TABLE OF CONTENTS
TECHNICAL APPENDIX H

Analysis from John Fio H3

Approach

Sump discharge data from Broadview, Central California, Charleston, Firebaugh, Pacheco, and Panoche irrigation districts is stored as tables on computer diskettes in spreadsheet format. This data was compiled and collated in order to separate high-flow conditions measured during the irrigated season (typically late January through September) and low-flow conditions measured during the nonirrigated season (typically October through December). Total-, high-, and low-flow drainage volumes at each monitoring site were plotted (1992 data) using the ARC/INFO Geographic Information System (GIS) database developed by Cal Poly San Luis Obispo for spatial analysis of the data. Subsurface drainage during low-flow months may approximate ground-water baseflows intercepted by the drainage systems during nonirrigated conditions.

Drainflows

A summary of total annual drainflow and total drainflow during low-flow conditions in 1992 is reported in Table 1 (1992 was selected because it was the most comprehensive when considering the data reported by all the water districts). The greatest volume of subsurface drainage during low-flow conditions in 1992 was discharged by Panoche Water District, and the smallest volume was discharged by Charleston Water District. In general, the greatest volumes of discharge during low-flow conditions is measured in water districts that discharge the greatest volume of total annual drainflow. The proportion of total drainflow discharged during low-flow conditions in 1992 ranges from 6 to 14 percent, with the average for all the water districts being 13 percent. Hence, 13 percent of the total annual drainflow occurs during the nonirrigated months (assumed to be October through December, or 25 percent of the reporting period).

Total drainflow from Panoche Water District, as measured at PE-14, was 12,117 acre-ft in 1992 and is more than 180 percent greater than total flow calculated from the sump measurements. One plausible explanation for the deviation is that flows at PE-14 include irrigation tailwater, seepage of ground-water into the unlined canals that transport the drainwater, and flows from unmetered sumps and collectors. For example, the weirs used to measure drainflow from unmetered sumps and collectors during 1987-88 were no longer operable in 1990, and many had been washed away; in 1987-88 weirs measured drainflow from 19 drainage points (38 percent of the total sites monitored) and accounted for about 50 percent of the total measured drainflow.

Maps of total drainflow for low- and high-flow conditions, as well as annual totals measured in 1992, are shown in plates 1, 2 and 3, respectively. Sumps that generate the most drainwater on an annual basis (plate 3) discharge the greatest volumes during low-flow conditions (plate 1), and most of these sumps are located in the northwestern part of the study area and are downslope of undrained areas.

Results

Data set

The drainflow data provided by the water districts is difficult to use because reporting periods, sampling dates, sampling frequency, and scope of analyses vary between reporting entities. Furthermore, the supporting ancillary data necessary for interpretation of the data is lacking (for example, site description, field conditions at the time of sampling, recent irrigation and drainage history, and so forth). One important piece of information missing from the data set and the ARC/INFO data base is a link between each point representing a sump and the area drained that discharges to it. This would be useful for assessing whether sumps discharging the greatest volumes of drainwater are a result of larger drainage areas, high rates of applied water, or if the drainage system is collecting substantial volumes of ground-water.

Retrieval of the raw measured data (volumes, dates, concentrations, and so forth) was time consuming because of reporting formats, embedded graphs and programmed cell formulas associated with the software each entity uses for their operations, and our own software incompatibility. Well-defined and consistent protocols and reporting formats for data storage and transmittal are therefore needed. For example, transmitted data should consist of only raw data and should be in ASCII format (American Standard Code of Information Interchange).

Groundwater

Preliminary results from a steady-state ground-water-flow model constructed by Fio (in review) provide some insight into subsurface flow to drainage systems in Panoche Water District. The flow model simulates average hydrologic conditions within the District from data collected during the period 1986-90. Average recharge to the water table specified in the flow model (water applied less consumptive-use by crops) was about 45,100 acre-ft/yr (1.1 ft/yr). The model simulates bare-soil evaporation, drainflow, and deep flow of ground-water across depths of about 85 feet below land surface, and results indicate that these flows during the study period averaged 8,350 acre-ft/yr, 16,900 acre-ft/yr, and 21,000 acre-ft/yr, respectively. For comparison, measured drainflow in 1987-88 was 16,865 acre-ft/yr.

The model indicates that recharge originating in undrained areas of Panoche Water District upslope of the drainage system contribute about 11 percent of the total downslope drainflow. Irrigation water percolating past the drainage systems is removed by pumping from the semi-confined zone or recharges the underlying confined zone. Simulated incidental recharge within Panoche Water District, calculated as recharge less bare-soil evaporation and drainflow, is about 19,850 acre-ft/yr (0.5 ft/yr). The model does not explicitly simulate recharge to the confined zone, but average annual recharge to the confined zone calculated by Belitz and others (1992) for the region (over 350,000 acres studied) was about 0.3 ft/yr in 1980.

Results from the regional model provide qualitative insight into the relative magnitude of lateral and deep vertical flow at the water district scale in 1990. Net lateral flow out of San Luis and Panoche Water Districts simulated by the regional model is 220 acre-ft/yr and 260 acre-ft/yr, respectively; net lateral flow into Broadview and Firebaugh Water Districts is about 1 acre-ft/yr and 450 acre-ft/yr, respectively. These lateral flows are net flows, and in most cases are the result of lateral inflows and outflows across each district boundary. Also, it is important to note that not all flows are quantified for San Luis and Panoche Water Districts because the regional model does not include all of their service areas.

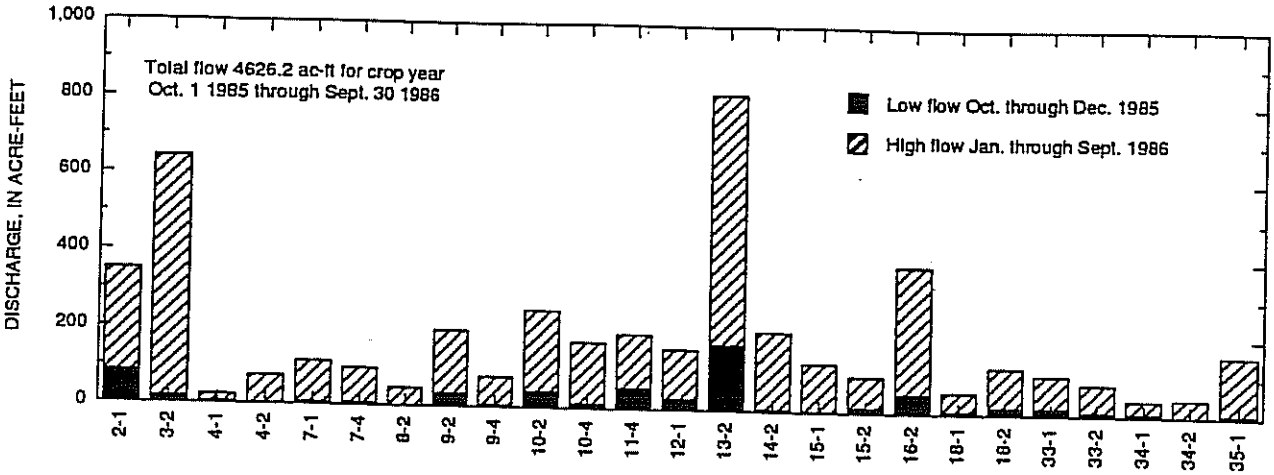
The results from the regional model are limited for interpreting 1990 conditions because recharge to the saturated zone (calculated as water applied less consumptive use by crops) and pumpage estimates specified in the model reflect conditions in 1980. Specified recharge in the regional model for San Luis, Panoche, Broadview, and Firebaugh Water Districts is 0.79 ft/yr, 0.96 ft/yr, 0.78 ft/yr, and 0.75 ft/yr, respectively; simulated incidental recharge to pumping wells and the confined zone in these water districts is 0.54 ft/yr, 0.31 ft/yr, 0.26 ft/yr, and 0.21 ft/yr, respectively.

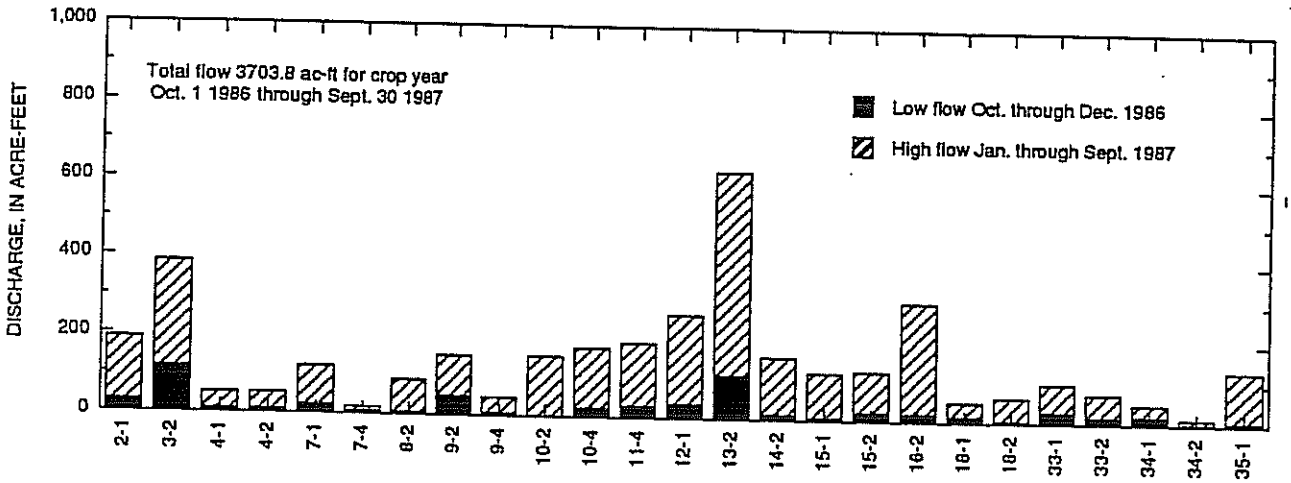
TABLE 1

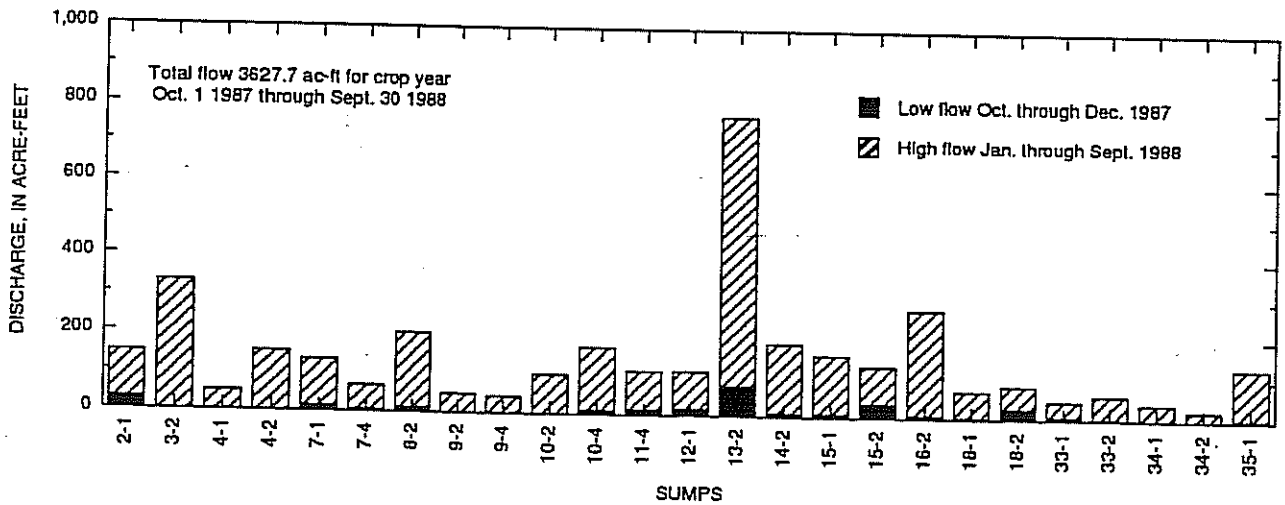
Subsurface Drainage Totals Reported at Sumps
(Calendar year 1992)

Water District	Total (Jan. 1 - Sept. 30)	Low-flow (Oct. 1 - Dec. 31)	Percent Total
Broadview	853	52	6
Firebaugh	3,045	409	13
CCID	-	-	-
Pacheco	4,232	575	14
Charleston	320	30	9
Panoche	6,715	970	14
Total	15,165	2,036	13

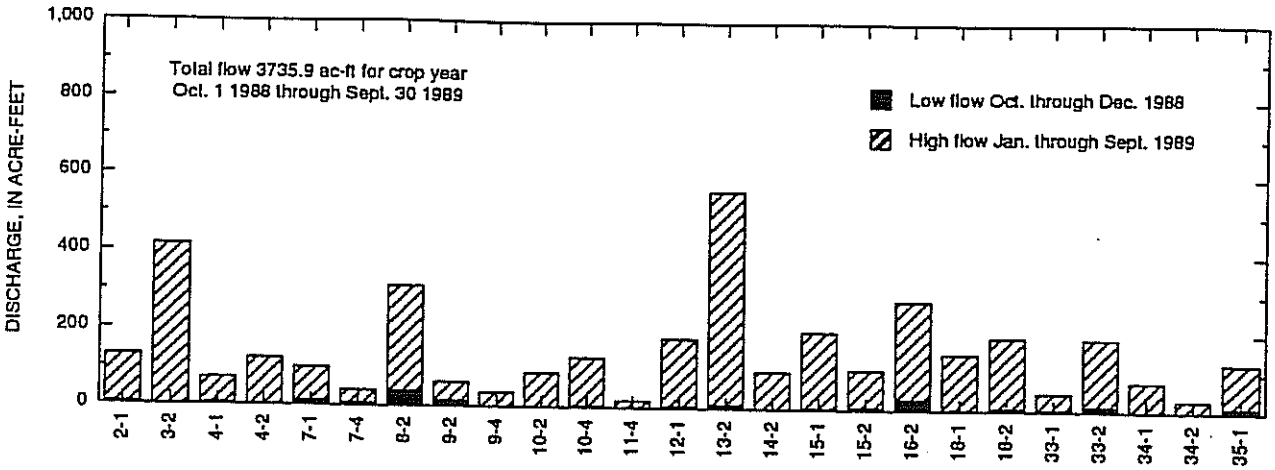
Broadview Water District

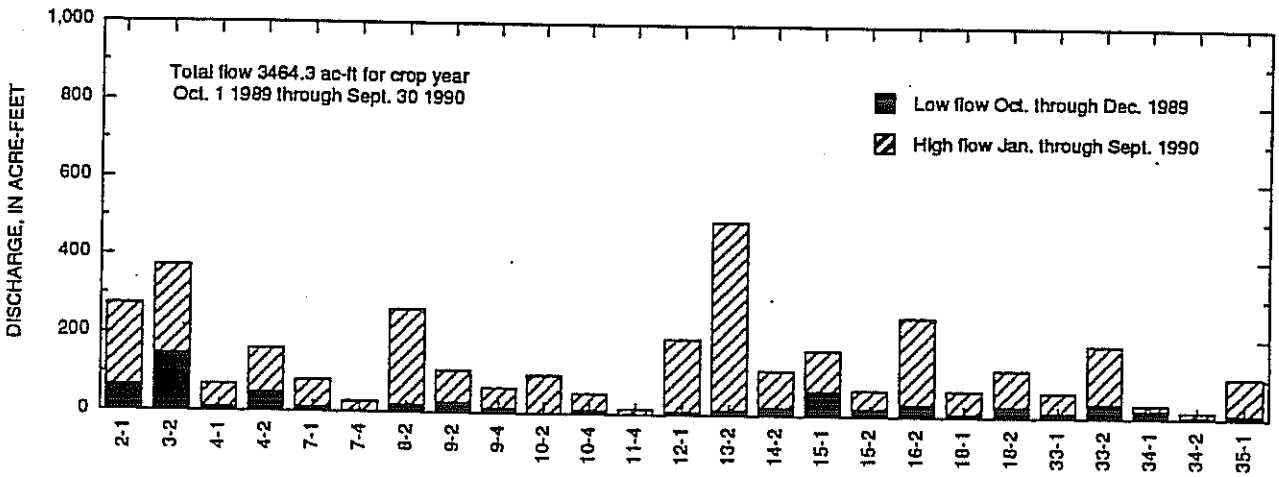


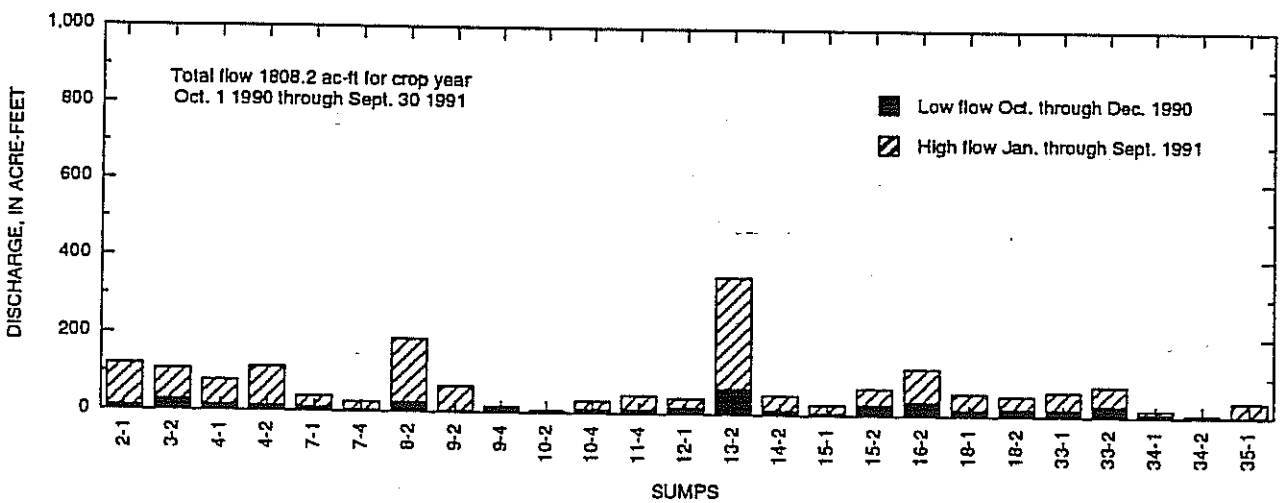


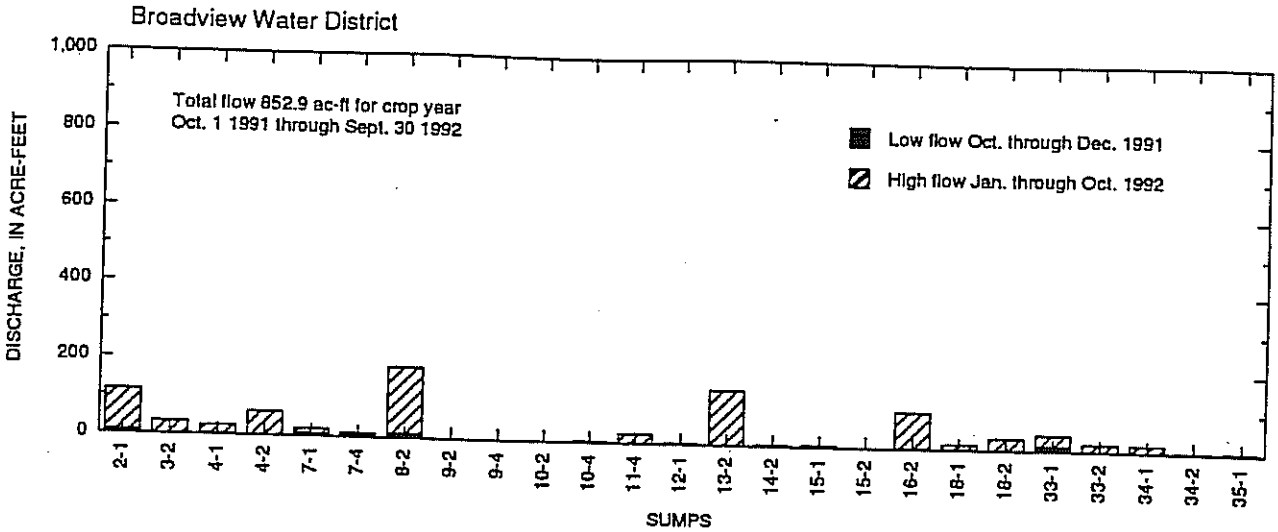


Broadview Water District

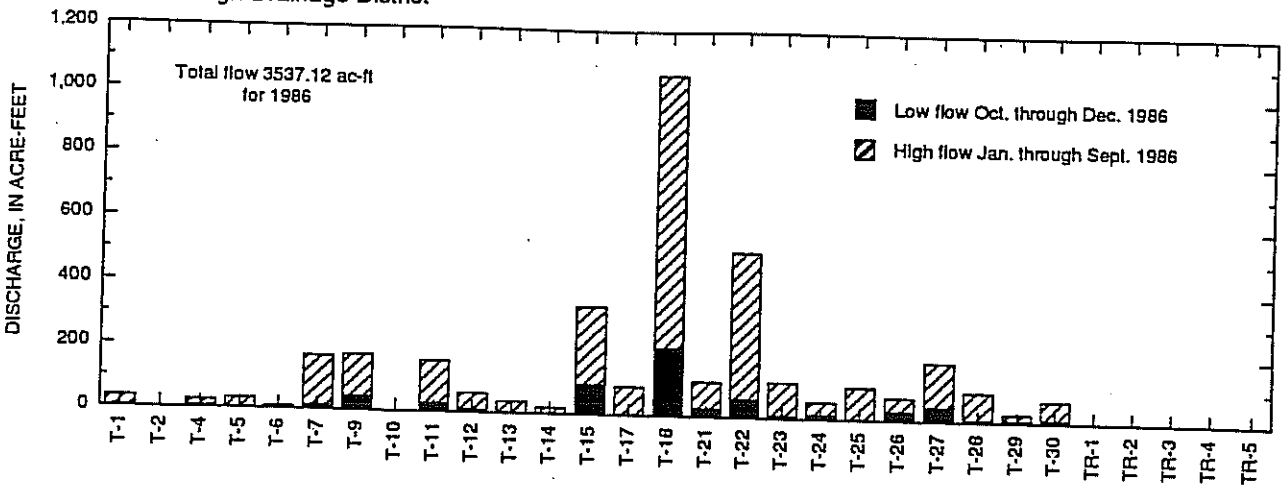


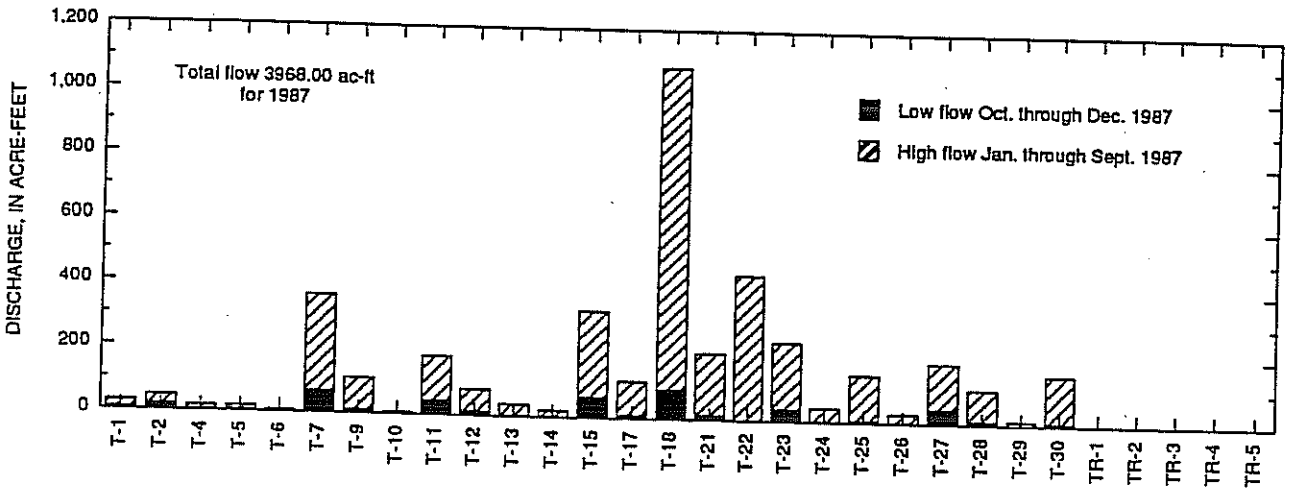


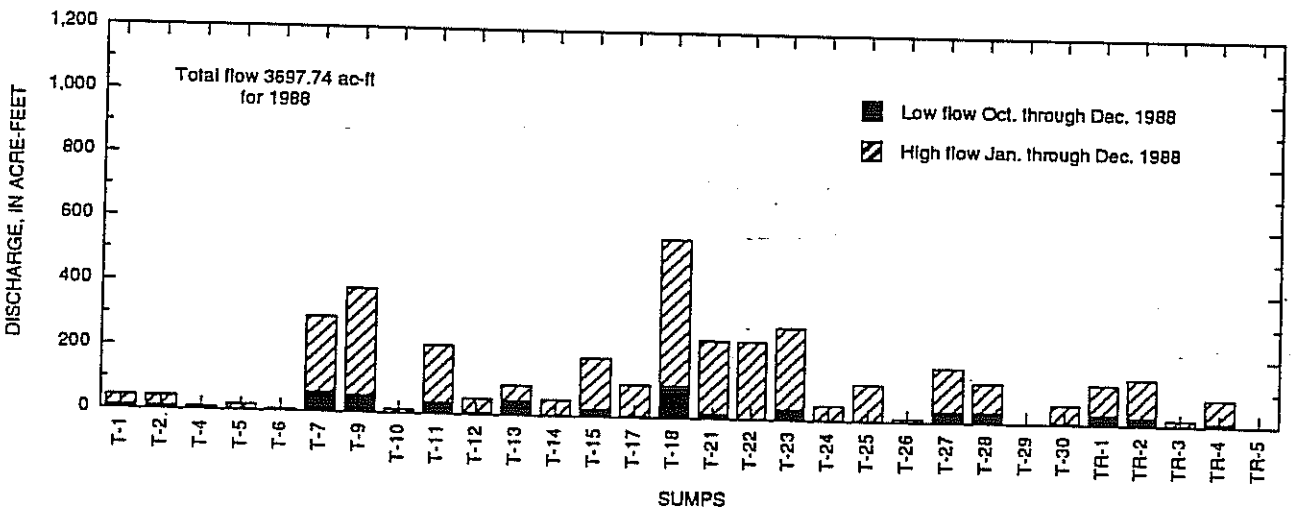



Broadview Water District
Total flow 852.9 ac-ft for crop year
Oct. 1 1991 through Sept. 30 1992
Low flow Oct. through Dec. 1991
High flow Jan. through Oct. 1992
DISCHARGE, IN ACRE-FEET
1,000
800
600
400
200
0
2-1
3-2
4-1
4-2
7-1
7-4
8-2
9-2
9-4
10-2
10-4
11-4
12-1
13-2
14-2
15-1
15-2
16-2
18-1
18-2
33-1
33-2
34-1
34-2
35-1
SUMPS

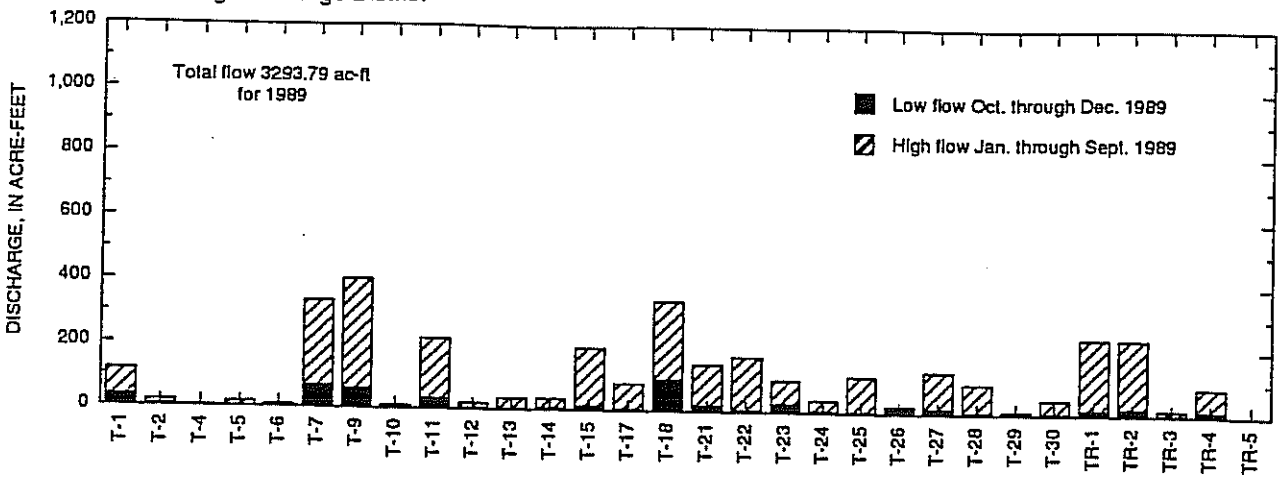
Firebaugh Drainage District

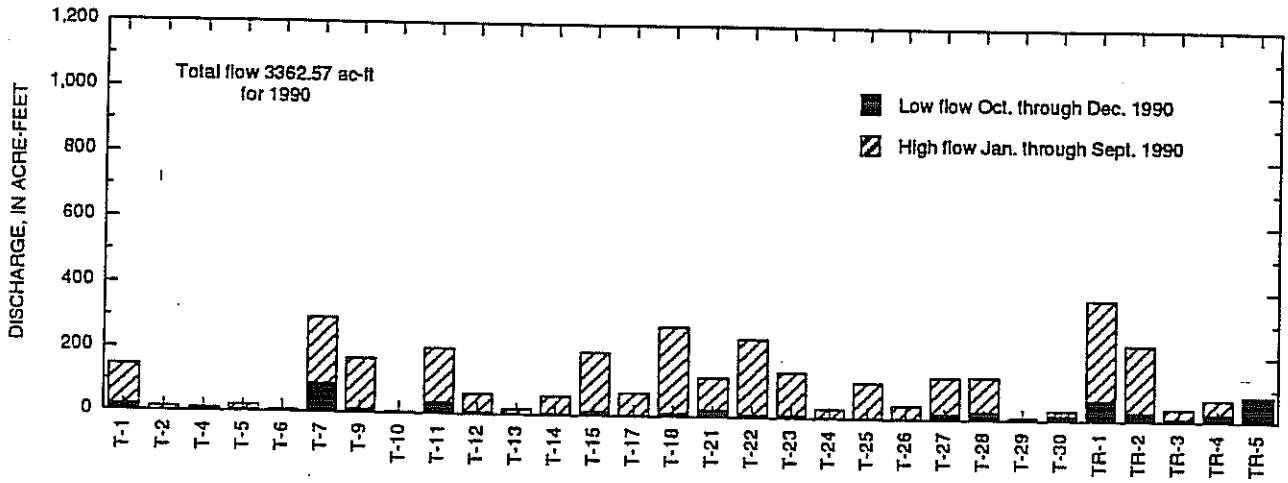


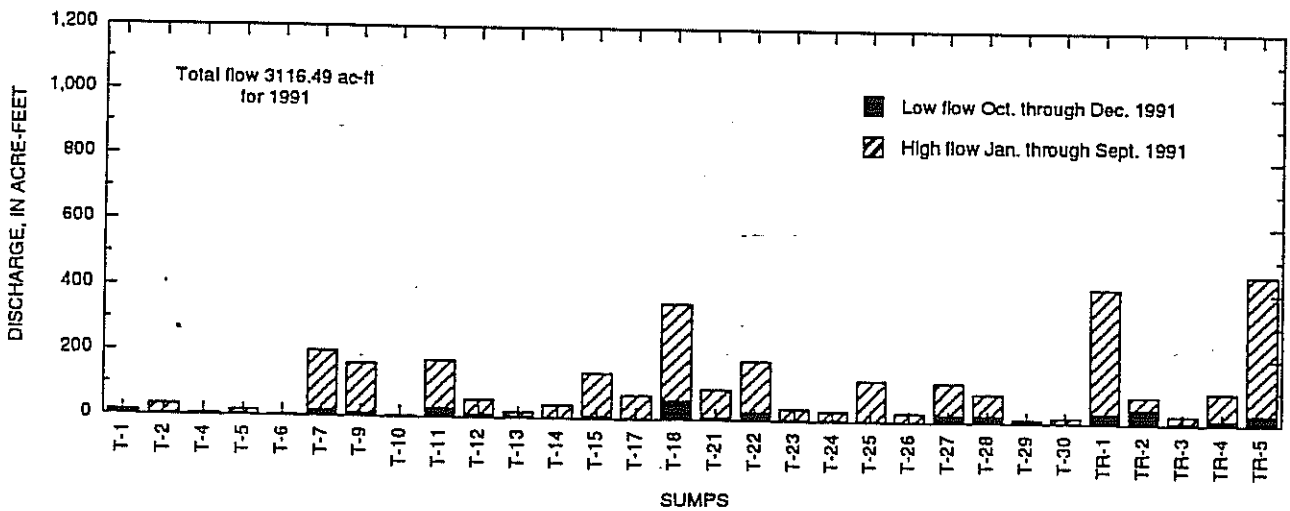


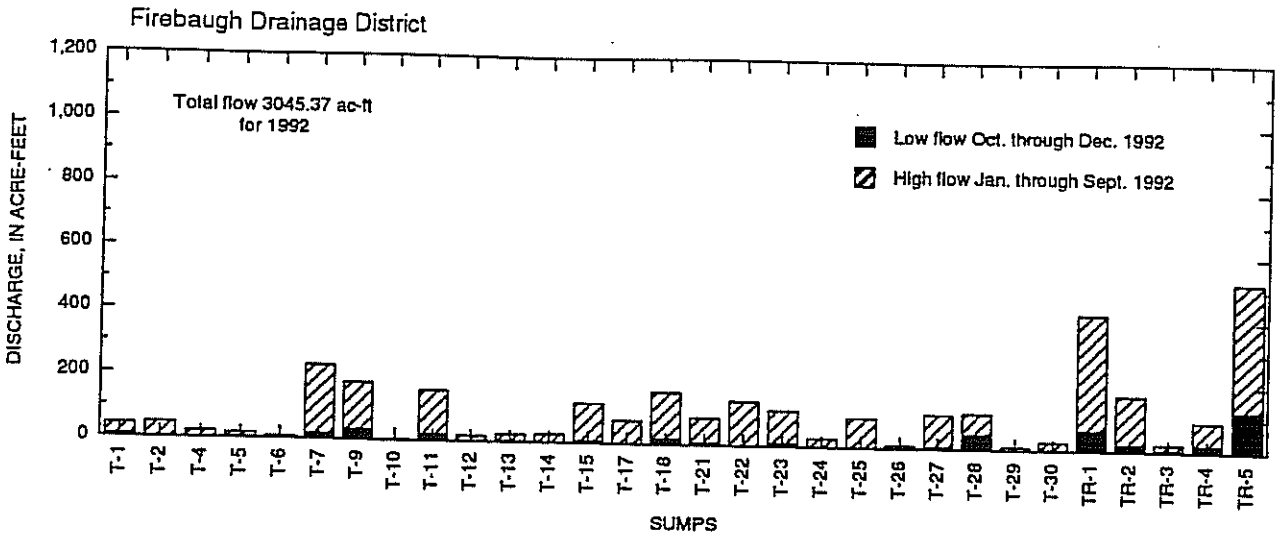


Firebaugh Drainage District

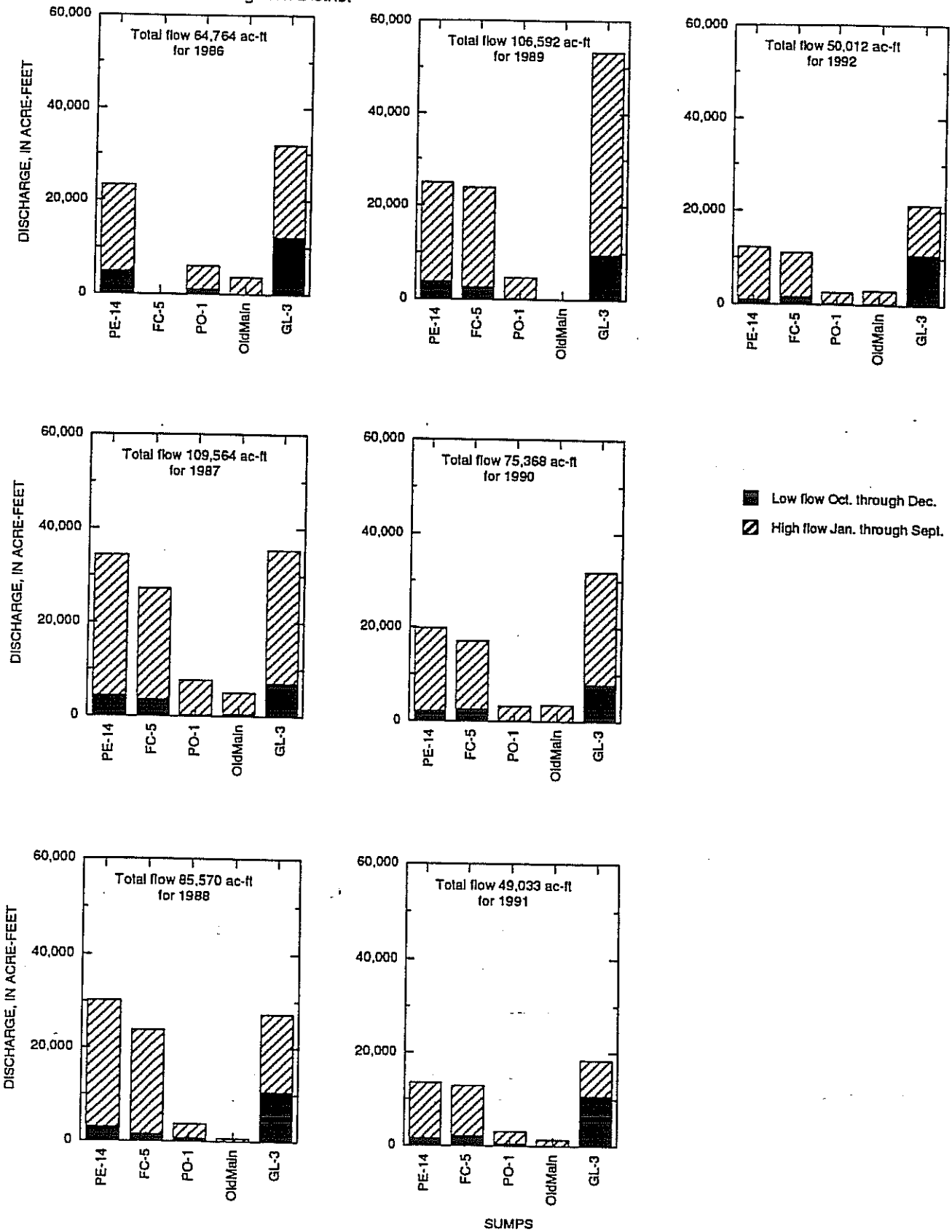




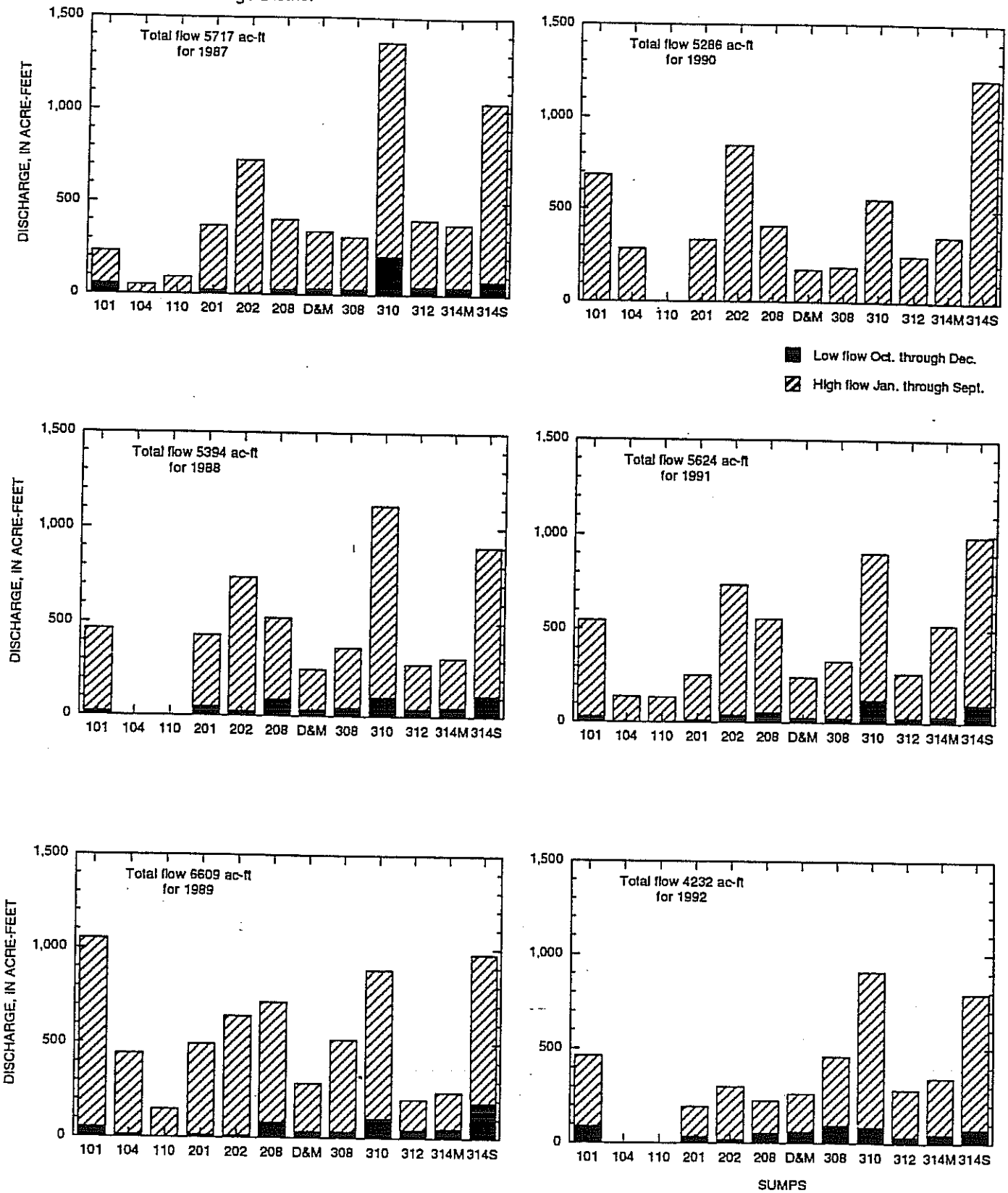


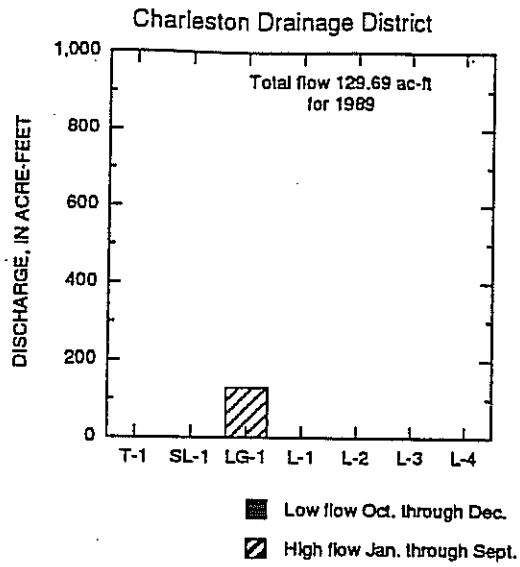

Firebaugh Drainage District
Total flow 3045.37 ac-ft
for 1992
Low flow Oct. through Dec. 1992
High flow Jan. through Sept. 1992
DISCHARGE, IN ACRE-FEET
1,200
1,000
800
600
400
200
0
T-1
T-2
T-4
T-5
T-6
T-7
T-9
T-10
T-11
T-12
T-13
T-14
T-15
T-17
T-18
T-21
T-22
T-23
T-24
T-25
T-26
T-27
T-28
T-29
T-30
TR-1
TR-2
TR-3
TR-4
TR-5
SUMPS

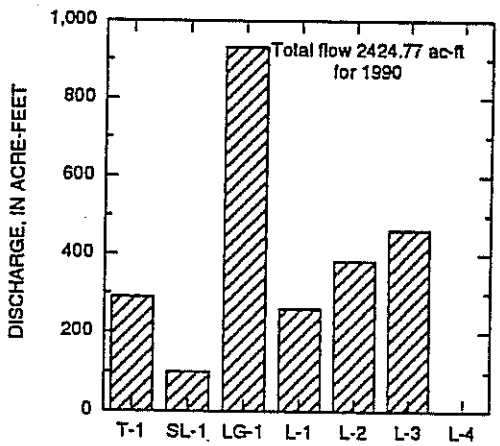
Central California Irrigation District

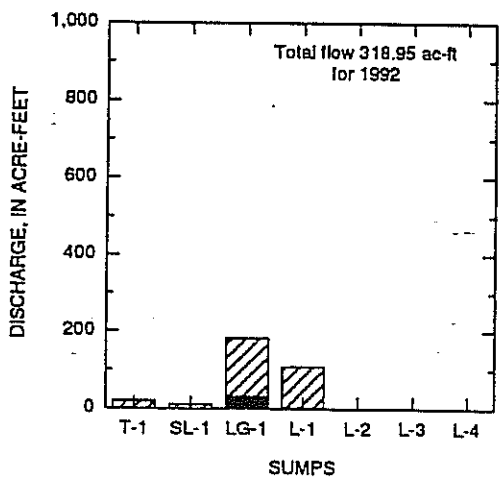


Pacheco Drainage District

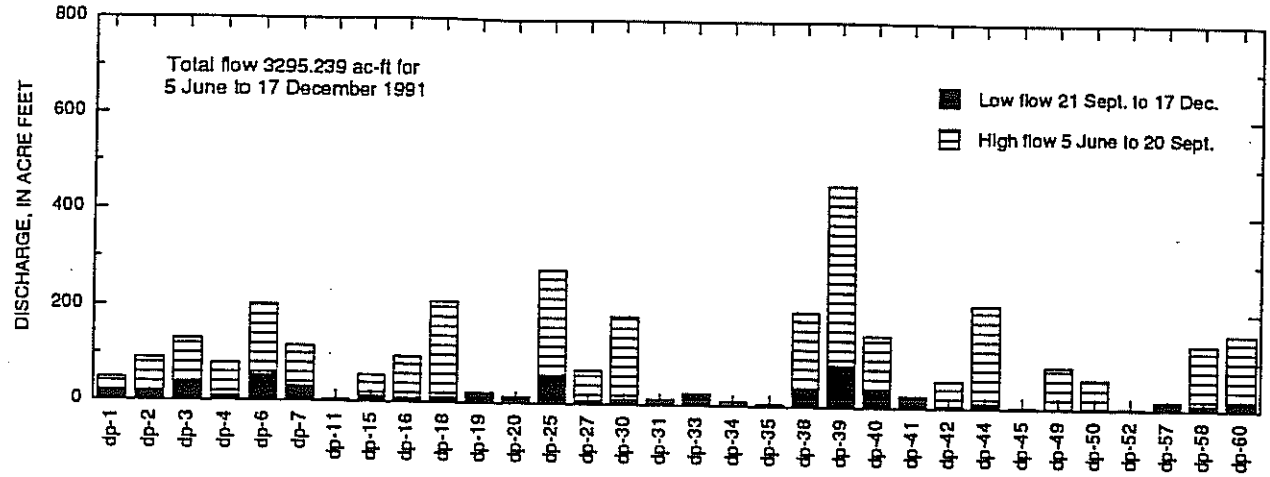


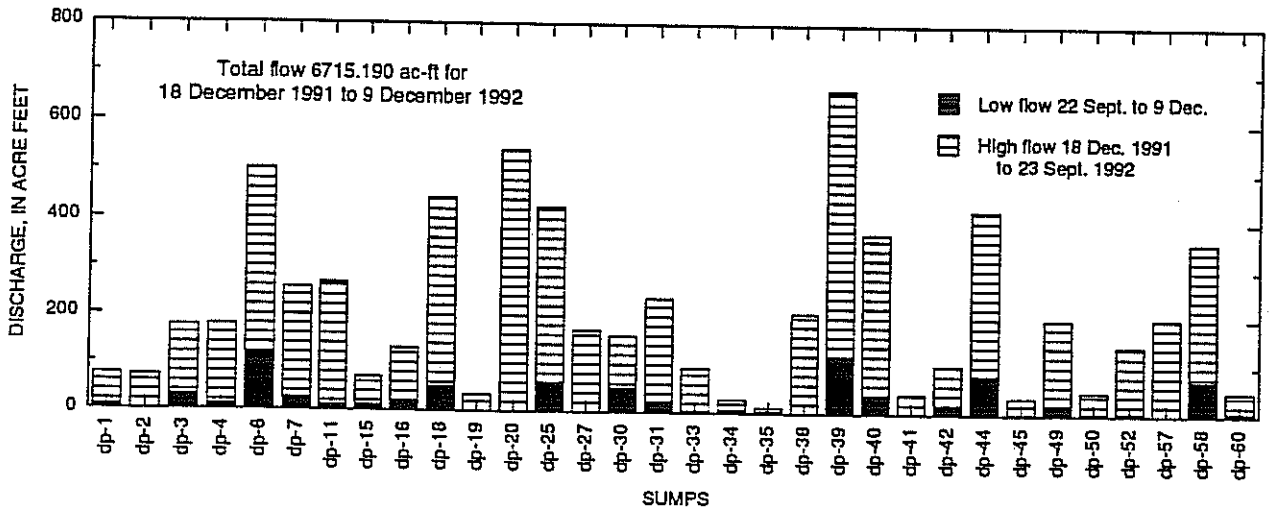

Charleston Drainage District
Total flow 129.69 ac-ft
for 1989
DISCHARGE, IN ACRE-FEET
1,000
800
600
400
200
0
T-1
SL-1
LG-1
L-1
L-2
L-3
L-4
Low flow Oct. through Dec.
High flow Jan. through Sept.


Total flow 2424.77 ac-ft
for 1990
DISCHARGE, IN ACRE-FEET
1,000
800
600
400
200
0
T-1
SL-1
LG-1
L-1
L-2
L-3
L-4


Total flow 318.95 ac-ft
for 1992
DISCHARGE, IN ACRE-FEET
1,000
800
600
400
200
0
T-1
SL-1
LG-1
L-1
L-2
L-3
L-4
SUMPS

Panoche Drainage District





Broadview Water District

	85-86			86-87			87-88			88-89			89-90			90-91			91-92		
	tot	low	high	tot	low	high	tot	low	high	tot	low	high	tot	low	high	tot	low	high	tot	low	high
2-1	349.2	83.4	265.8	189.6	27.5	162.1	147.1	28.2	118.9	129.9	5.5	124.4	272.7	66.9	205.8	119.2	10.7	108.5	114.9	7.7	107.2
3-2	642.7	16.8	625.9	385.1	115.2	269.9	330.2	0	330.2	416.8	0.2	416.6	372.3	146	226.3	107.9	27.5	80.4	32.6	0	32.6
4-1	22.5	2.9	19.6	51.6	7.8	43.8	49.8	0	49.8	70.1	2.7	67.4	70.1	9.7	60.4	70.3	15.1	63.2	24	2.3	21.7
4-2	74.1	0.7	73.4	52.2	8.5	43.7	150.1	0.3	149.8	120.9	0.5	120.4	160.6	48.9	111.7	113.2	12.4	100.8	61.7	0.1	61.6
7-1	113.3	5.7	107.6	119.1	21.9	97.2	131.7	12.8	118.9	98.2	11.3	86.9	81.1	10.7	70.4	37.9	9.5	28.4	20	7.2	12.8
7-4	95.9	4.7	91.2	17	6.3	10.7	66.2	4	62.2	40.3	5.9	34.4	27.5	1.9	25.6	25.4	3.7	21.7	9.2	0.9	8.3
8-2	46.4	0	46.4	88	5.6	82.4	200.7	11.8	188.9	310.6	37.5	273.1	261.3	20.5	240.8	187.3	24.2	163.1	183	10.9	172.1
9-2	197	33.1	163.9	151.6	48.4	103.2	48.1	0	48.1	62.8	15.1	47.7	108.3	25.9	82.4	67.2	3.1	64.1	0	0	0
9-4	78.5	5.5	73	47.3	6	41.3	43.2	0	43.2	36.5	0.1	36.4	65.4	13.6	51.8	16.8	10.8	6	0	0	0
10-2	252.5	41.5	211	153.1	0.7	152.4	99.9	0	99.9	88.2	0	88.2	97.9	0.4	97.5	6.9	1.4	5.5	0	0	0
10-4	171.4	11.5	159.9	176.5	22.9	153.6	169.4	9	160.4	128.7	3.8	124.9	53.1	9.5	43.6	31.5	9	22.5	3.1	0	3.1
11-4	193.8	54.5	139.3	190.4	29.3	161.1	110.4	13.2	97.2	18.9	0	18.9	15.1	0.1	15	45.6	10.1	35.5	35.2	0	25.2
12-1	156.5	28.5	128	263	36.7	226.3	111.3	16.5	94.8	179.3	4.9	174.4	193.1	8.7	184.4	39.7	15.7	24	3.5	3.5	0
13-2	820.4	170.1	650.3	629.3	110.1	519.2	773.7	74.9	698.8	560.1	9.7	550.4	493	12.5	480.5	350.7	65.6	285.1	141.6	0	141.6
14-2	205.6	5.5	200.1	158.4	13	145.4	183.9	8	175.9	96	0.1	95.9	114.1	20.7	93.4	50.2	10.9	39.3	2.8	0.3	2.5
15-1	126.1	1.1	125	119.4	6.4	113	155.4	8.2	147.2	199.6	2.5	197.1	166.9	65.6	101.3	27.9	5	22.9	4.6	0	4.6
15-2	95.2	13.6	81.6	124.4	21.1	103.3	129.3	34.9	94.4	102.5	6.2	96.3	68.1	19.1	49	69.4	28.2	41.2	0	0	0
16-2	381.9	50	331.9	300.9	20.3	280.6	274.8	6.5	268.3	281.2	27.8	253.4	251	31.7	219.3	120.3	34.1	86.2	95.2	1.8	93.4
18-1	55.9	7.2	48.7	51.1	14.6	36.5	68.5	2.2	66.3	145.7	1.9	143.8	68.1	7.6	60.5	57.5	16.9	40.6	14.8	1.2	13.6
18-2	121.5	17.8	103.7	63.9	4.3	59.6	83.6	24.5	59.1	188.2	6.6	181.6	119.7	28.1	91.6	51.3	18.6	32.7	31	0.7	30.3
33-1	102.2	17.8	84.4	99.8	28.1	71.7	45.5	7.1	38.4	45.9	4	41.9	64.7	13.5	51.2	63	17.9	45.1	41	13	28
33-2	79.4	7.5	71.9	74.1	16.8	57.3	61.6	1.4	60.2	185.5	13.9	171.6	183	36.6	146.4	77.2	28.6	48.6	20.3	0.2	20.1
34-1	40.7	6.8	33.9	49.7	19.9	29.8	40.4	0.1	40.3	75.7	0	75.7	34.4	22.2	12.2	18.6	9	9.6	19	0	19
34-2	45.7	0.6	45.1	14.3	2.8	11.5	23	0	23	29.3	0	29.3	17.8	4.3	13.5	6.9	1.3	5.6	2.2	0	2.2
35-1	157.8	7.1	150.7	134	5.9	128.1	129.9	2.4	127.5	125	13.4	111.6	105	12.3	92.7	38.3	1.4	36.9	3.2	2	1.2
	4626.2	593.9	4032.3	3703.8	600.1	3103.7	3627.7	266	3361.7	3735.9	173.6	3562.3	3464.3	637	2827.3	1808.2	390.7	1417.5	852.9	51.8	801.1

Firebaugh Drainage District

	1986			1987			1988			1989			1990			1991			1992		
	tot	low	high	tot	low	high	tot	low	high	tot	low	high	tot	low	high	tot	low	high	tot	low	high
T-1	33.94	2.05	31.89	28.14	5.91	22.23	42.03	10.39	31.64	115.65	34.34	81.31	146.28	20.54	125.74	13.1	5.85	7.25	41	5.1	35.9
T-2	0	0	0	45.39	17.21	28.18	40.92	8.93	31.99	20.3	3.28	17.02	14.12	1.03	13.09	34.03	1.31	32.72	46.2	0.44	45.76
T-4	23.9	3.24	20.66	15.34	4.78	10.56	10.01	2.99	7.02	2.95	0	2.95	9.13	2.24	6.89	5.23	0.83	4.4	21.9	0.4	21.5
T-5	30.69	2.27	28.42	16.6	3.24	13.36	18.34	1.67	16.67	15.58	0.07	15.51	20.57	4.21	16.36	18.02	2.85	15.17	16.74	1.46	15.28
T-6	7.89	2.12	5.77	5.68	0.41	5.27	5.35	0.31	5.04	7.67	0.58	7.09	6.74	0.42	6.32	3.52	0.49	3.03	5.34	0.39	4.95
T-7	167.59	12.61	154.98	361.26	65.2	296.06	294.85	59.82	235.03	335.38	67.75	267.63	296.09	89.18	206.91	201.94	17.72	184.22	227.52	15.92	211.6
T-9	174.94	41.44	133.5	108.45	9.78	98.67	383.02	51.88	331.14	403.75	60.91	342.84	170.26	9.76	160.5	162.83	10.52	152.31	175.91	29.15	146.76
T-10	0.61	0.2	0.41	5.53	0.4	5.13	11.9	0.36	11.54	10.26	0.08	10.18	3.86	1.72	2.14	2.81	0.03	2.78	2.61	0	2.61
T-11	160.47	26.75	133.72	177.01	41.66	135.35	212.9	33.02	179.88	220.4	34.79	185.61	204.44	34.85	169.59	175.87	27.41	148.46	153.62	19.87	133.75
T-12	60.7	8.14	52.56	79.25	12.01	67.24	49.32	4.8	44.52	19.4	4.91	14.49	63.82	6.33	57.49	56.04	8.62	47.42	17.81	0	17.81
T-13	36.54	1.92	34.62	35.69	1.15	34.54	91.57	43.87	47.7	35.74	1	34.74	17.05	1.76	15.29	19.35	4.65	14.7	24.24	1.81	22.43
T-14	19.01	1.76	17.25	19.65	0	19.65	49.01	1.08	47.93	35.02	5.65	29.37	59.59	3.49	56.1	40.76	1.84	38.92	26.26	0.92	25.34
T-15	338.32	93.25	245.07	325.81	61.21	264.6	181.03	22.44	158.59	194.93	13.13	181.8	197.79	11.21	186.58	140.6	7.04	133.56	122.8	5.91	116.89
T-17	90	2.13	87.87	114.29	7.54	106.75	101.63	3.39	98.24	84.62	4.78	79.84	72.5	2.54	69.96	74.04	2.53	71.51	72.05	0.02	72.03
T-18	1062.07	212.86	849.21	1083.49	88.55	994.94	551.95	99.02	452.93	343.61	98.21	245.4	279.33	10.41	268.92	356.47	58.48	296.99	159.32	17.07	142.25
T-21	109.35	25.73	83.62	201.11	14.5	186.61	241.26	13.78	227.48	145.02	17.46	127.56	123.63	21.19	102.44	93.34	7.71	85.63	83.79	6.32	77.47
T-22	513.8	57.26	456.54	443.71	0.31	443.4	240.43	0.03	240.4	170.77	5.94	164.83	243.7	8.64	235.06	183.78	25.02	158.76	136.35	0	136.35
T-23	112.73	7.44	105.29	239.63	36.06	203.57	285.01	31.63	253.38	99.97	27.23	72.74	143.49	7.28	136.21	37.74	3.24	34.5	109.01	10.28	98.73
T-24	53.07	14.08	38.99	42.65	1.84	40.81	46.35	0.89	45.46	40.34	5.15	35.19	30.55	1.99	28.56	31.76	2.6	29.16	26.61	0.64	25.97
T-25	101.81	2.87	98.94	143.52	5.11	138.41	114.24	1.11	113.13	114.45	4.07	110.38	112.9	1.09	111.81	126.05	0.76	125.29	90.81	0.12	90.69
T-26	71.85	27.33	44.52	27.38	2	25.38	10.59	0.05	10.54	24.36	21.77	2.59	43.22	2.7	40.52	27.38	0	27.38	9.8	0	9.8
T-27	182.91	43.87	139.04	182.54	42.84	139.7	168.23	32.31	135.92	129.86	18.55	111.31	132.8	18.78	114.02	118.67	22.54	96.13	104.75	6.89	97.86
T-28	91.6	6.04	85.56	105.22	9.37	95.85	123.7	30.69	93.01	92.75	6.6	86.15	135.89	25.64	110.25	87.11	20.83	66.28	109.01	45.12	63.89
T-29	25.17	6.72	18.45	11.82	0.69	11.13	0.25	0.14	0.11	10.55	1.5	9.05	6.97	1.61	5.36	11.11	1.95	9.16	10.67	0.29	10.38
T-30	68.16	7.2	60.96	148.84	6.34	142.5	58.99	3.82	55.17	45.26	4.35	40.91	31.18	15.01	16.17	18.18	2.48	15.7	26.49	2.41	24.08
TR-1	0	0	0	0	0	0	123.07	30.55	92.52	236.43	15.97	220.46	373.16	62.86	310.3	412.53	32.47	380.06	417.55	62.71	354.84
TR-2	0	0	0	0	0	0	142.49	24.06	118.43	234.67	22.62	212.05	235.29	28.7	206.59	84.12	45.36	38.76	169.78	21.27	148.51
TR-3	0	0	0	0	0	0	18.47	2.44	16.03	17.85	4.42	13.43	38.79	8.52	30.27	28.21	6.29	21.92	23.65	6	17.65
TR-4	0	0	0	0	0	0	80.83	8.95	71.88	86.25	15.92	70.33	68.66	24.54	44.12	98.09	15.51	82.58	91.35	22.44	68.91
TR-5	0	0	0	0	0	0	0	0	0	0	0	0	80.78	80.78	0.0	454.81	30.84	423.97	522.43	125.72	396.71
	3537.12	609.28	2927.84	3968	438.11	3529.89	3697.74	524.42	3173.32	3293.79	501.03	2792.76	3362.57	509.02	2853.55	3116.49	367.77	2748.72	3045.37	408.67	2636.7

Central California Irrigation District

	1986			1987			1988			1989			1990			1991			1992		
	tot	low	high	tot	low	high	tot	low	high	tot	low	high	tot	low	high	tot	low	high	tot	low	high
PE-14	23334	4827	18507	34336	4322	30014	30144	2891	27253	24855	3691	21164	19835	2064	17771	13487	1467	12020	12117	906	11211
FC-5	0	0	0	27214	3525	23689	23899	1383	22516	23887	2644	21243	17042	2522	14520	12913	1944	10969	10979	1581	9398
PO-1	6001	962	5039	7630	185	7445	3669	535	3134	4647	60	4587	3186	86	3100	3013	383	2630	2589	216	2373
OldMain	3549	0	3549	4970	401	4569	575	0	575	0	0	0	3430	0	3430	1253	0	1253	2996	168	2828
GL-3	31080	12106	19774	35424	7036	28388	27283	10609	16674	53203	9612	43591	31875	7775	24100	18367	10651	7716	21331	10662	10669
	64764	17895	46869	109574	15469	94105	85570	15418	70152	106592	16007	90585	75368	12447	62921	49033	14445	34588	50012	13533	36479

Pacheco Drainage District

	1987			1988			1989			1990			1991			1992		
	tot	low	high	tot	low	high	tot	low	high	tot	low	high	tot	low	high	tot	low	high
101	229	56	173	466	16	450	1051	51	1000	685	0	685	545	28	517	462	86	376
104	49	0	49	0	0	0	444	11	433	284	0	284	137	0	137	0	0	0
110	91	0	91	0	0	0	146	0	146	0	0	0	133	0	133	0	0	0
201	370	21	349	432	46	386	495	11	484	333	0	333	255	10	245	191	33	158
202	724	6	718	736	23	713	645	10	635	845	0	845	735	36	699	299	16	283
208	404	28	376	525	86	439	716	79	637	407	0	407	556	53	503	224	52	172
D&M	341	33	308	252	31	221	289	31	258	173	0	173	245	25	220	263	59	204
308	313	31	282	369	44	325	519	33	486	187	0	187	331	22	309	461	92	369
310	1367	208	1159	1117	103	1014	886	103	783	555	0	555	904	122	782	910	84	826
312	405	44	361	281	40	241	203	41	162	251	0	251	267	25	242	285	33	252
314M	381	42	339	314	47	267	244	49	195	358	0	358	524	33	491	345	47	298
314S	1043	75	968	902	113	789	971	186	785	1208	0	1208	992	97	895	792	73	719
	5717	544	5173	5394	549	4845	6609	605	6004	5286	0	5286	5624	451	5173	4232	575	3657

Charleston Drainage District

	1989			1990			1992		
	tot	low	high	tot	low	high	tot	low	high
T-1	0.009	0.009	0	289.33	0	289.33	19.409	0	19.409
SL-1	0	0	0	100.51	0	100.51	10.99	0	10.99
LG-1	128.96	0	128.96	931.37	0	931.37	181.62	29.43	152.19
L-1	0	0	0	260.18	0	260.18	106.93	0.71	106.22
L-2	0.721	0.721	0	382.206	0	382.206	0	0	0
L-3	0	0	0	461.17	0	461.17	0	0	0
L-4	0	0	0	0	0	0	0	0	0
	129.69	0.73	128.96	2424.766	0	2424.766	318.949	30.14	288.809

Panoche Drainage District

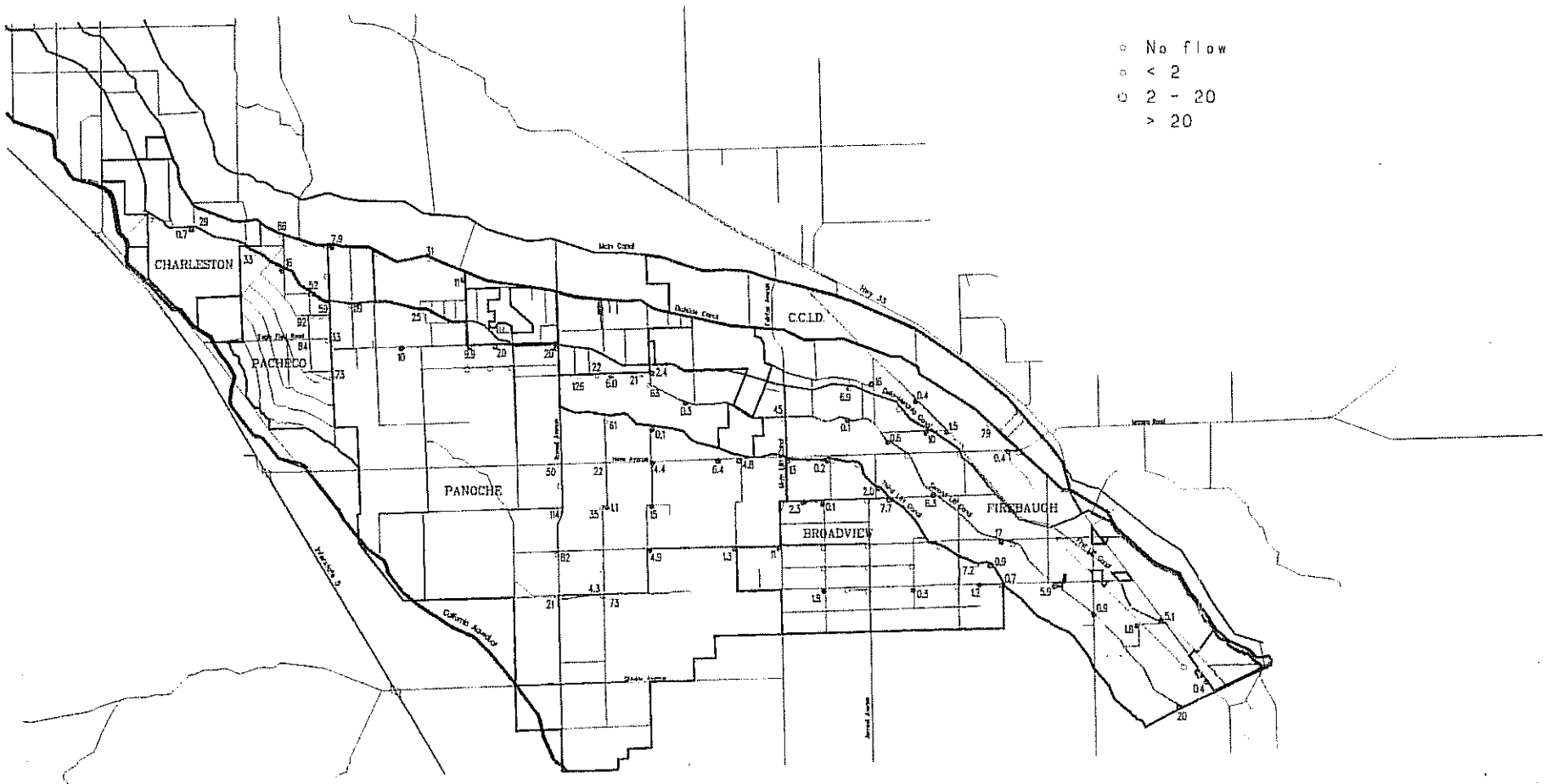
	1991	low	high	1992	low	high
DP-1	48.053	16.022	32.031	74.903	7.856	67.047
DP-2	89.948	19.967	69.981	72.425	0	72.425
DP-3	130.706	34.427	96.279	176.436	30.981	145.455
DP-4	78.702	8.902	69.8	177.94	11.143	166.798
DP-6	200.77	53.596	147.174	501.839	118.902	382.937
DP-7	115.95	30.57	85.38	256.37	24.82	231.55
DP-11	3.81	0.666	3.144	266.401	10.305	256.096
DP-15	56.627	11.339	45.288	70.296	9.945	60.351
DP-16	95.904	8.47	87.434	130.863	20.001	110.862
DP-18	211.019	10.176	200.843	443.185	50.295	392.89
DP-19	21.0545	21.0545	0	34.0245	0	34.0245
DP-20	13.9673	13.9673	0	540.7327	0	540.7327
DP-25	278.99	54.46	224.53	425.51	60.59	364.92
DP-27	70.736	6.455	64.281	170.192	0.059	170.133
DP-30	183.56	11.08	172.48	158.52	49.97	108.55
DP-31	11.401	11.4	0.001	237.29	22.19	215.1
DP-33	25.96	16.8	9.16	93.46	4.42	89.04
DP-34	9.397	2.887	6.51	28.388	6.42	21.968
DP-35	4.91	4.91	0	12.44	4.85	7.59
DP-38	197.29	38.37	158.92	208.18	0	208.18
DP-39	459.969	87.753	372.216	665.951	113.959	551.992
DP-40	150.512	34.397	116.115	373.044	35.056	337.988
DP-41	25.369	17.878	7.491	40.863	1.142	39.721
DP-42	57.292	4.796	52.496	101.728	14.962	86.766
DP-44	214.312	12.193	202.119	423.036	81.686	341.35

DP-45	2.645	2.645	0	35.06	1.312	33.748
DP-49	88.112	1.607	86.505	198.36	20.978	177.382
DP-50	63.093	2.903	60.19	47.279	4.334	42.945
DP-52	65.721	65.721	0	142.317	4.852	137.465
DP-57	17.76	17.76	0	201.493	0	201.493
DP-58	135.201	12.049	123.152	357.984	72.992	284.992
DP-60	157.37	17.66	139.71	48.68	6.27	42.41
	3295.239	680.7038	2614.536	6715.190	970.289	5744.901

Drainflows in the Grassland Area

Low flows in 1992, in acre-feet

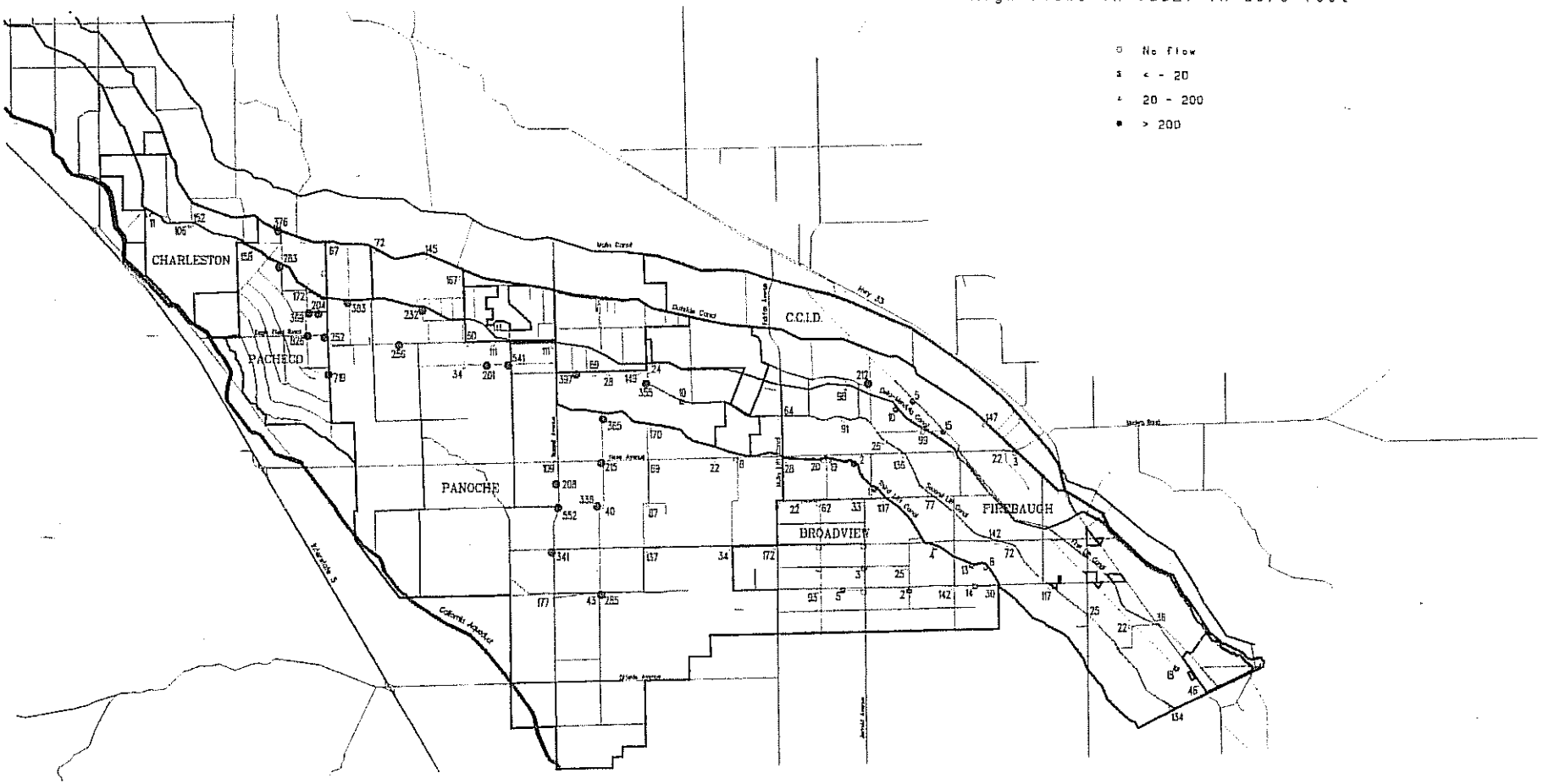
- No flow
- < 2
- 2 - 20
- > 20

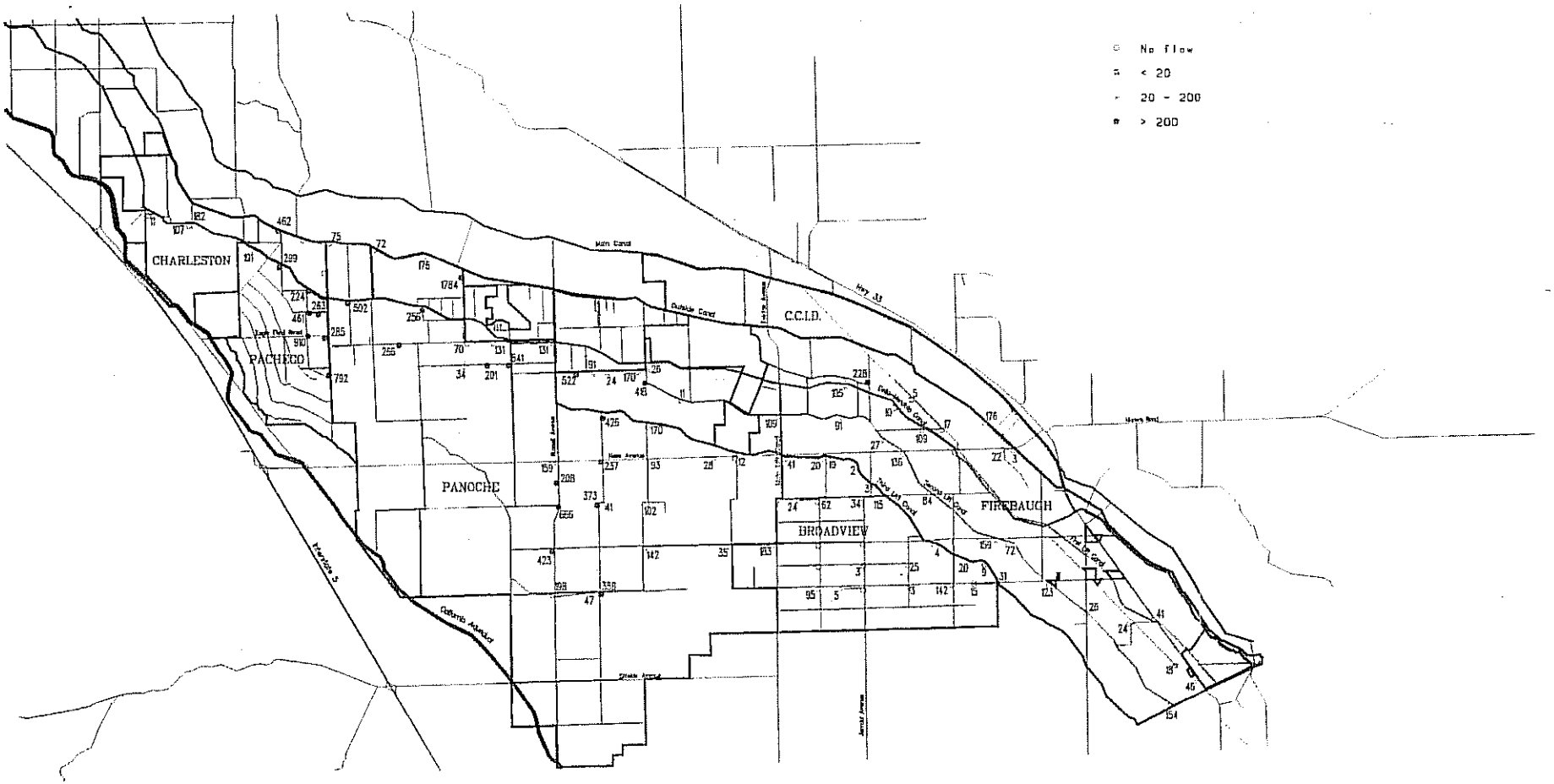


Drainflows in the Grassland Area

High flows in 1992, in acre-feet

- No flow
- < - 20
- 20 - 200
- > 200



Drainflows in the Grassland Area

Total flow in 1992, in acre-feet