303 (d) Deadline:1/31/06

United States Department of the Interior

BUREAU OF RECLAMATION
Mid-Pacific Regional Office
2800 Cottage Way
Sacramento, California 95825-1898

IN REPLY
REFER TO:
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Ms. Tam Doduc, Chair
California State Water Resources Control Board
1001 I Street
Sacramento, California 95814

Subject: State Water Resources Control Board (SWRCB) Hearing on Revision to the Federal Clean Water Act Section 303(d) List

Dear Ms. Doduc:

Reclamation requests that the State Water Resources Control Board de-list the Lower San Joaquin River (LSJR) from the Mendota Pool to the Airport Way Bridge at Vernalis for salinity and boron impairment. The original listing analysis did not consider data that reflect the altered hydrology of the basin; the model used for the analysis did not accurately reflect the altered hydrology; and collected data fulfills the criteria for de-listing of a water quality limited segment. The following statements are detailed on the referenced pages of the enclosed reports:

- The initial analysis did not consider the significant impact from changes in the basin.
  - The hydrology of the Lower San Joaquin River Basin has changed and the initial analysis does not accurately reflect the current conditions of the basin (pgs 2-5; 7-10).
  - The data used in the initial analysis failed to account for the Grassland Bypass Project and its significant reduction of salt load in the basin (pgs 3-5).
  - The initial analysis did not account for the changes in the basin due to the Central Valley Project Improvement Act (pgs 2-3).
  - Current modeling analyses are consistent with collected data, and draw a different conclusion than the original technical total maximum daily load analysis. Divergent conclusions were drawn due to inaccurate assumptions and incomplete data sets (pgs 1-2).

- The initial analysis was performed using a model that did not accurately reflect the basin. CALSIM II is a planning model, jointly developed by Reclamation and the California Department of Water Resources (DWR), that more accurately reflects the current condition of the basin. CALSIM II is the model of choice, by Reclamation and DWR, for current or future studies because of its updated data sets and improved simulations of San Joaquin operations, particularly of non-federal reservoirs (pgs 5-6).

- More than ten years of data have shown compliance with the salinity water quality objective at Vernalis. Using the binomial distribution, the water quality objective has not been exceeded and the data supports the rejection of the null hypothesis as presented in Table 4.2 of the Listing Policy (pgs 6-7).

The water quality objective has been met for over ten years, which is protective of the identified existing and potential beneficial uses of the LSJR. Reclamation believes the data and information presented to you warrants the request to de-list the Lower San Joaquin River from the 303(d) list for salinity and boron.

Sincerely,

Kirk C. Rodgers
Regional Director

Enclosures

Project Definition
Although the Lower San Joaquin River water segment is listed for both salinity and boron, this report will just address the salinity impairment. Regional Board staff has concurred that if the salinity impairment is addressed, the boron objective will likewise be addressed.

The State Water Resources Control Board (SWRCB) placed the Lower San Joaquin River (LSJR) on California's Clean Water Act (CWA) Section 303(d) list of impaired waters due to elevated concentrations of salt and boron. The CWA requires states to develop TMDLs for all impaired waters. The Regional Board states the "water quality data collected during water years 1986 to 1998 indicates that the non-irrigation season salinity objective of 1,000 μS/cm (1 Sep. - 31 Mar.), was exceeded 11 percent of the time and the irrigation season salinity objective of 700 μS/cm (1 Apr. - 31 Aug.) was exceeded 49 percent of the time at the Airport Way Bridge near Vernalis. Consequently, the river does not fully support all of its designated beneficial uses".

Faulty Listing
Analyzing the same data set that the Regional Board used for their analysis and extending it to the present day, there is not a single data point where the water quality objective was exceeded after 1995. Because the Regional Board did not examine the complete data set, the listing should not have occurred.

Since 1995, the year the water quality objective for salinity was adopted into the Water Quality Control Plan, the water quality objective never exceeded the numeric targets. Therefore, the listed beneficial uses have been protected since 1995 to the present.

Data collected over the last ten years fulfills the criteria for de-listing of a water quality limited segment. Using the binomial distribution analysis, the data supports the rejection of the null hypothesis as presented in Table 4.2 of the Listing Policy

Reclamation believes the data is reflective of the significant changes in hydrology of the Lower San Joaquin River Basin due to several major water projects that occurred in the 1990s – most notably the enactment of the Central Valley Project Improvement Act in 1992 and the beginning of the Grasslands Bypass Project in 1996.

The most current modeling analyses performed on the basin are consistent with the actual collected data and draws a different conclusion than the original technical TMDL analysis. Due to inaccurate assumptions and incomplete data sets, divergent conclusions were drawn.

The Regional Board's initial analysis was performed using a model that did not accurately reflect the basin. Although the analysis was based on historical flow data, the Regional Board's model could not account for the major hydrologic changes in the basin and did not include the most current data set. CALSIM II is a planning model that more accurately reflects the current condition of the basin. Continuous development work since 2000 has resulted in a more detailed simulation of the San Joaquin Valley than was

Enclosure 1

previously possible. CALSIM II is the model of choice for current or future studies because of its updated data sets and improved simulations of San Joaquin operations, particularly of non-federal reservoirs.

Watershed Description

The San Joaquin River (SJR) watershed is bordered by the Sierra Nevada Mountains on the east, the Coast Range on the west, the Delta to the north, and the Tulare Lake Basin to the south. From its source in the Sierra Nevada Mountains, the San Joaquin River flows southwesterly until it reaches Friant Dam. Below Friant Dam, the SJR flows westerly to the center of the San Joaquin Valley near Mendota, where it turns northwesterly to eventually join the Sacramento River in the Delta. The main stem of the entire SJR is about 300 miles long and drains approximately 13,500 square miles.

The major tributaries to the San Joaquin River upstream of the Airport Way Bridge near Vernalis (the boundary of Delta) are on the east side of the San Joaquin Valley, with drainage basins in the Sierra Nevada Mountains. These major east side tributaries are the Stanislaus, Tuolumne, and Merced Rivers. The Consumnes, Mokelumne, and Calaveras Rivers flow into the San Joaquin River downstream of the Airport Way Bridge near Vernalis. Several smaller, ephemeral streams flow into the SJR from the west side of the valley. These streams include Hospital, Ingram, Del Puerto, Orestimba, Panoche, and Los Banos Creeks. All have drainage basins in the Coast Range, flow intermittently, and contribute sparsely to water supplies. Mud Slough (north) and Salt Slough also drain the Grassland Watershed on the west side of San Joaquin Valley.

Changes to the Watershed

As mentioned earlier, several major projects were implemented in the 1990's that had broad implications on the hydrology of the basin. In 1992, Congress passed the Central Valley Project Improvement Act (CVPIA), which amended previous authorizations of the California Central Valley Project (CVP) to include fish and wildlife protection, restoration, enhancement, and mitigation as project purposes having equal priority with power generation, and irrigation and domestic water uses.

The intent of Congress in passing the CVPIA is contained in Section 3402. Through the CVPIA, Congress identified the importance of the CVP in California's water resources picture, but made significant changes in the policies and administration of the project. To achieve the CVPIA's purposes and the identified goals and objectives, a large number of provisions were incorporated into the statute. These include specific programs and measures to be undertaken as well as operational and management directives, all to be implemented consistent with the requirements of California and Federal law. These provisions deal with water contracts, improved water management, restoration of anadromous fish populations, water supplies for State and Federal refuges, mitigation for other fish and wildlife impacted by the CVP, and retirement of drainage-impaired farm lands.

Since the implementation of the CVPIA, the Agricultural Land Retirement Program has acquired 1,228 acres of farmland in the Sacramento-San Joaquin Delta and nearly 8,700 acres of irrigated agricultural land in the San Joaquin Valley. With the retirement of the drainage-impaired lands in the San Joaquin Valley, there was a reduction in the amount of agricultural drainage entering the San Joaquin River system.

With the passage of CVPIA, a full and reliable supply of water to meet identified needs was made available to the identified Central Valley State and Federal refuges and private wetland areas. A base level of supply (referred to as Level 2 supplies) was made available immediately; the remaining portions of their full supply (referred to as Level 4 supplies) were to be made available in 10 percent increments over 10 years. As of 2002, 484,114 acre-feet of annual water supplies and 6,300 acre-feet or permanent water supplies have been acquired for delivery to Central Valley refuge areas.

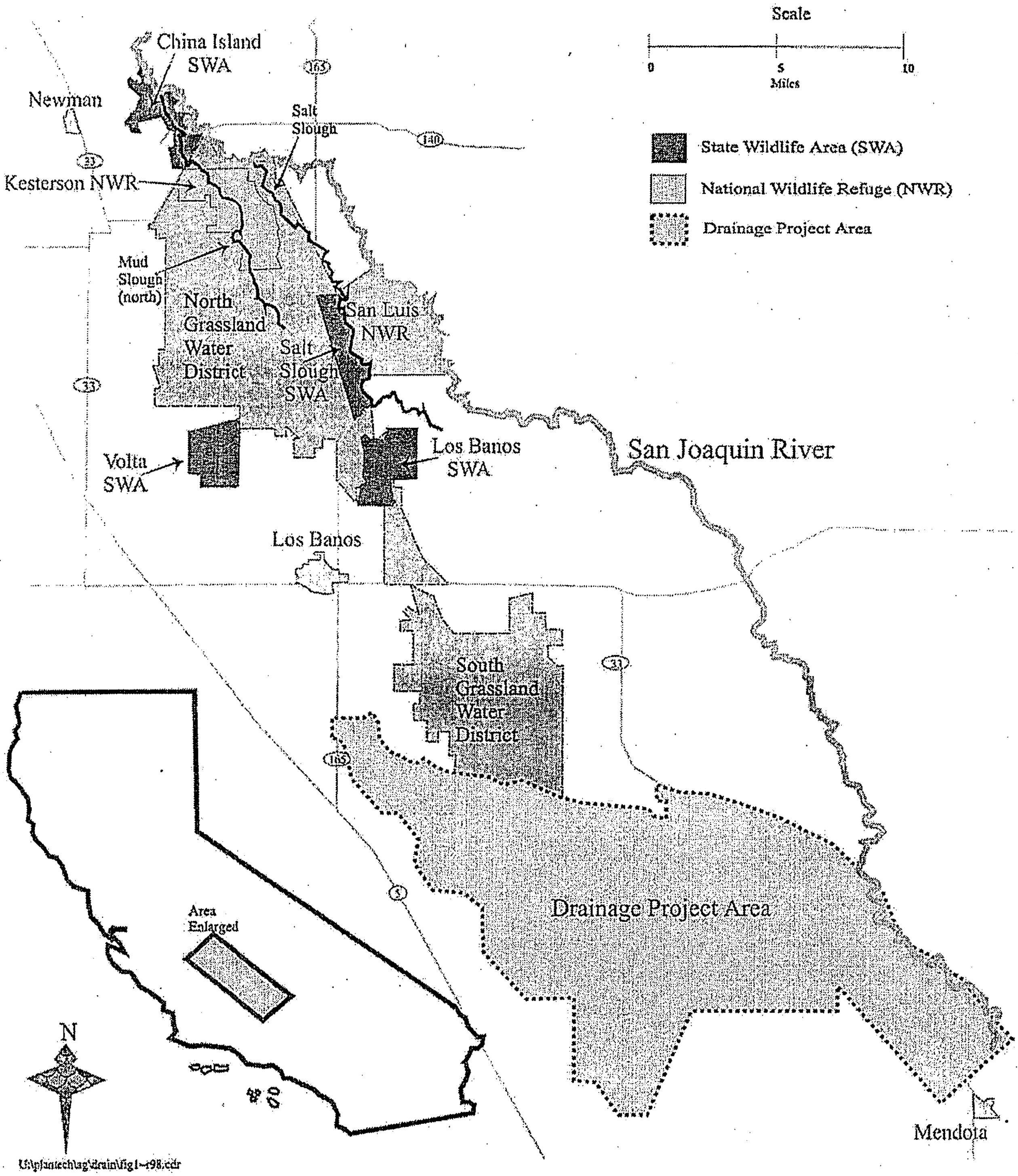
The second major water project that occurred in the 1990s that significantly affected the San Joaquin basin was the Grassland Bypass Project. The Grassland Watershed is located west of the San Joaquin River between the towns of Newman and Mendota, in the San Joaquin River Basin in California. The watershed encompasses approximately 370,000 acres and includes the northern and southern divisions of Grassland Water District (GWD), and farmlands adjacent to the district. The watershed contains a 97,000-acre area known as the Drainage Project Area (DPA), and approximately 100,000 acres of wetland habitat, including State and Federal wildlife refuges and private duck ponds flooded for waterfowl habitat (**Figure 1**).

Prior to October 1996, agricultural lands east, west, and south of the GWD discharged subsurface agricultural drainage water (tile drainage) and surface runoff (irrigation tailwater) through GWD. Subsurface drainage from this area often contains high concentrations of salt, selenium and other trace elements. This regional drainage flowed north through the GWD, carried by a network of canals that could divert water in several possible ways before discharging into Mud Slough or Salt Slough. These two sloughs are tributary to the San Joaquin River and serve as the primary drainage outlets for the Grassland Watershed. After October 1996, all subsurface agricultural drainage from the DPA was rerouted into the Grassland Bypass which discharges into the final 28 miles of the San Luis Drain. The consolidated subsurface drainage is then released into Mud Slough, nine miles upstream of its confluence with the San Joaquin River.

The Grassland Bypass Project is based upon an agreement between Reclamation and the San Luis and Delta-Mendota Water Authority (Authority) to use the San Luis Drain. The first Use Agreement was signed November 3, 1995, and drainage water was conveyed though the Drain from September 27, 1996 to September 30, 2001. The Second Use Agreement, executed September 27, 2001, allows the Authority to continue to use the San Luis Drain through December 31, 2009.

The California Regional Water Quality Control Board, Central Valley Region (Regional Board), issued revised Waste Discharge Requirements for the Project on September 7, 2001 that specified the conditions for discharging drainage water into Mud Slough

Figure 1. Grassland Watershed, State and Federal Wildlife Refuges, and Drainage Project Area



(North). Approval of the GBP was granted with the understanding that certain benefits and risks were associated with the Project. Anticipated benefits include:

1. Agricultural drainage water will be removed from the Grassland Water District (GWD) delivery channels allowing refuge managers to receive and apply all of their fresh water allocations according to optimum habitat management schedules.

2. Removal of agricultural drainage water from the GWD channels will reduce the selenium exposures to fish, wildlife, and humans in the wetland channels and Salt Slough. Concentrations of salinity and other constituents may also be reduced within the wetland channels and Salt Slough.

3. Combining agricultural drainage flows within a single concrete-lined structure, the SLD, allows for better monitoring, potentially leading to a more detailed evaluation and effective control of selenium and agricultural drainage.

4. The establishment of an accountable drainage entity will provide the framework necessary for responsible watershed management in the Grassland Basin.

Updated Watershed Simulation

The California Simulation Model (CALSIM II) is a computer model that simulates much of the water resources systems and their operations in California's Central Valley and Sacramento-San Joaquin Delta region. The focus of CALSIM II representation is primarily on the Central Valley Project and State Water Project systems (CVP-SWP). The model was developed jointly by the California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (Reclamation). Its purpose is to provide quantitative hydrologic information related to scenario-based CVP-SWP operations and assumptions related to climate, water demands, and regulatory environment. As the official planning model of both agencies, CALSIM II is used extensively to support a variety of studies describing comparative effects of alternative scenarios varying by infrastructure, operational rules, regulations, water demands, and/or climate.

Over the 2002 – 2005 period, Reclamation sponsored several efforts to improve some major aspects of the San Joaquin River Valley system in the CALSIM II model. These efforts have focused on modeling Eastside surface hydrology and operations; Eastside water demands; and salinity in the San Joaquin River mainstem.

In 2005, the CALFED Science Program and the California Water and Environment Modeling Forum sponsored, supported and oversaw the external review of the new San Joaquin CALSIM II model (officially SJR_2001X10A_PRELIM_040105). The complete report from the review team could be found at http://science.calwater.ca.gov/pdf/calsim/CALSIM_II_Panel_Report_Public_Review_Draft_112005.pdf.

Overall, the review panel concluded that, "the new representations of Eastside hydrology, operations, and water demands, and the new water quality module for representing salinity in the mainstem are significantly superior methodologically" and that "these new representations have considerably greater functionality and flexibility for representing potential future planning and management decisions and scenarios and with proper inputs and calibration they will be more accurate". The review panel also noted that "in the course of developing the hydrologic representation of the system, the modelers describe in their oral presentations numerous fundamental improvements in hydrologic data and representations".

Water Quality Objectives

In the 1995 *Water Quality Control Plan for the San Francisco Bay/Sacramento San Joaquin Delta Estuary* (Bay Delta Plan), the State Water Board adopted salinity water quality objectives (WQO) for the San Joaquin River at the Airport Way Bridge near Vernalis. In 1999, the State Water Board adopted Water Right Decision 1641, which, in part, implements the salinity standards contained in the 1995 Bay Delta Plan. The existing salinity WQOs for the SJR at Vernalis are 1000 υS/cm between September 1 and March 31 (non-irrigation season), and 700 υS/cm between April 1 and August 31 (irrigation season).

Data Analysis

Over ten years of data have been collected at the Vernalis compliance point and there has not been one instance of a violation. The data meets the criteria given to de-list a water body in Section 4.0 of the *"Water Quality Control Policy,"* adopted in September 2004 and written by the California Water Boards.

For sample sizes greater than 121, the maximum number of exceedances allowed is established at α and $\beta < 0.2$ and where $|\alpha - \beta|$ is minimized

α = Excel® Function BINOMDIST(k, n, 0.25, TRUE)
β = Excel® Function BINOMDIST(n-k-1, n, 1 – 0.1, TRUE

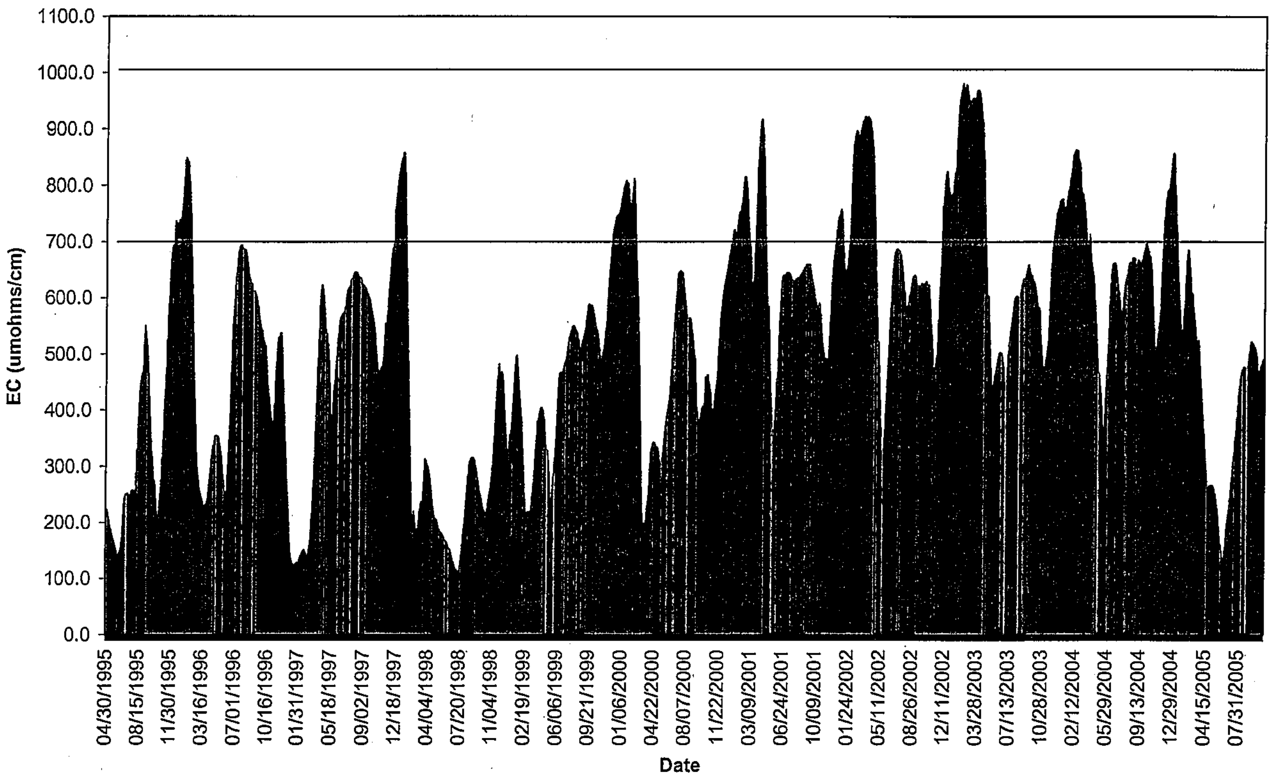
where

n=the number of samples
k = maximum number of measured exceedances allowed,
0.10 = acceptable exceedance proportion, and
0.25 = unacceptable exceedance proportion.

n=3859 collected from 4/1/2005 to 10/25/2005
k=0
alpha =0

beta = would not be able to be calculated according to the formula cited because there would be zero exceedances.

Vernalis WQ Data



Regional Board's Analysis of the Grassland Bypass Project

The Regional Board's Staff Report titled *Agricultural Drainage Contributions to Water Quality in the Grassland Watershed of Western Merced County, California: October 1998 – September 2000* contains laboratory results and a summary of water quality analyses for all constituents measured within the Grassland Watershed as part of a water quality monitoring program to evaluate the effects of subsurface agricultural drainage on the water quality of canals, drains, and sloughs in the Grassland Watershed in western Merced County.

Pre-Grassland Bypass Project water years were either wet (water years 1986, 1993, 1995, and 1996) or critically dry. Discharge and corresponding loads during the pre-project period reflected the hydrology with the highest discharge and loads occurring during the wettest years and the lowest discharge and loads occurring after multiple critically dry years.

The data collected for the report showed discharge for the DPA and Grassland Watershed decreased 3% and 7%, respectively, from Water Year 1999 to Water Year 2000. When compared to Water Year 1996, the last pre-project water year, discharge from the DPA decreased 36% and 37% during Water Year 1999 and Water Year 2000, respectively, while discharge from the Grassland Watershed decreased 6% and 13%, respectively.

The collected data also shows that salt loads for the DPA and Grassland Watershed both decreased 7% from Water Year 1999 to Water Year 2000. When compared to Water Year 1996, the last pre-project water year, salt load from the DPA decreased 26% and 31% during Water Year 1999 and Water Year 2000, respectively, while salt load from the Grassland Watershed decreased 16% and 22%, respectively.

The report concluded that decreasing trend for "discharge and the various loads from the DPA and Grassland Watershed can be partially explained based on what is known about the changing hydrology and management of the DPA. New management practices resulting from the GBP and use of the San Luis Drain to route agricultural drainage from the DPA to Mud Slough (north) have affected the quality and quantity of water discharged from the DPA".

Although the Regional Board's report only went through water year 2000, the Grasslands Annual Report covers preceding years and can be found at the following link http://www.sfei.org/grassland/reports.

Grassland Bypass Project Data

The following section on the Grassland Bypass load reduction for 2003 and the theoretical analysis was taken directly from chapter 6 of the *2003 Grassland Annual Report*. Please refer to the document to review the calculations used for the analysis.

The Grassland Bypass Project began in 1996 and has significantly reduced salt loading into the San Joaquin River each year since the inception of the project. The *2003 Grassland Annual Report* stated that during 2003, the GBP contributed between two and twelve percent of the flow, and nine to fifty-two percent of the salt load in the river each month (see Table 1a of the 2003 Grassland Bypass Project Annual Report). During WY 2003, overall discharge from the GBP was five percent of the flow and about 20 percent of the salt load in the river as measured at Crows Landing (see Table 1b of the 2003 Grassland Bypass Project Annual Report). During Calendar Year 2003, overall discharge from the GBP was five percent of the flow and about 21 percent of the salt load in the river as measured at Crows Landing (see Table 1c of the 2003 Grassland Bypass Project Annual Report). The overall discharge and load of salts in 2003 were comparable with those of 1999 through 2002. Tables 2a and 2b (of the 2003 Grassland Bypass Project Annual Report) compare the volumes of water discharged from the 97,000 acre Grassland Drainage Area with flows in the Mud and Salt Slough watershed. The annual discharge from the Grassland Drainage Area ranged from 12 to 16 percent of the regional flow during the seven years of the Project (1997 – 2003). During the WY 2003, 27,140 acre-feet of water were discharged from the GDA, which was approximately 13 percent of the 215,500 acre-feet that flowed from the region (see Table 2a of the 2003 Grassland Bypass Project Annual Report). The WY 2003 volume was about 45 percent less than the average annual volume of drainage water discharged prior to the GBP (see Table 2b of the 2003 Grassland Bypass Project Annual Report). Tables 3a and 3b (of the 2003 Grassland Bypass Project Annual Report) compare the loads of salts discharged from the GDA with the salts in water in Mud and Salt Sloughs. During 2003, about 118,150 tons of salt were discharged from the GDA, which was almost 32 percent of the 373,000 tons that left the region through Mud and Salt Sloughs (see Table 3a of the 2003 Grassland Bypass Project Annual Report). The 2003 salt load was about 38 percent less than the average annual salt load discharged prior to the GBP (see Table 3b of the 2003 Grassland Bypass Project Annual Report). The WY 2003 regional salt load was about four percent less than the average regional annual salt load discharged prior to the GBP (see Table 3b of the 2003 Grassland Bypass Project Annual Report).

Theoretical Dilution Analysis

In order to assess the effect of GBP on salinity in the San Joaquin River, an analysis was developed to theoretically isolate the effects of GBP from other activities potentially affecting salinity concentrations in the River. Drainage from GBP was assumed as the only drainage relevant to project-related changes in salt load on the San Joaquin River. The analysis was cast in terms of theoretical dilution water needed to bring the GBP discharges to the Vernalis seasonal EC objectives.

The salinity objectives for Vernalis are 1,000 µS/cm (640 mg/L Total Dissolved Solids) in the winter months (September-March) and 700 µS/cm (448 mg/L TDS) in the summer months (April-August). Figure 1(from chapter 6 of the 2003 Grassland Annual Report) shows the theoretical volume of water that would be needed to dilute the combined salt loads from the GDA, measured at Station B, and the regional watershed, drained by Mud Slough and Salt Slough (Stations D & F), to meet the Vernalis standards. This analysis does not take into account any of the other operational criteria, nor does it consider salinity contributions to the River other than those derived from the GDA. The value of the analysis is that it permits a "with" and "without" project comparison with prior year hydrology, in terms (water quality releases from a reservoir) meaningful to water users and managers. The assimilative capacity analysis considers the total volume of dilution water (assumed to have a salinity of 100 ppm) that would be needed to reduce the drainage water alone to the salinity objective. Note that the monthly volume of dilution water is highly dependent on the 100-ppm assumption. Note also that the relation between dilution water quality and required volume is non-linear. Figure 1 (from chapter 6 of the 2003 Grassland Annual Report) shows the monthly theoretical dilution requirements for WY 1986 through 2003. Figure 2 (from chapter 6 of the 2003 Grassland Annual Report) shows the total theoretical dilution requirement for each water year. The unshaded areas in Figures 1 and 2 represent the theoretical dilution requirements for salt loads generated by the Mud and Salt Slough watershed, which includes the GDA and other agricultural areas, wetlands, and uncontrolled runoff from the Coast Range watersheds. The shaded area in the Figures shows the theoretical dilution requirements for salt loads discharged from only the GDA. The data for Figure 2 are summarized in Tables 4a and 4b (from chapter 6 of the 2003 Grassland Annual

Report). During WY 2003, about 181,800 acre-feet of water would have been required to dilute the 27,140 acre-feet of drainage water discharged from the GDA (Tables 2a and 4a). In comparison, approximately 419,000 acre-feet of water would have been needed to dilute the 215,500 acre-feet of regional discharges to meet the Vernalis standards. The WY 2003 theoretical dilution requirement for the GDA is about 32 percent less than that required during the years prior to the implementation of the GBP (Table 4b). The WY 2003 theoretical dilution requirement for the region was 24 percent more than that required during the years prior to implementation of the GBP. These percentages should be put into context of the 1990 – 1994 drought and the initiation of CVPIA water deliveries to wetlands (private, State and Federal) in the Grasslands Basin that preceded the authorization of the Grassland Bypass Project. The latter has profoundly affected the hydrology of the Grasslands Basin and has affected the timing of salt loading to the San Joaquin River. The allocation to federal contractors in WY 2003 was 75 percent. Data for the GDA for WY 1986 to 2003 show that between WY 1999 and 2003, the salt loads (Tables 3a and 3b) and theoretical dilution requirements (Tables 4a and 4b, and Figures 1 and 2) were smaller than in all other years with the exception of the drought years of WY 1991 and 1992. The theoretical dilution required for the entire region in WY 2003 was 18 percent more than the average of all prior years and about 19 percent more than the average of above normal water years (Table 4b). WY 1999 through 2003 had no unusual or unexpected hydrologic events as occurred in WY 1997 and WY 1998. As listed in Table 2a, CVP irrigation deliveries during WY 1999 – 2003 were lower than the WY 1997 and 1998, and the volume of water discharged from the GDA continued to be comparable to that discharged during the drought years of 1991 and 1992.

Rationale for Delisting

Reclamation believes that the original analysis used to place the Lower San Joaquin River at Vernalis on the 303(d) list did not consider the significance of the cited water projects and feels the data and information presented to you warrants the request to de-list the Lower San Joaquin River at Vernalis from the 303(d) list for salinity and boron.

1. Over ten years of compliance with the water quality objective at Vernalis.
2. The data meets the criteria outlined in section 4.2 of the California Water Boards Delisting Policy.
3. The original analysis was performed with an incomplete data set. The combination of land retirement, refuge water supply transfers, and reduced salt loading from the Grasslands Bypass Project have altered the hydrology of the basin and have improved the water quality of the San Joaquin River since the original analysis was performed.
4. The computer model used for the original analysis did not accurately reflect current basin conditions.

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CHAPTER 6

Project Impacts on San Joaquin River

January 1, 2003 – December 31, 2003

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U.S. Bureau of Reclamation[1]

Nigel W.T. Quinn
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Grassland Bypass Project

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Enclosure 2

Introduction

The purpose of this chapter is to compare the loads of salt discharged by the Grassland Bypass Project (GBP) with loads that might exist in the absence of the Project. This comparison uses flow and salinity data for Stations B, D, F, and N from October 1985 to December 2003. Two methods are used:

1) simple comparison of flow and salt loads as percentages, and

2) a theoretical dilution analysis.

The theoretical dilution analysis was agreed upon in meetings involving the U.S. Bureau of Reclamation (Reclamation), the South Delta Water Agency and its legal counsel, and the California Regional Water Quality Control Board, as a means of demonstrating that the Project was not causing adverse downstream impacts. This analysis was not specified in the Compliance Monitoring Program (Reclamation et.al., June 2002) or the Quality Assurance Project Plan (Reclamation et.al., August 2002). Work continues to standardize the methodologies used to calculate loads and the theoretical dilution.

The 2001 Agreement for Use of the San Luis Drain includes the following statement:

> *"It is the objective and intention of RECLAMATION and the AUTHORITY, among other things, to ensure that continued use of the Drain as provided in this Agreement results in improvement in water quality and environmental conditions in the San Joaquin River, delta, and estuary relative to the quality that existed prior to the term of this Agreement, insofar as such quality or conditions may be affected by drainage discharges from the Drainage Area (as hereinafter defined), and to ensure that such continued use of the Drain does not reduce the ability to meet the salinity standard at Vernalis compared to the ability to meet the salinity standard that existed prior to the term of this Agreement." (Reclamation and San Luis & Delta-Mendota Water Authority, 2001)*

Comparison of Flow and Salt Loads as Percentages

Tables 1a, 1b, and 1c compare the monthly flows and loads of salt discharged by the GBP with those in the San Joaquin River at Crows Landing through the seven years of the Project. During 2003, the GBP contributed between two and twelve percent of the flow, and nine to fifty-two percent of the salt load in the river each month (Table 1a). During WY 2003, overall discharge from the GBP was five percent of the flow and about 20 percent of the salt load in the river as measured at Crows Landing (Table 1b). During Calendar Year 2003, overall discharge from the GBP was five percent of the flow and about 21 percent of the salt load in the river as measured at Crows Landing (Table 1c). The overall discharge and load of salts in 2003 were comparable with those of 1999 through 2002.

Tables 2a and 2b compare the volumes of water discharged from the 97,000 acre Grassland Drainage Area with flows in the Mud and Salt Slough watershed. The annual discharge from the Grassland Drainage Area ranged from 12 to 16 percent of the regional flow during the seven years of the Project (1997 - 2003). During the WY 2003, 27,140 acre-feet of water were discharged from the GDA, which was approximately 13 percent of the 215,500 acre-feet that flowed from the region (Table 2a). The WY 2003 volume was about 45 percent less than the average annual volume of drainage water discharged prior to the GBP (Table 2b).

Tables 3a and 3b compare the loads of salts discharged from the GDA with the salts in water in Mud and Salt Sloughs. During 2003, about 118,150 tons of salt were discharged from the GDA, which was almost 32 percent of the 373,000 tons that left the region through Mud and Salt Sloughs (Table 3a). The 2003 salt load was about 38 percent less than the average annual salt load discharged prior to the GBP

(Table 3b). The WY 2003 regional salt load was about four percent less than the average regional annual salt load discharged prior to the GBP (Table 3b).

Theoretical Dilution of GBP Discharges to Meet Vernalis Standards

In order to assess the effect of GBP on salinity in the San Joaquin River, an analysis was developed to theoretically isolate the effects of GBP from other activities potentially affecting salinity concentrations in the River. Drainage from GBP was assumed as the only drainage relevant to project-related changes in salt load on the San Joaquin River. The analysis was cast in terms of theoretical dilution water needed to bring the GBP discharges to the Vernalis seasonal EC objectives.

The salinity objectives for Vernalis are 1,000 µS/cm (640 mg/L Total Dissolved Solids) in the winter months (September-March) and 700 µS/cm (448 mg/L TDS) in the summer months (April-August). Figure 1 shows the theoretical volume of water that would be needed to dilute the combined salt loads from the GDA, measured at Station B, and the regional watershed, drained by Mud Slough and Salt Slough (Stations D & F), to meet the Vernalis standards. This analysis does not take into account any of the other operational criteria, nor does it consider salinity contributions to the River other than those derived from the GDA. The value of the analysis is that it permits a "with" and "without" project comparison with prior year hydrology, in terms (water quality releases from a reservoir) meaningful to water users and managers.

The assimilative capacity analysis considers the total volume of dilution water (assumed to have a salinity of 100 ppm) that would be needed to reduce the drainage water alone to the salinity objective. Note that the monthly volume of dilution water is highly dependent on the 100-ppm assumption. Note also that the relation between dilution water quality and required volume is non-linear.

Figure 1 shows the monthly theoretical dilution requirements for WY 1986 through 2003. Figure 2 shows the total theoretical dilution requirement for each water year. The unshaded areas in Figures 1 and 2 represent the theoretical dilution requirements for salt loads generated by the Mud and Salt Slough watershed, which includes the GDA and other agricultural areas, wetlands, and uncontrolled runoff from the Coast Range watersheds. The shaded area in the Figures shows the theoretical dilution requirements for salt loads discharged from only the GDA.

The data for Figure 2 are summarized in Tables 4a and 4b. During WY 2003, about 181,800 acre-feet of water would have been required to dilute the 27,140 acre-feet of drainage water discharged from the GDA (Tables 2a and 4a). In comparison, approximately 419,000 acre-feet of water would have been needed to dilute the 215,500 acre-feet of regional discharges to meet the Vernalis standards. The WY 2003 theoretical dilution requirement for the GDA is about 32 percent less than that required during the years prior to the implementation of the GBP (Table 4b). The WY 2003 theoretical dilution requirement for the region was 24 percent more than that required during the years prior to implementation of the GBP.

These percentages should be put into context of the 1990 – 1994 drought and the initiation of CVPIA water deliveries to wetlands (private, State and Federal) in the Grasslands Basin that preceded the authorization of the Grassland Bypass Project. The latter has profoundly affected the hydrology of the Grasslands Basin and has affected the timing of salt loading to the San Joaquin River.

The allocation to federal contractors in WY 2003 was 75 percent. Data for the GDA for WY 1986 to 2003 show that between WY 1999 and 2003, the salt loads (Tables 3a and 3b) and theoretical dilution requirements (Tables 4a and 4b, and Figures 1 and 2) were smaller than in all other years with the exception of the drought years of WY 1991 and 1992.

The theoretical dilution required for the entire region in WY 2003 was 18 percent more than the average of all prior years and about 19 percent more than the average of above normal water years (Table 4b).

WY 1999 through 2003 had no unusual or unexpected hydrologic events as occurred in WY 1997 and WY 1998. As listed in Table 2a, CVP irrigation deliveries during WY 1999 – 2003 were lower than the WY 1997 and 1998, and the volume of water discharged from the GDA continued to be comparable to that discharged during the drought years of 1991 and 1992.

Data for several more years will be necessary before the impact of the GBP on the San Joaquin River can be quantified with confidence.

Calculations

The formula for theoretical dilution is

Q2 = Q1(C3-C1)/(C2-C3)

Q1 = Drainwater discharge in acre-feet per month

Q2 = Volume of water needed to dilute Q1 to meet Vernalis standards in acre-feet per month

C1 = Measured concentration of GBP drainage water in parts per million (mg/L)

C2 = Assumed concentration of dilution water = 100 mg/L

C3 = Vernalis standard concentration = 448 mg/L April - August

640 mg/L September - March

References

U.S. Bureau of Reclamation and the San Luis & Delta-Mendota Water Authority. September 28, 2001. Agreement for Use of the San Luis Drain. Agreement No. 01-WC-20-2075.

U.S. Bureau of Reclamation, et.al. June 2002. Monitoring Program for the Operation of the Grassland Bypass Project, Phase II October 1, 2001 – December 31, 2009.

U.S. Bureau of Reclamation, et.al. August 22, 2002. Quality Assurance Project Plan for the Compliance Monitoring Program for the Use and Operation of the Grassland Bypass Project.

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Table 1a. Comparison of Flows and Salt Loads Discharged to the San Joaquin River January - December 2003

	Total Monthly Flow			Total Monthly Salt Load		
	Discharged from Grassland Bypass Project	San Joaquin River at Crows Landing		Discharged from Grassland Bypass Project	San Joaquin River at Crows Landing	
	Station B	Station N	B as %	Station B	Station N	B as %
	acre-feet	acre-feet	of N	tons	tons	of N
January 2003	1,390	60,900	2%	6,270	71,220	9%
February 2003	3,060	48,800	6%	13,280	67,490	20%
March 2003	3,370	66,500	5%	17,090	92,180	19%
April 2003	2,460	55,910	4%	12,250	58,930	21%
May 2003	2,460	61,180	4%	11,360	47,770	24%
June 2003	2,790	28,660	10%	11,940	33,200	36%
July 2003	3,170	25,440	12%	12,740	24,510	52%
August 2003	3,300	26,740	12%	11,650	28,750	41%
September 2003	1,390	19,840	7%	5,300	21,770	24%
October 2003	1,390	40,850	3%	5,830	29,520	20%
November 2003	1,320	43,500	3%	5,520	38,690	14%
December 2003	1,300	43,150	3%	5,440	45,850	12%

Data Sources: Station B - US Geological Survey Site 11262895
Station N - US Geological Survey Site 11274550

Table 1b. Comparison of Flows and Salt Loads Discharged to the San Joaquin River, Water Years 1997 – 2003

	Total Flow			Total Salt Load		
	Discharged from Grassland Bypass Project	San Joaquin River at Crows Landing		Discharged from Grassland Bypass Project	San Joaquin River at Crows Landing	
	Station B	Station N	B as %	Station B	Station N	B as %
	acre-feet	acre-feet	of N	tons	tons	of N
WY 1997	37,550	3,844,270	1%	167,740	1,080,700	16%
WY 1998	45,940	4,904,910	1%	205,100	1,511,470	14%
WY 1999	32,310	1,015,350	3%	149,130	680,100	22%
WY 2000	31,260	1,027,480	3%	134,990	703,880	19%
WY 2001	28,250	653,430	4%	120,010	623,560	19%
WY 2002	28,400	556,430	5%	116,180	542,460	21%
WY 2003	27,140	546,120	5%	118,170	576,360	21%

Table 1c. Comparison of Flows and Salt Loads Discharged to the San Joaquin River, Calendar Years 1997 – 2003

	Total Flow			Total Salt Load		
	Discharged from Grassland Bypass Project	San Joaquin River at Crows Landing		Discharged from Grassland Bypass Project	San Joaquin River at Crows Landing	
	Station B	Station N	B as %	Station B	Station N	B as %
	acre-feet	acre-feet	of N	tons	tons	of N
CY 1997	37,480	3,590,370	1%	169,240	1,072,470	16%
CY 1998	46,240	5,064,280	1%	208,880	1,516,100	14%
CY 1999	32,250	864,520	4%	146,530	664,460	22%
CY 2000	30,210	1,059,220	3%	128,580	689,510	19%
CY 2001	28,010	638,210	4%	119,270	623,840	19%
CY 2002	28,480	523,240	5%	117,840	528,470	22%
CY 2003	27,400	521,460	5%	118,640	559,880	21%

Table 2a. Annual Volume of Water Discharged from the Grassland Drainage Area and Mud/Salt Sloughs

Water Year (1)		% CVP Contract Delivery (2)	Discharge from Grassland Drainage Area (3)	Discharge from Mud & Salt Sloughs (4)	GDA discharge as percent of discharge from the Sloughs
		acre-feet	acre-feet	acre-feet	
WY 1986		100%	67,010	284,320	24%
WY 1987		100%	74,900	233,840	32%
WY 1988		100%	65,330	230,450	28%
WY 1989		100%	54,190	211,390	26%
WY 1990		50%	41,660	194,660	21%
WY 1991		25%	29,290	102,160	29%
WY 1992		25%	24,530	85,430	29%
WY 1993		50%	41,200	167,960	25%
WY 1994		35%	38,670	183,550	21%
WY 1995		100%	57,570	263,770	22%
WY 1996		95%	52,980	267,950	20%
WY 1997	GBP	90%	37,550	287,020	13%
WY 1998	GBP	100%	45,940	378,670	12%
WY 1999	GBP	70%	32,310	253,130	13%
WY 2000	GBP	65%	31,260	235,500	13%
WY 2001	GBP	49%	28,250	226,760	12%
WY 2002	GBP	65%	28,400	180,150	16%
WY 2003	GBP	75%	27,140	215,500	13%

Data Sources:
Station B - US Geological Survey Site 11262895 San Luis Drain
Station D - US Geological Survey Site 11262900 Mud Slough near Gustine
Station F - US Geological Survey Site 11361100 Salt Slough at Hwy 165

Table 1a. Comparison of Flows and Salt Loads Discharged to the San Joaquin River January - December 2003

	Total Monthly Flow			Total Monthly Salt Load		
	Discharged from Grassland Bypass Project	San Joaquin River at Crows Landing		Discharged from Grassland Bypass Project	San Joaquin River at Crows Landing	
	Station B	Station N	B as %	Station B	Station N	B as %
	acre-feet	acre-feet	of N	tons	tons	of N
January 2003	1,390	60,900	2%	6,270	71,220	9%
February 2003	3,060	48,800	6%	13,280	67,490	20%
March 2003	3,370	66,500	5%	17,090	92,180	19%
April 2003	2,460	55,910	4%	12,250	58,930	21%
May 2003	2,460	61,180	4%	11,360	47,770	24%
June 2003	2,790	28,660	10%	11,940	33,200	36%
July 2003	3,170	25,440	12%	12,740	24,510	52%
August 2003	3,300	26,740	12%	11,650	28,750	41%
September 2003	1,390	19,840	7%	5,300	21,770	24%
October 2003	1,390	40,850	3%	5,830	29,520	20%
November 2003	1,320	43,500	3%	5,520	38,690	14%
December 2003	1,300	43,150	3%	5,440	45,850	12%

Data Sources: Station B - US Geological Survey Site 11262895
Station N - US Geological Survey Site 11274550

Table 1b. Comparison of Flows and Salt Loads Discharged to the San Joaquin River, Water Years 1997 – 2003

	Total Flow			Total Salt Load		
	Discharged from Grassland Bypass Project	San Joaquin River at Crows Landing		Discharged from Grassland Bypass Project	San Joaquin River at Crows Landing	
	Station B	Station N	B as %	Station B	Station N	B as %
	acre-feet	acre-feet	of N	tons	tons	of N
WY 1997	37,550	3,844,270	1%	167,740	1,080,700	16%
WY 1998	45,940	4,904,910	1%	205,100	1,511,470	14%
WY 1999	32,310	1,015,350	3%	149,130	680,100	22%
WY 2000	31,260	1,027,480	3%	134,990	703,880	19%
WY 2001	28,250	653,430	4%	120,010	623,560	19%
WY 2002	28,400	556,430	5%	116,180	542,460	21%
WY 2003	27,140	546,120	5%	118,170	576,360	21%

Table 1c. Comparison of Flows and Salt Loads Discharged to the San Joaquin River, Calendar Years 1997 – 2003

	Total Flow			Total Salt Load		
	Discharged from Grassland Bypass Project	San Joaquin River at Crows Landing		Discharged from Grassland Bypass Project	San Joaquin River at Crows Landing	
	Station B	Station N	B as %	Station B	Station N	B as %
	acre-feet	acre-feet	of N	tons	tons	of N
CY 1997	37,480	3,590,370	1%	169,240	1,072,470	16%
CY 1998	46,240	5,064,280	1%	208,880	1,516,100	14%
CY 1999	32,250	864,520	4%	146,530	664,460	22%
CY 2000	30,210	1,059,220	3%	128,580	689,510	19%
CY 2001	28,010	638,210	4%	119,270	623,840	19%
CY 2002	28,480	523,240	5%	117,840	528,470	22%
CY 2003	27,400	521,460	5%	118,640	559,880	21%

Table 2a. Annual Volume of Water Discharged from the Grassland Drainage Area and Mud/Salt Sloughs

Water Year (1)		% CVP Contract Delivery (2)	Discharge from Grassland Drainage Area (3)	Discharge from Mud & Salt Sloughs (4)	GDA discharge as percent of discharge from the Sloughs
		acre-feet	acre-feet	acre-feet	
WY 1986		100%	67,010	284,320	24%
WY 1987		100%	74,900	233,840	32%
WY 1988		100%	65,330	230,450	28%
WY 1989		100%	54,190	211,390	26%
WY 1990		50%	41,660	194,660	21%
WY 1991		25%	29,290	102,160	29%
WY 1992		25%	24,530	85,430	29%
WY 1993		50%	41,200	167,960	25%
WY 1994		35%	38,670	183,550	21%
WY 1995		100%	57,570	263,770	22%
WY 1996		95%	52,980	267,950	20%
WY 1997	GBP	90%	37,550	287,020	13%
WY 1998	GBP	100%	45,940	378,670	12%
WY 1999	GBP	70%	32,310	253,130	13%
WY 2000	GBP	65%	31,260	235,500	13%
WY 2001	GBP	49%	28,250	226,760	12%
WY 2002	GBP	65%	28,400	180,150	16%
WY 2003	GBP	75%	27,140	215,500	13%

Data Sources:
Station B - US Geological Survey Site 11262895 San Luis Drain
Station D - US Geological Survey Site 11262900 Mud Slough near Gustine
Station F - US Geological Survey Site 11361100 Salt Slough at Hwy 165

Table 2b. Comparison of 2003 WY Discharge Volume to Previous Years

	Water Year	Discharge from Grassland Drainage Area (3) acre-feet	WY 2003 difference	Discharge from Mud & Salt Sloughs (4) acre-feet	WY 2003 difference
Average, all years	1986 - 2003	43,230	-37%	222,350	-3%
Prior years average	1986 - 2002	44,180	-39%	222,750	-3%
Before GBP average	1986 - 1996	49,760	-45%	202,320	7%
GBP average	1997 - 2003	32,980	-18%	253,820	-15%
Below Normal Water Years	(5)	40,720	-33%	192,100	12%
Above Normal Water Years	(6)	47,880	-43%	253,470	-15%

Notes:

Pre-project data compiled by Nigel Quinn (LBNL) from CVRWQCB and USGS reports.

(1) Water Year - October 1 - September 30

(2) Percent of Contract Delivery of CVP water to Delta Division and San Luis Unit

(3) Grassland Drainage Area

(4) Mud and Salt Sloughs

(5) Below Normal Water Years with 50 percent or less CVP delivery: WY 1990 - 1994, 2001

(6) Above Normal Water Years with more than 50 percent CVP delivery:
WY 1986 - 1989, 1995 - 2000, 2002, 2003

Table 3a. Annual Loads of Salt Discharged from the Grassland Drainage Area and Mud/Salt Sloughs

Water Year (1)		% CVP Contract Delivery (2)	Discharge from Grassland Drainage Area (3) tons	Discharge from Mud & Salt Sloughs (4) tons	GDA discharge as percent of discharge from the Sloughs
WY 1986		100%	214,250	494,540	43%
WY 1987		100%	241,530	438,900	55%
WY 1988		100%	236,300	455,960	52%
WY 1989		100%	202,420	389,330	52%
WY 1990		50%	171,270	380,560	45%
WY 1991		25%	129,900	221,540	59%
WY 1992		25%	110,330	197,350	56%
WY 1993		50%	183,020	336,520	54%
WY 1994		35%	171,500	379,410	45%
WY 1995		100%	237,530	499,340	48%
WY 1996		95%	197,530	477,730	41%
WY 1997	GBP	90%	167,740	446,690	38%
WY 1998	GBP	100%	205,100	627,690	33%
WY 1999	GBP	70%	149,130	401,610	37%
WY 2000	GBP	65%	134,990	372,450	36%
WY 2001	GBP	49%	120,010	383,160	31%
WY 2002	GBP	65%	116,180	331,600	35%
WY 2003	GBP	75%	118,170	372,980	32%

Data Sources:

Station B - US Geological Survey Site 11262895 San Luis Drain

Station D - US Geological Survey Site 11262900 Mud Slough near Gustine

Station F - US Geological Survey Site 11361100 Salt Slough at Hwy 165

Table 3b. Comparison of 2002 WY Salt Loads to Previous Years

		Discharge from Grassland Drainage Area (3)	WY 2003 difference	Discharge from Mud & Salt Sloughs (4)	WY 2003 difference
		tons		tons	
Average, all years	1986 - 2003	172,610	-32%	400,410	-7%
Prior years average	1986 - 2002	175,810	-33%	402,020	-7%
Before GBP average	1986 - 1996	190,510	-38%	388,290	-4%
GBP average	1997 - 2003	144,470	-18%	419,450	-11%
Below Normal Water Years	(5)	177,210	-33%	379,710	-2%
Above Normal Water Years	(6)	185,070	-36%	442,400	-16%

Data source: San Francisco Estuary Institute

Notes: Pre-project data compiled by Nigel Quinn (LBNL) from CVRWQCB and USGS reports.

(1) Water Year - October 1 - September 30

(2) Percent of Contract Delivery of CVP water to Delta Division and San Luis Unit

(3) Grassland Drainage Area

(4) Mud and Salt Sloughs

(5) Below Normal Water Years with 50 percent or less CVP delivery: WY 1990 - 1994, 2001

(6) Above Normal Water Years with more than 50 percent CVP delivery: WY 1986 - 1989, 1995 - 2000, 2002, 2003

Table 4a. Theoretical Annual Volumes of Dilution Water Needed to Meet Vernalis Standards

Water Year (1)		% CVP Contract Delivery (2)	Theoretical Annual Volume of Water Needed to Dilute GDA Discharge to Meet Vernalis Standard (3)		Theoretical Annual Volume Water Needed to Dilute Regional Discharge to Meet Vernalis Standard (4)
			acre-feet		acre-feet
WY 1986		100%	303,360		426,150
WY 1987		100%	332,190		406,130
WY 1988		100%	335,150		424,450
WY 1989		100%	294,830		350,410
WY 1990		50%	245,170		341,300
WY 1991		25%	186,450		235,850
WY 1992		25%	160,420		191,070
WY 1993		50%	272,850		325,960
WY 1994		35%	249,060		363,090
WY 1995		100%	344,980		451,510
WY 1996		95%	283,340		418,390
WY 1997	GBP	90%	246,090		301,220
WY 1998	GBP	100%	303,000		456,680
WY 1999	GBP	70%	216,580		290,090
WY 2000	GBP	65%	195,420		400,730
WY 2001	GBP	49%	174,540		458,770
WY 2002	GBP	65%	124,540		320,030
WY 2003	GBP	75%	181,780		418,960

Table 4b. Comparison of Theoretical Dilution Requirements

		Theoretical Annual Volume of Water Needed to Dilute GDA Discharge to Meet Vernalis Standard (3)	WY 2003 difference	Theoretical Annual Volume Water Needed to Dilute Regional Discharge to Meet Vernalis Standard (4)	WY 2003 difference
		acre-feet		acre-feet	
Average, all years	1986 - 2003	247,208	-26%	365,599	15%
Prior years average	1986 - 2002	251,060	-28%	362,460	16%
Before GBP average	1986 - 1996	273,440	-34%	357,660	17%
GBP average	1997 - 2003	205,990	-12%	378,070	11%
Below Normal Water Years	(5)	257,700	-29%	383,210	9%
Above Normal Water Years	(6)	263,438	-31%	388,729	8%

Notes:

Pre-project data compiled by Nigel Quinn (LBNL) from CVRWQCB and USGS reports.

(1) Water Year - October 1 - September 30

(2) Percent of Contract Delivery of CVP water to Delta Division and San Luis Unit

(3) Grassland Drainage Area

(4) Mud and Salt Sloughs

(5) Below Normal Water Years with 50 percent or less CVP delivery: WY 1990 - 1994, 2001

(6) Above Normal Water Years with more than 50 percent CVP delivery: WY 1986 - 1989, 1995 - 2000, 2002, 2003

Table 5a. Concentration of Selenium in Water in the Grassland Wetland Supply Channels, January - December 2003

GBP Station	J	K	L	L2	M	M2
CVRWQCB Site ID:	MER505	MER506	MER532	MER563	MER519	MER545
	Camp 13	Agatha Canal	San Luis Canal	San Luis Canal, d/s of Splits	Santa Fe Canal	Santa Fe Canal, d/s of Splits
	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L
January 2003	1.64	1.84		1.28		1.14
February 2003	2.43	2.00		2.35		3.75
March 2003	2.20	1.98		1.88		2.33
April 2003	1.28	1.42		1.84		1.74
May 2003	1.60	1.15		1.28		1.50
June 2003	1.40	0.80		1.30		1.75
July 2003	0.98	0.86		1.18		1.42
August 2003	0.85	0.68		1.03		0.93
September 2003	0.63	0.55		0.80		0.68
October 2003	0.37	0.37		0.46		0.54
November 2003	0.63	0.58		0.73		0.55
December 2003	0.41	0.43		1.04		0.52

Data source: Monthly average selenium concentrations calculated from weekly grab samples collected by the Regional Board

Table 5b. Average Concentration of Selenium in Water in Grassland Wetland Supply Channels, Water Years 1986 – 2003

GBP Station	J	K	L	L2	M	M2
CVRWQCB Site ID:	MER505	MER506	MER532	MER563	MER519	MER545
	Camp 13	Agatha Canal	San Luis Canal	San Luis Canal, d/s of Splits	Santa Fe Canal	Santa Fe Canal, d/s of Splits
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Pre-Project						
WY 1986 - 1995 average	52.00	36.00	15.00		12.00	
WY 1996	55.90	28.20	6.50		2.10	
WY 1997	2.92	1.36	2.14		2.12	
WY 1998	2.30	4.23	2.59		2.43	
WY 1999	1.59	1.36		1.88		1.58
WY 2000	1.32	1.10		1.65		1.35
WY 2001	1.69	1.65		2.29		1.60
WY 2002	1.42	1.06		1.53		1.10
WY 2003	1.42	1.12		1.39		1.44
Data source:	Water Year selenium concentrations calculated from weekly grab samples collected by the Regional Board					

Table 5c. Average Concentration of Selenium in Water in Grassland Wetland Supply Channels, Calendar Years 1997 – 2003

GBP Station	J	K	L	L2	M	M2
CVRWQCB Site ID:	MER505	MER506	MER532	MER563	MER519	MER545
	Camp 13	Agatha Canal	San Luis Canal	San Luis Canal, d/s of Splits	Santa Fe Canal	Santa Fe Canal, d/s of Splits
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
CY 1997	3.35	1.49	2.26		2.09	
CY 1998	2.18	4.31	2.55		2.56	
CY 1999	1.40	1.17		1.74		1.51
CY 2000	1.34	1.10		2.03		1.38
CY 2001	1.57	1.53		1.95		1.48
CY 2002	1.57	1.10		1.54		1.15
CY 2003	1.20	1.05		1.26		1.40
Data source:	Annual selenium concentrations calculated from weekly grab samples collected by the Regional Board					

Table 6a. Concentration of Selenium in Water in the San Joaquin River, January - December 2003

GBP Station	G	H	N
CVRWQCB Site ID:	MER505	MER512	MER506
	San Joaquin River at Fremont Ford	San Joaquin River at Hills Ferry	San Joaquin River at Crows Landing
	µg/L	µg/L	µg/L
January 2003	0.43	2.54	1.73
February 2003	0.94	6.28	4.14
March 2003	1.01	5.83	4.14
April 2003	0.62	7.38	3.18
May 2003	0.45	7.94	2.53
June 2003	0.57	6.28	3.75
July 2003	0.57	6.74	4.03
August 2003	0.49	4.94	3.00
September 2003	0.32	4.22	2.33
October 2003	0.38	3.84	1.69
November 2003	0.33	3.12	1.77
December 2003	0.46	4.45	2.19

Data source: Site H averages calculated from weekly grab samples collected by the Grassland Area Farmers.
Monthly average selenium concentrations calculated from weekly grab samples collected by the Regional Board

Table 6b. Average Concentration of Selenium in Water in the San Joaquin River, Water Years 1986 – 2003

GBP Station	G	H	N
CVRWQCB Site ID:	MER505	MER512	MER506
	San Joaquin River at Fremont Ford	San Joaquin River at Hills Ferry	San Joaquin River at Crows Landing
	µg/L	µg/L	µg/L
Pre-Project			
WY 1986 - 1995 average	12.00	10.00	5.30
WY 1996	9.20	7.00	3.50
WY 1997	0.75	6.45	2.99
WY 1998	0.57	3.11	1.44
WY 1999	0.62	5.08	2.71
WY 2000	0.70	na	2.50
WY 2001	0.64	5.82	3.19
WY 2002	0.48	6.10	3.11
WY 2003	0.56	5.32	2.85

Data source: Water Year selenium concentrations calculated from weekly grab samples collected by the Regional Board
Notes: Site H averages for WY 1997 - 1999 calculated from weekly grab samples collected by the Regional Board.
Site H averages for WY 2001 - 2003 calculated from weekly grab samples collected by the Grassland Area Farmers.

Table 6c. Average Concentration of Selenium in Water in the San Joaquin River, Calendar Years 1997 – 2003

GBP Station	G	H	N
CVRWQCB Site ID:	MER505	MER512	MER506
	San Joaquin River at Fremont Ford	San Joaquin River at Hills Ferry	San Joaquin River at Crows Landing
	µg/L	µg/L	µg/L
CY 1997	0.82	6.61	3.14
CY 1998	0.46	2.75	1.32
CY 1999	0.68	6.01	2.79
CY 2000	0.64	4.38	2.39
CY 2001	0.60	5.65	3.13
CY 2002	0.50	6.38	3.21
CY 2003	0.55	5.30	2.87
Data source:	Annual selenium concentrations calculated from weekly grab samples collected by the Regional Board		
Notes:	Site H averages for CY 1997 - 1999 calculated from weekly grab samples collected by the Regional Board. Site H averages for CY 2001 - 2003 calculated from weekly grab samples collected by the Grassland Area Farmers.		

Figure 1. Theoretical Monthly Volumes of Water Needed to Dilute Drainage Water from the Grassland Drainage Area and Regional Watershed to Meet Vernalis Standards October 1986 - December 2003

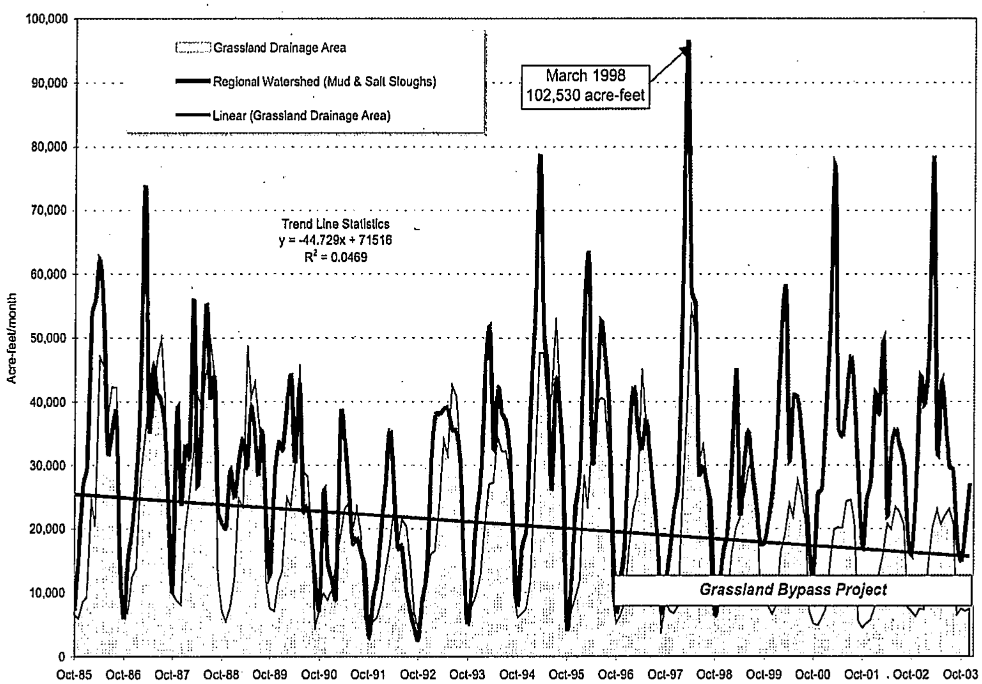
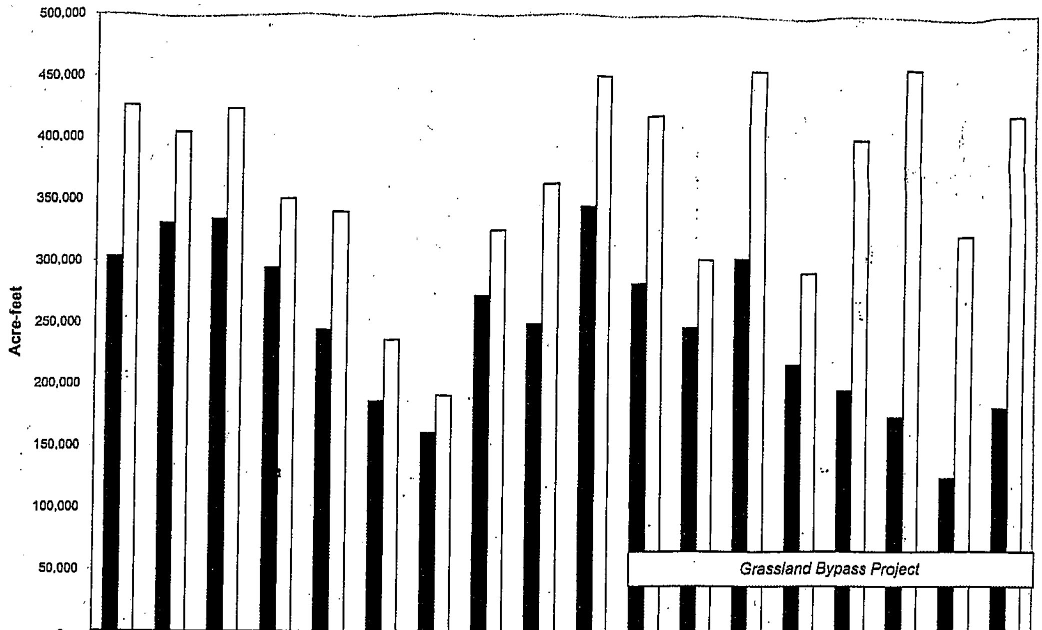


Figure 2 - Theoretical Annual Volumes of Water Needed to Dilute Drainage from the Grassland Drainage Area and the Regional Watershed to Meet Vernalis Standards (1986 - 2003 Water Years)



	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
■ GDA	303,360	332,190	335,150	294,830	245,170	186,450	160,420	272,850	249,060	344,080	283,340	246,090	303,000	216,580	195,420	174,540	124,540	181,780
□ Regional	426,150	406,130	424,450	350,410	341,300	235,850	191,070	325,960	363,090	451,510	418,390	301,220	456,680	290,090	400,730	453,770	320,030	418,960