

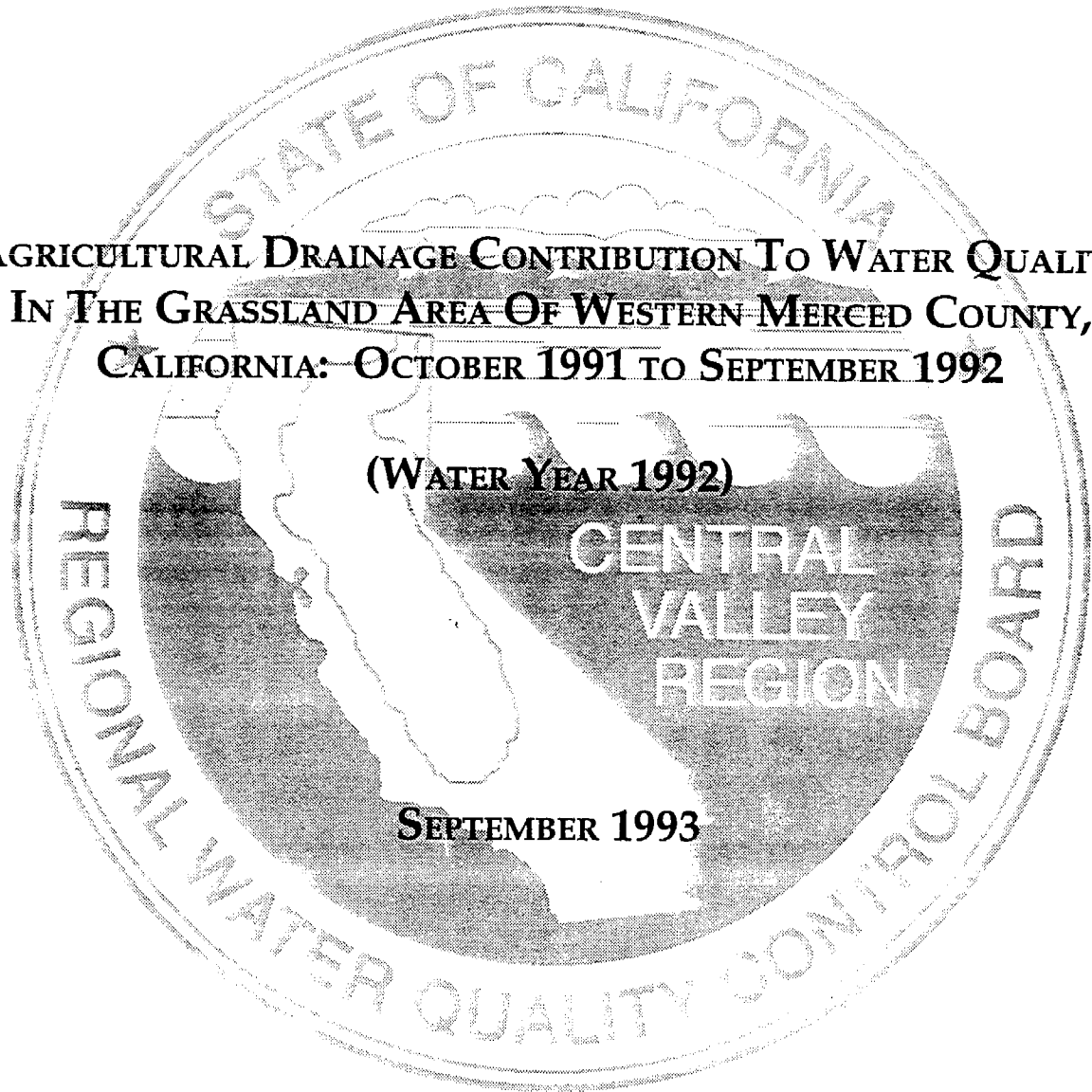
Staff Report of the
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

AGRICULTURAL DRAINAGE CONTRIBUTION TO WATER QUALITY
IN THE GRASSLAND AREA OF WESTERN MERCED COUNTY,
CALIFORNIA: OCTOBER 1991 TO SEPTEMBER 1992

(WATER YEAR 1992)

CENTRAL
VALLEY
REGION

SEPTEMBER 1993



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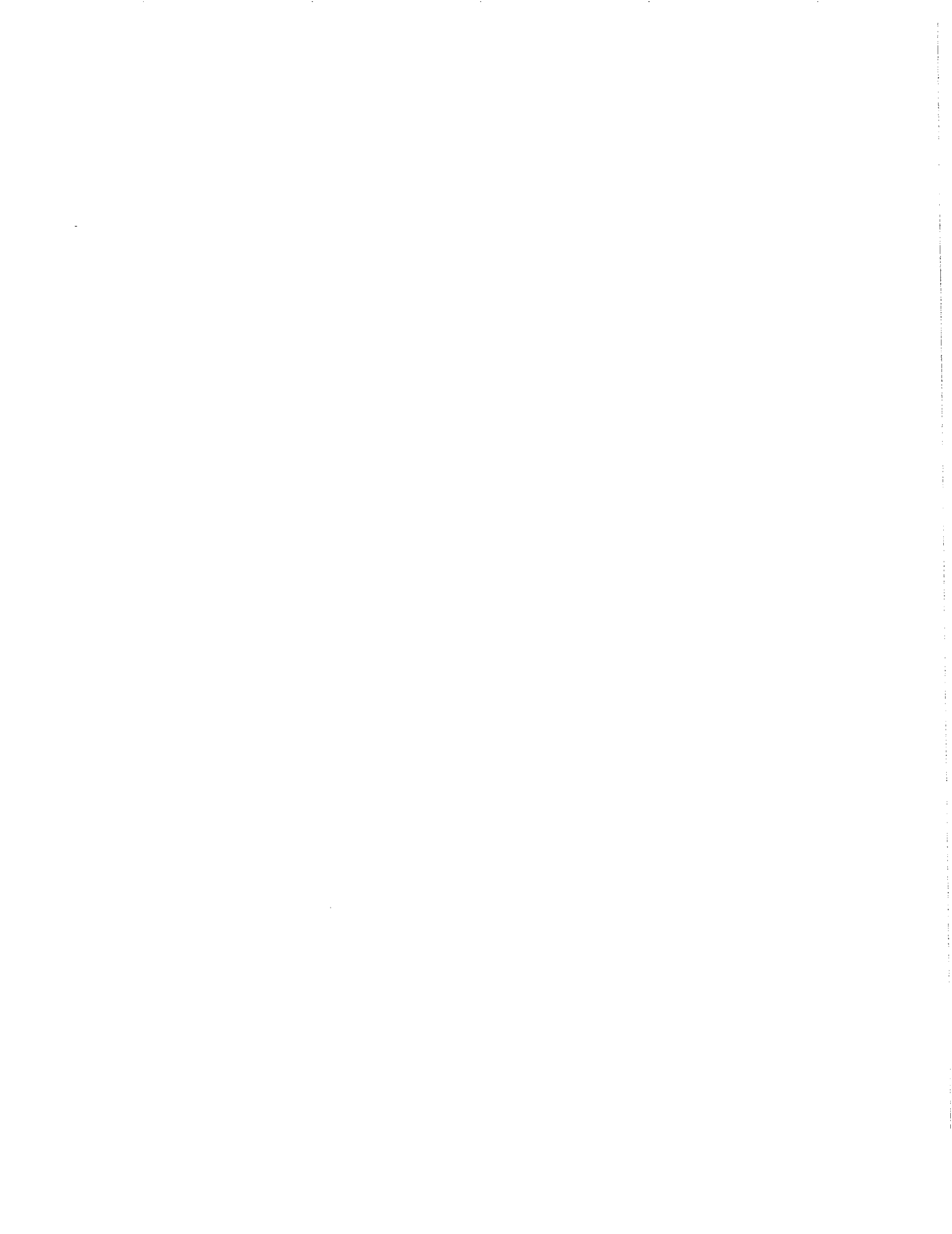
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EXECUTIVE SUMMARY AND RECOMMENDATIONS

In May 1985, Regional Board staff began a water quality monitoring program to evaluate the effects of subsurface agricultural drainage on the water quality of the drains in the Grassland Area of western Merced County. This database is used in the development and evaluation of future agricultural drainage reduction programs in the San Joaquin River Basin. Reports on this water quality survey have already been prepared and approved by the Board for May 1985 through September 1991. The current report covers October 1991 through September 1992, a critically dry Water Year.

Agricultural lands east, west, and south of the Grassland Area discharge subsurface agricultural drainage water (tile drainage) and surface runoff (irrigation tailwater) to the Grassland Area. This drainage often contains high concentrations of salts, selenium, and other trace elements. This regional drainage flows north through the Grassland Area where it is carried by a network of canals which can divert water in a number of possible ways before it reaches Mud Slough (north) or Salt Slough and ultimately the San Joaquin River.

As previous studies and this study show, the highest constituent concentrations are found at the inflow monitoring stations near the southern boundary of the study area. This inflow water is generally a blend of subsurface tile drainage and surface runoff or operational spills from irrigation canals. Four of these inflow points carry a substantial portion of subsurface drainage water that has the highest concentrations of salts, boron, and selenium. Other inflows contain little selenium; however, elevated levels of salt and boron are present.

Water quality objectives are established in the Regional Board's Basin Plan 5C¹ (State Water Resources Control Board, 1989) for selenium, boron, and molybdenum in Mud Slough (north) and Salt Slough. The Basin Plan selenium objective, which has a compliance date of October 1993, is 10 µg/L based on a monthly mean. The selenium levels in the sloughs vary depending on which slough is carrying drainage² from the drainage study area. The presence of drainage water in a slough results in selenium concentrations between 10 and 50 µg/L. In the absence of drainage water, selenium levels were always less than 5 µg/L and often less than 2 µg/L.

¹ The State Water Resources Control Board recently indicated that the Inland Surface Waters Plan 5 µg/L 4-day average concentration objective for selenium supersedes the Basin Plan objectives. Since data collection in Water Year 1992 was performed under the Basin Plan objectives and compliance schedule, only Basin Plan objectives will be considered in this report.

²The "drains" or "drainage water" will refer to the combined tail and tile water discharge from the following districts: Broadview W.D., the Camp 13 Study Area of Central California I.D.(CCID), Charleston D.D., Firebaugh Canal W.D., Pacheco W.D., and Panoche D.D.

The boron objective is 2.0 mg/L and the molybdenum objective is 19 µg/L for the sloughs based on a monthly mean. In contrast to selenium, boron and molybdenum levels remained above water quality objectives in Mud Slough (north) even in the absence of drainage water. Since boron and molybdenum levels appear naturally elevated in the Mud Slough (north), it is recommended that concentration based objectives for these constituents be eliminated or substantially revised. A load based objective may be a more appropriate standard to protect downstream beneficial uses.

In Salt Slough, the boron objective was exceeded when drainage water was present and objectives were met in the absence of drainage water. The molybdenum objective was met at all times.

An analysis of loads of selenium, boron, and salt from the sloughs indicates that significant reductions (45%-65%) have taken place since water year 1989. The reductions in mass loading have not lead to significant changes in annual concentration values (a 14% decrease to 25% increase). The limited impact of load reductions on slough water quality indicates the need for alternative strategies (besides drainage reduction) to meet objectives in the sloughs.

Selenium and boron concentrations will continue to be reviewed and analyzed in future water years.

INTRODUCTION

The Agricultural Unit of the Central Valley Regional Water Quality Control Board (Regional Board) initiated a water quality monitoring program in May of 1985 to evaluate the effects of subsurface agricultural drainage on the water quality of the drains in the Grassland Area in western Merced County. The study area is located west of the San Joaquin River between Newman and Oro Loma, California (Figure 1). The purpose of this monitoring program is to compile an on-going database for selected inorganic constituents found in the agricultural drains discharging to and flowing through the Grassland Area. This database is used in the development and evaluation of an agricultural drainage reduction program in the San Joaquin River Basin. This report contains laboratory results and a brief summary of the water quality analysis for samples collected from October 1991 through September 1992. Five previous reports (James, et al., 1988, Chilcott, et al., 1989, Westcot, et al., 1990, Westcot, et al., 1991 and Westcot, et al., 1992) present data for the period May 1985 through September 1991.

STUDY AREA

The Grassland Area is composed of the Northern and Southern Divisions of the Grassland Water District and the farmlands adjacent to the District (Figure 1). Land in this area is primarily used for agriculture and wetlands for wildlife.

Agricultural lands east, west, and south of the Grassland Area discharge subsurface agricultural drainage water (tile drainage) and surface runoff (irrigation tailwater) to the Grassland Area. This drainage often contains high concentrations of salts, selenium, and other trace elements. This regional drainage flows north through the Grassland Area where it is carried by a network of canals that can divert water in several possible ways before it reaches Mud Slough (north) or Salt Slough and ultimately the San Joaquin River.

There were 32 stations in the Grassland monitoring program as described by James, et al., 1988. They were divided into three categories: inflows to, internal flows within, and outflows from the Grassland Area. Inflow monitoring stations were located on drains that discharge into the Grassland area and are mainly located at the southern end of the study area. Monitoring stations on the internal flow canals were located on drains within the Grassland Area that carry or could carry subsurface tile drainage as it passes through the area before discharging to the San Joaquin River. Outflow monitoring stations were located where drains or natural waterways flow out of the Grassland Area. Many of the internal flow stations described by James, et al. (1988), have been dropped from the monitoring program. The present report concentrates on the inflow and outflow stations. A list of the monitoring stations is shown in Table 1. Stations that have continuous data from May 1985 through September 1992 have been highlighted. The remaining stations were dropped from the monitoring program prior to October 1989. In this study, there are 11 inflow, two internal flow and five outflow monitoring stations. The two internal flow stations are maintained to assess the approximate concentration of selenium in the two main water supply canals to the

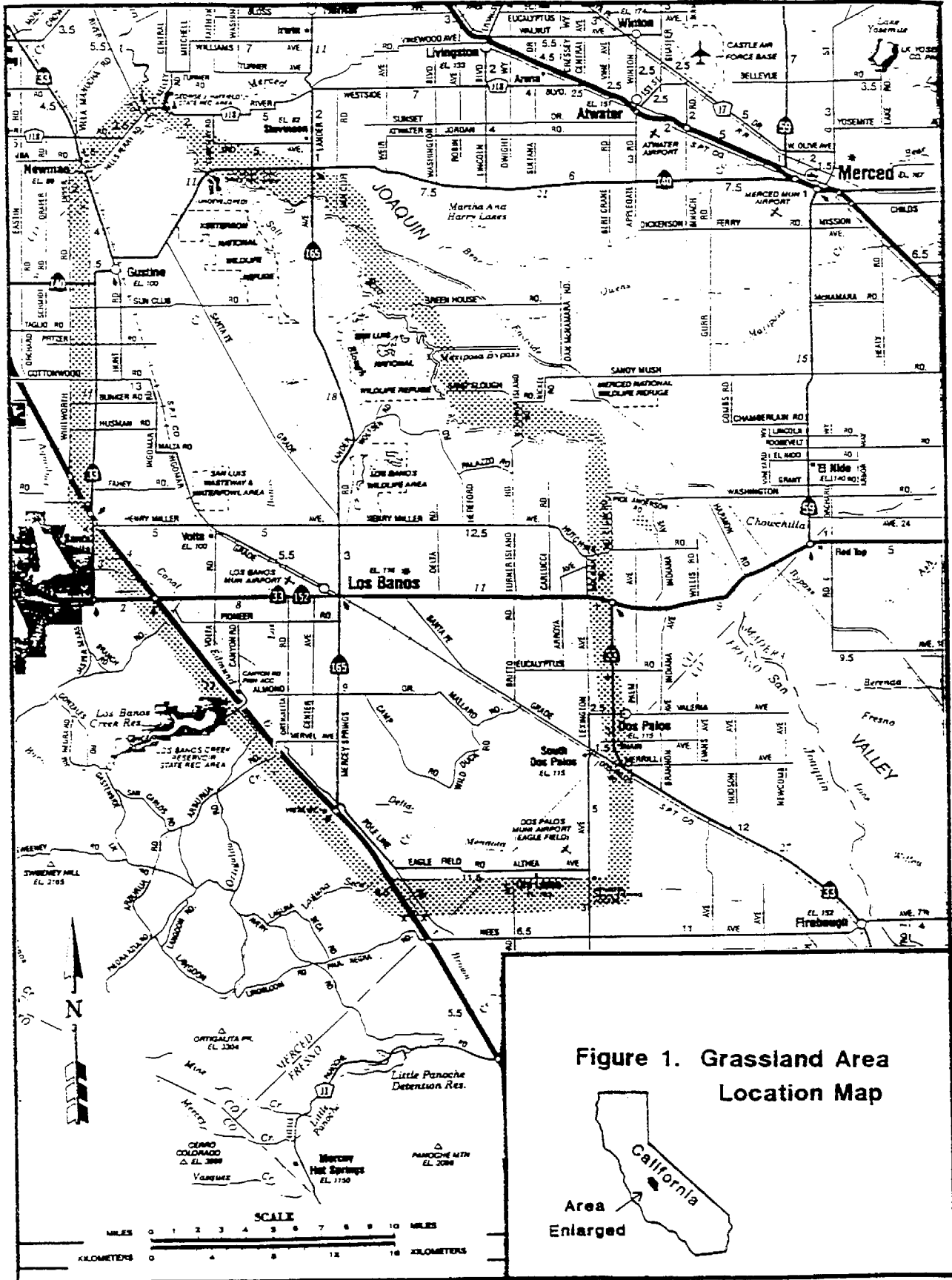


Figure 1. Grassland Area Location Map



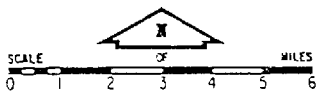
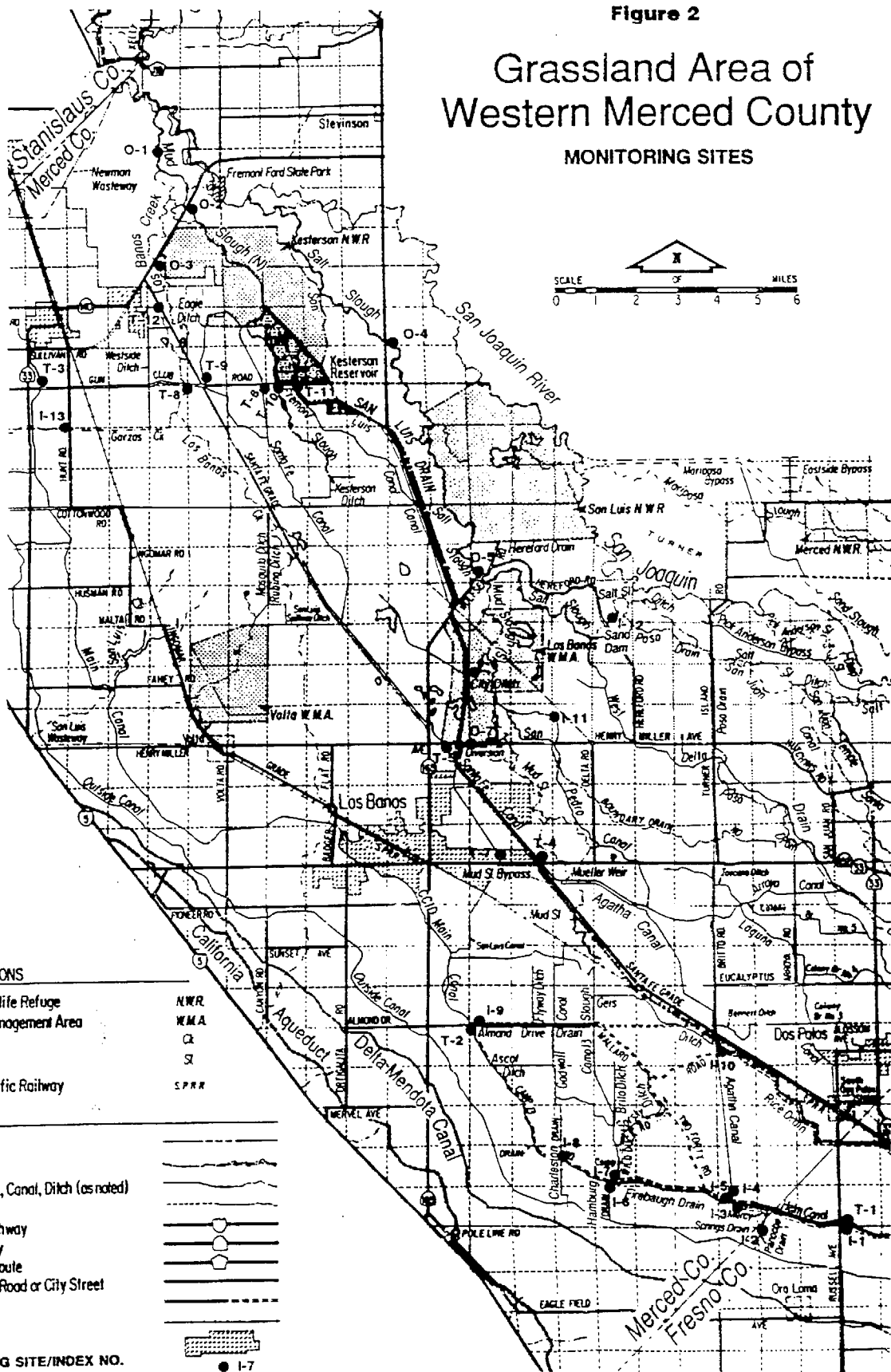
Table 1

Water Quality Monitoring Sites in the Grassland Area
(adapted from James et al., 1988, and Chilcott et al., 1989).

Map Index	RWQCB Site I.D.	Site Name	Site Type
I-1	MER556	Main (Firebaugh) Drain @ Russell	Inflow
I-2	MER501	Panoche Drain	Inflow
I-3	MER552	Agatha Inlet (Mercy Springs) Drain	Inflow
I-4	MER506	Agatha Canal	Inflow
I-5	MER507	Helm Canal	Inflow
I-6	MER504	Hamburg Drain	Inflow
I-7	MER505	Camp 13 Slough	Inflow
I-8	MER502	Charleston Drain	Inflow
I-9	MER555	Almond Drive Drain	Inflow
I-10	MER509	Rice Drain	Inflow
I-11	MER521	Boundary Drain	Inflow
I-12	MER528	Salt Slough Ditch @ Hereford Road	Inflow
I-13	MER513	Garzas Creek @ Hunt Road	Inflow
T-1	MER510	CCID Main @ Russell Avenue	Internal Flow
T-2	MER511	CCID Main @ Almond Drive	Internal Flow
T-3	MER512	CCID Main @ Gun Club Road	Internal Flow
T-4	MER540	Santa Fe Canal @ HWY 152	Internal Flow
T-5	MER519	Santa Fe Canal @ Henry Miller Rd.	Internal Flow
T-6	MER517	Santa Fe Canal @ Gun Club Rd.	Internal Flow
T-7	MER527	San Luis Canal @ HWY 152	Internal Flow
T-8	MER514	Los Banos Creek @ Gun Club Rd.	Internal Flow
T-9	MER518	Eagle Ditch	Internal Flow
T-10	MER516	Mud Slough (North) @ Gun Club Rd.	Internal Flow
T-11	MER515	Freemont Canal @ Gun Club Rd.	Internal Flow
T-12	MER553	Gustine Sewage Treatment Plant Ditch	Internal Flow
O-1	MER551	Mud Slough (N) @ Newman Gun Club	Outflow
O-2	MER541	Mud Slough (N) @ HWY 140	Outflow
O-2A	MER542	Mud Slough (N) @ San Luis Drain	Outflow
O-3	MER554	Los Banos Creek @ HWY 140	Outflow
O-4	MER531	Salt Slough @ Lander Avenue	Outflow
O-5	MER530	Salt Slough @ Wolfsen Road	Outflow
O-6	MER543	City Ditch	Outflow
O-7	MER548	Santa Fe Canal-Mud Slough Diversion	Outflow

Bold print indicates that site has data for WY 92

Figure 2
Grassland Area of
Western Merced County
MONITORING SITES



ABBREVIATIONS

- National Wildlife Refuge NWR
- Waterfowl Management Area WMA
- Creek CR
- Slough SL
- Southern Pacific Railway SPRR

LEGEND

- County Line
- River
- Creek, Slough, Canal, Ditch (as noted)
- Drain
- Interstate Highway
- State Highway
- County Sign Route
- Major County Road or City Street
- Other Roads
- Railroad
- City, Town
- MONITORING SITE/INDEX NO. ● I-7

Grasslands Area. Table 1 also identifies the map index number for each site as shown on the location map in Figure 2.

One inflow monitoring site was relocated in July, 1992. The Agatha canal near Helm canal site was relocated to near Mallard Road. The Mallard site is more accessible to the Agatha and water quality should not differ significantly between the two sites.

METHODS

The frequency of sample collection for this monitoring program consisted of grab samples that were collected both weekly and monthly. Water temperature, pH, electrical conductivity (EC), and sample time were recorded in the field for each site. There were 12 sites sampled weekly and an additional six sites sampled monthly. Laboratory analyses for total recoverable selenium, boron and electrical conductivity (EC)³ were performed on all samples. Selected sites were also monitored for copper, chromium, nickel, lead, zinc and molybdenum. Samples were collected in polyethylene bottles. The selenium and trace element sample bottles were acid washed and rinsed with de-ionized water in the laboratory before use. All sample bottles were rinsed three times with the water to be sampled prior to sample collection. Selenium and trace element samples were preserved by lowering the pH to less than two using ultra-pure nitric acid fixation techniques. All samples were kept on ice until preservation or submittal to the laboratory.

A quality control and quality assurance program was conducted using spike and duplicate samples in the laboratory. In addition, blind replicate samples were collected at 10 percent of the sites, and 50 percent of the blind replicates were spiked for laboratory quality assurance. Reported results fall within quality assurance tolerance guidelines outlined in Table 2.

LOAD CALCULATION

The loads and flow weighted concentrations were calculated for selenium, boron and salt for Mud and Salt Sloughs and the total from the drains. Loads for selenium and boron were calculated in pounds and salt was calculated in tons. The flow weighted concentrations for salt and boron were calculated in units of mg/l and selenium was calculated in units of µg/l. The drains used in the load calculation were the following: Firebaugh Main drain (includes Broadview, CCID, Firebaugh), Panoche drain, Charleston drain and Hamburg drain (Pacheco). The total load from the drains were the summation of Main, Panoche, Charleston, and Hamburg drain loads minus the drainage water mixed with CCID supply water. A portion of the drain water mixed into CCID's supply canal (which is not sampled) is also routed to the Camp 13 ditch (which is sampled); therefore, when the drain water is mixed into CCID's supply canal, then its quality can be assumed to be the same as the drain water in Camp 13 ditch.

³ Electrical conductivity values reported in the Appendices are laboratory EC values.

TABLE 2

Quality Assurance Tolerance Guidelines

Constituent	Recovery Range at Low Levels ($\mu\text{g/L}$)*	Acceptable Blind Duplicate Spike Recovery Range
Copper	1-20 +/- 5	> 20 70-130%
Chromium	1-20 +/- 5	> 20 70-130%
Lead	5-25 +/- 8	> 25 60-140%
Molybdenum	1	90-110%
Nickel	5-25 +/- 6	>25 65-135%
Selenium	0.2	90-110%
Zinc	1-20 +/- 6	> 20 70-130%
Boron	50	85-115%
Chloride	5000	85-115%

* For certain constituents, recovery is expressed as an absolute value rather than a percentage at low levels. For example, if the result of copper analysis for a particular sample is 10 $\mu\text{g/L}$, a duplicate analysis must fall between 5 $\mu\text{g/L}$ and 15 $\mu\text{g/L}$. If the sample is greater than 20 $\mu\text{g/L}$, recovery is expressed as a percent and must be between 70% and 130%. If a recovery range is not shown at low levels, the detection limit is given.

The data used in calculating the loads and flow weighted concentrations for both the Sloughs and drains, consisted of data from Summers Engineering, the Central Valley Regional Board, the United States Geological Survey (USGS), the United States Bureau of Reclamation and the Department of Water Resources. Even with these different data sources, some sites had limited data and the available data was averaged or extrapolated to fill in necessary information⁴.

In calculating the loads for Mud and Salt Slough, daily sample concentrations were multiplied by the daily flow rate (from the USGS) and a conversion factor to determine the daily loads of selenium, salt and boron. The average daily load for the month was multiplied by the number of days in the month to determine the monthly loads. Annual loads were calculated by summing the monthly loads.

⁴A more detailed discussion of the loading calculations will be presented in a future Regional Board report.

To determine the selenium, boron and salt loads for the drains, monthly average concentrations were first calculated, since daily flow records were not available for all drains. Then the monthly average concentration was multiplied by the monthly flow and a conversion factor to determine the monthly load. The annual load was calculated by summing all monthly loads.

Since salt concentration is generally represented by electrical conductivity, a conversion from EC to total dissolved solids was used (see Table 3). The ratios in the table were developed from USGS (Shelton and Miller, 1988, 1991) and Regional Board reports.

To find the annual flow weighted concentration, the calculated annual loads were divided by the annual flow of water. The annual flow of water for the drains was calculated by adding up the monthly flow data available. Mud and Salt Slough annual (for 1992) flows were found by summing the daily flow data.

TABLE 3

TDS/EC Ratios for Selected Sites

Site	TDS/EC Ratio	Number of Points
Mud Slough @ SLD	0.675	44
Salt Slough @ Lander	0.656	81
Firebaugh (Main) Drain @ Russell	0.708	11
Panoche Drain	0.718	16
Hamburg Drain	0.784	19
Charleston Drain	0.743	11
Camp 13 Ditch	0.761	7

RESULTS

Following the trend found in other WYs, the highest concentrations of the measured constituents were found at the inflow monitoring stations near the southern boundary of the study area. The internal flow stations carried supply water which had the lowest measured constituent concentrations. Constituent concentrations of outflow monitoring stations varied depending on whether the channel carried drainage water from the study area. Water quality analysis results at the inflow, internal flow, and outflow monitoring stations will be discussed separately.

Water quality results for both minerals and trace elements are listed by site in Appendices A through C; Grassland inflows (Appendix A), internal flows (Appendix B), and outflows

(Appendix C). The ranges, mean and median values for each measured constituent at each site are also shown in these appendices. For this study, electrical conductivity (EC) represented relative salinity; while boron, chloride, and sulfate were the primary mineral constituents of concern. Selenium and molybdenum were the primary trace elements of concern. The median mineral and trace element values at each inflow monitoring station are listed in Table 4 for WY 92.

Minerals

Inflow Monitoring Stations:

The inflow monitoring stations represent the quality of the agricultural drainage entering the Grassland Area. The first nine monitoring stations (I-1 to I-4, I-6 to I-10) listed in Table 1 represent inflow into the South Grassland Area. The remaining three inflow stations (I-11 to I-13) either discharge to sloughs or the North Grassland Area (Figure 2).

Continuing the trend found in previous WYs, the inflows that carry a substantial portion of subsurface drainage water, Main (Firebaugh) (I-1), Panoche (I-2), Agatha Inlet (Mercy Springs) (I-3), Hamburg (I-6), and Charleston Drains (I-8), had elevated salinity levels. Hamburg Drain had the highest median EC (5090 $\mu\text{mhos/cm}$), chloride (725 mg/L), hardness (1580 mg/L) and sulfate (1580 mg/L) values. Panoche drain had the highest median boron (8.0 mg/L) value.

Internal Flow Monitoring Stations:

The internal flow monitoring stations were monitored at points in which most of the water in the canal was supply water that could enter the Grasslands Water District. Only two of the original internal flow monitoring stations, the CCID Main at Russell Avenue (T-1) and the San Luis Canal at Highway 152 (T-7), were monitored during WY 92. The median EC, boron, chloride, and sulfate values recorded during this study for each of the internal flow monitoring stations are listed in Table 4.

Outflow Monitoring Stations:

Mud Slough (north) and Salt Slough are the only two tributaries to the San Joaquin River which drain the Grassland Area and are described in detail by James, et al. (1988), Pierson, et al. (1989a and 1989b). Mud Slough (north) at the San Luis Drain (0-2A) and Salt Slough at Lander Avenue (0-4) are the principal stations in this monitoring program. These two sites best represent the water quality of the drainage leaving the Grassland Area. Los Banos Creek at HWY 140 (0-3) drains into Mud Slough (north) upstream of the San Joaquin River. Mud Slough at Newman Gun Club (0-1) represents the combined quality of Mud Slough (north) and Los Banos Creek.

Table 4

Median Constituent Concentrations for Grassland Area Canals & Streams: Water Years 1985-1992.

(Data for WY's 85, 86, and 87 from James et al., 1988, for WY 88 from Chilcott et al., 1989, and for WY's 89, 90, and 91 from Westcot et al., 1990, 1991, and 1992).

Map ID	Monitoring Site Water Year	umhos/cm EC	Median Constituent Concentrations														
			B	Cl	SO4	Se	Mo	Cr	Cu	Ni	Pb	Zn	U	V			
			-----mg/L-----			-----ug/L-----											
I-1	Main (Firebaugh) Drain @ Russell																
	Dry WY 85	2400	3.2	230	693	35	--	--	--	--	--	--	--	--	--	--	--
	Wet WY 86	2700	3.5	250	900	46	14	16	9	27	--	14	--	--	--	--	--
	Critical WY 87	2600	3.4	270	630	42	9	19	9	22	--	28	--	--	--	--	--
	Critical WY 88	3000	3.6	320	790	49	10	22	12	22	<5	29	--	--	--	--	--
	Critical WY 89	2980	3.9	315	835	49	13	17	9	19	<5	23	--	--	--	--	--
	Critical WY 90	3400	4.6	370	1200	52	24	10	5	11	<5	13	--	--	--	--	--
	Critical WY 91	3450	4.6	440	1400	52	21	10	23	<5	21	18	16	12	--	--	--
Critical WY 92	3700	5.2	319	849	59	28	14	8	17	<5	18	--	--	--	--	--	
I-2	Panoche Drain/O'Banion																
	Dry WY 85	3500	6.5	460	985	38	3	--	--	--	--	--	--	--	--	--	--
	Wet WY 86	3400	5.8	390	800	56	6.1	26	5.5	15	--	15	--	--	--	--	--
	Critical WY 87	4375	7.8	550	1075	47	2.5	40	10	13	--	18	--	--	--	--	--
	Critical WY 88	3650	6.4	440	890	54	3	43	12	21	<5	29	--	--	--	--	--
	Critical WY 89	4180	6.5	520	1000	69	6	32	5	8.0	<5	11	--	--	--	--	--
	Critical WY 90	4550	7.5	665	1400	72	8	32	4	9	<5	10	--	--	--	--	--
	Critical WY 91	4450	7.5	620	1300	64	8	3	20	<5	7	7	11	7	--	--	--
Critical WY 92	4870	8.0	655	1490	82	11	16	2.7	<5	<5	6	--	--	--	--	--	
I-3	Mercy Springs Drain (Agatha Inlet Drain)																
	Dry WY 85	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Wet WY 86	3300	7.2	360	1000	14	10	7	5	13	--	10	--	--	--	--	--
	Critical WY 87	3125	7.0	302	800	6	16	5	3	7	--	3	--	--	--	--	--
	Critical WY 88	4150	8.6	540	1300	7.9	39	10	5	15	<5	12	--	--	--	--	--
	Critical WY 89	3655	7.6	435	895	6.7	--	--	--	--	--	--	--	--	--	--	--
	Critical WY 90	4910	8.4	640	1400	7.9	--	--	--	--	--	--	--	--	--	--	--
	Critical WY 91	3770	6.4	655	1095	4.7	--	--	--	--	--	--	--	--	--	--	--
Critical WY 92	4470	7.4	600	1280	7.8	--	--	--	--	--	--	--	--	--	--	--	
I-4	Agatha Canal																
	Dry WY 85	2600	4.9	315	1100	26	1	--	--	--	--	--	--	--	--	--	--
	Wet WY 86	3300	5.6	400	900	44	<5	13	9	21	--	16	--	--	--	--	--
	Critical WY 87	3305	5.6	410	760	38	6	22	7	12	--	12	--	--	--	--	--
	Critical WY 88	3550	5.6	430	895	39	3	--	--	--	--	--	--	--	--	--	--
	Critical WY 89	880	0.36	130	100	2.9	2	--	--	--	--	--	--	--	--	--	--
	Critical WY 90	4040	6.6	480	1100	26	8	--	--	--	--	--	--	--	--	--	--
	Critical WY 91	4295	6.6	515	1100	53	9	--	--	--	--	--	--	--	--	--	--
Critical WY 92	3440	5.6	378	726	31	9	--	--	--	--	--	--	--	--	--	--	
I-6	Hamburg Drain																
	Dry WY 85	3200	3.8	435	900	47	6	--	--	--	--	--	--	--	--	--	--
	Wet WY 86	3250	4.0	400	1000	51	4	13	5	10	--	13	--	--	--	--	--
	Critical WY 87	3345	3.7	420	925	58	<5	17	5	8	--	10	--	--	--	--	--
	Critical WY 88	3600	4.1	450	1050	56	4.5	11	5	<5	<5	6	--	--	--	--	--
	Critical WY 89	5120	5.7	660	1500	95	5	16	2	<5	<5	6	--	--	--	--	--
	Critical WY 90	4740	5.4	720	1400	84	5	14	1	<5	<5	6	--	--	--	--	--
	Critical WY 91	5540	5.6	730	1675	99	7	1	11	1	<5	<5	19	6	--	--	--
Critical WY 92	5090	5.2	725	1580	86	9	20	9	13	<5	18	--	--	--	--	--	

Table 4 (continued)

Median Constituent Concentrations for Grassland Area Canals & Streams: Water Years 1985-1992.
 (Data for WY's 85, 86, and 87 from James et al., 1988, for WY 88 from Chilcott et. al., 1989, and for WY's 89, 90, and 91 from Westcot et al., 1990, 1991, and 1992).

Map ID	Monitoring Site Water Year	umhos/cm EC	Median Constituent Concentrations												
			B	Cl	SO ₄	Se	Mo	Cr	Cu	Ni	Pb	Zn	U	V	
			-----mg/L-----			-----ug/L-----									
I-7	Camp 13 Slough														
	Dry WY 85	2550	3.4	280	745	32	4	--	--	--	--	--	--	--	
	Wet WY 86	2950	3.9	375	905	43	<5	14	7	20	--	16	--	--	
	Critical WY 87	2650	3.7	280	590	43	6	30	11	13	--	19	--	--	
	Critical WY 88	4400	6.2	500	1050	43	4	--	--	--	--	--	--	--	
	Critical WY 89	3750	5.2	440	940	59	8	--	--	--	--	--	--	--	
	Critical WY 90	3440	4.9	455	1010	54	9	--	--	--	--	--	--	--	
	Critical WY 91	3960	5.5	560	1300	55	21	--	--	--	--	--	--	--	
	Critical WY 92	4130	5.5	492	1240	64	11	--	--	--	--	--	--	--	
I-8	Charleston Drain														
	Dry WY 85	3900	2.6	395	1275	48	--	--	--	--	--	--	--	--	
	Wet WY 86	4500	4.7	510	1580	93	7.9	9	10	14	--	18	--	--	
	Critical WY 87	3855	4.2	480	1035	79	2	32	12	22	--	50	--	--	
	Critical WY 88	4450	4.5	520	1300	71	3	31	13	27	--	47	--	--	
	Critical WY 89	4400	3.8	520	1400	66	3	25	12	17	<5	33	--	--	
	Critical WY 90	4350	3.7	525	1400	69	6	14	3	8	<5	17	--	--	
	Critical WY 91	4370	4.2	645	1700	60	8	3	10	<5	7	11	20	--	
	Critical WY 92	4283	4.3	609	1300	66	8	10	7	9	<5	21	--	--	
I-9	Almond Drive Drain														
	Dry WY 85	1520	1.6	160	340	2	--	--	--	--	--	--	--	--	
	Wet WY 86	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Critical WY 87	1925	2.1	224	395	4.8	4.5	28	11	21	--	25	--	--	
	Critical WY 88	2300	2.1	230	460	4.6	--	18	7	13	--	15	--	--	
	Critical WY 89	2160	2.2	190	420	3.7	--	--	--	--	--	--	--	--	
	Critical WY 90	1320	0.91	155	220	2.3	--	--	--	--	--	--	--	--	
	Critical WY 91	1415	1	200	250	2.9	--	--	--	--	--	--	--	--	
	Critical WY 92	1670	1.5	220	320	2.2	--	--	--	--	--	--	--	--	
I-10	Rice Drain														
	Dry WY 85	2450	5.7	245	715	2.5	--	--	--	--	--	--	--	--	
	Wet WY 86	3300	8.1	350	1080	3	14	5	6	23	--	13	--	--	
	Critical WY 87	2500	6.1	260	550	2.6	11	3	3	6	--	<1	--	--	
	Critical WY 88	2790	5.1	310	700	2.6	15	--	--	--	--	--	--	--	
	Critical WY 89	2745	5.4	280	673	3.1	14	--	--	--	--	--	--	--	
	Critical WY 90	3050	5.4	350	855	2.7	16	--	--	--	--	--	--	--	
	Critical WY 91	2640	4.7	420	1145	2.6	22	--	--	--	--	--	--	--	
	Critical WY 92	3000	5.9	400	868	3.4	20	--	--	--	--	--	--	--	
I-11	Boundary Drain														
	Dry WY 85	1090	0.45	195	135	1	--	--	--	--	--	--	--	--	
	Wet WY 86	1710	0.65	250	210	1	6	2	7	9	--	14	--	--	
	Critical WY 87	1250	0.54	200	145	1.6	4	<1	2	<5	--	3	--	--	
	Critical WY 88	1470	0.50	230	180	1.4	6	--	--	--	--	--	--	--	
	Critical WY 89	1435	0.53	240	190	1.0	--	--	--	--	--	--	--	--	
	Critical WY 90	1500	0.44	250	175	0.9	--	--	--	--	--	--	--	--	
	Critical WY 91	1420	0.44	233	175	0.8	--	--	--	--	--	--	--	--	
	Critical WY 92	1330	0.48	237	164	0.8	--	--	--	--	--	--	--	--	

Table 4 (continued)

Median Constituent Concentrations for Grassland Area Canals & Streams: Water Years 1985-1992.

(Data for WY's 85, 86, and 87 from James et al., 1988, for WY 88 from Chilcott et. al., 1989, and for WY's 89, 90, and 91 from Westcot et al., 1990, 1991, and 1992).

Map ID	Monitoring Site Water Year	umhos/cm EC	Median Constituent Concentrations															
			B	Cl	SO4	Se	Mo	Cr	Cu	Ni	Pb	Zn	U	V				
			-----mg/L-----			-----ug/L-----												
I-12	Salt Slough @ Hereford																	
	Dry WY 85	850	0.37	120	100	1	--	--	--	--	--	--	--	--	--	--	--	
	Wet WY 86	785	0.33	100	99	1	<5	3	5	9	--	22	--	--	--	--	--	
	Critical WY 87	1000	0.39	130	120	1.4	3	1	2	<5	--	2	--	--	--	--	--	
	Critical WY 88	1150	0.38	160	140	1.2	5	--	--	--	--	--	--	--	--	--	--	
	Critical WY 89	1070	0.36	160	140	1.2	--	--	--	--	--	--	--	--	--	--	--	--
	Critical WY 90	1030	0.30	160	110	0.6	--	--	--	--	--	--	--	--	--	--	--	--
	Critical WY 91	1045	0.30	180	130	0.9	--	--	--	--	--	--	--	--	--	--	--	--
	Critical WY 92	1140	0.37	180	125	1.0	--	--	--	--	--	--	--	--	--	--	--	
T-1	CCID Main Canal																	
	Dry WY 85	430	0.21	72	35	<1	--	--	--	--	--	--	--	--	--	--	--	
	Wet WY 86	385	0.21	53	47	1.3	<5	3	3	5	--	8	--	--	--	--	--	
	Critical WY 87	570	0.28	65	58	2.2	<5	1	3	<5	--	3	--	--	--	--	--	
	Critical WY 88	760	0.29	120	65	1.7	--	--	--	--	--	--	--	--	--	--	--	--
	Critical WY 89	700	0.26	94	68	1.7	--	--	--	--	--	--	--	--	--	--	--	--
	Critical WY 90	680	0.32	120	93	2.3	--	--	--	--	--	--	--	--	--	--	--	--
	Critical WY 91	710	0.27	135	86	1.5	--	--	--	--	--	--	--	--	--	--	--	--
	Critical WY 92	800	0.38	130	110	2.0	--	--	--	--	--	--	--	--	--	--	--	
T-7	San Luis Canal/Hwy 152																	
	Dry WY 85	1550	1.4	180	295	4.5	--	--	--	--	--	--	--	--	--	--	--	
	Wet WY 86	1200	1.4	130	200	2	<5	4	4	10	--	9	--	--	--	--	--	
	Critical WY 87	2630	3.4	260	520	4	<5	3	3	<5	--	7	--	--	--	--	--	
	Critical WY 88	2550	3.6	280	570	3.9	--	--	--	--	<5	--	--	--	--	--	--	
	Critical WY 89	1045	0.76	135	140	2.5	--	--	--	--	--	--	--	--	--	--	--	
	Critical WY 90	1400	1.7	180	270	2.5	--	--	--	--	--	--	--	--	--	--	--	
	Critical WY 91	1625	1.6	260	455	2.6	--	--	--	--	--	--	--	--	--	--	--	--
	Critical WY 92	1030	0.60	170	240	1.7	--	--	--	--	--	--	--	--	--	--	--	
O-1	Mud Slough @ NGC																	
	Dry WY 85	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
	Wet WY 86	1800	2.0	215	330	4	5	9	5	11	--	15	--	--	--	--	--	
	Critical WY 87	2600	2.4	300	420	5.1	13	7	4	10	--	1	--	--	--	--	--	
	Critical WY 88	2480	2.2	330	440	4.7	--	--	--	--	--	--	--	--	--	--	--	
	Critical WY 89	2310	1.7	325	385	2.1	--	--	--	--	--	--	--	--	--	--	--	
	Critical WY 90	2480	2.1	335	510	4.3	10	--	--	--	--	--	--	--	--	--	--	
	Critical WY 91	3540	3.2	540	905	3.9	15	--	--	--	--	--	--	--	--	--	--	--
	Critical WY 92	3130	2.6	450	663	2.3	--	--	--	--	--	--	--	--	--	--	--	

Table 4 (continued)

Median Constituent Concentrations for Grassland Area Canals & Streams: Water Years 1985-1992.
 (Data for WY's 85, 86, and 87 from James et al., 1988, for WY 88 from Chilcott et al., 1989, and for WY's 89, 90, and 91 from Westcot et al., 1990, 1991, and 1992).

Map ID	Monitoring Site Water Year	umhos/cm EC	Median Constituent Concentrations											
			B	Cl	SO4	Se	Mo	Cr	Cu	Ni	Pb	Zn	U	V
			-----mg/L-----			-----ug/L-----								
O-2A	Mud Slough @ SLD													
	Dry WY 85	2600	3.1	305	525	13	--	--	--	--	--	--	--	--
	Wet WY 86	2300	3.0	280	630	8.5	8	6	5	14	--	11	--	--
	Critical WY 87	2600	3.0	320	540	17	9	12	9	11	--	7	--	--
	Critical WY 88	2820	2.7	350	510	9.3	11	--	--	--	--	--	--	--
	Critical WY 89	3000	2.4	425	480	2.1	11	10	4	<5	12	12	--	--
	Critical WY 90	3060	3.4	410	590	5.2	12	6	2	8	<5	7	--	--
	Critical WY 91	4030	4.4	640	1000	2.4	27	3	5	<5	6	5	7	10
Critical WY 92	3130	2.5	460	660	1.5	22	6	4	10	<5	8	--	--	
O-3	Los Banos Ck/HWY 140													
	Dry WY 85	--	--	--	--	--	--	--	--	--	--	--	--	--
	Wet WY 86	2200	2.3	430	300	1	<5	6	8	18	--	17	--	--
	Critical WY 87	1855	1.6	215	215	1.4	--	--	--	--	--	--	--	--
	Critical WY 88	1690	1.2	230	210	1.1	--	--	--	--	--	--	--	--
	Critical WY 89	1630	1.0	240	200	0.9	--	--	--	--	--	--	--	--
	Critical WY 90	1870	1.2	210	290	0.8	--	--	--	--	--	--	--	--
	Critical WY 91	2745	1.6	490	495	1	14	--	--	--	--	--	--	--
Critical WY 92	1500	1.4	--	--	1.1	--	--	--	--	--	--	--	--	
O-4	Salt Slough @ Lander													
	Dry WY 85	1250	0.96	185	195	4.5	--	--	--	--	--	--	--	--
	Wet WY 86	1610	1.3	240	245	7.4	7	4	6	12	--	18	--	--
	Critical WY 87	1720	1.7	250	350	12	6	6	4	6	--	4	--	--
	Critical WY 88	1940	1.9	260	385	13	6	--	--	--	--	--	--	--
	Critical WY 89	2040	1.9	270	430	15	6	13	6	1	12	18	--	--
	Critical WY 90	2340	2.3	340	525	15	7	10	4	9	<5	15	--	--
	Critical WY 91	2460	2	335	370	15	11	2	3	<5	<5	5	12	6
Critical WY 92	2420	2.1	400	445	13	11	6	3	8	<5	8	--	--	
O-6	City Ditch													
	Dry WY 85	2100	3.1	240	540	18	--	--	--	--	--	--	--	--
	Wet WY 86	2600	4.1	345	740	27	6	12	9	27	--	29	--	--
	Critical WY 87	3110	3.8	300	630	41	11	15	4	11	--	16	--	--
	Critical WY 88	3280	4.4	380	810	39	--	18	18	35	<5	52	--	--
	Critical WY 91	3550	5.1	400	950	41	--	--	--	--	--	--	--	--
Critical WY 92	3730	5.3	500	1000	39	--	--	--	--	--	--	--	--	

Water Years (WY) run from 1 October through 30 September.

During this study, Mud Slough (north) at the San Luis Drain (0-2A) had EC values ranging from 660 to 8670 $\mu\text{mhos/cm}$ with a median of 3130 $\mu\text{mhos/cm}$. Boron at this site ranged from 0.2 to 6.8 mg/L with a median value of 2.5 mg/L.

Salt Slough at Lander Avenue (0-4) is the last monitoring station before Salt Slough discharges to the San Joaquin River. Salt Slough at Lander Avenue had EC values ranging from 1110 to 3760 $\mu\text{mhos/cm}$ with a median value of 2420 $\mu\text{mhos/cm}$, and boron values ranging from 0.37 to 3.8 mg/L with a median of 2.1 mg/L (Appendix C). Concentrations at this site are generally lower than the South Grassland inflow monitoring stations due to additional dilution that occurs as the drainage water moves further downstream within the Grassland Area. Median concentrations for salinity and boron were lower in Salt Slough than in Mud Slough (north).

Trace Elements

Although selenium was monitored at every site and molybdenum at most sites, analyses of additional trace elements were limited based on the overall low concentrations found by James, et al. (1988). Total recoverable selenium, molybdenum, copper, chromium, lead, nickel, and zinc are listed in Appendices A through C for inflow, internal flow, and outflow monitoring stations, respectively. The ranges, mean and median concentrations for the trace elements measured at each station are also listed in these appendices. The median trace element concentrations at each station for WY 92 are tabulated in Table 4.

Inflow Monitoring Stations:

The highest median trace element concentrations occurred at the South Grassland inflow stations (I-1 to I-10), where the median selenium values ranged from 3.4 $\mu\text{g/L}$ at Rice Drain (I-10) to 86 $\mu\text{g/L}$ at Hamburg Drain (I-6). The Main (I-1), Panoche (I-2), Hamburg (I-6), and Charleston (I-8) Drains all had high median selenium concentrations. As with salinity and boron, the concentrations vary depending upon the amount of dilution water and quality of the tile water in the drain at the time of sampling. The combination of low water supply and higher irrigation efficiency led to a greater amount of tile water relative to tail water. Therefore, total recoverable selenium concentrations in drainage canals remain high. Concentrations in excess of 100 $\mu\text{g/L}$ have been found at the Main Drain (22% of the time), Charleston Drain (13%), Hamburg Drain (29%), and Panoche Drain (7%). These higher concentrations occurred throughout the year, indicating a lack of dilution (tail) water during both the irrigation and non-irrigation season. Inflow sites that carry drainage from Sierra Nevada deposits (Rice Drain, Boundary Drain and Salt Slough at Hereford) continue to contain the lowest median selenium concentrations.

The Main Drain (I-1) and Rice Drain (I-10) had the highest median molybdenum concentrations at 28 $\mu\text{g/L}$ and 20 $\mu\text{g/L}$, respectively. The remaining inflow drains had median molybdenum concentrations ranging from 8 $\mu\text{g/L}$ to 13 $\mu\text{g/L}$.

In addition to selenium and molybdenum, copper, chromium, nickel, lead, and zinc were analyzed at the four major subsurface drainage inflows (Main, Panoche, Hamburg and Charleston Drains). Based on the extreme hardness of the water from the inflow stations (median concentrations from 640 to 1650 mg/L), toxicity from copper, nickel, lead, and zinc is not expected (Marshack, 1993). Total recoverable chromium values were greater than the chronic toxicity value (11 µg/L) for hexavalent chromium at times. Since analyses do not include quantification of the different species of chromium for these sites, it is not known whether hexavalent chromium is high enough to cause toxicity.

Internal Flow Monitoring Stations:

Selenium was the only trace element measured at both internal flow monitoring stations. From October 1991 through September 1992, CCID Main Canal at Russell Avenue (T-1) had selenium concentrations ranging from 0.7 µg/L to 4.9 µg/L with a median concentration of 2.0 µg/L. During the same period, selenium concentrations at San Luis Canal at Hwy 152 (T-7) ranged from 0.6 µg/L to 3.6 µg/L with a median concentration of 1.7 µg/L.

Outflow Monitoring Stations:

Selenium was monitored at all five outflow stations, molybdenum was monitored at three stations (0-1, 0-2A and 0-4), and copper, chromium, nickel, lead, and zinc were monitored at two outflow stations (0-2A and 0-4) on a limited basis. The median trace element concentrations detected during this study are tabulated in Table 4.

The outflow monitoring stations, as mentioned earlier, are related to one of two tributaries of the San Joaquin River; the outflow through Salt Slough (site 0-4) and those that outflow through Mud Slough (north), (sites 0-1 through 0-3) as described in Table 1.

Selenium concentrations at the furthest downstream monitoring station on Salt Slough at Lander Avenue (0-4), ranged from 0.6 to 27 µg/L with a median of 13 µg/L.

Selenium concentrations at Mud Slough (north) at the San Luis Drain (0-2A) ranged from 0.4 to 50 µg/L with a median of 1.5 µg/L. Los Banos Creek flows into Mud Slough (north) downstream of the Mud Slough (north) monitoring station near the San Luis Drain. The creek, along with any groundwater seepage, can have a diluting effect on the Slough with respect to selenium, as measured at the Newman Land and Cattle Company station (0-1). Los Banos Creek receives its flow from the western portion of the North Grassland Area and from areas west of the study area. The creek receives little subsurface drainage. In WY 92, selenium concentrations range from 0.5 to 2.1 µg/L with a median of 1.1 µg/L at the Los Banos Creek at Highway 140 station (0-3). The downstream Mud Slough (north) station (0-1) had selenium concentrations ranging from 0.8 to 48 µg/L and a median of 2.3 µg/L. A t-test on the mean concentrations of selenium for Mud Slough (north) near the San Luis Drain and Mud Slough (north) at Newman Land and Cattle Company showed no significant difference

between the means. This indicates that during the times that Mud Slough (north) was carrying drainage water, flows from Los Banos Creek were inconsequential.

As is the case with the inflow stations, copper, nickel, lead, and zinc would not be expected to cause toxicity due to the high hardness of the water in the sloughs. Total recoverable chromium concentrations in the sloughs were all less than the chronic toxicity value of hexavalent chromium.

LOADS

Since 1989 flow weighted concentrations from the drains increased for the boron, selenium and salt while the respective loads decreased (Figures 3 - 5). The loads of boron and salt are higher in Mud and Salt Sloughs than from the drains; whereas, the normal selenium load from Mud and Salt Slough is lower than from the drains (Figure 5). Elevated selenium levels in groundwater are limited to the drainage study area in the Grasslands, but elevated levels of salt and boron are found throughout the Grasslands. When performing a mass balance between the drains and the sloughs, it would be expected that selenium loads would be approximately equal and boron and salt loads would be greater in the sloughs than the drains.

Since all agricultural drainage water in the study area drains to the sloughs, the smaller amount of selenium in the sloughs than the drains suggests that a selenium sink exists between the drainage discharge points and slough monitoring points. Lawrence Berkeley Laboratories is currently under contract with the Bureau of Reclamation to try to determine the mechanism of this sink (N. Quinn, LBL, personal communication).

The mechanism(s) of the sink (eg. seepage from canals) may also effect boron and salt. Since significant loads of these two constituents originate from outside of the drainage study area (i.e. from wetlands and other agricultural lands), the sink would not be readily apparent when comparing loads from the sloughs with loads from the drains.

DISCUSSION

WY 1992 was the sixth consecutive critical water year and the second consecutive year of a 75% water allocation for the exchange contractors (Firebaugh Canal W.D. and CCID) and 25% water allocation for the Federal contractors (Broadview W.D., Charleston D.D., Pacheco W.D., and Panoche D.D.).

The combined effects of reduced water supply and improved on-farm irrigation practices can be seen in Figures 3-5 and Table 5. Since WY 1989⁵, significant (41% to 45%) load reductions from the drainers have occurred. At the same time, constituent concentrations have increased (22% - 29%). The increased constituent concentrations are likely due to the

⁵WY 89 was chosen as a base year, since Drainage Operation Plans and the implementation of best management practices were required by the Basin Plan 5C beginning in calendar year 1990.

Annual Salt Loads and Concentrations for the Drainers & Sloughs

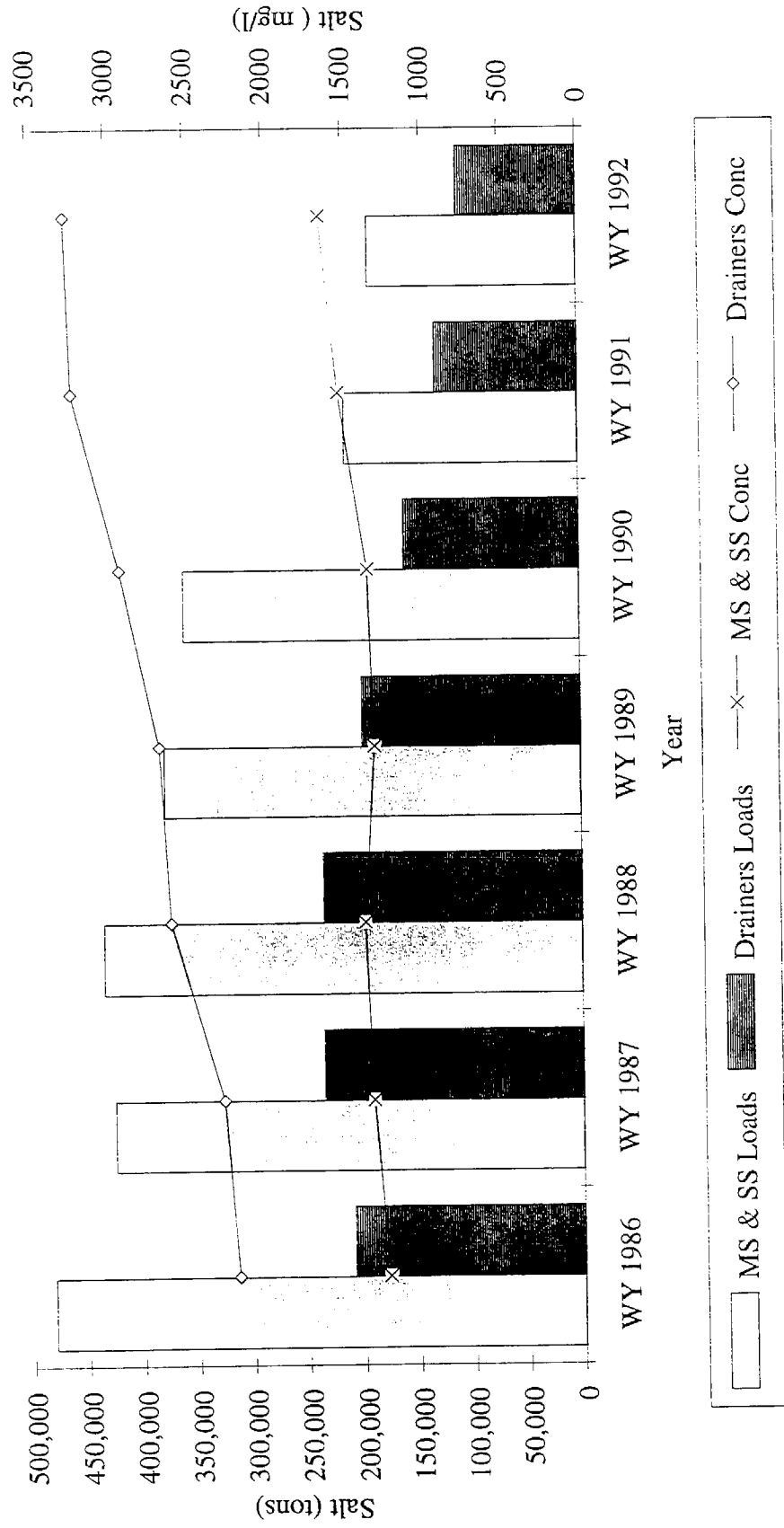


Figure 3

Annual Boron Loads and Concentrations for the Drainers & Sloughs

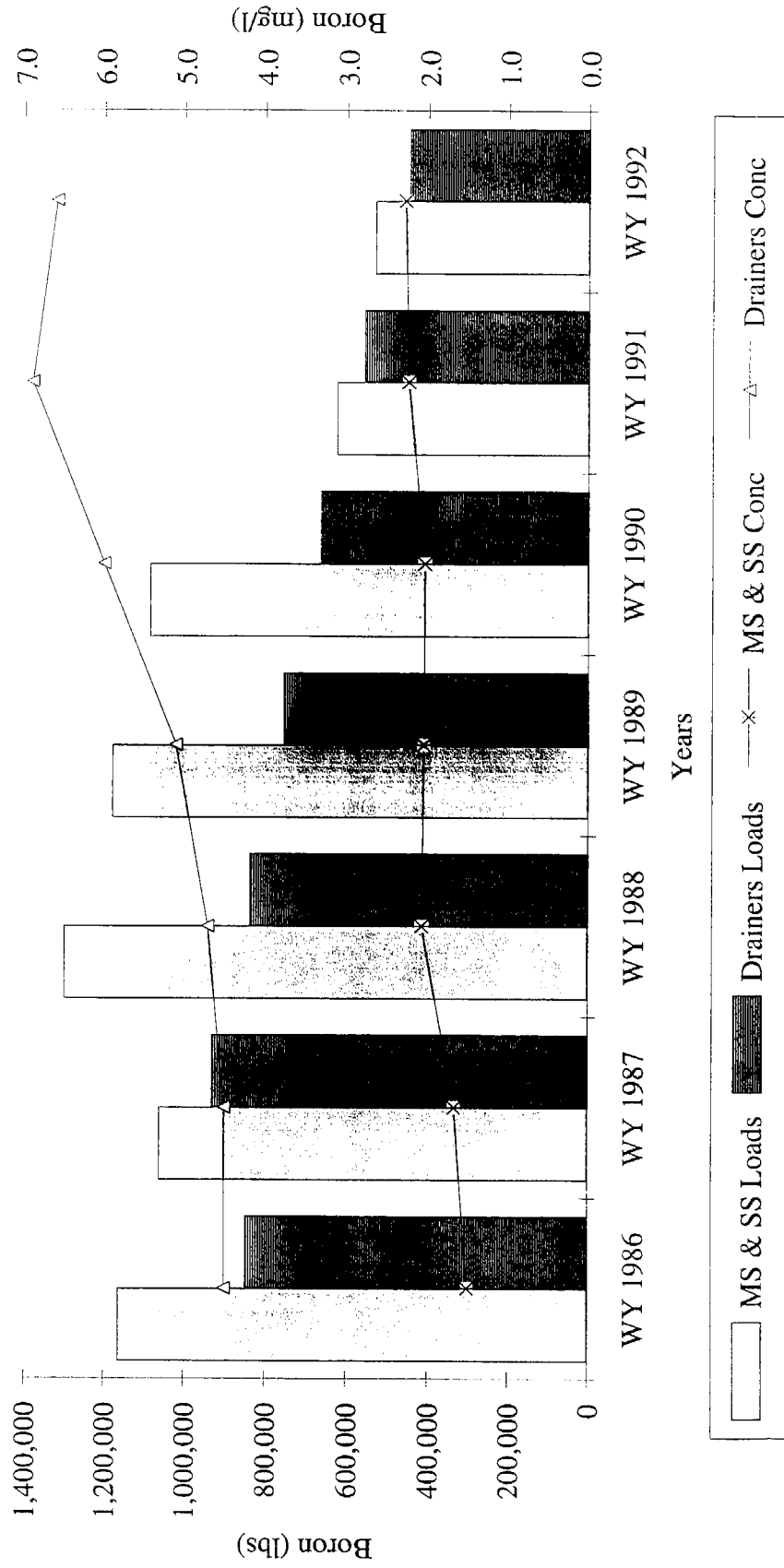


Figure 4

Annual Selenium Loads and Concentrations for the Drainers and Sloughs

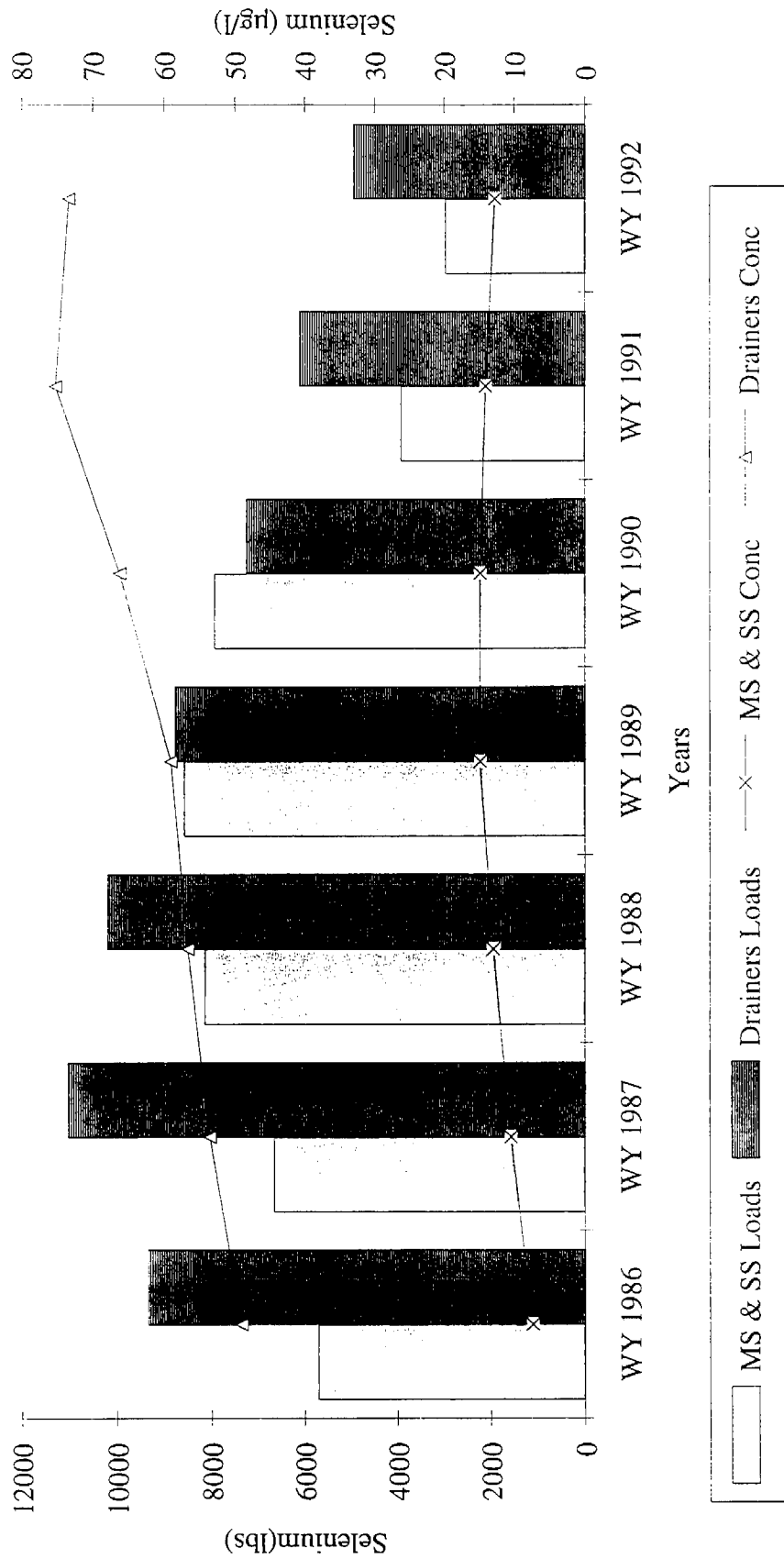


Figure 5

Table 5

Annual Salt, Boron, and Selenium Loads and Concentrations for the Sloughs and Drainers
WYs 1986-1992

Salt Loads and Concentrations								
Water Year	MS+SS Load Tons	Drainers Load Tons	MS+SS % Change from WY 89	Drainers % Change from WY 89	MS+SS Conc mg/L	Drainers Conc mg/L	MS+SS % Change from WY 89	Drainers % Change from WY 89
WY 1986	480,000	209,000	27%	5%	1240	2190	-5%	-18%
WY 1987	425,000	235,000	12%	18%	1330	2280	2%	-15%
WY 1988	434,000	235,000	15%	18%	1380	2610	5%	-3%
WY 1989	378,000	199,000	0%	0%	1310	2680	0%	0%
WY 1990	360,000	160,000	-5%	-20%	1350	2920	3%	9%
WY 1991	213,000	131,000	-44%	-34%	1530	3220	17%	20%
WY 1992	191,000	110,000	-49%	-45%	1640	3260	25%	22%

Boron Loads and Concentrations								
Water Year	MS+SS Load Pounds	Drainers Load Pounds	MS+SS % Change from WY 89	Drainers % Change from WY 89	MS+SS Conc mg/L	Drainers Conc mg/L	MS+SS % Change from WY 89	Drainers % Change from WY 89
WY 1986	1,164,000	848,000	-1%	13%	1.5	4.5	-25%	-12%
WY 1987	1,061,000	930,000	-10%	24%	1.7	4.5	-15%	-12%
WY 1988	1,299,000	837,000	10%	11%	2.1	4.7	5%	-8%
WY 1989	1,180,000	753,000	0%	0%	2.0	5.1	0%	0%
WY 1990	1,086,000	662,000	-8%	-12%	2.0	6.0	0%	18%
WY 1991	624,000	557,000	-47%	-26%	2.2	6.9	10%	35%
WY 1992	530,000	447,000	-55%	-41%	2.3	6.6	15%	29%

Selenium Loads and Concentrations								
Water Year	MS+SS Load Pounds	Drainers Load Pounds	MS+SS % Change from WY 89	Drainers % Change from WY 89	MS+SS Conc µg/L	Drainers Conc µg/L	MS+SS % Change from WY 89	Drainers % Change from WY 89
WY 1986	5,700	9,300	-34%	6%	7	49	-50%	-17%
WY 1987	6,700	11,000	-22%	25%	11	54	-30%	-9%
WY 1988	8,100	10,200	-6%	16%	13	57	-13%	-4%
WY 1989	8,600	8,800	0%	0%	15	59	0%	0%
WY 1990	7,900	7,300	-8%	-17%	15	66	0%	12%
WY 1991	3,900	6,100	-55%	-31%	14	75	-5%	27%
WY 1992	3,000	5,000	-65%	-43%	13	73	-14%	24%

reduced amount of higher quality tail water in the drains. Tail water reduction would occur as irrigation management improves.

The impact of reduced constituent loads and increased drainage concentrations has contributed to the reduction in constituent loads (from 49% - 65%) in Mud and Salt Sloughs, but has led to less dramatic changes in water quality (a 14% annual average reduction in selenium concentration and a 25% increase in salt concentration).

Figures 6-9 show monthly average selenium and boron concentrations for the sloughs. In WY 91 and 92, drainage water was routed to Salt Slough until mid-June. Drainage water was then routed to Mud Slough (north) until the end of the water year (mid to late September). The drainage water contains median selenium levels 6 to 8 times higher than Slough objectives (Table 6), boron levels 2-4 times higher than objectives, and molybdenum levels that are 1/2 to 1 times the Slough objectives. The impact of the routing of the drainage water can be seen most dramatically on the figures depicting selenium concentration. The Slough that carries drainage water violates WY 94 Basin Plan objectives, even though loads are significantly reduced from WY 1989 levels.

Mud Slough (north) has less dilution water, so the violation of WY 94 objectives is much greater than in Salt Slough. It should also be noted that boron and molybdenum (Figure 10) levels in Mud Slough (north) exceed objectives with or without the presence of drainage water, while Salt Slough meets the boron objectives in the absence of drainage water and meets the molybdenum objective at all times. This indicates that the drainage area of Mud Slough (north) is naturally high in boron and molybdenum and suggests that these objectives for Mud Slough (north) should be revised or eliminated.

TABLE 6

Water Quality Objectives for Mud and Salt Sloughs (from Basin Plan 5C)

<u>Constituent</u>	<u>Maximum Concentration</u>	<u>Compliance Date</u>
Selenium (µg/L)	26 10 (monthly mean)	October 1993
Boron (mg/L) (March 15-Sept 15)	5.8 2.0 (monthly mean)	October 1993
Molybdenum (µg/L)	58 19 (monthly mean)	January 1989

Figure 6

Boron Monthly Mean Concentration for Salt Slough at Lander, WY 91/92

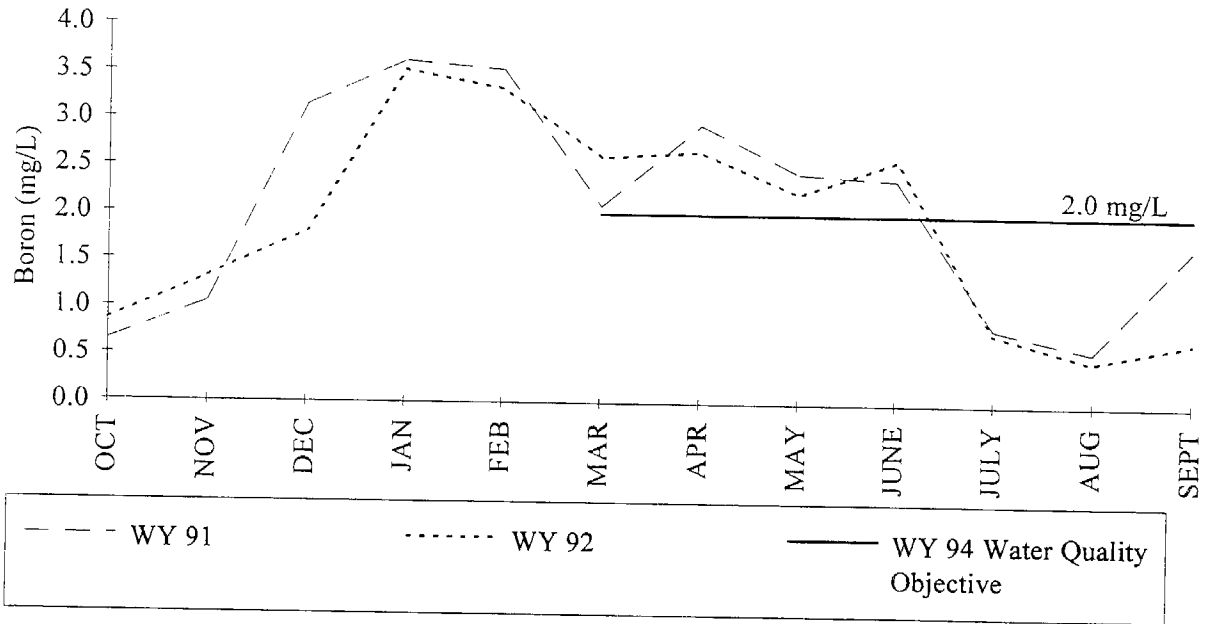


Figure 7

Boron Monthly Mean Concentration for Mud Slough @ SLD, WY 91/92

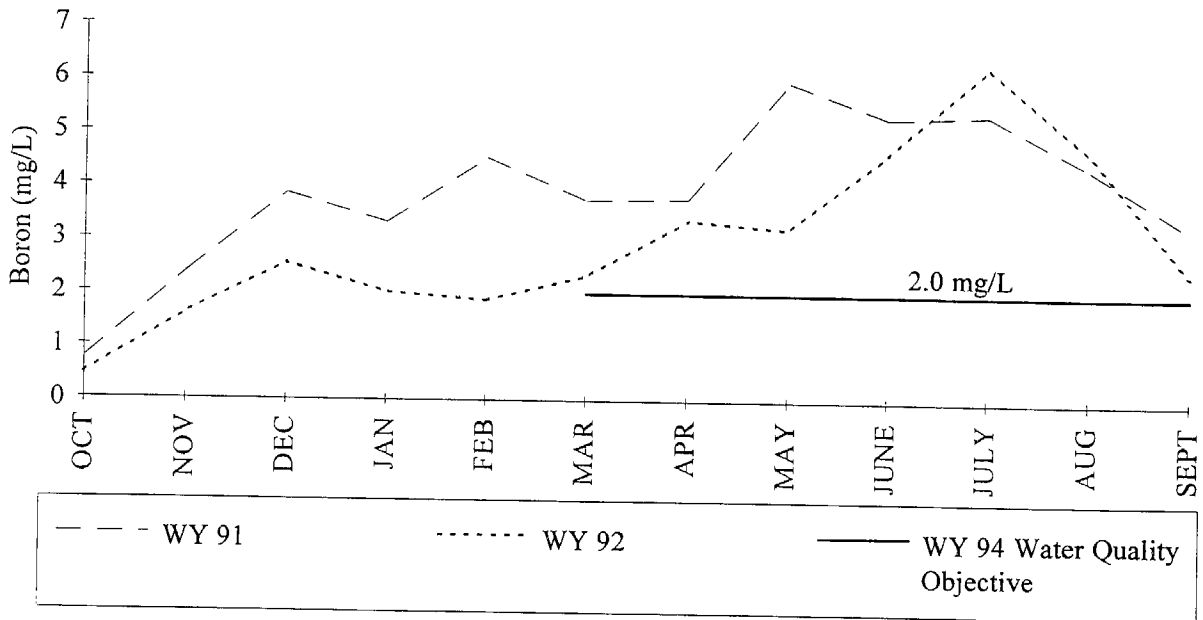


Figure 8

Selenium Monthly Mean Concentration for Salt Slough at Lander, WY 91/92

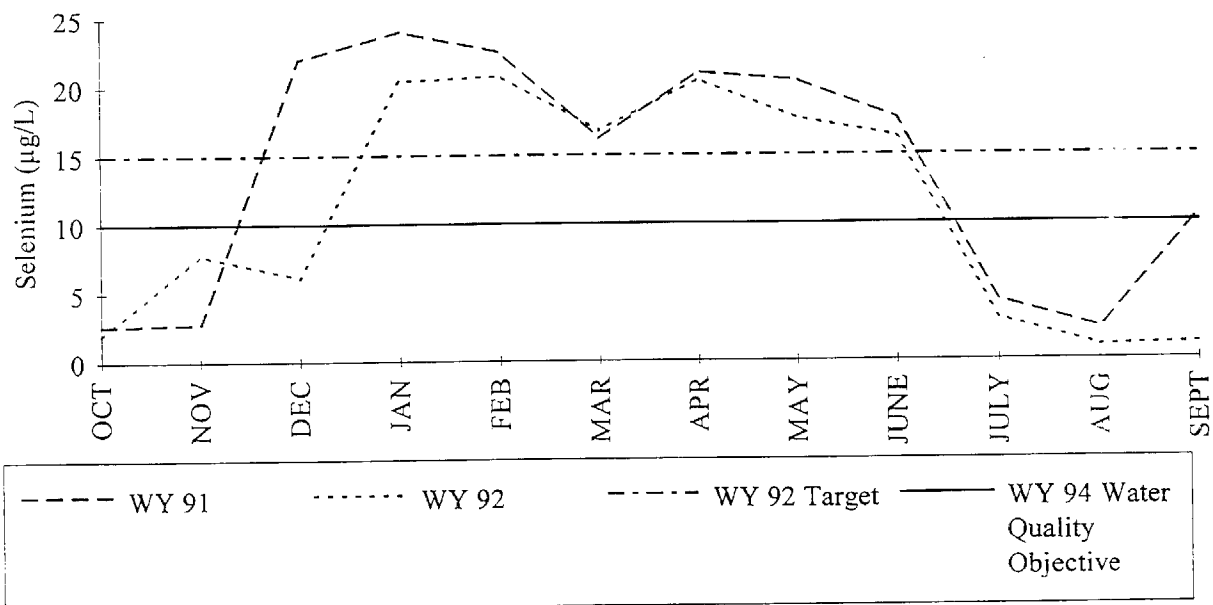


Figure 9

Selenium Monthly Mean Concentration for Mud Slough @ SLD, WY91/92

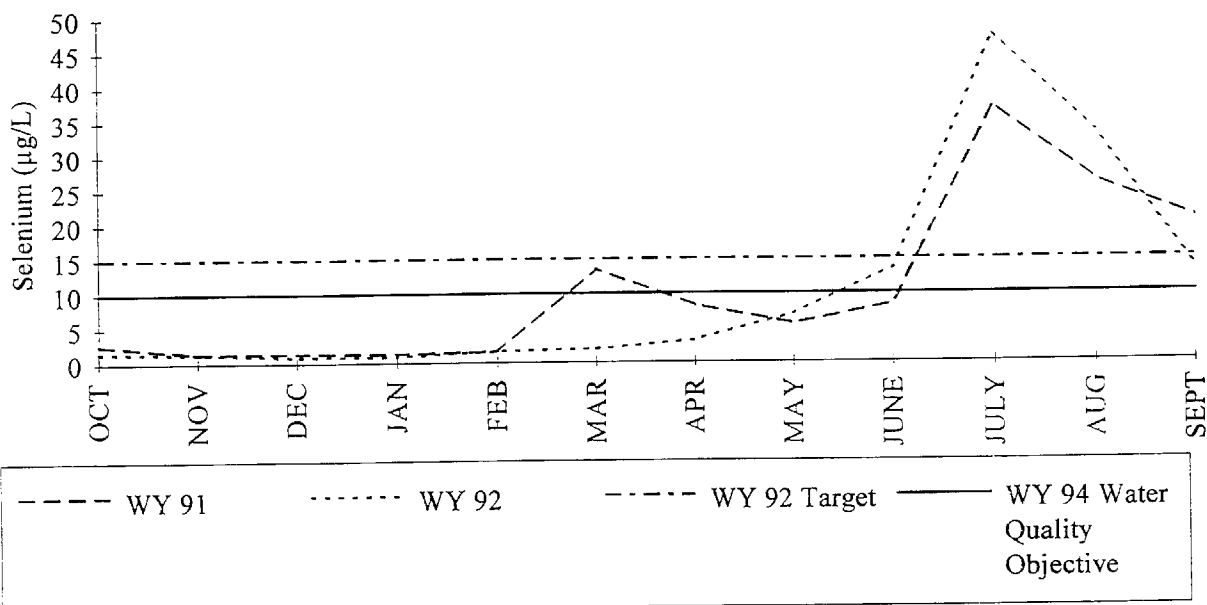
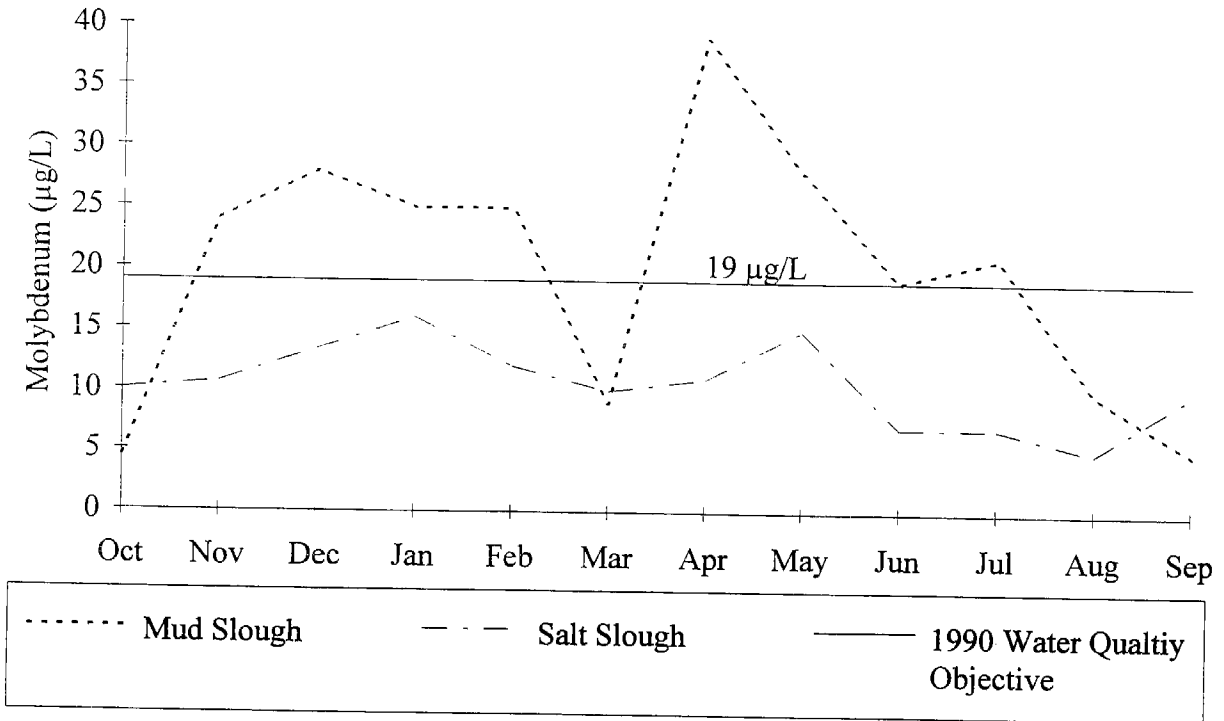


Figure 10
WY 1992 Molybdenum Monthly Mean Concentration for Mud and Salt Sloughs



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APPENDIX A

Mineral and Trace Element Water Quality Data for Inflow Monitoring Stations
Listed in Order by Map Index Number

Map Index	RWQCB Site I.D.	Site Name	Page
I-1	MER556	Main (Firebaugh) @ Russell Avenue	28
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I-9	MER555	Almond Drive Drain	35
I-10	MER509	Rice Drain	36
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Map Index I-1 . Main (Firebaugh) Drain at Russell Avenue (MER556)

Location: Latitude 36° 55'27". Longitude 120°39'11". In SW 1/4, SW 1/4, SW 1/4, Sec. 34, T.11S.,
R.12E. E side of Russell Avenue., 2.7 mi. S of South Dos Palos.

DATE	TIME	PH	EC umhos/cm	TDS mg/L	Cr µg/L	Cu µg/L	Pb µg/L	Ni µg/L	Zn µg/L	Se µg/L	Mo µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1340	8.0	2170							25		2.4				74
10/7/91	900	7.6	4130							46		6.2				68
10/11/91	720	7.3	2580							22		3.4				68
10/18/91	915	7.7	2970							25		3.7				68
10/25/91	1050	7.2	3220		5	3	<5	8	4	39	41	5.3	340	1300	690	
11/1/91	1045	8.1	3520							67		5.2				56
11/8/91	1030	7.9	2280							44	10	2.5				60
11/15/91	1105	8.1	3070							65	24	4.7				58
11/25/91	905	7.7	2360		8	6	<5	11	14	34	21	3.2	240	610	490	55
12/6/91	845	8.3	7050							121	98	13				41
12/13/91		8.7	7970							158	116	19				44
12/20/91	1315	8.7	8120							174		17				
12/26/91	820	8.8	7480							137	122	15	780	3000	1700	47
1/10/92	920	8.4	3350							23		4.6				46
1/17/92	840	8.5	4160							37		5.3				42
1/24/92	805	8.1	4540							86		6.8				
1/31/92	1005	8.8	2510							29	21	3.0	260	700	560	
2/28/92	1115	8.0	4310		16	7	<5	17	18	76	28	5.8	470	1500	1000	62
3/6/92	750	8.1	3810							73		5.5				54
3/13/92	805	8.2	5150							110		8.3				58
3/20/92	820	8.3	4720							97		7.9	390			58
3/26/92	750	8.0	5510							132		6.8				62
3/30/92	920	8.0	4780		15	7	<5	19	17	99	28	6.1	520	1400	1100	60
4/2/92	745	8.1	5910							128		9.3				62
4/9/92	810	8.2	4030							85		5.2				59
4/16/92	845	8.2	4950							118		6.6				60
4/23/92	900	8.2	3890							87		4.9				58
4/30/92	1205	7.9	2530		25	15	<5	36	46	32	10	2.7	270	650	580	66
5/7/92	1825	8.1	3090							44		3.2				76
5/15/92	1545	8.1	3830							67		5.1				74
5/21/92	1800	8.2	3700							65		4.8				
5/28/92	1715	8.0	3050									4.4				83
5/29/92	1030	7.8	4700		4	13	<5	17	24	81	48	8.2				72
6/5/92	1755	8.2	3300							47		5.0				84
6/12/92	1705	8.2	3550							55		4.4				73
6/19/92	1805	8.2	3590							56		5.0				78
6/26/92	945	7.8	4170		16	8	2	23	28	71	31	5.8	440	1500	920	72
7/3/92	1030	7.9	3700							56		5.5				74
7/10/92	850	7.5	3650							59		5.3				75
7/17/92	825	7.5	3380							49		5.3				76
7/24/92	740	8.0	3310							39		4.9				72
7/30/92	1030	7.8	2990	1990	58	30	7	44	68	40	10	4.1	298	849	640	73
8/7/92	850	8.1	3370							41		5.2				66
8/14/92	745	7.8	2620							22		3.6				74
8/23/92	1320	7.9	2700							29		3.7				83
8/27/92	1320	8.0	2910	2100	12	13	<5	16	13	28	24	4.0	265	761	578	76
9/4/92	855	7.5	4970							61		8.0				67
9/11/92	1020	7.9	6120							112		12				71
9/18/92	750	8.6	8010							168		16				68
9/25/92	1020	7.8	2460	1660	7	7	<5	12	10	16	29	3.3	241	635	443	66
Count		50	50	3	10	10	10	10	10	49	16	50	12	11	11	45
Min		7.2	2170		4	3	2	8	4	16	10	2.4	240	610	443	41
Max		8.8	8120		58	30	7	44	68	174	122	19	780	3000	1700	84
Mean		8.0	4080		17	11		20	24	69	41	6.3	376	1170	791	65
Geo Mean		8.0	3850		12	9		18	18	58	30	5.6	352	1030	729	64
Median		8.1	3680		14	8	<5	17	18	59	28	5.2	319	849	640	67

Map Index I-2. Panoche Drain at O'Banion Gauge Station (MER501)

Location: Latitude 36° 55'27", Longitude 120°41'19". In SW 1/4, SW 1/4, SW 1/4, Sec. 32,T.11S,R.T.12E.
 Located 0.5 mi S of CCID Main Canal, 1.9 mi W of Russell Rd., 5.5 mi. SW of Dos Palos 3.4 SW of South Dos Palos.

DATE	TIME	PH	EC	TDS	Cr	Cu	Pb	Ni	Zn	Se	Mo	B	Cl	SO4	HDNS	TEMP
			µmhos/cm	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	deg F
10/4/91	1350	7.8	4870							28		8.1				82
10/7/91	910	7.7	5220							39		8.4				65
10/11/91	735	6.6	5770							65		9.5				68
10/18/91	925	7.7	5080							83		8.0				66
10/25/91	1105	7.1	4770		6.5	2	<5	<5	2.6	71	14	9.0	760	1500	1200	
11/1/91	1105	7.8	4930							70		7.8				61
11/8/91	1040	7.9	4290							39	11	7.2				65
11/15/91	1125	7.9	4830							54	12	9.2				58
11/25/91	920	7.7	4300		18	1.6	<5	<5	3	34	9	7.8	610	1000	1000	56
12/20/91	1335	8.4	4720							82		7.9				
12/26/91	840	8.2	4670							74	15	7.2	660	1300	1200	46
1/17/92	855	8.2	4810							86		7.3				47
1/24/92	815	8.1	4410							68		6.9				
1/31/92	1025	8.1	4600							71	8	7.2	590	1200	1100	
2/28/92	1040	8.0	4870		31	2.5	<5	8.5	6.9	82	7	7.8	670	1400	1200	59
3/13/92	815	7.9	4960							81		8.4				57
3/20/92	810	8.1	4910							76		8.6	620			58
3/30/92	935	7.9	4620		31	2.6	<5	8.9	6.3	72	8	7.9	560	1100	1200	60
4/9/92	825	8.0	5050							92		7.5				59
4/16/92	855	8.1	5300							102		9.5				61
4/23/92	910	8.1	4760							92		7.1				58
4/30/92	1215	8.0	5320		34	2.8	<5	13	12	112	11	9.2	650	1500	1400	68
5/7/92	1810	8.3	4790							85		6.8				77
5/15/92	1555	8.2	5150							95		7.5				81
5/21/92	1740	8.4	4880							82		6.7				
5/28/92	1700	8.2	4730									8.3				79
5/29/92	1050	8.1	4990		<1	25	<5	5.8	6.7	88	14	8.4				74
6/5/92	1745	8.3	4960							97		8.7				85
6/12/92	1655	8.3	4870							65		8.0				79
6/19/92	1755	8.3	5430							103		7.8				82
6/26/92	1000	7.8	4810		45	6	3	19	28	80	8	7.4	700	1500	1200	72
7/3/92	1045	7.8	4850							84		8.4				73
7/10/92	900	7.5	4800							88		7.3				74
7/17/92	835	7.5	4750							80		7.8				74
7/24/92	755	7.9	5040							92		7.8				70
7/30/92	1345	8.0	5360	3950	14	4	<5	8	4	93	6	8.6	701	1560	1250	83
8/7/92	905	8.0	4960							99		7.9				72
8/14/92	800	7.6	5740							137		9.2				74
8/23/92	1330	8.2	4600							79		8.6				83
8/27/92	1330	8.2	4870	3820	14	4	<5	7	5	92	16	8.5	579	1490	1090	81
9/4/92	910	7.7	4770							75		7.5				65
9/11/92	1000	7.9	4930							94		8.8				70
9/18/92	800	7.8	5240							71		9.0				63
9/25/92	1030	7.6	5860	4490	11	2	<5	6	2	83	16	9.6	799	1540	1250	63
Count		44	44	3	10	10	10	10	10	43	14	44	12	11	11	39
Min		6.6	4290		<1	1.6	3	<5	2.0	28	6	6.7	560	1000	1000	46
Max		8.4	5860		45	25		19	28	137	16	9.6	799	1560	1400	85
Mean		7.9	4940			5.3			7.7	80	11	8.1	658	1372	1190	68
Geo Mean		7.9	4930			3.5			5.6	77	11	8.1	655	1358	1190	68
Median		8.0	4870		16.0	2.7	<5	7.5	5.7	82	11	8.0	655	1490	1200	68

Map Index I-3. Agatha Inlet (Mercy Springs) Drain near Panoche Drain (MER552)

Location: Latitude 36°56'01". In SE 1/4, SE 1/4, NW 1/4, Sec 31, T. 11S., R.12E.
 S of Firebaugh Drain, 2.6 mi W of Russell Ave., 2.8 mi S of south Dos Palos

DATE	TIME	PH	EC µmhos/cm	TDS mg/L	Se µg/L	Mo µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1400	8.3	6180		4.4		14				96
10/7/91	915	7.9	2840		20		4.0				68
10/18/91	930	7.8	6770		2.3		13				66
10/25/91	1115	7.1	6380		2.7		14	1100	2200	1600	
12/26/91	830	8.3	4680		2.4		7.4	640	1600	1500	46
1/31/92	1000	8.4	3605		19		3.5				
2/28/92	1050	8.0	4915		79		8.6	640	1400	1200	60
4/30/92	1225	8.1	3170		37		6.1	380	990	890	74
5/29/92	1110	7.8	4470		7.8	13	8.7				77
6/26/92	1015	7.8	3790		6.5		6.6	560	1000	830	76
7/30/92	1400	8.1	3900	2710	6.3		7.3	487	944	769	79
8/28/92	1340	8.4	4250	3000	74		6.7	494	1150	891	80
9/25/92	1035	7.8	5730	4310	83		9.2	719	1470	1310	63
Count		13	13	3	13	1	13	8	8	8	11
Min		7.1	2840		2.3		3.5	380	944	769	46
Max		8.4	6770		83		14.0	1100	2200	1600	96
Mean		8.0	4670		26.5		8.4	628	1340	1120	71
Geo Mean		8.0	4510		12.3		7.7	599	1290	1080	70
Median		8.0	4470		7.8		7.4	600	1280	1050	74

Map Index I-4. Agatha Canal at Helm Canal (MER506)

Latitude 36°56'04", Longitude 120°41'06". In NE 1/4, SE 1/4, NW 1/4, Sec. 31, T. 11S., R.12E. 150ft N of Helm Canal, 2.6 mi. W of Russel Ave., 3.4 mi. SW of South Dos Palos. The site was relocated to the Agatha Canal @ Mallard Road in July, 1992. The new site is at latitude 36°59'30", longitude 120°42'00".

DATE	TIME	PH	EC µmhos/cm	TDS mg/L	Se µg/L	Mo µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1325	7.9	3890		49		5.7				80
10/7/91	850	7.9	670		0.9		0.21				71
10/11/91	715	7.3	3890		30		5.6				69
10/18/91	855	8.0	565		1.4		0.18				71
10/25/91	1035	7.4	560		0.8	1	0.26	97	61	120	
11/25/91	850	7.7	2100		31		4.6	360	800	680	56
12/26/91	805	8.4	4720		82		7.9				
1/31/92	815	8.1	4410		68		6.9				
3/30/92	900	8.4	730		2.4	4	0.44	100	120	180	64
4/30/92	1150	8.1	3440		5	16	6.6	400	1100	950	66
5/29/92	945	7.8	4970		72		8.7				71
6/26/92	920	7.9	4490		61	9	6.8	640	1400	1100	72
7/30/92	1020	7.8	4750	3390	53	13	7.1	609	1240	975	72
8/28/92	1305	8.1	3010	2140	16		4.6	395	651	558	75
9/25/92	1000	8.5	980				0.45	157	127	168	70
Count		15	15	2	14	5	15	8	8	8	12
Min		7.3	560		0.8		0.18	97	61	120	56
Max		8.5	4970		82.0		8.7	640	1400	1100	80
Mean		8.0	2878		33.8		4.40	345	687	591	70
Geo Mean		8.0	2168		14.0		2.26	276	418	440	70
Median		7.9	3440		30.5		5.60	378	726	619	71

Map Index I-6. Hamburg Drain near Camp 13 Slough (MER 504)

Location : Latitude 36°56' 32", Longitude 120° 45' 23" . In SE 1/4, SE 1/4,SW 1/4, Sec 27, T.11S., R11E
50 ft. S of CCID main Canal, 9.2 mi. S-SE of Los Banos , 6.7 mi. W-SW of South Dos Palos.

DATE	TIME	PH	EC	TDS	Cr	Cu	Pb	Ni	Zn	Se	Mo	B	Cl	SO4	HDNS	TEMP
			µmhos/cm	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	deg F
10/4/91	1305	7.9	3000							34		3.0				82
10/7/91	835	7.3	4090							55		4.4				66
10/11/91	640	7.3	4590							77		4.7				68
10/18/91	835	7.5	3300							25		3.6				65
10/25/91	1020	6.7	4440		3	<1	<5	<5	<1	70	8	5.6	720	1700	1600	
11/1/91	1025	8.1	4560							79		4.7				62
11/8/91	1010	8.3	4570							77	9	4.8				65
11/15/91	1045	7.7	4780							77	9	5.2				50
11/25/91	830	7.8	4520		22	4	<5	16	24	70	6	5.0	590	1400	1500	54
12/6/91	830	8.3	5000							83	8	5.1				49
12/13/91		8.5	5030							74	8	6.1				50
12/20/91	1300	8.3	5170							92		5.6				
12/26/91	740	8.1	5130							89	7	5.2	740	1600	2000	46
1/10/92	815	8.0	5000							79		5.5				54
1/17/92	815	8.1	5170							92		4.6				52
1/24/92	730	7.4	5090							87		4.3				
1/31/92	900	8.1	5090							92	10	4.8	670	1500	1700	
2/28/92	915	8.1	5200		17	1	<5	6	7	88	7	4.8	750	1700	1800	58
3/13/92	740	7.9	5270							95		4.7				57
3/20/92	740	8.0	4380							76		4.5	560			57
3/26/92	710	7.8	5130							95		5.0				58
3/30/92	835	8.1	3370		17	17	18	11	15	53	28	4.3	880	1400	970	66
4/2/92	705	7.9	4130							69		4.0				60
4/6/92	705	7.9	4130							69		4.0				60
4/9/92	755	8.0	4140							75		4.0				55
4/16/92	820	8.0	3720							52		4.3				62
4/23/92	835	8.2	5220							100		5.2				55
4/30/92	1125	8.2	5470		24	10	14	23	17	156	63	6.4	730	1600	1800	70
5/7/92	1745	8.1	4990							80		4.5				80
5/15/92	1530	8.2	5210							90		4.9				82
5/21/92	1730	8.2	5950							116		5.7				80
5/28/92	1645	8.3	5900									6.9				79
5/29/92	905	7.8	5890		2	23	<5	9	27	145	35	6.6				68
6/5/92	1815	8.1	5650							108		6.1				83
6/12/92	1720	8.2	5760							100		6.1				80
6/19/92	1825	8.4	5730							117		6.1				82
6/26/92	845	7.8	4920		30	7	4	21	30	76	3	5.2	770	1500	1500	68
7/3/92	950	7.8	4850							84		5.7				74
7/10/92	820	7.6	5880							118		6.5				68
7/17/92	755	7.5	6300							138		6.7				68
7/24/92	715	7.9	6180							118		7.5				65
7/30/92	955	7.9	6280	4860	33	11	<5	15	18	142	12	7.7	856	1670	1650	69
8/7/92	835	8.0	5640							112		6.4				65
8/14/92	715	7.7	6590							142		7.8				68
8/23/92	1240	7.9	5370							116		6.1				83
8/27/92	1240	7.9	5080	4090	58	17	6	31	40	102	5	5.8	655	1580	1470	79
9/4/92	815	7.7	4500							68		4.9				65
9/11/92	915	8.1	4430							83		4.5				67
9/18/92	725	7.6	5080							86		6.1				62
9/25/92	925	8.1	5250	4080	16	2	<5	<5	4	76	10	6.4	706	1450	1720	62
Count		50	50	3	10	10	10	10	10	49	16	50	12	11	11	46
Min		6.7	3000		2	<1	4	<5	<1	25	3	3.0	560	1400	970	46
Max		8.5	6590		58	23	18	31	40	156	63	7.8	880	1700	2000	83
Mean		7.9	5000		22					90	14	5.4	719	1555	1610	66
Geo Mean		7.9	4940		16					85	10	5.3	713	1551	1587	65
Median		8.0	5090		20	9	<5	13	18	86	8.5	5.2	725	1580	1650	65

Map Index I-7. Camp 13 Slough at Gauge Station (MER505)

Latitude 36°56'04", Longitude 120°41'06". In SE 1/4, SE 1/4, SW 1/4, Sec 27, T.11s., R.11E. 150 ft. N of CCID Main Canal, 6.4 mi W of Russell Ave., 9.2 mi. SE of Los Banos, 6.7 mi. SW of South Dos Palos.

DATE	TIME	PH	EC µmhos/cm	TDS mg/L	Se µg/L	Mo µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1310	8.5	720		1.4		0.27				80
10/7/91	840	7.8	710		1.8		0.25				74
10/11/91	700	7.5	790		2.8		0.33				68
10/18/91	840	7.8	1190		6.3		0.97				70
10/25/91	1025	7.2	910		4.9	2	0.85	150	180	190	
11/25/91	840	8.0	990		5.5		0.49	170	140	210	55
12/26/91	750	8.3	4870		74	16	7.5	680	1400	1200	47
1/31/92	905	8.2	4030		63		5.9	490	1100	1000	
2/28/92	925	8.1	4560		70	11	5.9	590	1400	1200	60
3/30/92	840	8.0	4450		67	10	6.7	520	1500	1100	62
4/30/92	1130	8.3	5170		122	34	6.5	700	1600	1600	70
5/29/92	925	7.7	4960		76		6.6				72
6/26/92	855	8.0	4020		54	9	4.6	620	1300	1100	70
7/3/92	955	7.9	4900		81		6.1				74
7/10/92	830	7.7	3910		53		6.2				75
7/17/92	805	7.6	3840		62		5.3				76
7/24/92	720	8.0	4490		68		6.1				69
7/30/92	1005	8.0	3850	2690	55	15	4.7	440	1050	822	73
8/7/92	840	8.1	3250		48		3.5				71
8/14/92	725	7.8	4540		69		6.0				72
8/23/92	1250	8.0	4220		71		5.4				83
8/28/92	1250	8.2	4450	3600	74	7	5.9	492	1240	1340	79
9/4/92	825	7.8	4430		65		4.8				65
9/11/92	925	8.1	4410		81		5.0				70
9/18/92	735	7.8	4930		78		5.5				62
9/25/92	935	8.2	3740	2740	35	32	5.7	393	1100	820	68
Count		26	26	3	26	9	26	11	11	11	24
Min		7.2	710		1.4	2	0.25	150	140	190	47
Max		8.5	5170		122	34	7.5	700	1600	1600	83
Mean		7.9	3550		53	15	4.5	477	1092	962	69
Geo Mean		7.9	2990		33	12	3.1	431	879	811	69
Median		8.0	4130		64	11	5.5	492	1240	1100	70

Map Index I-8, Charleston Drain at CCID Main Canal (MER502)

Location: Latitude 36°56'59", Longitude 121°46'55". In NE 1/4, SE 1/4, NE 1/4, Sec. 29, T.11S., R.11E.

N side of CCID Main Canal , 8.7 mi S-SE of Los Banos, 7.9mi. W-SW of South Dos Palos.

DATE	TIME	PH	EC	TDS	Cr	Cu	Pb	Ni	Zn	Se	Mo	B	Cl	SO4	HDNS	TEMP
			umhos/cm	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	deg F
10/4/91	1255	7.7	2190							19		1.7				78
10/7/91	830	7.3	1830							15		1.4				70
10/11/91	630	7.5	1830							15		1.4				69
10/18/91	825	7.5	1350							9.5		0.7				70
10/25/91	1000	6.7	1370		6	4	<5	6	7	12	2	1.2	230	390	370	
11/1/91	1015	7.9	2780							32		2.3				61
11/8/91	1000	7.8	2970							42	8	2.6				64
11/15/91	1030	7.8	1400							12	3	0.9				58
11/25/91	815	7.7	3500		5	1	<5	6	12	44	10	3.2	620	420	1000	54
12/6/91	820	8.3	4020							56	12	3.8				46
12/13/91		7.7	4990							73	15	5.4				50
12/20/91	1250	8.3	5190							89		5.7				
12/26/91	735	7.9	5110							79	16	4.9	540	2000	1800	47
1/10/92	2805	7.9	5110							80		4.6				52
1/17/92	810	7.8	5420							73		5.3				47
1/24/92	720	7.4	5340							84		5.2				
1/31/92	850	7.8	5160							68	8	5.6	740	1400	1700	
2/28/92	900	7.9	5690		14	6	<5	11	22	103	15	6.0	760	1900	1800	58
3/13/92	725	7.9	5400							99		5.6				58
3/20/92	730	7.9	4990							81		4.9	660			57
3/26/92	700	7.8	4270							71		4.4				59
3/30/92	820	7.9	5550		10	3	<5	9	36	106	8	1.4	700	1600	1900	59
4/2/92	655	7.8	5400							101		4.9				60
4/9/92	745	7.8	5190							104		4.4				56
4/16/92	810	7.8	5290							106		4.7				59
4/23/92	830	8.0	3770							45		3.8				54
4/30/92	1120	8.0	4220		5	1	<5	9	7	74	10	4.3	580	1300	1400	70
5/7/92	1740	7.8	4650							97		3.5				74
5/15/92	1520	8.0	5060							75		4.6				79
5/21/92	1715	7.8	4600							84		3.7				74
5/28/92	1635	8.3	4300									4.3				77
5/29/92	850	7.3	4320		<1	8	<5	7	34	63	8	3.9				68
6/5/92	1830	8.0	3920							4.6		4.5				76
6/12/92	1735	7.9	4670							91		4.6				79
6/19/92	1835	8.1	4430							76		4.0				81
6/26/92	830	7.6	4420		45	27	16	57	140	72	2	4.3	700	1400	1300	70
7/3/92	930	8.0	3170							27		3.5				74
7/10/92	810	7.2	2300							3.6		2.2				76
7/17/92	745	7.3	5240							81		6.0				72
7/24/92	700	7.8	3420							51		2.8				69
7/30/92	1430	8.1	4020	2890	10	7	<5	6	15	59	5	4.7	597	1060	1140	78
8/7/92	800	8.1	4920							73		4.9				69
8/14/92	705	7.5	4170							49		4.6				72
8/23/92		7.9	3790							59		3.6				83
8/27/92	1230	7.8	4190	3220	35	15	6	22	51	60	3	4.9	597	1130	1310	73
9/4/92	805	7.6	3350							34		3.2				64
9/11/92	900	7.5	3790							47		3.9				68
9/18/92	715	7.3	4430							51		5.0				62
9/25/92	910	8.1	1280	791	13	7	<5	12	20	4.7	2	1	184	208	305	69
Count		49	49	3	10	10	10	10	10	48	16	49	12	11	11	45
Min		6.7	1280		<1	1	<5	6	7	3.6	2	1	184	208	305	46
Max		8.3	5690		45	27	16	57	140	106	16	6	760	2000	1900	83
Mean		7.8	4040			8		15	34	59	8	4	576	1160	1280	66
Geo Mean		7.8	3770			5		11	23	46	6	3	534	959	1110	65
Meadian		7.8	4300		10	7	<5	9	21	66	8	4	609	1300	1310	69

Map index I-9 Almond Drive Drain (MER555)

Latitude 36° 59'55", Longitude 120° 49'00". In SW 1/4, SW 1/4, SW 1/4, Sec. 6, T11S.,
 R.11E. N side of Almond Dr., 1.1 mi. E of Mercy Spring Drain, 100 ft. E of CCID
 Main Canal, 4.7 mi. S of Los Banos

DATE	TIME	PH	EC µmhos/cm	TDS mg/L	Se µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1245	7.2	2760		2.2	3.9				80
10/7/91	820	7.2	710		1.0	0.25				73
10/11/91	620	7.6	620		1.0	0.19				69
10/18/91	815	7.7	590		0.7	0.18				69
10/25/91	905	7.1	530		0.7	0.23	99	56	110	
11/25/91	800	7.9	520		0.7	0.31	94	100	150	54
12/26/91	725	8.1	2630		6.6	3.1	460	920	590	48
1/31/92	830	8.2	2620		5.5	3.1	300	640	580	
2/28/92	840	8.0	2000		3.6	1.8	230	370	450	59
3/30/92	800	7.3	2100		3.4	1.9	240	420	470	60
4/30/92	1100	8.0	1680		2.5	1.4	190	280	430	67
5/29/92	825	7.0	1660		2.6	1.5				66
6/26/92	810	7.6	1670		3.0	2.0	220	320	330	72
7/30/92	935	7.9	1170	677	3.4	0.99	150	200	260	74
8/28/92	1215	7.8	2170	1440	1.8	2.7	262	414	275	80
9/25/92	845	8.2	970	579	1.6	0.55	155	133	221	69

Count	16	16	3	15	16	11	11	11	14
Min	7.01	520		0.7	0.18	94	56	110	48
Max	8.2	2760		6.6	3.9	460	920	590	80
Mean	7.7	1530		2.5	1.5	218	350	351	67
Geo Median	7.7	1300		2.0	1.0	198	268	311	67
Median	7.7	1670		2.2	1.5	220	320	330	69

Map Index I-10. Rice Drain at Mallard Road (MER 509)

Location: Latitude 36°59'22", Longitude 120°14'42". In NE 1/4, NW 1/4, SW 1/4, Sec 7,T.11S.,R11E.
 South of Santa Fe Grade at Brito, 50 ft. W of Mallard Rd.,4.5 mi. W of Dos Palos.

DATE	TIME	PH	EC µmhos/cm	TDS mg/L	Se µg/L	Mo µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1420	8.7	2530		4.1		4.7				82
10/7/91	935	7.9	2080		2.0		4.2				68
10/11/91	750	7.0	1580		2.9		2.4				68
10/18/91	940	8.0	1760		1.6		3.0				69
10/25/91	1130	8.3	1090		1.1		1.6	180	240	230	
11/1/91	1120	7.8	1970		2.3		3.4				58
11/8/91	1100	8.1	1820		5.2		2.2				64
11/15/91	1150	8.0	1700		2.9		2.2				58
11/25/91	945	7.6	1990		3.8		3.0	370	690	450	56
12/6/91	855	8.4	1630		2.3		2.2				40
12/13/91		8.6	2750		2.8		5.6				50
12/20/91	1400		4810		3.7		11				
12/26/91	910	8.7	5540		4.2		14	750	1900	1400	46
1/10/92	900	8.4	5390		4.4		12				46
1/17/92	910	8.6	4180		3.4		8.4				42
1/24/92	835	8.3	6360		4.2		15				
1/31/92	945	8.1	7100		5.2		18	860	2200	1500	
2/28/92	1010	8.3	6830		6.3	38	15	860	2300	1600	60
3/6/92	735	7.8	3480		4.3		6.7				54
3/13/92	845	7.9	4110		7.1		8.6				58
3/20/92	840	8.0	5780		3.7		14	690			59
3/26/92	805	7.7	4390		4.1		10				62
3/30/92	1000	8.1	4510		3.4	26	11	520	1300	1200	60
4/2/92	810	7.7	4470		2.9		11				62
4/6/92	810	7.7	4470		2.9		11				62
4/9/92	845	7.7	2340		2.9		4.5				59
4/16/92	910	8.0	2440		3.4		5.2				61
4/23/92	930	8.1	3040		3.5		6.2				60
5/7/92	1835	8.2	3650		4.1		7.5				77
5/15/92	1615	7.9	3490		4.3		6.4				77
5/21/92	1810	8.1	2530		3.3		3.9				
5/28/92	1725	8.2	2420				4.9				81
5/29/92	1135	7.9	2470		2.2	9	5.4				75
6/5/92	1730	8.0	2230		3.8		4.8				84
6/12/92	1630	8.1	2240		2.7		3.9				76
6/19/92	1735	8.1	2180		3.5		3.6				78
6/26/92	1035	7.9	3100		3.0	20	6.0	390	960	760	76
7/3/92	1110	7.9	2950		3.4		6.0				75
7/10/92	920	7.5	3790		3.6		8.7				74
7/17/92	855	7.4	3160		3.9		6.6				78
7/24/92	810	8.0	3670		3.2		7.6				71
7/30/92	1510	7.9	3150	2200	2.2	22	6.2	352	776	639	80
8/7/92	930	8.1	2750		3.4		5.7				73
8/14/92	815	7.8	3580		2.9		7.2				74
8/23/92	1405	8.2	2600		3.2		4.8				83
8/28/92	1405	8.1	2930	2120	2.9	16	5.5	336	729	591	80
9/4/92	935	7.3	2430		4.0		3.9				68
9/11/92	1045	7.6	2160		1.8		3.4				72
9/18/92	820	7.9	3430		2.8		6.8				65
9/25/92	1055	8.0	3070	2110	5.6	17	5.2	398	744	589	65
Count		49	50	3	49	7	50	11	10	10	45
Min		7.0	1090		1.1	9	1.6	180	240	230	40
Max		8.7	7100		7.1	38	18	860	2300	1600	84
Mean		8.0	3280		3.5	21	6.8	520	1180	896	66
Geo Median		8.0	3020		3.3	19	5.8	470	982	767	65
Median		8.0	3000		3.4	20	5.9	400	868	700	68

Map Index I-11. Boundry Drain at Department of Fish and Game Pump (MER521)

Location: Latitude 37°06'32", Longitude 120°46'45". In NE 1/4, SE 1/4, NE 1/4,
 Sec 32, T.9S., R.11E. North of Henery Miller Rd., 4.6 mile NE of Los Banos

DATE	TIME	PH	EC µmhos/cm	Se µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1505	8.4	1160	1.4	0.32				84
10/7/91	1000	7.8	1050	0.8	0.34				71
10/11/91	845	7.3	1230	0.7	0.34				69
10/18/91	1040	7.7	1290	0.4	0.36				73
10/25/91	1205	8.4	1160	0.4	0.42	200	130	220	
11/25/91	1035	7.4	1370	0.5	0.51	250	150	280	57
12/26/91	1000	8.4	3860	1.3	2.7				
1/31/92	1135	7.4	3550	0.8	1.2	680	500	720	
3/30/92	1050	7.9	2310	1.6	0.89	290	270	500	62
4/30/92	1330	8.0	1630	2.0	0.61	240	180	340	72
5/29/92	1215	7.3	1470	0.7	0.46	230	170	300	76
6/26/92	1125	7.4	1570	1.4	0.56	300	190	310	76
7/30/92	1615	8.1	1290	0.5	0.43	214	149	245	84
8/28/92	1450	8.1	1330	1.2	0.48	234	157	250	80
9/25/92	1135	7.8	1260	0.6	0.49	228	152	247	68

Count	15	15	15	15	10	10	10	12
Min	7.3	1050	0.4	0.32	200	130	220	57
Max	8.4	3860	2.0	2.70	680	500	720	84
Mean	7.8	1700	1.0	0.67	287	205	341	73
Geo Mean	7.8	1560	0.8	0.55	267	188	318	72
Median	7.8	1330	0.8	0.48	237	164	290	73

Map Index I-12 Salt Slough Ditch at Hereford Road (MER528)

Location: Latitude 37° 08'30" , Longitude 120° 45'17". In NW 1/4, NE 1/4, NW 1/4,
Sec. 22 T.9S., R.11E. 3.0 mi. N on Hereford Rd. from Henry Miller Rd.

DATE	TIME	PH	EC	TDS	Cr	Cu	Pb	Ni	Zn	Se	B	Cl	SO4	HDNS	TEMP
			µmhos/cm	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	deg F
10/4/91	1520	8.0	960							0.9	0.26				82
10/7/91	1010	7.8	960							0.7	0.28				71
10/11/91	830	7.3	1040							0.7	0.30				69
10/18/91	1025	7.7	1010							0.6	0.30				72
10/25/91	1155	8.4	950							0.4	0.38	180	100	210	
11/1/91	1230	8.0	820							0.7	0.22				60
11/8/91	1150	8.2	790							1.4	0.27				65
11/15/91	1240	8.6	1040							1.1	0.30				59
11/25/91	1025	7.8	1010							0.5	0.34	170	110	230	54
12/6/91	930	8.3	1040							0.6	0.28				42
12/13/91		8.3	1215							0.6	0.29				48
12/20/91	1215	8.7	1220							1.1	0.44				
12/26/91	955	8.3	1440							0.5	0.25	260	150	400	46
1/10/92	1015	7.8	1440							0.5	0.26				46
1/24/92	945	8.6	1430							2.5	0.60				
1/31/92	1150	7.9	1500							1.6	0.55	230	230	350	
2/21/92	1040	7.7	1265							0.7	0.31				60
2/28/92	1245	7.7	1215								0.35	190	140	280	65
3/6/92	910	8.0	1070							2.0	0.40				56
3/13/92	1020	7.6	1185							2.0	0.41				62
3/20/92	930	7.8	1185							1.8	0.38	160			59
3/30/92	1105	7.6	1320							1.0	0.48	200	150	340	64
4/2/92	855	7.7	1260							1.5	0.37				63
4/16/92	1000	8.2	1198							2.0	0.52				64
4/23/92	1030	8.1	1125							1.6	0.46				62
4/30/92	1340	8.0	1140							1.0	0.41	180	150	300	73
5/7/92	1920	8.3	1430							1.9	0.54				76
5/15/92	1425	7.9	1340							0.5	0.35				78
5/21/92	1855	8.4	940							1.2	0.24				
5/28/92	1810	8.4	1130								0.38				81
5/29/92	1205	7.8	1200		<1	2	<5	<5	7	0.9	0.39	190	120	290	77
6/5/92	1640	8.4	1190							0.4	0.35				85
6/12/92	1530	8.5	932							0.8	0.34				78
6/19/92	1645	8.6	1110							1.4	0.46				80
6/26/92	1140	7.5	1200							0.6	0.36	210	130	300	79
7/10/92	1010	7.4	1020							1.7	0.38				80
7/17/92	950	7.4	920							1.3	0.33				78
7/24/92	915	8.3	1110							1.3	0.32				72
7/30/92	1630	8.2	1000	602						0.6	0.34	153	110	187	84
8/7/92	1045	8.4	1150							1.3	0.38				77
8/14/92	910	8.1	813							0.7	0.30				80
8/23/92		7.6	1020							0.5	0.34				80
8/28/92	1050	7.5	1060	633						0.4	0.32	170	110	219	69
9/4/92	1050	7.5	1070							1.4	0.43				69
9/11/92	1135	7.2	1180							0.6	0.44				75
9/18/92	940	7.6	1210							0.8	0.43				68
9/25/92	1150	8.2	1050	615						0.5	0.39	163	119	217	68
Count		47	47	3	1	1	1	1	1	45	47	13	12	12	42
Min		7.2	790							0.4	0.22	153	100	187	42
Max		8.7	1500							2.5	0.60	260	230	400	85
Mean		8.0	1130							1.0	0.37	189	135	277	68
Geo Median		8.0	1110							0.9	0.36	187	132	270	68
Median		8.0	1140							1.0	0.37	180	125	285	69

APPENDIX B

Mineral and Trace Element Water Quality Data for Internal Flow Monitoring Stations
Listed in Order by Map Index Number

Map Index	RWQCB Site I.D.	Site Name	Page
T-1	MER510	CCID Main @ Russell Avenue	40
T-7	MER527	San Luis Canal @ HWY 152	41

Map Index T-1. CCID Main Canal at Russell Avenue (MER510).

Location: Latitude 36°55'28" . Longitude 120°37'30". In SE 1/4, SE 1/4, SE 1/4,
SEC 33, T.11S.,R.12E.2.7 mi. S of Dos Palos.

DATE	TIME	PH	EC	TDS	Se	B	Cl	SO4	HDNS	TEMP
			$\mu\text{mhos/cm}$	mg/L	$\mu\text{g/L}$	mg/L	mg/L	mg/L	mg/L	deg F
10/4/91	1335	8.2	710		1.5	0.26				80
10/7/91	900	7.9	680		0.8	0.23				72
10/11/91	725	7.5	600		1.2	0.17				69
10/18/91	905	8.0	560		0.9	0.16				71
10/25/91	1045	7.4	530		0.7	0.20	87	54	110	
11/1/91	1040	8.4	600		1.0	0.22				59
11/8/91	1025	8.2	660		2.1	0.26				64
11/15/91	1100	8.4	750		2.3	0.31				59
11/25/91	900	7.9	760		1.0	0.25	140	74	140	55
12/6/91	845	8.6	880		2.6	0.38				44
12/13/91		8.7	930		3.2	0.46				46
12/20/91	1320	8.8	1030		4.6	0.54				
12/26/91	815	8.9	1040		4.5	0.64	140	190	260	48
1/10/92	915	8.5	1040		2.4	0.67				48
1/17/92	840	8.9	1060		3.5	0.73				44
1/24/92	800	8.3	1040		4.9	0.65				
1/31/92	1000	8.3	1330		4.8	1.0	140	270	280	
2/28/92	1110	8.3	1280		3.1	0.86	180	240	280	65
3/6/92	750	8.1	790		1.8	0.44				56
3/20/92	830	8.2	635		2.1	0.36	78			59
3/26/92	740	8.1	545		2.0	0.30				63
3/30/92	915	8.3	770		2.1	0.49	100	140	180	64
4/2/92	750	8.3	875		3.1	0.55				63
4/6/92	750	8.3	875		3.1	0.55				63
4/9/92	805	8.5	901		3.2	0.72				62
4/16/92	840	8.4	885		2.6	0.54				63
4/23/92	855	8.5	743		2.0	0.46				62
4/30/92	1200	8.3	847		1.7	0.45	120	120	190	69
5/7/92	1820	8.5	840		2.8	0.43				74
5/15/92	1545	8.4	780		2.0	0.42				74
5/21/92	1755	8.5	740		2.3	0.33				
5/28/92	1710	8.5	700			0.31				78
5/29/92	1020	8.3	715		2.6	0.41				74
6/5/92	1800	8.4	690		2.3	0.33				79
6/12/92	1710	8.4	680		2.6	0.32				72
6/19/92	1810	8.5	760		1.8	0.35				75
6/26/92	940	8.3	790		2.1	0.36	130	90	160	72
7/3/92	1025	8.3	780		1.9	0.32				72
7/10/92	850	7.8	815		1.6	0.33				74
7/17/92	825	7.8	825		1.6	0.35				76
7/24/92	735	8.5	799		1.7	0.32				72
7/30/92	1050	8.1	805	443	1.4	0.31	131	88.8	155	74
8/7/92	850	8.5	838		1.5	0.35				76
8/14/92	745	8.1	802		1.1	0.33				75
8/23/92	1315	8.4	910		1.3	0.37				83
8/28/92	1315	8.3	900	550	1.1	0.39	128	109	161	76
9/4/92	850	7.9	1120		2.2	0.56				68
9/11/92	1010	7.8	1000		1.8	0.54				72
9/18/92	750	8.0	1020	505	1.9	0.53				70
9/25/92	1015	8.0	870		0.8	0.40				70
Count		50	50	3	49	50	11	10	10	45
Min		7.4	530		0.7	0.16	78	54	110	44
Max		8.9	1330		4.9	1.0	180	270	280	83
Mean		8.3	831		2.2	0.42	120	140	190	67
Geo Mean		8.3	810		2.0	0.39	120	120	180	66
Median		8.3	800		2.0	0.38	130	110	170	70

Map Index T-7b, San Luis Canal at HWY 152 (MER527)

Location: Latitude 36°03'03", Longitude 120°48'10". In SE 1/4, SW 1/4

SE 1/4 Sec. 18, T.10S., R.11E. N side of Hwy 152 , 2.5 mi. E of Los Banos.

DATE	TIME	PH	EC µmhos/cm	Se µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1435	8.4	740	1.4	0.25				80
10/7/91	950	8.0	700	1.0	0.27				72
10/11/91	805	7.3	700	1.2	0.28				70
10/18/91	1000	8.1	640	1.0	0.26				71
10/25/91	1145	8.3	570	0.6	0.32	94	59	120	
11/25/91	1010	7.6	860	0.9	0.45	140	100	170	54
12/26/91	935	8.9	1040	1.8	0.55	150	180	200	45
1/31/92	1100	8.2	2910	3.5	4.0	360	560	600	
2/28/92	1145	8.1	980	3.6	0.52	140	180	230	64
3/30/92	1015	8.1	2680	3.6	3.3	260	520	640	61
4/30/92	1255	8.3	7790	1.2	14	870	2500	2100	72
5/29/92	1155	8.1	1730	2.5	2.1				72
6/26/92	1100	7.8	1740	2.0	1.6	230	250	430	76
7/30/92	1525	8.2	1470	2.7	1.3	170	241	272	81
8/28/92	1425	8.0	1820	1.7	1.7	236	340	382	76
9/25/92	1115	8.4	1020	1.6	0.64	154	133	204	70
Count		16	16	16	16	11	11	11	14
Min		7.3	570	0.6	0.25	94	59	120	45
Max		8.9	7790	3.6	14	870	2500	2100	81
Mean		8.1	1710	1.9	2.0	255	460	490	69
Geo Mean		8.1	1290	1.7	0.9	208	260	340	68
Median		8.1	1030	1.7	0.6	170	240	270	72

APPENDIX C

Mineral and Trace Element Water Quality Data for Outflow Monitoring Stations
Listed in Order by Map Index Number

Map Index	RWQCB Site I.D.	Site Name	Page
O-1	MER551	Mud Slough (N) @ Newman Gun Club	43
O-2A	MER542	Mud Slough (N) @ San Luis Drain	44
O-3	MER554	Los Banos Creek @ Hwy 140	45
O-4	MER531	Salt Slough @ Lander Avenue	46
O-6	MER543	City Ditch	47

Map Index O-1. Mud Slough at Newman Land and Cattle Company (MER551)

Location : Latitude 37°18'33" , Longitude 120°57'18". In NW 1/4, NW 1/4, SW 1/4,
 Sec. 23, T.7S., R.9E., 1.7 mi. NE of Santa Fe Grade, 1.2 mi. N of HWY 140.
 4.2 mi NE of Gustine.

DATE	TIME	PH	EC umhos/cm	Se ug/L	Mo ug/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1650	8.2	2870	3.3		2.4				88
10/7/91	1010	7.9	2280	3.6		1.8				70
10/10/91	1800	8.3	1550	2.9		0.85				78
10/18/91	905	8.0	1860	3.0		1.2				62
10/25/91	1050	7.9	1310	2.5		0.94	190	230	290	58
11/1/91	1425	8.7	1480	3.1		0.94				66
11/8/91	1350	8.6	1250	2.4	9	0.83				66
11/15/91	1410	8.5	2030	2.9	16	1.6				59
11/25/91	845	8.1	2450	1.8	16	1.8	320	420	480	49
12/6/91	1100	8.3	3070	1.1	19	2.1				49
12/13/91		8.4	3020	1.2	21	2.2				49
12/20/91	1055	8.4	3860	1.3		2.7				
12/26/91	915	8.3	3530	1.0	21	2.5	660	970	700	46
1/10/92	1200	8.1	1690	1.1		1.2				48
1/17/92	1100	8.1	2420	1.0		1.5				44
1/24/92	1130	8.3	2590	0.8		1.6				
1/31/92	955	8.2	3100	1.4		2.1	450	530	520	48
2/28/92	1125	7.4	2290			1.7	330	390	390	64
3/13/92	1140	7.9	3230	1.5		2.5				68
3/20/92	1130	8.1	2800	1.2		2.2	390			60
3/26/92	1100	7.9	2340	2.0		2.0				68
3/30/92	845	7.9	2760	1.9		2.5	570	700	480	63
4/2/92	1050	7.8	2420	1.2		2.2				72
4/6/92	1115	8.1	2790	1.2		2.6				64
4/9/92	1100	8.1	2820	1.5		2.5				68
4/13/92	930	8.1	3420	1.7		2.6				64
4/16/92	1155	8.0	3730	1.4		2.9				72
4/20/92	1015	8.4	4230	1.4		3.5				70
4/23/92	1210	8.4	4410	8.9		2.4				68
4/27/92	1330	8.4	5010			3.9				79
4/30/92	1535	8.7	5550	2.4		4.3	860	1200	1100	82
5/7/92	1825	8.1	3090	1.7		4.7				74
5/15/92	1200	8.4	5100	1.7		3.4				81
5/21/92		8.5	7570	1.5		4.4				82
5/29/92	1025	8.3	7320	2.1		4.4	1300	1800	1500	80
6/5/92	1340	8.4	3590	2.1		2.6				90
6/12/92	1135	8.2	4390	2.8		3.0				79
6/19/92	1145	8.3	4740	2.2		3.4				85
6/26/92	920	8.4	4260	48		5.7	560	130	960	76
7/3/92	1325	8.3	4100	23		5.6				81
7/10/92	1140	8.4	4830	36		6.8				85
7/17/92	1145	8.2	3480	41		5.1				84
7/24/92	1055	8.7	3630	31		6.5				79
7/30/92	1010	8.7	4220	38		5.6	543	1140	796	76
8/7/92	1250	8.5	3650	27		4.5				84
8/14/92	1125	8.7	3550	22		4.3				84
8/23/92	1010	8.2	2800	23		3.4				73
8/28/92	1010	8.3	2950	14		2.9	353	625	558	74
9/4/92	1300	8.4	3090	4.5		2.1				79
9/11/92	1320	8.4	3690	40		6.0				78
9/18/92	1200	8.2	3480	5.7		3.1				78
9/25/92	950	7.9	3150	3.3		3.0	377	742	651	67
Count		52	52	50	6	52	13	12	12	50
Min		7.4	1250	0.8	9	0.83	190	130	290	44
Max		8.7	7570	48	21	6.8	1300	1800	1500	90
Mean		8.2	3360	8.6		3.0	531	740	702	70
Geo Mean		8.2	3130	3.6		2.6	473	596	636	69
Median		8.3	3130	2.3		2.6	450	663	605	72

Map Index O-2A. Mud Slough at San Luis Drain (MER542)

Location : Latitude 37°19'50", Longitude 120°57'03". In NW 1/4, NE 1/4, NW 1/4, Section 14, T.7S., R.9
5.0 mi. E of Gustine, 3.5 mi. SE of HWY 140, Located inside Kesterson N.W.R.

DATE	TIME	PH	EC µmhos/cm	Cr µg/L	Cu µg/L	Pb µg/L	Ni µg/L	Zn µg/L	Se µg/L	Mo µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1615	8.8	760						1.9		0.38				84
10/7/91	940	8.3	740						1.6		0.28				70
10/10/91	1830	8.4	660						1.3	1	0.20				78
10/18/91	945	7.9	980						1.6		0.71				62
10/25/91	1125	8.0	950	6	3	<5	10	4	1.1	8	0.73	150	110	210	60
11/1/91	1350	8.4	1110						1.4		0.73				65
11/8/91	1300	8.1	1990						1.8	22	1.6				66
11/15/91	1340	8.8	2880						1.2	30	2.4				58
11/25/91	930	8.1	2270	2	2	<5	6	6	0.8	20	1.7	290	340	410	52
12/6/91	1025	8.0	3300						0.7	29	2.3				47
12/13/91		8.3	3140						1.2	22	2.3				47
12/20/91	1120	8.1	3380						0.8		2.7				
12/26/91	1000	8.2	4050						0.7	33	2.9	630	860	710	48
1/2/92	1010	8.3	2510						0.6		1.4				45
1/10/92	1130	7.9	1880						0.6		1.3				48
1/17/92	1025	8.0	3320						0.7		2.3				46
1/24/92	1100	8.2	3720						1		2.5				
1/31/92	1030	8.1	3670						1.5	25	2.6	550	660	630	50
2/7/92	1330	8.0	3830						1.6	25	2.8				58
2/14/92	1240	7.9	1825						0.4		1.3				56
2/21/92	925	7.8	2000						3.6		1.7				57
2/28/92	1230	7.4	2280	7	3	<5	11	8	1		1.7	340	360	380	64
3/6/92	1015	7.9	2810						1.4		2.3				58
3/13/92	1115	7.7	2945						1.4		2.4				66
3/20/92	1040	8.1	2640						1		2.1	380			60
3/26/92	1010	7.8	2545						3.3		2.3				66
3/30/92	930	8.0	2855	6	2	<5	11	5	2.4	9	2.6	410	460	470	62
4/2/92	1005	7.9	2640						1.5		2.3				66
4/9/92	1020	8.1	3120						1.5		2.7				64
4/16/92	1100	8.1	3610						1.1		3.0				67
4/23/92	1135	8.1	5060						12		4.5				65
4/30/92	1440	8.0	6890	2	<1	<5	7	<1	1.6	39	5.5	1100	1600	1200	79
5/7/92	1000	7.7	6910						0.7		2.1				70
5/15/92	1240	8.0	6900								4.3				81
5/21/92		7.9	8040						19		2.2				87
5/29/92	1100	7.9	7660	1	4	<5	6	11	1.2	28	4.3	1200	1800	1200	79
6/5/92	1100	7.9	4400						2.2		3.2				78
6/12/92	1220	7.9	8670						1		5.5				75
6/19/92	1230	8.7	6360						1.2		4.1				81
6/26/92	1000	8.3	3990	8	4	1	17	10	50	19	5.8	510	1200	890	77
7/3/92	1300	8.3	4210						45		6.3				81
7/10/92	1110	8.5	4660						50		6.6				82
7/17/92	1105	8.1	3890						47		5.7				82
7/24/92	1020	8.6	4060						48		6.3				77
7/30/92	1115	8.4	4350	6	4	<5	9	7	47	21	6.5	517	1160	894	75
8/7/92	1145	8.5	3480						40		5.0				84
8/14/92	1030	8.2	3940						45		6.8				80
8/23/92		8.1	2340						24	10	2.9				73
9/4/92	1220	8.5	2750						24		4.0				76
9/11/92	1200	7.9	2670						25		3.8				77
9/18/92	1040	8.1	1450						3.5	6	1.1				70
9/25/92	1050	8.1	1390	8	4	<5	12	5	2.3	4	0.86	206	175	270	65
Count		52	52	9	9	9	9	9	51	18	52	12	11	11	50
Min		7.4	660	1	<1		6	<1	0.4	1	0.20	150	110	210	45
Max		8.8	8670	8	4		17	11	50	39	6.8	1200	1800	1200	87
Mean		8.1	3430	5			10		10	20	3.0	524	793	660	67
Geo Mean		8.1	2910	4			9		2.9	15	2.3	443	579	572	66
Median		8.1	3130	6	4	<5	10	8	1.5	22	2.5	460	660	630	66

Map Index O-3. Los Banos Creek at Hwy 140 (MER 554)

Location : Latitude 37°16'35", Longitude 120°57'14". In NE 1/4, SW 1/4,
SW 1/4, Sec. 35, T.7S.,R.9E. S side of HWY 140, 2.9 mi. NE of Gustine.

DATE	TIME	PH	EC µmhos/cm	Se µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1630	8.4	1730	1.8	1.2				78
12/26/91	950	8.1	1010	1.3	0.49				
1/31/92	1430	8.3	1445	2.1	0.56				
2/28/92	1200	7.2	2200		1.9	340	330	400	64
3/30/92	910	7.8	2370	0.5	2.3	350	350	410	63
4/30/92	1455	8.2	2500	0.8	2.2	340	320	510	77
7/30/92	1100	7.9	1500	0.9	1.4	157	295	308	75
8/28/92	1040	7.6	1340	1.9	1.2	152	275	280	74
Count		8.0	8	7	8	5	5	5	6
Min		7.2	1010	0.5	0.49				63
Max		8.3	2500	2.1	2.3				77
Mean		7.9	1770	1.3	1.4				71
Geo Mean		7.9	1680	1.1	1.2				70
Median		7.9	1500	1.1	1.4				74

Map Index. O-4 Salt Slough at Lander Ave. (HWY 165) (MER531)

Location: Latitude 37°14'55" , Longitude 120°51'04" . In NW 1/4, SE 1/4, SE 1/4 , Sec 10, T.8S.,
R.10E. 13.0 mi N of Los Banos, 5.0 mi. S of HWY 140. Salt Slough at Lander Avenue.

DATE	TIME	PH	EC µmhos/cm	Cr µg/L	Cu µg/L	Pb µg/L	Ni µg/L	Zn µg/L	Se µg/L	Mo µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1540	8.1	1950						3.6		0.94				84
10/7/91	855	7.6	1910						3.5		0.99				65
10/10/91	1910	7.4	1620						1.1	9	0.51				76
10/18/91	1015	2.1	1920						0.8		0.74				65
10/25/91	1205	8.4	2240	1	<1	<5	<5	3	0.6	11	1.1	480	360	410	60
11/1/91	1300	7.9	1460						1.9		0.67				59
11/8/91	1215	7.9	1700						11	9	1.4				64
11/15/91	1305	8.0	2500						14	15	2.1				57
11/25/91	1010	8.0	1820	3	2	<5	6	9	4.2	8	1.1	260	250	380	52
12/6/91	955	8.1	1960						1.8	11	1.0				45
12/13/91		8.2	2360						3.8	13	1.6				48
12/20/91	1200	8.4	2720						8.8		2.2				
12/26/91	1040	8.1	2810						10	16	2.4	440	530	590	46
1/2/92	1040	8.1	3340						19		3.4				47
1/10/92	1100	7.9	3230						21		3.6				48
1/17/92	955	8.3	3370						20		3.3				46
1/24/92	1000	8.4	3605						19		3.5				
1/31/92	1110	7.8	3760						23	16	3.8	570	800	810	50
2/7/92	1400	7.9	3555						24		3.6				56
2/14/92	1305	7.4	2865						18	12	3.0				56
2/21/92	1010	7.7	3140						17		3.2				58
2/28/92	1340	7.5	3440	6	3	<5	8	12	24		3.5	480	830	780	65
3/6/92	930	7.8	3050						21		3.4				58
3/13/92	1045	7.7	2865						18		2.9				63
3/20/92	1000	7.8	3235						23		3.1	470			60
3/23/92	1015	7.8	2080						13		1.9				61
3/26/92	925	7.6	2020						8.6		1.8				64
3/30/92	1010	7.8	2565	6	3	<5	7	4	17	10	2.5	320	610	600	63
4/2/92	925	7.7	2650						16		2.5				65
4/6/92	1010	8.0	2910						21		3.0				62
4/9/92	945	7.9	2960						23		3.2				64
4/13/92	1020	8.1	2780						25		2.8				64
4/16/92	1025	8.0	2570						19		2.7				66
4/20/92	930	8.2	2170						15		2.2				65
4/23/92	1055	8.0	2650						25		2.8				64
4/27/92	1235	8.0	2320						15		2.1				71
4/30/92	1400	7.9	2750	8	4	<5	13	13	25	11	2.7	400	610	640	73
5/7/92	1940	8.1	2600						12		1.6				78
5/15/92	1310	8.2	2560								1.8				76
5/21/92	1920	8.4	2420						20		2.2				
5/28/92	1830	8.6	2930								3.0				82
5/29/92	1145	8.0	2960						21	15	2.5	450	620	750	76
6/5/92	1615	8.5	2960						27		3.6				88
6/12/92	1510	8.6	2950						23		3.8				80
6/19/92	1625	8.8	2230						13		2.2				83
6/26/92	1045	7.7	1510	6	5	2	11		2.3	7	0.74	270	260	310	75
7/3/92	1225	8.2	1420						2.3		0.75				78
7/10/92	1030	7.8	1870						8.4		1.4				80
7/17/92	1015	7.6	1560						1.6		0.74				80
7/24/92	940	8.3	1350						1.8		0.48				74
7/30/92	1150	8.3	1430	6	3	<5	7	8	0.9	7	0.47	227	160		79
8/7/92	1105	8.3	1400						1.0		0.58				78
8/14/92	935	7.9	1500						0.9		0.51				76
8/23/92	1130	7.9	1110						1.1		0.37				80
8/28/92	1130	7.9	1260	<5	3	<5	8	8	0.8	5	0.42	217	136	243	76
9/4/92	1115	8.0	1510						0.9		0.55				71
9/11/92	1235	8.1	1590						0.8		0.64				76
9/18/92	1055	7.9	1750						1.5		0.74				71
9/25/92	1225	8.0	2020	<5	2	<5	<5	3	1.2	10	0.81	356	245	392	68
Count		59	59	9	9	9	9	8	57	17	59	13	12	11	56
Min		2.1	1110	1	<1		<5	3	0.6	5	0.37	217	136	243	45
Max		8.8	3760	8	5		13	13	27	16	3.8	570	830	810	88
Mean		7.9	2370					8	12	11	2.0	380	451	537	67
Geo Median		7.8	2260					7	6.7	10	1.6	363	384	501	66
Median		8.0	2420	6	3	<5	8	8	13	11	2.1	400	445	590	65

Map Index O-6. City Ditch (San Luis Wasteway to Mud Slough) (MER543)

Location : Latitude 37°07'44", Longitude 120°48'53". In Sw 1/4, SW 1/4, Sec. 19, T.9S.,R.11E.2.2 mi. N of Henery Miller Rd. along San Luis Canal.

DATE	TIME	PH	EC umhos/cm	Se µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1455	8.1	4360	63	6.6				82
10/7/91	830	7.5	930	3.7	0.54				68
10/18/91	1040	8.0	1480	9.4	1.6				68
10/25/91	1215	8.5	910	5.5	0.90	160	200	200	
11/1/91	1215	8.0	2200	19	2.6				59
11/8/91	1135		2280	27	2.7				
11/15/91	1220		2730	27	3.7				
11/25/91	1105	8.1	2840	15	3.6	310	650	690	
12/6/91	920	8.3	2690	9.1	3.3				43
12/13/91		8.3	3360	15	4.6				47
12/20/91	1230	8.3	2910	21	3.5				
12/26/91	1020	8.4	3700	34	5.2	490	1000	940	44
1/10/92	1040	8.0	3650	28	5.4				48
1/17/92	940	8.5	3640	28	4.9				45
1/24/92	930	8.2	4100	39	6.1				
1/31/92	1200	8.1	4180	46	6.2	630	1100	1100	50
2/14/92	1330	7.9	3660	35	5.0				58
2/21/92	1025	8.0	3910	36	5.4				59
3/6/92	840	8.2	4010	47	6.2				58
3/13/92	950	8.1	4420	54	6.8				63
3/20/92	910	7.6	4630	54	6.7	530			59
3/26/92	835	7.9	3010	26	4.3				62
3/30/92	1030	8.2	3510	40	5.5	500	840	880	64
4/2/92	835	8.0	3970	44	5.7				65
4/6/92	835	8.0	3970	44	5.7				65
4/9/92	910	8.2	4110	52	5.6				63
4/16/92	940	8.3	3750	46	5.9				64
4/23/92	1000	8.3	3140	51	4.2				63
4/30/92	1315	8.3	4140	66	6.0	500	1100	1100	72
5/7/92	1900	8.4	4310	69	5.2				74
5/15/92	1440	8.6	4410	64	5.5				77
5/21/92	1840	8.3	3910	46	4.9				
5/28/92	1755	8.4	4650		7.8				80
5/29/92	1220	8.5	4610	68	7.0				74
6/5/92	1655	8.3	1430	7.7	1.6				85
6/12/92	1550	8.0	2620	17	3.5				84
6/19/92	1705	8.6	4000	50	6.3				82
6/26/92	1110	8.5	4330	62	6.4	580	1300	1000	79
Count		36	38	37	38	8	7	7	33
Min		7.5	910	3.7	0.54	160	200	200	43
Max		8.6	4650	69	7.8	630	1300	1100	85
Mean		8.2	3430	37	4.8	460	880	840	64
Geo Mean		8.2	3220	30	4.3	430	780	750	63
Median		8.2	3730	39	5.3	500	1000	940	63

