



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

Selenium TMDL for Grasslands Marshes



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1. Grassland Watershed Wetland Channels for Which Beneficial Uses Have Been Identified
2. Regional Water Quality Control Board, Central Valley Region, 1996 Basin Plan Amendments for the Control of Agricultural Subsurface Drainage Discharges, Resolution 96-147, Administrative Record Index
3. Regional Water Quality Control Board, Central Valley Region, 1996 Basin Plan Amendments for the Control of Agricultural Subsurface Drainage Discharges, Letters Received
4. Regional Water Quality Control Board, Central Valley Region, 1996 Basin Plan Amendments for the Control of Agricultural Subsurface Drainage Discharges, Response to Comments

Summary of TMDL Action

Following are the waste load allocations and load allocations for the Grassland Marshes selenium TMDL:

TMDL (Loading Capacity)	2 ppb Selenium as a monthly mean
Load Allocation Subsurface Drainage from Drainage Problem Area Background	2 ppb Selenium as a monthly mean 2 ppb Selenium as a monthly mean
Waste Load Allocation (no NPDES sources)	0 lbs Selenium

Problem Statement

The Grassland Marshes are listed in accordance with Section 303(d) of the Clean Water Act for exceeding selenium water quality objectives. Areal extent of the impairment was listed as 8,224 acres in 1988 as part of the water quality assessment and 303(d) listing process. The original basis for determining the extent of impairment is not available. As part of its 1996 Basin Plan Amendment, the Regional Board re-evaluated the miles of wetland channels and the extent of wetland acreage impaired or threatened by selenium contamination. The Regional Board determined that approximately 75 miles of wetland supply channels and 61,810 acres of wetland marshes were impaired or threatened by elevated selenium concentrations in agricultural subsurface drainage water (California Regional Water Quality Control Board, Central Valley Region, 1998b, Appendix 40). The Regional Board has not updated its 305(b) report or 303(d) list to reflect the more recent evaluation. The TMDL described below is based on the more recent information available regarding the extent of impairment.

Soils in the Grassland Watershed (Figure 1) are derived from rocks of marine origin in the Coast Range that are high in selenium and salts. Major land uses in the watershed include agriculture and wetlands. Water supplied to the 61,810 acres of wetland marshes through supply channels that, prior to completion of the Grassland Bypass Project in September 1996, also conveyed agricultural drainage water (California Regional Water Quality Control Board, Central Valley Region, 1996). Prior to completion of the Grassland Bypass Project, these supply channels alternately conveyed fresh water supplies and agricultural drainage water from 97,000 acres of tile drained farmland. Subsurface tile drainage water from these 97,000 acres is the primary source of selenium in the Grassland Watershed. The result of this combined use was that the wetland water supply channels and the wetlands, periodically had elevated selenium concentrations. There are no NPDES permitted sources that drain to the wetland channels that convey water to the Grassland marshes.

Dry conditions make irrigation necessary for nearly all crops grown commercially in the watershed. Irrigation of soils derived from marine sediments leaches selenium into the shallow groundwater. Subsurface drainage is produced when farmers drain the salty groundwater from the root zone to protect their crops, and a portion of the Grassland Watershed that generates subsurface drainage has been designated as the Drainage Project Area (DPA). The discharge of subsurface drainage from that area resulted in elevated selenium concentrations in the wetland supply channels and other water bodies within the watershed and downstream. Selenium is a

highly bioaccumulative trace element which, under certain conditions, can be mobilized through the food chain and cause both acute and chronic toxicity to fish and wildlife. Deformities and deaths of waterfowl have been linked to toxic concentrations of selenium. There was concern that elevated selenium concentrations in subsurface drainage would cause problems for the aquatic birds and wildlife that use the Grassland marshes. The Grassland marshes were placed on the Section 303(d) list in 1988 because water in the wetland supply channels routinely exceeded 2 µg/L. At the time of the 1988 listing, 2 µg/L was the United States Fish and Wildlife Service recommended selenium criteria to protect waterfowl and other wildlife uses.

The Grassland Watershed has undergone dramatic changes in hydrology and water quality due to agricultural development over the years. Prior to September 1996, subsurface drainage from the DPA flowed through the Grassland wetlands on its way to the San Joaquin River (figure 2). Starting in September 1996, this subsurface drainage was collected and conveyed in a single channel, the Grassland Bypass, to the northern reach of the San Luis Drain. The San Luis Drain discharges into Mud Slough (north) nine miles upstream of its confluence with the San Joaquin River. The effect of this Grassland Bypass Project was removal of most of the selenium load from wetland supply channels and therefore the wetlands themselves (Figure 3).

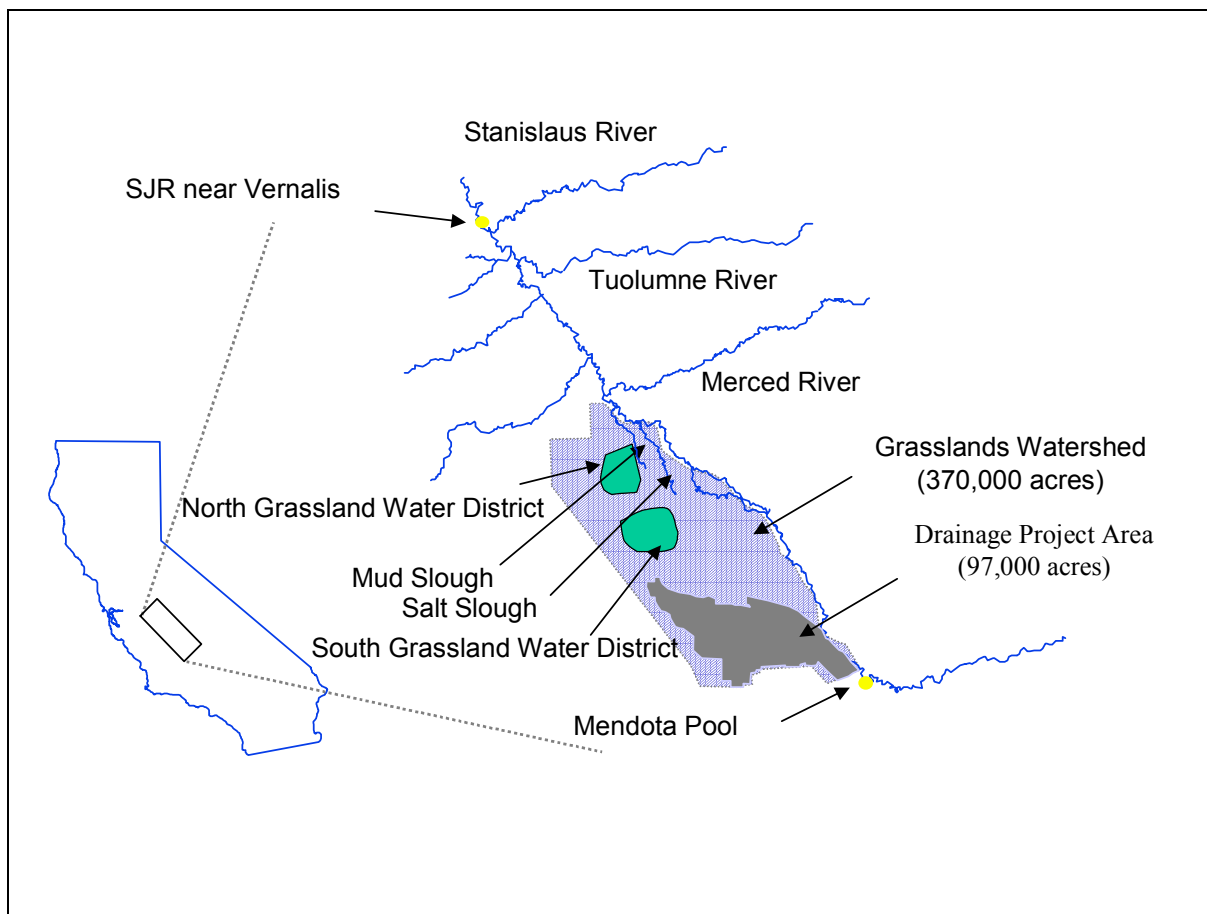


Figure 1. Location Map

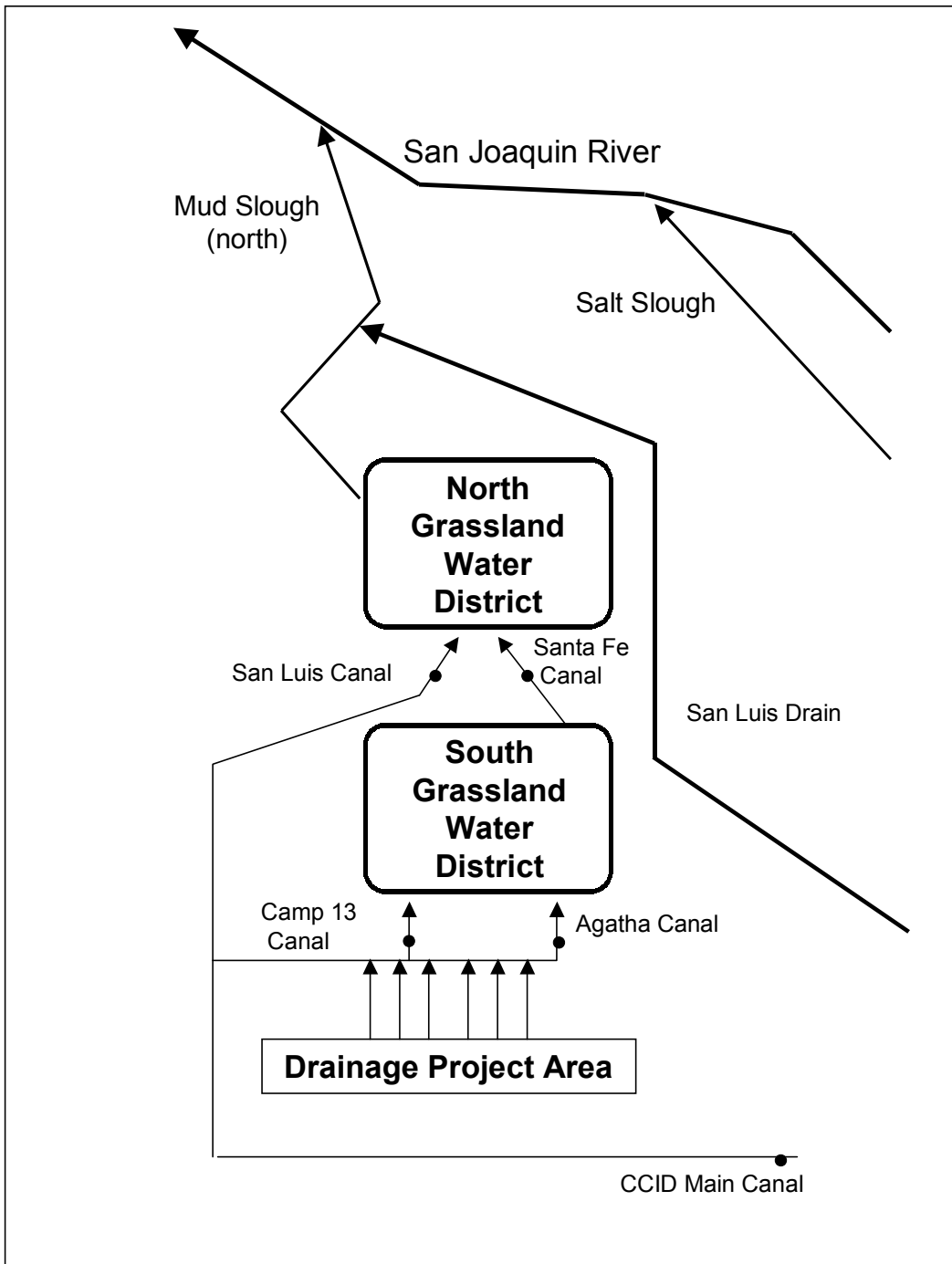


Figure 2. Wetland Water Supply Schematic Before Grassland Bypass Project

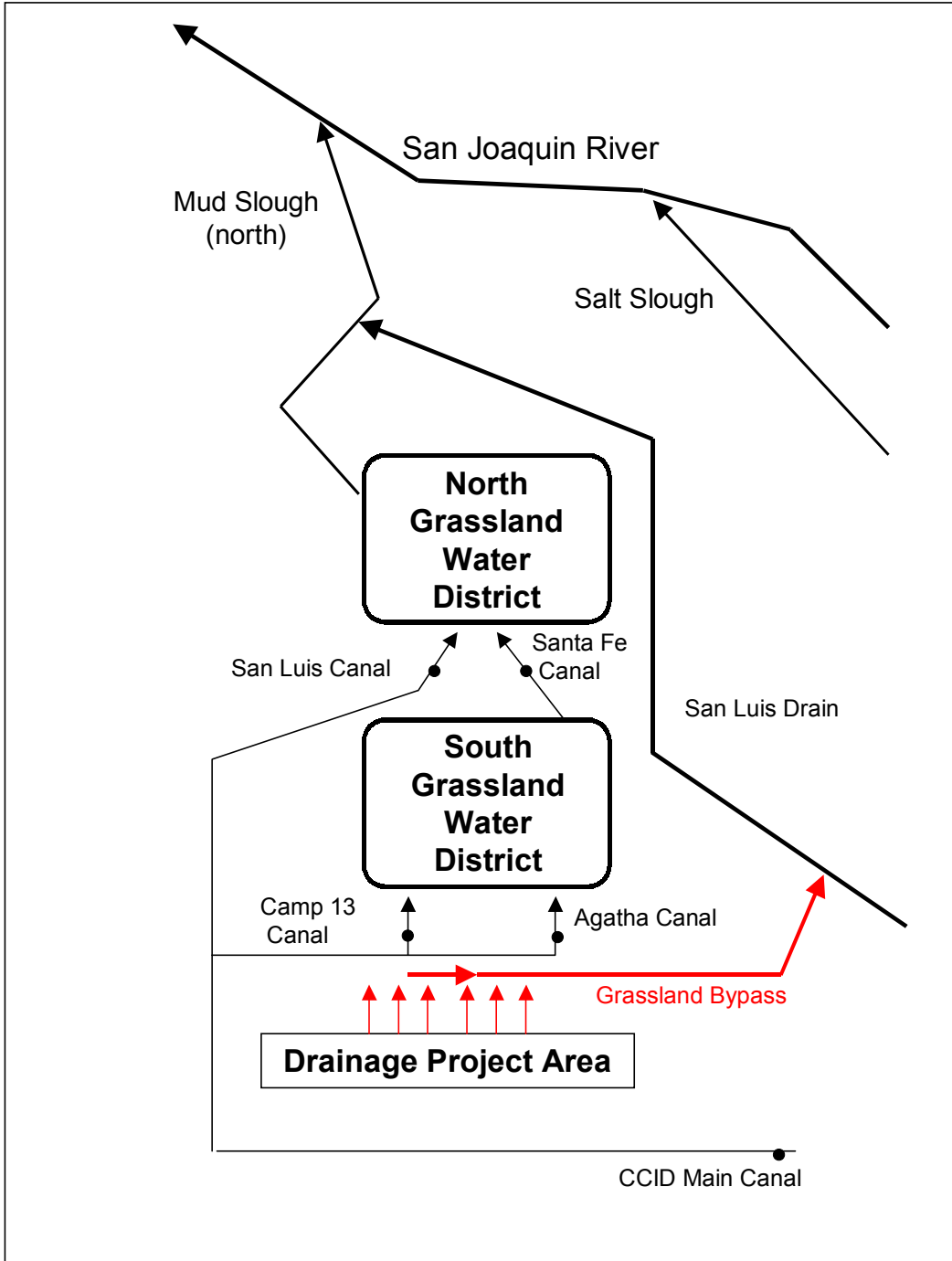


Figure 3. Wetland Water Supply Schematic After Grassland Bypass Project

Numeric Target

In 1996, the Regional Board adopted a Basin Plan Amendment for the Regulation of Agricultural Subsurface Drainage. The amendment contained a selenium water quality objective for wetland water supply channels and Salt Slough. This objective, which was approved by the State Board and the Office of Administrative Law, is a monthly mean concentration of 2 µg/L. The objective for the supply channels was made more stringent than the selenium objective for downstream waterbodies to offer added protection to the waterfowl using the wetlands. Based on a review of the available scientific literature, the Regional Board determined that a 2 µg/L monthly mean selenium objective would be protective of waterfowl. This 2 µg/L monthly mean selenium objective incorporates a margin of safety because it is based upon threshold water borne concentrations of 2.3 to 2.5 µg/L correlated with selenium tissue concentrations in aquatic birds that have shown impaired hatchability of eggs and susceptibility to disease (California Regional Water Quality Control Board, Central Valley Region; 1996; pg. 61).

Consideration was given to translating the selenium water quality objective into a load limit, but water quality data collected in wetland water delivery channels in the late 1980's through early 1990's showed little change in concentration even in response to significant load reductions (California Regional Water Quality Control Board, Central Valley Region; 1995; pp. 5-7). Based on this information, the Regional Board concluded that removal of untreated subsurface agricultural drainage was required to meet water quality objectives (California Regional Water Quality Control Board, Central Valley Region; 1996; pp. 67-68). Therefore, a concentration based objective was determined to be the best measure of success for protecting beneficial uses and achieving water quality improvements. The numeric target for wetland water supply channels and the Grassland Marshes TMDL is the adopted Basin Plan selenium water quality objective of 2 µg/L (monthly mean).

Source Analysis

Although selenium exists naturally in the soils of this watershed, some land use practices accelerate its movement to ground water and surface water. Prior to the Grassland Bypass Project, water supply for the Grassland Marshes shared conveyance channels with subsurface and surface drainage from the DPA. Subsurface drainage, specifically from the tile drains in the DPA, is the most significant source of selenium in the Grassland Watershed. A survey of tile drainage in the San Joaquin River Basin (Chilcott et al., 1988) found the highest concentrations of selenium in the Grassland Watershed. Eighty-two percent of the samples collected at 173 tile drainage sites in the Grassland Watershed had selenium concentrations ranging from 11 to 500 µg/L. The Regional Board has conducted water quality sampling in wetland water supply channels since 1985. Some of these channels, such as CCID Main Canal at Russel Blvd., are upstream of the tile drainage discharges from the DPA. This site represents background selenium concentrations in supply water delivered to the wetland channels. The source of water in CCID Main Canal at Russel Blvd. includes deliveries from the Delta Mendota Canal, Mendota Pool, and agricultural return flows from outside the DPA. The median value of selenium was 1.6 µg/L and the mean was 2.2 µg/L for over 200 samples collected (California Regional Water Quality Control Board, Central Valley Region; February, 1998a; pg. 178).

Tile drainage from the Drainage Project Area is the primary source of selenium in the Grassland Watershed. There are no municipal or industrial sources. Selenium is a naturally occurring

element in sediments of the Grassland Watershed. Selenium can therefore be found in surface runoff and groundwater throughout the watershed.

Implementation Plan

In 1996, the Regional Board amended its Basin Plan for control of agricultural subsurface drainage discharges. This Basin Plan Amendment prohibits discharge of subsurface drainage water to Grassland Watershed wetland supply channels if the discharge results in concentrations exceeding the water quality objective. Removal of selenium from wetland supply channels will remove the source of selenium loading to the Grassland Marshes. This prohibition has eliminated the largest loading of selenium to the wetland supply channels. Since September 1996, the Grasslands Bypass Project has isolated and rerouted tile drainage from the DPA away from wetland supply channels by using a portion of the former San Luis Drain to convey tile drainage directly to Mud Slough. The San Luis Drain discharges to Mud Slough approximately nine miles upstream of the San Joaquin River confluence (figure 3).

Other sources of water in the wetland supply channels are deliveries from the Delta Mendota Canal and Mendota Pool via the Main Canal, wetland discharges, overland flows from the DPA during storm events, surface agricultural return flows, and groundwater accretions. Information available prior to 1996 indicated that selenium concentrations of those sources commonly fell below 2 µg/L. On this basis, no other implementation provisions appeared necessary, nor were included, in the 1996 Basin Plan Amendment for the Control of Agricultural Subsurface Drainage Discharges (California Regional Water Quality Control Board, Central Valley Region; 1996).

Allocations

Subsurface drainage is prohibited from discharge into Grassland wetland supply channels if the discharge results in concentrations exceeding the water quality objective; therefore, the subsurface drainage allocation is expressed as the water quality concentration of 2 µg/L as a monthly mean. As discussed in the *Source Analysis* section above, load allocations for the surface agricultural drainage and wetlands discharges are not necessary since they are not significant sources. Regional Board monitoring data shows that surface agricultural drainage and wetland discharges typically have selenium concentrations of less than 2 µg/L. Background sources such as groundwater and surface runoff are given a load allocation expressed as a monthly mean water quality concentration of 2 µg/L.

Performance Measures and Feedback

Water quality monitoring conducted after the start of the Grassland Bypass Project in September, 1996 indicates that overall selenium concentrations in wetland supply channels have decreased dramatically, although the mean monthly objective is still being exceeded. The 2 µg/L objective has been exceeded in ten out of 24 months in the Santa Fe Canal (figure 4) and eleven out of 24 months in the San Luis Canal (figure 5). The 2 µg/L objective has been exceeded in 10 out of 24 months in the Camp 13 canal (figure 6) and 5 out of 24 months in the Agatha Canal (figure 7). These four channels are representative of supply channels that deliver water to the Grassland Marshes.

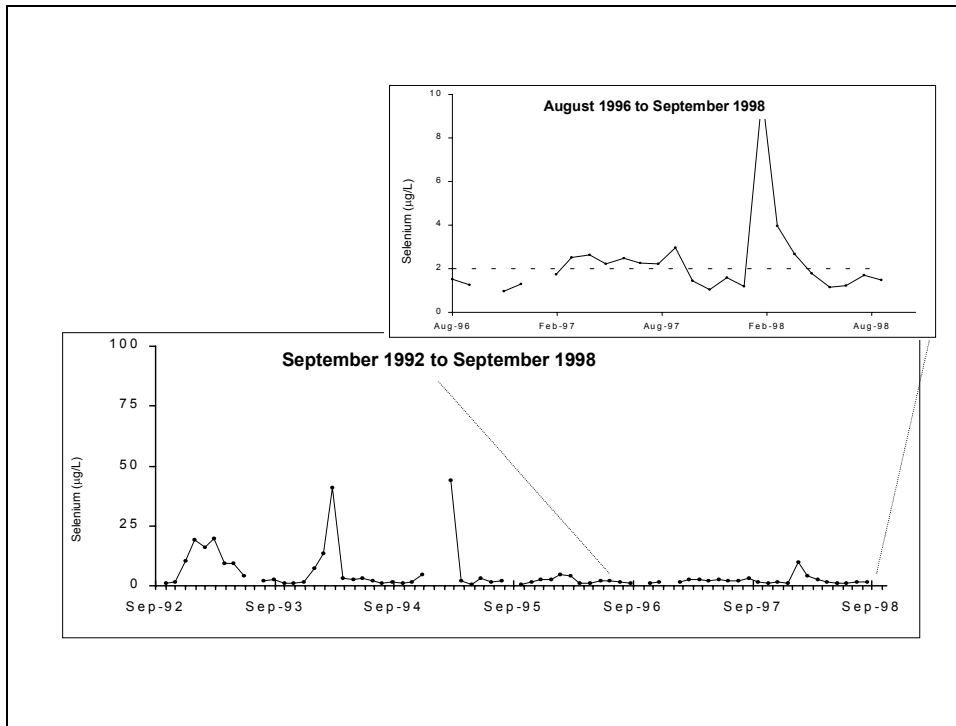


Figure 4. Mean Monthly Selenium in Santa Fe Canal

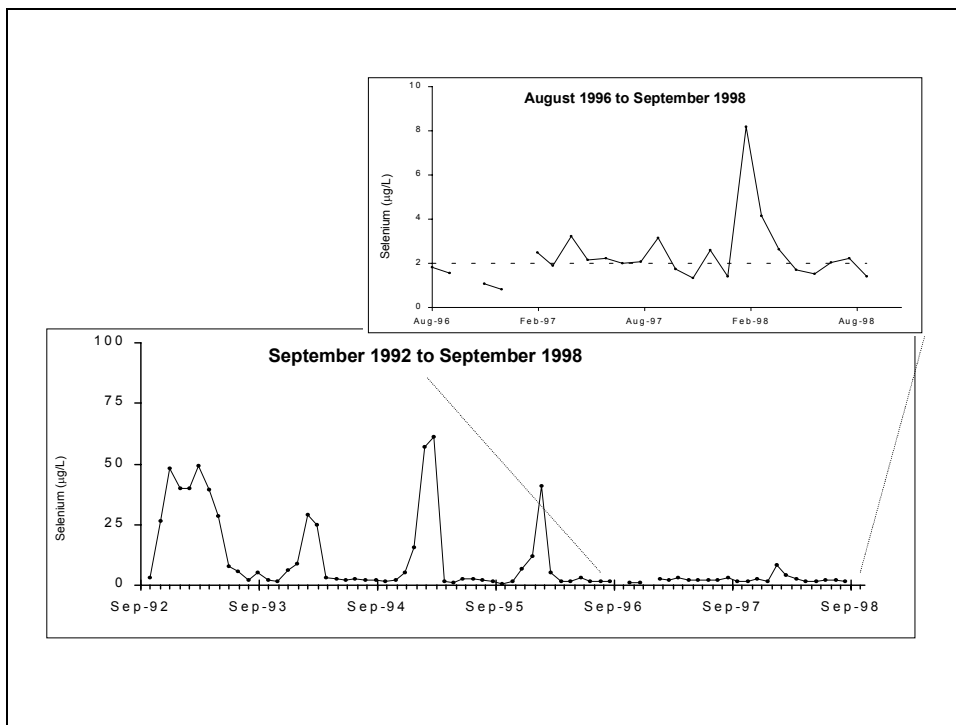


Figure 5. Mean Monthly Selenium in San Luis Canal

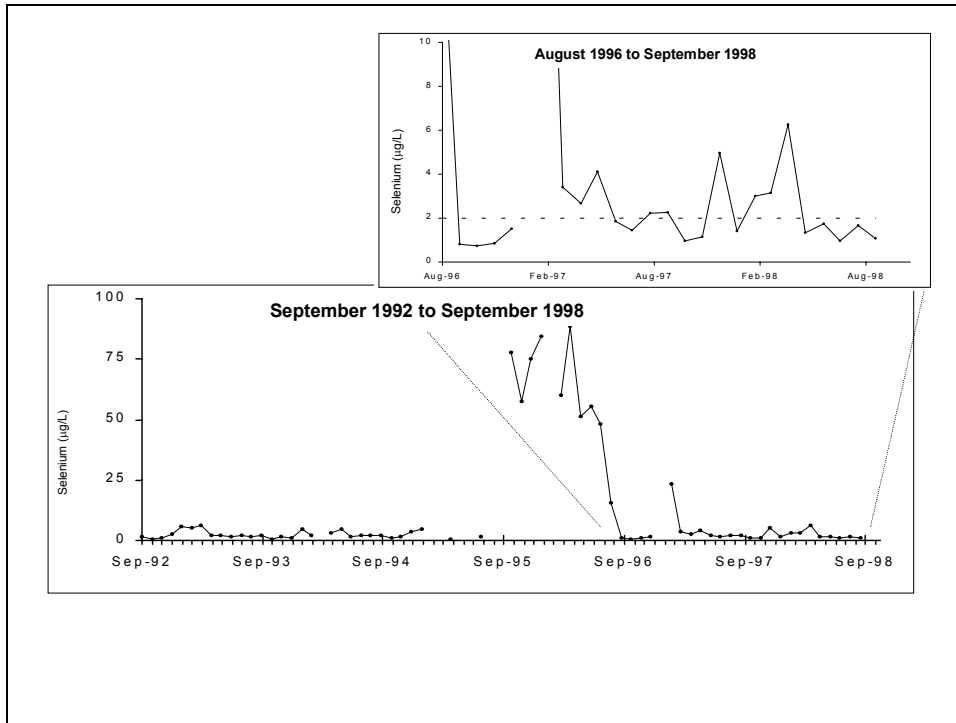


Figure 6. Mean Monthly Selenium in Camp 13 Canal

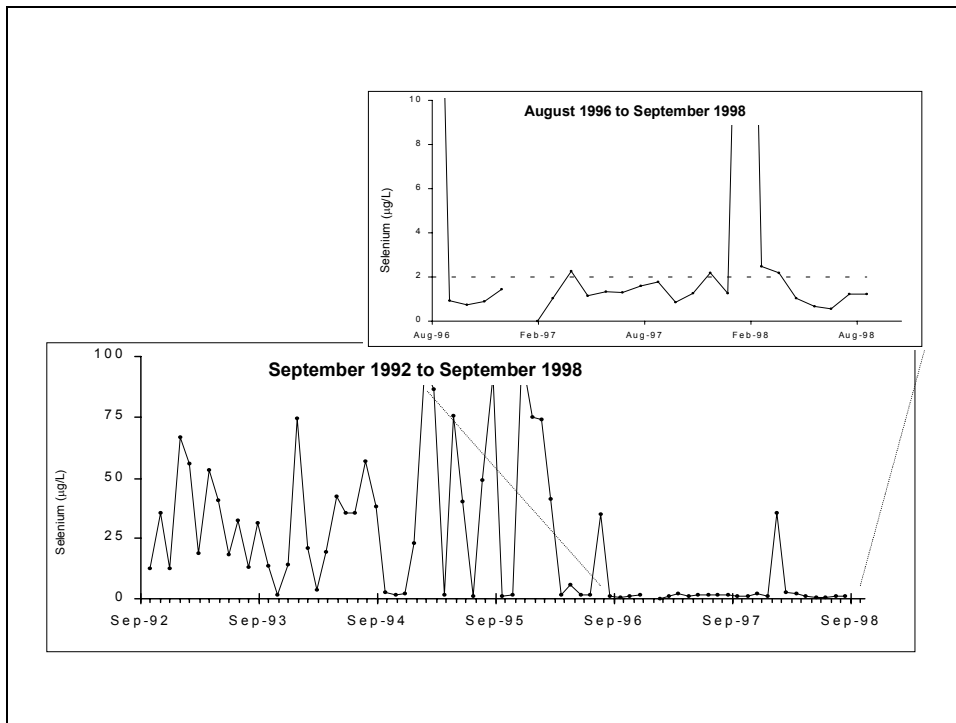


Figure 7. Mean Monthly Selenium in Agatha Canal

Most elevated selenium concentrations occurred during and immediately following storm events when surface runoff from the DPA that exceeded the capacity of the GBP was diverted into the wetland supply channels (Chilcott, 2000). There are some minor exceedances throughout the year. The median annual selenium concentration was less than or equal to 2.0 µg/L for all four sites in water years 1997 and 1998 except for the Santa Fe Canal which had a median concentration of 2.1 µg/L in water year 1997 (table 2). These median concentrations are much lower than the concentrations observed prior to use of the Grassland Bypass when median annual selenium concentrations sometimes exceeded 50 µg/L in these channels. This data suggests that with the control program already in place, most of the selenium has been diverted from the wetland supply channels. Annual median selenium concentrations were near or below 2 µg/L, indicating that exceedances of the objective are generally minor compared with concentrations observed prior to use of the Grassland Bypass.

Monitoring Site	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Agatha Canal	44	38	39	2.9	26	53	31	23	14	4.4	3.6	1.2	1.2
Camp 13 Slough	43	43	43	59	54	55	64	56	58	32	57	1.6	1.6
CCID Main Canal @ Russel Blvd.	1.3	2.2	1.7	1.7	2.3	1.5	2	1.4	1.7	1.4	0.9	-	1.1
Santa Fe Canal @ Henry Miller Road	25	30	-	-	-	-	-	5.3	1.8	1.7	1.8	2.1	1.5
San Luis Canal @ Henry Miller Road	-	-	-	-	-	-	-	12	2.5	2.2	1.8	2	1.8

Table 1. Annual Median Selenium Concentrations

A review of potential causes for the continued exceedances of the 2 µg/L objective is currently underway. Preliminary findings from this review suggest several possible causes for the elevated selenium concentrations, including: releases from the DPA during flooding, seepage from DPA gates and canals, elevated selenium concentrations in supply water, surface and subsurface agricultural drainage from areas outside of the DPA, and groundwater accretions (Chilcott, 2000). Most exceedances of the 2 µg/L objectives have been associated with flood flows, seepage from the DPA, subsurface agricultural drainage from outside the DPA, and supply water.

Several efforts are currently underway in response to these findings. A stormwater management plan has been put in place by local agencies to reduce selenium loading during and following storm events and to increase monitoring during storm events. Other recent efforts have focused on further controlling seepage from the DPA and consolidating and rerouting agricultural discharges from outside the DPA. Continued monitoring will be used to assess the effectiveness of these actions. Regional Board staff will review this monitoring data and will assess other sources, including supply water and groundwater, if selenium objectives are still being exceeded. At this time, Regional Board staff believes that corrective action taken to minimize stormwater flow, to control subsurface drainage outside the DPA, and to prevent seepage from the DPA, will eliminate the largest exceedances. Further action may be needed to eliminate all exceedances, particularly if these exceedances are associated with elevated selenium concentrations in water supplied to the wetland supply channels from the Mendota Pool, the Delta Mendota Canal, and

other sources. Appropriate actions will be evaluated subsequent to the corrective actions currently underway. A load allocation for these possible sources is unnecessary at this time because the prohibition of subsurface drainage is sufficient to fully implement the TMDL and meet the objective. Should further corrective actions be necessary to reduce concentrations in the supply water, a TMDL will be established for the sources of this supply water.

Margin of Safety

The Clean Water Act requires that a margin of safety be included with TMDL development. Sources of uncertainty in this analysis include the following three assumptions:

- there will be no future discharges of tile drainage to wetland channels
- complete removal of tile drainage alone will result in the attainment of established water quality objectives
- the numeric objective is fully protective of beneficial uses

Load reductions needed to meet water quality objectives for this TMDL are achieved through the complete prohibition of discharge of tile drainage to wetland water supply channels unless the 2 µg/L objective is being met. This prohibition has, in practice, resulted in a selenium load allocation of zero for tile drainage. As described in the *Implementation Plan* section, all tile drainage in the DPA is now discharged to a portion of the San Luis Drain. The mean annual selenium concentration of tile drainage discharged to the San Luis Drain was 62 µg/L in water year 1997, and 67 µg/L in 1998 (Chilcott et al, 2000). No future discharges of this tile drainage to wetland supply channels will be possible without removal of over 95 percent of the selenium load. This level of selenium load reduction is not likely in the foreseeable future. An additional implicit margin of safety is provided with the 2 µg/L mean monthly selenium objective. As explained in the *Numeric Target* section above, this objective is fully protective of waterfowl.

Complete removal of selenium load attributable to the major source (tile drainage) provides the maximum possible margin of safety. Revision of this TMDL or the margin of safety may be necessary if ongoing monitoring suggests that current and subsequent control measures are insufficient to reduce selenium concentrations in the wetland supply channels below 2 µg/L.

Seasonal Variation

The load allocation for subsurface drainage, expressed as a mean monthly water quality concentration of 2 µg/L, applies year round. As discussed in the *Implementation Plan* section, all tile drainage in the DPA is now discharged to a portion of the San Luis Drain. Discharge of tile drainage into wetland supply channels has been eliminated during all seasons of the year including periods of low flow. As discussed in the *Numeric Target* section above, the 2 µg/L mean monthly selenium objective is fully protective of waterfowl during all seasons.

Prior to the 1996 amendments to the Basin Plan, wetland water supplies had generally been protected seasonally during the fall, when seasonal wetlands that had been dry during the summer months were then filled.. Subsequent to this Basin Plan amendment, wetland water supplies may be delivered to wildlife refuges using the wetland water supply channels at any time during the year. A seasonal adjustment in the numeric target (the water quality objective) is therefore not needed.

Public Participation

The Regional Board held workshops and public hearings for the 1996 Basin Plan Amendments for the Control of Agricultural Subsurface Drainage Discharges. The State Board also held approval hearings. Adoption of the Basin Plan Amendment in 1996 enabled implementation of the Grasslands Marshes TMDL; therefore, the public hearings held for the Amendment will be used to fulfill the public participation requirements of this TMDL. The administrative record for the workshops and public hearings held for the Amendment are on file at the Regional Board in five 3.5 inch binders. The index for the administrative record is included as Attachment 2. Letters received during the comment periods are included in Attachment 3 and responses to these letters and the comments made during the workshops are included in Attachment 4.

This TMDL will be incorporated into the Regional Board's Water Quality Control Plan during the next Basin Plan Update. The Grasslands Marshes will be taken off the Section 303(d) list during the next Section 303(d) update, pending full compliance with established selenium water quality objectives.

References

California Regional Water Quality Control Board, Central Valley Region, 1995, *Staff Report on the Beneficial Uses Designations and Water Quality Criteria to be Use(d) for the Regulation of Agricultural Subsurface Drainage Discharges in the San Joaquin Basin (5c)*; June, 1995.

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California Regional Water Quality Control Board, Central Valley Region, 1998b, *Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins*; September, 1998.

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Chilcott, J.E., 2000, *Review of Selenium Concentrations in Wetland Water Supply Channels in the Grassland Watershed*, Regional Water Quality Control Board, Central Valley Region, Draft Staff Report.

Chilcott, J.E., Grober, L., Vargas, A, Eppinger, J., 2000, *Agricultural Drainage Contribution to Water Quality in the Grassland Watershed of Western Merced County, California: October 1997 to September 1998 (Water Year 1998)*, Draft Staff Report.

Attachment Note

Attachments 1 through 4 are available upon request. Please contact Jennifer Heyd at (916) 464 – 4735 or at jheyd@waterboards.ca.gov to request copies.