APPENDIX A

Draft Use Agreement

Agreement No. _____________

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Central Valley Project, California

and

SAN LUIS & DELTA-MENDOTA WATER AUTHORITY
Los Banos, California

AGREEMENT FOR CONTINUED USE OF THE SAN LUIS DRAIN

FOR THE PERIOD
JANUARY 1, 2010 THROUGH DECEMBER 31, 2019

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Central Valley Project, California

AGREEMENT FOR CONTINUED USE OF THE SAN LUIS DRAIN

THIS AGREEMENT is entered into this _____ day of ______, 2009, in accordance with the Act of Congress approved June 17, 1902 (32 Stat. 388) and all Acts amendatory thereof and supplemental thereto, all such Acts commonly known as and referred to as the Federal Reclamation Law, by the United States of America (UNITED STATES), acting by and through its Bureau of Reclamation, Mid-Pacific Region (RECLAMATION), Department of the Interior, represented by the officer executing this Agreement, and the San Luis & Delta-Mendota Water Authority (AUTHORITY), a joint powers Authority, duly organized, existing and acting pursuant to the laws of the State of California, acting by and through its Executive Director.

RECITALS

A. The UNITED STATES has acquired land and constructed the San Luis Drain as a feature of its Central Valley Project.

B. The AUTHORITY has requested that the UNITED STATES permit it to continue using a portion of the San Luis Drain (as hereinafter defined and hereinafter referred to as the "Drain") for the discharge and transportation of a maximum flow of 150 cubic feet per second ("CFS") of drainage water to Mud Slough.

C. The AUTHORITY and RECLAMATION have evaluated potential environmental consequences of the proposed continued use of the Drain to convey drainage water, as set forth in this Agreement, and have completed the necessary environmental reviews in accordance with the AUTHORITY'S responsibilities under the California Environmental Quality Act ("CEQA") and RECLAMATION's responsibilities under the National Environmental Policy Act ("NEPA").

On the basis of their environmental reviews of the proposed action, the AUTHORITY issued an Environmental Impact Report ("EIR") and Notice of Determination ("NOD"), filed on

___________, and RECLAMATION issued an Environmental Impact Statement ("EIS") and Record of Decision ("ROD") on _______________.

D. It is the intention and objective 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.

E. It is also the intention and objective of RECLAMATION and the AUTHORITY, among other things, to pursue planning to report to the Oversight Committee by the end of Year Four (2013) measures to meet loads in Years Six through Ten (2015-2019) in order to meet water quality objectives in Mud Slough by the Regional Board's Basin Plan (as hereinafter defined) compliance date, as amended in relation to this Agreement. These efforts will be coordinated with the California Department of Fish and Game and the United States Fish and Wildlife Service to accommodate their activities relating to endangered and non-endangered species in or adjacent to Mud Slough.

F. The Draining Parties have developed a long-term drainage management plan, termed the "Westside Regional Drainage Plan," designed to provide long-term drainage service to lands in the Grassland Drainage Area. Continued drainage discharge under the Use Agreement is a component of the Westside Regional Drainage Plan. After the term of the Use Agreement, the Westside Regional Drainage Plan is designed to manage drain water produced from irrigation in the Grassland Drainage Area without the need for discharge of such drainage to the San Joaquin River.

G. Even with full implementation of the Westside Regional Drainage Plan, the Draining Parties expect that high rainfall events occasionally will create drainage flows that cannot be controlled by the Draining Parties, and it is the intention and objective of the AUTHORITY in coordination with RECLAMATION to develop, beginning no later than Year Seven (2016), a long-term storm water management program. Development of such program may include the evaluation of utilizing a portion of the San Luis Drain to bypass storm water flows around some wetland areas, in order to minimize the impact of such flows.

H. The AUTHORITY has entered into an agreement with its members, known as the Grassland Basin Drainage Management Activity Agreement, and into memoranda of understanding with certain other parties described in section I.D. (collectively, the "Activity Agreement"), all of which have a need for continued use of the San Luis Drain. RECLAMATION has no objection to the AUTHORITY entering into such agreements.

I. The UNITED STATES has no objection to continued use of the Drain as described in this Agreement and RECLAMATION land as such continued use is, at this time, not incompatible with the purpose of the Drain and the purpose for which the RECLAMATION land was withdrawn or acquired and is being administered by the UNITED STATES.

J. The AUTHORITY has entered into Contract No. 8-07-20-X0354 (the "Transfer Agreement"), with RECLAMATION, whereby the AUTHORITY is responsible for, among other things, the operation and maintenance of the San Luis Drain to the extent described in the Transfer Agreement and according to the terms set forth therein; the scope of AUTHORITY's responsibility for operation and maintenance of the San Luis Drain and of its authority delegated by RECLAMATION will be as set forth in the Transfer Agreement, except that the terms of this Agreement providing any more specific responsibilities and authority supersede the Transfer Agreement for that portion of the Drain subject to this Agreement.

K. RECLAMATION anticipates that any long-term use of the Drain beyond the term of this Agreement will be for a program for discharging storm water only. Any such stormwater discharge program will require further specific planning and compliance with all environmental laws, including the National Environmental Policy Act and the Endangered Species Act. Terms of this Agreement have been negotiated by a group of agricultural and environmental stakeholders, and contains three distinct mechanisms to provide incentives to implement an in-valley drainage management solution as soon as possible, such that (i) Load Values decrease over the term of this Agreement;(ii) Incentive Fees increase over the term of this Agreement and (iii) mitigation obligations increase over the term of this Agreement, with significant changes applying during Years Six through Ten (2015-2019) in particular; however, such mechanisms do not constitute a model, or form the baseline of requirements for any long-term storm water discharge program, which will be required to meet regulatory requirements for such programs.

L. This Agreement is the successor to and supersedes the 2001 Use Agreement between RECLAMATION and the AUTHORITY (as hereinafter defined), which earlier agreement was based in part on that certain Final Environmental Impact Statement and Environmental Impact Report dated May 25, 2001 ("EIS-EIR"), the AUTHORITY's Notice of Determination ("NOD") filed on August 14, 2001, and RECLAMATION's Record of Decision ("ROD") dated September 28, 2001.

M. The parties expect to obtain Waste Discharge Requirements from the Regional Board for discharges under the Use Agreement. Provisions of the Use Agreement are not intended to predetermine provisions included in WDR's.

AGREEMENT

Subject to the following terms, conditions, and limitations, the UNITED STATES grants permission to the AUTHORITY to continue to enter upon, use, operate and maintain the Drain, including check structures and all other land and facilities appurtenant to the Drain for the purpose of conveying drainwater flows from the Drainage Area, from Milepost 105.72, Check 19 to the terminus and into Mud Slough. In addition, RECLAMATION grants permission to use Drain rights-of-way from the terminus (Kesterson Reservoir) to Check 19, as reasonably required in accordance with this Agreement. "Land" includes land owned and/or controlled by the United States and land in which the United States holds an interest that is affected by the AUTHORITY's activities under this Agreement.

I. DEFINITIONS AND REFERENCED TERMS

For purposes of this Agreement:

A. "Attributable Discharge" means the amount of selenium load or salt load, whichever is applicable, discharged from the Drain, plus any storm event discharges to the Grassland Water District from the Drainage Area, minus any amount exempted pursuant to the high rainfall exemption as specified in Appendix F (attached hereto and incorporated herein), and minus any amount exempted pursuant to the upper watershed exemption as specified in Appendix G (attached hereto and incorporated herein).

B. "Drainage Area" means those lands identified in Appendix A (attached hereto and incorporated herein) within the geographic area shown on Appendix B which are within the boundaries of districts identified as "Draining Parties" or whose owners have become Draining Parties.

C. "Drainage Oversight Committee" or "Oversight Committee" means the Oversight Committee formed pursuant to the First Use Agreement that is composed of agency managers from RECLAMATION, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, California Department of Fish and Game, and the Regional Water Quality Control Board, and which continues to exercise the functions described in this Agreement.

D. "Draining Parties" means the AUTHORITY member agencies which have entered into, and are currently participating in, the Grassland Basin Drainage Management Activity Agreement with the AUTHORITY and with the parties to various Memoranda of Understanding ("MOU's") by the terms of which the parties who would discharge into the Drain have agreed to abide by the terms of this Agreement. Members of the AUTHORITY which have entered into the Grassland Basin Drainage Management Activity Agreement include the Broadview Water District, the Firebaugh Canal Water District, the Pacheco Water District, the Panoche Drainage District, the Charleston Drainage District and the Widren Water District, the parties to that certain MOU with the AUTHORITY referred to as the Camp 13 Drainers (now Camp 13 Drainage District), and any other parties which may enter into MOU's with the AUTHORITY including the owners of certain additional lands, described in Appendix A hereto, from which lands drainage waters historically entered channels utilized to provide water to wetland habitat in the Grassland Water District and state and federal refuges.

E. “2001 Use Agreement” means that certain agreement for use of the San Luis Drain between the United States, Department of the Interior, Bureau of Reclamation and the San Luis & Delta Mendota Water AUTHORITY entered into September 28, 2001, Agreement No. 6-07- 20-W1319 and any amendments thereto, including Modification No. 1, Use Agreement for Use of the San Luis Drain, dated June 8, 2007.

F. “Regional Board Basin Plan” means the Regional Water Quality Control Board’s Water Quality Control Plan for the Sacramento River and San Joaquin River Basins, as amended.

G. “Regional Water Quality Control Board” or “Regional Board” means the Region 5 California Regional Water Quality Control Board, Central Valley Region.

H. “Salinity” or “salinity” means the content of dissolved mineral salts, measured by determining the amount of total dissolved solids or by measuring the electrical conductivity and through appropriate conversion factors estimating the total dissolved solids.

I. “Salts” or “salts” means the products, other than water, of the reaction of an acid with a base; such products found in soils, when dissolved in water, break up into cations (e.g., sodium, calcium) and anions (e.g., chloride, sulfate).

J. “Salt Load” or “salt load” means the total mass of salts in a given volume of water entering or leaving an area.

K. “San Luis Drain” or the “Drain” mean the drain owned by the United States and consisting of approximately 28 miles from the terminus (Kesterson Reservoir) to Milepost 105.72, Check 19 (near Russell Avenue).

L. “Selenium” or “selenium” means the metalloid element, assigned atomic number 34, in all of its chemical forms, including but not limited to selenate, selenite, selenomethionine and elemental selenium. An essential nutrient in low concentrations, it bioaccumulates in the food web and can have significant adverse effects on sensitive predators.

M. “Selenium Load” means the total mass of selenium in a given volume of water entering or leaving an area.

N. “Total Dissolved Solids” or “TDS” shall mean the non-filterable portion of the material residue remaining after a liquid sample is evaporated.

O. “TMDL” means the Total Maximum Daily Load. For purposes of this Use Agreement, “Selenium TMDL” shall mean the TMDL for selenium on the lower San Joaquin River approved by the USEPA on March 28, 2002, or any subsequent TMDL for selenium on the lower San Joaquin River approved by the USEPA .

P. "TMML" means the Total Maximum Monthly Load. For purposes of this Use Agreement, TMML values will be those calculated under the Selenium TMDL approved by the United States Environmental Protection Agency on March 28, 2002.

Q. "Unacceptable Adverse Environmental Effects" shall be determined by RECLAMATION, based upon available data and science and after consultation with the Oversight Committee, after considering applicable federal and state laws (e.g. Migratory Bird Treaty Act, Endangered Species Act, Clean Water Act, Porter-Cologne Act), as well as the impacts in Mud Slough or at any point downstream of Mud Slough, including adjacent wetland and riparian areas.

R. "Unforeseeable and Uncontrollable Events" are events that cannot reasonably be anticipated and are caused by events outside the control of the Authority. Final determinations as to what constitutes Unforeseeable and Uncontrollable Events are made solely by the Oversight Committee.

S. "USEPA" means the United States Environmental Protection Agency.

T. "Waste Discharge Requirements" or "WDR" means the terms and conditions for discharges of drainage issued by the Regional Board pursuant to California law.

II. PURPOSE AND SCOPE OF USE

A. RECLAMATION and the AUTHORITY have entered into this Agreement to

1. continue the separation of unusable agricultural drainage water discharged from the Grassland Drainage Area from wetland water supply conveyance channels for the period 2010-2019; and,

2. facilitate drainage management that maintains the viability of agriculture in the project area and promotes continuous improvement in water quality in the San Joaquin River.

B. The lands to be served pursuant to this Agreement are only those lands located within the geographic area in Appendix A and shown in Appendix B (attached hereto and incorporated herein), which consists of approximately 97,400 acres, together with additional lands not to exceed 1,100 acres whose owners choose to become Draining Parties.

C. The AUTHORITY shall be permitted to use the Drain for the discharge into and transportation of drainage water from the Draining Parties within the Drainage Area, in accordance with the terms and conditions of this Agreement.

D. The AUTHORITY may incorporate terms into the Activity Agreement or MOU's or may promulgate bylaws, rules or regulations thereunder concerning the sharing of responsibilities, costs and obligations arising from this Agreement and for the payment of fees as compensation to the AUTHORITY for its performance of its obligations and responsibilities under this Agreement, but in no event shall any such Activity Agreement or MOU entered into between the AUTHORITY and the Draining Parties include rights and responsibilities which are inconsistent with the specific terms and conditions of this Agreement, or which are in violation of any laws or regulations applicable to this Agreement.

III. PERMITS AND RESPONSIBILITIES

A. Permits and Approvals. The AUTHORITY shall be responsible for obtaining all permits and other approvals necessary for its continued use, operation and maintenance of the Drain in accordance with the terms and conditions of this Agreement, the Waste Discharge Requirements issued to Reclamation and to the AUTHORITY on behalf of Draining Parties by the Regional Board on September 7, 2001, as they have been or may be amended and any subsequent WDR issued in relation to this Agreement, or any alternative form of requirements of the Regional Board, and all applicable local, state and federal laws and regulations.

B. Discharges into and from Drain. The AUTHORITY shall be responsible for ensuring that only drainage water from the Drainage Area pursuant to the terms of the Activity Agreement or MOU enters the Drain, and that such drainage water is controlled and monitored to ensure that its quality and composition comply with this Agreement and all applicable federal, state and local standards, requirements, regulations and laws. During its use of the Drain under, this Agreement, the AUTHORITY shall be solely responsible for and have sole authority over the proper management and disposal of all discharges into and from the Drain, subject to this Agreement and all applicable laws and regulations.

C. Check 19. For purposes of this project the AUTHORITY shall not use the Drain in any manner that will affect water levels in or cause drainage water to flow into the portions of the Drain south of Check 19. Management and control of the operation of Check 19 shall be in accordance with the Transfer Agreement.

D. Silt Removed by RECLAMATION. RECLAMATION, in its discretion, shall, at any time during the term of this Agreement, have the option of either removing the sediment and organic materials now deposited in the Drain, or, of delegating this responsibility to the AUTHORITY. If RECLAMATION elects to remove the sediment during the term of this Agreement, RECLAMATION shall endeavor to conduct and coordinate such activities in a manner which will not unreasonably interfere with the AUTHORITY's use of the Drain. In any event, unless directed otherwise by RECLAMATION, the AUTHORITY shall be responsible for the management, removal and disposal, at its own and sole expense, of all sediment, organic materials and other substances accumulating in the Drain as a result of its use of the Drain pursuant to the First Use Agreement, the 2001 Use Agreement, and this Agreement. Any costs incurred by either RECLAMATION or the AUTHORITY for the management, removal and disposal of the sediment and other materials in the Drain shall be apportioned between RECLAMATION and the AUTHORITY on the basis of the total volume of materials and the total concentration of contaminants in those materials in the Drain attributable to each party's use of the Drain.

E. Payment of Direct Costs. AUTHORITY shall pay to RECLAMATION such specific items of direct costs reasonably incurred by RECLAMATION for work associated with this Agreement as are normally charged by RECLAMATION under similar agreements and properly and equitably are chargeable to the AUTHORITY, plus a percentage of direct cost to cover RECLAMATION administrative and general overhead in accordance with the procedures approved by RECLAMATION. AUTHORITY shall pay the total annual costs within sixty (60) days following its receipt of a detailed cost statement from RECLAMATION for each year during the term of this Agreement.

F. Water Conservation Programs. All Draining Parties discharging into the Drain pursuant to this Agreement that are subject to Federal Reclamation law shall be implementing an effective water conservation and efficiency program based on that Draining Party's Water Management Plan that has been determined by RECLAMATION to meet the conservation and efficiency criteria for evaluating such plans established under Federal law.

G. Management Plans. The AUTHORITY shall prepare the following reports and develop the following plans:

1. By the end of Year Four (2013), a Report to the Oversight Committee provided at a noticed meeting regarding the Draining Parties' plan to meet loads in Years Six through Ten (2015-2019).

2. No later than Year Seven (2016), the Draining Parties shall begin developing a long-term storm water management plan, which may include evaluation of utilizing the San Luis Drain to bypass storm water flows around some wetland areas.

3. The Draining Parties, in coordination with Reclamation, shall develop a Sediment Management Plan consistent with this agreement.

H. Environmental Commitments:

1. Operational Commitments. The AUTHORITY commits to the following:

(a) <u>Spill Prevention</u>. The structure in the San Luis Drain at Check 19 has been modified to prevent drainage waters from flowing southerly and to provide a mechanism to allow any groundwater that has seeped into the San Luis Drain south of Check 19 to be discharged downstream as necessary to prevent overtopping. The Drain will continue to be operated and maintained to prevent drainage water from flowing south of Check 19 and to allow groundwater from south of Check 19 to spill into the Drain as necessary to prevent overtopping.

(b) Downstream Users Notification. The AUTHORITY will make flow and monitoring data available to downstream entities that have requested it. The AUTHORITY will provide advance notice to such parties of operations that may cause sudden changes in flow or quality and will develop procedures to coordinate with such parties on such operations. The AUTHORITY will work cooperatively with downstream entities regarding the timing of discharges and establish procedures that will ensure advance notice to, and coordination with, downstream diverters of upcoming releases.

(c) Regional Archeology. Any proposed construction areas will be evaluated and cleared by Reclamation's Regional Archeologist. If, during construction, subsurface or previously unidentified archeological resources are encountered, activities will immediately be halted and the Regional Archeologist notified. Appropriate clearance will be obtained prior to resumption of work.

(d) Protection of China Island. The AUTHORITY coordinated with the California Department of Fish and Game regarding the design and construction of retainer dikes or other measures to protect Fish and Game's China Island Wildlife Area and the immediately adjacent portion of the San Joaquin River from drainage water discharged from the Drainage Area. In addition, the AUTHORITY shall enter into a Memorandum of Agreement with the California Department of Fish and Game relating to use of Mud Slough (North) within the boundaries of the China Island Wildlife Area. Said MOA may be modified from time to time with the mutual consent of the parties thereto.

(e) Public Health Projections in Mud Slough. In the event RECLAMATION or the AUTHORITY receive notification from appropriate local, state or federal authorities that a potential public health risk exists in Mud Slough or the San Joaquin River associated with drainage from the Drainage Area, RECLAMATION and the AUTHORITY will notify resource management agencies in the affected area. RECLAMATION and the AUTHORITY will, in collaboration with such resource management agencies jointly develop and implement a program to protect public health that is acceptable to those agencies. All costs of developing and implementing said program to protect public health will be borne by the AUTHORITY.

(f) Sediment. Selenium already contained in sediments in the Drain is a source of concern because flows may suspend and transport sediments; selenium may migrate into the water column; and sediments may act as a sink, and selenium may concentrate into sediment. To avoid re-suspending sediment in the Drain, the maximum rate of flow in the Drain shall be 150 cfs. Under normal operations, flows will be slow enough to not cause sediment movement. Monitoring activities will detect any movements or selenium migration. In the event that selenium in sediments migrates into the water column, such selenium will be included in the total annual load discharged by, and attributed to, the Authority. If monitoring results indicate that the Drain behaves like a sink, the measured loads will be used to estimate total selenium concentration within the sediments, and the information will be used to determine if the sediments must be removed from the Drain. Sediments will be removed well before composite concentrations indicate hazardous material values. The specific details of responses to monitoring results that indicate any of these scenarios exist will be presented in the Sediment Management Plan specified in III.G.3.

(g) Mitigation for Continued Use of Mud Slough. The specific commitments of the Draining Parties for mitigation arising from the continued use of Mud Slough and the anticipated extension of the compliance period before selenium water quality objectives are fully met in Mud Slough and the San Joaquin River between Mud Slough and the confluence of the Merced River are set forth in Appendix L to this Agreement.

2. Load Reduction Assurances

(a) Selenium Load Values.

(1)The Selenium Load Values in Appendix C are hereby incorporated and made a part of this Agreement. These Values specify both annual and monthly Selenium Loads.

(2) If the agency with final regulatory approval changes the Water Quality Objective for selenium in the lower San Joaquin River or changes the TMDL for selenium in the lower San Joaquin River that was approved by USEPA on March 28, 2002, the provisions set forth in Appendix D shall apply.

(3) To determine if Selenium Load Values are being met, the Attributable Discharge of selenium will be compared to the Selenium Load Value for the time period under consideration. Selenium load will be measured at the terminus of the Drain (referred to as “Site B”), except that load discharged to the Grassland Water District from the Drainage Area during storm events will be measured at the discharge points into the Grassland Water District, and selenium load to be exempted under Appendices F or G will be determined as described in those Appendices.

(4) If the Attributable Discharge of Selenium exceeds the applicable Selenium Load Value in any given month or year during the term of this Agreement, a Drainage Incentive Fee shall be calculated in accordance with the Performance Incentive System as stated in section IV.B. of this Agreement, and the Agreement may be subject to termination pursuant to Section VII.B.

(b) Salinity Load Values:

(1) The Salinity Load Values in Appendix E are hereby incorporated and made a part of this Agreement. These Values specify both annual and monthly salt loads.

(2) To determine if Salt Load Values are being met, the Attributable Discharge of salts will be compared to the Salt Load Value for the time period under consideration. Salt load will be measured at the inlet to the Drain (referred to as "Site A"), except that salt load discharged to the Grassland Water District from the Drainage Area during storm events will be measured at the discharge points in to the Grassland Water District, and load to be exempted under Appendices F and G will be determined as described in those Appendices.

(3) If the Attributable Discharge of Salinity exceeds the applicable Salinity Load Value in any given month or year during the term of this Agreement, a Drainage Incentive Fee shall be calculated in accordance with the Performance Incentive System as stated in section IV.B. of this Agreement.

3. Record of Decision. The Authority will implement those commitments contained in the ROD relating to this Use Agreement.

IV. DRAINAGE OVERSIGHT COMMITTEE AND PERFORMANCE INCENTIVE SYSTEM

A. Role of Drainage Oversight Committee

The Oversight Committee will meet as needed and may conduct its meetings by noticed telephone conference calls that are open to participation by interested parties. The Oversight Committee reviews progress and operation of the project including drainage reduction goals, progress in achieving water quality objectives, monitoring data, etc. It makes recommendations to the Draining Parties, RECLAMATION, and/or the Regional Board, as appropriate, regarding all aspects of the project, including modifications to project operation, appropriate mitigative actions, and termination of the Agreement if necessary. It carries out other functions required of it under this Agreement, which include determining the occurrence and extent of load exceedances, determining the Drainage Incentive Fees that are payable, and selecting projects to be funded from the Drainage Incentive Fee Account as set forth in subsection IV.B.4. For example, if any Draining Party resumes discharges into channels cleaned up through the Project, the Oversight Committee can determine appropriate remedies, up to and including termination of this Agreement.

1. The Oversight Committee may appoint and be assisted by a technical committee as determined necessary or appropriate by the Oversight Committee.

2. The Oversight Committee may appoint one or more subcommittees comprised of experts to help in the analysis of biological or water quality monitoring data or other information relevant to the drainage issue as necessary or appropriate to assist in carrying out its role.

3. If the Oversight Committee determines, based on monitoring data or otherwise, that adverse environmental impacts have occurred and the Oversight Committee finds those impacts to be significant, the Oversight Committee will identify appropriate mitigative actions. Appropriate mitigative actions, depending on the situation, would include, but are not necessarily limited to, interruption of a specific identified contamination pathway through hazing or habitat manipulation; increased management, enhancement, and recovery activities directed at impacted species in channels cleaned up as a result of the project; and/or, establishment and attainment of more stringent contaminant load reductions. The costs of mitigation, as well as any required clean-up, shall be borne by the Draining Parties.

4. The Oversight Committee shall also make other determinations as specified in this Agreement including without limitation those described in Sections VII.B and VII.F.

B. Performance Incentive System

The performance incentive system shall be implemented by means of the following:

1. Drainage Incentive Fee Account. The AUTHORITY shall maintain an account known as the Drainage Incentive Fee Account. Disbursements shall be made from said Drainage Incentive Fee Account only at the direction of the Oversight Committee. A detailed accounting of the Account will be provided by the AUTHORITY to member(s) of the public upon request.

2. Calculation of Drainage Incentive Fees. Based upon information from the monitoring program established pursuant to Section V of this Agreement, RECLAMATION shall calculate the Attributable Discharge for each year and month. Drainage Incentive Fees are not the result of damage to federal property and are not revenue due to the Federal Government. Drainage Incentive Fees shall be calculated based on Attributable Discharge.

(a) <u>Preliminary and Final Calculations</u> - Drainage Incentive Fees.

(1) Within sixty (60) days of the close of each calendar year for the duration of this Agreement, RECLAMATION shall, based on the monitoring results, determine whether an Annual Drainage Incentive Fee or any Monthly Drainage Incentive Fees are due for such period, and if due, shall calculate the preliminary Annual Incentive Fee or Monthly Incentive Fees in accordance with Appendix C ("Selenium Load Values"), Appendix E

("Salinity Load Values"), and Appendix H ("Performance Incentive System for Selenium and Salt"). RECLAMATION shall immediately submit such calculations to the Oversight Committee.

(2) Within (ninety) 90 days of the close of each calendar year for the duration of this Agreement, the Oversight Committee shall, with the advice of any technical committee it may establish, determine the Annual Drainage Incentive Fee and any Monthly Drainage Incentive Fees. Such Annual Drainage Incentive Fee and any Monthly Drainage Incentive Fees shall be the amount calculated by RECLAMATION for each such fee reduced by the amount, if any, that is waived by the Oversight Committee pursuant to subsection (b)(1) of this section, and/or reduced or credited pursuant to subsections (b)(2), (b)(3), or (b)(4) of this subsection IV.B.2.

(3) The Annual Drainage Incentive Fees shall not exceed the Annual Drainage Incentive Fee cap of $300,000 and the sum of the Monthly Drainage Incentive Fees shall not exceed the Monthly Drainage Incentive Fee cap of $300,000 per year during Years One through Five (2010-2014) of this Agreement; thereafter the annual and monthly incentive fees shall increase and be capped as set forth in Appendix H.

(4) The Oversight Committee's determination of the Annual Drainage Incentive Fee shall be transmitted to the AUTHORITY in writing immediately; the period for deposit of the Drainage Incentive Fees under subsection IV.B.3 of this Agreement shall commence five (5) days following the date of transmittal.

(b) Adjustment of Incentive Fees.

(1) Waiver for Uncontrollable and Unforeseeable Events. The Oversight Committee may waive the Drainage Incentive Fee, in whole or in part, only upon a finding that the AUTHORITY has shown that exceedances, in particular months or for the year as a whole, were caused by Unforeseeable and Uncontrollable Events.

(2) Duplicative Regional Board Penalties. In the event that the Regional Board or other regulatory agency imposes a financial penalty which the AUTHORITY or Draining Parties become responsible to pay for discharges of Selenium or Salt that are the subject of Drainage Incentive Fees assessed under this Agreement, the Drainage Incentive Fee owed by such parties shall be reduced by the amount of such other financial penalty. The Oversight Committee shall determine when this payment relief is applicable.

(3) Incentive Fee Credits. In order to provide incentive to reduce selenium and salinity discharges beyond the current annual Load Values, a credit toward future incentive fees will be given if the annual or monthly selenium Attributable Discharge or the annual or monthly salinity Attributable Discharge is below the annual or monthly Load Value for

such constituent. The annual and monthly incentive fee credits will be determined as set forth in Appendices "I" and "J" to this Agreement, respectively.

(4) Exceedances of both Selenium and Salinity Load Values. In the event that both the applicable Selenium Load Values and Salinity Load Values are exceeded in any given month or year, only the incentive fee for exceeding the Selenium Load Values shall be imposed.

3. Deposit of Incentive Fees. Within sixty (60) days of the receipt of the Oversight Committee's determination, the AUTHORITY shall deposit the amount of the Drainage Incentive Fee in the Drainage Incentive Fee Account. Failure to deposit said amount in the Drainage Incentive Fee Account within ninety (90) days of receipt of the Oversight Committee's decision shall constitute grounds for immediate termination of this Use Agreement.

4. Disposition of Incentive Fees. The Oversight Committee shall determine the disposition of funds deposited in the Drainage Incentive Fee Account, taking into account the considerations and procedures set forth in this subsection IV.B.4.

(a) Such determination shall be made only after consultation with the Draining Parties and any other interested parties, and may be based on recommendations from subcommittees established by the Oversight Committee.

(b) These funds are to be used for such projects as the Oversight Committee determines will assist in meeting Selenium Load Values, Salinity Load Values, water quality objectives in the Drainage Area, and/or will enhance wildlife values in the Drainage Area or adjacent areas. In determining the disposition of Account funds, the Oversight Committee shall give special consideration to projects that will help reduce drainage production in the region. Examples of projects to be given special consideration include, but are not limited to: irrigation improvements that are likely to reduce drainage; voluntary land retirement that is likely to reduce drainage; irrigation water conveyance facility improvements that are likely to reduce drainage. It is intended that projects funded through the Drainage Incentive Fee Account will be supplemental to, and shall not replace, budgeted actions of the AUTHORITY or of RECLAMATION to accomplish drainage reduction targets. At its discretion, the Oversight Committee may accumulate funds in the Drainage Incentive Fee Account until sufficient funds have accumulated to fund larger programs or actions. Upon making its determination as to the disposition of funds in the Drainage Incentive Fee Account, the Oversight Committee shall instruct the AUTHORITY to make such disbursements from the Account to such persons and in such amounts as are consistent with that determination.

(c) It is the intent of the parties to expedite the efficient disposition and use of Annual/Monthly Drainage Incentive Fees assessed, if any, towards drainage reduction projects as soon as possible. Prior to the meeting of the Oversight Committee or an appropriate technical committee established by the Oversight Committee to determine any Annual /Monthly

Incentive Fees, the Oversight Committee or technical committee shall cooperate with the Draining Parties, the Authority and other interested parties to screen potential drainage reduction projects that will be submitted to it by the Draining Parties.

(d) At the time the Oversight Committee meets to determine the Annual/Monthly Incentive Fees, it shall also consider projects to be funded, including the screened proposed project(s) submitted to it by the Draining Parties, and select one or more projects to be funded from the Drainage Incentive Fee Account. Promptly following the selection of a project(s) , the Oversight Committee shall notify the Authority of the project(s) and direct the Authority to distribute funds deposited in the Drainage Incentive Fee Account for the selected project(s).

(e) If the Oversight Committee determines that there are no projects for use of Incentive Fees collected for exceedances in Years Nine and Ten (2018 and 2019) that meet the goals described in subsection IV.B.4.b., then the Oversight Committee may consider utilizing such Incentive Fees to enhance fish or wildlife values in the Drainage Area or adjacent areas.

5. Treatment of Incentive Fees Upon Termination. Drainage Incentive Fees owed by the AUTHORITY pursuant to subsection IV.B. and any funds held in the Drainage Incentive Fee Account as of the date of termination of this Agreement shall be paid, held, administered and disposed of in accordance with subsection IV.B.4. Except for Drainage Incentive Fees owed on the date of termination, the AUTHORITY shall have no obligation for Drainage Incentive Fees under the Agreement following the termination hereof.

V. MONITORING

A. The AUTHORITY shall be responsible for implementing a comprehensive monitoring program that meets the following objectives:

1. to provide water quality data for purposes of determining the Draining Parties' compliance with Selenium Load Values and Salinity Load Values as set forth in this Agreement;

2. to provide biological data to allow an assessment of whether or not any environmental impacts constitute Unacceptable Adverse Environmental Effects that have resulted from this Agreement; and

3. to provide data on sediment levels, distribution, and selenium content.

The monitoring program shall consist of the monitoring program established by the parties during the 2001 Use Agreement, as such program may be modified by the parties after consultation with the agencies represented by the Oversight Committee. The Oversight

Committee in consultation with the AUTHORITY shall resolve disagreement as to proposed modifications. Such modifications shall not constitute an amendment of this Agreement. Data collected in the course of the monitoring program may be utilized as appropriate to meet requirements of biological opinions issued in relation to this Agreement; the balance of data to meet the requirements of such biological opinions will be developed by alternate studies pursuant to Section III.H.3. of this Agreement. RECLAMATION and the AUTHORITY will compile the results of the monitoring program into an Annual Report and present it for review by the Oversight Committee.

B. On a regular basis, and in no event less frequently than monthly, the results of the monitoring program, including the monitoring results pertaining to the discharges of selenium and salts being delivered from the Drain to Mud Slough, shall be submitted to RECLAMATION, to the Oversight Committee, and to other interested parties.

C. Results of the monitoring program will be reviewed annually or as required to implement this Agreement, by the Oversight Committee.

D. The AUTHORITY shall be responsible for implementing this monitoring program; provided that, nothing contained in this Agreement is intended to extend monitoring requirements downstream of Crows Landing ("Site N") on the San Joaquin River.

VI. CONSTRUCTION, OPERATION AND MAINTENANCE

A. The AUTHORITY shall be responsible for the construction, installation, operation, maintenance, and ultimate removal, if such removal is required by RECLAMATION, of any new facilities necessary for the AUTHORITY's use of the Drain; for the operation and maintenance of all existing features of the Drain; for the repair of any damage to the Drain arising out of its use of the Drain; and for the restoration of any land requiring restoration as a result of the AUTHORITY's use of the Drain.

B. The AUTHORITY shall furnish to RECLAMATION for approval the plans and specifications for all facilities or structures that are to be constructed on Land of the UNITED STATES. The AUTHORITY shall not commence construction or installation of any such facility prior to submitting the plans and specifications to RECLAMATION for review and obtaining written approval, which approval shall not unreasonably be withheld.

C. RECLAMATION shall promptly furnish to the AUTHORITY copies of documents, drawings and other records available to RECLAMATION which are appropriate or necessary for the AUTHORITY's use of the Drain in accordance with this Agreement, as requested by the AUTHORITY in writing. The AUTHORITY shall revise such drawings to reflect new facilities and any modifications to existing facilities installed by the AUTHORITY and shall promptly furnish a copy of each revised drawing to RECLAMATION.

D. The Parties acknowledge and agree that the Draining Parties shall be responsible to the AUTHORITY for payment of all operation and maintenance, administration, and construction costs arising from performance by the AUTHORITY pursuant to this Agreement, provided, that payment for baseline operation and maintenance and administration costs incurred by the AUTHORITY for the Drain pursuant to the Transfer Agreement shall be budgeted, and repayment responsibility shall be allocated, in accordance with the terms of the Transfer Agreement without regard to this Agreement.

VII. TERM, REVISION AND TERMINATION

A. Term. This Agreement shall become effective on January 1, 2010, and unless sooner terminated in accordance with applicable terms herein, shall remain in effect through December 31, 2019 .

B. Termination for Exceedance of Selenium Load Values

1. Annual Exceedances.

(a) If the calculated annual Attributable Discharge of selenium loads in Years One through Five (2010-2014) of this Use Agreement exceeds by 20% or more the annual Selenium Load Values, RECLAMATION shall terminate this Agreement unless the Oversight Committee, after consulting with the Draining Parties, any other stakeholders, and any technical committee established by the Oversight Committee, makes an affirmative finding that the AUTHORITY has shown that such exceedance was caused by Unforeseeable and Uncontrollable Events.

(b) If the calculated annual Attributable Discharge of selenium loads in Years Six through Ten (2015-2019) of this Use Agreement exceeds the amount shown in the Mandatory Termination Chart, attached to this Agreement as Appendix “K” and incorporated herein by this reference, RECLAMATION shall terminate this Agreement unless the Oversight Committee, after consulting with the Draining Parties, any other stakeholders, and any technical committee established by the Oversight Committee, makes an affirmative finding that the AUTHORITY has shown that such exceedance was caused by Unforeseeable and Uncontrollable Events.

(c) Appendix “K,” attached hereto and incorporated by this reference herein, contains the Mandatory Termination Chart described in this subsection VII.B.1 and in subsection VII.B.2 of this Agreement.

2. Monthly Exceedances. This Agreement may be terminated on account of monthly Attributable Discharge in excess of Selenium Load Values only pursuant to the conditions set forth in Paragraphs VII.C and VII.D of this Agreement.

3. Salinity Exceedances. No annual or monthly exceedances of salinity shall be the basis of termination pursuant to this section VII.B.

C. Termination by Prohibition of Discharge. This Agreement shall terminate immediately upon any final order or action by the California State Water Resources Control Board, Regional Board, Environmental Protection Agency, or any other federal, State or local government entity with jurisdiction over the drainwater discharges contemplated by this Agreement which prohibits or substantially prohibits the discharge of drainage water by the AUTHORITY into the San Luis Drain, Mud Slough, or the San Joaquin River.

D. Termination for Cause. Reclamation shall review this Agreement at least annually for compliance with its terms and conditions and, except as otherwise set forth herein, shall be subject to termination upon a finding that the AUTHORITY failed to comply with any of the terms or conditions of this Agreement or if Unacceptable Adverse Environmental Effects occur. For purposes of this paragraph, if RECLAMATION determines, based on available data and science and after consultation with the Oversight Committee and the AUTHORITY, that Unacceptable Adverse Environmental Effects have occurred due to the use of the Drain, RECLAMATION shall notify the AUTHORITY of its determination and provide the AUTHORITY an adequate opportunity to refute this determination. If, in RECLAMATION's judgement, the AUTHORITY fails to provide sufficient evidence refuting RECLAMATION's determination, RECLAMATION shall terminate this Agreement.

E. Termination after Notice. Except as otherwise set forth herein, RECLAMATION may terminate this Agreement upon failure of the AUTHORITY or a Draining Party to comply with any of the terms, conditions and limitations of this Agreement, if such noncompliance is continuing sixty (60) days after written notice to the AUTHORITY of such noncompliance. The requirement of continuing noncompliance for sixty (60) days after written notice does not apply to violation of terms, conditions and limitations of this Agreement, where such provisions state requirements that, if violated, cannot be cured by subsequent AUTHORITY action.

F. Termination for Resumption of Discharge to Wetland Channels. The parties to this Agreement agree that a critical purpose of this Agreement is the removal of drainage water from the channels utilized to provide water to wetland habitat in the Grassland Water District and state and federal wildlife refuges. In the event that any of the Draining Parties withdraw from the Grasslands Basin Drainage Management Activity Agreement and resume the discharge of drainage water into those channels, or if any individuals within the Drainage Area who have commenced using the Drain resume the discharge of drainage water into those channels, the Oversight Committee shall review the impact of such resumed discharge and shall recommend appropriate remedies, up to and including termination of this Agreement. In making its evaluation, the Oversight Committee shall give special consideration to the existence of exceedances of water quality standards in the channels and to the probable causes of such exceedances.

G. Termination by the Authority. This Agreement may be terminated by the AUTHORITY upon thirty (30) days' written notice to RECLAMATION.

H. Termination upon Completion of Drain. In the event that construction of the San Luis Drain, including both the Drain as defined herein and segments that are not subject to this Agreement, is completed as an out-of-valley drainage facility, discharge permits obtained, and environmental compliance completed during the term of this Agreement, or any extension hereof, this Agreement shall terminate.

VIII. RESTORATION

Upon termination of this Agreement, at the discretion of the UNITED STATES, the AUTHORITY shall remove without delay, and at the expense of the AUTHORITY, all equipment and improvements and other facilities constructed or placed upon the Land, and shall restore said Land to as nearly the same condition as existed prior to the issuance of this Agreement and repair any damage to the Drain arising out of its use of the Drain. In the event the AUTHORITY fails to remove all equipment, improvements or facilities within a reasonable time, not to exceed sixty (60) days, the UNITED STATES may remove them and restore the land and repair the Drain at the expense of the AUTHORITY.

IX. MISCELLANEOUS

A. The AUTHORITY's use of the Land shall be subject to existing valid rights to such Land held by third parties.

B. RECLAMATION, in its discretion, may, at any time during the AUTHORITY's use of the Drain under this Agreement, have access to, or make modifications to the Drain and issue such outgrants as easements, leases, licenses or permits, so long as such access, modifications or outgrants do not unreasonably interfere with the AUTHORITY's intended use of the Drain under this Agreement; specifically, during the AUTHORITY's use of the Drain under this Agreement, RECLAMATION will not use or authorize the use of the Drain in such a manner as to reduce the AUTHORITY's use of the Drain with an authorized maximum flow of 150 CFS of drainage water.

C. The AUTHORITY shall continue to carry out the operation and maintenance obligations of the AUTHORITY described in the Transfer Agreement created pursuant to such agreement consistent with the guidelines provided by existing design operating criteria, standard operating procedures and/or manufacturer's technical memorandums, except that any terms of this Agreement providing more specific operation and maintenance responsibilities shall supersede the Transfer Agreement.

D. This Agreement shall not be construed to affect the positions of RECLAMATION nor of AUTHORITY nor any of the Draining Parties within the Drainage Area discharging into the

Drain pursuant to this Agreement concerning the question of ultimate liability for costs initially funded by the UNITED STATES in undertaking management actions with respect to the Drain, nor shall this Agreement affect the positions of the UNITED STATES, the AUTHORITY nor any other Draining Party utilizing the Drain concerning any contractual or legal obligation of RECLAMATION to provide drainage service pursuant to the San Luis Act.

E. This Agreement does not constitute a contract or an amendment of a contract as described in Section 203(a) of the Reclamation Reform Act of 1982 and the implementing rules and regulations, nor does it constitute a new contract nor an amendment of a contract for the delivery of water from the Central Valley Project within the meaning of Sections 105 and 106 of Public Law 99-546 (l00 Stat. 3050, et seq.), nor does this constitute an amendment of the Second Amended Contract for Exchange of Waters dated February 14, 1968, between the United States of America and Central California Irrigation District, Columbia Canal Company, San Luis Canal Company and Firebaugh Canal Company.

F. The UNITED STATES shall not be liable for any claims for damages, cleanup, or remedial actions arising from or attributed to discharges from the Drain by or on behalf of the AUTHORITY or the Draining Parties during the AUTHORITY's use of the Drain pursuant to the term of the First Use Agreement or this Agreement.

G. The UNITED STATES, its agents, employees, licensees and permittees shall not be liable for any damages to the property of the AUTHORITY under this Agreement by reason of any act committed on the land, save and except any damages to said property caused by or resulting from the negligent or willful act or omission of the UNITED STATES, its agents, employees, licensees and permittees to the extent provided by the Federal Tort Claims Act, 28 U.S.C. 2671 et seq.

H. The AUTHORITY shall hold the United States free and harmless from, and indemnify it against, any and all direct treatment and clean-up costs, losses, damages, claims and liabilities related thereto arising from the AUTHORITY's, or anyone or all of the Draining Party's performance or nonperformance under this Agreement; provided, that RECLAMATION shall exercise care to prevent any harm to personal and real property in carrying out its rights and responsibilities under this Agreement, and shall cooperate to the extent authorized by law in the resolution of any claims pursuant to the Federal Tort Claims Act, 28 U.S.C. Section 2671 et seq., arising from these activities; provided further the AUTHORITY shall have no obligation under this Section IX.H to provide a defense to the United States, nor to indemnify it for legal fees or costs incurred in legal proceedings instituted against the United States relating to use of the Drain.

I. Notwithstanding anything in this Agreement to the contrary, the AUTHORITY is authorized to enter into agreements with other entities, including but not limited to one or more of the Draining Parties, pursuant to which the AUTHORITY is or will be indemnified and/or held harmless with regard to all or any portion of the AUTHORITY's obligations under this Agreement.

J. Nothing in this Agreement shall create any rights in favor of any person or entity that is not a signatory to this Agreement, save and except for rights created pursuant to the Grassland Basin Drainage Management Activity Agreement and any MOU's between the AUTHORITY and the Draining Parties within the Drainage Area.

K. The expenditure of any money or the performance of any obligation of RECLAMATION under this Agreement shall be contingent upon appropriation or allotment of funds. Absence of appropriation or allotment of funds shall not relieve the AUTHORITY from any obligation under this Agreement. No liability shall accrue to the RECLAMATION in case funds are not appropriated or allotted.

L. No member of or delegate to Congress, or official of the AUTHORITY shall benefit from this Agreement other than as a water user or landowner in the same manner as other water users or landowners in the AUTHORITY.

M. If any of the provisions of this Agreement shall be formally determined to be invalid or unenforceable in whole or in part, the remaining provisions hereof shall remain in full force and effect and be binding upon the parties hereto. The parties agree to reform the Agreement to replace any such invalid or unenforceable provision with a valid and enforceable provision that comes as close as possible to the intention of the stricken provision.

N. The terms and conditions in Sections III.D, E, and H; VI.D; VIII; and IX.D through H, J and K of this Agreement shall survive the use of the Drain and/or completion of the performance under this Agreement by the AUTHORITY and the Draining Parties and the termination of this Agreement for any cause.

THE UNITED STATES OF AMERICA

DATED: ______ By ____________________________
Don Glaser
Regional Director,
Mid-Pacific Region, Bureau of Reclamation

SAN LUIS & DELTA-MENDOTA WATER AUTHORITY

DATED: _______ By ____________________________
Daniel G. Nelson
Executive Director

AGREEMENT FOR CONTINUED USE
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APPENDIX “A” - Description of Lands

1. Lands within Broadview Water District, the Firebaugh Canal Water District, the Pacheco Water District, the Panoche Drainage District, the Charleston Drainage District and the Widren Water District

Containing 84,470 acres, more or less.

2. All of those portions of Sections 26,27,34,35 and 36 in T. 11 S., R. 11 E., M.D.B.&M., Sections 31, 32,33 and 34 in T. 11 S., R. 12 E., M.D.B.&M., Section 1 in T. 12S., R. 11 E., M.D.B.&M., and Sections 2,3,4,5,6,9,10,11 and 12 in T. 12S., R. 12E., M.D.B.&M., bounded on the north by the south right-of-way line of the Central California Irrigation District Main Canal, bounded on the east by the boundary of the Central California Irrigation District, bounded on the south by the north right-of-way line of the Central California Irrigation District Outside Canal, and bounded on the west by the Central California District Camp 13 Bypass Canal.Containing 5,380 acres, more or less.

3. All of those portions of Section 13, T. 12S, R. 12E, M.D.B.&M., and Sections 7,17,18 and 19, T. 12S., R. 13E., M.D.B.&M., bounded partially on the north and west by the Panoche Drainage District, bounded partially on the west, south and east by the Firebaugh Canal Water District and the Widren Water District, and bounded partially on the north by the southerly right-of way line of the Central California Irrigation District Outside Canal.

Containing 1,410 acres, more or less.

4. All of those portions of Sections 1 and 12, T. 12S. R. 12 E., M.D.B.&M., Sections 5,6, 7,8,9, 10, 11, 13, 14, 15, 16, 17 and 24, T. 12S., R. 13E., M.D.B.&M. And Sections 19,29,30,32, and 33, T. 12S., R. 14E., M.D.B.&M. being lands within the Central California Irrigation District, bounded on the north and east by the south right-of-way line of the Central California Irrigation District Main Canal, bounded on the south and west by the north right-of-way line of the Central California Irrigation District Outside Canal, bounded on the west by the boundary line of the Central California Irrigation District and bounded on the east by the Southern Pacific Railroad right-of-way line. These lands also known as the Camp 13 Drainage District.Containing 5,490 acres, more or less.

5. All of those portions of Sections 3 and 4, T. 12 S., R. 11 E. and Section 34, T. 11 S., R. 11 E., M.D.B.& M. lying southerly of the Central California Irrigation District Outside Canal, bounded on the west by the Pacheco Lift Canal, bounded on the south by the Delta Mendota Canal, and bounded on the east by the east line of said Section 3.

Containing 676 acres, more or less.

6. The west half of Sections 27 and 34, T. 11 S., R. 12 E., M.D.B.& M. lying southerly of the San Luis Drain and northerly of the Central California Irrigation District Main Canal, and the east half of Sections 28 and 33 T. 11 S., R. 12 E., M.D.B.& M. also lying southerly of the San Luis Drain and northerly of the Central California Irrigation District Main Canal.

Containing 1,100 acres, more or less.

7. Lands adjacent to right-of-ways that may be acquired in the future necessary for drainage facilities to serve the Drainage Area.

AGREEMENT FOR CONTINUED USE
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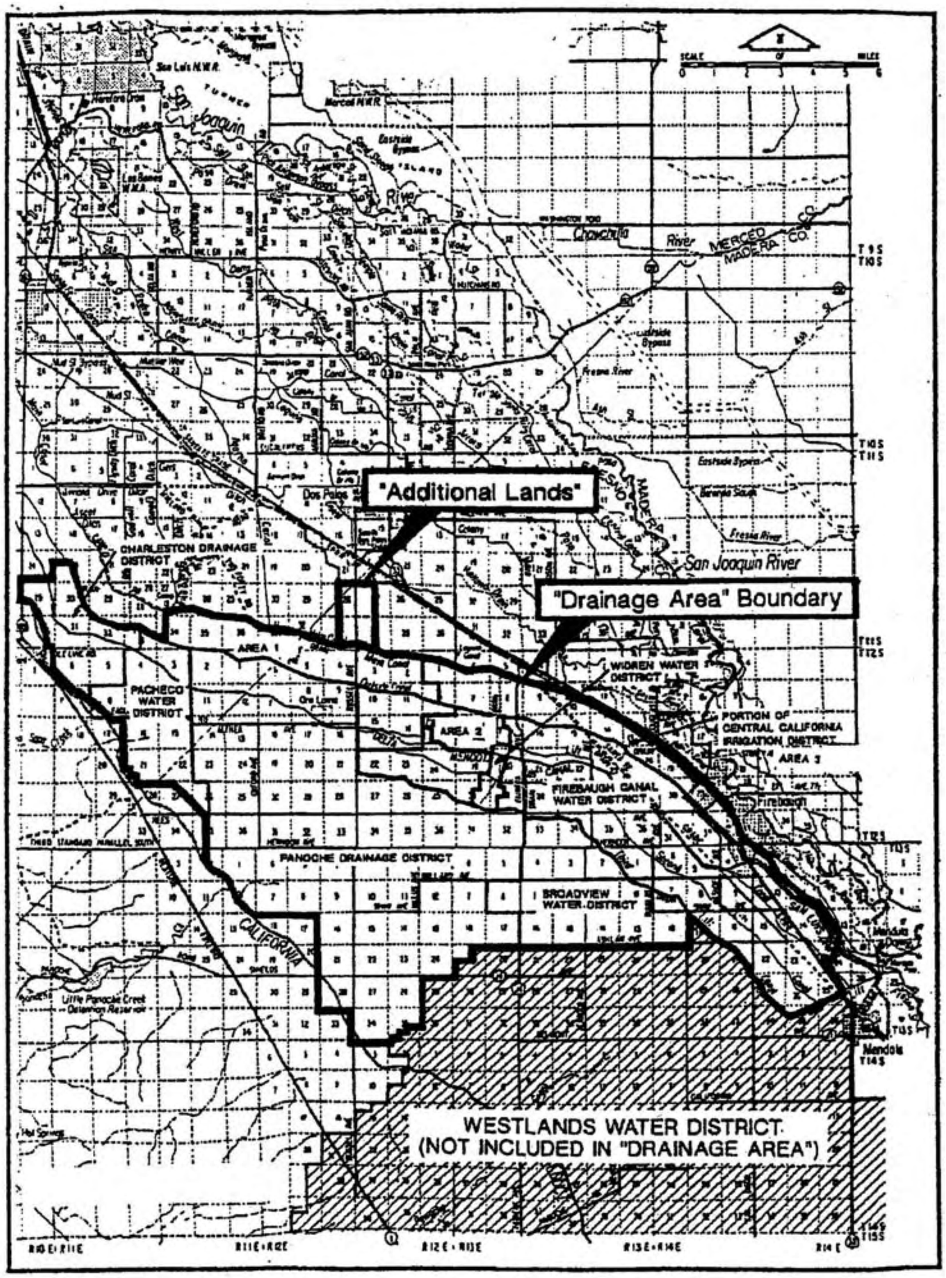
APPENDIX "B" - Geographic Location



AGREEMENT FOR CONTINUED USE
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APPENDIX "C" - Selenium Load Values

Note: As used in this Appendix, the term Dry Years includes years classified as Dry and Below Normal The water year classification will be established using the best available estimate of the 60-20-20 San Joaquin Valley water year hydrologic classification (as defined in Footnote 17 for Table 3 in the State Water Resources Control Board's *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary*, May 1995) using data from the Department of Water Resources Bulletin 120 series.

The negotiated Selenium Load Values in the Selenium Load Charts below are based upon the TMML load values in effect on the date of this Agreement and reflect the following approaches:

(1) **Year One** (Jan –Sept 2010) monthly load values equal to an average of the 2009 monthly load values & TMML monthly load values for each water year type.
(2) **Years Two through Five** (Oct 2010 – Dec 2014): Load values equal to TMML load values.
(3) **Years Six through Eight** (Jan 2015 – Dec 2017): Loads on glide path to 2018/2019 very low loads
(4) **Years Nine-Ten** (Jan 2018- Dec 2019): Annual Loads at approximately highest month in water year type. (Crit-150lbs, Dry/BN-300 lbs, AN-450 lbs, Wet 600 lbs). Monthly loads equal to monthly TMML loads.

Any revisions to TMML load values will be handled as provided in Appendix D.

SELENIUM LOAD VALUE CHARTS

CRITICAL YEAR TYPES				2008 Use Agreement						
	1	2	3	4	5	6	7	8	9	10
	2010	2011	2012	2013	2014	2015	2016	2017	2018*	2019*
Jan	210	151	151	151	151	119	86	54	150	150
Feb	184	93	93	93	93	73	53	33	93	93
March	183	92	92	92	92	72	52	33	92	92
April	194	101	101	101	101	79	58	36	101	101
May	199	105	105	105	105	82	60	37	105	105
June	103	69	69	69	69	54	39	24	69	69
July	105	70	70	70	70	55	40	25	70	70
Aug	111	75	75	75	75	59	43	27	75	75
Sep	107	57	57	57	57	45	32	20	57	57
Oct	55	55	55	55	55	43	31	20	55	55
Nov	55	55	55	55	55	43	31	20	55	55
Dec	152	152	152	152	152	119	87	54	150	150
Total	**1658**	**1075**	**1075**	**1075**	**1075**	**844**	**613**	**381**	**150**	**150**
Values in pounds of selenium										

DRY-BELOW NORMAL YEAR TYPES				2008 Use Agreement						
	1	2	3	4	5	6	7	8	9	10
	2010	2011	2012	2013	2014	2015	2016	2017	2018*	2019*
Jan	338	319	319	319	319	249	179	109	300	300
Feb	254	185	185	185	185	144	104	63	185	185
March	253	184	184	184	184	144	103	63	184	184
April	264	193	193	193	193	151	108	66	193	193
May	269	197	197	197	197	154	110	67	197	197
June	150	130	130	130	130	101	73	44	130	130
July	151	131	131	131	131	102	73	45	131	131
Aug	158	137	137	137	137	107	77	47	137	137
Sep	242	235	235	235	235	183	132	80	235	235
Oct	233	233	233	233	233	182	131	79	233	233
Nov	233	233	233	233	233	182	131	79	233	233
Dec	319	319	319	319	319	249	179	109	300	300
Total	**2864**	**2496**	**2496**	**2496**	**2496**	**1947**	**1398**	**849**	**300**	**300**
Values in pounds of selenium										

SELENIUM LOAD VALUE CHARTS
(Continued)

ABOVE NORMAL YEAR TYPES				2008 Use Agreement						
	1	2	3	4	5	6	7	8	9	10
	2010	2011	2012	2013	2014	2015	2016	2017	2018*	2019*
Jan	398	398	398	398	398	309	221	132	398	398
Feb	472	472	472	472	472	367	262	156	450	450
March	472	472	472	472	472	367	262	156	450	450
April	490	490	490	490	490	381	271	162	450	450
May	497	497	497	497	497	386	275	165	450	450
June	212	212	212	212	212	165	117	70	212	212
July	214	214	214	214	214	166	119	71	214	214
Aug	225	225	225	225	225	175	125	74	225	225
Sep	264	264	264	264	264	205	146	87	264	264
Oct	260	260	260	260	260	202	144	86	260	260
Nov	260	260	260	260	260	202	144	86	260	260
Dec	398	398	398	398	398	309	221	132	398	398
Total	**4162**	**4162**	**4162**	**4162**	**4162**	**3234**	**2306**	**1378**	**450**	**450**
Values in pounds of selenium										

WET YEAR TYPES				2008 Use Agreement						
	1	2	3	4	5	6	7	8	9	10
	2010	2011	2012	2013	2014	2015	2016	2017	2018*	2019*
Jan	211	211	211	211	211	165	120	74	211	211
Feb	488	488	488	488	488	382	277	171	488	488
March	488	488	488	488	488	382	277	171	488	488
April	506	506	506	506	506	396	287	177	506	506
May	512	512	512	512	512	401	290	179	512	512
June	354	354	354	354	354	277	201	124	354	354
July	356	356	356	356	356	279	202	125	356	356
Aug	366	366	366	366	366	287	208	128	366	366
Sep	332	332	332	332	332	260	188	116	332	332
Oct	328	328	328	328	328	257	186	115	328	328
Nov	328	328	328	328	328	257	186	115	328	328
Dec	211	211	211	211	211	165	120	74	211	211
Total	**4480**	**4480**	**4480**	**4480**	**4480**	**3510**	**2540**	**1570**	**600**	**600**
Values in pounds of selenium										

* - The rationale for the monthly values in Years 9 and 10 is as follows: The Authority's anticipated operating target for Years 9 and 10 is zero or very low discharge during most or all months. During these years, discharge may occur during any month(s) of the year, as long as such discharge does not exceed the applicable monthly TMML selenium load value and the cumulative monthly discharges do not exceed the annual selenium load value.

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APPENDIX "D" - Revisions of TMML, TMDL, or Water Quality Objectives for Selenium in the Lower San Joaquin River

As specified in Section III.H.2.(a)(2) of the Use Agreement, if the agency with final regulatory approval authority changes the TMML, TMDL, or the Water Quality Objective for Selenium in the lower San Joaquin River, the following provisions shall apply:

(1) In the event the USEPA approves a TMDL for selenium in the lower San Joaquin River that is more stringent than the March 28, 2002 Selenium TMDL for the Lower San Joaquin River, the new selenium TMDL shall apply and the Selenium Load Values set forth in Exhibit "C" shall be adjusted as specified in section (2) of this Appendix below. In the event the USEPA approves a TMDL for selenium in the Lower San Joaquin River that is less stringent than the March 28, 2002 Selenium TMDL, the selenium load values in this Use Agreement shall not be adjusted.

(2) If the Regional Water Quality Control Board establishes a new selenium TMDL for the Lower San Joaquin River, or new selenium objectives for the Lower San Joaquin River, that include compliance dates that occur while this Use Agreement remains in effect, the Selenium Load Values set forth in Appendix "C" of this Agreement will be adjusted as follows: Upon the adopted compliance dates established by Regional Board, the Selenium Load Values will be adjusted to the lower of: (1) the Selenium Load Values set forth in Appendix C of this Agreement or (2) any applicable newly adopted Selenium Loads imposed by the Regional Board.

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APPENDIX "E" - Salinity Load Values

Salt loads have been developed utilizing a similar methodology as the 2001 Use Agreement in order to continue to have selenium loads as the driving management constraint.

SALT LOAD VALUE CHARTS

Critical Year Types				2008 Use Agreement						
	1	2	3	4	5	6	7	8	9	10
	2010	2011	2012	2013	2014	2015	2016	2017	2018*	2019*
Jan	5738	4283	4283	4283	4283	3626	2888	2031	4283	4283
Feb	9081	6779	6779	6779	6779	5739	4570	3214	6779	6779
Mar	10759	8031	8031	8031	8031	6799	5414	3808	8031	8031
Apr	7918	5910	5910	5910	5910	5003	3984	2802	5910	5910
May	7760	5792	5792	5792	5792	4903	3905	2746	5792	5792
June	8026	5991	5991	5991	5991	5072	4039	2841	5991	5991
July	8111	6055	6055	6055	6055	5126	4082	2871	6055	6055
Aug	7198	5373	5373	5373	5373	4549	3622	2548	5373	5373
Sep	3802	2838	2838	2838	2838	2403	1913	1346	2838	2838
Oct	2920	2180	2180	2180	2180	1845	1469	1033	2180	2180
Nov	3035	2265	2265	2265	2265	1918	1527	1074	2265	2265
Dec	3352	2502	2502	2502	2502	2118	1687	1186	2502	2502
Annual	**77,700**	**58,000**	**58,000**	**58,000**	**58,000**	**49,100**	**39,100**	**27,500**	**13,000**	**13,000**
* The Monthly Values are equal to 2014 values								Values in Tons of Salt		

Dry/Below Normal Year Types				2008 Use Agreement						
	1	2	3	4	5	6	7	8	9	10
	2010	2011	2012	2013	2014	2015	2016	2017	2018*	2019*
Jan	8353	7282	7282	7282	7282	5901	4512	3131	7282	7282
Feb	13219	11524	11524	11524	11524	9339	7141	4956	11524	11524
Mar	15660	13653	13653	13653	13653	11063	8460	5871	13653	13653
Apr	11525	10047	10047	10047	10047	8142	6226	4321	10047	10047
May	11295	9847	9847	9847	9847	7979	6102	4234	9847	9847
June	11683	10185	10185	10185	10185	8254	6312	4380	10185	10185
July	11806	10293	10293	10293	10293	8341	6378	4426	10293	10293
Aug	10477	9134	9134	9134	9134	7402	5660	3928	9134	9134
Sep	5535	4825	4825	4825	4825	3910	2990	2075	4825	4825
Oct	4250	3706	3706	3706	3706	3003	2296	1593	3706	3706
Nov	4417	3851	3851	3851	3851	3121	2386	1656	3851	3851
Dec	4879	4253	4253	4253	4253	3447	2636	1829	4253	4253
Annual	**113,100**	**98,600**	**98,600**	**98,600**	**98,600**	**79,900**	**61,100**	**42,400**	**23,700**	**23,700**
* The Monthly Values are equal to 2014 values								Values in Tons of Salt		

SALT LOAD VALUE CHARTS
(Continued)

Above Normal Year Types					2008 Use Agreement					
	1	2	3	4	5	6	7	8	9	10
	2010	2011	2012	2013	2014	2015	2016	2017	2018*	2019*
Jan	12141	12141	12141	12141	12141	9763	7385	5007	12141	12141
Feb	19215	19215	19215	19215	19215	15451	11688	7924	19215	19215
Mar	22764	22764	22764	22764	22764	18305	13846	9388	22764	22764
Apr	16753	16753	16753	16753	16753	13471	10190	6909	16753	16753
May	16418	16418	16418	16418	16418	13202	9987	6771	16418	16418
June	16983	16983	16983	16983	16983	13656	10330	7004	16983	16983
July	17162	17162	17162	17162	17162	13800	10439	7078	17162	17162
Aug	15230	15230	15230	15230	15230	12247	9264	6281	15230	15230
Sep	8045	8045	8045	8045	8045	6469	4894	3318	8045	8045
Oct	6178	6178	6178	6178	6178	4968	3758	2548	6178	6178
Nov	6421	6421	6421	6421	6421	5163	3906	2648	6421	6421
Dec	7092	7092	7092	7092	7092	5703	4314	2925	7092	7092
Annual	**164,400**	**164,400**	**164,400**	**164,400**	**164,400**	**132,200**	**100,000**	**67,800**	**35,600**	**35,600**
* The Monthly Values are equal to 2014 values								Values in Tons of Salt		

Wet Year Types					2008 Use Agreement					
	1	2	3	4	5	6	7	8	9	10
	2010	2011	2012	2013	2014	2015	2016	2017	2018*	2019*
Jan	12396	12396	12396	12396	12396	10679	8286	5893	12396	12396
Feb	19618	19618	19618	19618	19618	16901	13114	9327	19618	19618
Mar	23241	23241	23241	23241	23241	20022	15536	11049	23241	23241
Apr	17104	17104	17104	17104	17104	14735	11433	8132	17104	17104
May	16762	16762	16762	16762	16762	14441	11205	7969	16762	16762
June	17339	17339	17339	17339	17339	14937	11590	8243	17339	17339
July	17521	17521	17521	17521	17521	15095	11712	8330	17521	17521
Aug	15549	15549	15549	15549	15549	13395	10394	7392	15549	15549
Sep	8214	8214	8214	8214	8214	7076	5491	3905	8214	8214
Oct	6308	6308	6308	6308	6308	5434	4217	2999	6308	6308
Nov	6555	6555	6555	6555	6555	5647	4382	3117	6555	6555
Dec	7240	7240	7240	7240	7240	6238	4840	3442	7240	7240
Annual	**167,846**	**167,846**	**167,846**	**167,846**	**167,846**	**144,600**	**112,200**	**79,800**	**47,400**	**47,400**
* The Monthly Values are equal to 2014 values								Values in Tons of Salt		

AGREEMENT FOR CONTINUED USE
OF THE
SAN LUIS DRAIN

APPENDIX “F” - High Rainfall Exemption

This Appendix describes a High Rainfall Exemption that will, under certain specified circumstances, reduce the Attributable Discharge amount defined in Section 1.A. of the Use Agreement. The overall objective of this High Rainfall Exemption is to accomplish the following:

- Respond to the concern that farmers may lose their ability to control discharges to the levels required by the Use Agreement during high-rainfall months.
- Protect water quality in the San Joaquin River and the estuary downstream; and
- Be consistent with current federal and state policy.

Notwithstanding any other provision of this Appendix or of the Use Agreement, this High Rainfall Exemption is not applicable for any period for which the Oversight Committee, in its sole discretion, has determined that the actual discharge of selenium has caused significant adverse environmental impacts in Mud Slough or at any point downstream of Mud Slough pursuant to Section IV.A.3. of the Agreement.

1. When applicable: If during a running 90-day period, cumulative rainfall, measured at the Panoche Water District gauge, equals or exceeds 6 inches in either the current month, or in any of the previous three months; and, if the actual “4-day monthly equivalent low flow at Crow’s Landing” during the current month is equal to or exceeds 300% of the “4-day monthly equivalent low flow at Crow’s Landing” (i.e., design flow) used to calculate the TMML for that month; provided, that installation, maintenance and operation of a rainfall monitoring gauge at the Panoche Water District has been approved by the Oversight Committee and said station is being operated and maintained by the Authority or the Draining Parties at the time of the high rainfall period.

2. Calculation of Exemption for Selenium

a. The amount of discharge that is exempted is limited by a monthly and annual ceiling as follows:

i. The monthly ceiling is the lesser of the following:

a) A selenium load in pounds that, in the absence of all other discharges, would result in a 1.5 parts per billion selenium concentration at Crows Landing, based on the actual “4-day monthly equivalent low flow” in acre feet for that month; i.e. (monthly ceiling) = (actual Crows Landing 4-day monthly equivalent low flow measured in acre feet for that month)x(1.5 ppb)x 0.002718); or

b) The highest selenium load discharged the same month of 1997, 1998, or 1999 as shown in the attached Table F-l.

ii. The annual ceiling is the amount fixed by the Basin Plan above which the discharge of selenium from agricultural subsurface drainage systems in the Grassland watershed to the San Joaquin River is prohibited, currently 8,000 pounds per year.

b. Monthly and Annual Amounts Exempted:

i. The amount of selenium discharge excused in any month would be the lesser of the following:

a) the difference between the monthly ceiling and the Selenium Load Value for that month; or

b) the difference between i) the amount calculated as follows: the amount of selenium discharged from the Drain (measured at the terminus) plus the amount of selenium in any discharges during a storm event to the Grassland Water District (measured at the discharge points) minus any amount of selenium discharge exempted under the Upper Watershed Exemption described in Appendix G and ii) the Selenium Load Value for that month.

ii. The amount of selenium discharge excused in any year would be the lesser of the following:

a) the sum of the monthly amounts excused; or

b) the difference between the annual ceiling and the annual Selenium Load Value.

3. Calculation of Exemption for Salt. When an Excessive Rainfall exemption is granted for selenium, an exemption shall also be granted for salt. The amount of salt exempted shall be calculated as follows:

Salt exemption in tons = selenium exemption in pounds x (average salt: se correlation factor) + 20% [to account for the imperfect correlation between salt and selenium] x (lbs to tons conversion)

Average salt: se correlation factor = (average ratio of monthly salt discharges to monthly selenium discharges from 1986 to 1996) = 44,350

So,

Salt exemption (tons) = selenium exemption (lbs) x 26.6

TABLE F-1
Calculation of Monthly Ceiling for Excessive Rainfall Exemption (pounds of selenium)

Month	1997 Actual	1998 Actual	1999 Actual	Higher of Columns 2,3 & 4
1	2	3	4	5
Jan	672	335	284	672
Feb	926	851	609	926
Mar	1119	1586	799	1586
April	1280	1549	529	1549
May	849	1367	482	1367
June	611	807	524	807
July	428	615	462	615
Aug	348	500	418	500
Sept	109	388	275	388
Oct	248	277	181	277
Nov	207	226	193	226
Dec	178	239	236	239

Note: The data in Table F-1 have been corrected to exclude any loads originating in the upper watershed.

AGREEMENT FOR CONTINUED USE
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APPENDIX "G" - Upper Watershed Exemption

Under certain conditions of high rainfall in the Coastal Range, water carrying selenium loads runs off from the Upper Panoche/Silver Creek watershed, through the channels of the Grassland Area Farmers, and is discharged into the San Joaquin River through the Grassland Bypass and/or the San Luis Drain. The parties to the Use Agreement have agreed that the selenium load from the upper watershed discharged though the Bypass and the San Luis Drain under certain specified conditions should not be included in the computation of Attributable Discharges for purposes of this Use Agreement.

Notwithstanding any other provision of this Appendix G or of the Use Agreement, no amount of discharge will be exempted pursuant to this Appendix G until an Upper Watershed Selenium Monitoring System has been developed as described in this Appendix and submitted to and approved by the Oversight Committee.

Measurable upper watershed loads of both selenium and salt that enter the drainage area and are discharged from the drainage area through the Bypass; Drain or wetland channels will be exempted. The measurement of these upper watershed loads shall be in accordance with the "Upper Watershed Selenium Monitoring System" to be submitted for approval by the Oversight Committee.

1. Components of the "Upper Watershed Selenium Monitoring System" (hereinafter "UWSMS"). The UWSMS shall describe, not only the monitoring activities, but also the method of calculating the amount of selenium and salt that is to be excluded. The monitoring activities shall include the following elements:

a. The monitoring procedure to be developed shall ensure that usable data is collected from the area during a rain event. The procedure shall be fully described in the UWSMS plan and shall reflect the best currently-available science that is obtainable at reasonable cost.

b. The Storm Event Plan shall require, to the extent physically possible, that drainage sump pump operations and associated discharge of subsurface drainage cease during the period of time covered by the exemption.

c. Any measurable flow at Panoche Creek at 1-5 will trigger both 1) the implementation of the UWSMS to quantify the amount of selenium and salt entering the drainage area from the upper watershed and discharged through the Bypass or Drain and 2) the management of the drainage channels, the Bypass and the Drain in accordance with the Storm Event Plan.

d. The UWSMS will use photographic and field observations to identify and document surface impoundment and sheet flow.

e. Groundwater will be monitored at existing, representative wells.

2. Discretion of Oversight Committee to Revise. The Oversight Committee shall have the discretion to update the UWSMS, including the method used to calculate the amount of selenium and salt that comes from the upper watershed and discharged through the Bypass, Drain or wetland channels.

AGREEMENT FOR CONTINUED USE
OF THE
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APPENDIX "H" - Performance Incentive System for Selenium and Salt

The following chart establishes the maximum annual and monthly incentive fees payable under this system for exceedances of Selenium Load Values or Salinity Load Values. In the event that both the applicable Selenium Load Values and Salinity Load Values are exceeded in any given month or year, only the incentive fee for exceeding the Selenium Load Values shall be imposed.
.

MAXIMUM ANNUAL AND MONTHLY INCENTIVE FEE CHART

Incentive Fee Caps	Year 1	Years 2-5	Year 6	Year 7	Year 8	Year 9	Year 10
Annual Incentive Fee Cap	$300,000	$300,000	$400,000	$400,000	$500,000	$600,000	$600,000
Monthly Incentive Fee Cap	$300,000	$300,000	$400,000	$400,000	$ 500,000	$ 600,000	$ 600,000
Total Incentive Fee Cap	$600,000	$600,000	$800,000	$800,000	$1,000,000	$1,200,000	$1,200,000

The following chart establishes the applicable charge per pound of selenium that is subject to annual and/or monthly incentive fees.

ANNUAL AND MONTHLY PER-POUND SELENIUM FEE CHART

Monthly & Annual Incentive Fees per Lb ($/Lb)	Year 1	Years 2-5	Year 6	Year 7	Year 8	Year 9	Year 10
Critical Year Type	$ 903.61	$1,395.35	$1,731.60	$1,731.60	$2,164.50	$ 4,000.00	$ 4,000.00
Dry / Below Normal Year Type	$ 523.56	$ 601.20	$ 728.60	$ 728.60	$ 910.75	$ 2,000.00	$ 2,000.00
Above Normal Year Type	$ 360.58	$ 360.58	$ 431.03	$ 431.03	$ 538.79	$ 1,333.33	$ 1,333.33
Wet Year Type	$ 334.82	$ 334.82	$ 412.37	$ 412.37	$ 515.46	$ 1,000.00	$ 1,000.00

The following chart establishes the applicable charge per ton of salt that is subject to annual and/or monthly incentive fees..

ANNUAL AND MONTHLY PER-TON SALINITY FEE CHART

Monthly & Annual Incentive Fees per Ton ($/Ton)	Year 1	Years 2-5	Year 6	Year 7	Year 8	Year 9	Year 10
Critical Year Type	$19.31	$25.86	$29.72	$27.07	$30.04	$46.15	$46.15
Dry / Below Normal Year Type	$13.26	$15.21	$17.75	$16.67	$18.24	$25.32	$25.32
Above Normal Year Type	$9.12	$9.12	10.54	$9.94	$10.95	$16.85	$16.85
Wet Year Type	$8.94	$8.94	$10.01	$9.34	$10.14	$12.66	$12.66

1. Selenium

A. Annual Incentive Fees:

Annual incentive fees are set as an annually variable flat price per pound of Attributable Discharges that exceed Annual Load Values. The applicable price per pound is shown in the Annual and Monthly Per-Pound Selenium Fee Chart above..

Maximum annual incentive fees will be $300,000 per year for Years One through Five (2010-2014); $400,000 per year in Years Six and Seven (2015-2016); $500,000 per year for Year Eight (2017); and $600,000 per year for Years Nine-Ten (2018-2019). Annual incentive fees may be reduced by the credits described in Appendix I.
If there are incentive credits in accordance with Appendix I, the credit will be added to the annual load value as follows:

Amount subject to annual incentive fees (lbs) = annual Attributable Discharge (lbs) minus the sum of the annual load value (lbs) and the incentive credit (lbs).

B. Monthly Incentive Fees:

Monthly incentive fees are set as an annually variable flat price per pound of Attributable Discharges that exceed Monthly Load Values. The applicable price per pound is shown in the Annual and Monthly Per-Pound Selenium Fee Chart above.

If the monthly exceedance is less than or equal to 5% of the Monthly Load Value there will be no monthly incentive fee.

If the monthly exceedance is greater than 5% of the monthly load value, the monthly incentive fee will apply to the entire monthly exceedance, including the first 5% of the monthly exceedance. Maximum cumulative monthly incentive fees will be $300,000 per year for Years One through Five (2010-2014); $400,000 per year in Years Six and Seven (2015-2016); $500,000 per year for Year Eight (2017); and $600,000 per year for Years Nine-Ten (2018-2019).

2. Salt

A. Annual Incentive Fees:

Annual incentive fees are set as an annually variable flat price per ton of Attributable Discharges that exceed Annual Load Values. The applicable price per ton is shown in the Annual and Monthly Per-Ton Salinity Fee Chart above.

Maximum annual incentive fees will be $300,000 per year for Years One through Five (2010-2014); $400,000 per year in Years Six and Seven (2015-2016); $500,000 per year for Year Eight (2017); and $600,000 per year for Years Nine-Ten (2018-2019).. Annual incentive fees may be reduced by the credits described in Appendix I.

If there are incentive credits in accordance with Appendix I, the credit will be added to the annual load value as follows:

Amount subject to incentive fees (tons) = annual Attributable Discharge (tons) minus the sum of the annual load value (tons) and the incentive credit (tons).

B. Monthly Incentive Fees:

Monthly incentive fees are set as an annually variable flat price per ton of Attributable Discharges that exceed Monthly Load Values. The applicable price per ton is shown in the Annual and Monthly Per-Ton Salinity Fee Chart above.

If the monthly exceedance is less than or equal to 5% of the Monthly Load Value, there will be no monthly incentive fee.

Maximum cumulative monthly incentive fees will be $300,000 per year for Years One through Five (2010-2014); $400,000 per year in Years Six and Seven (2015-2016); $500,000 per year for Year Eight (2017); and $600,000 per year for Years Nine-Ten (2018-2019).

AGREEMENT FOR CONTINUED USE
OF THE
SAN LUIS DRAIN

"APPENDIX I" - Calculation and Application of Annual Incentive Fee Credits

In order to provide incentive to reduce selenium or salt discharges beyond the current annual load value, a credit toward future annual incentive fees will be given if annual selenium or salt discharges are below the annual load value. The incentive credits will accrue until applied at the option of the Authority and will be determined at the beginning of the Agreement and each year in the following manner:

a) Annual credits earned and not applied during the 2001 Use Agreement shall be carried forward for application under this Agreement and in accordance with this Appendix I at any time when an annual credit may be applied.

b) If the annual Attributable Discharge is 90% or more of the annual Load Value, no incentive credit will be given.

c) If the annual Attributable Discharge is less than 90% of the annual Load Value, then an incentive credit will be given that can be used to offset future incentive fees.

1) If the credit is to be applied in the same water year type in which it was earned, the credit will be equal to the total pounds of selenium or tons of salt, whichever is applicable, by which the Attributable Discharge in the year in which it is earned is less than the annual Load Value in the year in which it is earned.

2) If the credit is to be applied in a different water year type than the water year type in which it was earned, the credit will be equal to the total pounds of selenium or tons of salt (whichever is applicable) by which the Attributable Discharge is less than the annual Load Value multiplied by an adjustment factor. That adjustment factor shall be defined as a ratio with the numerator being the annual Salt or Selenium Load Value for the year and water year type in which the credit is to be applied and with the denominator being the annual Salt or Selenium Load Value for the year in which the credit is to be applied and for the water year type in which the credit was earned.

d) The incentive fee credit applies only to the calculation of incentive fees and not to any other provision of this Agreement.

AGREEMENT FOR CONTINUED USE
OF THE
SAN LUIS DRAIN

"APPENDIX J" - Calculation and Application of Monthly Incentive Fee Credits

In order to provide incentive to reduce selenium or salt discharges, and in addition to the Annual Incentive Fee Credit structure set forth in Appendix "I" herein, a credit toward future monthly incentive fees will be given if monthly selenium or salt discharges are below the monthly load value. The monthly incentive credits will accrue during the calendar year until applied at the option of the Authority. Said credits will be determined at the end of each year, and must be used in the same year, as follows:

a) if the Basin Plan selenium objectives are met in the San Joaquin River (at Crows Landing) during the month the credit will be applied, available credits can be applied up to the total selenium or salinity exceedance for that month.

b) if the Basin Plan selenium objectives are not met in the San Joaquin River (at Crows Landing) during the month the credit will be applied, available credits cannot be applied for that month.

c) if application of credits is authorized in more than one month under the criteria set forth herein, the Draining Parties can utilize credits in the month(s) of their choice.

d) the Monthly Incentive Fee Credit for selenium or salt will be equal to the applicable Monthly Load Value minus total pounds of Attributable Discharge of selenium or total tons of Attributable Discharge of salt, respectively, for the month. (Monthly Load Value – Monthly Attributable Discharge = Monthly Incentive Fee Credit).

e) The monthly incentive fee credit structure set forth in this Appendix shall not apply during Years Nine and Ten (2018-2019) of this Agreement.

f) The Monthly Incentive Fee Credit applies only to the calculation of incentive fees and not to any other provision of this Agreement.

AGREEMENT FOR CONTINUED USE
OF THE
SAN LUIS DRAIN

APPENDIX "K" – Mandatory Termination for Selenium Exceedance

TERMINATION VALUE	YEAR 1	YEARS 2-5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
CRITICAL YEAR	1,990	1,290	1,075	844	612	300	300
BELOW NORMAL YEAR	3,437	2,995	2,496	1,947	1,398	600	600
ABOVE NORMAL YEAR	4,994	4,994	4,162	3,234	2,306	900	900
WET YEAR	5,376	5,376	4,480	3,510	2,540	1,200	1,200

Termination Chart values refer to pounds of Attributable Selenium Discharge

AGREEMENT FOR CONTINUED USE
OF THE
SAN LUIS DRAIN

APPENDIX "L" Mitigation for the Continued Use of Mud Slough

1. Baseline Mitigation Habitat

Baseline mitigation will be developed and maintained so long as the Use Agreement remains in effect. The GAF will provide Baseline mitigation in the form of alternate wetland habitat as outlined below. This habitat will be located on USFWS lands and CDFG lands. The proposals were developed by working with USFWS & CDFG staff to determine the habitat needs within their respective wetland complexes. Ownership of all capital improvements on agency land will remain with the agencies after the term of the Use Agreement.

- <u>CDFG Mitigation Proposal:</u> Supply year-round water to a series of ponds between Mud Slough and the San Joaquin River. Water will be delivered through an existing pipeline and turned out into natural swales to create wetland habitat. The water surface area of the ponds will be approximately 95.3 acres. (Mud Slough affected area in China Island = 76.8 acres.) As a result of the applied water vegetation will emerge in and around the ponds. Water will likely be developed locally from wells.

- <u>USFWS Mitigation Proposal:</u> Create year around wetlands on USFWS lands. This proposal will establish 31.6 acres of year around wetland marsh habitat. It may create wetland Slough habitat in a drainage ditch next to the Schwab Unit (BG001). This could create a broad yet linear habitat that could provide slough mitigation habitat. The final site has not been selected. (Mud Slough affected area within San Luis Unit = 24 acres) Water will likely be developed locally from wells.

The Baseline Mitigation projects are designed to expand permanent wetlands in the area of Mud Slough to provide benefits to species such as waterfowl, shorebirds, and terrestrial wildlife. The habitat may be suitable for use by special status species including, Giant Garter Snakes, San Joaquin Valley Kit Fox and Tricolored Blackbirds.

2. Supplemental Mitigation Habitat

Supplemental mitigation will be implemented beginning in Year Six (2015) of the Use Agreement by the establishment of a "Mitigation Project Fund" held by the San Luis Delta Mendota Water Authority. Beginning in that year, the Grassland Area Farmers will be required to pay a fee per pound of Attributable selenium discharge. The fee per pound will vary depending upon the water year type and year. (See Supplemental Mitigation Fee Chart, below) The fee will be charged on the Attributable selenium pounds discharged from the first pound up to the selenium load value for that year. Loads discharged above the Load Values will incur Incentive Fees but not Supplemental Mitigation Fees.

The Supplemental Mitigation Project Fund will be administered by the San Luis Delta Mendota Water Authority (SLDMWA) and held in a separate account of the SLDMWA with transparent detailed accounting provided to the Oversight Committee and available to the public. After considering recommendations from the Mitigation Sub-Committee, the Oversight Committee will select projects to be funded from the Supplemental Mitigation Project Fund and shall authorize and direct the SLDMWA to release funds for the selected project(s).

The Mitigation Sub-Committee shall develop a list of recommended projects that may be funded by the Mitigation Project Fund.The Supplemental Mitigation Sub-Committee shall include a representative from each of the following, each of which shall have 1 vote: (1) The Grassland region California Department of Fish & Game wildlife areas; (2) The Grassland region United States Fish & Wildlife Service refuges; and (3) A nonprofit organization with a background in restoration efforts in the Grassland Region. The three Sub-Committee Members shall select one of their members to serve as Chairman, who is authorized to call meetings and is responsible to keep the Oversight Committee informed of all Sub-Committee meetings and actions. 2 of 3 members are required for a quorum, and the vote of 2 of 3 members (regardless of the number of members present) is required to include a project on the list of recommended projects. The Mitigation Sub-Committee shall hold open public meetings and shall allow interested parties to have input into the decision making process. The Supplemental Mitigation Project Fund shall be spent on projects that enhance fish, wildlife or ecological values in the Grasslands region.

Below are examples of the types of projects that the Oversight Committee may choose to implement with the Supplemental Mitigation Project Fund. This list is intended to give examples of potential projects but not to limit the use of the funds on other projects:

- Refuge water supply augmentation
- Increased water flows in Mud Slough after drain flows cease.
- Habitat restoration projects
- Species specific habitat establishment

3. Supplemental Mitigation Fee Charts

MAXIMUM ANNUAL SUPPLEMENTAL MITIGATION FEE

	Annual Maximum Supp. Mitigation Fee Year 6	Annual Maximum Supp. Mitigation Fee Year 7	Annual Maximum Supp. Mitigation Fee Year 8	Annual Maximum Supp. Mitigation Fee Year 9	Annual Maximum Supp. Mitigation Fee Year 10	Total Possible Supp. Mitigation Fee Generated in 5 Years
Maximum Fee	$ 112,500	$ 112,500	$ 150,000	$ 187,500	$ 187,500	$ 750,000
Above fees are calculated assuming the discharge of the total annual Load Value for that year.						

SUPPLEMENTAL MITIGATION FEE PER POUND OF SELENIUM

	SUPPLEMENTAL MITIGATION FEE PER POUND				
	$ per Lb of Discharge Year 6	$ per Lb of Discharge Year 7	$ per Lb of Discharge Year 8	$ per Lb of Discharge Year 9	$ per Lb of Discharge Year 10
Critical Year Type	$ 133.29	$ 183.52	$ 393.70	$ 1,250.00	$ 1,250.00
Below Normal Year Type	$ 57.78	$ 80.47	$ 176.68	$ 625.00	$ 625.00
Above Normal Year Type	$ 34.79	$ 48.79	$ 108.85	$ 416.67	$ 416.67
Wet Year Type	$ 32.05	$ 44.29	$ 95.54	$ 312.50	$ 312.50
The above Supplemental Mitigation Fees are paid on Attributable Selenium Discharge from first pound up to the Annual Load Value. Selenium Loads discharged above Load Values result in Incentive Fees but not Supplemental Mitigation Fees.					

APPENDIX B

Sediment Management Plan

DRAFT
SEDIMENT MANAGEMENT PLAN
FOR USE OF THE SAN LUIS DRAIN

GRASSLAND BYPASS PROJECT 2010 – 2019

FRESNO & MERCED COUNTIES, CALIFORNIA

Prepared for:
U.S. BUREAU OF RECLAMATION
Fresno, CA

&

SAN LUIS & DELTA-MENDOTA WATER AUTHORITY
Los Banos, CA 93835

Prepared by:

ENTRIX, INC.
Ventura, CA

Project No. 3197001

June 16, 2009

DRAFT
SEDIMENT MANAGEMENT PLAN
FOR THE USE OF THE SAN LUIS DRAIN

GRASSLAND BYPASS PROJECT 2010 – 2019
FRESNO & MERCED COUNTIES, CALIFORNIA

Prepared for:

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Project No. 3197001

June 16, 2009

Page

SEDIMENT MANAGEMENT PLAN

GRASSLAND BYPASS PROJECT 2010 – 2019
FRESNO & MERCED COUNTIES, CALIFORNIA

This report has been prepared by ENTRIX, Inc. (ENTRIX) under the professional supervision of the Principal(s) and/or staff whose signature(s) appear hereon.

The scope of work and specifications are presented in accordance with generally accepted professional geologic practice. There is no other warranty either expressed or implied.

Daniel R. Tormey, Ph.D.
California Professional Geologist No. 5927

June 16, 2009

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This Sediment Management Plan (SMP) addresses potential options for disposal of sediments dredged from the San Luis Drain (Site) in order to maintain desired flow rates. The San Luis Drain is operated by the U.S. Bureau of Reclamation as part of the Central Valley Project to transport agricultural drainage from the western side of the San Joaquin Valley to the San Joaquin River. The 2001 Use Agreement between the San Luis and Delta-Mendota Water Authority (Authority) and U.S. Bureau of Reclamation for use of the San Luis Drain stipulates that the Authority is responsible for sediments that accumulate in the Drain due to its use of the Drain. Since the sediments contain high concentrations of selenium, the long-term accumulation of sediment in the Drain may pose a disposal problem. The purpose of this SMP is to identify applicable human health, ecologic risk, and hazardous material standards for selenium, and then to specify appropriate disposal or reuse actions for the dredged sediments.

Prior to or following each dredging event, sediment cores will be collected from the Site to characterize the level of selenium in the dredged material. The cores will consist of discrete sediment samples collected from the Drain check area(s) to be dredged in accordance with the methods outlined in this document. The samples will be submitted to a State of California certified laboratory and analyzed for selenium. Results of sampling will be compared to the sampling risk criteria for hazardous waste, ecological risk, and human health risk.

Although recent sampling results indicate that selenium concentrations in drain sediments are well below the State of California criteria for hazardous waste, if sampling results at the time of dredging exceed these criteria, materials will be disposed in a permitted and approved hazardous waste landfill. Sediments which contain selenium concentrations below hazardous waste criteria but exceed ecological risk criteria may be applied for reuse to lands zoned for agricultural, residential or industrial development. Sediments which are below the ecological risk criteria may be applied with unrestricted use.

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1.0
INTRODUCTION

ENTRIX, Inc. (ENTRIX) has prepared this Sediment Management Plan (SMP) on behalf of the U.S. Bureau of Reclamation and the San Luis-Delta Mendota Water Authority to address potential options for disposal of sediments dredged from the San Luis Drain (Site) in order to maintain desired flow rates.

The San Luis Drain is operated by the U.S. Bureau of Reclamation as part of the Central Valley Project to transport agricultural drainage from the western side of the San Joaquin Valley to the San Joaquin River. Sediments have been accumulating in the Drain since its completion in 1974 resulting in over 200,000 cubic yards of sediment residing within the Drain. In addition, the conveyance of selenium-bearing drainage has resulted in the accumulation of selenium within the sediment. The presence of sediment in the Drain decreases its storage capacity and restricts its flow capacity, particularly during emergency operations.

The 2001 Use Agreement between the San Luis and Delta-Mendota Water Authority (Authority) and U.S. Bureau of Reclamation for use of the San Luis Drain stipulates that the Authority is responsible for sediments that accumulate in the Drain due to its use of the Drain. Recent measurements from cross-sections of the Drain have indicated that average sediment depth is approximately 3 feet with a maximum depth of 7.68 feet. When sediment depth exceeds 4.4 feet, flow rate decreases below the desired rate of 150 cubic feet per second (total Drain depth is 9.6 feet). Therefore, an initial maximum dredging volume of 74,576 cubic yards of sediment would occur from the area between Drain check 14 and Drain check 17 (the portion of the Drain with sediment levels above 4.4 feet) following implementation of the Proposed Action (McGahan 2008b).

Since the sediments contain high concentrations of selenium, the long-term accumulation of sediment in the Drain may pose a disposal problem. In 1998 the U.S. Bureau of Reclamation commissioned a pilot study by the Lawrence Berkeley National Laboratory to investigate if disposal of sediments as hazardous waste was necessary or if potential reuse options could be explored. This laboratory evaluated sediment selenium levels and the fate of selenium in the dredged material and determined that based on existing selenium concentrations, land application and reuse of sediments may be an appropriate option for dredged sediments (Zawislanski et al 2001).

The purpose of this SMP is to identify applicable human health, ecologic risk, and hazardous material standards for selenium, and then to specify appropriate disposal or reuse actions for the dredged sediments. The following items are addressed in this SMP:

- Background discussion of the Site history and current sediment conditions;
- Human health, ecological, and hazardous levels for selenium in sediment;
- Protocols for determining appropriate placement locations of dredged sediment;

- Protocols for sampling and analyzing dredged sediments before and after placement;
- Performance standards for dredged sediments;
- Potential sediment volumes and frequency of dredging;
- Methods for handling and disposing of sediments considered hazardous materials;
- Conditions for reuse of sediments; and
- Available sites able to receive the dredged sediment.

This section presents background information for the Site to provide an understanding of Site conditions and assist in the proper planning of future disposal options for dredged sediments so that appropriate measures are taken to protect human health and the environment.

2.1 SITE LOCATION

The San Luis Drain drains water from the Grassland Drainage Area near South Dos Palos in Fresno County, and conveys the water northward to its outlet at Mud Slough near Gustine in Merced County (as displayed in Figure 2-4 of the Grassland Bypass Project EIS/EIR). The San Luis Drain is located in the San Joaquin Valley and is surrounded by agricultural lands and open space.

2.2 SITE DESCRIPTION

2.2.1 SEDIMENT ACCUMULATION AND FLOW

As discussed in the study by Lawrence Berkeley National Laboratory (Zawislanski et al. 2001), sediments have been accumulating in the San Luis Drain since its completion in 1974. Dust, wind-blown plant debris, algae, cattails, and suspended sediments have accumulated within the Drain. These sediments decrease the storage capacity of the Drain and restrict its flow capacity, particularly during emergency operations created by storm events. In order to minimize resuspension and erosion of accumulated sediments in the Drain, a 1-foot per second maximum flow rate is used. Monitoring of the Drain sediments has indicated that this flow limitation has prevented the net movement and suspension of sediments from the bottom of the Drain.

Sediment accumulation rates appear to have slowed in recent years; between October 2006 and October 2007 the accumulation rate was 251 cubic yards per month compared to 1,700 cubic yards per month from October 2005 to October 2006. An estimated 162,000 cubic yards of sediment has accumulated in the Drain since 1996, the majority of it located in the upstream portion between Drain checks 11-16 (Table 1). The remaining 60,000 was accumulated prior to the Grassland Bypass Project. The average depth of sediments in the Drain in 2006 was 3 feet, with a maximum depth of sediments of 7.96 feet at Drain check 14 (McGahan 2008a). When sediment depth exceeds 4.4 feet, the 1 foot per second flow rate is not met. The most recent sampling indicates that the area between Drain check 14 and Drain check 17 exceeds 4.4 feet (McGahan 2008b).

Table 1. Sediment Volumes by Reach over Time (cubic yards)

Drain Check Number	2002	2003	2004	2005	2006	2007
0-1	6,338	8,595	9,498	9,290	9,811	11,013
1-2	7,661	7,993	9,258	9,535	10,070	10,555
2-3	2,496	2,219	2,719	3,269	3,585	3,852
3-4	9,349	9,301	11,567	12,847	12,990	14,133
4-5	11,496	12,522	15,244	15,662	16,920	18,293
5-6	7,765	8,710	10,945	11,088	13,413	12,965
6-7	3,530	3,891	4,822	4,613	5,297	5,040
7-8	2,990	2,851	2,987	2,657	6,175	2,860
8-9	1,175	2,050	2,382	2,355	3,051	3,120
9-10	10,420	12,306	12,820	10,878	13,535	14,496
10-11	4,975	5,791	6,279	6,295	8,389	8,386
11-12	13,692	16,099	17,099	17,179	20,537	21,596
12-13	2,324	2,454	2,806	2,943	3,966	5,144
13-14	5,884	6,965	8,530	11,346	12,041	12,597
14-15	18,720	21,788	25,335	27,518	28,179	27,917
15-16	19,214	19,126	19,675	19,435	19,598	19,216
16-17	20,971	21,209	21,947	22,236	22,750	21,750
17-18	5,318	5,446	5,275	5,443	5,120	5,447
18-19	3,571	4,039	3,804	3,936	3,583	3,645
TOTAL	158,489	173,355	192,992	198,525	219,008	222,025

Source: McGahan 2008a

2.2.2 Applicable Standards for Selenium

2.2.2.1 Hazardous Materials Criteria

The State of California has established a characteristic of toxicity for hazardous waste containing selenium with a concentration of 100 micrograms Se per gram, wet weight[1]. Although recent sediment sampling indicates that selenium concentrations are below this criterion, should selenium concentrations of dredged material equal or exceed this value it must be considered a hazardous material and disposed of according to applicable State and local regulations.

[1] Wet weight = dry weight * (1 - percent moisture)

2.2.2.2 Ecological Risk Criteria

As discussed in the progress report prepared by Tim McLaughlin (2006), sedimentary selenium is a reliable indicator of adverse biological effects (VanDeerver and Canton 1997). Selenium is most bioavailable in its oxidized form and can bioaccumulate through the food chain resulting in toxic levels for wildlife at the top of the food chain. In 1985 the San Luis Drain was closed due to selenium poisoning of waterbirds in a reservoir at the terminus of the Drain. Results of sediment sampling described in Section 3.1 will be compared to the following ecological risk guidelines used previously for sediment monitoring for selenium concentrations in Mud Slough and Salt Slough to determine the appropriateness of sediment placement on lands adjacent to wetlands or other areas of ecological concern. The criteria for ecological risk are listed below:

No Effect – less than 2 micrograms Se per gram (µg Se /g), dry weight

Level of Concern – 2 to 4 µg Se /g, dry weight

Toxic – greater than 4 µg Se /g, dry weight

2.2.2.3 Human Health Risk Criteria

To assess human health risk the U.S. Environmental Protection Agency (USEPA) has set preliminary remediation goals (PRGs) for soils used in residential and industrial environments. These PRGs set the worst case scenario human exposure through various pathways (inhalation, dermal contact, ingestion) to potentially dangerous compounds and represent the maximum concentration of selenium allowed in sediments placed on lands zoned for residential or industrial use. For selenium, a PRG has been set for ingestion of soils. The PRG criteria for selenium in residential and industrial setting are as follows:

Residential – 390 µg Se /g, dry weight

Industrial – 5,100 µg Se /g, dry weight

2.2.3 SELENIUM IN DRAIN SEDIMENTS

The conveyance of selenium-bearing drainage from 1974 to 1986, and more recently during the Grassland Bypass Project, has resulted in the accumulation of selenium in the sediments present in the San Luis Drain (Zawislanski et al. 2001). The sediments tend to become further selenium-enriched through biogeochemical processes after deposition in the Drain. In general, the concentration of selenium in sediment tends to be higher at the north end of the Drain, particularly between Drain checks 1 and 3. The highest concentrations were 74 µg Se /g, dry weight at check 3 in June of 2005 and 77µg Se /g, dry weight at Check 1 in June of 2006 (McLaughlin 2006). Selenium concentration is also greater generally at deeper levels of sediment (3-8 centimeters depth).

Land disposal tests of selenium-bearing sediments conducted by the Lawrence Berkeley National Laboratory found that selenium remains physically stable in sediments but oxidation of selenium following dredging can measurably increase selenium concentration in sediments. Selenium is known to be more bioavailable in its oxidized state (Salton Sea Authority 2004), so that after oxidation during dredging and spreading, the selenium is taken up by plants.

There is some indication that rainfall and irrigation may mobilize selenium and move it down the soil column at much as 1.5 meters. In areas with a shallow local water table, this phenomenon could result in selenium impacting groundwater (Zawislanski et al 2001).

The following section presents the sampling protocols for sediment and risk criteria for determining appropriate handling and management of dredged materials.

3.1 SEDIMENT SAMPLING PROCEDURES

The procedures outlined in this section will be followed for sampling of sediment in the San Luis Drain prior to or following dredging activities.

Prior to or following each dredging event, sediment cores will be collected from the Site to characterize the level of selenium in the dredged material. The cores will consist of discrete sediment samples collected from the Drain check area(s) to be dredged in accordance with the methods outlined in the following sub-section. The samples will be submitted to a certified laboratory and analyzed for selenium using EPA Method 7741A or 7742. Results of sampling will be compared to the sampling risk criteria described in Section 3.2 and managed accordingly as described in Section 4.0.

3.1.1 SOIL SAMPLING AND HANDLING METHODS

Sediment samples selected for analytical testing will be collected into clean, stainless steel or brass sample liners, sealed with 2 mil Teflon™ film, and fitted with plastic end caps. Sample containers will be labeled using a waterproof marker, and sample labels will include the sampler's initials, location ID, and time. All samples will be placed in individual ziploc-type bags, sealed, and stored in coolers on ice to maintain samples at 4^{o}C prior to and during shipment to the analytical laboratory. Ice will be sealed in double plastic bags. A chain-of-custody manifest will be completed on-site and will accompany the samples to the lab. The samples will be transferred to the laboratory within 24 hours of sampling.

The on-site fill sources will be characterized by collecting a three-point composite sample for every 500 cubic yards of soil. The samples will be submitted to a certified laboratory for selenium by EPA Method 7741A or 7742. The analytical results for selenium will be used to determine whether the soil is suitable for land application based on the screening criteria described below in Section 3.2, including Federal (RCRA-TCLP) and State (title 22-STLC, TTLC) hazardous waste criteria, and USEPA Region 9 PRGs.

3.2 SEDIMENT SAMPLING RISK CRITERIA

The results of sediment sampling will be compared against each of the three risk criteria summarized in Table 2 to determine the appropriate placement location of dredged material Based on sediment sampling conducted over the last 10 years, dredged sediments are typically appropriate for most uses. However, while none of the sediments samples have exceeded the human health criteria or hazardous waste criterion, approximately 72 percent have exceeded the ecological criteria.

Table 2. Sediment Sampling Risk Criteria

Risk Criteria	Selenium Level (µg /g, dry weight)
Hazardous Material (Federal RCRA-TCLP and State title 22 – STLC, TTLC)	
Hazardous Waste	> 100*
Human Health (USEPA Region 9 PRGs)	
Residential	<390
Industrial	391-5,100
Ecological (VanDeerver and Canton 1997)	
No Effect	<2
Level of Concern	2-4
Toxic	>4

Notes: * wet weight
RCRA – Resource Conservation and Recovery Act, TCLP – toxicity characteristic leaching procedure, STLC – soluble threshold limit concentration, TTLC – total threshold limit concentration

3.3 Health and Safety – Construction Worker Recommended PPE

Although there are no specific worker health and safety measures regarding sediment contamination that need to be taken when dredging work at the Site, it is recommended that workers performing work involving sediment disturbance wear appropriate personal protective equipment (PPE). At a minimum, this will include work boots, safety glasses or goggles, hearing protection when working with or near loud equipment, and appropriate gloves. In addition, workers are to wash exposed areas of skin that may have come in contact with sediment after leaving the work area or prior to eating, drinking, smoking or applying cosmetics, including lip balm and sunscreen. It is recommended that the contractor responsible for dredging and spreading have a health and safety plan prepared prior to work, in the event that hazardous levels of selenium in sediment are encountered.

3.4 Dust and Erosion Controls

Movement of sediment can result in exposure to dusts and fine particulate matter generated during dredging activities (movement of heavy vehicles during dredging) and transport of sediments from the San Luis Drain to the planned disposal or reuse location. Dust control measures will be implemented during dredging activities. In general, the most effective dust control measure is to water all areas adjacent to the planned dredge site where heavy vehicles are likely to travel at least twice per day, or as necessary, to prevent visible dust plumes from migrating off site. Tarpaulins or other covers may be used for trucks carrying sediments off site.

This section describes the management of dredged materials based on results of sediment sampling compared to the stated risk criteria as described in Section 3.0

4.1 HAZARDOUS MATERIAL DISPOSAL

If the concentration of selenium in the dredged material is equal to or greater than 100 µg Se /g, wet weight the sediment will be handled according to all applicable State and local regulations for hazardous materials and disposed in a licensed hazardous waste facility. The nearest facility to the Site which accepts hazardous material is Kettleman Hills Landfill, located in Kings County.

4.2 LAND APPLICATION

Dredged sediments that have selenium concentrations below 100 µg Se /g wet weight may be locally reused through land application. Although the human health standard for selenium is greater than the hazardous waste standard, as a precaution, the more stringent standard has been used in this plan to determine if land application is appropriate. Current proposals for land application of the sediments include agricultural lands adjacent to the Drain; however, other options for land application may include residential and industrial reuse and open space lands if such parcels become available. Table 3 summarizes the appropriate land application based on measured selenium concentrations within dredged sediments, as further discussed in the following sub-sections.

Table 3. Acceptable Concentrations of Selenium in Dredged Material by Land Use

Land Use	Acceptable Concentration of Se in Sediment
Residential development	< 100 µg Se /g, wet weight
Industrial development	< 100 µg Se /g, wet weight
Agriculture	< 10 µg Se /g, dry weight*
Open Space (Wetland and Upland)	< 2 µg Se /g, dry weight

Note: *Source: Zawislanski et al 2001. The 10 µg/g concentration is a general guideline recommended by the Lawrence Berkeley National Laboratory which if exceeded triggers certain monitoring as described in Section 4.2.2 below.

4.2.1 RESIDENTIAL/INDUSTRIAL REUSE

If selenium concentration less than 390 micrograms per gram dry weight with less than 97 percent moisture content (which would exceed hazardous material criteria), sediments may be applied on lands zoned for residential use. If the concentration of selenium is greater than 390 micrograms per gram, dry weight, but below hazardous material criteria, the sediments may only be applied on land areas zoned for industrial use.

4.2.2 APPLICATION ON AGRICULTURAL LANDS

The majority of land available for application of dredged sediments in the vicinity of the San Luis Drain is zoned for agriculture and open space. Plot experiments conducted by the Lawrence Berkeley National Laboratory (Zawislanski et al 2001) indicate that while application of sediments on these lands is appropriate with regards to human health PRGs and hazardous material criteria, leaching of selenium into groundwater is of concern due to the physical mixing of soils and irrigation which occur regularly as part of agricultural operations. Therefore, the LBL study recommends that only dredged sediments with selenium concentration below 10 micrograms per gram be applied to agricultural lands. With regard to plant uptake and human ingestion, selenium concentration within sediments is well below stated PRGs. However, sediments with selenium concentrations above 50 micrograms per gram may result in plant concentrations above U.S. Department of Agriculture Recommended Daily Levels (Zawislanski et al 2002); therefore, sediments with selenium concentrations greater than 10 micrograms per gram may only be applied to agricultural fields growing non-consumptive crops (e.g. pasture, alfalfa, wheatgrass) until monitoring shows selenium levels have decreased to 10 micrograms/gram. This plan does not place a limit on the type of agricultural field that sediments with concentrations below 10 micrograms per gram may be applied to. For sediments that exceed the 10 microgram per gram recommendation (but that are still below human health PRGs and hazardous material criteria) to be applied to agricultural lands the following sections apply.

4.2.2.1 Pre-Application Groundwater Sampling

Prior to application of sediments above the recommended threshold to agricultural lands, depth to groundwater shall be measured at three points within the proposed plot of land and a groundwater gradient determined based on the water levels. Plot experiments conducted by the Lawrence Berkeley National Laboratory (Zawislanski et al2001) indicate that selenium within applied sediments settled approximately 1.5 meters below ground surface due to irrigation, rainfall, and other transportation mechanisms. Therefore, depth to groundwater table will be greater than 2 meters below ground surface at all sampling points within the agricultural parcel.

If the depth to groundwater table criterion is met, a minimum of two groundwater monitoring wells will be installed (one upgradient and one downgradient of the proposed parcel). Prior to application of sediments, groundwater will be monitored to determine a baseline selenium concentration.

According to the Basin Plan for the Sacramento and San Joaquin River Basins, at a minimum, ground waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels (MCLs) specified in the following provisions of Title 22 of the California Code of Regulations. Section 64431 provides the MCL for inorganic chemicals. The MCL for selenium in groundwater as stated in this section is 0.05 mg/L.

4.2.2.2 Post-Application Groundwater Monitoring

Following application of sediments, groundwater will be monitored quarterly from both the upgradient and downgradient wells for a period of one year. If baseline selenium concentrations in groundwater indicate that the basin already exceeds the MCL, post-application monitoring within the down-gradient well should indicate that concentration of selenium has not increased in the aquifer due to downward movement of applied sediments. If baseline selenium concentrations are below the MCL, post-application monitoring should remain below the MCL level.

If post-application monitoring shows that selenium from sediments led to an increase in selenium concentrations or an increase to concentrations above the MCL, then remedial actions must be taken to address the exceedence. The California Regional Water Quality Control Board-Central Valley Region, will be consulted regarding the required cleanup standards applicable at the time, and must approve the remedial action.

4.2.2.3 Applied Sediment Management

Plot experiments conducted by the Lawrence Berkeley National Laboratory (Zawislanski et al 2001) indicate that discing of sediments on the agricultural fields may have contributed to the downward movement of selenium towards groundwater. Therefore, if sediments with selenium concentration greater than 10 micrograms per gram are applied, manual tilling, discing, or mixing of soil will not occur during the wet season. Normal agricultural practices may still occur throughout the dry season.

4.2.3 APPLICATION ON OPEN SPACE LANDS

Application of sediments on open space lands is of concern due to leaching of sediments into wetlands and other areas of ecological significance which may result in impacts to wildlife. Prior to application of dredged materials onto open space areas, wetland areas will be delineated and avoided. All required permits and approvals would be obtained prior to application of sediment on adjacent areas. Sediments, deemed not hazardous material and meeting the criteria provided in Table 3, may be applied to upland areas outside of the wet season.

4.2.4 SEDIMENT APPLICATION

Soils will be applied so that the geotechnical characteristic of the spread material is consistent with existing land uses. Sediments may become mixed during the dredging operation; however, purposeful mixing or homogenizing of sediments, other than natural mixing during dredging, will not occur prior to land application.

4.2.5 POST-APPLICATION MONITORING

The following monitoring protocol, as recommended by the Lawrence Berkeley National Laboratory study (Zawislanski et al. 2001) will be applied to all land application sites until selenium levels have decreased to unrestricted use (in areas where applied sediments exceeded ecological or human health risk criteria, where applicable). In areas where revegetation was conducted as part of the application of sediments, monitoring will continue until the predetermined success criteria for the revegetation program is met (i.e. percent cover or establishment of a particular vegetation community).

- Quarterly monitoring of soil water and groundwater to confirm that soluble selenium is not migrating toward the water table.

- Biannual soil sampling to monitor selenium displacement and solubility.

- Annual plant sampling and analysis at agriculture and open space sites to confirm that selenium is not being accumulated to levels of concern. Selenium uptake may change as selenium solubility increases.

- Installation of either neutron probe access pipes and/or tensiometers in agricultural sites to measure soil water movement.

- In agricultural area where sediments greater than 10 mg/kg are applied and crops are grown for human consumption, the selenium concentration of the plants will be tested prior to harvest. If the selenium concentration is greater than 10 mg/kg, compliance monitoring designed for small mammals as required by the 2001 USFWS Biological Opinion will be implemented to confirm that selenium uptake by wildlife is not being accumulated to levels of concern.

5.0
NOTIFICATIONS AND LIMITATIONS

A notification is hereby given that all of the environmental documents prepared for the Grassland Bypass Project should be reviewed by each contractor to fully understand the Site conditions. This SMP will remain in effect until future plans result in changes in management of the San Luis Drain. At such time, this SMP would be modified to reflect the changes in management actions as they affect the environmental condition of the Site.

This plan was formulated with the standard of practice generally acceptable at the time it is written. This document does not account for events that may change the Site conditions after the described activities are performed, whether occurring naturally or caused by external forces. Accordingly, this document does not cover conditions not generally recognized as predictable at the time of preparation. In addition, this document does not address the stability of excavations or on-site structures or safety of excavation work. These parameters are the responsibility of the contractor.

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APPENDIX C

Drainage and Water Balance Models

APPENDIX C

DEVELOPMENT OF THE DRAINAGE AND WATER BALANCE MODELS OF THE SAN JOAQUIN RIVER

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Appendix C. Development of the Drainage and Water Balance Models of the San Joaquin River

C1 INTRODUCTION

Two flow and water quality models were developed for the Grassland Bypass Project to assist with estimating the impacts of proposed alternatives on selenium, salt, and boron concentrations in the San Joaquin River. The area of interest is shown in Section 2 of the EIS/EIR on Figure 2-4. A drainage model was developed to predict the concentration and load of selenium, salt and boron leaving the Grassland Drainage Area (GDA). The output of this model was considered equivalent to the discharge from the San Luis Drain to Mud Slough. A Receiving Water Model was developed to predict the load and concentration for selected locations in the San Joaquin River. It was used to estimate the impacts to the San Joaquin River and Mud Slough for the various alternatives.

C2 DRAINAGE MODEL

C2.1 Introduction

The drainage model contains two components. The first component is based on a water balance of the unsaturated zone (root zone model) and calculates the recharge to the saturated zone and soil moisture in the unsaturated zone. The second component calculates the amount of drainage produced (sump model). The two components are linked together by a saturated zone model described in Section D.3.2. Estimates of recharge to the saturated zone from the root zone model were used as inputs to the saturated zone model, which provided an estimate of the water table elevation. The water table elevation was then used to estimate the amount of drainage produced by the sump model.

The subsurface drainage from the districts within the GDA and concentrations in the San Joaquin River were modeled for four different water year classifications: Wet, Above Normal, Below Normal/Dry, and Critical.

C2.2 Description of Root Zone Model

The root zone model was based on a water balance approach as shown on Figure C-1 and by Equation C-1.

$$ID + Pe + Re - ET - R = SM_t - SM_{t-1} \qquad \text{(C-1)}$$

Where

ID = delivered irrigation water, in inches/month
Pe = effective precipitation, in inches/month
Re = recirculated drainwater, in inches/month
ET = consumptive use by plants, in inches/month
R = recharge to the water table, in inches/month
SM_t = the soil moisture at the end of the current month
SM_{t-1} = the soil moisture at the end of the previous month

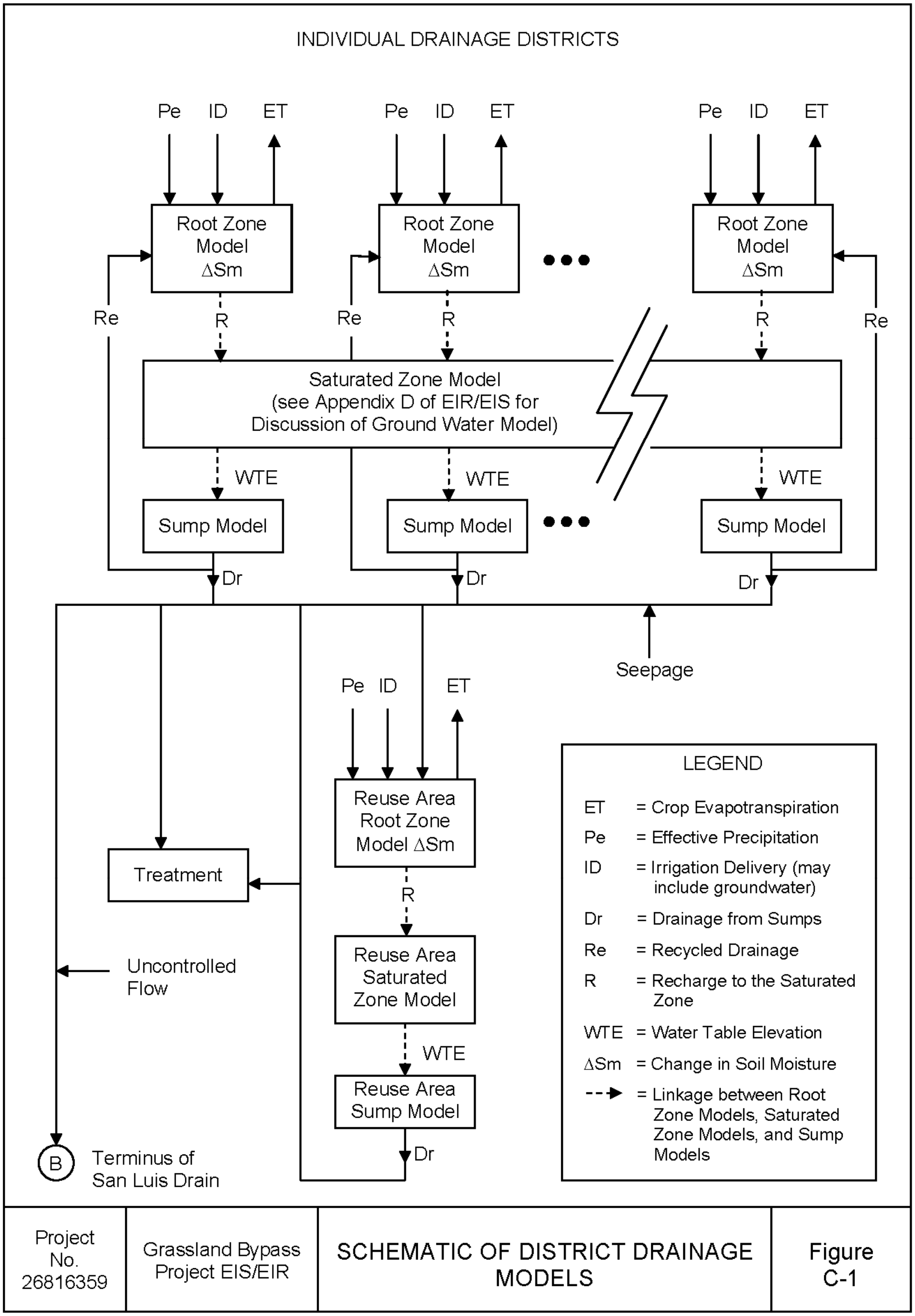


Figure C-1 Schematic of District Drainage Models

The following sections describe each of the components in Equation (C-1) and how they were calculated.

C2.2.1 Irrigation Water Deliveries (ID)

It was assumed that average reported or estimated irrigation deliveries to the districts within the GDA during Water Years 2002 to 2007 would be representative of future deliveries during all water year types. The period from 2002 to 2007 was selected due the transition from Phase I to Phase II of the Grassland Bypass Project at the end of 2001. It is possible that deliveries in future years may be reduced due to court-ordered restrictions on pumping from the Sacramento-San Joaquin Delta in order to protect sensitive fish populations. However, it is unclear exactly how deliveries would be affected.

Irrigation deliveries were obtained from the "GBP 00_07.xls" Excel file emailed to URS by Chris Linneman of Summers Engineering (Linneman, written comm., 2008). The average annual irrigation deliveries to the GDA between Water Years 2002 and 2007 totaled 181,694 acre-feet. This included both measured and estimated values to areas other than the San Joaquin River Water Quality Improvement Project (SJRIP). Deliveries to individual districts are shown in Table C-1. Based on the total reported or estimated irrigation deliveries between Water Year 2002 and Water Year 2007, the irrigation deliveries compared to the average were a maximum of approximately 6% higher in Water Year 2004 and 6% lower in Water Year 2005. Table C-2 shows the water year types determined by the California Department of Water Resources from 2000 to 2007.

Irrigation deliveries were either supplied from the Delta-Mendota Canal or the San Luis Canal. Irrigation supplied by groundwater pumping was estimated for Panoche Drainage District, Charleston Drainage District, and Pacheco Water District. For Panoche Drainage District, annual groundwater pumping was estimated to be 5,500 acre-feet for Above Normal and Wet water year types. For Below Normal, Dry, and Critical water year types, the pumping was estimated at 6,500 acre-feet (Linneman, written comm., 2008). It was assumed that Charleston Drainage District and Pacheco Water District would have the same ratio of applied groundwater per acre as Panoche Drainage District. Firebaugh Canal Water District was estimated to have up to 15,000 acre-feet of groundwater pumping by 2019. However, it was assumed that none of this groundwater would be applied within the GDA. It is likely that this groundwater will be transferred to districts outside of the GDA (Linneman, written comm., 2008). For Camp 13, no estimates of groundwater pumping were made. It was assumed that this district would not have a substantial amount of groundwater pumping. It was assumed that the annual totals for groundwater would be distributed in May, June, July, and August at 15%, 30%, 30%, and 25% of the annual total, respectively. These estimates were based on communication with Chris Linneman of Summers Engineering (Linneman, written comm., 2008).

The applied water in Panoche Drainage District was increased in order to obtain a ratio of 2.2 acre-feet of applied water per irrigated acre. This value was based on comments from Summers Engineering that the total applied water in Panoche Drainage District should be closer to 2.2 to 2.5 acre-feet per irrigated acre (Linneman, written comm., 2008). It was assumed that the monthly application of this water would follow the same pattern as the deliveries of canal water in Panoche Water District. The source of this water is not documented. It was assumed that it would be a combination of canal water, possibly from water transfers, and groundwater.

Historical and proposed future irrigation deliveries to SJRIP are shown in Table C-3.

Table C-1
Annual Irrigation Deliveries in Used in Root Zone Model

District	Proposed Irrigated Area (excludes fallow) (acres)	Irrigation Deliveries (canal water) (acre-feet)	Applied Groundwater (acre-feet)		Additional Water (includes canal and groundwater) (acre-feet)	Total Applied Water (acre-ft/acre)		Notes for Irrigation Deliveries
			Above Normal and Wet Years	Below Normal, Dry, and Critical Years		Above Normal and Wet Years	Below Normal, Dry, and Critical Years	
Camp-13 Drainage District	5,611	20,928	0	0	0	3.7	3.7	Average between WY 2002 and 2007.
Charleston Drainage District	3,644	9,474	514	607	0	2.7	2.8	Estimated from WY 2002 to 2007 average ratio of applied canal water per acre for Pacheco WD = 2.6 acre-feet per acre. Assumes average 2002 to 2005 irrigated acreage in Pacheco for WY 2006 and 2007 and 1999 irrigated acreage for Charleston. Assumes the same ratio of applied groundwater per acre as Panoche.
Firebaugh Canal Water District[1]	21,640	65,775	0	0	0	3.0	3.0	Average between WY 2002 and 2007.
Pacheco Water District	4,751	12,293	670	791	0	2.7	2.8	Average canal deliveries between WY 2002 and 2007. Assumes the same ratio of applied groundwater per acre as Panoche.
Panoche Drainage District (excluding SJRIP)	39,029	63,310	5,500	6,500	17,000	2.2	2.2	Includes average of reported WY 2002 to 2007 deliveries for Panoche WD and Eagle Field WD. Deliveries to Oro Loma WD were estimated from the WY 2002 to 2007 average ratio of applied canal water per acre for Panoche WD = 1.6 acre-feet per acre. This assumes average 2002-2005 irrigated acreage in Panoche WD for WY 2006 and 2007 and 1999 irrigated acreage for Oro Loma. It was assumed that Mercy Springs WD was not irrigated. Water in addition to applied groundwater was estimated in order to result in a ratio of 2.2 acre-feet per acre.
Total	**74,675**	**171,780**	**6,683**	**7,898**	**17,000**	**2.6**	**2.6**	

Note:
Broadview and Widren are excluded from the model.
[1] Groundwater pumping in Firebaugh is expected to be transferred outside of the Grassland Drainage Area.
Sources: Fio, written comm., 2000: sosdata.xls and Linneman, written comm., 2008: GBP 00_07 Data.xls.

It was assumed that 100 percent of the irrigation deliveries are applied to the fields. Any losses that occur, such as canal seepage, were assumed to be insignificant.

Table C-2
San Joaquin River Index from 1997 to 2007

Water Year	Classification	Abbreviation
1997	Wet	W
1998	Wet	W
1999	Above Normal	AN
2000	Above Normal	AN
2001	Dry	D
2002	Dry	D
2003	Below Normal	BN
2004	Dry	D
2005	Wet	W
2006	Wet	W
2007	Critical	C

Source: California Department of Water Resources (DWR) 2008. WSIHIST. http://cdec.water.ca.gov/cgi-progs/iodir/wsihist

Table C-3
Irrigation Deliveries for SJRIP

	Total Area (includes fallow) (acres)	Irrigated Area (excludes fallow) (acres)	Irrigation Deliveries (canal water) (acre-feet)	Applied Ground-water (acre-feet)	Applied Drain Water (acre-feet)	Total Applied Water (acre-ft/acre)	Notes
SJRIP 2007	3,873	3,813	2,409	2,409	10,408	4.0	
SJRIP Avg. 2002-2007	3,873	2,819	1,610	1,610	7,449	3.8	
SJRIP Future Max	6,900	5,520	690	690	23,460	4.5	Drain water would be applied up to a maximum of 4.25 acre-feet per acre on the irrigated areas. Additional drain water could also be applied to fallow areas to infiltrate to groundwater, if needed. Irrigated acreage was based on assuming that 20% of the total acreage is fallow. Applied freshwater assumes equal portions of groundwater and canal water so that total applied water reaches a maximum of 4.5 acre-feet per acre. The drainage model will only apply freshwater when drain water is insufficient to meet crop water needs with a 25% leaching fraction.

Sources: Linneman, written comm., 2008: GBP 00_07 Data.xls and sjrip crop ac.xls.

C2.2.2 Effective Precipitation (Pe)

Effective precipitation was defined as the rainfall that infiltrates into the soil. The remainder of the precipitation either evaporates or runs off. The amount of precipitation that infiltrates was estimated based on the method used in the *Grassland Basin Irrigation and Drainage Study* (Cal Poly 1994); however, Cal Poly evaluated daily precipitation events, whereas this model evaluated precipitation on a monthly basis. Depending upon how the precipitation is distributed during a month, this method applied to monthly data may overestimate infiltration. Table C-4 shows how the precipitation was categorized each month.

The monthly precipitation data were obtained from data in the file “GARAIN.xls” for Panoche Water District (Linnemann, written comm., 2008). Precipitation for Water Year 2000 was used for modeling Above Normal years, Water Year 2004 was used for Below Normal/Dry years, Water Year 2005 for Wet years, and Water Year 2007 for Critical years (see Attachment C-1).

Table C-4
Categorization of Precipitation

P = Rainfall (inches)	Evaporation (inches)	Infiltration (inches)	Runoff (inches)
P < 0.2	100% * P	0	0
0.2 < P < 0.5	0.2	P – 0.2	0
0.5 < P	0.2	0.3 + (0.7*(P – 0.5))	0.3 * (P – 0.5)

Source: adapted from Cal Poly 1994.

C2.2.3 Crop Evapotranspiration

Crop evapotranspiration was calculated from reference evapotranspiration and crop coefficients for optimal growth. Crop evapotranspiration is a measurement of the consumptive use by plants, and is calculated according to the following equation, as used in the Grassland Basin Irrigation and Drainage Study (Cal Poly 1994).

$$ET = Kc * F1 * F2 * ETo \qquad \text{(C-2)}$$

Where

ET = consumptive use by plants, in inches/month

Kc = the monthly crop coefficient

F1 = the adjustment factor of 0.86 for stunted growth and bare spots (Cal Poly 1994)

F2 = the adjustment factor of 0.85 to account for contribution of shallow groundwater to plant consumption in June through September

ETo = the monthly reference evapotranspiration, in inches/month

The districts that will be included in the model as well as the total cropped area are given in Table C-5. The acreage was assumed to be the same for all water year types. The cropping patterns and acreage were based on the average acreage between 2002 and 2007, when the data were available. If no acreage was reported for a district between 2002 and 2007, the year with the most recent data available was used. The cropping patterns for each district were obtained from the files “sos data.xls” (Fio, written comm., 2000) and “GBP 00_07 Data.xls” (Linneman, written comm., 2008).

Crop coefficients are crop and day specific. Daily values for each crop were calculated from data obtained from the University of California Cooperative Extension Leaflets (21427, 21428, and

21454), crop coefficients used in the Grassland Basin Irrigation and Drainage Study (Cal Poly 1994), and estimates of crop coefficients specifically related to districts located in the GDA (Zander, pers. comm., 2000).

Since the root zone model uses a monthly time step, the daily estimates needed to be converted to monthly values. To do this, daily crop coefficients were determined for each crop and averaged over each month. Table C-6 shows the monthly crop coefficients used for each crop. To determine the representative monthly crop coefficient for each district, the crop weighted average monthly crop coefficient was calculated based upon the acreage of each particular crop in each district. The weighted monthly average crop coefficients determined for each district are shown in Attachment C-1. Crops not included in the model were grouped with similar crops. See Attachment C-1 for a table of cropping patterns.

The reference evapotranspiration was obtained from the California Irrigation Management Information System (CIMIS) station at Firebaugh/Telles. Evapotranspiration for Water Year 2000 was used for modeling Above Normal years, Water Year 2004 was used for Below Normal/Dry years, Water Year 2005 for Wet years, and Water Year 2007 for Critical years. (See Attachment C-1.)

Table C-5
Crop Acreage by District

District	Total Cropped Area (includes fallow areas)	Notes/Assumptions
Camp-13 Drainage Area	5,772	Based on average of reported crops from 2002 to 2007.
Charleston Drainage District	3,685	Based on reported crops in 1999.
Firebaugh Canal Water District	22,091	Based on average of reported crops from 2002 to 2007.
Pacheco Water District	4,751	Based on average of reported crops from 2002 to 2005.
Panoche Drainage District (excluding SJRIP)	40,547	Based on sum of reported crops in Eagle Field for 2000 (1334 acres), area of Mercy Springs (720 fallow acres), reported crops for Oro Loma in 1999 (1088 acres), average of reported crops for Panoche WD from 2002 to 2005 (37,405 acres).

Table C-6
Monthly Average Crop Coefficients (Kc)

Month	Alfalfa	Almonds	Asparagus	Barley	Beans	Cereal (use Barley)	Citrus	Corn	Cotton	Deciduous Orchard, c	Deciduous Orchard, d	Avg. of Deciduous Orchard	Fallow	Garlic (use Onion)	Grain Sorghum (Milo)
Jan	0.00	0.00	0.25	0.98	0.00	0.98	0.65	0.00	0.00	0.00	0.00	0.00	0.06	1.15	0.00
Feb	0.29	0.18	0.25	1.20	0.00	1.20	0.65	0.00	0.00	0.00	0.00	0.00	0.06	1.15	0.00
Mar	0.90	0.62	0.25	1.14	0.00	1.14	0.65	0.00	0.00	0.58	0.60	0.59	0.06	1.13	0.00
Apr	0.93	0.71	0.61	0.78	0.00	0.78	0.65	0.20	0.11	0.70	0.75	0.73	0.06	0.96	0.00
May	0.86	0.80	0.95	0.24	0.28	0.24	0.65	0.60	0.22	0.82	0.91	0.86	0.06	0.40	0.16
Jun	1.00	0.89	0.95	0.00	1.08	0.00	0.65	1.11	0.75	0.87	0.97	0.92	0.06	0.00	0.51
Jul	1.02	0.74	0.95	0.00	0.98	0.00	0.65	0.99	1.17	0.87	0.97	0.92	0.06	0.00	1.04
Aug	1.01	0.62	0.95	0.00	0.25	0.00	0.65	0.59	1.05	0.87	0.97	0.92	0.06	0.00	0.81
Sep	0.00	0.80	0.95	0.00	0.00	0.00	0.65	0.00	0.62	0.83	0.95	0.89	0.06	0.00	0.00
Oct	0.00	0.62	0.95	0.00	0.00	0.00	0.65	0.00	0.01	0.71	0.88	0.80	0.06	0.12	0.00
Nov	0.00	0.02	0.85	0.25	0.00	0.25	0.65	0.00	0.00	0.00	0.00	0.00	0.06	0.30	0.00
Dec	0.00	0.00	0.45	0.36	0.00	0.36	0.65	0.00	0.00	0.00	0.00	0.00	0.06	0.84	0.00

Month	Grapes (wine)	Melons	Misc. (High) (use Corn)	Misc. (Low)	Misc. (Med) (use avg. of High and Low)	Nursery/ Lettuce	Olives	Pasture (Improved)	Potatoes	Rice	Sugarbeets	Tomatoes (canning)	Tomatoes (fresh market)	Wheat
Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.98
Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.00	0.00	0.00	0.00	1.20
Mar	0.17	0.09	0.00	0.00	0.00	0.00	0.02	0.90	0.58	0.00	0.08	0.00	0.02	1.20
Apr	0.40	0.26	0.20	0.00	0.10	0.00	0.62	0.90	1.01	0.95	0.27	0.00	0.08	1.09
May	0.52	0.90	0.60	0.00	0.30	0.00	0.71	0.90	1.19	1.14	0.75	0.27	0.64	0.74
Jun	0.63	0.63	1.11	0.00	0.56	0.00	0.78	0.90	0.71	1.25	1.10	0.62	1.00	0.24
Jul	0.64	0.00	0.99	0.00	0.49	0.00	0.80	0.90	0.00	1.17	1.09	1.04	0.90	0.00
Aug	0.56	0.00	0.59	0.13	0.36	0.13	0.80	0.90	0.00	1.02	1.02	0.99	0.05	0.00
Sep	0.00	0.00	0.00	0.21	0.10	0.21	0.80	0.90	0.00	0.00	0.48	0.38	0.00	0.00
Oct	0.00	0.00	0.00	0.71	0.35	0.71	0.80	0.90	0.00	0.00	0.00	0.00	0.00	0.00
Nov	0.00	0.00	0.00	1.01	0.50	1.01	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.25
Dec	0.00	0.00	0.00	0.48	0.24	0.48	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.36

C2.2.4 Recirculated Drainage

In the drainage model, the monthly selenium load values for the 2010 Use Agreement can be met by recycling, reuse, and/or treatment. It was assumed that recycling would be used to meet the total maximum monthly load (TMML) for selenium until the applied water (canal deliveries and groundwater plus recycled water) reached a total dissolved solids (TDS) concentration of 600 mg/L. If this amount of recycling was insufficient to meet the TMML, then the SJRIP Reuse Area would be utilized to meet the TMML.

The crop water requirement for the SJRIP was calculated as the crop evapotranspiration increased by 25% for leaching. It was assumed that the crop water requirement would be met by drainage, infiltrated precipitation, and freshwater, if needed. If the TMMLs still can not be met, then extra drain water can be applied to fallow areas in the SJRIP to infiltrate to groundwater as long as it would not result in ponding.

All districts except Camp 13 Drainage District were assumed to be capable of recycling their sump discharge. It was assumed that discharge from the Reuse Area would be blended with drainage from the rest of the GDA until a treatment facility was developed (assumed to occur in 2015). It was assumed that the treatment facility would have sufficient capacity to treat all the discharge from the Reuse Area.

For each water year type analyzed, the percentage of recycled water was adjusted each month in order to meet the TMML values for selenium. If the load at Station B, at the terminus of the San Luis Drain, exceeded the load value for a particular month, drain water would be recycled. The percentage of drain water recycled was the same for each district subject to the 600 mg/L limit on TDS concentration. If the amount of recycling exceeded the average monthly volume recycled between Water Years 2002 and 2007, the amount in exceedance replaced an equivalent amount of irrigation deliveries for that particular month, i.e., the delivered water was reduced by the amount of the increased recycling. However, it was assumed that the total volume of recycled drain water would not exceed the average monthly irrigation deliveries (including groundwater) plus recycling determined between Water Years 2002 and 2007.

If the load at Station B was less than the load value for a particular month, then drain water recycling would not occur. Attachment C-1 includes tables showing the monthly volume of recycled drainage for each district and for each water year type.

Recycling from the Panoche Drainage District was treated differently from the other districts. The district presently recirculates the sump flows with the highest selenium concentrations. It was assumed that Panoche would continue to recirculate this water first. The volume and concentration of the drainage at a higher selenium concentration would be based on the average monthly volume and load of drain water recycled between water years 2002 and 2007. When additional recycling is needed, the increase in recycling would be above this amount, and the concentration of selenium in the additional recycled water would be lower, as described in Section C2.4.4.

The flow reported in the San Luis Drain at Station B generally exceeded the amount of flow reported as leaving the Districts. This difference was attributed to seepage entering the drainage canals within each district, or uncontrolled flows entering the Grassland Bypass Channel or the San Luis Drain. The seepage and uncontrolled flows were added to the sum of the produced drainage from all districts to determine whether the selenium load limits were being met.

C2.2.5 Soil Moisture

It was assumed that there was no net change in soil moisture over a water year; however, soil moisture did change on a monthly basis. The maximum soil moisture was set equal to the field capacity, estimated to be 20 percent of the soil volume in the unsaturated zone.

C2.2.6 Water Table Recharge

The recharge was calculated as the quantity of soil moisture above the field capacity. Soil moisture was calculated at the end of the month using Equation (C-1). If the soil moisture exceeded field capacity, the soil moisture was set equal to the field capacity and the remaining water was assumed to recharge the water table.

C2.3 Calculation of Produced Drainwater (Sump Model)

The drainage discharge was calculated based on the depth to the water table and the depth to the drains using the following equation.

$$GW = C * (D_D - D_{WT}) \qquad \text{(C-3)}$$

Where:

GW = the monthly volume of drainflow, in acre-feet/month

C = the drain conductance factor, in acre-feet/month per foot of head difference

D_D = average depth to the drains, in feet

D_{WT} = the monthly depth to groundwater, in feet

The average depth to the drains for the entire GDA was assumed to be 7.7 feet. This value was previously calibrated, as discussed in Section D.3.2.2 of the 2001 EIS/EIR (URS 2001), and agrees with typical design depths in the GDA (6 to 9 feet).

The drain conductance factors for districts in the GDA had been previously determined through calibration using the groundwater flow model developed by the U.S. Geological Survey (USGS), updated by HydroFocus, Inc., and discussed in Section D.3.2.1 of the 2001 EIS/EIR (URS 2001).

The annual average depths to groundwater under the drained areas were estimated for the period from 2000 to 2007 based on the annual depth that corresponded most closely to the total annual sump flows from the GDA. The estimated annual depths to groundwater ranged from 6.6 feet in Water Year 2005 to 6.9 feet in Water Year 2002. The average estimated depth over this period was 6.8 feet.

The monthly depths to groundwater were determined by applying previously determined monthly multipliers to the annual water depths, as discussed in Section D.3.2.2 of the 2001 EIS/EIR (URS 2001). The monthly factors are provided in Attachment C-1.

An average annual depth to groundwater of 6.8 feet was used to model future conditions for all water year types.

C2.3.1 Discharge Leaving Districts

The quantity of discharge leaving each district was calculated as the modeled sump flow minus the modeled recirculated drainage and any diversions to the SJRIP. This calculation method does not account for groundwater that collects in the deep drains throughout the region and gets measured at the district discharge points but not at the district sumps. However, any losses or gains in drainage prior to the district discharge points are probably within the error tolerance of the sump model.

C2.3.2 Downstream Seepage in the GDA

More flow is generally measured at the monitoring points that are the furthest downstream in the GDA compared to the discharge that is reported leaving the individual districts. The extra flow is attributed mainly to seepage that enters deep open drains with a smaller contribution from the drained portion of the SJRIP. The two downstream sites are designated as PE14 and FC5. Site PE14 is located nearly 1 mile upstream (south) of the entrance to the Grassland Bypass Channel and 2 miles west of Russell Avenue. Site FC5 is located approximately 2 miles upstream (southeast) of the entrance to the Grassland Bypass Channel at Russell Avenue. Although there is a large annual variability in the estimated seepage in the GDA, based on a comparison between the total district discharge (minus diversions to SJRIP that occur upstream of PE14 and FC5) and the total flow at PE14 and FC5 measured from 2000 to 2007, it was determined that the variability in downstream seepage within the GDA is independent of water year type. In February 2005, some of the discharge leaving the districts was discharged through the Grassland Water District because the capacity of the Grassland Bypass Channel was exceeded. This volume was subtracted from the reported district discharge to more accurately determine the volume of seepage. The monthly difference in flow (PE14 and FC5 minus the district discharge) was averaged from Water Year 2002 to 2007.

Since the amount of discharge from the SJRIP will increase in the future as tile drains are installed, the SJRIP discharge was estimated and subtracted from the average to obtain the monthly seepage flows. The monthly SJRIP discharge was estimated using the average drain conductance factor and monthly groundwater depth factors from the sump model, a drained area of 1,700 acres, and an average groundwater depth 0.9 feet above the average drain depth. Figure C-2 shows the estimated total seepage flows (seepage plus SJRIP discharge) from 2000 to 2007 as well as the average from 2002 to 2007 and the proposed seepage flows for the model.

C2.3.3 Uncontrolled Flow

The uncontrolled flow was characterized as seepage that either enters the Grassland Bypass Channel or the San Luis Drain upstream of Station B and downstream of the SJRIP. It was calculated as the discharge at Station B minus the sum of the measured flows at PE14 and FC5. Station B is located near the terminus of the San Luis Drain, approximately 30 miles downstream (northwest) of PE14 and FC5. The uncontrolled flows are shown on Figure C-3 from 2000 to 2007. Water Year 2005 was an extremely wet year and some of the calculated differences were negative. Water year 2006 was also a wet year, but the flow values generally agree with the rest of the data. The monthly values calculated from the average of 2002 to 2007, excluding January 2006 (a negative difference) and all of Water Year 2005, were used for the model.

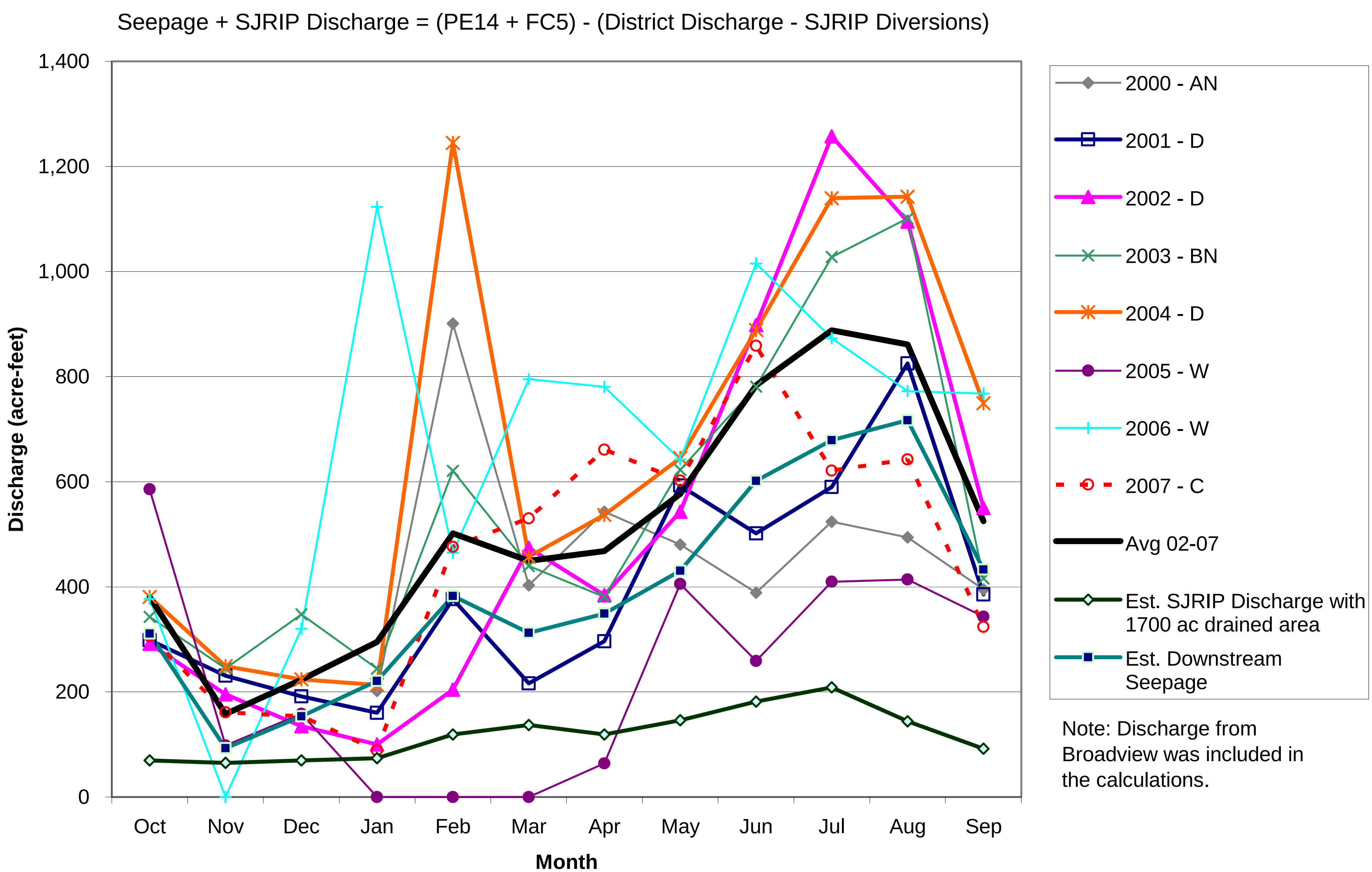


Figure C-2 Calculation of Downstream Seepage in the GDA

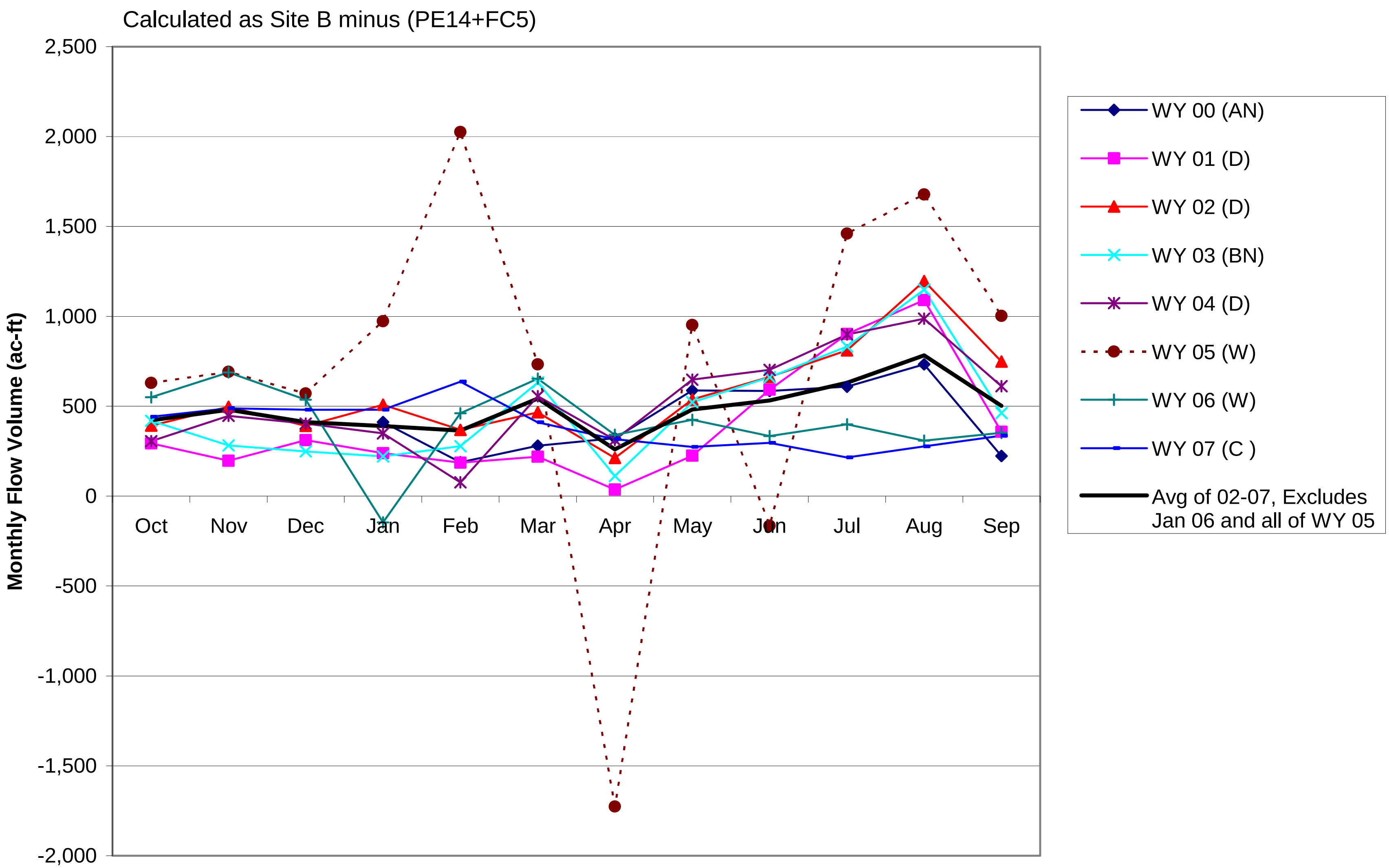


Figure C-3 Uncontrolled Flows downstream of the Grassland Drainage Area

C2.4 Water Quality of Drainage Model Components

The quality of the applied water was tracked in the root zone and sump models to determine when the drainage would be recirculated and when it should be diverted to the SJRIP.

C2.4.1 Quality of Irrigation Water Deliveries

It was assumed that the quality of irrigation deliveries to the districts within the GDA could be based on the average water quality for Water Years 2002 to 2007 for all water years and year types. Measured data are provided in Table C-7.

Water quality delivered to Camp 13, Firebaugh, and the SJRIP was represented by the measurements at Mendota Pool at Check 21 of the Delta-Mendota Canal. Mendota Pool is located at the southern end of the Delta-Mendota Canal at Milepost 116.50.

The measurements at O'Neill Forebay, located at Milepost 70.01 of the Delta-Mendota Canal, and at O'Neill Forebay in the San Luis Canal were used to represent the quality of deliveries to Pacheco Water District, Charleston Drainage District and lands within Panoche Drainage District. Approximately half of Charleston's deliveries, 60 percent of Pacheco's deliveries, and about 70 percent of Panoche's deliveries come from the San Luis Canal. These percentages were applied to the irrigation deliveries to obtain the water quality of water delivered to the above districts.

Since groundwater pumping occurs for the Panoche Drainage District, Charleston Drainage District, Pacheco Water District, and the SJRIP, the water quality of the groundwater is needed for these districts. The groundwater quality for the SJRIP was based on the average selenium, boron, and specific conductivity measured at two wells in the SJRIP in April 2007. The measured and average concentrations are shown in Table C-8.

The groundwater quality for Panoche Drainage District, Charleston Drainage District, and Pacheco Water District was estimated based on measurements from a well near the border between Panoche Drainage District and Pacheco Water District. The representative values are shown in Table C-9.

The additional water applied to Panoche Drainage District is assumed to be made up of surface and groundwater and will be estimated as the combined quality of the canal and groundwater specifically estimated for this district. Water quality of combined groundwater and canal deliveries used in the root zone model are shown in Tables C-10 to C-12.

Table C-7
Water Quality of Delivered Irrigation Water

Month[1]	Selenium (µg/L)			Total Dissolved Solids (mg/L)			Boron (mg/L)		
	Check 21 Mendota Pool Delta-Mendota Canal Milepost 116.50[2]	Check 13 O'Neill Forebay Delta-Mendota Canal Milepost 70.01[3]	San Luis Canal at O'Neill Forebay[4]	Check 21 Mendota Pool Delta-Mendota Canal Milepost 116.50[5,6]	Check 13 O'Neill Forebay Delta-Mendota Canal Milepost 70.01[5,7]	San Luis Canal at O'Neill Forebay[8]	Check 21 Mendota Pool Delta-Mendota Canal Milepost 116.50[9]	Washoe Avenue Delta-Mendota Canal Milepost 110.12[10]	San Luis Canal at O'Neill Forebay[8]
October	0.3	0.2	1	278	268	270	0.1	0.1	0.1
November	0.7	0.3	1	290	289	289	0.2	0.2	0.2
December	0.9	0.3	2	338	337	340	0.3	0.3	0.2
January	1.1	0.3	0.8	323	285	261	0.3	0.3	0.2
February	1.2	0.6	1	314	297	245	0.3	0.2	0.2
March	1.7	0.6	1.3	318	279	247	0.4	0.3	0.2
April	2.8	0.4	0.8	296	231	238	0.3	0.3	0.2
May	3.4	0.3	1	311	211	272	0.2	0.4	0.2
June	1.9	0.2	0.9	245	187	222	0.1	0.4	0.1
July	0.7	0.3	0.5	190	183	194	0.1	0.1	0.09
August	0.5	0.2	0.9	226	214	215	0.1	0.1	0.08
September	0.5	0.2	0.8	271	258	257	0.1	0.2	0.07

For purposes of data evaluation, non-detect data were assumed to equal one half of the reporting limit.
[1] Averaged across Water Years 2002 to 2007 for each respective month, unless otherwise specified.
[2] Data were not available from October 2001 through June 2002, December 2003, December 2004, and January 2006.
[3] Data were not available from October 2001 through June 2002, and September 2007.
[4] Data were not available from October 2001 through February 2002, April 2002 through March 2004, and November 2004.
[5] Data were not available from October 2001 through June 2002.
[6] Monthly Total Dissolved Solids (TDS, units of mg/L) concentrations provided by Eacock (2008) were calculated based on EC (µS/cm). At Check 21, TDS = EC * 0.5252 + 24.87.
[7] Monthly Total Dissolved Solids (TDS, units of mg/L) concentrations provided by Eacock (2008) were calculated based on EC (µS/cm). At Check 13, TDS = EC * 0.5317 + 21.
[8] Data were not available from January, March, and November 2004.
[9] Includes only July 2002 through October 2003.
[10] Data were not available from October 2001 through June 2002, November 2002, September 2003, December 2003, January 2004, November 2005, and February 2007.
Sources: Eacock 2008, Reclamation 2008.

Table C-8
Water Quality of Deep Wells in SJRIP

Analyte	Units	Date	Well #1	Well #5	Average of Well #1 and #5
Boron	mg/L	4/26/2007	3	3.3	3.2
Selenium (Total)	µg/L	4/20/2007	5.5	6.3	5.9
Specific Conductivity (EC)	µmho/cm	4/17/2007	2600	3300	2950
TDS Estimated from EC[1]	mg/L		1820	2310	2065

[1] TDS in mg/L calculated as 0.7 * EC in µmho/cm

Table C-9
Water Quality of Well near Panoche/ Pacheco Border

Analyte	Units	Analysis Date	Result	Detection Limit for Reporting	Representative Value
Boron	mg/L	3/17/2008	0.92	0.1	0.92
Selenium (Total)	µg/L	3/19/2008	ND[1]	2	1
Specific Conductivity (EC)	µmho/cm	3/18/2008	1300	1	1300
Total Dissolved Solids (TDS)	mg/L	3/17/2008	870	5	870

[1] ND = None Detected at Detection Limit for Reporting. Value was estimated at half the detection limit.

Table C-10
Selenium Concentrations of Combined Irrigation Deliveries from Canals and Groundwater Used in Drainage Model (µg/L)

	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Flow-Weighted Average
Oct	0.3	0.6	0.3	0.7	0.8	0.5
Nov	0.7	0.7	0.7	0.7	0.8	0.7
Dec	0.9	1.2	0.9	1.3	1.5	1.3
Jan	1.1	0.6	1.1	0.6	0.7	0.8
Feb	1.2	0.8	1.2	0.8	0.9	1.1
Mar	1.7	1.0	1.7	1.0	1.1	1.4
Apr	2.8	0.6	2.8	0.6	0.7	1.7
May	3.4	0.7	3.4	0.7	0.8	1.9
Jun	1.9	0.6	1.9	0.7	0.7	1.3
Jul	0.7	0.4	0.7	0.5	0.5	0.6
Aug	0.5	0.6	0.5	0.7	0.7	0.6
Sep	0.5	0.5	0.5	0.6	0.6	0.5

Table C-11
Total Dissolved Solids Concentrations of Combined Irrigation Deliveries from Canals and Groundwater Used in Drainage Model (mg/L)

	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Flow-Weighted Average
Oct	278	272	278	272	273	276
Nov	290	289	290	289	289	290
Dec	338	339	338	339	339	339
Jan	323	273	323	271	268	287
Feb	314	271	314	266	261	292
Mar	318	263	318	260	257	286
Apr	296	235	296	235	236	265
May	311	277	311	284	328	348
Jun	245	258	245	262	293	303
Jul	190	238	190	239	262	258
Aug	226	274	226	272	304	306
Sep	271	258	271	257	257	266

Table C-12
Boron Concentrations of Combined Irrigation Deliveries from Canals and Groundwater Used in Drainage Model (mg/L)

	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Flow-Weighted Average
Oct	0.1	0.1	0.1	0.1	0.1	0.1
Nov	0.2	0.2	0.2	0.2	0.2	0.2
Dec	0.3	0.3	0.3	0.2	0.2	0.2
Jan	0.3	0.3	0.3	0.2	0.2	0.3
Feb	0.3	0.2	0.3	0.2	0.2	0.3
Mar	0.4	0.3	0.4	0.2	0.2	0.3
Apr	0.3	0.3	0.3	0.2	0.2	0.3
May	0.3	0.3	0.3	0.3	0.3	0.4
Jun	0.1	0.3	0.1	0.3	0.3	0.3
Jul	0.1	0.2	0.1	0.2	0.2	0.2
Aug	0.1	0.2	0.1	0.2	0.2	0.2
Sep	0.1	0.1	0.1	0.1	0.1	0.1

C2.4.2 Quality of Precipitation

It was assumed that selenium, TDS, and boron concentrations in rainfall were negligible, so these concentrations were set to zero.

C2.4.3 Quality of Crop Evapotranspiration

It was assumed that the crop evapotranspiration would not take up any selenium, TDS, or boron.

C2.4.4 Quality of Recirculated Drainage

For all districts except Panoche Drainage District, it was assumed that the quality of the recirculated drainwater was equal to the average recirculated drainwater quality between Water Years 2002 and 2007. Tables C-13 to C-15 show the recirculated drainage concentrations used in the model for each district. These concentrations were determined from the average flow volumes and loads in the file “GBP 00_07 Data.xls” (Linneman written. comm., 2008).

For Panoche Drainage District, two different concentrations of recirculated water were used for selenium; high selenium concentration water that is recirculated first and lower concentration water that is recirculated when additional recycling is needed to meet the TMMLs.

The high selenium concentration water for Water Years 2002 to 2007 was determined from the selenium concentration data for the recirculated drainage in the file “GBP 00_07 Data.xls” (Linneman, written comm., 2008). This water is presently part of the Panoche recirculation system. The selenium concentration of additional water for recycling from Panoche Drainage District was estimated based on the average difference in water volume and selenium load between the total sump flows and the recirculated flows between Water Years 2002 and 2007.

The TDS and boron concentrations of the recirculated flow in Panoche were based on the average recirculated drainage water quality between Water Years 2002 and 2007. This was calculated from information in “GBP 00_07 Data.xls” (Linnemann, written comm., 2008). It was assumed that the TDS and boron concentrations were evenly distributed throughout the region so that the same concentrations were used for any additional recycling.

C2.4.5 Quality of Water Table Recharge

Changes in the quality of the recharge to the saturated zone were predicted with the groundwater and agricultural production models discussed in Appendix D and Appendix G.

C2.4.6 Quality of Soil Moisture

Changes in the unsaturated zone water quality were predicted with the groundwater and agricultural production models discussed in Appendix D and Appendix G.

Table C-13
Selenium Concentrations of Recycled Flows and/or Produced Drainwater Used in Drainage Model (μg/L)

	Camp 13 Drainage Area[1]	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District Concentrations	
					Higher	Lower
Oct	46	119	199	96	154	110
Nov	48	93	182	89	158	98
Dec	64	137	153	82	170	81
Jan	73	142	168	81	201	70
Feb	64	133	166	92	178	62
Mar	64	139	176	132	221	68
Apr	59	95	174	118	288	73
May	55	142	177	101	257	87
Jun	48	139	209	99	206	69
Jul	45	153	205	99	237	59
Aug	43	92	194	109	243	59
Sep	44	136	187	102	200	84

[1] Camp 13 does not recycle drainwater. Concentrations were calculated from average produced drainwater quality in Camp 13.

Table C-14
Total Dissolved Solids Concentrations of Recycled Flows and/or Produced Drainwater Used in Drainage Model (mg/L)

	Camp 13 Drainage Area[1]	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct	4,323	3,124	10,150	3,428	3,825
Nov	4,067	3,005	11,992	3,598	3,771
Dec	5,094	3,301	11,055	3,453	3,545
Jan	4,963	3,702	7,867	3,625	3,918
Feb	3,902	3,990	5,822	4,255	3,965
Mar	5,106	4,295	6,041	4,092	4,245
Apr	4,388	4,478	5,831	4,131	5,047
May	4,056	4,778	4,949	4,337	4,699
Jun	4,027	4,479	4,815	3,702	4,326
Jul	3,940	4,511	5,162	3,824	4,564
Aug	3,838	3,880	5,192	4,000	4,345
Sep	4,156	3,177	6,015	3,118	4,335

[1]Camp 13 does not recycle drainwater. Concentrations were calculated from average produced drainwater quality in Camp 13.

Table C-15
Boron Concentrations of Recycled Flows and/or Produced Drainwater Used in Drainage Model (mg/L)

	Camp 13 Drainage Area[1]	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct	13	2	20	6	9
Nov	11	2	26	6	9
Dec	14	2	22	5	8
Jan	14	5	16	6	8
Feb	11	5	12	6	9
Mar	14	6	12	6	8
Apr	12	6	11	7	9
May	12	6	9	6	9
Jun	12	6	10	7	8
Jul	11	6	10	7	8
Aug	11	5	10	7	9
Sep	12	5	11	7	9

[1] Camp 13 does not recycle drainwater. Concentrations were calculated from average produced drainwater quality in Camp 13.

C2.4.7 Quality of Produced Drainwater

Except for the selenium concentrations in Panoche Drainage District, the concentration of selenium, TDS, and boron in the drainwater produced from the sumps was assumed to be equal to the average recirculated drainage concentration for Water Years 2002 to 2007 from data in the file “GBP 00_07 Data.xls” (Linneman, written comm., 2008). No long-term trends were apparent in the measured water quality of the sump flows between 2002 and 2007. For Panoche Drainage District, the selenium concentration of the drainwater was assumed to be equal to the average sump concentration between Water Years 2002 and 2007.

C2.4.8 Quality of District Discharge

The quality of district discharge was taken to be the average quality of discharge leaving each district between Water Years 2002 and 2007 for TDS and boron. The selenium quality was assumed to be the same as the produced drainage from the sumps. Selenium concentrations of the measured district discharge are generally slightly lower than the concentrations of the produced drainage. For simplifying the calculations in the model, the same selenium concentrations were used for the produced drainage and the district discharge. Using the higher selenium concentrations from the produced drainage, instead of the lower concentrations from the district discharge, meant that the necessary volumes to be recirculated or diverted to the SJRIP would not be underestimated.

The district discharge data were obtained from the file “GBP 00_07 Data.xls” (Linneman, written comm., 2008). No long-term trends were apparent in the measured water quality of the district discharge between 2002 and 2007. Tables C-16 to C-18 show the district discharge quality used in the model.

Table C-16
Selenium Concentrations of District Discharge and Produced Drainwater Used in Drainage Model (μg/L)

	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct	46	119	199	96	110
Nov	48	93	182	89	98
Dec	64	137	153	82	81
Jan	73	142	168	81	74
Feb	64	133	166	92	69
Mar	64	139	176	132	76
Apr	59	95	174	118	87
May	55	142	177	101	98
Jun	48	139	209	99	84
Jul	45	153	205	99	104
Aug	43	92	194	109	95
Sep	44	136	187	102	109

Table C-17
Total Dissolved Solids Concentrations of District Discharge Used in Drainage Model (mg/L)

	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct	4,323	3,124	5,930	3,428	3,825
Nov	4,067	3,005	5,434	3,598	3,771
Dec	5,094	3,301	6,183	3,453	3,545
Jan	4,963	3,702	5,422	3,625	3,367
Feb	3,902	3,990	3,670	3,713	3,685
Mar	5,106	4,295	5,796	3,978	4,654
Apr	4,388	4,124	5,046	4,010	3,764
May	4,056	4,473	5,141	3,819	3,580
Jun	4,027	4,279	5,128	3,868	3,218
Jul	3,940	3,443	5,763	3,567	3,188
Aug	3,838	3,008	6,057	3,438	3,326
Sep	4,156	3,177	5,427	3,660	3,286

Table C-18
Boron Concentrations of District Discharge Used in Drainage Model (mg/L)

	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct	13	2	15	6	9
Nov	11	2	16	6	9
Dec	14	2	15	5	8
Jan	14	5	13	6	8
Feb	11	5	8	6	9
Mar	14	6	13	6	8
Apr	12	6	11	7	9
May	12	6	12	6	9
Jun	12	6	11	7	8
Jul	11	6	12	7	8
Aug	11	5	14	7	9
Sep	12	5	13	7	9

C2.4.9 Quality of Downstream Seepage and Discharge from the SJRIP

The quality of the flow entering the drainage system between the monitoring points for the discharge leaving the districts and sites PE14 and FC5 was based on the difference in flow volume and in selenium, salt, and boron loads at these locations. There should be an increase in load with an increase in flow unless the water seeping into the canals does not contain TDS, boron or selenium, which is unlikely. This was not always the case, which suggests that the water quality monitoring may not be sufficient to completely ascertain how the loads are changing. However, the average differences in loads from 2002 to 2007 can probably provide a better estimate of the general trends, which do show an increase in load. The average difference in load from 2002 to 2007 was divided by the average difference in flow between PE14 and FC5 and the district discharges to come up with the concentration of the combined flow from seepage and the drained portion of the SJRIP.

In order to determine the concentrations that should be assigned to each component (either seepage downstream of the measured district discharges or discharge from the SJRIP) it was assumed that the existing SJRIP discharge would have a concentration three times higher than the concentration of the seepage component and the SJRIP discharge component combined. This resulted in positive selenium, salt, and boron seepage loads for all months except November. The selenium concentration of the SJRIP discharge was assumed to be 100 micrograms/liter in November. This ratio of the SJRIP discharge to the combined discharge concentration was also used to determine the boron and TDS concentrations of the SJRIP discharge in November. The annual average concentrations for the SJRIP discharge determined using the above method were similar to the initial groundwater concentrations (prior to extensive application of drainage) estimated in Appendix C of the San Luis Drain Feature Re-evaluation (SLDFR) Final EIS (Reclamation 2006). The initial selenium, TDS, and boron concentrations in the SLDFR Final EIS were estimated as 140 μg/L, 14,700 mg/L and 25.9 mg/L, respectively.

Once the concentration of the SJRIP discharge was estimated for existing conditions, the loads attributed to the SJRIP discharge could be subtracted from the total to estimate the monthly seepage loads and concentrations.

It was assumed that the concentration of the seepage would stay the same in the future. However, the concentration of the discharge from the SJRIP could increase as more drain water is applied. It was assumed that by 2010, at the start of the new Use Agreement, the discharge from the SJRIP would have reached the likely final concentrations that were estimated in Appendix C of the SLDFR Final EIS (Reclamation 2006). The estimated selenium, TDS, and boron concentrations of the SJRIP discharge are shown in Table C-19 for both existing and future conditions.

The estimated volume, load, and concentration of the seepage are shown in Table C-20.

Table C-19
Quality of SJRIP Discharge

	Estimate of SJRIP Discharge Concentrations for Existing Conditions			**Estimate of SJRIP Discharge Concentrations after 2010**		
	Se (μg/L)	**TDS (mg/L)**	**B (mg/L)**	**Se (μg/L)**	**TDS (mg/L)**	**B (mg/L)**
Oct	138	10,677	27	320	15,000	30
Nov	100	9,337	19	320	15,000	30
Dec	147	8,641	21	320	15,000	30
Jan	96	8,861	17	320	15,000	30
Feb	176	10,564	21	320	15,000	30
Mar	133	9,981	19	320	15,000	30
Apr	199	11,714	32	320	15,000	30
May	157	10,607	27	320	15,000	30
Jun	121	10,326	25	320	15,000	30
Jul	85	9,586	25	320	15,000	30
Aug	132	9,628	25	320	15,000	30
Sep	137	11,838	32	320	15,000	30
Average	**135**	**10,147**	**24**	**320**	**15,000**	**30**

Table C-20
Seepage Flow Volume, Load, and Concentration

	Estimate of Downstream Seepage in the Grassland Drainage Area						
	Volume (ac-ft)	**Se Load (lb)**	**Salt Load (tons)**	**Boron Load (lb)**	**[Se] (μg/L)**	**[TDS] (mg/L)**	**[B] (mg/L)**
Oct	311	22	833	4,163	25	1,969	4.9
Nov	93	1	67	279	6	530	1.1
Dec	154	2	57	279	5	274	0.7
Jan	221	6	293	1,124	11	975	1.9
Feb	383	23	695	2,713	22	1,334	2.6
Mar	313	5	175	668	5	412	0.8
Apr	349	20	590	3,215	21	1,243	3.4
May	431	20	668	3,391	17	1,141	2.9
Jun	602	26	1,114	5,391	16	1,362	3.3
Jul	679	20	1,137	5,863	11	1,231	3.2
Aug	717	51	1,872	9,766	26	1,920	5.0
Sep	433	31	1,337	7,170	26	2,270	6.1
Total/Avg	**4,685**	**227**	**8,839**	**44,023**	**18**	**1,387**	**3.5**

C2.4.10 Quality of Uncontrolled Flow

The quality of the flow entering the Grassland Bypass Channel or the San Luis Drain between the monitoring points at PE14 and FC5 on the upstream end and Station B at the downstream end was based on the difference in flow volume and in selenium, salt, and boron loads at these locations. The average difference in selenium load and flow over the period from Water Year 2002 to 2007, but excluding January 2006 and all of Water year 2005, was used to calculate the selenium concentration. The average difference in selenium loads between Station B and the sum of PE14 and FC5 is actually negative from October through January. This could indicate that there is some uptake of selenium in the drainage channels, or that even though more water is coming into the channel than going out, the water leaving the channel upstream is at a much higher selenium concentration. Even if this is the case the load and flow values should be internally consistent. Due to the difficulty in determining the exact process for reducing the selenium load at Station B, it was assumed that some minor losses of selenium would occur in October through January, based on the average calculated loads. The same method was used for calculating TDS and boron concentrations, except the load and flow in March 2007 were also excluded. This resulted in additional salt and boron loads entering the system downstream of the GDA. The concentrations and monthly volume of uncontrolled flows used in the model are shown in Figure C-4.

C2.4.11 Drainage from Grassland Drainage Area

Station A at the entrance to the San Luis Drain was not modeled directly. Any gains or losses in flow between Stations A and B would be included in the uncontrolled flow calculated as the difference between Station B and the sum of PE14 and FC5.

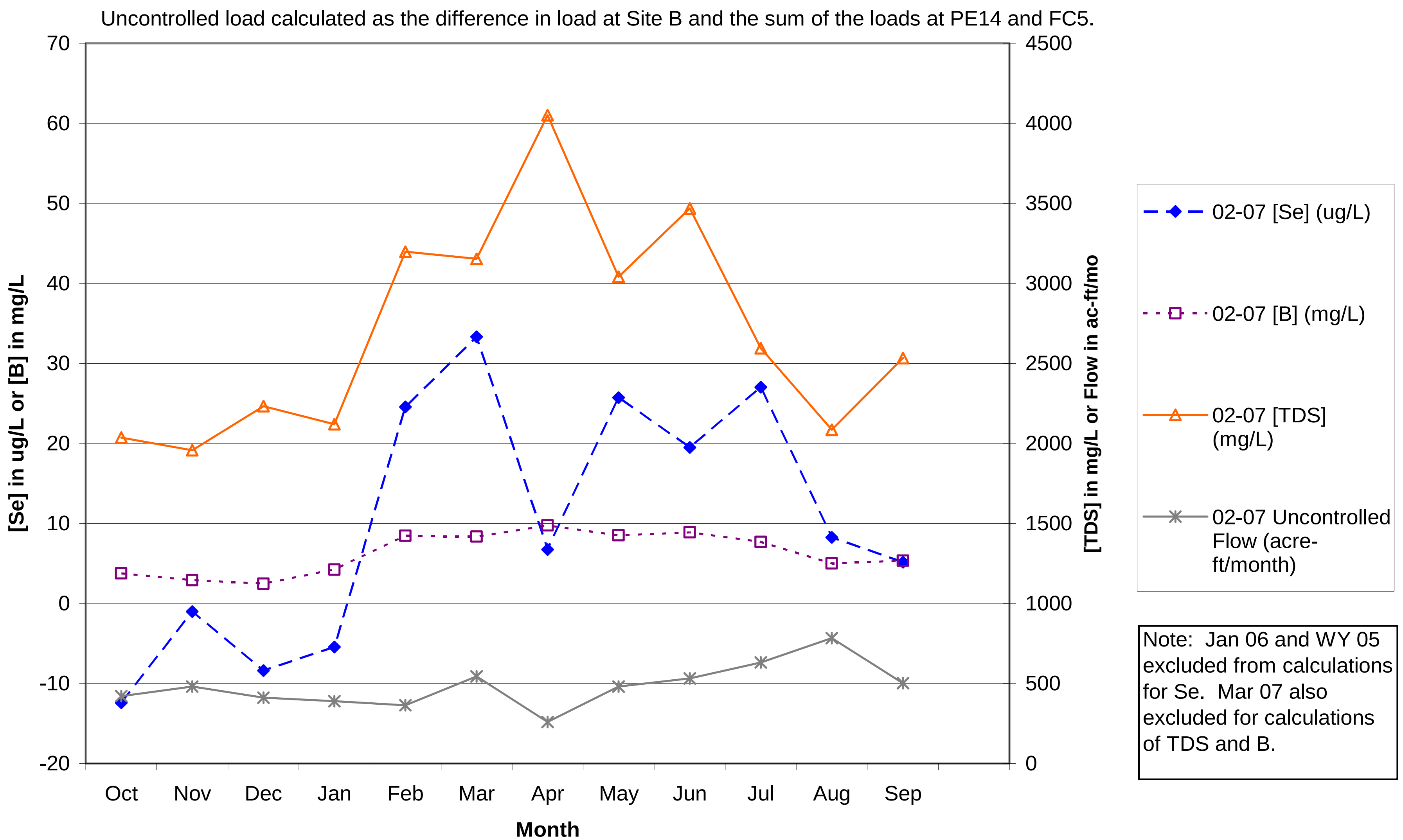


Figure C-4 Concentration of Uncontrolled Flow from Average of WY 2003–2007 Loads

C2.5 Drainage Model Results

C2.5.1 Monthly Salt Load from Grassland Drainage Area

Tables C-21a and C-21b show the predicted monthly salt loads from the GDA for each water year type. The preliminary increase in salt loads from 2010 to 2014 shown in Table C-21a for Wet and Above Normal years is due to the assumed expansion of the tile drainage system installed under the Reuse Area. It was also assumed that drainage from the Reuse Area would not be treated until 2015, so initially there is an increased volume of drainage from the area with high TDS concentrations. The decrease in salt loads shown in the table is a result of the recycling and diversions to the SJRIP for drainage reuse and/or treatment undertaken to reduce the load of selenium in the discharge. Reducing the load of selenium reduces the salt load from the GDA between about 50 to 70 percent for the proposed values depending upon water year type from 2010 to 2019. Implementing the 2001 Requirements Alternative values results in smaller reductions in the salt loads than the proposed alternative since it has higher selenium load values. The reductions in salt loads would likely be less than 30 percent.

C2.5.2 Summary of Flows and Loads from Drainage Model Output

The irrigation deliveries were generally based on the average deliveries to the GDA Districts from 2002 to 2007. Deliveries were decreased when drainage was recycled at volumes that exceeded the average recycle volumes from 2002 to 2007. Table C-22 summarizes the annual irrigation volumes and loads for modeled years. The irrigation deliveries to the Reuse Area supplemented the applied drainage when needed to meet the crop water requirement. It was assumed that the Treatment Facility would be available starting in 2015.

The annual amounts of recycling and diversions to SJRIP for reuse and/or treatment are shown in Table C-23. It was assumed that the capacity of the Treatment Facility would be sufficient to manage all the discharge from the Reuse Area sumps. For modeling purposes, it was assumed that the Reuse Area would be comprised of 6,230 acres and that the maximum capacity of the Treatment Facility would be 6,500 acre-feet per year. If the Reuse Area were expanded to 6,900 acres, it is assumed that the capacity of the Treatment Facility might be greater than 6,500 acre-feet per year if that were required to manage all the discharge from the Reuse Area sumps. The amount of recycling by the GDA districts would not change significantly since the maximum amount of recycling (resulting in an applied water concentration of 600 mg/L TDS, excluding precipitation) occurred for almost every month and water year type. Tables C-24 and C-25 provide an annual summary of the selenium and salt loads associated with the volumes shown in Table C-23.

The predicted annual discharge volume and associated selenium and salt loads are provided in Table C-26. The selenium load values are either based on meeting the monthly selenium load values for the 2010 Use Agreement, or are based on projected annual values that could be met, up to the termination load values in the 2010 Use Agreement. The projections were provided by Summers Engineering (McGahan, written comm., 2008). The salt loads are estimated to be less than the annual salt loads proposed for the 2010 Use Agreement except for in 2018 and 2019 for Below Normal or Dry years and in 2015 through 2019 for Critical years.

Table C-21a
Predicted Monthly Salt Loads Leaving the Grassland Drainage Area for Wet and Above Normal Years with Selenium Load Values for the 2010 Use Agreement

Water Year Type:	Wet						Above Normal					
Year:	2010	2014	2015	2016	2017	2018, 2019	2010	2014	2015	2016	2017	2018, 2019
Month	Predicted Monthly Salt Loads at the San Luis Drain Terminus -- Station B (tons/month)											
Jan	5,413	5,684	4,347	3,486	4,180	2,965	9,287	9,618	7,290	5,387	6,275	3,248
Feb	11,138	12,050	8,665	6,993	6,497	4,450	10,790	11,689	8,326	6,668	7,210	3,871
Mar	11,794	12,053	9,375	7,141	4,906	3,827	11,449	11,699	9,046	6,820	4,594	3,256
Apr	11,794	12,300	9,280	7,087	4,889	3,458	11,504	11,953	8,969	6,778	4,586	2,716
May	11,549	12,180	8,924	6,832	4,740	3,600	11,250	11,861	8,641	6,550	4,459	2,996
Jun	9,559	9,849	7,602	6,043	4,472	3,651	6,485	6,649	5,306	4,337	3,368	2,851
Jul	8,853	9,179	6,857	5,323	3,788	3,136	5,814	5,991	4,615	3,665	2,715	2,419
Aug	10,157	10,265	8,040	6,481	4,704	3,666	6,946	7,010	5,748	4,623	3,498	2,747
Sep	8,184	8,547	6,559	5,187	3,815	2,950	6,834	7,120	5,510	4,386	3,263	2,359
Oct	7,400	7,864	5,879	4,645	3,411	2,596	6,162	6,533	4,924	3,917	2,910	2,023
Nov	7,369	7,832	5,818	4,570	4,772	3,341	6,112	6,479	4,852	3,834	5,108	2,866
Dec	5,671	5,890	4,639	3,753	4,467	3,217	9,300	9,825	7,440	5,709	6,518	3,508
Total:	108,881	113,691	85,985	67,540	54,640	40,856	101,932	106,426	80,667	62,674	54,504	34,859

Table C-21b
Predicted Monthly Salt Loads Leaving the Grassland Drainage Area for Below Normal/ Dry and Critical Years with Selenium Load Values for the 2010 Use Agreement

Water Year Type:	Below Normal/ Dry						Critical					
Year:	**2010**	**2014**	**2015**	**2016**	**2017**	**2018, 2019**	**2010**	**2014**	**2015**	**2016**	**2017**	**2018, 2019**
Month	**Predicted Monthly Salt Loads at the San Luis Drain Terminus -- Station B (tons/month)**											
Jan	8,055	7,956	5,953	4,599	3,731	2,475	5,399	4,421	4,098	3,591	2,462	1,514
Feb	6,629	5,211	4,156	3,284	2,929	2,242	5,093	3,135	3,348	3,038	2,334	1,749
Mar	6,728	5,317	4,325	3,469	2,613	2,474	5,220	3,278	2,816	2,430	2,430	2,347
Apr	6,817	5,510	4,352	3,500	2,649	2,034	5,365	3,515	2,922	2,486	2,050	1,552
May	6,693	5,469	4,254	3,436	2,619	2,298	5,295	3,509	2,909	2,483	2,362	2,071
Jun	5,136	4,801	4,007	3,421	3,041	2,769	4,133	3,426	3,041	3,041	3,041	2,626
Jul	4,464	4,127	3,339	2,765	2,631	2,419	3,472	2,758	2,631	2,631	2,631	2,319
Aug	5,422	4,978	4,224	3,548	3,373	2,791	4,349	3,547	3,373	3,373	3,373	2,478
Sep	6,396	6,512	5,093	4,107	3,121	2,416	3,709	2,778	2,449	2,319	2,319	1,862
Oct	5,670	6,005	4,572	3,682	2,791	2,092	2,428	2,522	2,165	1,959	1,754	1,484
Nov	5,612	5,942	4,496	3,595	3,119	2,198	2,321	2,400	2,651	2,541	1,852	1,425
Dec	7,836	8,163	6,258	4,898	4,005	2,694	4,488	4,648	4,398	3,872	2,707	1,725
Total:	75,459	69,991	55,028	44,304	36,622	28,903	51,271	39,937	36,801	33,764	29,315	23,153

Table C-22
Summary of Irrigation Delivery Volumes and Loads from Drainage Model Results for the 2010 Use Agreement

	GDA Districts				Reuse Area / SJRIP			
Water Year Type:	**W**	**AN**	**BN/D**	**C**	**W**	**AN**	**BN/D**	**C**
Year	**Annual Irrigation Volume Supplied by Canal Water and Groundwater (ac-ft)**							
2010	188,164	188,473	189,315	189,153	12,418	13,141	10,957	7,100
2014	187,937	187,937	189,153	189,153	7,784	8,297	6,463	3,383
2015	187,937	187,937	189,153	189,153	14,024	15,331	11,726	7,249
2019	187,937	187,937	189,153	189,153	7,421	7,351	8,185	6,122
	Annual Selenium Load of Delivered Canal Water and Groundwater (lb)							
2010	511	512	514	514	128	136	113	75
2014	510	510	514	514	80	86	67	36
2015	510	510	514	514	143	157	119	75
2019	510	510	514	514	75	75	85	64
	Annual Salt Load of Delivered Canal Water and Groundwater (tons)							
2010	68,209	68,322	69,615	69,556	19,573	20,819	17,337	11,204
2014	68,119	68,119	69,556	69,556	12,268	13,156	10,226	5,330
2015	68,119	68,119	69,556	69,556	22,094	24,298	18,533	11,416
2019	68,119	68,119	69,556	69,556	11,653	11,571	12,908	9,624
	Annual Boron Load of Delivered Canal Water and Groundwater (1000s of lbs)							
2010	103	103	106	106	56	60	50	32
2014	103	103	106	106	35	38	29	15
2015	103	103	106	106	63	70	53	33
2019	103	103	106	106	33	33	37	28

Note: Assumes that treatment is available starting in 2015.

Table C-23
Summary of Discharges from Drainage Model Results for the 2010 Use Agreement

Water Year Type:	Total Drainage from Sumps (ac-ft)	Total Drainage Recycled[1] (ac-ft)	Percent of Drainage Recycled[1]	In-District Seepage (ac-ft)	Drainage Discharge from Reuse Area Sumps[2] (ac-ft)	W	AN	BN/D	C	W	AN	BN/D	C	Uncontrolled Flows Outside of GDA (ac-ft)
Year						Drainage Applied to Reuse Area (ac-ft)				Drainage Diverted to Treatment[3] (ac-ft)				
2010	26,427	13,789	52%	4,685	1,426	3,479	4,996	9,076	13,311	0	0	0	0	5,801
2011	26,427	13,789	52%	4,685	2,327	5,511	6,565	11,886	16,628	0	0	0	0	5,801
2012	26,427	13,789	52%	4,685	3,228	7,418	8,266	13,321	17,742	0	0	0	0	5,801
2013	26,427	13,789	52%	4,685	4,130	9,151	9,890	14,650	18,813	0	0	0	0	5,801
2014	26,427	13,789	52%	4,685	5,031	10,724	11,407	15,903	19,853	0	0	0	0	5,801
2015	26,427	13,789	52%	4,685	5,224	1,974	4,512	8,591	12,497	6,218	5,224	6,268	6,414	5,801
2016	26,427	13,789	52%	4,685	5,224	5,483	7,659	10,967	13,221	6,500	5,530	6,287	6,357	5,801
2017	26,427	13,789	52%	4,685	5,224	8,564	9,641	12,459	14,452	6,342	5,471	6,500	6,130	5,801
2018	26,427	13,789	52%	4,685	5,224	11,524	12,916	14,215	15,514	6,500	6,489	6,500	6,500	5,801
2019	26,427	13,789	52%	4,685	5,224	11,524	12,905	14,215	15,514	6,500	6,500	6,500	6,500	5,801

[1] Slightly less drainage could be recycled for some years or year types, but would not be less than 49% of the total drainage.

[2] Assumes an average head difference (groundwater elevation above drain elevation) of 0.9 feet and between 1,700 and 6,230 acres with tile drains.

[3] Assumes treatment is available starting in 2015.

Table C-24
Summary of Selenium Loads in Discharges from Drainage Model Results for the 2010 Use Agreement

Water Year Type: / Year	Total Drainage from Sumps (lb)	Total Drainage Recycled[1] (lb)	In-District Seepage (lb)	Drainage Discharge from Reuse Area Sumps[2] (lb)	W	AN	BN/D	C	W	AN	BN/D	C	Uncontrolled Flows Outside of GDA (lb)
					Drainage Applied to Reuse Area (lb)				Drainage Diverted to Treatment[3] (lb)				
2010	7,954	4,251	227	1,241	960	1,385	2,519	3,693	0	0	0	0	181
2011	7,954	4,251	227	2,025	1,672	2,025	3,640	5,061	0	0	0	0	181
2012	7,954	4,251	227	2,810	2,441	2,768	4,425	5,846	0	0	0	0	181
2013	7,954	4,251	227	3,594	3,225	3,543	5,209	6,630	0	0	0	0	181
2014	7,954	4,251	227	4,379	4,010	4,328	5,994	7,415	0	0	0	0	181
2015	7,954	4,251	227	4,547	487	1,018	1,949	2,841	4,775	4,547	4,768	4,817	181
2016	7,954	4,251	227	4,547	1,282	1,742	2,479	3,022	4,836	4,610	4,781	4,792	181
2017	7,954	4,251	227	4,547	1,960	2,173	2,825	3,290	4,798	4,605	4,833	4,755	181
2018	7,954	4,251	227	4,547	2,620	2,941	3,218	3,518	4,838	4,816	4,840	4,839	181
2019	7,954	4,251	227	4,547	2,620	2,939	3,218	3,518	4,838	4,819	4,840	4,839	181

[1] Slightly less drainage could be recycled for some years or year types, but would not be less than 49% of the total drainage.

[2] Assumes an average head difference (groundwater elevation above drain elevation) of 0.9 feet and between 1,700 and 6,230 acres with tile drains.

[3] Assumes treatment is available starting in 2015.

Table C-25
Summary of Salt Loads in Discharges from Drainage Model Results for the 2010 Use Agreement

Water Year Type:	Total Drainage from Sumps (tons)	Total Drainage Recycled[1] (tons)	In-District Seepage (tons)	Drainage Discharge from Reuse Area Sumps[2] (tons)	W	AN	BN/D	C	W	AN	BN/D	C	Uncontrolled Flows Outside of GDA (tons)
Year					Drainage Applied to Reuse Area (tons)				Drainage Diverted to Treatment[3] (tons)				
2010	163,468	75,188	8,839	29,077	19,630	28,763	52,540	75,985	0	0	0	0	20,840
2011	163,468	75,188	8,839	47,464	35,017	42,829	77,270	106,312	0	0	0	0	20,840
2012	163,468	75,188	8,839	65,851	51,948	59,343	95,010	124,456	0	0	0	0	20,840
2013	163,468	75,188	8,839	84,238	69,452	76,689	112,868	142,645	0	0	0	0	20,840
2014	163,468	75,188	8,839	102,625	87,112	94,378	130,813	160,867	0	0	0	0	20,840
2015	163,468	75,188	8,839	106,559	9,485	19,982	38,670	56,028	110,908	106,559	111,191	111,909	20,840
2016	163,468	75,188	8,839	106,559	25,090	34,201	49,211	59,397	112,108	107,863	111,223	111,577	20,840
2017	163,468	75,188	8,839	106,559	38,672	42,914	55,991	64,831	111,426	107,793	112,125	110,592	20,840
2018	163,468	75,188	8,839	106,559	51,719	57,961	63,621	69,386	112,162	111,918	112,215	112,199	20,840
2019	163,468	75,188	8,839	106,559	51,719	57,911	63,621	69,386	112,162	111,968	112,215	112,199	20,840

[1] Slightly less drainage could be recycled for some years or year types, but would not be less than 49% of the total drainage.

[2] Assumes an average head difference (groundwater elevation above drain elevation) of 0.9 feet and between 1,700 and 6,230 acres with tile drains.

[3] Assumes treatment is available starting in 2015.

Table C-26
Summary of Volumes and Loads Discharged from the Grassland Drainage Area with Results for the 2010 Use Agreement

Water Year Type:	W	AN	BN/D	C	W	AN	BN/D	C	W	AN	BN/D	C
Year	**Annual Discharge Volume at Terminus of San Luis Drain -- Station B (acre-feet)**				**Selenium Load at Terminus of San Luis Drain -- Station B (lb)**				**Salt Load at Terminus of San Luis Drain -- Station B (tons)**			
2010	21,410	20,280	15,592	11,238	4,480	4,156	2,864	1,658	108,881	101,932	75,459	51,271
2011	20,001	19,081	13,565	8,822	4,480	4,162	2,496	1,075	110,803	103,988	68,373	39,331
2012	18,933	18,123	13,031	8,610	4,480	4,162	2,496	1,075	112,082	104,917	69,020	39,574
2013	18,102	17,364	12,603	8,441	4,480	4,162	2,496	1,075	112,965	105,727	69,549	39,772
2014	17,430	16,748	12,251	8,302	4,480	4,162	2,496	1,075	113,691	106,426	69,991	39,937
2015	20,573	19,154	13,512	9,436	3,510	3,234	1,947	1,000	85,985	80,667	55,028	36,801
2016	16,365	15,159	11,093	8,769	2,540	2,306	1,398	844	67,540	62,674	44,304	33,764
2017	13,441	13,311	9,389	7,766	1,900	1,900	1,000	612	54,640	54,504	36,622	29,315
2018	10,324	8,943	7,632	6,334	1,200	900	600	300	40,856	34,859	28,903	23,153
2019	10,324	8,943	7,632	6,334	1,200	900	600	300	40,856	34,859	28,903	23,153

C.2.5.3 Summary of Applied Water Quality

The annual average selenium, TDS, and boron concentrations in the applied water (including irrigation deliveries, precipitation, and recycled drainage) are listed for each district in Table C-27. Monthly concentrations are provided in Attachment C-1. The applied water concentrations within each district are similar for the different water year types and from 2010 to 2019. The applied water in the Reuse Area changes depending on the size of the area with installed drains and whether treatment is available.

Table C-27
Average Concentrations of Applied Water (Including Irrigation Deliveries, Precipitation, and Recycled Drainage) from Drainage Model Results for the 2010 Use Agreement

	[Se] of Applied Water (µg/L)				[TDS] of Applied Water (mg/L)				[B] of Applied Water (mg/L)			
Water Year Type:	W	AN	BN/D	C	W	AN	BN/D	C	W	AN	BN/D	C
Year	Camp 13 Drainage Area											
2010	1	1	1	1	197	249	236	243	0.1	0.2	0.2	0.2
2014	1	1	1	1	197	249	236	243	0.1	0.2	0.2	0.2
2015	1	1	1	1	197	249	236	243	0.1	0.2	0.2	0.2
2019	1	1	1	1	197	249	236	243	0.1	0.2	0.2	0.2
	Charleston Drainage District											
2010	8	10	10	10	413	508	498	520	0.5	0.5	0.5	0.6
2014	8	11	10	10	413	517	498	520	0.5	0.5	0.5	0.6
2015	8	11	10	10	413	517	498	520	0.5	0.5	0.5	0.6
2019	8	11	10	10	413	517	498	520	0.5	0.5	0.5	0.6
	Firebaugh Canal Water District											
2010	7	8	8	8	368	470	460	470	0.5	0.6	0.6	0.7
2014	7	8	8	8	377	483	460	470	0.5	0.7	0.6	0.7
2015	7	8	8	8	377	483	460	470	0.5	0.7	0.6	0.7
2019	7	8	8	8	377	483	460	470	0.5	0.7	0.6	0.7
	Pacheco Water District											
2010	7	9	9	9	411	509	497	518	0.6	0.7	0.7	0.7
2014	7	9	9	9	411	517	497	518	0.6	0.7	0.7	0.7
2015	7	9	9	9	411	517	497	518	0.6	0.7	0.7	0.7
2019	7	9	9	9	411	517	497	518	0.6	0.7	0.7	0.7
	Panoche Drainage District											
2010	6	7	7	7	398	499	489	505	0.6	0.7	0.7	0.7
2014	6	8	7	7	400	514	499	505	0.6	0.8	0.7	0.7
2015	6	8	7	7	400	514	499	505	0.6	0.8	0.7	0.7
2019	6	8	7	7	400	514	499	505	0.6	0.8	0.7	0.7
	Reuse Area / SJRIP											
2010	29	32	46	70	1,603	1,821	2,308	3,115	3	3	5	6
2014	69	74	92	114	3,216	3,521	4,171	4,994	6	7	8	10
2015	10	17	29	58	937	1,317	1,590	2,493	2	2	3	5
2019	44	53	52	64	1,947	2,302	2,268	2,668	4	5	5	6

Note: Assumes that treatment is available starting in 2015.

C3 RECEIVING WATER MODEL

C3.1 Description of Model

A water balance model for the San Joaquin River between Salt Slough and Vernalis was developed to predict the concentrations and loads in the river due to the different hydrology and alternatives analyzed for the EIR/EIS. Figure C-5 shows a schematic of the elements included in the water balance model. Locations were selected for analysis that correspond to the monitoring locations used for the Grassland Bypass Project Compliance Monitoring Program.

For each input location shown on Figure C-5, a flow and a concentration for selenium, boron, and salt was determined. The load at any identified downstream location was then estimated as the sum of the loads for all the points upstream. Calculations were done monthly.

The flow and concentrations in Mud Slough include Mud Slough upstream of the San Luis Drain Discharge and the drainage discharges coming from the GDA.

D = B + C

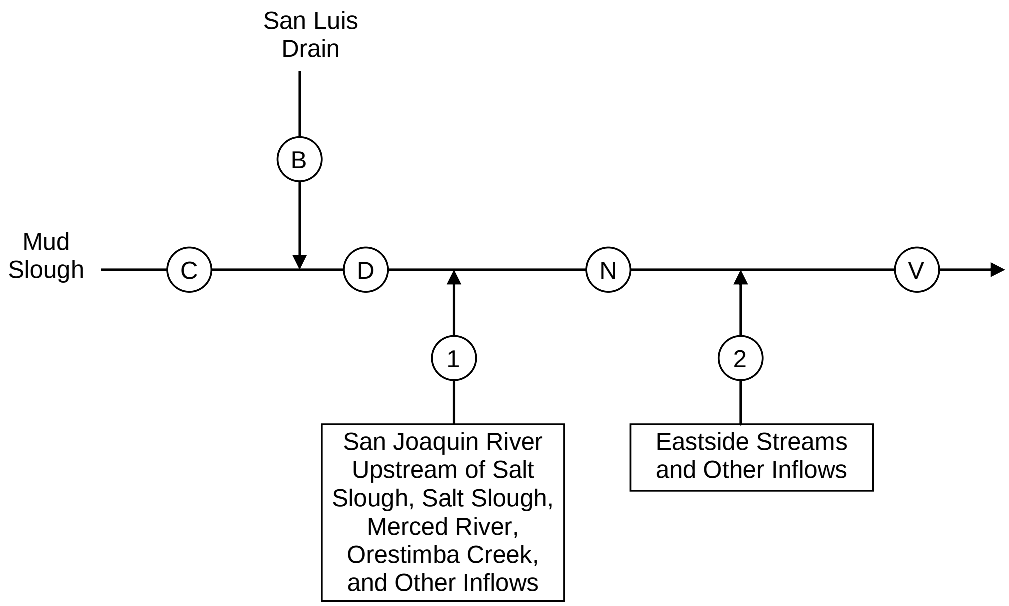
The water balance model was used to determine the flow and constituent concentration at the San Joaquin River at Crows Landing (Station N) for selenium and boron. Flows beyond Crows Landing were added to the water balance model to determine the flow and TDS concentration at Vernalis. Station N is a sum of contributions originating primarily from the Merced River, Mud Slough, Salt Slough, and the San Joaquin River upstream of Salt Slough.

$$N = D + \text{Input } 1 \qquad \text{(C-5)}$$

Where D, B, C, and Input 1 are as defined on Figure C-5. For Vernalis, contributions from eastside streams (shown as Input 2) are added to Station N.

(C-6)

Input 1 consists of the load and flow contributions between Mud Slough downstream of the San Luis Drain and the San Joaquin River at Crows Landing. Input 1 is a category created to capture other unaccounted inputs, e.g. the San Joaquin River upstream of Salt Slough, Salt Slough, Merced River, Orestimba Creek, and any other tributaries with potential flow or water quality impacts at the San Joaquin River at Crows Landing.



LEGEND

B = San Luis Drain

C = Mud Slough Upstream of the San Luis Drain

D = Mud Slough Downstream of the San Luis Drain

1 = Receiving Water Model Input Between Mud Slough (Downstream of the San Luis Drain) and the San Joaquin River at Crows Landing

N = San Joaquin River at Crows Landing

2 = Receiving Water Model Input to the San Joaquin River Between Crows Landing and Vernalis

V = San Joaquin River at Vernalis

Project No. 26816359	Grassland Bypass Project EIS/EIR	SCHEMATIC OF RECEIVING WATER MODEL	Figure C-5

Figure C-5 Schematic of Receiving Water Model

C3.2 Flow Data Used in the Model

The Grassland Bypass Project was modeled for four water year types: Critical, Dry/Below Normal, Above Normal, and Wet. To establish flows in the San Joaquin River and tributaries for these different water year types, representative years were selected to represent each water year type. The San Joaquin River Index from the California Department of Water Resources was used to determine water year types. Table C-2 shows the water year types determined for Water Years 1997 through 2007. Water Years 2007, 2004, 2000, and 2005 were used as representative of the Critical, Dry/Below Normal, Above Normal, and Wet years, respectively.

The monthly flow data used in the model came from Reclamation (Eacock, written comm., 2008). Input flows for Mud Slough upstream of the San Luis Drain are shown in Table C-28 for the representative water year types.

The flow at Station B was taken from the drainage model output.

The input flows between Mud Slough (downstream of the San Luis Drain) and the San Joaquin River at Crows Landing (shown as Input 1 on Figure C-5) were calculated as the difference in the measured monthly flows at Crows Landing (Station N) and Mud Slough downstream of the San Luis Drain. The monthly flows used in the model are shown in Table C-29 for the representative water year types.

The inflow to the San Joaquin River between Crows Landing and Vernalis (shown as Input 2 on Figure C-5) was calculated by subtracting the measured monthly flows at those two locations. The monthly flows used in the model are shown in Table C-30 for the representative water year types.

Table C-28
Input Flows to the Receiving Model for Mud Slough Upstream of the San Luis Drain (acre-feet/month)

Representative Water Year:	2005	2000	2004	2007
Water Year Type:	**Wet**	**Above Normal**	**Below Normal/ Dry**	**Critical**
Oct	7,970	9,280	7,230	9,750
Nov	7,760	7,920	8,690	10,540
Dec	8,740	5,960	8,360	8,970
Jan	15,360	10,070	8,000	7,800
Feb	14,480	12,420	8,060	5,890
Mar	13,000	9,030	12,740	6,420
Apr	3,370	2,580	1,260	1,090
May	2,610	2,470	1,360	1,040
Jun	2,340	1,450	610	360
Jul	1,930	540	1,710	500
Aug	1,160	180	370	280
Sep	1,700	1,310	1,150	1,130
Total	**80,420**	**63,210**	**59,540**	**53,770**

Table C-29
Input Flows to the Receiving Model Between Mud Slough Downstream of the San Luis Drain and the San Joaquin River at Crows Landing (acre-feet/month)

Representative Water Year:	**2005**	**2000**	**2004**	**2007**
Water Year Type:	**Wet**	**Above Normal**	**Below Normal/ Dry**	**Critical**
Oct	34,960	40,760	32,230	80,000
Nov	40,930	42,600	33,490	52,970
Dec	40,810	34,870	33,480	41,220
Jan	192,300	47,330	45,090	42,650
Feb	121,750	186,090	53,520	43,010
Mar	165,800	262,540	70,110	54,190
Apr	226,250	94,950	46,840	42,560
May	258,310	79,510	63,310	58,310
Jun	289,570	38,720	23,490	42,040
Jul	97,400	37,410	19,880	25,640
Aug	71,850	35,180	26,210	22,520
Sep	68,910	33,080	19,700	20,230
Total	1,608,840	933,040	467,350	525,340

Table C-30
Input Flows to the Receiving Model for the San Joaquin River Between Crows Landing and Vernalis (acre-feet/month)

Representative Water Year:	**2005**	**2000**	**2004**	**2007**
Water Year Type:	**Wet**	**Above Normal**	**Below Normal/ Dry**	**Critical**
Oct	64,260	104,110	77,670	134,140
Nov	46,390	75,770	57,320	84,350
Dec	45,300	61,770	50,090	91,700
Jan	97,330	71,890	51,970	98,100
Feb	458,520	233,300	57,190	87,590
Mar	280,580	469,100	115,200	90,110
Apr	361,220	197,800	113,680	103,930
May	379,780	211,170	97,660	123,730
Jun	319,210	121,200	60,240	67,720
Jul	189,370	75,390	45,710	34,630
Aug	94,190	94,200	40,570	38,100
Sep	64,300	102,820	44,550	38,000
Total	**2,400,450**	**1,818,520**	**811,850**	**992,100**

C3.3 Water Quality

The water quality data used in the model came from Reclamation (Eacock, written comm., 2008). This data had been compiled such that monthly flow-weighted concentrations and loads were available. Salinity was measured as EC and then converted to TDS using a site-specific conversion factor. Table C-31 shows the factors used in converting between EC and TDS.

Table C-31
Site-Specific Ratios of TDS to EC

Monitoring Station	Description	TDS/EC Ratio
B	San Luis Drain near Gun Club Road	**0.74**
C	Mud Slough upstream of current San Luis Drain discharge	**0.68**
D	Mud Slough downstream of current San Luis Drain discharge	**0.69**
N	San Joaquin River near Crows Landing	**0.62**
VER	San Joaquin River near Vernalis	**0.62**

C3.3.1 Methodology for Calculating Average Monthly Concentrations

It was assumed that the average monthly water quality during the period from 2002 to 2007 would be representative of the monthly water quality for all water year types. For Mud Slough upstream of the San Luis Drain, the average monthly concentrations were calculated by averaging the flow-weighted monthly average concentrations from each year.

The concentrations at Station B were taken from the drainage model output, based on the monthly flows and loads.

The concentrations of the input flows between Mud Slough (downstream of the San Luis Drain) and the San Joaquin River at Crows Landing (shown as Input 1 on Figure C-5) were based on the differences in the measured monthly flows and loads at Crows Landing (Station N) and Mud Slough downstream of the San Luis Drain (Station D). The monthly concentrations were calculated between 2002 and 2007. For some of the months, even though there was an increase in flow, there was a decrease in the load from upstream to downstream. This occurred for multiple months with the selenium loads but only occurred during two months for the boron loads. The TDS loads always increased between Station D and Station N during the period from 2002 to 2007. For any load differences that were negative, the concentrations were set to zero before calculating the overall monthly average.

Only the TDS concentrations of the inflow to the San Joaquin River between Crows Landing and Vernalis (shown as Input 2 on Figure C-5) were needed as input to the model. The concentrations were based on the differences in the measured monthly flows and TDS loads in the San Joaquin River at Vernalis and at Crows Landing (Station N). The concentrations determined from the flow and load differences each month were averaged together between 2002 and 2007 to obtain the representative monthly concentrations. There was one month during the period from 2002 to 2007 where the flow increased but the TDS load decreased. This concentration was set to zero before it was included in the average.

The monthly input concentrations to the receiving model (other than Station B) are shown in Table C-32 for selenium, boron, and TDS.

Verification plots using measured flows and concentrations at Station B with all other inputs modeled are shown for Water Years 1997 through 2007 in Attachment C-2.

Table C-32
Average Monthly Concentrations Used in the Receiving Water Model for All Water Year Types

	Mud Slough Upstream of San Luis Drain			Input Between Station D and Station N			TDS of Input Between Station N and Vernalis (mg/L)
	Selenium (µg/L)	TDS (mg/L)	Boron (mg/L)	Selenium (µg /L)	TDS (mg/L)	Boron (mg/L)	
Oct	0.3	648	0.6	0.3	359	0.3	180
Nov	0.3	847	0.9	0.3	489	0.4	244
Dec	0.3	1,055	1.2	0.2	538	0.5	261
Jan	0.3	1,155	1.4	0.5	507	0.5	196
Feb	0.6	1,355	1.8	0.4	617	0.5	191
Mar	0.8	1,462	2.0	0.4	595	0.5	120
Apr	0.8	1,570	2.1	0.5	498	0.3	85
May	0.7	1,093	1.5	0.2	300	0.2	80
Jun	0.7	973	1.3	0.2	425	0.3	104
Jul	1.0	760	1.1	0.3	496	0.3	138
Aug	1.0	698	1.0	0.1	502	0.4	170
Sep	0.4	557	0.6	0.3	531	0.4	212

Note: Station D is located in Mud Slough downstream of the San Luis Drain. Station N is located in the San Joaquin River at Crows Landing.

C3.3.2 Results

Results from the Receiving Water Model for the Grassland Bypass Project Alternatives are provided below. Tables C-33 to C-44 show the predicted selenium, TDS, and boron concentrations for Stations B, D, and N (and Vernalis for TDS) over the course of the Project for the four water year types (Wet, Above Normal, Dry/Below Normal, and Critical) using the selenium load values proposed for the 2010 Use Agreement.

The results for the 2001 Requirements Alternative would be the same as the results shown in Tables C-33 to C-44 from 2010 to 2014. From 2015 to 2019, water quality would be very similar to the results shown for 2014.

The actual monthly selenium load values in the proposed 2010 Use Agreement and for the 2001 Requirements Alternative are shown for years 2010 to 2019 in Attachment C-3. Tables C-33 to C-36 list the selenium load values used in the drainage model analysis at the terminus of the San Luis Drain (Station B). The differences between the modeled values and the values from the 2010 Use Agreement are also shown. Differences greater than zero occur for years when the projected annual load values were increased. For these years, the annual totals remain at or below the termination load values from the 2010 Use Agreement.

As described in Section 4.2.2.1 of the EIS/EIR, a monthly selenium water quality benchmark of 4 µg/L in the San Joaquin River at Crows Landing (Station N) was determined to indicate when the 4-day average selenium Water Quality Objective of 5 µg/L could be exceeded. The benchmark of 4 μg/L was only exceeded for Below Normal or Dry years during September from 2010 to 2014 using the selenium load values for the 2010 Use Agreement. It is likely that the benchmark would also be exceeded in September of Below Normal or Dry Years from 2015 to 2019 with the 2001 Requirements Alternative. However, this would still be a decrease in potential exceedances of the Water Quality Objective compared to existing conditions. For the four Below Normal or Dry years that occurred from 2001 to 2004, there were 11 monthly average concentrations greater than the 4 μg/L benchmark.

The average decrease in monthly selenium concentrations in the San Joaquin River at Crows Landing over the period from 2010 to 2019 was 62 percent, with a minimum decrease of 24 percent and a maximum of 77 percent. Smaller decreases in selenium concentrations would be expected for the 2001 Requirements Alternative.

Over the period from 2010 to 2019, the monthly TDS concentrations in the San Joaquin River at Vernalis decreased an average of 6 percent, with a minimum decrease of 1 percent and a maximum decrease of 11 percent. There are not expected to be any exceedances of the Water Quality Objective for EC at Vernalis from 2010 to 2019. Boron and molybdenum concentrations at Crows Landing are also expected to remain below the Water Quality Objective from 2010 to 2019.

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Table C-33
Modeled Monthly Average Selenium Concentrations of Receiving Water for Wet Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (µg/L)			Monthly Selenium Loads for Wet Years (lb)		
	Station B	Station D	Station N	Modeled at Station B	Value from 2010 UA	Difference = Model - Value
Oct-09	71	11	2.5	260	260	0
Nov-09	71	11	2.2	260	260	0
Dec-09	62	8	1.8	211	211	0
Jan-10	63	5	0.9	211	211	0
Feb-10	83	11	1.7	488	488	0
Mar-10	87	13	1.4	488	488	0
Apr-10	91	35	1.3	506	506	0
May-10	89	40	1.0	512	512	0
Jun-10	76	33	0.6	354	354	0
Jul-10	74	36	1.6	356	356	0
Aug-10	62	41	1.9	366	366	0
Sep-10	71	36	2.0	332	332	0
Oct-10	76	13	3.0	328	328	0
Nov-10	77	13	2.7	328	328	0
Dec-10	62	8	1.8	211	211	0
Jan-11	66	5	0.9	211	211	0
Feb-11	90	11	1.7	488	488	0
Mar-11	91	13	1.4	488	488	0
Apr-11	98	36	1.3	506	506	0
May-11	96	41	1.0	512	512	0
Jun-11	84	34	0.6	354	354	0
Jul-11	82	38	1.6	356	356	0
Aug-11	67	43	1.9	366	366	0
Sep-11	75	37	2.0	332	332	0
Oct-11	80	13	3.0	328	328	0
Nov-11	80	13	2.7	328	328	0
Dec-11	65	8	1.8	211	211	0
Jan-12	70	5	0.9	211	211	0
Feb-12	97	12	1.7	488	488	0
Mar-12	96	13	1.4	488	488	0
Apr-12	104	37	1.3	506	506	0
May-12	101	43	1.0	512	512	0
Jun-12	90	35	0.6	354	354	0
Jul-12	88	39	1.6	356	356	0
Aug-12	72	45	1.9	366	366	0
Sep-12	78	38	2.0	332	332	0
Oct-12	82	13	3.0	328	328	0
Nov-12	83	13	2.7	328	328	0
Dec-12	68	8	1.8	211	211	0

Table C-33
Modeled Monthly Average Selenium Concentrations of Receiving Water for Wet Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (µg/L)			Monthly Selenium Loads for Wet Years (lb)		
	Station B	Station D	Station N	Modeled at Station B	Value from 2010 UA	Difference = Model - Value
Jan-13	73	5	0.9	211	211	0
Feb-13	103	12	1.7	488	488	0
Mar-13	99	13	1.4	488	488	0
Apr-13	109	37	1.3	506	506	0
May-13	106	43	1.0	512	512	0
Jun-13	95	36	0.6	354	354	0
Jul-13	92	40	1.6	356	356	0
Aug-13	75	46	1.9	366	366	0
Sep-13	81	38	2.0	332	332	0
Oct-13	85	13	3.0	328	328	0
Nov-13	86	13	2.7	328	328	0
Dec-13	70	8	1.8	211	211	0
Jan-14	75	5	0.9	211	211	0
Feb-14	108	12	1.7	488	488	0
Mar-14	103	13	1.4	488	488	0
Apr-14	114	38	1.3	506	506	0
May-14	111	44	1.0	512	512	0
Jun-14	99	36	0.6	354	354	0
Jul-14	96	40	1.6	356	356	0
Aug-14	78	47	2.0	366	366	0
Sep-14	84	39	2.0	332	332	0
Oct-14	87	13	3.0	328	328	0
Nov-14	88	13	2.7	328	328	0
Dec-14	72	8	1.8	211	211	0
Jan-15	51	4	0.8	165	165	0
Feb-15	69	9	1.4	382	382	0
Mar-15	75	10	1.2	382	382	0
Apr-15	76	28	1.1	396	396	0
May-15	73	32	0.8	401	401	0
Jun-15	56	25	0.5	277	277	0
Jul-15	54	27	1.3	279	279	0
Aug-15	48	32	1.6	287	287	0
Sep-15	60	29	1.6	260	260	0
Oct-15	66	10	2.4	257	257	0
Nov-15	66	11	2.1	257	257	0
Dec-15	52	6	1.4	165	165	0
Jan-16	45	3	0.7	120	120	0
Feb-16	63	7	1.1	277	277	0
Mar-16	70	8	1.0	277	277	0
Apr-16	73	22	1.0	287	287	0
May-16	69	26	0.6	290	290	0

Table C-33
Modeled Monthly Average Selenium Concentrations of Receiving Water for Wet Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (µg/L)			Monthly Selenium Loads for Wet Years (lb)		
	Station B	Station D	Station N	Modeled at Station B	Value from 2010 UA	Difference = Model - Value
Jun-16	52	20	0.4	201	201	0
Jul-16	50	22	1.0	202	202	0
Aug-16	42	26	1.2	208	208	0
Sep-16	54	23	1.2	188	188	0
Oct-16	58	8	1.8	186	186	0
Nov-16	58	8	1.6	186	186	0
Dec-16	46	5	1.1	120	120	0
Jan-17	50	4	0.8	156	74	83
Feb-17	62	6	1.1	254	171	83
Mar-17	61	5	0.8	171	171	0
Apr-17	66	16	0.8	177	177	0
May-17	61	18	0.5	179	179	0
Jun-17	44	14	0.3	124	124	0
Jul-17	43	16	0.7	125	125	0
Aug-17	34	19	0.8	128	128	0
Sep-17	44	16	0.9	116	116	0
Oct-17	47	5	1.3	115	115	0
Nov-17	60	8	1.7	197	115	83
Dec-17	51	6	1.4	156	74	83
Jan-18	40	2	0.7	92		
Feb-18	57	4	0.8	158		
Mar-18	53	4	0.7	120		
Apr-18	57	10	0.7	106		
May-18	52	13	0.4	119		
Jun-18	38	10	0.3	84		
Jul-18	38	13	0.6	92		
Aug-18	26	14	0.6	82		
Sep-18	34	11	0.6	71		
Oct-18	34	3	0.9	68		
Nov-18	47	5	1.1	116		
Dec-18	40	4	0.9	92		
Jan-19	40	2	0.7	92		
Feb-19	57	4	0.8	158		
Mar-19	53	4	0.7	120		
Apr-19	57	10	0.7	106		
May-19	52	13	0.4	119		
Jun-19	38	10	0.3	84		
Jul-19	38	13	0.6	92		
Aug-19	26	14	0.6	82		
Sep-19	34	11	0.6	71		

Table C-33
Modeled Monthly Average Selenium Concentrations of Receiving Water for Wet Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (μg/L)			Monthly Selenium Loads for Wet Years (lb)		
	Station B	**Station D**	**Station N**	**Modeled at Station B**	**Value from 2010 UA**	**Difference = Model - Value**
Oct-19	34	3	0.9	68		
Nov-19	47	5	1.1	116		
Dec-19	40	4	0.9	92		

Table C-34
Modeled Monthly Average Selenium Concentrations of Receiving Water for Above Normal Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (µg/L)			Monthly Selenium Loads for Above Normal Years (lb)		
	Station B	Station D	Station N	Modeled at Station B	Value from 2010 UA	Difference = Model - Value
Oct-09	71	9	2.2	260	260	0
Nov-09	71	11	2.1	260	260	0
Dec-09	62	11	2.1	211	211	0
Jan-10	75	12	2.9	398	398	0
Feb-10	82	12	1.3	472	472	0
Mar-10	86	16	1.1	472	472	0
Apr-10	90	40	2.3	490	490	0
May-10	88	41	2.4	497	497	0
Jun-10	65	30	2.1	212	212	0
Jul-10	63	44	2.3	214	214	0
Aug-10	51	46	2.4	225	225	0
Sep-10	66	35	3.0	264	264	0
Oct-10	71	9	2.2	260	260	0
Nov-10	71	11	2.1	260	260	0
Dec-10	75	18	3.6	392	398	-6
Jan-11	79	13	2.9	398	398	0
Feb-11	90	13	1.3	472	472	0
Mar-11	91	16	1.1	472	472	0
Apr-11	97	41	2.3	490	490	0
May-11	95	42	2.4	497	497	0
Jun-11	70	31	2.1	212	212	0
Jul-11	68	47	2.3	214	214	0
Aug-11	55	49	2.4	225	225	0
Sep-11	69	36	3.0	264	264	0
Oct-11	74	9	2.2	260	260	0
Nov-11	74	11	2.1	260	260	0
Dec-11	79	19	3.7	398	398	0
Jan-12	84	13	2.9	398	398	0
Feb-12	97	13	1.3	472	472	0
Mar-12	95	17	1.1	472	472	0
Apr-12	103	42	2.3	490	490	0
May-12	101	43	2.4	497	497	0
Jun-12	74	32	2.1	212	212	0
Jul-12	72	48	2.3	214	214	0
Aug-12	58	51	2.4	225	225	0
Sep-12	72	37	3.0	264	264	0
Oct-12	76	9	2.2	260	260	0
Nov-12	76	11	2.1	260	260	0
Dec-12	83	19	3.7	398	398	0
Jan-13	88	13	2.9	398	398	0

Table C-34
Modeled Monthly Average Selenium Concentrations of Receiving Water for Above Normal Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (µg/L)			Monthly Selenium Loads for Above Normal Years (lb)		
	Station B	Station D	Station N	Modeled at Station B	Value from 2010 UA	Difference = Model - Value
Feb-13	103	13	1.3	472	472	0
Mar-13	99	17	1.1	472	472	0
Apr-13	109	43	2.3	490	490	0
May-13	106	44	2.4	497	497	0
Jun-13	78	32	2.1	212	212	0
Jul-13	75	50	2.3	214	214	0
Aug-13	60	53	2.4	225	225	0
Sep-13	75	37	3.0	264	264	0
Oct-13	78	9	2.2	260	260	0
Nov-13	79	11	2.1	260	260	0
Dec-13	86	19	3.7	398	398	0
Jan-14	92	13	2.9	398	398	0
Feb-14	108	13	1.3	472	472	0
Mar-14	102	17	1.1	472	472	0
Apr-14	114	44	2.3	490	490	0
May-14	110	45	2.4	497	497	0
Jun-14	80	33	2.1	212	212	0
Jul-14	77	51	2.3	214	214	0
Aug-14	62	55	2.4	225	225	0
Sep-14	77	38	3.0	264	264	0
Oct-14	80	9	2.2	260	260	0
Nov-14	81	11	2.1	260	260	0
Dec-14	90	19	3.7	398	398	0
Jan-15	63	10	2.4	309	309	0
Feb-15	68	10	1.1	367	367	0
Mar-15	74	13	0.9	367	367	0
Apr-15	76	32	1.9	381	381	0
May-15	73	33	1.9	386	386	0
Jun-15	49	23	1.7	165	165	0
Jul-15	48	34	1.8	166	166	0
Aug-15	39	35	1.9	175	175	0
Sep-15	55	28	2.4	205	205	0
Oct-15	60	7	1.7	202	202	0
Nov-15	60	8	1.7	202	202	0
Dec-15	64	15	2.9	309	309	0
Jan-16	56	7	1.8	221	221	0
Feb-16	63	7	0.9	262	262	0
Mar-16	69	10	0.8	262	262	0
Apr-16	72	26	1.5	271	271	0
May-16	68	26	1.5	275	275	0
Jun-16	43	18	1.2	117	117	0

Table C-34
Modeled Monthly Average Selenium Concentrations of Receiving Water for Above Normal Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (µg/L)			Monthly Selenium Loads for Above Normal Years (lb)		
	Station B	Station D	Station N	Modeled at Station B	Value from 2010 UA	Difference = Model - Value
Jul-16	43	28	1.4	119	119	0
Aug-16	33	30	1.4	125	125	0
Sep-16	49	22	1.8	146	146	0
Oct-16	52	5	1.3	144	144	0
Nov-16	52	6	1.3	144	144	0
Dec-16	58	11	2.1	221	221	0
Jan-17	60	9	2.1	262	132	130
Feb-17	64	8	0.9	287	156	131
Mar-17	59	6	0.7	156	156	0
Apr-17	65	18	1.1	162	162	0
May-17	59	18	1.0	165	165	0
Jun-17	34	12	0.8	70	70	0
Jul-17	34	20	0.9	71	71	0
Aug-17	25	22	0.9	74	74	0
Sep-17	38	15	1.2	87	87	0
Oct-17	40	3	0.9	86	86	0
Nov-17	62	9	1.8	217	86	131
Dec-17	61	13	2.5	262	132	131
Jan-18	43	4	1.1	107		
Feb-18	54	4	0.6	131		
Mar-18	48	4	0.6	93		
Apr-18	48	9	0.8	69		
May-18	46	11	0.6	87		
Jun-18	27	9	0.6	45		
Jul-18	30	17	0.8	56		
Aug-18	17	14	0.6	41		
Sep-18	23	8	0.7	40		
Oct-18	21	2	0.6	35		
Nov-18	40	4	0.9	89		
Dec-18	43	6	1.2	107		
Jan-19	43	4	1.1	107		
Feb-19	54	4	0.6	131		
Mar-19	48	4	0.6	93		
Apr-19	48	9	0.8	69		
May-19	46	11	0.6	87		
Jun-19	27	9	0.6	45		
Jul-19	30	17	0.8	56		
Aug-19	17	14	0.6	41		
Sep-19	23	8	0.7	40		
Oct-19	21	2	0.6	35		
Nov-19	40	4	0.9	89		
Dec-19	43	6	1.2	107		

Table C-35
Modeled Monthly Average Selenium Concentrations of Receiving Water for Below Normal/Dry Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (µg/L)			Monthly Selenium Loads for Below Normal/Dry Years (lb)		
	Station B	**Station D**	**Station N**	**Modeled at Station B**	**Value from 2010 UA**	**Difference = Model - Value**
Oct-09	70	11	2.5	246	246	0
Nov-09	70	9	2.3	246	246	0
Dec-09	62	8	2.0	211	211	0
Jan-10	72	13	2.7	338	338	0
Feb-10	74	11	1.9	254	254	0
Mar-10	74	7	1.6	253	253	0
Apr-10	82	40	2.5	264	264	0
May-10	77	38	1.7	269	269	0
Jun-10	57	35	2.4	150	150	0
Jul-10	55	21	2.8	151	151	0
Aug-10	43	34	2.2	158	158	0
Sep-10	64	35	4.3	242	242	0
Oct-10	68	10	2.4	233	233	0
Nov-10	68	9	2.2	233	233	0
Dec-10	71	12	2.9	319	319	0
Jan-11	75	13	2.6	319	319	0
Feb-11	73	8	1.5	185	185	0
Mar-11	69	6	1.3	184	184	0
Apr-11	81	34	1.9	193	193	0
May-11	73	31	1.3	197	197	0
Jun-11	56	33	2.1	130	130	0
Jul-11	54	19	2.5	131	131	0
Aug-11	42	32	2.0	137	137	0
Sep-11	67	35	4.2	235	235	0
Oct-11	71	10	2.4	233	233	0
Nov-11	71	9	2.2	233	233	0
Dec-11	75	12	2.9	319	319	0
Jan-12	80	13	2.6	319	319	0
Feb-12	77	8	1.5	185	185	0
Mar-12	71	6	1.3	184	184	0
Apr-12	85	34	1.9	193	193	0
May-12	76	32	1.3	197	197	0
Jun-12	58	34	2.1	130	130	0
Jul-12	56	19	2.5	131	131	0
Aug-12	43	33	2.0	137	137	0
Sep-12	69	36	4.2	235	235	0
Oct-12	73	10	2.4	233	233	0
Nov-12	73	9	2.2	233	233	0
Dec-12	78	12	2.9	319	319	0

Table C-35
Modeled Monthly Average Selenium Concentrations of Receiving Water for Below Normal/Dry Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (μg/L)			Monthly Selenium Loads for Below Normal/Dry Years (lb)		
	Station B	Station D	Station N	Modeled at Station B	Value from 2010 UA	Difference = Model - Value
Jan-13	83	13	2.6	319	319	0
Feb-13	81	8	1.5	185	185	0
Mar-13	73	6	1.3	184	184	0
Apr-13	89	35	1.9	193	193	0
May-13	79	32	1.3	197	197	0
Jun-13	60	34	2.1	130	130	0
Jul-13	57	20	2.5	131	131	0
Aug-13	45	34	2.0	137	137	0
Sep-13	72	37	4.2	235	235	0
Oct-13	75	10	2.4	233	233	0
Nov-13	75	9	2.2	233	233	0
Dec-13	81	12	2.9	319	319	0
Jan-14	87	13	2.6	319	319	0
Feb-14	84	8	1.5	185	185	0
Mar-14	74	6	1.3	184	184	0
Apr-14	92	35	1.9	193	193	0
May-14	81	32	1.3	197	197	0
Jun-14	62	35	2.1	130	130	0
Jul-14	58	20	2.5	131	131	0
Aug-14	46	34	2.0	137	137	0
Sep-14	74	37	4.2	235	235	0
Oct-14	77	11	2.4	233	233	0
Nov-14	77	9	2.2	233	233	0
Dec-14	84	12	2.9	319	319	0
Jan-15	59	10	2.1	249	249	0
Feb-15	56	6	1.3	144	144	0
Mar-15	57	5	1.1	144	144	0
Apr-15	63	26	1.6	151	151	0
May-15	58	25	1.1	154	154	0
Jun-15	41	25	1.7	101	101	0
Jul-15	40	15	2.0	102	102	0
Aug-15	31	24	1.6	107	107	0
Sep-15	53	28	3.3	183	183	0
Oct-15	58	8	1.9	182	182	0
Nov-15	58	7	1.8	182	182	0
Dec-15	60	9	2.3	249	249	0
Jan-16	53	7	1.7	179	179	0
Feb-16	50	5	1.0	104	104	0
Mar-16	50	4	0.9	103	103	0
Apr-16	57	21	1.3	108	108	0
May-16	51	19	0.9	110	110	0

Table C-35
Modeled Monthly Average Selenium Concentrations of Receiving Water for Below Normal/Dry Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (μg/L)			Monthly Selenium Loads for Below Normal/Dry Years (lb)		
	Station B	Station D	Station N	Modeled at Station B	Value from 2010 UA	Difference = Model - Value
Jun-16	35	20	1.3	73	73	0
Jul-16	35	12	1.5	73	73	0
Aug-16	25	19	1.2	77	77	0
Sep-16	46	22	2.5	132	132	0
Oct-16	50	6	1.5	131	131	0
Nov-16	50	5	1.4	131	131	0
Dec-16	54	7	1.8	179	179	0
Jan-17	47	6	1.4	133	109	24
Feb-17	48	4	0.9	87	63	24
Mar-17	39	2	0.8	63	63	0
Apr-17	47	14	1.0	66	66	0
May-17	40	13	0.6	67	67	0
Jun-17	30	16	1.0	54	44	10
Jul-17	33	11	1.4	67	45	22
Aug-17	24	18	1.1	69	47	22
Sep-17	36	15	1.6	80	80	0
Oct-17	38	4	1.0	79	79	0
Nov-17	44	4	1.1	103	79	24
Dec-17	48	5	1.4	133	109	24
Jan-18	34	3	0.9	66		
Feb-18	39	3	0.7	55		
Mar-18	36	2	0.7	56		
Apr-18	33	8	0.8	35		
May-18	33	10	0.5	50		
Jun-18	25	13	0.8	41		
Jul-18	30	9	1.2	56		
Aug-18	17	12	0.7	43		
Sep-18	24	9	1.0	43		
Oct-18	23	2	0.7	39		
Nov-18	28	2	0.7	51		
Dec-18	33	3	0.8	65		
Jan-19	34	3	0.9	66		
Feb-19	39	3	0.7	55		
Mar-19	36	2	0.7	56		
Apr-19	33	8	0.8	35		
May-19	33	10	0.5	50		
Jun-19	25	13	0.8	41		
Jul-19	30	9	1.2	56		
Aug-19	17	12	0.7	43		
Sep-19	24	9	1.0	43		

Table C-35
Modeled Monthly Average Selenium Concentrations of Receiving Water for Below Normal/Dry Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (μg/L)			Monthly Selenium Loads for Below Normal/Dry Years (lb)		
	Station B	Station D	Station N	Modeled at Station B	Value from 2010 UA	Difference = Model - Value
Oct-19	23	2	0.7	39		
Nov-19	28	2	0.7	51		
Dec-19	33	3	0.8	65		

Table C-36
Modeled Monthly Average Selenium Concentrations of Receiving Water for Critical Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (µg/L)			Monthly Selenium Loads for Critical Years (lb)		
	Station B	Station D	Station N	Modeled at Station B	Value from 2010 UA	Difference = Model - Value
Oct-09	57	5.5	0.9	153	153	0
Nov-09	57	5.1	1.1	153	153	0
Dec-09	62	7.8	1.7	211	211	0
Jan-10	63	8.9	2.0	210	210	0
Feb-10	69	10.4	1.8	184	184	0
Mar-10	67	9.7	1.6	183	183	0
Apr-10	76	35.7	2.1	194	194	0
May-10	70	35.4	1.5	199	199	0
Jun-10	47	32.9	1.1	103	103	0
Jul-10	46	29.0	1.7	105	105	0
Aug-10	35	28.5	1.8	111	111	0
Sep-10	45	19.7	2.0	107	107	0
Oct-10	31	2.2	0.5	55	55	0
Nov-10	30	2.1	0.6	55	55	0
Dec-10	55	5.8	1.3	152	152	0
Jan-11	58	6.7	1.6	151	151	0
Feb-11	57	5.8	1.1	93	93	0
Mar-11	50	5.5	1.0	92	92	0
Apr-11	65	22.8	1.3	101	101	0
May-11	55	22.5	0.9	105	105	0
Jun-11	38	25.1	0.8	69	69	0
Jul-11	37	21.8	1.2	70	70	0
Aug-11	28	22.0	1.3	75	75	0
Sep-11	31	11.8	1.2	57	57	0
Oct-11	31	2.2	0.5	55	55	0
Nov-11	31	2.1	0.6	55	55	0
Dec-11	57	5.9	1.3	152	152	0
Jan-12	61	6.7	1.6	151	151	0
Feb-12	59	5.8	1.1	93	93	0
Mar-12	50	5.5	1.0	92	92	0
Apr-12	67	23.1	1.3	101	101	0
May-12	56	22.8	0.9	105	105	0
Jun-12	39	25.5	0.8	69	69	0
Jul-12	37	21.9	1.2	70	70	0
Aug-12	29	22.4	1.3	75	75	0
Sep-12	31	11.9	1.2	57	57	0
Oct-12	32	2.2	0.5	55	55	0
Nov-12	31	2.1	0.6	55	55	0
Dec-12	59	5.9	1.3	152	152	0
Jan-13	63	6.7	1.6	151	151	0
Feb-13	60	5.8	1.1	93	93	0

Table C-36
Modeled Monthly Average Selenium Concentrations of Receiving Water for Critical Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (µg/L)			Monthly Selenium Loads for Critical Years (lb)		
	Station B	Station D	Station N	Modeled at Station B	Value from 2010 UA	Difference = Model - Value
Mar-13	51	5.5	1.0	92	92	0
Apr-13	69	23.4	1.3	101	101	0
May-13	57	22.9	0.9	105	105	0
Jun-13	40	25.7	0.8	69	69	0
Jul-13	37	22.0	1.2	70	70	0
Aug-13	29	22.7	1.3	75	75	0
Sep-13	32	12.0	1.2	57	57	0
Oct-13	32	2.2	0.5	55	55	0
Nov-13	32	2.1	0.6	55	55	0
Dec-13	61	5.9	1.3	152	152	0
Jan-14	65	6.7	1.6	151	151	0
Feb-14	62	5.9	1.1	93	93	0
Mar-14	51	5.5	1.0	92	92	0
Apr-14	71	23.6	1.3	101	101	0
May-14	58	23.1	0.9	105	105	0
Jun-14	40	25.9	0.8	69	69	0
Jul-14	37	22.1	1.2	70	70	0
Aug-14	29	22.9	1.3	75	75	0
Sep-14	32	12.0	1.2	57	57	0
Oct-14	33	2.2	0.5	55	55	0
Nov-14	32	2.1	0.6	55	55	0
Dec-14	62	5.9	1.3	152	152	0
Jan-15	50	6.6	1.6	152	119	34
Feb-15	51	6.4	1.2	107	73	34
Mar-15	42	4.5	0.9	72	72	0
Apr-15	51	18.1	1.2	79	79	0
May-15	44	18.0	0.7	82	82	0
Jun-15	30	19.7	0.6	54	54	0
Jul-15	33	20.1	1.2	67	55	12
Aug-15	24	19.0	1.2	69	59	10
Sep-15	25	9.4	1.0	45	45	0
Oct-15	25	1.8	0.5	43	43	0
Nov-15	37	2.8	0.7	77	43	34
Dec-15	51	5.8	1.3	153	119	34
Jan-16	46	5.5	1.4	125	86	39
Feb-16	49	5.7	1.1	92	53	39
Mar-16	35	3.5	0.8	54	52	2
Apr-16	44	14.0	1.0	58	58	0
May-16	37	13.9	0.6	60	60	0
Jun-16	30	19.7	0.6	54	39	15
Jul-16	33	20.1	1.2	67	40	27

Table C-36
Modeled Monthly Average Selenium Concentrations of Receiving Water for Critical Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Selenium Concentrations (μg/L)			Monthly Selenium Loads for Critical Years (lb)		
	Station B	Station D	Station N	Modeled at Station B	Value from 2010 UA	Difference = Model - Value
Aug-16	24	19.0	1.2	69	43	26
Sep-16	22	8.1	0.9	38	32	5
Oct-16	19	1.4	0.4	31	31	0
Nov-16	35	2.6	0.7	70	31	39
Dec-16	47	4.9	1.1	126	87	39
Jan-17	33	3.1	0.9	65	54	12
Feb-17	41	3.9	0.9	59	33	26
Mar-17	35	3.5	0.8	54	33	21
Apr-17	34	9.5	0.8	36	36	0
May-17	35	12.7	0.6	53	37	16
Jun-17	30	19.7	0.6	54	24	30
Jul-17	33	20.1	1.2	67	25	42
Aug-17	24	19.0	1.2	69	27	42
Sep-17	22	8.1	0.9	38	20	18
Oct-17	13	1.0	0.4	20	20	0
Nov-17	19	1.3	0.4	31	20	12
Dec-17	33	2.7	0.7	66	54	12
Jan-18	11	1.0	0.6	15		
Feb-18	29	2.4	0.7	32		
Mar-18	34	3.3	0.8	50		
Apr-18	14	3.6	0.6	11		
May-18	28	9.5	0.5	38		
Jun-18	22	13.9	0.5	34		
Jul-18	29	16.7	1.0	51		
Aug-18	13	9.7	0.6	29		
Sep-18	10	3.3	0.5	14		
Oct-18	3	0.4	0.3	4		
Nov-18	5	0.5	0.3	7		
Dec-18	11	0.8	0.3	15		
Jan-19	11	1.0	0.6	15		
Feb-19	29	2.4	0.7	32		
Mar-19	34	3.3	0.8	50		
Apr-19	14	3.6	0.6	11		
May-19	28	9.5	0.5	38		
Jun-19	22	13.9	0.5	34		
Jul-19	29	16.7	1.0	51		
Aug-19	13	9.7	0.6	29		
Sep-19	10	3.3	0.5	14		
Oct-19	3	0.4	0.3	4		
Nov-19	5	0.5	0.3	7		
Dec-19	11	0.8	0.3	15		

Table C-37
Modeled Monthly Average Total Dissolved Solids Concentrations of Receiving Water for Wet Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled TDS Concentrations for Wet Years (mg/L)				Modeled Salt Load at Station B (tons)
	Station B	Station D	Station N	Vernalis	
Oct-09	3364	1041	503	311	6,162
Nov-09	3343	1215	621	440	6,112
Dec-09	3358	1341	696	491	5,671
Jan-10	3218	1309	571	452	5,413
Feb-10	3774	1670	743	319	11,138
Mar-10	4194	1837	698	347	11,794
Apr-10	4235	2577	547	265	11,794
May-10	4013	2401	338	185	11,549
Jun-10	4099	2295	450	270	9,559
Jul-10	3700	2162	556	284	8,853
Aug-10	3418	2475	589	356	10,157
Sep-10	3493	2035	602	418	8,184
Oct-10	3452	1111	521	319	7,400
Nov-10	3454	1285	637	448	7,369
Dec-10	3358	1341	696	491	5,671
Jan-11	3466	1318	572	452	5,504
Feb-11	4317	1713	747	320	11,695
Mar-11	4453	1854	699	347	11,879
Apr-11	4626	2674	548	266	11,993
May-11	4391	2512	339	186	11,770
Jun-11	4575	2411	451	270	9,674
Jul-11	4138	2289	558	284	8,986
Aug-11	3739	2625	591	357	10,198
Sep-11	3730	2113	604	419	8,302
Oct-11	3661	1130	524	320	7,544
Nov-11	3673	1306	640	450	7,516
Dec-11	3554	1354	697	491	5,741
Jan-12	3684	1326	572	452	5,576
Feb-12	4756	1740	750	320	11,947
Mar-12	4684	1868	700	347	11,948
Apr-12	4966	2750	549	266	12,117
May-12	4720	2602	340	186	11,939
Jun-12	4953	2495	451	270	9,752
Jul-12	4475	2379	559	285	9,072
Aug-12	3999	2740	593	357	10,227
Sep-12	3943	2181	605	420	8,399
Oct-12	3853	1145	526	321	7,667
Nov-12	3871	1323	642	451	7,639
Dec-12	3731	1364	699	492	5,799
Jan-13	3877	1332	572	453	5,635

Table C-37
Modeled Monthly Average Total Dissolved Solids Concentrations of Receiving Water for Wet Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled TDS Concentrations for Wet Years (mg/L)				Modeled Salt Load at Station B (tons)
	Station B	Station D	Station N	Vernalis	
Feb-13	5074	1754	750	321	12,004
Mar-13	4892	1880	700	347	12,005
Apr-13	5275	2814	549	266	12,217
May-13	5009	2677	340	186	12,072
Jun-13	5260	2557	451	270	9,807
Jul-13	4743	2446	560	285	9,133
Aug-13	4214	2831	594	358	10,248
Sep-13	4135	2239	607	421	8,479
Oct-13	4030	1159	529	322	7,772
Nov-13	4050	1338	644	452	7,743
Dec-13	3891	1373	700	493	5,848
Jan-14	4050	1337	573	453	5,684
Feb-14	5357	1765	751	321	12,050
Mar-14	5080	1890	701	347	12,053
Apr-14	5556	2868	549	266	12,300
May-14	5264	2739	341	186	12,180
Jun-14	5515	2606	452	270	9,849
Jul-14	4960	2497	561	285	9,179
Aug-14	4394	2904	594	358	10,265
Sep-14	4308	2289	608	421	8,547
Oct-14	4194	1171	531	323	7,864
Nov-14	4213	1351	646	453	7,832
Dec-14	4037	1381	701	493	5,890
Jan-15	2707	1266	567	449	4,347
Feb-15	3119	1573	731	316	8,665
Mar-15	3679	1741	689	343	9,375
Apr-15	3577	2296	539	262	9,280
May-15	3269	2039	331	182	8,924
Jun-15	3057	1887	445	267	7,602
Jul-15	2652	1699	541	279	6,857
Aug-15	2686	2000	569	347	8,040
Sep-15	3020	1750	586	410	6,559
Oct-15	3015	1009	497	309	5,879
Nov-15	2975	1179	616	437	5,818
Dec-15	2941	1276	682	483	4,639
Jan-16	2644	1243	565	448	3,486
Feb-16	3201	1539	724	314	6,993
Mar-16	3616	1678	682	340	7,141
Apr-16	3602	2180	533	260	7,087
May-16	3248	1895	326	180	6,832
Jun-16	3104	1782	442	266	6,043
Jul-16	2644	1578	532	275	5,323

Table C-37
Modeled Monthly Average Total Dissolved Solids Concentrations of Receiving Water for Wet Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled TDS Concentrations for Wet Years (mg/L)				Modeled Salt Load at Station B (tons)
	Station B	Station D	Station N	Vernalis	
Aug-16	2595	1861	556	341	6,481
Sep-16	2966	1594	575	404	5,187
Oct-16	2922	939	479	302	4,645
Nov-16	2860	1111	601	429	4,570
Dec-16	2862	1235	672	477	3,753
Jan-17	2697	1262	567	449	4,180
Feb-17	3201	1528	722	314	6,497
Mar-17	3503	1612	674	337	4,906
Apr-17	3647	2040	527	257	4,889
May-17	3208	1715	320	178	4,740
Jun-17	3187	1651	439	264	4,472
Jul-17	2630	1423	523	272	3,788
Aug-17	2476	1669	542	334	4,704
Sep-17	2877	1403	563	397	3,815
Oct-17	2776	865	462	294	3,411
Nov-17	2882	1123	603	430	4,772
Dec-17	2928	1268	680	482	4,467
Jan-18	2591	1230	563	447	2,965
Feb-18	3201	1477	714	312	4,450
Mar-18	3406	1578	671	335	3,827
Apr-18	3710	1932	524	256	3,458
May-18	3168	1596	318	177	3,600
Jun-18	3263	1569	437	263	3,651
Jul-18	2619	1342	519	270	3,136
Aug-18	2364	1524	533	330	3,666
Sep-18	2785	1257	556	393	2,950
Oct-18	2620	813	450	289	2,596
Nov-18	2683	1040	585	420	3,341
Dec-18	2796	1209	665	474	3,217
Jan-19	2591	1230	563	447	2,965
Feb-19	3201	1477	714	312	4,450
Mar-19	3406	1578	671	335	3,827
Apr-19	3710	1932	524	256	3,458
May-19	3168	1596	318	177	3,600
Jun-19	3263	1569	437	263	3,651
Jul-19	2619	1342	519	270	3,136
Aug-19	2364	1524	533	330	3,666
Sep-19	2785	1257	556	393	2,950
Oct-19	2620	813	450	289	2,596
Nov-19	2683	1040	585	420	3,341
Dec-19	2796	1209	665	474	3,217

Table C-38
Modeled Monthly Average Total Dissolved Solids Concentrations of Receiving Water for Above Normal Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled TDS Concentrations for Above Normal Years (mg/L)				Modeled Salt Load at Station B (tons)
	Station B	Station D	Station N	Vernalis	
Oct-09	3364	993	490.2	282.3	6,162
Nov-09	3343	1209	617.6	395.6	6,112
Dec-09	3358	1452	694.2	436.3	5,671
Jan-10	3483	1534	715.5	431.0	9,287
Feb-10	3764	1705	695.5	424.4	10,790
Mar-10	4184	1958	649.9	315.2	11,449
Apr-10	4249	2737	601.1	257.7	11,504
May-10	4006	2420	414.8	175.0	11,250
Jun-10	3977	2333	546.7	216.4	6,485
Jul-10	3442	2630	592.5	293.6	5,814
Aug-10	3157	2911	618.8	296.7	6,946
Sep-10	3424	2072	650.1	325.3	6,834
Oct-10	3364	993	490.2	282.3	6,162
Nov-10	3343	1209	617.6	395.6	6,112
Dec-10	3555	1665	745.5	459.0	9,300
Jan-11	3745	1557	718.6	432.2	9,430
Feb-11	4388	1763	698.8	425.8	11,518
Mar-11	4439	1982	650.4	315.4	11,531
Apr-11	4624	2847	603.0	258.2	11,656
May-11	4381	2533	417.4	175.7	11,464
Jun-11	4344	2434	549.1	216.8	6,550
Jul-11	3751	2798	595.2	294.3	5,886
Aug-11	3392	3106	621.1	297.0	6,970
Sep-11	3640	2149	653.2	325.9	6,927
Oct-11	3556	1005	492.3	282.9	6,277
Nov-11	3541	1225	619.9	396.4	6,228
Dec-11	3805	1705	751.2	461.1	9,551
Jan-12	3989	1573	720.2	432.7	9,451
Feb-12	4745	1783	699.5	426.0	11,589
Mar-12	4667	2001	650.7	315.5	11,597
Apr-12	4962	2939	604.6	258.6	11,776
May-12	4706	2625	419.4	176.1	11,627
Jun-12	4625	2506	550.7	217.1	6,594
Jul-12	3979	2917	597.0	294.8	5,933
Aug-12	3577	3256	622.7	297.3	6,987
Sep-12	3832	2215	655.8	326.5	7,003
Oct-12	3732	1016	494.1	283.4	6,375
Nov-12	3719	1238	621.8	397.1	6,326
Dec-12	4028	1734	754.5	462.2	9,657
Jan-13	4234	1590	722.2	433.4	9,527
Feb-13	5060	1799	700.1	426.2	11,645
Mar-13	4872	2018	651.0	315.6	11,652

Table C-38
Modeled Monthly Average Total Dissolved Solids Concentrations of Receiving Water for Above Normal Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled TDS Concentrations for Above Normal Years (mg/L)				Modeled Salt Load at Station B (tons)
	Station B	Station D	Station N	Vernalis	
Apr-13	5269	3016	605.8	258.9	11,873
May-13	4991	2700	420.9	176.5	11,756
Jun-13	4847	2559	551.8	217.3	6,625
Jul-13	4154	3006	598.2	295.1	5,966
Aug-13	3726	3377	623.9	297.5	7,000
Sep-13	4005	2273	658.0	326.9	7,067
Oct-13	3893	1025	495.7	283.9	6,460
Nov-13	3879	1250	623.4	397.7	6,408
Dec-13	4234	1758	757.3	463.2	9,748
Jan-14	4459	1605	724.2	434.1	9,618
Feb-14	5340	1812	700.5	426.4	11,689
Mar-14	5057	2032	651.3	315.6	11,699
Apr-14	5548	3083	606.9	259.2	11,953
May-14	5243	2763	422.2	176.8	11,861
Jun-14	5027	2601	552.7	217.5	6,649
Jul-14	4293	3075	599.1	295.3	5,991
Aug-14	3848	3475	624.8	297.7	7,010
Sep-14	4160	2322	659.8	327.3	7,120
Oct-14	4042	1034	497.1	284.3	6,533
Nov-14	4024	1260	624.8	398.2	6,479
Dec-14	4423	1780	759.7	464.0	9,825
Jan-15	2989	1432	692.7	420.4	7,290
Feb-15	3088	1594	686.9	420.3	8,326
Mar-15	3671	1831	643.9	312.9	9,046
Apr-15	3581	2408	583.2	251.6	8,969
May-15	3267	2051	392.6	168.6	8,641
Jun-15	3136	1972	525.2	211.0	5,306
Jul-15	2638	2083	569.4	285.8	4,615
Aug-15	2553	2372	594.4	289.9	5,748
Sep-15	2981	1791	624.8	318.5	5,510
Oct-15	2947	917	473.6	276.6	4,924
Nov-15	2890	1122	601.0	388.7	4,852
Dec-15	3090	1521	716.1	446.6	7,440
Jan-16	2759	1355	673.1	410.8	5,387
Feb-16	3201	1558	682.3	417.9	6,668
Mar-16	3604	1748	638.9	310.9	6,820
Apr-16	3606	2280	569.6	246.5	6,778
May-16	3244	1901	376.3	163.7	6,550
Jun-16	3197	1880	511.0	207.0	4,337
Jul-16	2628	1984	555.3	280.4	3,665
Aug-16	2469	2264	576.4	284.2	4,623
Sep-16	2920	1638	606.0	313.1	4,386

Table C-38
Modeled Monthly Average Total Dissolved Solids Concentrations of Receiving Water for Above Normal Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled TDS Concentrations for Above Normal Years (mg/L)				Modeled Salt Load at Station B (tons)
	Station B	Station D	Station N	Vernalis	
Oct-16	2845	864	461.1	272.2	3,917
Nov-16	2765	1065	589.0	383.5	3,834
Dec-16	3007	1425	692.3	436.0	5,709
Jan-17	2860	1390	682.2	415.3	6,275
Feb-17	3201	1572	683.9	418.7	7,210
Mar-17	3479	1658	633.9	308.9	4,594
Apr-17	3657	2120	555.9	241.5	4,586
May-17	3200	1711	359.9	158.7	4,459
Jun-17	3299	1767	496.7	202.9	3,368
Jul-17	2610	1845	541.0	274.9	2,715
Aug-17	2341	2110	558.1	278.4	3,498
Sep-17	2823	1449	587.0	307.7	3,263
Oct-17	2688	809	448.5	267.8	2,910
Nov-17	2915	1136	604.0	390.0	5,108
Dec-17	3044	1471	703.4	440.9	6,518
Jan-18	2622	1277	652.2	400.4	3,248
Feb-18	3201	1478	674.2	413.8	3,871
Mar-18	3333	1600	630.9	307.7	3,256
Apr-18	3771	1945	544.1	237.1	2,716
May-18	3136	1546	348.3	155.2	2,996
Jun-18	3386	1695	489.0	200.7	2,851
Jul-18	2602	1789	536.5	273.2	2,419
Aug-18	2212	1963	545.7	274.6	2,747
Sep-18	2690	1260	571.4	303.4	2,359
Oct-18	2457	759	437.3	263.9	2,023
Nov-18	2584	1009	577.5	378.5	2,866
Dec-18	2834	1291	661.6	422.4	3,508
Jan-19	2622	1277	652.2	400.4	3,248
Feb-19	3201	1478	674.2	413.8	3,871
Mar-19	3333	1600	630.9	307.7	3,256
Apr-19	3771	1945	544.1	237.1	2,716
May-19	3136	1546	348.3	155.2	2,996
Jun-19	3386	1695	489.0	200.7	2,851
Jul-19	2602	1789	536.5	273.2	2,419
Aug-19	2212	1963	545.7	274.6	2,747
Sep-19	2690	1260	571.4	303.4	2,359
Oct-19	2457	759	437.3	263.9	2,023
Nov-19	2584	1009	577.5	378.5	2,866
Dec-19	2834	1291	661.6	422.4	3,508

Table C-39
Modeled Monthly Average Total Dissolved Solids Concentrations of Receiving Water for Below Normal/Dry Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled TDS Concentrations for Below Normal/Dry Years (mg/L)				Modeled Salt Load at Station B (tons)
	Station B	Station D	Station N	Vernalis	
Oct-09	3342	1059	506	292	5,907
Nov-09	3316	1168	645	417	5,853
Dec-09	3358	1353	719	473	5,671
Jan-10	3423	1558	694	452	8,055
Feb-10	3870	1695	777	498	6,629
Mar-10	3952	1684	776	397	6,728
Apr-10	4229	2859	615	245	6,817
May-10	3828	2422	386	203	6,693
Jun-10	3883	2761	572	241	5,136
Jul-10	3244	1683	639	304	4,464
Aug-10	2956	2470	623	355	5,422
Sep-10	3396	2108	711	378	6,396
Oct-10	3320	1044	502	290	5,670
Nov-10	3288	1155	641	415	5,612
Dec-10	3495	1457	749	488	7,836
Jan-11	3634	1559	691	450	7,687
Feb-11	4088	1637	763	490	5,150
Mar-11	3953	1639	766	392	5,263
Apr-11	4520	2781	598	239	5,395
May-11	3959	2301	372	197	5,329
Jun-11	4100	2795	563	238	4,746
Jul-11	3347	1649	629	300	4,074
Aug-11	3031	2482	614	350	4,956
Sep-11	3592	2166	711	378	6,340
Oct-11	3504	1058	504	291	5,774
Nov-11	3476	1168	644	416	5,717
Dec-11	3724	1477	752	489	7,941
Jan-12	3890	1580	694	451	7,795
Feb-12	4334	1648	764	490	5,176
Mar-12	4078	1644	766	392	5,284
Apr-12	4789	2854	599	240	5,442
May-12	4161	2357	373	197	5,387
Jun-12	4289	2873	565	239	4,771
Jul-12	3480	1674	631	300	4,098
Aug-12	3150	2557	615	351	4,965
Sep-12	3773	2231	715	379	6,408
Oct-12	3672	1071	506	292	5,863
Nov-12	3644	1179	646	417	5,804
Dec-12	3933	1493	755	490	8,027
Jan-13	4120	1598	696	452	7,883
Feb-13	4543	1656	765	491	5,195
Mar-13	4188	1647	767	392	5,302

Table C-39
Modeled Monthly Average Total Dissolved Solids Concentrations of Receiving Water for Below Normal/Dry Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled TDS Concentrations for Below Normal/Dry Years (mg/L)				Modeled Salt Load at Station B (tons)
	Station B	Station D	Station N	Vernalis	
Apr-13	5027	2914	600	240	5,479
May-13	4333	2402	374	198	5,432
Jun-13	4435	2931	566	239	4,788
Jul-13	3578	1692	632	301	4,115
Aug-13	3242	2614	616	351	4,973
Sep-13	3936	2288	719	380	6,464
Oct-13	3826	1082	508	292	5,939
Nov-13	3795	1188	648	418	5,878
Dec-13	4123	1507	757	491	8,100
Jan-14	4327	1614	697	453	7,956
Feb-14	4723	1663	765	491	5,211
Mar-14	4284	1650	767	392	5,317
Apr-14	5241	2966	601	240	5,510
May-14	4479	2440	374	198	5,469
Jun-14	4551	2976	567	239	4,801
Jul-14	3654	1706	633	301	4,127
Aug-14	3317	2660	617	351	4,978
Sep-14	4081	2337	721	380	6,512
Oct-14	3967	1091	510	293	6,005
Nov-14	3931	1196	649	418	5,942
Dec-14	4298	1519	759	492	8,163
Jan-15	2803	1424	668	438	5,953
Feb-15	3201	1551	751	484	4,156
Mar-15	3456	1596	758	389	4,325
Apr-15	3666	2428	582	235	4,352
May-15	3194	1973	360	192	4,254
Jun-15	3225	2324	540	232	4,007
Jul-15	2623	1419	604	292	3,339
Aug-15	2430	2041	593	342	4,224
Sep-15	2961	1816	671	364	5,093
Oct-15	2916	960	483	284	4,572
Nov-15	2852	1083	624	407	4,496
Dec-15	3033	1359	725	476	6,258
Jan-16	2722	1366	653	430	4,599
Feb-16	3200	1513	743	479	3,284
Mar-16	3363	1568	752	386	3,469
Apr-16	3708	2329	572	231	3,500
May-16	3161	1859	352	189	3,436
Jun-16	3291	2262	526	227	3,421
Jul-16	2612	1339	589	286	2,765
Aug-16	2348	1936	578	336	3,548
Sep-16	2900	1670	645	355	4,107

Table C-39
Modeled Monthly Average Total Dissolved Solids Concentrations of Receiving Water for Below Normal/Dry Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled TDS Concentrations for Below Normal/Dry Years (mg/L)				Modeled Salt Load at Station B (tons)
	Station B	Station D	Station N	Vernalis	
Oct-16	2815	903	469	279	3,682
Nov-16	2727	1035	611	402	3,595
Dec-16	2960	1297	707	467	4,898
Jan-17	2665	1327	644	425	3,731
Feb-17	3200	1497	740	477	2,929
Mar-17	3219	1540	746	383	2,613
Apr-17	3778	2211	561	227	2,649
May-17	3108	1724	344	185	2,619
Jun-17	3350	2215	517	224	3,041
Jul-17	2608	1319	586	285	2,631
Aug-17	2322	1905	575	334	3,373
Sep-17	2807	1492	618	345	3,121
Oct-17	2664	842	455	274	2,791
Nov-17	2640	1010	605	398	3,119
Dec-17	2888	1254	694	461	4,005
Jan-18	2523	1268	631	417	2,475
Feb-18	3200	1466	734	474	2,242
Mar-18	3188	1536	745	383	2,474
Apr-18	3870	2110	553	225	2,034
May-18	3078	1664	340	184	2,298
Jun-18	3403	2176	510	222	2,769
Jul-18	2602	1286	580	283	2,419
Aug-18	2221	1786	562	329	2,791
Sep-18	2701	1337	598	338	2,416
Oct-18	2480	793	444	270	2,092
Nov-18	2396	958	592	392	2,198
Dec-18	2712	1188	677	452	2,694
Jan-19	2523	1268	631	417	2,475
Feb-19	3200	1466	734	474	2,242
Mar-19	3188	1536	745	383	2,474
Apr-19	3870	2110	553	225	2,034
May-19	3078	1664	340	184	2,298
Jun-19	3403	2176	510	222	2,769
Jul-19	2602	1286	580	283	2,419
Aug-19	2221	1786	562	329	2,791
Sep-19	2701	1337	598	338	2,416
Oct-19	2480	793	444	270	2,092
Nov-19	2396	958	592	392	2,198
Dec-19	2712	1188	677	452	2,694

Table C-40
Modeled Monthly Average Total Dissolved Solids Concentrations of Receiving Water for Critical Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled TDS Concentrations for Critical Years (mg/L)				Modeled Salt Load at Station B (tons)
	Station B	Station D	Station N	Vernalis	
Oct-09	3142	877	421	277	4,213
Nov-09	3068	1037	587	392	4,133
Dec-09	3358	1335	696	417	5,671
Jan-10	3217	1437	670	360	5,399
Feb-10	3795	1705	767	400	5,093
Mar-10	3805	1780	738	371	5,220
Apr-10	4215	2792	602	240	5,365
May-10	3721	2411	373	176	5,295
Jun-10	3778	2911	492	255	4,133
Jul-10	3028	2184	580	332	3,472
Aug-10	2759	2358	613	341	4,349
Sep-10	3111	1673	634	368	3,709
Oct-10	2725	779	408	271	2,428
Nov-10	2559	949	569	384	2,321
Dec-10	3236	1278	682	412	4,488
Jan-11	3313	1390	658	355	4,291
Feb-11	3781	1581	743	391	3,109
Mar-11	3517	1659	718	362	3,261
Apr-11	4417	2554	576	231	3,456
May-11	3605	2107	353	169	3,448
Jun-11	3795	2799	481	250	3,404
Jul-11	2862	1990	563	324	2,743
Aug-11	2641	2211	593	333	3,536
Sep-11	2978	1463	607	357	2,740
Oct-11	2811	782	408	271	2,457
Nov-11	2630	951	570	385	2,346
Dec-11	3406	1287	683	412	4,539
Jan-12	3499	1401	659	355	4,344
Feb-12	3928	1587	744	391	3,120
Mar-12	3568	1662	718	362	3,268
Apr-12	4620	2598	576	232	3,480
May-12	3719	2138	353	169	3,473
Jun-12	3885	2843	481	250	3,414
Jul-12	2902	2007	563	324	2,750
Aug-12	2701	2250	593	333	3,541
Sep-12	3042	1478	608	357	2,755
Oct-12	2887	785	408	272	2,482
Nov-12	2691	953	570	385	2,367
Dec-12	3557	1294	684	412	4,582
Jan-13	3662	1409	660	355	4,386
Feb-13	4049	1592	744	391	3,128
Mar-13	3611	1664	719	362	3,273

Table C-40
Modeled Monthly Average Total Dissolved Solids Concentrations of Receiving Water for Critical Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled TDS Concentrations for Critical Years (mg/L)				Modeled Salt Load at Station B (tons)
	Station B	Station D	Station N	Vernalis	
Apr-13	4797	2634	577	232	3,499
May-13	3813	2162	354	169	3,493
Jun-13	3951	2876	481	250	3,421
Jul-13	2931	2020	563	324	2,754
Aug-13	2747	2280	594	333	3,544
Sep-13	3098	1491	609	358	2,767
Oct-13	2954	787	408	272	2,504
Nov-13	2745	955	570	385	2,385
Dec-13	3692	1300	685	413	4,618
Jan-14	3807	1417	661	356	4,421
Feb-14	4150	1596	744	391	3,135
Mar-14	3649	1666	719	362	3,278
Apr-14	4952	2665	577	232	3,515
May-14	3892	2183	354	169	3,509
Jun-14	4003	2901	481	250	3,426
Jul-14	2953	2029	563	324	2,758
Aug-14	2783	2303	594	333	3,547
Sep-14	3146	1501	609	358	2,778
Oct-14	3014	789	409	272	2,522
Nov-14	2791	957	570	385	2,400
Dec-14	3815	1306	686	413	4,648
Jan-15	2692	1348	653	353	4,098
Feb-15	3200	1568	744	391	3,348
Mar-15	3260	1624	713	360	2,816
Apr-15	3751	2321	567	229	2,922
May-15	3130	1901	346	167	2,909
Jun-15	3350	2517	474	248	3,041
Jul-15	2608	1864	559	322	2,631
Aug-15	2322	1985	585	330	3,373
Sep-15	2707	1353	598	354	2,449
Oct-15	2503	762	406	271	2,165
Nov-15	2531	961	572	386	2,651
Dec-15	2923	1260	680	411	4,398
Jan-16	2653	1325	647	351	3,591
Feb-16	3200	1551	741	390	3,038
Mar-16	3178	1600	710	358	2,430
Apr-16	3798	2252	561	227	2,486
May-16	3096	1818	342	165	2,483
Jun-16	3350	2517	474	248	3,041
Jul-16	2608	1864	559	322	2,631
Aug-16	2322	1985	585	330	3,373
Sep-16	2682	1322	594	352	2,319
Oct-16	2435	751	404	270	1,959

Table C-40
Modeled Monthly Average Total Dissolved Solids Concentrations of Receiving Water for Critical Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled TDS Concentrations for Critical Years (mg/L)				Modeled Salt Load at Station B (tons)
	Station B	Station D	Station N	Vernalis	
Nov-16	2502	956	571	385	2,541
Dec-16	2875	1236	674	409	3,872
Jan-17	2521	1270	634	346	2,462
Feb-17	3200	1509	733	387	2,334
Mar-17	3178	1600	710	358	2,430
Apr-17	3867	2175	555	225	2,050
May-17	3085	1793	340	165	2,362
Jun-17	3350	2517	474	248	3,041
Jul-17	2608	1864	559	322	2,631
Aug-17	2322	1985	585	330	3,373
Sep-17	2682	1322	594	352	2,319
Oct-17	2355	739	403	269	1,754
Nov-17	2264	923	564	382	1,852
Dec-17	2714	1180	660	403	2,707
Jan-18	2293	1222	624	342	1,514
Feb-18	3199	1473	726	384	1,749
Mar-18	3157	1595	709	358	2,347
Apr-18	4000	2074	548	222	1,552
May-18	3052	1728	337	164	2,071
Jun-18	3436	2475	468	245	2,626
Jul-18	2599	1804	552	319	2,319
Aug-18	2152	1791	563	321	2,478
Sep-18	2573	1202	582	347	1,862
Oct-18	2229	724	401	268	1,484
Nov-18	2049	902	560	380	1,425
Dec-18	2455	1131	649	399	1,725
Jan-19	2293	1222	624	342	1,514
Feb-19	3199	1473	726	384	1,749
Mar-19	3157	1595	709	358	2,347
Apr-19	4000	2074	548	222	1,552
May-19	3052	1728	337	164	2,071
Jun-19	3436	2475	468	245	2,626
Jul-19	2599	1804	552	319	2,319
Aug-19	2152	1791	563	321	2,478
Sep-19	2573	1202	582	347	1,862
Oct-19	2229	724	401	268	1,484
Nov-19	2049	902	560	380	1,425
Dec-19	2455	1131	649	399	1,725

Table C-41
Modeled Monthly Average Boron Concentrations of Receiving Water for Wet Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Boron Concentrations (mg/L)			Modeled Boron Load at Station B (1000s of lbs)
	Station B	Station D	Station N	
Oct-09	7	2	0.6	26
Nov-09	7	2	0.6	25
Dec-09	6	2	0.7	22
Jan-10	7	2	0.6	22
Feb-10	8	3	0.8	48
Mar-10	8	3	0.7	47
Apr-10	9	5	0.5	50
May-10	9	5	0.3	52
Jun-10	9	5	0.4	42
Jul-10	9	5	0.5	42
Aug-10	8	5	0.6	47
Sep-10	8	4	0.6	37
Oct-10	7	2	0.6	32
Nov-10	7	2	0.7	30
Dec-10	6	2	0.7	22
Jan-11	7	2	0.6	22
Feb-11	9	3	0.8	50
Mar-11	9	3	0.7	48
Apr-11	10	5	0.5	51
May-11	10	5	0.3	52
Jun-11	10	5	0.4	43
Jul-11	10	5	0.5	42
Aug-11	8	6	0.6	46
Sep-11	8	4	0.6	37
Oct-11	8	2	0.6	32
Nov-11	7	2	0.7	31
Dec-11	7	2	0.7	22
Jan-12	7	2	0.6	23
Feb-12	10	3	0.8	51
Mar-12	10	3	0.7	49
Apr-12	10	5	0.5	51
May-12	10	5	0.3	53
Jun-12	11	5	0.4	43
Jul-12	10	5	0.5	42
Aug-12	9	6	0.6	46
Sep-12	9	4	0.6	37
Oct-12	8	2	0.6	32
Nov-12	8	2	0.7	31
Dec-12	7	2	0.7	22
Jan-13	8	2	0.6	23
Feb-13	11	3	0.8	51
Mar-13	10	3	0.7	49

Table C-41
Modeled Monthly Average Boron Concentrations of Receiving Water for Wet Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Boron Concentrations (mg/L)			Modeled Boron Load at Station B (1000s of lbs)
	Station B	Station D	Station N	
Apr-13	11	5	0.5	51
May-13	11	5	0.3	53
Jun-13	11	5	0.4	43
Jul-13	11	5	0.5	42
Aug-13	9	6	0.6	45
Sep-13	9	5	0.6	37
Oct-13	8	2	0.6	33
Nov-13	8	2	0.7	31
Dec-13	7	2	0.7	22
Jan-14	8	2	0.6	23
Feb-14	11	3	0.8	51
Mar-14	10	3	0.7	49
Apr-14	12	5	0.5	52
May-14	12	5	0.3	53
Jun-14	12	5	0.4	43
Jul-14	11	5	0.5	42
Aug-14	10	6	0.6	45
Sep-14	9	5	0.6	37
Oct-14	9	2	0.6	33
Nov-14	8	2	0.7	31
Dec-14	8	2	0.7	22
Jan-15	6	2	0.6	18
Feb-15	7	2	0.8	38
Mar-15	7	3	0.7	38
Apr-15	8	4	0.4	40
May-15	8	4	0.3	41
Jun-15	7	4	0.3	35
Jul-15	7	4	0.4	34
Aug-15	6	5	0.6	39
Sep-15	7	4	0.5	31
Oct-15	7	2	0.6	25
Nov-15	6	2	0.6	24
Dec-15	5	2	0.7	17
Jan-16	5	2	0.6	14
Feb-16	7	2	0.7	31
Mar-16	8	3	0.7	30
Apr-16	8	4	0.4	31
May-16	8	4	0.3	32
Jun-16	7	4	0.3	28
Jul-16	7	4	0.4	27
Aug-16	6	4	0.5	31
Sep-16	7	3	0.5	24

Table C-41
Modeled Monthly Average Boron Concentrations of Receiving Water for Wet Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Boron Concentrations (mg/L)			Modeled Boron Load at Station B (1000s of lbs)
	Station B	Station D	Station N	
Oct-16	6	1	0.5	20
Nov-16	6	2	0.6	18
Dec-16	5	2	0.7	14
Jan-17	6	2	0.6	17
Feb-17	7	2	0.7	29
Mar-17	8	2	0.7	22
Apr-17	8	3	0.4	22
May-17	8	3	0.2	23
Jun-17	8	3	0.3	21
Jul-17	7	3	0.4	20
Aug-17	6	4	0.5	23
Sep-17	7	3	0.5	17
Oct-17	6	1	0.5	14
Nov-17	6	2	0.6	19
Dec-17	5	2	0.7	17
Jan-18	5	2	0.6	12
Feb-18	7	2	0.7	20
Mar-18	8	2	0.7	18
Apr-18	8	3	0.4	16
May-18	8	3	0.2	18
Jun-18	8	3	0.3	18
Jul-18	7	3	0.4	17
Aug-18	6	3	0.5	18
Sep-18	6	2	0.4	13
Oct-18	5	1	0.4	11
Nov-18	5	1	0.6	13
Dec-18	5	1	0.6	11
Jan-19	5	2	0.6	12
Feb-19	7	2	0.7	20
Mar-19	8	2	0.7	18
Apr-19	8	3	0.4	16
May-19	8	3	0.2	18
Jun-19	8	3	0.3	18
Jul-19	7	3	0.4	17
Aug-19	6	3	0.5	18
Sep-19	6	2	0.4	13
Oct-19	5	1	0.4	11
Nov-19	5	1	0.6	13
Dec-19	5	1	0.6	11

Table C-42
Modeled Monthly Average Boron Concentrations of Receiving Water for Above Normal Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Boron Concentrations (mg/L)			Modeled Boron Load at Station B (1000s of lbs)
	Station B	Station D	Station N	
Oct-09	7	1	0.5	26
Nov-09	7	2	0.6	25
Dec-09	6	2	0.7	22
Jan-10	7	2	0.9	39
Feb-10	8	3	0.7	46
Mar-10	8	3	0.6	46
Apr-10	9	5	0.6	49
May-10	9	5	0.4	50
Jun-10	9	5	0.6	30
Jul-10	8	6	0.6	29
Aug-10	7	7	0.7	32
Sep-10	8	4	0.7	31
Oct-10	7	1	0.5	26
Nov-10	7	2	0.6	25
Dec-10	7	3	0.8	37
Jan-11	8	2	0.9	39
Feb-11	9	3	0.7	49
Mar-11	9	3	0.6	47
Apr-11	10	5	0.6	50
May-11	10	5	0.5	51
Jun-11	10	5	0.6	30
Jul-11	9	7	0.6	29
Aug-11	8	7	0.7	32
Sep-11	8	4	0.7	31
Oct-11	8	1	0.5	27
Nov-11	7	2	0.6	25
Dec-11	8	3	0.9	38
Jan-12	8	2	0.9	39
Feb-12	10	3	0.7	49
Mar-12	10	3	0.6	47
Apr-12	10	6	0.6	50
May-12	10	5	0.5	51
Jun-12	10	5	0.6	30
Jul-12	10	7	0.6	29
Aug-12	8	7	0.7	32
Sep-12	9	5	0.7	31
Oct-12	8	1	0.5	27
Nov-12	7	2	0.6	25
Dec-12	8	3	0.9	38
Jan-13	9	2	0.9	39
Feb-13	11	3	0.7	49
Mar-13	10	3	0.6	48
Apr-13	11	6	0.6	50

Table C-42
Modeled Monthly Average Boron Concentrations of Receiving Water for Above Normal Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Boron Concentrations (mg/L)			Modeled Boron Load at Station B (1000s of lbs)
	Station B	Station D	Station N	
May-13	11	5	0.5	52
Jun-13	11	5	0.6	30
Jul-13	10	7	0.6	29
Aug-13	8	8	0.7	31
Sep-13	9	5	0.7	31
Oct-13	8	1	0.5	27
Nov-13	8	2	0.6	26
Dec-13	8	3	0.9	38
Jan-14	9	2	0.9	39
Feb-14	11	3	0.7	49
Mar-14	10	3	0.6	48
Apr-14	12	6	0.6	50
May-14	11	5	0.5	52
Jun-14	11	5	0.6	30
Jul-14	10	7	0.6	29
Aug-14	9	8	0.7	31
Sep-14	9	5	0.7	31
Oct-14	8	2	0.5	27
Nov-14	8	2	0.6	26
Dec-14	9	3	0.9	38
Jan-15	6	2	0.8	31
Feb-15	7	2	0.7	37
Mar-15	7	3	0.6	37
Apr-15	8	4	0.5	39
May-15	8	4	0.4	40
Jun-15	7	4	0.5	25
Jul-15	7	5	0.5	24
Aug-15	6	6	0.7	28
Sep-15	7	4	0.6	26
Oct-15	6	1	0.5	21
Nov-15	6	2	0.6	20
Dec-15	6	2	0.8	29
Jan-16	6	2	0.8	22
Feb-16	7	2	0.7	29
Mar-16	8	3	0.6	29
Apr-16	8	4	0.5	30
May-16	8	4	0.4	31
Jun-16	8	4	0.5	21
Jul-16	7	5	0.5	20
Aug-16	6	5	0.6	22
Sep-16	7	3	0.6	20
Oct-16	6	1	0.5	17
Nov-16	5	1	0.6	15

Table C-42
Modeled Monthly Average Boron Concentrations of Receiving Water for Above Normal Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Boron Concentrations (mg/L)			Modeled Boron Load at Station B (1000s of lbs)
	Station B	Station D	Station N	
Dec-16	6	2	0.7	22
Jan-17	6	2	0.8	26
Feb-17	7	2	0.7	32
Mar-17	8	3	0.6	21
Apr-17	8	4	0.5	20
May-17	8	3	0.3	22
Jun-17	8	4	0.5	17
Jul-17	7	5	0.4	15
Aug-17	6	5	0.6	17
Sep-17	6	3	0.5	15
Oct-17	6	1	0.4	12
Nov-17	6	2	0.6	21
Dec-17	6	2	0.8	25
Jan-18	5	2	0.7	13
Feb-18	7	2	0.6	18
Mar-18	8	2	0.6	16
Apr-18	9	3	0.4	12
May-18	8	3	0.3	15
Jun-18	9	3	0.5	14
Jul-18	8	5	0.4	14
Aug-18	5	5	0.5	13
Sep-18	6	2	0.5	10
Oct-18	5	1	0.4	8
Nov-18	5	1	0.5	11
Dec-18	5	2	0.7	12
Jan-19	5	2	0.7	13
Feb-19	7	2	0.6	18
Mar-19	8	2	0.6	16
Apr-19	9	3	0.4	12
May-19	8	3	0.3	15
Jun-19	9	3	0.5	14
Jul-19	8	5	0.4	14
Aug-19	5	5	0.5	13
Sep-19	6	2	0.5	10
Oct-19	5	1	0.4	8
Nov-19	5	1	0.5	11
Dec-19	5	2	0.7	12

Table C-43
Modeled Monthly Average Boron Concentrations of Receiving Water for Below Normal/Dry Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Boron Concentrations (mg/L)			Modeled Boron Load at Station B (1000s of lbs)
	Station B	Station D	Station N	
Oct-09	7	2	0.6	25
Nov-09	7	2	0.7	24
Dec-09	6	2	0.8	22
Jan-10	7	2	0.8	33
Feb-10	8	3	0.8	29
Mar-10	8	3	0.9	29
Apr-10	9	6	0.6	29
May-10	9	5	0.4	31
Jun-10	9	6	0.7	24
Jul-10	8	4	0.7	23
Aug-10	7	6	0.7	25
Sep-10	8	4	0.8	29
Oct-10	7	2	0.6	24
Nov-10	7	2	0.7	23
Dec-10	7	2	0.8	31
Jan-11	7	2	0.8	31
Feb-11	9	3	0.8	23
Mar-11	9	3	0.8	23
Apr-11	10	5	0.6	23
May-11	9	5	0.4	25
Jun-11	10	6	0.6	22
Jul-11	9	4	0.7	21
Aug-11	7	6	0.7	23
Sep-11	8	5	0.8	28
Oct-11	7	2	0.6	24
Nov-11	7	2	0.7	23
Dec-11	7	2	0.8	31
Jan-12	8	2	0.8	32
Feb-12	10	3	0.8	23
Mar-12	9	3	0.9	23
Apr-12	10	5	0.6	24
May-12	10	5	0.4	25
Jun-12	10	6	0.6	22
Jul-12	9	4	0.7	21
Aug-12	7	6	0.7	23
Sep-12	8	5	0.8	28
Oct-12	8	2	0.6	25
Nov-12	7	2	0.7	23
Dec-12	8	2	0.8	31
Jan-13	8	2	0.8	32
Feb-13	10	3	0.8	23
Mar-13	9	3	0.9	24
Apr-13	11	6	0.6	24

Table C-43
Modeled Monthly Average Boron Concentrations of Receiving Water for Below Normal/Dry Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Boron Concentrations (mg/L)			Modeled Boron Load at Station B (1000s of lbs)
	Station B	Station D	Station N	
May-13	10	5	0.4	25
Jun-13	10	6	0.6	22
Jul-13	9	4	0.7	21
Aug-13	7	6	0.7	23
Sep-13	9	5	0.8	28
Oct-13	8	2	0.6	25
Nov-13	8	2	0.7	23
Dec-13	8	2	0.8	31
Jan-14	9	2	0.8	32
Feb-14	10	3	0.8	23
Mar-14	10	3	0.9	24
Apr-14	11	6	0.6	24
May-14	10	5	0.4	26
Jun-14	11	6	0.6	22
Jul-14	9	4	0.7	21
Aug-14	7	6	0.7	23
Sep-14	9	5	0.8	28
Oct-14	8	2	0.6	25
Nov-14	8	2	0.7	23
Dec-14	8	2	0.8	32
Jan-15	6	2	0.8	25
Feb-15	7	2	0.8	19
Mar-15	8	2	0.8	20
Apr-15	8	5	0.5	19
May-15	8	4	0.3	21
Jun-15	8	5	0.6	19
Jul-15	7	3	0.6	18
Aug-15	6	5	0.6	20
Sep-15	7	4	0.7	24
Oct-15	6	1	0.5	20
Nov-15	6	1	0.6	18
Dec-15	6	2	0.8	24
Jan-16	6	2	0.7	19
Feb-16	8	2	0.8	15
Mar-16	8	2	0.8	17
Apr-16	8	4	0.5	16
May-16	8	4	0.3	17
Jun-16	8	5	0.6	17
Jul-16	7	3	0.6	16
Aug-16	6	5	0.6	17
Sep-16	7	3	0.7	19
Oct-16	6	1	0.5	16
Nov-16	5	1	0.6	14

Table C-43
Modeled Monthly Average Boron Concentrations of Receiving Water for Below Normal/Dry Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Boron Concentrations (mg/L)			Modeled Boron Load at Station B (1000s of lbs)
	Station B	Station D	Station N	
Dec-16	6	2	0.7	18
Jan-17	5	2	0.7	15
Feb-17	8	2	0.8	14
Mar-17	8	2	0.8	13
Apr-17	9	4	0.5	12
May-17	8	4	0.3	14
Jun-17	8	5	0.5	15
Jul-17	7	3	0.6	15
Aug-17	6	4	0.6	16
Sep-17	6	3	0.6	14
Oct-17	6	1	0.5	12
Nov-17	5	1	0.6	12
Dec-17	5	2	0.7	15
Jan-18	5	2	0.7	10
Feb-18	8	2	0.8	11
Mar-18	8	2	0.8	13
Apr-18	9	4	0.5	9
May-18	8	3	0.3	12
Jun-18	9	5	0.5	14
Jul-18	8	3	0.6	14
Aug-18	5	4	0.6	13
Sep-18	6	3	0.5	11
Oct-18	5	1	0.4	8
Nov-18	4	1	0.5	8
Dec-18	5	1	0.7	9
Jan-19	5	2	0.7	10
Feb-19	8	2	0.8	11
Mar-19	8	2	0.8	13
Apr-19	9	4	0.5	9
May-19	8	3	0.3	12
Jun-19	9	5	0.5	14
Jul-19	8	3	0.6	14
Aug-19	5	4	0.6	13
Sep-19	6	3	0.5	11
Oct-19	5	1	0.4	8
Nov-19	4	1	0.5	8
Dec-19	5	1	0.7	9

Table C-44
Modeled Monthly Average Boron Concentrations of Receiving Water for Critical Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Boron Concentrations (mg/L)			Modeled Boron Load at Station B (1000s of lbs)
	Station B	Station D	Station N	
Oct-09	7	1.2	0.4	18
Nov-09	6	1.3	0.6	16
Dec-09	6	1.8	0.7	22
Jan-10	7	2.1	0.8	22
Feb-10	8	2.7	0.8	23
Mar-10	8	2.9	0.8	23
Apr-10	9	5.4	0.6	23
May-10	9	5.2	0.4	25
Jun-10	9	6.6	0.5	20
Jul-10	8	5.5	0.6	19
Aug-10	6	5.4	0.7	20
Sep-10	7	3.3	0.6	17
Oct-10	6	0.9	0.4	10
Nov-10	5	1.1	0.5	8
Dec-10	6	1.7	0.7	16
Jan-11	7	2.0	0.8	17
Feb-11	9	2.4	0.8	15
Mar-11	9	2.7	0.8	16
Apr-11	10	4.8	0.5	15
May-11	9	4.5	0.3	17
Jun-11	9	6.4	0.4	17
Jul-11	8	5.2	0.5	15
Aug-11	6	5.0	0.6	17
Sep-11	6	2.8	0.6	12
Oct-11	6	0.9	0.4	10
Nov-11	5	1.1	0.5	8
Dec-11	6	1.7	0.7	17
Jan-12	7	2.0	0.8	18
Feb-12	9	2.4	0.8	15
Mar-12	9	2.7	0.8	16
Apr-12	10	4.9	0.5	15
May-12	9	4.6	0.3	17
Jun-12	9	6.5	0.4	17
Jul-12	8	5.2	0.5	15
Aug-12	6	5.1	0.6	16
Sep-12	7	2.8	0.6	12
Oct-12	6	0.9	0.4	10
Nov-12	5	1.1	0.5	8
Dec-12	6	1.7	0.7	17
Jan-13	7	2.0	0.8	18
Feb-13	9	2.4	0.8	15
Mar-13	9	2.7	0.8	16
Apr-13	11	4.9	0.5	15

Table C-44
Modeled Monthly Average Boron Concentrations of Receiving Water for Critical Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Boron Concentrations (mg/L)			Modeled Boron Load at Station B (1000s of lbs)
	Station B	Station D	Station N	
May-13	9	4.6	0.3	17
Jun-13	10	6.6	0.4	17
Jul-13	8	5.2	0.5	15
Aug-13	6	5.1	0.6	16
Sep-13	7	2.8	0.6	12
Oct-13	6	0.9	0.4	10
Nov-13	5	1.1	0.5	9
Dec-13	7	1.7	0.7	17
Jan-14	8	2.0	0.8	18
Feb-14	10	2.4	0.8	15
Mar-14	9	2.7	0.8	16
Apr-14	11	5.0	0.5	15
May-14	10	4.7	0.3	17
Jun-14	10	6.6	0.4	17
Jul-14	8	5.2	0.5	15
Aug-14	6	5.2	0.6	16
Sep-14	7	2.8	0.6	12
Oct-14	6	0.9	0.4	10
Nov-14	5	1.1	0.5	9
Dec-14	7	1.7	0.7	17
Jan-15	6	1.9	0.7	17
Feb-15	7	2.4	0.8	16
Mar-15	8	2.6	0.8	14
Apr-15	8	4.3	0.5	13
May-15	8	4.1	0.3	15
Jun-15	8	5.9	0.4	15
Jul-15	7	4.9	0.5	15
Aug-15	6	4.7	0.6	16
Sep-15	6	2.6	0.5	11
Oct-15	5	0.9	0.4	9
Nov-15	5	1.1	0.5	10
Dec-15	5	1.6	0.7	16
Jan-16	5	1.8	0.7	15
Feb-16	8	2.4	0.8	14
Mar-16	8	2.5	0.8	13
Apr-16	9	4.1	0.5	11
May-16	8	3.9	0.3	13
Jun-16	8	5.9	0.4	15
Jul-16	7	4.9	0.5	15
Aug-16	6	4.7	0.6	16
Sep-16	6	2.5	0.5	10
Oct-16	5	0.9	0.4	8
Nov-16	5	1.1	0.5	9

Table C-44
Modeled Monthly Average Boron Concentrations of Receiving Water for Critical Years Using Selenium Load Values for the 2010 Use Agreement

	Modeled Boron Concentrations (mg/L)			Modeled Boron Load at Station B (1000s of lbs)
	Station B	Station D	Station N	
Dec-16	5	1.6	0.7	14
Jan-17	5	1.7	0.7	10
Feb-17	8	2.3	0.8	11
Mar-17	8	2.5	0.8	13
Apr-17	9	3.9	0.5	10
May-17	8	3.9	0.3	13
Jun-17	8	5.9	0.4	15
Jul-17	7	4.9	0.5	15
Aug-17	6	4.7	0.6	16
Sep-17	6	2.5	0.5	10
Oct-17	5	0.8	0.4	7
Nov-17	4	1.0	0.5	6
Dec-17	5	1.4	0.6	9
Jan-18	5	1.6	0.7	6
Feb-18	8	2.2	0.7	9
Mar-18	8	2.5	0.8	12
Apr-18	10	3.7	0.5	7
May-18	8	3.7	0.3	11
Jun-18	9	5.8	0.4	13
Jul-18	8	4.8	0.5	14
Aug-18	5	4.1	0.6	12
Sep-18	5	2.1	0.5	8
Oct-18	4	0.8	0.3	6
Nov-18	3	1.0	0.5	4
Dec-18	3	1.3	0.6	5
Jan-19	5	1.6	0.7	6
Feb-19	8	2.2	0.7	9
Mar-19	8	2.5	0.8	12
Apr-19	10	3.7	0.5	7
May-19	8	3.7	0.3	11
Jun-19	9	5.8	0.4	13
Jul-19	8	4.8	0.5	14
Aug-19	5	4.1	0.6	12
Sep-19	5	2.1	0.5	8
Oct-19	4	0.8	0.3	6
Nov-19	3	1.0	0.5	4
Dec-19	3	1.3	0.6	5

ATTACHMENT C-1

Selected Inputs and Results from the Drainage Model

Attachment C-1: Selected Inputs and Results from the Drainage Model

Table C1-1
Monthly Precipitation from the Gauge at Panoche Water District

	WY 2005 Precipitation Used to Model Wet Years (inches)	WY 2000 Precipitation Used to Model Above Normal Years (inches)	WY 2004 Precipitation Used to Model Below Normal/Dry Years (inches)	WY 2007 Precipitation Used to Model Critical Years (inches)
Oct	2.57	0	0.09	0.94
Nov	0.86	0.30	0.50	0.27
Dec	2.21	0.08	1.42	0.62
Jan	1.81	1.63	0.68	0.38
Feb	2.57	1.88	2.38	0.72
Mar	1.52	0.49	0.39	0.11
Apr	0.99	1.49	0	0.38
May	0	0.08	0	0.05
Jun	0	0.40	0	0
Jul	0	0	0	0
Aug	0	0	0	0
Sep	0	0.07	0	0.29
Total	**12.53**	**6.42**	**5.46**	**3.76**

Table C1-2
Weight Monthly Average Crop Coefficients Used in the Model for All Water Year Types

	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Reuse Area / SJRIP
Oct	0.00	0.01	0.03	0.10	0.05	0.83
Nov	0.01	0.01	0.01	0.10	0.04	0.82
Dec	0.01	0.01	0.02	0.06	0.05	0.81
Jan	0.03	0.03	0.03	0.05	0.07	0.80
Feb	0.12	0.10	0.10	0.06	0.09	0.82
Mar	0.32	0.26	0.25	0.09	0.14	0.87
Apr	0.58	0.34	0.34	0.19	0.25	0.89
May	0.74	0.52	0.49	0.46	0.43	0.90
Jun	0.99	0.75	0.79	0.68	0.73	0.91
Jul	1.04	0.83	0.96	0.77	0.91	0.91
Aug	0.96	0.77	0.87	0.70	0.78	0.91
Sep	0.24	0.32	0.33	0.39	0.41	0.83

Attachment C-1: Selected Inputs and Results from the Drainage Model

Table C1-3
Estimated Acreage of Crops for Modeling All Water Year Types

District	Alfalfa	Almonds	Asparagus	Barley	Beans	Cereals, other (use barley)	Corn	Cotton	Deciduous Orchard[1]	Fallow	Garlic	Grain Sorghum (Milo)	Grapes (wine)	Melons	Misc. Truck/ Field Crops (Low)	Olives	Pasture (Improved)	Rice	Sugar Beets	Tomatoes (canning)	Tomatoes (fresh market)	Wheat	Total Irrigated Crop Acreage[2]
Camp 13 Drainage Area	1,670			18	28		132	1,141		161				128				1,069	1,213	82		130	5,611
Charleston Drainage District	800	25				108		1,667		41				810						233			3,644
Firebaugh Canal Water District	4,600		112		327		63	9,004	282	451	516	1,502		2,092			15	365	1,281	1,383		98	21,641
Pacheco Water District	71	45	310		44		88	1,744			36			1,065	197					1,015	33	103	4,751
Panoche Drainage District	1,544	796	1,145	293	506		222	19,934	14	1,518	1,224		690	4,106	73	6	6	1,016	110	4,575	2,014	755	39,029
Reuse Area / SJRIP[3]	384		220						10	1,200							4,186						4,800

[1]This category includes apples, cherries, and walnuts without a cover crop.
[2]Total irrigated crop acreage does not include fallow acreage.
[3]Assumed acreage for 2010 through 2014 is shown. Assumed that total acreage would increase by 230 acres for 2015 through 2019.

Table C1-4
Monthly Reference Evapotranspiration from the CIMIS Gauge at Firebaugh/Telles

	WY 2005 Reference Evapotranspiration Used to Model Wet Years (inches)	WY 2000 Reference Evapotranspiration Used to Model Above Normal Years (inches)	WY 2004 Reference Evapotranspiration Used to Model Below Normal/Dry Years (inches)	WY 2007 Reference Evapotranspiration Used to Model Critical Years (inches)
Oct	3.32	4.29	4.41	3.37
Nov	1.33	2.09	1.87	1.59
Dec	0.79	1.84	1.04	1.24
Jan	0.63	1.23	0.88	1.74
Feb	1.76	1.73	1.88	1.76
Mar	3.42	4.32	4.62	4.22
Apr	4.90	5.83	6.60	5.20
May	6.86	7.65	7.92	7.67
Jun	7.83	8.53	8.39	8.34
Jul	8.60	8.35	8.29	7.94
Aug	7.37	7.43	7.31	7.25
Sep	5.39	5.48	5.94	5.13
Total	**52.2**	**58.77**	**59.15**	**55.45**

Attachment C-1: Selected Inputs and Results from the Drainage Model

Table C1-5
Monthly Volume of Recycled Drainage by District for Wet Years, acre-feet

Month -Year	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Sum
Jan-10	0	29	48	41	354	471
Feb-10	0	50	190	61	507	809
Mar-10	0	46	152	66	382	645
Apr-10	0	66	198	94	375	733
May-10	0	105	416	143	569	1,233
Jun-10	0	169	564	266	1,377	2,376
Jul-10	0	195	648	308	1,675	2,825
Aug-10	0	141	447	184	991	1,763
Sep-10	0	37	177	52	174	440
Oct-10	0	25	40	28	89	181
Nov-10	0	9	44	9	91	153
Dec-10	0	13	6	15	98	133
Jan-11	0	29	48	41	354	471
Feb-11	0	50	305	61	588	1,005
Mar-11	0	46	152	66	382	645
Apr-11	0	66	212	94	375	748
May-11	0	105	416	143	569	1,233
Jun-11	0	169	564	266	1,377	2,376
Jul-11	0	195	648	308	1,675	2,825
Aug-11	0	141	447	184	991	1,763
Sep-11	0	37	177	52	174	440
Oct-11	0	25	40	28	89	181
Nov-11	0	9	44	9	91	153
Dec-11	0	13	6	15	98	133
Jan-12	0	29	48	41	354	471
Feb-12	0	50	341	61	588	1,040
Mar-12	0	46	152	66	382	645
Apr-12	0	66	212	94	375	748
May-12	0	105	416	143	569	1,233
Jun-12	0	169	564	266	1,377	2,376
Jul-12	0	195	648	308	1,675	2,825
Aug-12	0	141	447	184	991	1,763
Sep-12	0	37	177	52	174	440
Oct-12	0	25	40	28	89	181
Nov-12	0	9	44	9	91	153
Dec-12	0	13	6	15	98	133
Jan-13	0	29	48	41	354	471
Feb-13	0	50	341	61	588	1,040
Mar-13	0	46	152	66	382	645
Apr-13	0	66	212	94	375	748
May-13	0	105	416	143	569	1,233
Jun-13	0	169	564	266	1,377	2,376
Jul-13	0	195	648	308	1,675	2,825
Aug-13	0	141	447	184	991	1,763
Sep-13	0	37	177	52	174	440

Table C1-5
Monthly Volume of Recycled Drainage by District for Wet Years, acre-feet

Month -Year	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Sum
Oct-13	0	25	40	28	89	181
Nov-13	0	9	44	9	91	153
Dec-13	0	13	6	15	98	133
Jan-14	0	29	48	41	354	471
Feb-14	0	50	341	61	588	1,040
Mar-14	0	46	152	66	382	645
Apr-14	0	66	212	94	375	748
May-14	0	105	416	143	569	1,233
Jun-14	0	169	564	266	1,377	2,376
Jul-14	0	195	648	308	1,675	2,825
Aug-14	0	141	447	184	991	1,763
Sep-14	0	37	177	52	174	440
Oct-14	0	25	40	28	89	181
Nov-14	0	9	44	9	91	153
Dec-14	0	13	6	15	98	133
Jan-15	0	29	48	41	354	471
Feb-15	0	50	192	61	515	819
Mar-15	0	46	152	66	382	645
Apr-15	0	66	211	94	375	746
May-15	0	105	416	143	569	1,233
Jun-15	0	169	562	266	1,377	2,373
Jul-15	0	195	648	308	1,675	2,825
Aug-15	0	141	386	184	991	1,702
Sep-15	0	37	177	52	174	440
Oct-15	0	25	40	28	89	181
Nov-15	0	9	44	9	91	153
Dec-15	0	13	6	15	98	133
Jan-16	0	29	48	41	354	471
Feb-16	0	50	341	61	588	1,040
Mar-16	0	46	152	66	382	645
Apr-16	0	66	212	94	375	748
May-16	0	105	416	143	569	1,233
Jun-16	0	169	564	266	1,377	2,376
Jul-16	0	195	648	308	1,675	2,825
Aug-16	0	141	447	184	991	1,763
Sep-16	0	37	177	52	174	440
Oct-16	0	25	40	28	89	181
Nov-16	0	9	44	9	91	153
Dec-16	0	13	6	15	98	133
Jan-17	0	29	48	41	354	471
Feb-17	0	50	341	61	588	1,040
Mar-17	0	46	152	66	382	645
Apr-17	0	66	212	94	375	748
May-17	0	105	416	143	569	1,233
Jun-17	0	169	564	266	1,377	2,376

Table C1-5
Monthly Volume of Recycled Drainage by District for Wet Years, acre-feet

Month -Year	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Sum
Jul-17	0	195	648	308	1,675	2,825
Aug-17	0	141	447	184	991	1,763
Sep-17	0	37	177	52	174	440
Oct-17	0	25	40	28	89	181
Nov-17	0	9	44	9	91	153
Dec-17	0	13	6	15	98	133
Jan-18	0	29	48	41	354	471
Feb-18	0	50	341	61	588	1,040
Mar-18	0	46	152	66	382	645
Apr-18	0	66	212	94	375	748
May-18	0	105	416	143	569	1,233
Jun-18	0	169	564	266	1,377	2,376
Jul-18	0	195	648	308	1,675	2,825
Aug-18	0	141	447	184	991	1,763
Sep-18	0	37	177	52	174	440
Oct-18	0	25	40	28	89	181
Nov-18	0	9	44	9	91	153
Dec-18	0	13	6	15	98	133
Jan-19	0	29	48	41	354	471
Feb-19	0	50	341	61	588	1,040
Mar-19	0	46	152	66	382	645
Apr-19	0	66	212	94	375	748
May-19	0	105	416	143	569	1,233
Jun-19	0	169	564	266	1,377	2,376
Jul-19	0	195	648	308	1,675	2,825
Aug-19	0	141	447	184	991	1,763
Sep-19	0	37	177	52	174	440
Oct-19	0	25	40	28	89	181
Nov-19	0	9	44	9	91	153
Dec-19	0	13	6	15	98	133

Note: The treatment facility is assumed to be operational for Jan 2015 to Dec 2019

Table C1-6
Monthly Volume of Recycled Drainage by District for Above Normal Years, acre-feet

Month-Year	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Sum
Jan-10	0	8	17	18	20	63
Feb-10	0	50	205	61	562	879
Mar-10	0	46	152	66	382	645
Apr-10	0	66	212	94	375	748
May-10	0	105	416	143	569	1,233
Jun-10	0	169	564	266	1,377	2,376
Jul-10	0	195	648	308	1,675	2,825
Aug-10	0	141	447	184	991	1,763
Sep-10	0	37	177	52	174	440
Oct-10	0	25	40	28	89	181
Nov-10	0	9	44	9	91	153
Dec-10	0	0	0	0	0	0
Jan-11	0	21	45	41	112	220
Feb-11	0	50	340	61	588	1,040
Mar-11	0	46	152	66	382	645
Apr-11	0	66	212	94	375	748
May-11	0	105	416	143	569	1,233
Jun-11	0	169	564	266	1,377	2,376
Jul-11	0	195	648	308	1,675	2,825
Aug-11	0	141	447	184	991	1,763
Sep-11	0	37	177	52	174	440
Oct-11	0	25	40	28	89	181
Nov-11	0	9	44	9	91	153
Dec-11	0	13	6	15	96	131
Jan-12	0	29	48	41	303	421
Feb-12	0	50	341	61	588	1,040
Mar-12	0	46	152	66	382	645
Apr-12	0	66	212	94	375	748
May-12	0	105	416	143	569	1,233
Jun-12	0	169	564	266	1,377	2,376
Jul-12	0	195	648	308	1,675	2,825
Aug-12	0	141	447	184	991	1,763
Sep-12	0	37	177	52	174	440
Oct-12	0	25	40	28	89	181
Nov-12	0	9	44	9	91	153
Dec-12	0	13	6	15	98	133
Jan-13	0	29	48	41	354	471
Feb-13	0	50	341	61	588	1,040
Mar-13	0	46	152	66	382	645
Apr-13	0	66	212	94	375	748
May-13	0	105	416	143	569	1,233
Jun-13	0	169	564	266	1,377	2,376
Jul-13	0	195	648	308	1,675	2,825
Aug-13	0	141	447	184	991	1,763
Sep-13	0	37	177	52	174	440
Oct-13	0	25	40	28	89	181

Table C1-6
Monthly Volume of Recycled Drainage by District for Above Normal Years, acre-feet

Month-Year	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Sum
Nov-13	0	9	44	9	91	153
Dec-13	0	13	6	15	98	133
Jan-14	0	29	48	41	354	471
Feb-14	0	50	341	61	588	1,040
Mar-14	0	46	152	66	382	645
Apr-14	0	66	212	94	375	748
May-14	0	105	416	143	569	1,233
Jun-14	0	169	564	266	1,377	2,376
Jul-14	0	195	648	308	1,675	2,825
Aug-14	0	141	447	184	991	1,763
Sep-14	0	37	177	52	174	440
Oct-14	0	25	40	28	89	181
Nov-14	0	9	44	9	91	153
Dec-14	0	13	6	15	98	133
Jan-15	0	15	33	35	73	157
Feb-15	0	50	207	61	567	886
Mar-15	0	46	152	66	382	645
Apr-15	0	66	212	94	375	748
May-15	0	105	416	143	569	1,233
Jun-15	0	169	564	266	1,377	2,376
Jul-15	0	195	648	308	1,675	2,825
Aug-15	0	141	447	184	991	1,763
Sep-15	0	37	177	52	174	440
Oct-15	0	25	40	28	89	181
Nov-15	0	9	44	9	91	153
Dec-15	0	9	6	15	58	88
Jan-16	0	29	48	41	354	471
Feb-16	0	50	341	61	588	1,040
Mar-16	0	46	152	66	382	645
Apr-16	0	66	212	94	375	748
May-16	0	105	416	143	569	1,233
Jun-16	0	169	564	266	1,377	2,376
Jul-16	0	195	648	308	1,675	2,825
Aug-16	0	141	447	184	991	1,763
Sep-16	0	37	177	52	174	440
Oct-16	0	25	40	28	89	181
Nov-16	0	9	44	9	91	153
Dec-16	0	13	6	15	98	133
Jan-17	0	29	48	41	250	368
Feb-17	0	50	341	61	588	1,040
Mar-17	0	46	152	66	382	645
Apr-17	0	66	212	94	375	748
May-17	0	105	416	143	569	1,233
Jun-17	0	169	564	266	1,377	2,376
Jul-17	0	195	648	308	1,675	2,825
Aug-17	0	141	447	184	991	1,763

Table C1-6
Monthly Volume of Recycled Drainage by District for Above Normal Years, acre-feet

Month-Year	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Sum
Sep-17	0	37	177	52	174	440
Oct-17	0	25	40	28	89	181
Nov-17	0	9	44	9	91	153
Dec-17	0	13	6	15	98	133
Jan-18	0	29	48	41	354	471
Feb-18	0	50	341	61	588	1,040
Mar-18	0	46	152	66	382	645
Apr-18	0	66	212	94	375	748
May-18	0	105	416	143	569	1,233
Jun-18	0	169	564	266	1,377	2,376
Jul-18	0	195	648	308	1,675	2,825
Aug-18	0	141	447	184	991	1,763
Sep-18	0	37	177	52	174	440
Oct-18	0	25	40	28	89	181
Nov-18	0	9	44	9	91	153
Dec-18	0	13	6	15	98	133
Jan-19	0	29	48	41	354	471
Feb-19	0	50	341	61	588	1,040
Mar-19	0	46	152	66	382	645
Apr-19	0	66	212	94	375	748
May-19	0	105	416	143	569	1,233
Jun-19	0	169	564	266	1,377	2,376
Jul-19	0	195	648	308	1,675	2,825
Aug-19	0	141	447	184	991	1,763
Sep-19	0	37	177	52	174	440
Oct-19	0	25	40	28	89	181
Nov-19	0	9	44	9	91	153
Dec-19	0	13	6	15	98	133

Note: The treatment facility is assumed to be operational for Jan 2015 to Dec 2019

Table C1-7
Monthly Volume of Recycled Drainage by District for Below Normal/Dry, acre-feet

Month-Year	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Sum
Jan-10	0	29	48	41	191	309
Feb-10	0	50	341	61	588	1,040
Mar-10	0	46	152	66	382	645
Apr-10	0	66	212	94	375	748
May-10	0	105	416	143	569	1,233
Jun-10	0	169	564	266	1,377	2,376
Jul-10	0	195	648	308	1,675	2,825
Aug-10	0	141	447	184	991	1,763
Sep-10	0	37	177	52	174	440
Oct-10	0	25	40	28	89	181
Nov-10	0	9	44	9	91	153
Dec-10	0	13	6	15	98	133
Jan-11	0	29	48	41	354	471
Feb-11	0	50	341	61	588	1,040
Mar-11	0	46	152	66	382	645
Apr-11	0	66	212	94	375	748
May-11	0	105	416	143	569	1,233
Jun-11	0	169	564	266	1,377	2,376
Jul-11	0	195	648	308	1,675	2,825
Aug-11	0	141	447	184	991	1,763
Sep-11	0	37	177	52	174	440
Oct-11	0	25	40	28	89	181
Nov-11	0	9	44	9	91	153
Dec-11	0	13	6	15	98	133
Jan-12	0	29	48	41	354	471
Feb-12	0	50	341	61	588	1,040
Mar-12	0	46	152	66	382	645
Apr-12	0	66	212	94	375	748
May-12	0	105	416	143	569	1,233
Jun-12	0	169	564	266	1,377	2,376
Jul-12	0	195	648	308	1,675	2,825
Aug-12	0	141	447	184	991	1,763
Sep-12	0	37	177	52	174	440
Oct-12	0	25	40	28	89	181
Nov-12	0	9	44	9	91	153
Dec-12	0	13	6	15	98	133
Jan-13	0	29	48	41	354	471
Feb-13	0	50	341	61	588	1,040
Mar-13	0	46	152	66	382	645
Apr-13	0	66	212	94	375	748
May-13	0	105	416	143	569	1,233
Jun-13	0	169	564	266	1,377	2,376
Jul-13	0	195	648	308	1,675	2,825
Aug-13	0	141	447	184	991	1,763
Sep-13	0	37	177	52	174	440
Oct-13	0	25	40	28	89	181

Table C1-7
Monthly Volume of Recycled Drainage by District for Below Normal/Dry, acre-feet

Month-Year	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Sum
Nov-13	0	9	44	9	91	153
Dec-13	0	13	6	15	98	133
Jan-14	0	29	48	41	354	471
Feb-14	0	50	341	61	588	1,040
Mar-14	0	46	152	66	382	645
Apr-14	0	66	212	94	375	748
May-14	0	105	416	143	569	1,233
Jun-14	0	169	564	266	1,377	2,376
Jul-14	0	195	648	308	1,675	2,825
Aug-14	0	141	447	184	991	1,763
Sep-14	0	37	177	52	174	440
Oct-14	0	25	40	28	89	181
Nov-14	0	9	44	9	91	153
Dec-14	0	13	6	15	98	133
Jan-15	0	29	48	41	321	438
Feb-15	0	50	341	61	588	1,040
Mar-15	0	46	152	66	382	645
Apr-15	0	66	212	94	375	748
May-15	0	105	416	143	569	1,233
Jun-15	0	169	564	266	1,377	2,376
Jul-15	0	195	648	308	1,675	2,825
Aug-15	0	141	447	184	991	1,763
Sep-15	0	37	177	52	174	440
Oct-15	0	25	40	28	89	181
Nov-15	0	9	44	9	91	153
Dec-15	0	13	6	15	98	133
Jan-16	0	29	48	41	354	471
Feb-16	0	50	341	61	588	1,040
Mar-16	0	46	152	66	382	645
Apr-16	0	66	212	94	375	748
May-16	0	105	416	143	569	1,233
Jun-16	0	169	564	266	1,377	2,376
Jul-16	0	195	648	308	1,675	2,825
Aug-16	0	141	447	184	991	1,763
Sep-16	0	37	177	52	174	440
Oct-16	0	25	40	28	89	181
Nov-16	0	9	44	9	91	153
Dec-16	0	13	6	15	98	133
Jan-17	0	29	48	41	354	471
Feb-17	0	50	341	61	588	1,040
Mar-17	0	46	152	66	382	645
Apr-17	0	66	212	94	375	748
May-17	0	105	416	143	569	1,233
Jun-17	0	169	564	266	1,377	2,376
Jul-17	0	195	648	308	1,675	2,825

Table C1-7
Monthly Volume of Recycled Drainage by District for Below Normal/Dry, acre-feet

Month-Year	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Sum
Aug-17	0	141	447	184	991	1,763
Sep-17	0	37	177	52	174	440
Oct-17	0	25	40	28	89	181
Nov-17	0	9	44	9	91	153
Dec-17	0	13	6	15	98	133
Jan-18	0	29	48	41	354	471
Feb-18	0	50	341	61	588	1,040
Mar-18	0	46	152	66	382	645
Apr-18	0	66	212	94	375	748
May-18	0	105	416	143	569	1,233
Jun-18	0	169	564	266	1,377	2,376
Jul-18	0	195	648	308	1,675	2,825
Aug-18	0	141	447	184	991	1,763
Sep-18	0	37	177	52	174	440
Oct-18	0	25	40	28	89	181
Nov-18	0	9	44	9	91	153
Dec-18	0	13	6	15	98	133
Jan-19	0	29	48	41	354	471
Feb-19	0	50	341	61	588	1,040
Mar-19	0	46	152	66	382	645
Apr-19	0	66	212	94	375	748
May-19	0	105	416	143	569	1,233
Jun-19	0	169	564	266	1,377	2,376
Jul-19	0	195	648	308	1,675	2,825
Aug-19	0	141	447	184	991	1,763
Sep-19	0	37	177	52	174	440
Oct-19	0	25	40	28	89	181
Nov-19	0	9	44	9	91	153
Dec-19	0	13	6	15	98	133

Note: The treatment facility is assumed to be operational for Jan 2015 to Dec 2019

Table C1-8
Monthly Volume of Recycled Drainage by District for Critical Years, acre-feet

Month-Year	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Sum
Jan-10	0	29	48	41	354	471
Feb-10	0	50	341	61	588	1,040
Mar-10	0	46	152	66	382	645
Apr-10	0	66	212	94	375	748
May-10	0	105	416	143	569	1,233
Jun-10	0	169	564	266	1,377	2,376
Jul-10	0	195	648	308	1,675	2,825
Aug-10	0	141	447	184	991	1,763
Sep-10	0	37	177	52	174	440
Oct-10	0	25	40	28	89	181
Nov-10	0	9	44	9	91	153
Dec-10	0	13	6	15	98	133
Jan-11	0	29	48	41	354	471
Feb-11	0	50	341	61	588	1,040
Mar-11	0	46	152	66	382	645
Apr-11	0	66	212	94	375	748
May-11	0	105	416	143	569	1,233
Jun-11	0	169	564	266	1,377	2,376
Jul-11	0	195	648	308	1,675	2,825
Aug-11	0	141	447	184	991	1,763
Sep-11	0	37	177	52	174	440
Oct-11	0	25	40	28	89	181
Nov-11	0	9	44	9	91	153
Dec-11	0	13	6	15	98	133
Jan-12	0	29	48	41	354	471
Feb-12	0	50	341	61	588	1,040
Mar-12	0	46	152	66	382	645
Apr-12	0	66	212	94	375	748
May-12	0	105	416	143	569	1,233
Jun-12	0	169	564	266	1,377	2,376
Jul-12	0	195	648	308	1,675	2,825
Aug-12	0	141	447	184	991	1,763
Sep-12	0	37	177	52	174	440
Oct-12	0	25	40	28	89	181
Nov-12	0	9	44	9	91	153
Dec-12	0	13	6	15	98	133
Jan-13	0	29	48	41	354	471
Feb-13	0	50	341	61	588	1,040
Mar-13	0	46	152	66	382	645
Apr-13	0	66	212	94	375	748
May-13	0	105	416	143	569	1,233
Jun-13	0	169	564	266	1,377	2,376
Jul-13	0	195	648	308	1,675	2,825
Aug-13	0	141	447	184	991	1,763
Sep-13	0	37	177	52	174	440
Oct-13	0	25	40	28	89	181

Table C1-8
Monthly Volume of Recycled Drainage by District for Critical Years, acre-feet

Month-Year	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Sum
Nov-13	0	9	44	9	91	153
Dec-13	0	13	6	15	98	133
Jan-14	0	29	48	41	354	471
Feb-14	0	50	341	61	588	1,040
Mar-14	0	46	152	66	382	645
Apr-14	0	66	212	94	375	748
May-14	0	105	416	143	569	1,233
Jun-14	0	169	564	266	1,377	2,376
Jul-14	0	195	648	308	1,675	2,825
Aug-14	0	141	447	184	991	1,763
Sep-14	0	37	177	52	174	440
Oct-14	0	25	40	28	89	181
Nov-14	0	9	44	9	91	153
Dec-14	0	13	6	15	98	133
Jan-15	0	29	48	41	354	471
Feb-15	0	50	341	61	588	1,040
Mar-15	0	46	152	66	382	645
Apr-15	0	66	212	94	375	748
May-15	0	105	416	143	569	1,233
Jun-15	0	169	564	266	1,377	2,376
Jul-15	0	195	648	308	1,675	2,825
Aug-15	0	141	447	184	991	1,763
Sep-15	0	37	177	52	174	440
Oct-15	0	25	40	28	89	181
Nov-15	0	9	44	9	91	153
Dec-15	0	13	6	15	98	133
Jan-16	0	29	48	41	354	471
Feb-16	0	50	341	61	588	1,040
Mar-16	0	46	152	66	382	645
Apr-16	0	66	212	94	375	748
May-16	0	105	416	143	569	1,233
Jun-16	0	169	564	266	1,377	2,376
Jul-16	0	195	648	308	1,675	2,825
Aug-16	0	141	447	184	991	1,763
Sep-16	0	37	177	52	174	440
Oct-16	0	25	40	28	89	181
Nov-16	0	9	44	9	91	153
Dec-16	0	13	6	15	98	133
Jan-17	0	29	48	41	354	471
Feb-17	0	50	341	61	588	1,040
Mar-17	0	46	152	66	382	645
Apr-17	0	66	212	94	375	748
May-17	0	105	416	143	569	1,233
Jun-17	0	169	564	266	1,377	2,376
Jul-17	0	195	648	308	1,675	2,825
Aug-17	0	141	447	184	991	1,763

Table C1-8
Monthly Volume of Recycled Drainage by District for Critical Years, acre-feet

Month-Year	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District	Sum
Sep-17	0	37	177	52	174	440
Oct-17	0	25	40	28	89	181
Nov-17	0	9	44	9	91	153
Dec-17	0	13	6	15	98	133
Jan-18	0	29	48	41	354	471
Feb-18	0	50	341	61	588	1,040
Mar-18	0	46	152	66	382	645
Apr-18	0	66	212	94	375	748
May-18	0	105	416	143	569	1,233
Jun-18	0	169	564	266	1,377	2,376
Jul-18	0	195	648	308	1,675	2,825
Aug-18	0	141	447	184	991	1,763
Sep-18	0	37	177	52	174	440
Oct-18	0	25	40	28	89	181
Nov-18	0	9	44	9	91	153
Dec-18	0	13	6	15	98	133
Jan-19	0	29	48	41	354	471
Feb-19	0	50	341	61	588	1,040
Mar-19	0	46	152	66	382	645
Apr-19	0	66	212	94	375	748
May-19	0	105	416	143	569	1,233
Jun-19	0	169	564	266	1,377	2,376
Jul-19	0	195	648	308	1,675	2,825
Aug-19	0	141	447	184	991	1,763
Sep-19	0	37	177	52	174	440
Oct-19	0	25	40	28	89	181
Nov-19	0	9	44	9	91	153
Dec-19	0	13	6	15	98	133

Note: The treatment facility is assumed to be operational for Jan 2015 to Dec 2019

Table C1-9
Monthly Factors and Depth to Groundwater

	Monthly Factor	Estimated Depth to Groundwater for Sump Model of Future Conditions (ft)
Oct	1.06	7.2
Nov	1.06	7.2
Dec	1.06	7.2
Jan	1.05	7.1
Feb	1.00	6.8
Mar	0.98	6.7
Apr	1.00	6.8
May	0.97	6.6
Jun	0.93	6.3
Jul	0.90	6.1
Aug	0.97	6.6
Sep	1.03	7.0
Average	**1.00**	**6.8**

Table C1-10
Monthly Selenium Concentration of Applied Water by District for Wet Years

Month-Year	Applied Water Selenium (µg/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct-09	47.9	30.5	0.1	4.2	1.9	2.9	1.6
Nov-09	66.4	37.5	0.5	3.6	3.4	2.8	3.4
Dec-09	47.1	0.0	0.1	3.2	0.4	1.9	1.6
Jan-10	40.9	0.0	0.4	6.3	2.7	3.9	3.8
Feb-10	0.0	0.0	0.9	6.5	4.0	4.4	3.9
Mar-10	66.2	30.3	1.1	8.0	6.5	8.2	5.2
Apr-10	3.7	3.7	2.2	7.0	8.9	9.3	6.3
May-10	10.1	4.7	3.4	10.8	14.2	8.5	8.2
Jun-10	14.8	3.9	1.9	11.8	10.9	10.2	8.8
Jul-10	18.4	3.3	0.7	13.3	9.8	10.3	9.8
Aug-10	5.2	3.2	0.5	8.8	7.5	10.2	9.3
Sep-10	29.6	12.2	0.5	16.4	11.2	12.7	8.2
Average:	29.2	10.8	1.0	8.3	6.8	7.1	5.8
Oct-13	58.8	12.9	0.1	4.2	1.9	2.9	1.6
Nov-13	83.4	1.6	0.5	3.6	3.4	2.8	3.4
Dec-13	67.8	0.0	0.1	3.2	0.4	1.9	1.6
Jan-14	75.9	0.0	0.4	6.3	2.7	3.9	3.8
Feb-14	55.2	0.0	0.9	6.5	6.6	4.4	4.3
Mar-14	104.2	30.3	1.1	8.0	6.5	8.2	5.2
Apr-14	53.9	3.7	2.2	7.0	9.4	9.3	6.3
May-14	53.3	4.7	3.4	10.8	14.2	8.5	8.2
Jun-14	70.0	3.9	1.9	11.8	10.9	10.2	8.8
Jul-14	76.3	3.3	0.7	13.3	9.8	10.3	9.8
Aug-14	51.7	3.2	0.5	8.8	7.5	10.2	9.3
Sep-14	74.0	12.2	0.5	16.4	11.2	12.7	8.2
Average:	68.7	6.3	1.0	8.3	7.0	7.1	5.9
Oct-14	64.2	12.5	0.1	4.2	1.9	2.9	1.6
Nov-14	91.7	1.6	0.5	3.6	3.4	2.8	3.4
Dec-14	72.6	0.0	0.1	3.2	0.4	1.9	1.6
Jan-15	80.9	0.0	0.4	6.3	2.7	3.9	3.8
Feb-15	71.1	0.0	0.9	6.5	6.6	4.4	4.3
Mar-15	109.0	59.7	1.1	8.0	6.5	8.2	5.2
Apr-15	75.4	3.7	2.2	7.0	9.4	9.3	6.3
May-15	68.0	7.8	3.4	10.8	14.2	8.5	8.2
Jun-15	80.6	3.9	1.9	11.8	10.9	10.2	8.8
Jul-15	85.9	5.3	0.7	13.3	9.8	10.3	9.8
Aug-15	63.5	3.2	0.5	8.8	7.5	10.2	9.3

Table C1-10
Monthly Selenium Concentration of Applied Water by District for Wet Years

Month-Year	Applied Water Selenium (µg/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Sep-15	88.8	26.8	0.5	16.4	11.2	12.7	8.2
Average:	79.3	10.4	1.0	8.3	7.0	7.1	5.9
Oct-18	87.9	59.3	0.1	4.2	1.9	2.9	1.6
Nov-18	113.1	74.5	0.5	3.6	3.4	2.8	3.4
Dec-18	83.2	0.0	0.1	3.2	0.4	1.9	1.6
Jan-19	86.8	29.9	0.4	6.3	2.7	3.9	3.8
Feb-19	89.0	37.0	0.9	6.5	6.6	4.4	4.3
Mar-19	115.6	74.9	1.1	8.0	6.5	8.2	5.2
Apr-19	118.5	57.6	2.2	7.0	9.4	9.3	6.3
May-19	104.5	43.5	3.4	10.8	14.2	8.5	8.2
Jun-19	106.2	28.5	1.9	11.8	10.9	10.2	8.8
Jul-19	108.5	27.2	0.7	13.3	9.8	10.3	9.8
Aug-19	92.4	26.9	0.5	8.8	7.5	10.2	9.3
Sep-19	126.2	66.0	0.5	16.4	11.2	12.7	8.2
Average:	102.7	43.8	1.0	8.3	7.0	7.1	5.9

Note: Applied Water includes irrigation, precipitation, and recycled drainage

Table C1-11
Monthly Selenium Concentration of Applied Water by District for Above Normal Years

	Applied Water Selenium (µg/L)						
Month-Year	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct-09	40.9	26.8	0.3	14.2	6.8	10.6	10.8
Nov-09	51.2	23.6	0.6	8.2	5.0	6.4	7.2
Dec-09	85.6	51.8	0.9	13.1	4.6	8.0	8.0
Jan-10	0.0	0.0	0.5	2.0	1.3	2.0	0.9
Feb-10	0.0	0.0	0.9	7.5	4.7	5.0	4.8
Mar-10	54.4	27.7	1.5	10.7	8.8	10.9	7.5
Apr-10	5.0	3.5	2.0	6.3	8.3	8.4	5.4
May-10	11.3	4.7	3.4	10.8	14.2	8.5	8.2
Jun-10	31.7	11.7	1.9	11.5	10.6	9.9	8.5
Jul-10	37.0	13.6	0.7	13.3	9.8	10.3	9.8
Aug-10	25.4	7.4	0.5	8.8	7.5	10.2	9.3
Sep-10	43.6	26.4	0.5	16.4	11.2	12.7	8.2
Average:	32.2	16.4	1.1	10.2	7.7	8.6	7.4
Oct-13	67.9	26.8	0.3	14.2	6.8	10.6	10.8
Nov-13	103.9	23.6	0.6	8.2	5.0	6.4	7.2
Dec-13	45.8	3.4	0.9	13.1	4.6	8.0	8.0
Jan-14	40.7	0.0	0.5	6.7	2.9	4.1	4.0
Feb-14	68.6	0.0	0.9	7.5	7.2	5.0	4.9
Mar-14	122.6	27.7	1.5	10.7	8.8	10.9	7.5
Apr-14	48.8	3.5	2.0	6.3	8.3	8.4	5.4
May-14	50.0	4.7	3.4	10.8	14.2	8.5	8.2
Jun-14	83.0	11.7	1.9	11.5	10.6	9.9	8.5
Jul-14	96.8	13.6	0.7	13.3	9.8	10.3	9.8
Aug-14	71.8	7.4	0.5	8.8	7.5	10.2	9.3
Sep-14	87.4	26.4	0.5	16.4	11.2	12.7	8.2
Average:	73.9	12.4	1.1	10.6	8.1	8.8	7.7
Oct-14	74.1	25.9	0.3	14.2	6.8	10.6	10.8
Nov-14	117.2	22.8	0.6	8.2	5.0	6.4	7.2
Dec-14	64.9	3.4	0.9	13.1	4.6	8.0	8.0
Jan-15	65.6	0.0	0.5	6.7	2.9	4.1	4.0
Feb-15	83.3	0.0	0.9	7.5	7.2	5.0	4.9
Mar-15	126.9	49.3	1.5	10.7	8.8	10.9	7.5
Apr-15	67.0	5.9	2.0	6.3	8.3	8.4	5.4
May-15	63.2	9.2	3.4	10.8	14.2	8.5	8.2
Jun-15	88.5	17.0	1.9	11.5	10.6	9.9	8.5
Jul-15	102.4	19.0	0.7	13.3	9.8	10.3	9.8
Aug-15	78.7	14.1	0.5	8.8	7.5	10.2	9.3

Table C1-11
Monthly Selenium Concentration of Applied Water by District for Above Normal Years

	Applied Water Selenium (µg/L)						
Month-Year	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Sep-15	98.7	37.6	0.5	16.4	11.2	12.7	8.2
Average:	85.9	17.0	1.1	10.6	8.1	8.8	7.7
Oct-18	126.6	76.1	0.3	14.2	6.8	10.6	10.8
Nov-18	132.9	94.2	0.6	8.2	5.0	6.4	7.2
Dec-18	123.8	85.9	0.9	13.1	4.6	8.0	8.0
Jan-19	88.6	0.0	0.5	6.7	2.9	4.1	4.0
Feb-19	99.4	30.0	0.9	7.5	7.2	5.0	4.9
Mar-19	129.4	86.7	1.5	10.7	8.8	10.9	7.5
Apr-19	111.9	55.1	2.0	6.3	8.3	8.4	5.4
May-19	97.9	43.1	3.4	10.8	14.2	8.5	8.2
Jun-19	103.2	31.2	1.9	11.5	10.6	9.9	8.5
Jul-19	116.2	32.3	0.7	13.3	9.8	10.3	9.8
Aug-19	97.4	32.3	0.5	8.8	7.5	10.2	9.3
Sep-19	126.2	71.3	0.5	16.4	11.2	12.7	8.2
Average:	112.8	53.2	1.1	10.6	8.1	8.8	7.7

Note: Applied Water includes irrigation, precipitation, and recycled drainage

Table C1-12
Monthly Selenium Concentration of Applied Water by District for Below Normal/Dry Years

Month-Year	Applied Water Selenium (ug/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct-09	43.0	29.3	0.3	14.2	6.8	10.6	10.8
Nov-09	66.1	34.2	0.6	5.3	4.2	4.1	4.9
Dec-09	58.3	0.0	0.1	4.4	0.6	2.6	2.3
Jan-10	1.2	1.2	0.7	9.8	4.5	6.0	3.5
Feb-10	45.2	0.0	0.9	6.7	6.8	4.5	4.4
Mar-10	96.2	71.2	1.6	11.3	9.3	11.5	8.0
Apr-10	37.1	22.5	2.8	8.8	12.2	11.6	8.9
May-10	37.3	22.5	3.4	10.7	14.2	8.5	8.1
Jun-10	39.9	19.6	1.9	11.6	10.9	10.1	8.7
Jul-10	45.3	21.6	0.7	13.2	9.8	10.2	9.7
Aug-10	35.6	17.1	0.5	8.7	7.5	10.0	9.1
Sep-10	44.8	29.0	0.5	16.4	11.2	12.7	8.2
Average:	45.8	22.3	1.2	10.1	8.2	8.5	7.2
Oct-13	72.2	32.2	0.3	14.2	6.8	10.6	10.8
Nov-13	110.6	41.4	0.6	5.3	4.2	4.1	4.9
Dec-13	65.9	0.0	0.1	4.4	0.6	2.6	2.3
Jan-14	89.8	1.2	0.7	9.8	4.5	6.0	5.6
Feb-14	89.3	0.0	0.9	6.7	6.8	4.5	4.4
Mar-14	129.9	85.4	1.6	11.3	9.3	11.5	8.0
Apr-14	84.4	32.4	2.8	8.8	12.2	11.6	8.9
May-14	83.3	30.7	3.4	10.7	14.2	8.5	8.1
Jun-14	94.4	22.1	1.9	11.6	10.9	10.1	8.7
Jul-14	108.3	24.1	0.7	13.2	9.8	10.2	9.7
Aug-14	85.9	20.1	0.5	8.7	7.5	10.0	9.1
Sep-14	86.6	30.3	0.5	16.4	11.2	12.7	8.2
Average:	91.7	26.7	1.2	10.1	8.2	8.5	7.4
Oct-14	78.1	31.1	0.3	14.2	6.8	10.6	10.8
Nov-14	116.5	40.0	0.6	5.3	4.2	4.1	4.9
Dec-14	73.2	0.0	0.1	4.4	0.6	2.6	2.3
Jan-15	99.4	1.2	0.7	9.8	4.5	6.0	5.6
Feb-15	92.1	0.0	0.9	6.7	6.8	4.5	4.4
Mar-15	131.2	88.0	1.6	11.3	9.3	11.5	8.0
Apr-15	89.1	37.0	2.8	8.8	12.2	11.6	8.9
May-15	87.2	34.5	3.4	10.7	14.2	8.5	8.1
Jun-15	97.2	24.8	1.9	11.6	10.9	10.1	8.7
Jul-15	111.2	26.9	0.7	13.2	9.8	10.2	9.7
Aug-15	89.6	23.7	0.5	8.7	7.5	10.0	9.1

Table C1-12
Monthly Selenium Concentration of Applied Water by District for Below Normal/Dry Years

	Applied Water Selenium (ug/L)						
Month-Year	**SJRIP**	**SJRIP with Treatment**	**Camp 13 Drainage Area**	**Charleston Drainage District**	**Firebaugh Canal Water District**	**Pacheco Water District**	**Panoche Drainage District**
Sep-15	95.5	39.1	0.5	16.4	11.2	12.7	8.2
Average:	96.7	28.9	1.2	10.1	8.2	8.5	7.4
Oct-18	122.4	73.3	0.3	14.2	6.8	10.6	10.8
Nov-18	125.0	87.5	0.6	5.3	4.2	4.1	4.9
Dec-18	96.0	0.0	0.1	4.4	0.6	2.6	2.3
Jan-19	109.4	59.9	0.7	9.8	4.5	6.0	5.6
Feb-19	96.3	48.2	0.9	6.7	6.8	4.5	4.4
Mar-19	131.6	88.7	1.6	11.3	9.3	11.5	8.0
Apr-19	104.8	52.4	2.8	8.8	12.2	11.6	8.9
May-19	98.8	45.9	3.4	10.7	14.2	8.5	8.1
Jun-19	104.7	32.1	1.9	11.6	10.9	10.1	8.7
Jul-19	117.0	32.5	0.7	13.2	9.8	10.2	9.7
Aug-19	98.7	32.5	0.5	8.7	7.5	10.0	9.1
Sep-19	122.3	65.5	0.5	16.4	11.2	12.7	8.2
Average:	110.6	51.5	1.2	10.1	8.2	8.5	7.4

Note: Applied Water includes irrigation, precipitation, and recycled drainage

Table C1-13
Monthly Selenium Concentration of Applied Water by District for Critical Years

	Applied Water Selenium (µg/L)						
Month-Year	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct-09	86.0	67.4	0.2	7.8	3.6	5.5	3.5
Nov-09	106.8	94.2	0.7	8.9	5.1	7.0	7.8
Dec-09	76.6	52.3	0.3	7.3	1.3	4.4	3.9
Jan-10	62.0	22.6	0.9	11.9	5.8	7.2	6.6
Feb-10	78.0	51.2	1.1	10.1	8.7	6.8	6.6
Mar-10	105.9	92.0	1.7	12.5	10.3	12.6	9.1
Apr-10	58.6	39.9	2.6	8.2	11.2	10.9	8.0
May-10	46.7	31.3	3.4	10.7	14.2	8.5	8.1
Jun-10	46.1	25.5	1.9	11.6	10.9	10.1	8.7
Jul-10	53.4	28.6	0.7	13.2	9.8	10.2	9.7
Aug-10	42.8	24.0	0.5	8.7	7.5	10.0	9.1
Sep-10	82.6	63.9	0.5	15.1	10.6	11.7	7.2
Average:	70.4	49.4	1.2	10.5	8.2	8.8	7.4
Oct-13	107.6	77.6	0.2	7.8	3.6	5.5	3.5
Nov-13	127.8	94.2	0.7	8.9	5.1	7.0	7.8
Dec-13	101.5	52.3	0.3	7.3	1.3	4.4	3.9
Jan-14	115.3	58.5	0.9	11.9	5.8	7.2	6.6
Feb-14	118.7	53.4	1.1	10.1	8.7	6.8	6.6
Mar-14	134.3	92.0	1.7	12.5	10.3	12.6	9.1
Apr-14	123.3	56.4	2.6	8.2	11.2	10.9	8.0
May-14	96.9	42.4	3.4	10.7	14.2	8.5	8.1
Jun-14	102.8	29.8	1.9	11.6	10.9	10.1	8.7
Jul-14	121.3	33.1	0.7	13.2	9.8	10.2	9.7
Aug-14	95.8	29.3	0.5	8.7	7.5	10.0	9.1
Sep-14	122.4	75.3	0.5	15.1	10.6	11.7	7.2
Average:	114.0	57.9	1.2	10.5	8.2	8.8	7.4
Oct-14	112.0	80.6	0.2	7.8	3.6	5.5	3.5
Nov-14	133.4	94.3	0.7	8.9	5.1	7.0	7.8
Dec-14	106.9	52.3	0.3	7.3	1.3	4.4	3.9
Jan-15	116.4	55.8	0.9	11.9	5.8	7.2	6.6
Feb-15	119.6	51.2	1.1	10.1	8.7	6.8	6.6
Mar-15	135.6	92.0	1.7	12.5	10.3	12.6	9.1
Apr-15	125.2	58.2	2.6	8.2	11.2	10.9	8.0
May-15	98.2	43.5	3.4	10.7	14.2	8.5	8.1
Jun-15	103.7	30.6	1.9	11.6	10.9	10.1	8.7
Jul-15	120.6	32.4	0.7	13.2	9.8	10.2	9.7
Aug-15	95.7	29.1	0.5	8.7	7.5	10.0	9.1

Table C1-13
Monthly Selenium Concentration of Applied Water by District for Critical Years

	Applied Water Selenium (µg/L)						
Month-Year	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Sep-15	123.6	75.3	0.5	15.1	10.6	11.7	7.2
Average:	115.9	58.0	1.2	10.5	8.2	8.8	7.4
Oct-18	114.5	82.9	0.2	7.8	3.6	5.5	3.5
Nov-18	134.9	96.6	0.7	8.9	5.1	7.0	7.8
Dec-18	111.9	52.3	0.3	7.3	1.3	4.4	3.9
Jan-19	118.9	72.2	0.9	11.9	5.8	7.2	6.6
Feb-19	121.1	65.5	1.1	10.1	8.7	6.8	6.6
Mar-19	135.6	92.0	1.7	12.5	10.3	12.6	9.1
Apr-19	131.3	69.9	2.6	8.2	11.2	10.9	8.0
May-19	103.3	48.6	3.4	10.7	14.2	8.5	8.1
Jun-19	106.2	33.1	1.9	11.6	10.9	10.1	8.7
Jul-19	122.7	34.4	0.7	13.2	9.8	10.2	9.7
Aug-19	101.5	34.7	0.5	8.7	7.5	10.0	9.1
Sep-19	123.8	82.0	0.5	15.1	10.6	11.7	7.2
Average:	118.8	63.7	1.2	10.5	8.2	8.8	7.4

Note: Applied Water includes irrigation, precipitation, and recycled drainage

Table C1-14
Monthly Total Dissolved Solids Concentration of Applied Water by District for Wet Years

Month-Year	Applied Water TDS (mg/L)						
	SJRIP	**SJRIP with Treatment**	**Camp 13 Drainage Area**	**Charleston Drainage District**	**Firebaugh Canal Water District**	**Pacheco Water District**	**Panoche Drainage District**
Oct-09	1744	1061	88	176	167	166	87
Nov-09	2455	1419	194	194	375	184	217
Dec-09	1889	0	36	146	53	140	119
Jan-10	1620	0	129	271	223	278	297
Feb-10	0	0	223	311	320	308	293
Mar-10	2890	1632	211	384	376	389	344
Apr-10	1013	1013	235	478	446	479	422
May-10	1353	1188	311	599	600	599	598
Jun-10	1516	1155	245	598	443	598	598
Jul-10	1620	1128	190	598	411	598	598
Aug-10	1215	1146	226	598	407	598	598
Sep-10	1925	1396	271	600	600	600	600
Average:	1603	928	197	413	368	411	398
Oct-13	2269	646	88	176	167	166	87
Nov-13	3274	555	194	194	375	184	217
Dec-13	2829	0	36	146	53	140	119
Jan-14	3194	0	129	271	223	278	297
Feb-14	2492	0	223	311	405	308	318
Mar-14	4619	1632	211	384	376	389	344
Apr-14	2806	1013	235	478	462	479	422
May-14	2914	1188	311	599	600	599	598
Jun-14	3701	1155	245	598	443	598	598
Jul-14	3936	1128	190	598	411	598	598
Aug-14	3023	1146	226	598	407	598	598
Sep-14	3536	1396	271	600	600	600	600
Average:	3216	821	197	413	377	411	400
Oct-14	2511	635	88	176	167	166	87
Nov-14	3649	555	194	194	375	184	217
Dec-14	3058	0	36	146	53	140	119
Jan-15	3412	0	129	271	223	278	297
Feb-15	3214	0	223	311	405	308	318
Mar-15	4834	2532	211	384	376	389	344
Apr-15	3588	1013	235	478	462	479	422
May-15	3449	1270	311	599	600	599	598
Jun-15	4119	1155	245	598	443	598	598
Jul-15	4319	1175	190	598	411	598	598
Aug-15	3487	1146	226	598	407	598	598

Table C1-14
Monthly Total Dissolved Solids Concentration of Applied Water by District for Wet Years

	Applied Water TDS (mg/L)						
Month-Year	**SJRIP**	**SJRIP with Treatment**	**Camp 13 Drainage Area**	**Charleston Drainage District**	**Firebaugh Canal Water District**	**Pacheco Water District**	**Panoche Drainage District**
Sep-15	4046	1766	271	600	600	600	600
Average:	3640	937	197	413	377	411	400
Oct-18	3449	2059	88	176	167	166	87
Nov-18	4513	2616	194	194	375	184	217
Dec-18	3507	0	36	146	53	140	119
Jan-19	3658	1128	129	271	223	278	297
Feb-19	4020	1587	223	311	405	308	318
Mar-19	5129	3169	211	384	376	389	344
Apr-19	5150	2520	235	478	462	479	422
May-19	4750	2185	311	599	600	599	598
Jun-19	5110	1797	245	598	443	598	598
Jul-19	5193	1708	190	598	411	598	598
Aug-19	4609	1833	226	598	407	598	598
Sep-19	5304	2763	271	600	600	600	600
Average:	4533	1947	197	413	377	411	400

Note: Applied Water includes irrigation, precipitation, and recycled drainage

Table C1-15
Monthly Total Dissolved Solids Concentration of Applied Water by District for Above Normal Years

Month-Year	Applied Water TDS (mg/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct-09	2170	1730	278	600	600	600	600
Nov-09	2422	1606	266	435	541	426	455
Dec-09	3569	2451	338	600	600	600	600
Jan-10	0	0	137	173	166	204	150
Feb-10	0	0	243	358	361	356	356
Mar-10	2787	1844	278	517	513	519	495
Apr-10	1008	960	212	430	410	431	363
May-10	1390	1188	311	599	600	599	598
Jun-10	2047	1327	239	581	431	581	577
Jul-10	2228	1376	190	598	411	598	598
Aug-10	1907	1267	226	598	407	598	598
Sep-10	2330	1758	271	600	600	600	600
Average:	1821	1292	249	508	470	509	499
Oct-13	3118	1730	278	600	600	600	600
Nov-13	4243	1606	266	435	541	426	455
Dec-13	2574	1202	338	600	600	600	600
Jan-14	1712	0	137	287	239	294	314
Feb-14	3096	0	243	358	445	356	365
Mar-14	5449	1844	278	517	513	519	495
Apr-14	2579	960	212	430	410	431	363
May-14	2800	1188	311	599	600	599	598
Jun-14	4171	1327	239	581	431	581	577
Jul-14	4728	1376	190	598	411	598	598
Aug-14	3801	1267	226	598	407	598	598
Sep-14	3986	1758	271	600	600	600	600
Average:	3521	1188	249	517	483	517	514
Oct-14	3370	1709	278	600	600	600	600
Nov-14	4758	1588	266	435	541	426	455
Dec-14	3243	1202	338	600	600	600	600
Jan-15	2765	0	137	287	239	294	314
Feb-15	3764	0	243	358	445	356	365
Mar-15	5632	2506	278	517	513	519	495
Apr-15	3239	1026	212	430	410	431	363
May-15	3277	1305	311	599	600	599	598
Jun-15	4396	1466	239	581	431	581	577
Jul-15	4957	1507	190	598	411	598	598
Aug-15	4077	1461	226	598	407	598	598

Table C1-15
Monthly Total Dissolved Solids Concentration of Applied Water by District for Above Normal Years

Month-Year	Applied Water TDS (mg/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Sep-15	4381	2041	271	600	600	600	600
Average:	3988	1317	249	517	483	517	514
Oct-18	5017	2894	278	600	600	600	600
Nov-18	5302	3312	266	435	541	426	455
Dec-18	5221	3332	338	600	600	600	600
Jan-19	3736	0	137	287	239	294	314
Feb-19	4489	1287	243	358	445	356	365
Mar-19	5740	3667	278	517	513	519	495
Apr-19	4861	2405	212	430	410	431	363
May-19	4514	2176	311	599	600	599	598
Jun-19	4963	1836	239	581	431	581	577
Jul-19	5488	1831	190	598	411	598	598
Aug-19	4804	1989	226	598	407	598	598
Sep-19	5304	2897	271	600	600	600	600
Average:	4953	2302	249	517	483	517	514

Note: Applied Water includes irrigation, precipitation, and recycled drainage

Attachment C-1: Selected Inputs and Results from the Drainage Model

Table C1-16
Monthly Total Dissolved Solids Concentration of Applied Water by District for Below Normal/Dry Years

Month-Year	Applied Water TDS (mg/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct-09	2227	1789	278	600	600	600	600
Nov-09	2680	1712	229	281	453	270	306
Dec-09	2336	0	54	202	79	195	170
Jan-10	412	412	211	421	377	427	330
Feb-10	1986	0	228	322	415	320	330
Mar-10	4201	3206	290	543	540	545	527
Apr-10	2209	1689	296	600	600	600	600
May-10	2175	1647	311	601	600	601	602
Jun-10	2350	1564	245	602	443	602	602
Jul-10	2502	1572	190	602	411	602	602
Aug-10	2253	1548	226	602	407	602	602
Sep-10	2364	1822	271	600	600	600	600
Average:	2308	1413	236	498	460	497	489
Oct-13	3249	1858	278	600	600	600	600
Nov-13	4342	1888	229	281	453	270	306
Dec-13	2749	0	54	202	79	195	170
Jan-14	3780	412	211	421	377	427	442
Feb-14	4030	0	228	322	415	320	330
Mar-14	5757	3642	290	543	540	545	527
Apr-14	4044	1966	296	600	600	600	600
May-14	3982	1857	311	601	600	601	602
Jun-14	4639	1628	245	602	443	602	602
Jul-14	5170	1633	190	602	411	602	602
Aug-14	4347	1636	226	602	407	602	602
Sep-14	3960	1856	271	600	600	600	600
Average:	4171	1531	236	498	460	497	499
Oct-14	3493	1833	278	600	600	600	600
Nov-14	4638	1853	229	281	453	270	306
Dec-14	3079	0	54	202	79	195	170
Jan-15	4189	412	211	421	377	427	442
Feb-15	4159	0	228	322	415	320	330
Mar-15	5822	3720	290	543	540	545	527
Apr-15	4226	2095	296	600	600	600	600
May-15	4135	1954	311	601	600	601	602
Jun-15	4762	1700	245	602	443	602	602
Jul-15	5296	1700	190	602	411	602	602
Aug-15	4500	1739	226	602	407	602	602

Table C1-16
Monthly Total Dissolved Solids Concentration of Applied Water by District for Below Normal/Dry Years

Month-Year	Applied Water TDS (mg/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Sep-15	4272	2078	271	600	600	600	600
Average:	4381	1590	236	498	460	497	499
Oct-18	4885	2827	278	600	600	600	600
Nov-18	4990	3074	229	281	453	270	306
Dec-18	4048	0	54	202	79	195	170
Jan-19	4615	2258	211	421	377	427	442
Feb-19	4352	2066	228	322	415	320	330
Mar-19	5839	3752	290	543	540	545	527
Apr-19	4790	2526	296	600	600	600	600
May-19	4548	2246	311	601	600	601	602
Jun-19	5051	1888	245	602	443	602	602
Jul-19	5520	1836	190	602	411	602	602
Aug-19	4853	1995	226	602	407	602	602
Sep-19	5173	2749	271	600	600	600	600
Average:	4889	2268	236	498	460	497	499

Note: Applied Water includes irrigation, precipitation, and recycled drainage

Table C1-17
Monthly Total Dissolved Solids Concentration of Applied Water by District for Critical Years

Month-Year	Applied Water TDS (mg/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct-09	3131	2456	158	327	316	314	196
Nov-09	3952	3311	273	474	558	467	490
Dec-09	3071	2030	108	333	164	325	295
Jan-10	2692	1509	264	509	480	512	522
Feb-10	3427	2194	284	483	533	482	488
Mar-10	4566	3893	318	600	600	600	600
Apr-10	2847	2136	276	560	554	560	537
May-10	2458	1873	311	601	600	601	602
Jun-10	2553	1718	245	602	443	602	602
Jul-10	2766	1740	190	602	411	602	602
Aug-10	2499	1749	226	602	407	602	602
Sep-10	3424	2684	260	553	570	554	526
Average:	3115	2274	243	520	470	518	505
Oct-13	4155	2696	158	327	316	314	196
Nov-13	5015	3311	273	474	558	467	490
Dec-13	4235	2030	108	333	164	325	295
Jan-14	4851	2360	264	509	480	512	522
Feb-14	5359	2287	284	483	533	482	488
Mar-14	5952	3893	318	600	600	600	600
Apr-14	5399	2599	276	560	554	560	537
May-14	4465	2157	311	601	600	601	602
Jun-14	4963	1830	245	602	443	602	602
Jul-14	5668	1851	190	602	411	602	602
Aug-14	4731	1900	226	602	407	602	602
Sep-14	5136	2972	260	553	570	554	526
Average:	4994	2490	243	520	470	518	505
Oct-14	4384	2800	158	327	316	314	196
Nov-14	5308	3313	273	474	558	467	490
Dec-14	4498	2030	108	333	164	325	295
Jan-15	4907	2296	264	509	480	512	522
Feb-15	5403	2194	284	483	533	482	488
Mar-15	6016	3893	318	600	600	600	600
Apr-15	5483	2649	276	560	554	560	537
May-15	4524	2186	311	601	600	601	602
Jun-15	5011	1851	245	602	443	602	602
Jul-15	5659	1834	190	602	411	602	602
Aug-15	4739	1897	226	602	407	602	602

Table C1-17
Monthly Total Dissolved Solids Concentration of Applied Water by District for Critical Years

	Applied Water TDS (mg/L)						
Month-Year	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Sep-15	5197	2972	260	553	570	554	526
Average:	5094	2493	243	520	470	518	505
Oct-18	4494	2878	158	327	316	314	196
Nov-18	5381	3395	273	474	558	467	490
Dec-18	4720	2030	108	333	164	325	295
Jan-19	5014	2722	264	509	480	512	522
Feb-19	5470	2805	284	483	533	482	488
Mar-19	6016	3893	318	600	600	600	600
Apr-19	5705	2976	276	560	554	560	537
May-19	4707	2315	311	601	600	601	602
Jun-19	5108	1915	245	602	443	602	602
Jul-19	5738	1883	190	602	411	602	602
Aug-19	4962	2059	226	602	407	602	602
Sep-19	5202	3143	260	553	570	554	526
Average:	5210	2668	243	520	470	518	505

Note: Applied Water includes irrigation, precipitation, and recycled drainage

Table C1-18
Monthly Boron Concentration of Applied Water by District for Wet Years

	Applied Water Boron (mg/L)						
Month-Year	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct-09	3.8	2.4	0.0	0.1	0.2	0.2	0.1
Nov-09	5.3	3.0	0.1	0.1	0.6	0.2	0.3
Dec-09	4.0	0.0	0.0	0.1	0.1	0.2	0.2
Jan-10	3.3	0.0	0.1	0.3	0.3	0.4	0.5
Feb-10	0.0	0.0	0.2	0.3	0.4	0.4	0.5
Mar-10	5.3	2.8	0.3	0.5	0.6	0.5	0.5
Apr-10	1.5	1.5	0.2	0.6	0.7	0.7	0.6
May-10	2.1	1.7	0.3	0.7	0.9	0.8	0.9
Jun-10	2.5	1.6	0.1	0.8	0.5	1.0	0.9
Jul-10	2.8	1.6	0.1	0.6	0.5	0.9	0.8
Aug-10	1.8	1.6	0.1	0.6	0.5	0.8	0.8
Sep-10	3.7	2.3	0.1	0.7	0.7	0.9	0.8
Average:	3.0	1.6	0.1	0.5	0.5	0.6	0.6
Oct-13	4.9	1.3	0.0	0.1	0.2	0.2	0.1
Nov-13	6.9	0.8	0.1	0.1	0.6	0.2	0.3
Dec-13	5.9	0.0	0.0	0.1	0.1	0.2	0.2
Jan-14	6.5	0.0	0.1	0.3	0.3	0.4	0.5
Feb-14	5.1	0.0	0.2	0.3	0.6	0.4	0.5
Mar-14	8.8	2.8	0.3	0.5	0.6	0.5	0.5
Apr-14	5.4	1.5	0.2	0.6	0.7	0.7	0.6
May-14	5.5	1.7	0.3	0.7	0.9	0.8	0.9
Jun-14	7.2	1.6	0.1	0.8	0.5	1.0	0.9
Jul-14	7.8	1.6	0.1	0.6	0.5	0.9	0.8
Aug-14	6.0	1.6	0.1	0.6	0.5	0.8	0.8
Sep-14	7.4	2.3	0.1	0.7	0.7	0.9	0.8
Average:	6.4	1.3	0.1	0.5	0.5	0.6	0.6
Oct-14	5.4	1.2	0.0	0.1	0.2	0.2	0.1
Nov-14	7.7	0.8	0.1	0.1	0.6	0.2	0.3
Dec-14	6.4	0.0	0.0	0.1	0.1	0.2	0.2
Jan-15	6.9	0.0	0.1	0.3	0.3	0.4	0.5
Feb-15	6.5	0.0	0.2	0.3	0.6	0.4	0.5
Mar-15	9.2	4.6	0.3	0.5	0.6	0.5	0.5
Apr-15	7.2	1.5	0.2	0.6	0.7	0.7	0.6
May-15	6.7	1.9	0.3	0.7	0.9	0.8	0.9
Jun-15	8.1	1.6	0.1	0.8	0.5	1.0	0.9
Jul-15	8.6	1.8	0.1	0.6	0.5	0.9	0.8
Aug-15	7.0	1.6	0.1	0.6	0.5	0.8	0.8

Table C1-18
Monthly Boron Concentration of Applied Water by District for Wet Years

Month-Year	Applied Water Boron (mg/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Sep-15	8.6	3.4	0.1	0.7	0.7	0.9	0.8
Average:	7.4	1.5	0.1	0.5	0.5	0.6	0.6
Oct-18	7.4	4.6	0.0	0.1	0.2	0.2	0.1
Nov-18	9.5	5.8	0.1	0.1	0.6	0.2	0.3
Dec-18	7.3	0.0	0.0	0.1	0.1	0.2	0.2
Jan-19	7.4	2.3	0.1	0.3	0.3	0.4	0.5
Feb-19	8.1	3.3	0.2	0.3	0.6	0.4	0.5
Mar-19	9.8	5.8	0.3	0.5	0.6	0.5	0.5
Apr-19	10.6	5.2	0.2	0.6	0.7	0.7	0.6
May-19	9.6	4.3	0.3	0.7	0.9	0.8	0.9
Jun-19	10.2	3.3	0.1	0.8	0.5	1.0	0.9
Jul-19	10.5	3.3	0.1	0.6	0.5	0.9	0.8
Aug-19	9.6	3.7	0.1	0.6	0.5	0.8	0.8
Sep-19	11.7	6.4	0.1	0.7	0.7	0.9	0.8
Average:	9.3	4.0	0.1	0.5	0.5	0.6	0.6

Note: Applied Water includes irrigation, precipitation, and recycled drainage

Table C1-19
Monthly Boron Concentration of Applied Water by District for Above Normal Years

Month-Year	Applied Water Boron (mg/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct-09	4.2	3.1	0.1	0.4	0.7	0.7	0.9
Nov-09	4.8	2.9	0.2	0.3	0.8	0.5	0.7
Dec-09	7.5	4.9	0.3	0.4	0.8	0.7	0.9
Jan-10	0.0	0.0	0.1	0.2	0.2	0.2	0.1
Feb-10	0.0	0.0	0.2	0.4	0.5	0.4	0.6
Mar-10	5.0	3.1	0.3	0.6	0.8	0.7	0.8
Apr-10	1.5	1.4	0.2	0.5	0.6	0.6	0.5
May-10	2.2	1.7	0.3	0.7	0.9	0.8	0.9
Jun-10	3.7	2.1	0.1	0.7	0.5	0.9	0.9
Jul-10	4.3	2.4	0.1	0.6	0.5	0.9	0.8
Aug-10	3.6	2.0	0.1	0.6	0.5	0.8	0.8
Sep-10	4.8	3.4	0.1	0.7	0.7	0.9	0.8
Average:	3.5	2.2	0.2	0.5	0.6	0.7	0.7
Oct-13	6.3	3.1	0.1	0.4	0.7	0.7	0.9
Nov-13	8.9	2.9	0.2	0.3	0.8	0.5	0.7
Dec-13	4.9	1.7	0.3	0.4	0.8	0.7	0.9
Jan-14	3.5	0.0	0.1	0.3	0.3	0.4	0.5
Feb-14	6.3	0.0	0.2	0.4	0.7	0.4	0.6
Mar-14	10.4	3.1	0.3	0.6	0.8	0.7	0.8
Apr-14	5.0	1.4	0.2	0.5	0.6	0.6	0.5
May-14	5.3	1.7	0.3	0.7	0.9	0.8	0.9
Jun-14	8.2	2.1	0.1	0.7	0.5	0.9	0.9
Jul-14	9.5	2.4	0.1	0.6	0.5	0.9	0.8
Aug-14	7.7	2.0	0.1	0.6	0.5	0.8	0.8
Sep-14	8.5	3.4	0.1	0.7	0.7	0.9	0.8
Average:	7.0	2.0	0.2	0.5	0.7	0.7	0.8
Oct-14	6.8	3.1	0.1	0.4	0.7	0.7	0.9
Nov-14	10.0	2.8	0.2	0.3	0.8	0.5	0.7
Dec-14	6.4	0.0	0.3	0.4	0.8	0.7	0.9
Jan-15	5.6	0.0	0.1	0.3	0.3	0.4	0.5
Feb-15	7.6	0.0	0.2	0.4	0.7	0.4	0.6
Mar-15	10.7	4.4	0.3	0.6	0.8	0.7	0.8
Apr-15	6.4	1.6	0.2	0.5	0.6	0.6	0.5
May-15	6.3	2.0	0.3	0.7	0.9	0.8	0.9
Jun-15	8.7	2.5	0.1	0.7	0.5	0.9	0.9
Jul-15	10.0	2.7	0.1	0.6	0.5	0.9	0.8
Aug-15	8.4	2.6	0.1	0.6	0.5	0.8	0.8

Table C1-19
Monthly Boron Concentration of Applied Water by District for Above Normal Years

	Applied Water Boron (mg/L)						
Month-Year	**SJRIP**	**SJRIP with Treatment**	**Camp 13 Drainage Area**	**Charleston Drainage District**	**Firebaugh Canal Water District**	**Pacheco Water District**	**Panoche Drainage District**
Sep-15	9.4	4.2	0.1	0.7	0.7	0.9	0.8
Average:	8.0	2.2	0.2	0.5	0.7	0.7	0.8
Oct-18	10.7	6.2	0.1	0.4	0.7	0.7	0.9
Nov-18	11.2	7.3	0.2	0.3	0.8	0.5	0.7
Dec-18	10.9	7.2	0.3	0.4	0.8	0.7	0.9
Jan-19	7.6	0.0	0.1	0.3	0.3	0.4	0.5
Feb-19	9.1	2.7	0.2	0.4	0.7	0.4	0.6
Mar-19	10.9	6.7	0.3	0.6	0.8	0.7	0.8
Apr-19	10.0	5.0	0.2	0.5	0.6	0.6	0.5
May-19	9.1	4.2	0.3	0.7	0.9	0.8	0.9
Jun-19	9.9	3.5	0.1	0.7	0.5	0.9	0.9
Jul-19	11.2	3.7	0.1	0.6	0.5	0.9	0.8
Aug-19	10.0	4.2	0.1	0.6	0.5	0.8	0.8
Sep-19	11.7	6.8	0.1	0.7	0.7	0.9	0.8
Average:	10.2	4.8	0.2	0.5	0.7	0.7	0.8

Note: Applied Water includes irrigation, precipitation, and recycled drainage

Table C1-20
Monthly Boron Concentration of Applied Water by District for Below Normal/Dry Years

Month-Year	Applied Water Boron (mg/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct-09	4.3	3.3	0.1	0.4	0.7	0.7	0.9
Nov-09	5.6	3.3	0.2	0.2	0.7	0.3	0.5
Dec-09	5.0	0.0	0.0	0.1	0.1	0.2	0.3
Jan-10	0.6	0.6	0.2	0.5	0.5	0.6	0.4
Feb-10	4.1	0.0	0.2	0.4	0.6	0.4	0.6
Mar-10	7.8	5.8	0.4	0.7	0.9	0.7	0.8
Apr-10	4.1	3.0	0.3	0.7	0.9	0.8	0.9
May-10	4.1	2.9	0.3	0.7	0.9	0.8	0.9
Jun-10	4.4	2.7	0.1	0.8	0.5	1.0	0.9
Jul-10	4.9	2.9	0.1	0.6	0.5	0.9	0.8
Aug-10	4.5	2.9	0.1	0.6	0.5	0.8	0.8
Sep-10	4.9	3.6	0.1	0.7	0.7	0.9	0.8
Average:	4.5	2.6	0.2	0.5	0.6	0.7	0.7
Oct-13	6.6	3.5	0.1	0.4	0.7	0.7	0.9
Nov-13	9.2	3.8	0.2	0.2	0.7	0.3	0.5
Dec-13	5.7	0.0	0.0	0.1	0.1	0.2	0.3
Jan-14	7.7	0.6	0.2	0.5	0.5	0.6	0.7
Feb-14	8.2	0.0	0.2	0.4	0.6	0.4	0.6
Mar-14	11.0	6.6	0.4	0.7	0.9	0.7	0.8
Apr-14	8.1	3.7	0.3	0.7	0.9	0.8	0.9
May-14	7.9	3.4	0.3	0.7	0.9	0.8	0.9
Jun-14	9.2	2.9	0.1	0.8	0.5	1.0	0.9
Jul-14	10.5	3.1	0.1	0.6	0.5	0.9	0.8
Aug-14	9.0	3.1	0.1	0.6	0.5	0.8	0.8
Sep-14	8.4	3.7	0.1	0.7	0.7	0.9	0.8
Average:	8.5	2.9	0.2	0.5	0.6	0.7	0.7
Oct-14	7.1	3.4	0.1	0.4	0.7	0.7	0.9
Nov-14	9.8	3.7	0.2	0.2	0.7	0.3	0.5
Dec-14	6.4	0.0	0.0	0.1	0.1	0.2	0.3
Jan-15	8.5	0.6	0.2	0.5	0.5	0.6	0.7
Feb-15	8.4	0.0	0.2	0.4	0.6	0.4	0.6
Mar-15	11.1	6.8	0.4	0.7	0.9	0.7	0.8
Apr-15	8.5	4.0	0.3	0.7	0.9	0.8	0.9
May-15	8.2	3.7	0.3	0.7	0.9	0.8	0.9
Jun-15	9.5	3.1	0.1	0.8	0.5	1.0	0.9
Jul-15	10.8	3.3	0.1	0.6	0.5	0.9	0.8
Aug-15	9.3	3.4	0.1	0.6	0.5	0.8	0.8

Table C1-20
Monthly Boron Concentration of Applied Water by District for Below Normal/Dry Years

Month-Year	Applied Water Boron (mg/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Sep-15	9.2	4.3	0.1	0.7	0.7	0.9	0.8
Average:	8.9	3.0	0.2	0.5	0.6	0.7	0.7
Oct-18	10.3	6.1	0.1	0.4	0.7	0.7	0.9
Nov-18	10.5	6.8	0.2	0.2	0.7	0.3	0.5
Dec-18	8.4	0.0	0.0	0.1	0.1	0.2	0.3
Jan-19	9.4	4.7	0.2	0.5	0.5	0.6	0.7
Feb-19	8.8	4.3	0.2	0.4	0.6	0.4	0.6
Mar-19	11.1	6.8	0.4	0.7	0.9	0.7	0.8
Apr-19	9.7	5.0	0.3	0.7	0.9	0.8	0.9
May-19	9.2	4.4	0.3	0.7	0.9	0.8	0.9
Jun-19	10.1	3.6	0.1	0.8	0.5	1.0	0.9
Jul-19	11.2	3.7	0.1	0.6	0.5	0.9	0.8
Aug-19	10.1	4.2	0.1	0.6	0.5	0.8	0.8
Sep-19	11.4	6.3	0.1	0.7	0.7	0.9	0.8
Average:	10.0	4.7	0.2	0.5	0.6	0.7	0.7

Note: Applied Water includes irrigation, precipitation, and recycled drainage

Table C1-21
Monthly Boron Concentration of Applied Water by District for Critical Years

Month-Year	Applied Water Boron (mg/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Oct-09	6.9	5.4	0.1	0.2	0.4	0.4	0.3
Nov-09	8.5	7.3	0.2	0.3	0.8	0.6	0.8
Dec-09	6.5	4.4	0.1	0.2	0.2	0.4	0.4
Jan-10	5.4	2.7	0.2	0.6	0.7	0.7	0.8
Feb-10	7.0	4.5	0.3	0.5	0.8	0.5	0.8
Mar-10	8.5	7.1	0.4	0.7	1.0	0.8	0.9
Apr-10	5.7	4.1	0.3	0.7	0.8	0.8	0.8
May-10	4.7	3.5	0.3	0.7	0.9	0.8	0.9
Jun-10	4.9	3.1	0.1	0.8	0.5	1.0	0.9
Jul-10	5.6	3.4	0.1	0.6	0.5	0.9	0.8
Aug-10	5.1	3.5	0.1	0.6	0.5	0.8	0.8
Sep-10	7.8	6.2	0.1	0.6	0.7	0.9	0.7
Average:	6.4	4.6	0.2	0.6	0.7	0.7	0.7
Oct-13	8.9	6.0	0.1	0.2	0.4	0.4	0.3
Nov-13	10.6	7.3	0.2	0.3	0.8	0.6	0.8
Dec-13	8.8	4.4	0.1	0.2	0.2	0.4	0.4
Jan-14	9.9	4.8	0.2	0.6	0.7	0.7	0.8
Feb-14	10.9	4.7	0.3	0.5	0.8	0.5	0.8
Mar-14	11.3	7.1	0.4	0.7	1.0	0.8	0.9
Apr-14	11.1	5.3	0.3	0.7	0.8	0.8	0.8
May-14	9.0	4.2	0.3	0.7	0.9	0.8	0.9
Jun-14	9.9	3.4	0.1	0.8	0.5	1.0	0.9
Jul-14	11.6	3.7	0.1	0.6	0.5	0.9	0.8
Aug-14	9.9	3.9	0.1	0.6	0.5	0.8	0.8
Sep-14	11.3	7.0	0.1	0.6	0.7	0.9	0.7
Average:	10.3	5.2	0.2	0.6	0.7	0.7	0.7
Oct-14	9.4	6.3	0.1	0.2	0.4	0.4	0.3
Nov-14	11.2	7.3	0.2	0.3	0.8	0.6	0.8
Dec-14	9.4	4.4	0.1	0.2	0.2	0.4	0.4
Jan-15	10.0	4.6	0.2	0.6	0.7	0.7	0.8
Feb-15	10.9	4.5	0.3	0.5	0.8	0.5	0.8
Mar-15	11.5	7.1	0.4	0.7	1.0	0.8	0.9
Apr-15	11.3	5.4	0.3	0.7	0.8	0.8	0.8
May-15	9.1	4.3	0.3	0.7	0.9	0.8	0.9
Jun-15	10.0	3.5	0.1	0.8	0.5	1.0	0.9
Jul-15	11.6	3.7	0.1	0.6	0.5	0.9	0.8
Aug-15	9.9	3.9	0.1	0.6	0.5	0.8	0.8

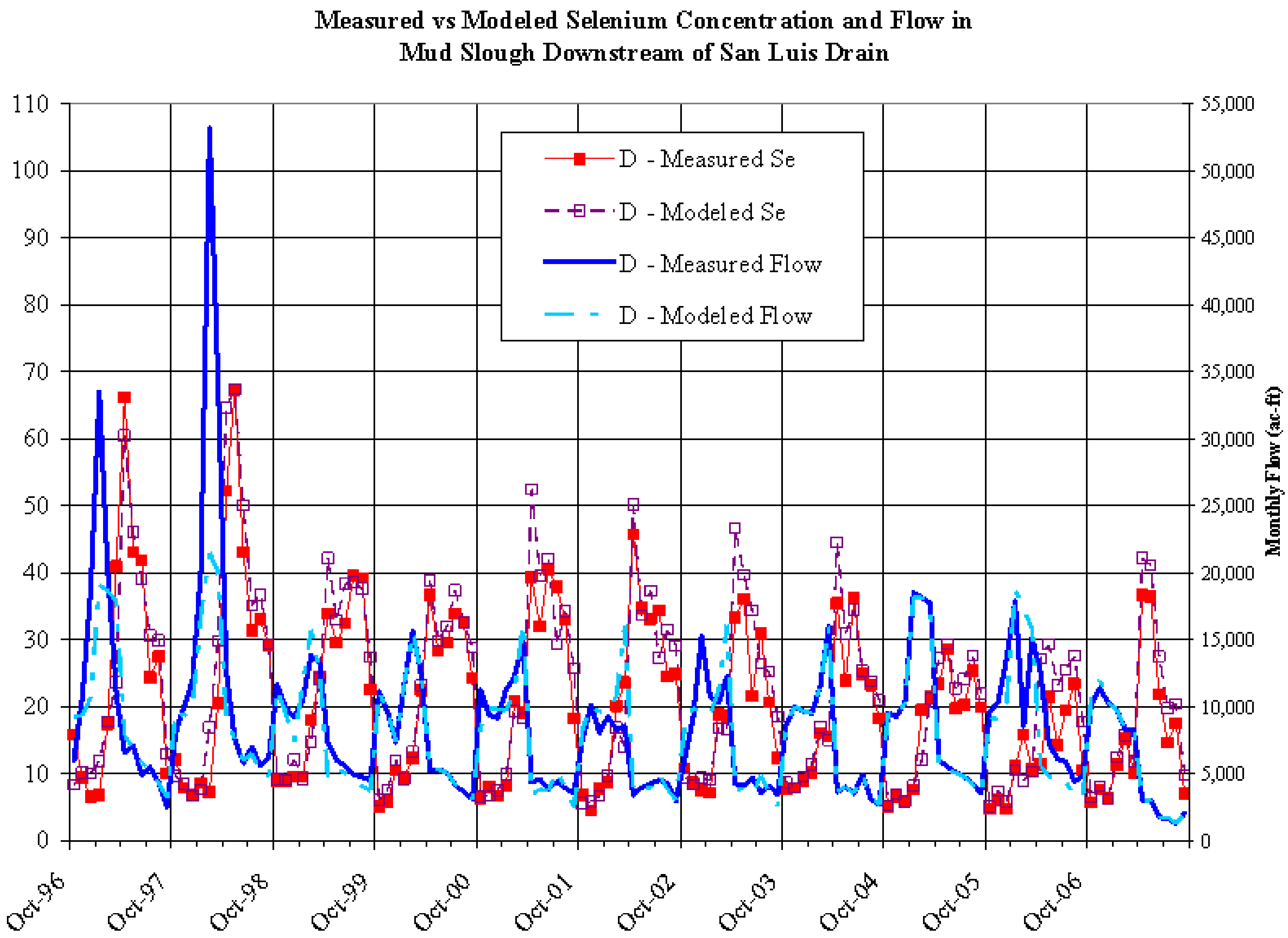
Table C1-21
Monthly Boron Concentration of Applied Water by District for Critical Years

Month-Year	Applied Water Boron (mg/L)						
	SJRIP	SJRIP with Treatment	Camp 13 Drainage Area	Charleston Drainage District	Firebaugh Canal Water District	Pacheco Water District	Panoche Drainage District
Sep-15	11.5	7.0	0.1	0.6	0.7	0.9	0.7
Average:	10.5	5.2	0.2	0.6	0.7	0.7	0.7
Oct-18	9.6	6.4	0.1	0.2	0.4	0.4	0.3
Nov-18	11.3	7.5	0.2	0.3	0.8	0.6	0.8
Dec-18	9.8	4.4	0.1	0.2	0.2	0.4	0.4
Jan-19	10.2	5.6	0.2	0.6	0.7	0.7	0.8
Feb-19	11.1	5.8	0.3	0.5	0.8	0.5	0.8
Mar-19	11.5	7.1	0.4	0.7	1.0	0.8	0.9
Apr-19	11.7	6.2	0.3	0.7	0.8	0.8	0.8
May-19	9.5	4.6	0.3	0.7	0.9	0.8	0.9
Jun-19	10.2	3.7	0.1	0.8	0.5	1.0	0.9
Jul-19	11.7	3.8	0.1	0.6	0.5	0.9	0.8
Aug-19	10.4	4.4	0.1	0.6	0.5	0.8	0.8
Sep-19	11.5	7.5	0.1	0.6	0.7	0.9	0.7
Average:	10.7	5.6	0.2	0.6	0.7	0.7	0.7

Note: Applied Water includes irrigation, precipitation, and recycled drainage

ATTACHMENT C-2

Verification of Receiving Water Model



Measured vs Modeled Selenium Concentration and Flow in
Mud Slough Downstream of San Luis Drain
D - Measured Se
D - Modeled Se
D - Measured Flow
D - Modeled Flow
Monthly Flow (ac-ft)
0
10
20
30
40
50
60
70
80
90
100
110
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
50,000
55,000
Oct-96
Oct-97
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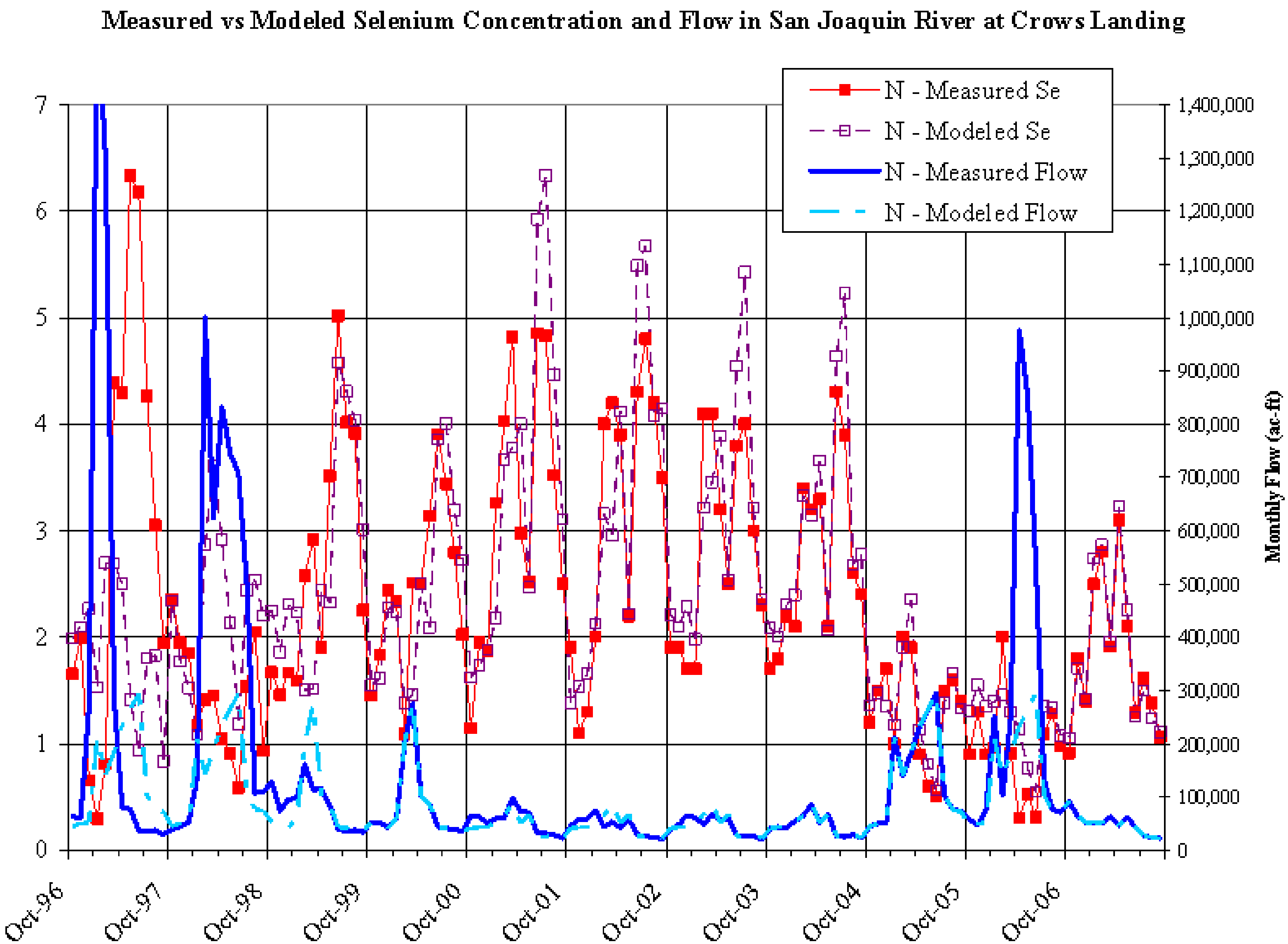
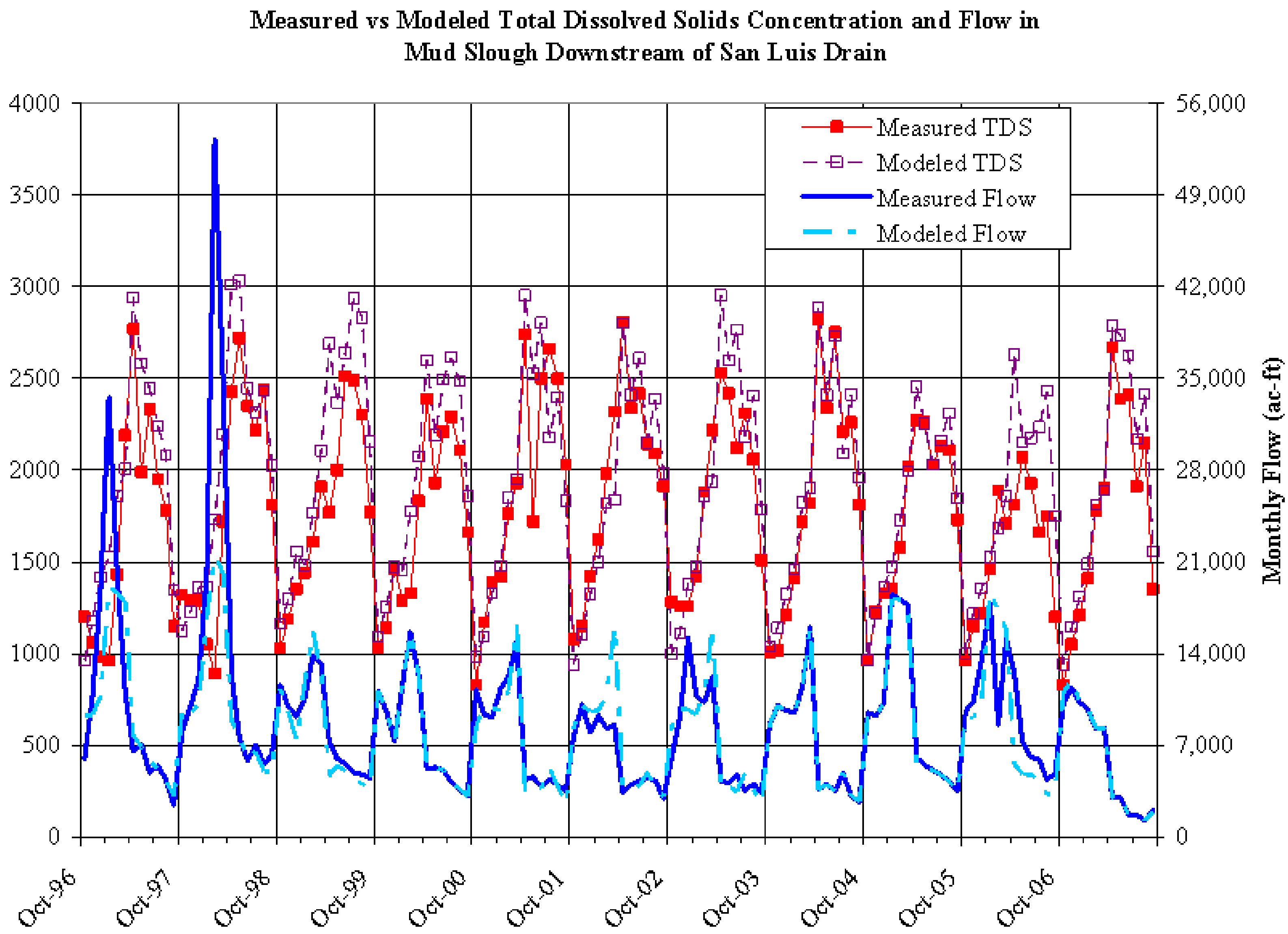
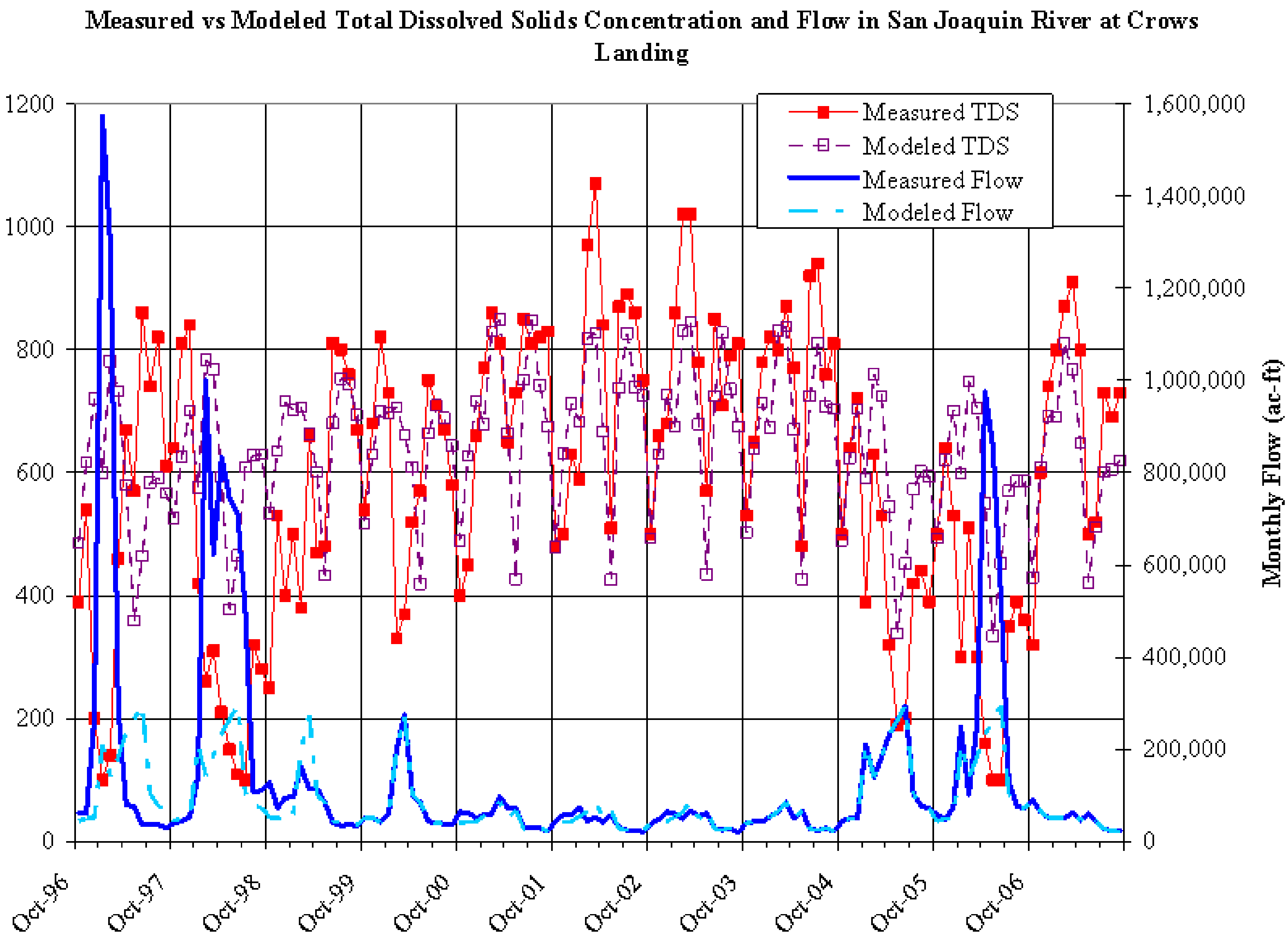
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06

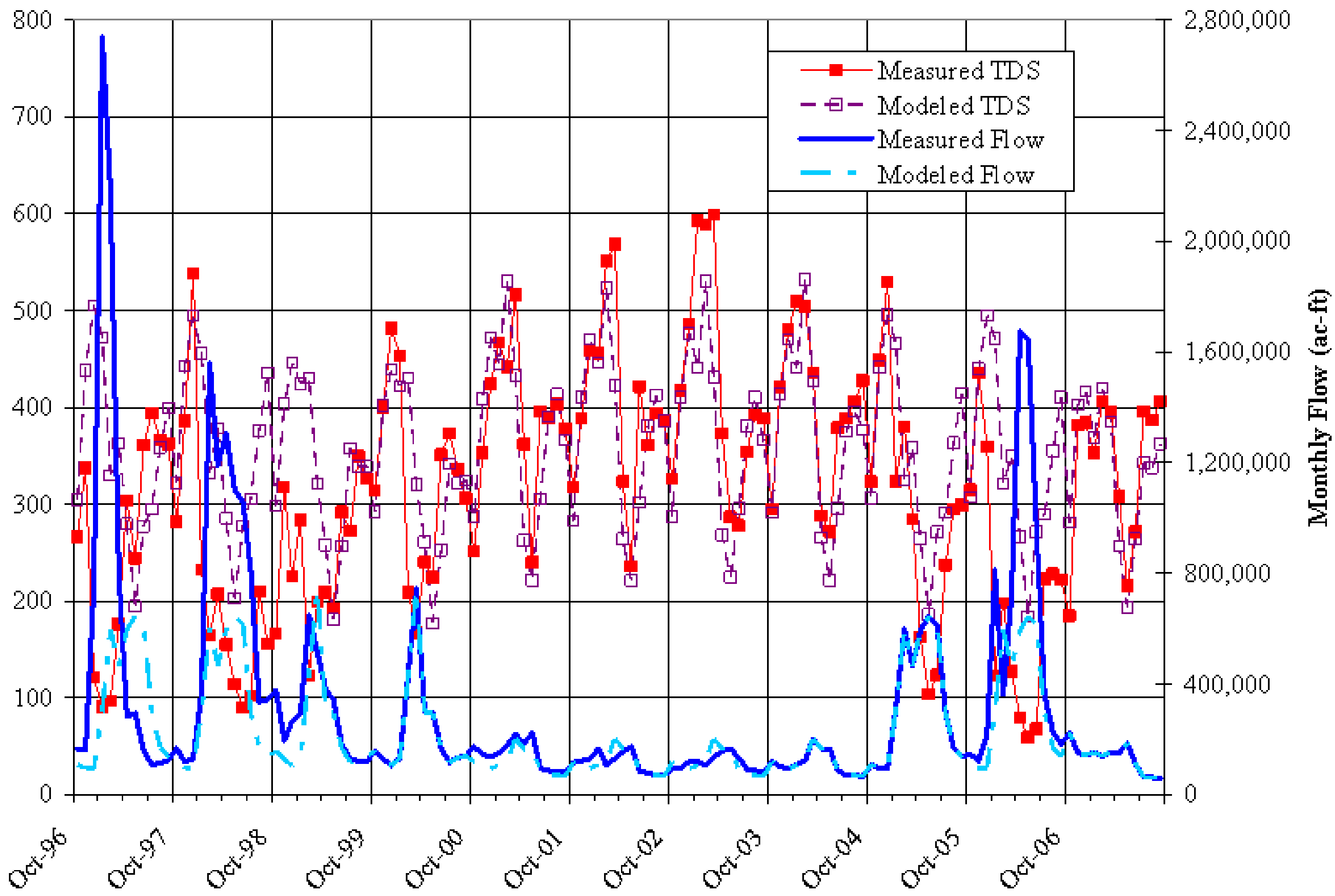

Measured vs Modeled Selenium Concentration and Flow in San Joaquin River at Crows Landing
N - Measured Se
N - Modeled Se
N - Measured Flow
N - Modeled Flow
0
1
2
3
4
5
6
7
0
100,000
200,000
300,000
400,000
500,000
600,000
700,000
800,000
900,000
1,000,000
1,100,000
1,200,000
1,300,000
1,400,000
Monthly Flow (ac-ft)
Oct-96
Oct-97
Oct-98
Oct-99
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06

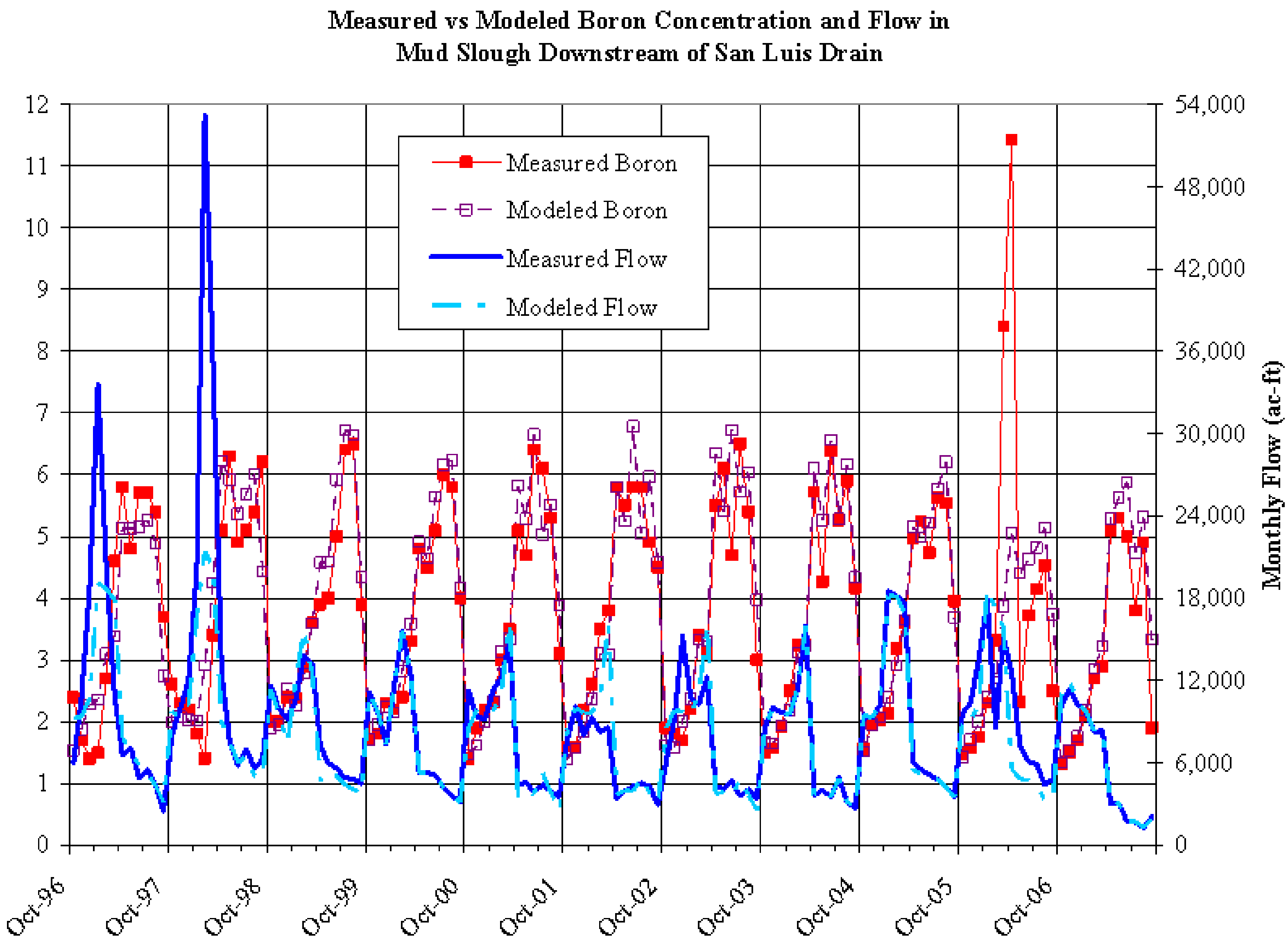


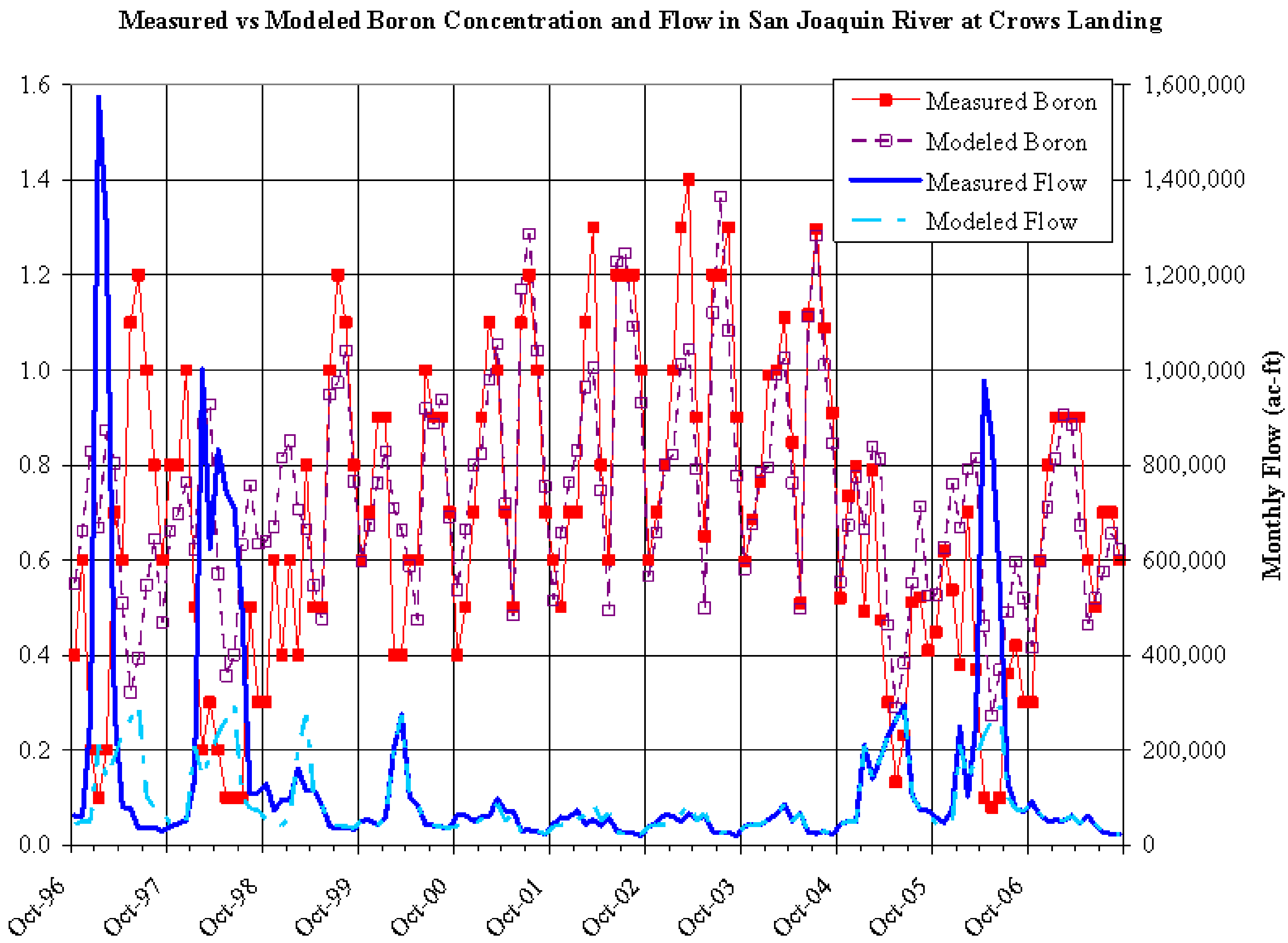
Measured vs Modeled Total Dissolved Solids Concentration and Flow in Mud Slough Downstream of San Luis Drain
Measured TDS
Modeled TDS
Measured Flow
Modeled Flow
Monthly Flow (ac-ft)
4000
3500
3000
2500
2000
1500
1000
500
0
56,000
49,000
42,000
35,000
28,000
21,000
14,000
7,000
0
Oct-96
Oct-97
Oct-98
Oct-99
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06


Measured vs Modeled Total Dissolved Solids Concentration and Flow in San Joaquin River at Crows Landing
Measured TDS
Modeled TDS
Measured Flow
Modeled Flow
1200
1000
800
600
400
200
0
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Monthly Flow (ac-ft)
Oct-96
Oct-97
Oct-98
Oct-99
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06

Measured vs Modeled Total Dissolved Solids Concentration and Flow in San Joaquin River at Vernalis




Measured vs Modeled Boron Concentration and Flow in
Mud Slough Downstream of San Luis Drain
Measured Boron
Modeled Boron
Measured Flow
Modeled Flow
0
1
2
3
4
5
6
7
8
9
10
11
12
0
6,000
12,000
18,000
24,000
30,000
36,000
42,000
48,000
54,000
Monthly Flow (ac-ft)
Oct-96
Oct-97
Oct-98
Oct-99
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06


Measured vs Modeled Boron Concentration and Flow in San Joaquin River at Crows Landing
Measured Boron
Modeled Boron
Measured Flow
Modeled Flow
Monthly Flow (ac-ft)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Oct-96
Oct-97
Oct-98
Oct-99
Oct-00
Oct-01
Oct-02
Oct-03
Oct-04
Oct-05
Oct-06

ATTACHMENT C-3

Proposed Selenium Load values

Attachment C-3: Proposed Selenium Load Values

Table C3-1
Proposed Selenium Load Values (pounds) for the 2010 Use Agreement for Wet Years

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Jan	211	211	211	211	211	165	120	74	211	211
Feb	488	488	488	488	488	382	277	171	488	488
March	488	488	488	488	488	382	277	171	488	488
April	506	506	506	506	506	396	287	177	506	506
May	512	512	512	512	512	401	290	179	512	512
June	354	354	354	354	354	277	201	124	354	354
July	356	356	356	356	356	279	202	125	356	356
Aug	366	366	366	366	366	287	208	128	366	366
Sep	332	332	332	332	332	260	188	116	332	332
Oct	328	328	328	328	328	257	186	115	328	328
Nov	328	328	328	328	328	257	186	115	328	328
Dec	211	211	211	211	211	165	120	74	211	211
Total	**4480**	**4480**	**4480**	**4480**	**4480**	**3510**	**2540**	**1570**	**600**	**600**

Note: Monthly values are equal to the TMML values for years 2018 and 2019

Attachment C-3: Proposed Selenium Load Values

Table C3-2
Proposed Selenium Load Values (pounds) for the 2010 Use Agreement for Above Normal Years

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Jan	398	398	398	398	398	309	221	132	398	398
Feb	472	472	472	472	472	367	262	156	472	472
March	472	472	472	472	472	367	262	156	472	472
April	490	490	490	490	490	381	271	162	490	490
May	497	497	497	497	497	386	275	165	497	497
June	212	212	212	212	212	165	117	70	212	212
July	214	214	214	214	214	166	119	71	214	214
Aug	225	225	225	225	225	175	125	74	225	225
Sep	264	264	264	264	264	205	146	87	264	264
Oct	260	260	260	260	260	202	144	86	260	260
Nov	260	260	260	260	260	202	144	86	260	260
Dec	398	398	398	398	398	309	221	132	398	398
Total	**4162**	**4162**	**4162**	**4162**	**4162**	**3234**	**2306**	**1378**	**450**	**450**

Note: Monthly values are equal to the TMML values for years 2018 and 2019

Attachment C-3: Proposed Selenium Load Values

Table C3-3
Proposed Selenium Load Values (pounds) for the 2010 Use Agreement for Below Normal/Dry Years

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Jan	338	319	319	319	319	249	179	109	319	319
Feb	254	185	185	185	185	144	104	63	185	185
March	253	184	184	184	184	144	103	63	184	184
April	264	193	193	193	193	151	108	66	193	193
May	269	197	197	197	197	154	110	67	197	197
June	150	130	130	130	130	101	73	44	130	130
July	151	131	131	131	131	102	73	45	131	131
Aug	158	137	137	137	137	107	77	47	137	137
Sep	242	235	235	235	235	183	132	80	235	235
Oct	233	233	233	233	233	182	131	79	233	233
Nov	233	233	233	233	233	182	131	79	233	233
Dec	319	319	319	319	319	249	179	109	319	319
Total	**2864**	**2496**	**2496**	**2496**	**2496**	**1947**	**1398**	**849**	**300**	**300**

Note: Monthly values are equal to the TMML values for years 2018 and 2019

Attachment C-3: Proposed Selenium Load Values

Table C3-4
Proposed Selenium Load Values (pounds) for the 2010 Use Agreement for Critical Years

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Jan	210	151	151	151	151	119	86	54	151	151
Feb	184	93	93	93	93	73	53	33	93	93
March	183	92	92	92	92	72	52	33	92	92
April	194	101	101	101	101	79	58	36	101	101
May	199	105	105	105	105	82	60	37	105	105
June	103	69	69	69	69	54	39	24	69	69
July	105	70	70	70	70	55	40	25	70	70
Aug	111	75	75	75	75	59	43	27	75	75
Sep	107	57	57	57	57	45	32	20	57	57
Oct	55	55	55	55	55	43	31	20	55	55
Nov	55	55	55	55	55	43	31	20	55	55
Dec	152	152	152	152	152	119	87	54	152	152
Total	**1658**	**1075**	**1075**	**1075**	**1075**	**844**	**613**	**381**	**150**	**150**

Note: Monthly values are equal to the TMML values for years 2018 and 2019

Attachment C-3: Proposed Selenium Load Values

Table C3-5
Selenium Load Values (pounds) for the 2001 Requirements Alternative

	Wet	Above Normal	Below Normal/Dry		Critical	
	2010 - 2019	2010 - 2019	2010	2011 - 2019	2010	2011 - 2019
Jan	211	398	338	319	210	151
Feb	488	472	254	185	184	93
March	488	472	253	184	183	92
April	506	490	264	193	194	101
May	512	497	269	197	199	105
June	354	212	150	130	103	69
July	356	214	151	131	105	70
Aug	366	225	158	137	111	75
Sep	332	264	242	235	107	57
Oct	328	260	233	233	55	55
Nov	328	260	233	233	55	55
Dec	211	398	319	319	152	152
Total	**4480**	**4162**	**2864**	**2496**	**1658**	**1075**

Note: Monthly values are equal to the Proposed 2010 Use Agreement for years 2010 through 2014

APPENDIX D

Groundwater and Soils Technical Report

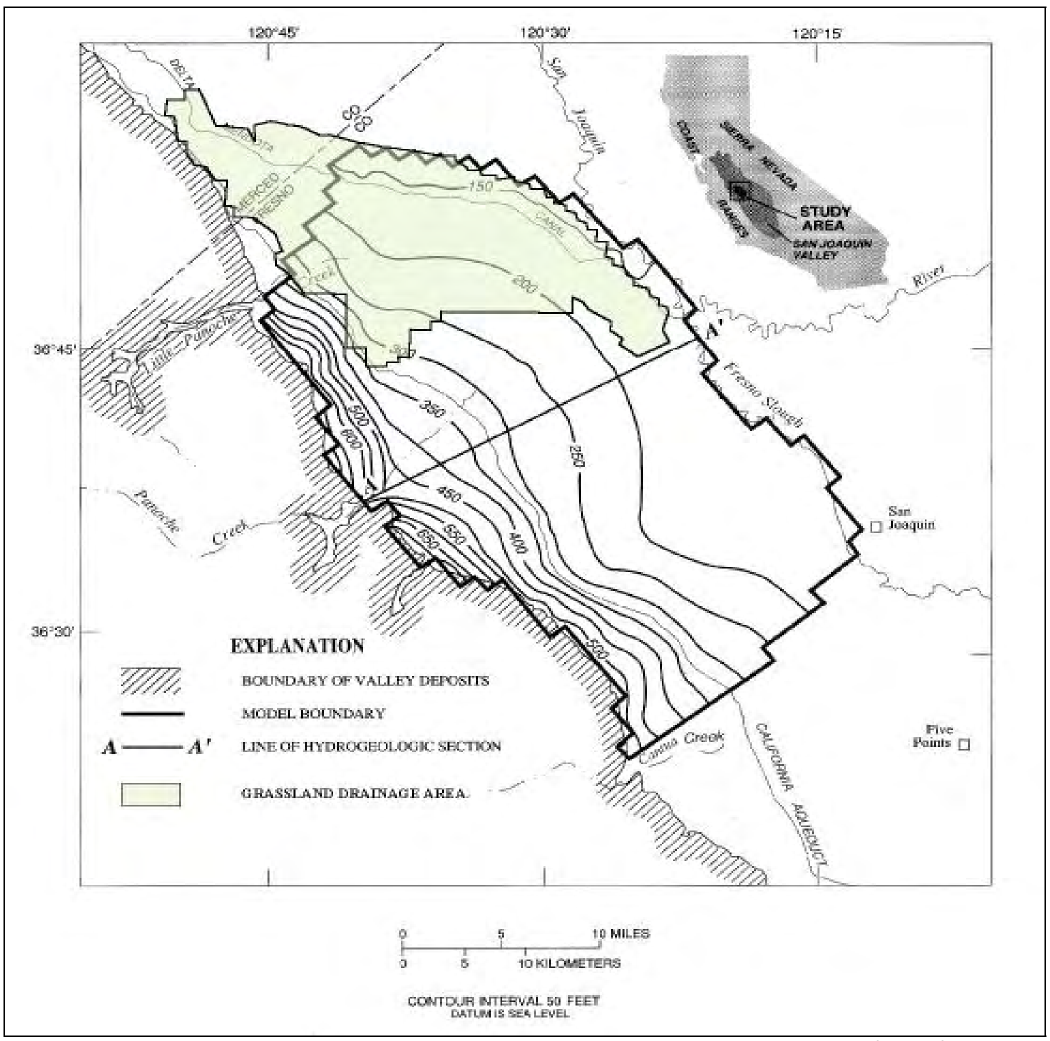
APPENDIX D
GROUNDWATER AND SOIL RESOURCES, GRASSLAND BYPASS PROJECT 2010-2019, EIS/EIR

LIST OF FIGURES

LIST OF TABLES

D.1 GROUNDWATER AND SOIL RESOURCES

The Grassland Drainage Area includes 97,400 acres of farmland approximately located between the California Aqueduct on the west and San Joaquin River on the east (Figure 1). Tile-drainage systems manage shallow groundwater conditions under about 32 percent (30,800 acres) of the area, and the drainage water is currently discharged to the Grassland Bypass. The tile-drainage systems prevent water logging and salt accumulation in the root zone. Drainwater volumes and salt loads discharged to the Bypass are managed using a drainage reuse facility (SJRIP). The facility currently consists of about 4,000 acres of land and is expected to expand to as much as 6,900 acres. Drainwater from the Grasslands Drainage Area is delivered to the SJRIP where it is applied and reused on salt-tolerant crops. This report describes estimated impacts to groundwater and soil resources under the Proposed Action, No Action, and 2001 Requirements alternatives for both the Grasslands Drainage Area and SJRIP reuse facility.



Note: The Grassland boundaries are approximate. See Chapter 2 for specific boundary location.

Figure 1. Western San Joaquin Valley and boundaries of groundwater-flow model.

D.2 AFFECTED ENVIRONMENT

D.2.1 Groundwater Resources

In the western San Joaquin Valley, sediments eroded from the Coast Ranges form gently sloping alluvial fans. The alluvium is more than 800 feet thick along the Coast Ranges and thins to 0 feet near the valley axis (Miller and others, 1971). The alluvium is a mixture of gravel, sand, silt and clay.

The groundwater system is divided into a lower confined zone and upper semiconfined zone, separated by the Corcoran Clay (Figure 2). In the upper fan areas, the water table is typically located several hundred feet below land surface. In contrast, most downslope areas are underlain by a shallow water table within 7 feet of land surface (Belitz and Heimes, 1990). The shallow water table is located within the semiconfined zone, and tile-drainage systems are employed to manage water table depth. Our objective is to assess relative impacts of continued and discontinued drainage-water exports, which affect basin water and salt budgets.

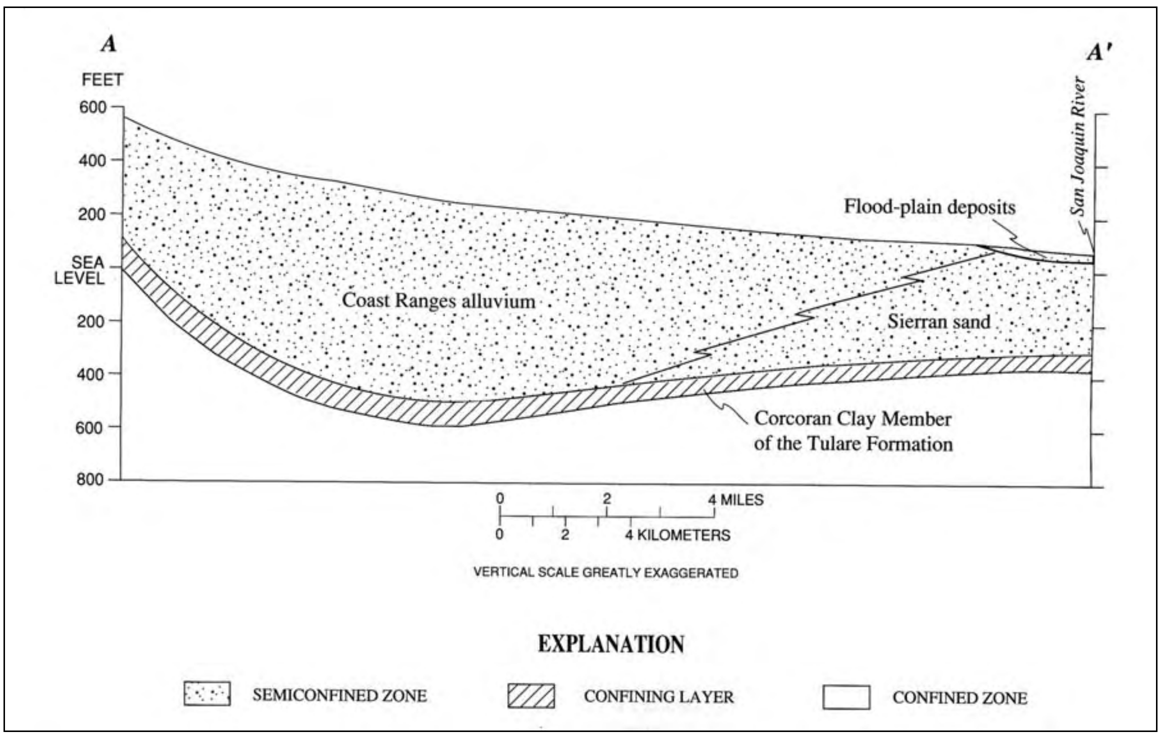


Figure 2. Geohydrologic section of the western San Joaquin Valley.

Prior to agricultural development, groundwater recharge occurred primarily by infiltration of runoff in Coast Range streams. Under natural conditions, rainfall was an insignificant recharge source (Davis and Poland, 1957). Rantz (1969) reported that average annual precipitation is only 6.5 to 8 inches per year on the valley floor, but annual precipitation can vary considerably from the long-term average. For example, since 1950 reported annual rainfall in Panoche Water District has ranged from 3 to almost 16 inches per year.

Under natural conditions, the shallow water table existed in eastern portions of the Grassland Drainage Area and in areas along the valley floor and adjacent to the San Joaquin River (Beltiz and Heimes, 1990). Groundwater discharge was primarily by evapotranspiration and water table seepage to the San Joaquin River. During the past 40 years, recharge has increased dramatically as a result of imported irrigation water. Irrigation recharge increases the volume of water beneath the land surface and causes the water table to rise. Presently, groundwater discharge is predominantly by tile-drainage systems and water table evaporation; groundwater pumpage as a supplemental irrigation water supply is reportedly small in the Grassland Drainage Area, but is increasing as a result of reduced surface water deliveries.

Long-term water levels (1972–2000) were constructed and reported by Brush and others (2006). Water-table well water levels remained fairly constant, whereas confined-aquifer well water levels varied significantly from year to year, declining in years of greater-than-average ground-water pumpage and recovering in years of reduced pumpage. Prior to 1993, significant withdrawals from storage occurred only during drought years (1977 and 1990–92), however since 1993 growers have increasingly relied on the ground-water flow system to supplement diminished surface-water supplies. Shallow water levels since 2000 continue to show spatial and seasonal variability, but have remained fairly stable over time (Figure 3); in some areas, water levels may have declined slightly as a result of long term reductions in water table recharge and possible increases in pumpage (for example, well 12S/12E-32J3).

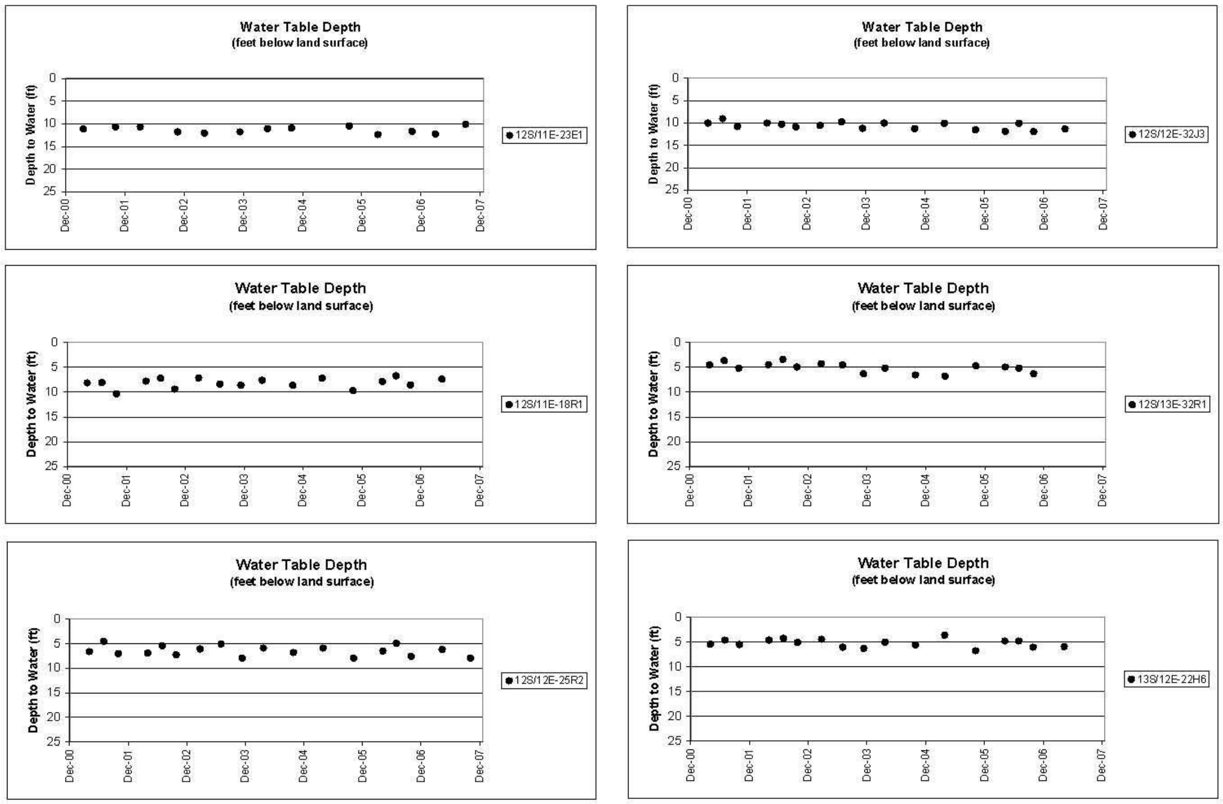


Figure 3 Depth to water in select water table wells (2000-2007)

D.2.2 Drainage System Hydrology

Tile drainage systems affect groundwater-flow in upper parts of the semiconfined aquifer. Seasonal changes in groundwater levels and drainflow indicate field conditions are affected by upslope irrigation activities. Furthermore, observation well data show that groundwater movement is upward towards the drainage systems from depths as great as 100 feet below land surface (Deverel and Fio, 1991; Fio, 1994). Therefore, drainflow estimates require geohydrologic information for areas considerably larger than single fields and depth intervals substantially deeper than the water table. In particular, estimates of irrigation recharge for drained and (or) undrained areas upslope of the field, and delineation of regional groundwater flow paths intercepted by the drainage systems, are necessary to describe drainflow.

D.2.3 Soil Resources

Soil salinity is an important consideration for irrigated agriculture and drainwater management. Irrigation dissolves soil salts and leaches them to the water table. Salts present in the irrigation water further increase salt loading to soil and groundwater. For example in 1999, the dissolved solids concentration in delivered irrigation water averaged 244 mg/L. This translates into more than 76,000 tons of imported salt applied in the Grassland Drainage Area.

Most of the Grassland Drainage Area soils are derived from marine sediments in the Coast Range, and contain salts and trace elements such as boron, molybdenum, and selenium. Under natural conditions, stormwater runoff from precipitation in the Coast Range infiltrated to the groundwater system. Harradine (1950) mapped the lowest soil salinities in the upper fan areas where they were partially leached by infiltration. In the downslope areas, precipitation was an insignificant recharge mechanism. Harradine (1950) mapped the highest soil-salinities in the downslope areas where recharge and subsequent leaching rates were low.

The presence of solid phase minerals like gypsum and calcite influence changes in soil and groundwater salinity. Based on soil samples from 17 sites in Panoche Drainage District, Tanji and others (1977) reported for the upper 6 feet of soil, 1 to 9 tons of native gypsum per acre-foot of soil. Soil saturation extracts and geochemical modeling results indicate soils are saturated with calcite and gypsum (Deverel and Fujii, 1988), and we have visibly identified salts in unsaturated and saturated-zone core samples.

An exact correlation between soil and groundwater high in salts and selenium is not observed (Gilliom, 1987). The highest concentrations occur in places where hydrologic processes, such as evaporative concentration, contribute to the accumulation of soluble salts and selenium in water and soil. To evaluate salt and selenium distributions in groundwater and soil it is necessary to understand the natural distribution of constituents and their redistribution by irrigated agriculture.

D.3 ENVIRONMENTAL CONSEQUENCES

D.3.1 Key Impact and Evaluation Criteria

The water table rise is the primary impact to soil and groundwater. The rising water table produces several soil and groundwater related effects. We considered the following effects to assess the potential water table impact:

- <u>Drainwater production</u>. Drainwater production, or tile drainage system sump flow, are proportional to water table depth and the flow increases as the water table rises. Potential drainwater production impacts are associated with its volume and quality. We considered a 10 percent increase in annual drainwater production volume as a potentially significant adverse impact.

- <u>Area affected by the shallow water table and bare soil evaporation rate</u>. As the water table rises, the area underlain by the shallow water table increases and water table evaporation rate increases. In the Grassland Drainage Area, evaporation from the shallow water table causes significant salinity increases in groundwater and soil (Deverel and Fujii, 1988). Belitz and others (1993) utilized a large amount of soil moisture, soil tension, and hydraulic conductivity data for Panoche clay loam and concluded that bare-soil evaporation is significant when the water table is within 7 feet of land surface.

  Our estimated water table depth is most reliable at the water district scale. We therefore considered a 20 square mile or greater increase in area underlain by a shallow water table (within 7 feet of land surface) as a significant adverse impact; area changes less than several square miles were considered no impact.

Our estimated evaporation rate is most reliable in the range between 0.0 to 0.4 feet/year, which corresponds to water table depths from 7 to 4 feet below land surface. If the water table rises above the 4 feet depth, the evaporation rate increases rapidly and the high evaporation rates maximize salinity increases in soil and groundwater. We therefore considered evaporation rates greater than 0.4 feet/year as a significant adverse impact, and relative evaporation rate changes less than about 0.05 feet/year (approximately 10-percent) as having no impact.

- Uncontrolled seepage and subsurface discharge. Seepage and subsurface discharge into unlined ditches and drainage canals are proportional to water table depth, and increase as the water table rises. The impacts are associated with the volume and quality. We considered a 10 percent increase in the volume of annual seepage or subsurface discharge as potentially significant adverse impacts. Our analysis does not include other waters and drainwater that cannot be recycled that enters drainage canals. Uncontrolled seepage is therefore a minimum estimate of uncontrolled discharge.

- Soil salinity. Increased soil salinity decreases crop yields, and the threshold salinity level is crop specific. For example, melon and tomato yields decline when soil salinity increases above 2.5 deci-Siemen/meter (dS/m); whereas, wheat, sugar beets, and cotton yields decline when soil salinity increases above 6.0, 7.0 and 7.7 dS/m, respectively (Tanji, 1990).

  Our analysis begins in the beginning of water year 2008 (fall of calendar year 2007). We estimated initial soil salinity for the Grasslands Drainage Area and SJRIP soils using soil extract data provided by Summers Engineering. Soil salinity is spatially variable, and we utilized a soil salinity of 0.9 dS/m to represent average conditions in the primary agricultural areas of the Grasslands Drainage Area. Soil saturation extract data reported for the SJRIP suggested an initial representative soil salinity of 5.2 dS/m. We considered mean soil salinity increases above 10 percent and likely to negatively impact soil productivity as a potentially significant adverse impact. In 2001 and 2002, saturation extracts from 32 sampling sites located in two SJRIP fields were analyzed for major ions and electrical conductivity. We utilized these extract data to also estimate the representative constituent concentrations contributing to the total salinity in the soil.

- Groundwater salinity. Groundwater salinity changes affect drainwater and seepage quality, which in turn affect constituent loads potentially discharged to the Grassland Bypass and adjacent wetlands. We considered groundwater salinity increases greater than 10 percent as a potentially significant adverse impact.

D.3.2 Methods Used to Evaluate Impacts

Our analysis focuses on changes in groundwater levels, soil salinity and groundwater salinity. Existing groundwater-flow and geochemical models estimated these changes for the No Action, the Proposed Project, and the 2001 Requirements Alternative.

D.3.2.1 Groundwater-Flow Model

We utilized a numerical groundwater-flow model to project changes in mean depth to the water table. The U.S. Geological Survey developed the model for the San Joaquin Valley Drainage Program (Belitz and others, 1993)[1]. It is a transient, three-dimensional, finite-difference model and utilizes mean recharge and pumpage data to project long-term changes in water table depth and drainflow.

The U.S. Geological Survey model represents groundwater conditions within about 88,000 acres of the Grassland Drainage Area, which is 90-percent of the irrigated area (see Figure 1 for a comparison between model boundaries and approximate Grassland Drainage Area boundaries). Model subareas represent single water districts (Panoche and Broadview), and all or parts of Mercy Springs, Eagle Field, Oro Loma, Widren, Camp-13, and Firebaugh water and drainage districts. The model does not include Pacheco Water District and Charleston Drainage District. For our analysis, we assumed area-averaged model results are representative of mean conditions in Pacheco and Charleston. We scaled model results by a factor of 1.2 to project model results to the entire land area within Grasslands Drainage Area boundary (Figure 1).

The U.S. Geological Survey calibrated the model to reproduce 1972-88 hydrologic conditions. HydroFocus, Inc. evaluated model-projected groundwater levels and drainflow during the period 1989-97 (HydroFocus, Inc., 1998). They updated boundary conditions, recharge, and pumpage data and concluded updated model results are acceptable to evaluate long-term changes in water-table depth.

D.3.2.1.1 Recharge

Water table recharge is computed as applied water less consumptive use by plants. We calculated 2000-07 water table recharge with the following unsaturated zone water budget:

$$ID + Pe + Dr + ETgw - ET = R, \text{ where } \quad (1)$$

ID is delivered irrigation water, in feet/year;
Pe is effective precipitation, in feet/year;
Dr is recycled drainwater, in feet/year;

[1] In 2005, Brush and others (2006) updated the 1993 groundwater-flow model utilized for this study. Their update extended the model grid to incorporate a larger geographic area, utilized a finer spatial and temporal discretization, and employed an annually varying water budget for water years 1973–2000. The calibrated model input files necessary to re-produce their reported results were not available at the time of this study.

ETgw is the contribution of shallow groundwater to plant consumption, in feet/year;
ET is consumptive use by plants, in feet/year; and,
R is water table recharge, in feet/year.

The reported Grassland Drainage Area water budget components are summarized in Table 1, and indicate 2000-07 average recharge was 0.90 feet/year. These values were calculated using water use information provided by URS (Jeanne Hudson, URS, written comm., July 31, 2008), We utilized the rates reported in Table 1 to represent average Grassland Drainage Area conditions for our analysis.

Table 1. Reported 2000-2007 Average Water Budget Components for Grassland Drainage Area subareas of the groundwater-flow model

Model Subarea	Model Area (acres)	Irrigation Delivery (feet)		Effective Precipitation (feet)	Recycled Water (feet)	Applied Drainwater (feet)	Consumptive Use (feet)	Water Table Recharge (feet)
		Canal	Wells					
Firebaugh	42,880	2.14	0.02	0.36	0.05	0.00	1.41	1.16
Panoche	30,720	1.88	0.19	0.36	0.04	0.00	1.63	0.84
SJRIP	3,840	0.40	0.40	0.36	0.00	1.77	2.11	0.82
Broadview	10,240	0.00	0.00	0.36	0.00	0.00	0.36	0.00
Sum/Average	87,680	1.72	0.09	0.36	0.04	0.08	1.40	0.90

Note: Water budget components are spatially averaged over model budget subareas, which include both irrigated and non-irrigated land areas.

D.3.2.1.2 Drainflow

Tile drainage systems consist of a parallel network of perforated drain laterals buried at variable depths and spacing. The drain laterals are typically installed at depths ranging from 6 to 9 feet below land surface, and spaced horizontally from 100 to 600 feet apart. Drainwater production is proportional to the hydraulic gradient between the water table and the drain laterals; drainflow increases as the water table rises, decreases as the water table declines, and is zero when the water table is below the drain laterals.

We utilized the groundwater-flow model and a district drainage model to calculate drainwater production during the period 2008 through 2019. The two models are indirectly linked by annual mean water table depth. The groundwater-flow model is a regional model, and provides annual water levels and drainwater production resulting from regional hydraulic stresses. In contrast, the district drainwater production model correlated monthly district sump flow to monthly water table depth. Additional information on drainage system representation in the groundwater model is provided below, and details on the district drainwater production model are provided later in this report.

The U.S. Geological Survey model simulates drainflow from 53 square miles of tile drainage systems. The model specified a representative drain lateral depth of 7.5 feet below land surface, and representative drain conductance of 0.52 ft^2/sec (Belitz and others, 1993). The conductance term represents the tile-drainage systems. However, unlined canals and ditches can intersect the water table and collect seepage that is transported with drainwater to the Bypass. We accounted for this seepage by increasing the drain conductance in cells with tile drains to 0.54 ft^2/sec. We calculated the conductance increase by assuming an effective drain/aquifer system conductivity of 115 feet/day and 130 miles of unlined ditches within the Grassland Drainage Area. We specified a drain conductance of 0.02 ft^2/sec in cells without tile drains to represent seepage to unlined canals and ditches in the un-drained cells. The adjusted conductance indicated that about 4-percent of annual drainflow is attributed to ditch seepage.

D.3.2.2 District Drainwater Production Model

We estimated monthly sump flow using a district drainwater production model that calculates total sump flow from areas that discharge to the Bypass. The model assumes monthly drainflow is proportional to the difference between water table and drain lateral depths. The proportionality constant, which represents a district-wide drain conductance, incorporates variable sediment permeability, variable numbers of drainage systems, and variable drain lateral spacing. Monthly water table depths were calculated from annual depths and seasonal changes in measured water levels. The groundwater-flow model determined the annual water table depth, which was adjusted to monthly values by month-specific factors.

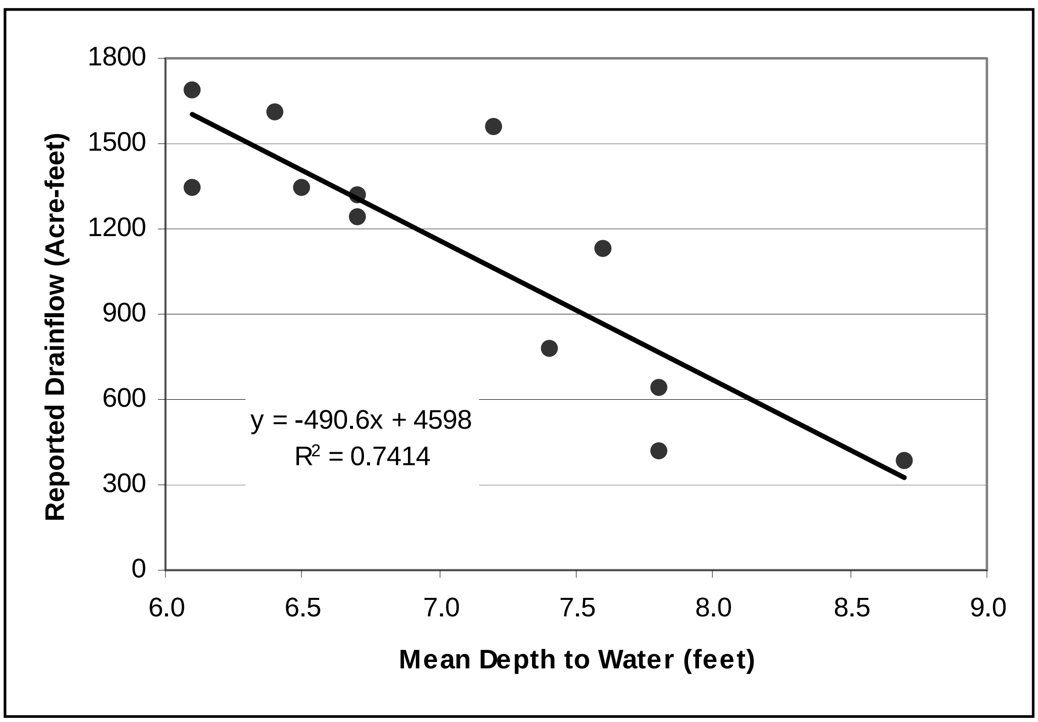


Figure 4. Relationships between mean monthly water table depth and district discharge from Panoche Water District, 1991.

Figure 4 indicates drainflow is proportional to water table depth. The plotted water levels represent mean monthly values computed from 950 bi-weekly measurements collected in Panoche Water District. Monthly drainflows are the reported 1991 district discharge from Panoche Drainage District. Minimum water table depth and maximum drainflow occurred during March (pre-irrigation) and July (the peak of the irrigation season). Maximum water table depth and minimum drainflow occurred during October and November, after the harvest and before the winter rains. The regression equation indicates drainflow ceases when the water table falls to a depth of about 9 feet below land surface. This agrees with reported maximum drain lateral depths in Panoche Water District, and probably represents the deeper collector lines and unlined ditches in the district.

The drainwater production model was calibrated by adjusting representative drain lateral depth, district drain conductance, and monthly water level factors. Calibrated drain lateral depths and monthly water level factors are representative of the entire Grassland Drainage Area; whereas, drain conductance was individually estimated for each district. During the calibration process, parameter adjustments were constrained by reported drain lateral depths, measured water levels, and normalized conductance values reported by previous studies (Belitz and others, 1993; Fio, 1994).

Results from the calibrated model are plotted in Figure 5. The percent difference between reported and estimated drainflow over the 8-year simulation period was on the average within 1-percent. The model used a representative drain lateral depth of 7.5 feet; adjusted monthly water level factors similar to measured values; and, conductance values that range from 0.060 to 0.139 per month. Because model parameters were calibrated, their reliability must be assessed.

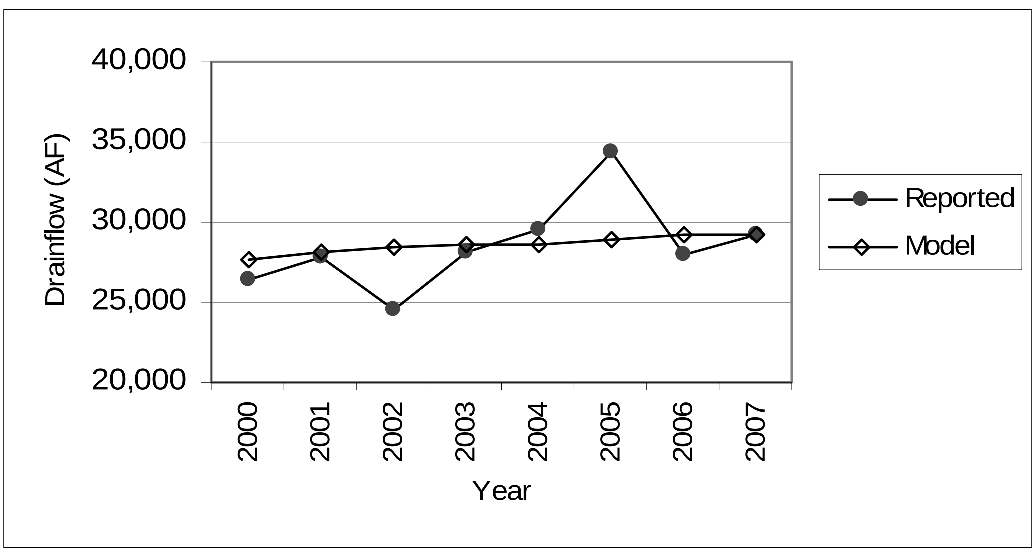


Figure 5. Annual estimated and reported drainwater production in the Grassland Drainage Area, 2000-07.

Calibrated drain lateral depth (7.5 feet) agrees with typical design depths in the Grassland Drainage Area (6 to 9 feet). The value also agrees with the value specified in the groundwater-flow model.

The magnitude of monthly drainflow is most sensitive to district drain conductance. Calibrated conductance values range from 0.060 to 0.139 per month, which are similar to values reported by previous studies (0.050 to 0.125 per month). We did adjust the monthly water level factors to improve the match between simulated and reported monthly drainflow (Figure 6). We felt some adjustment was reasonable because the estimated water-level factors were determined from 1991 data, and may not be entirely representative of 2000-07 conditions. Furthermore, the data was collected from wells located in Panoche Water District, and they are not necessarily representative of mean water level changes throughout the entire Grassland Drainage Area.

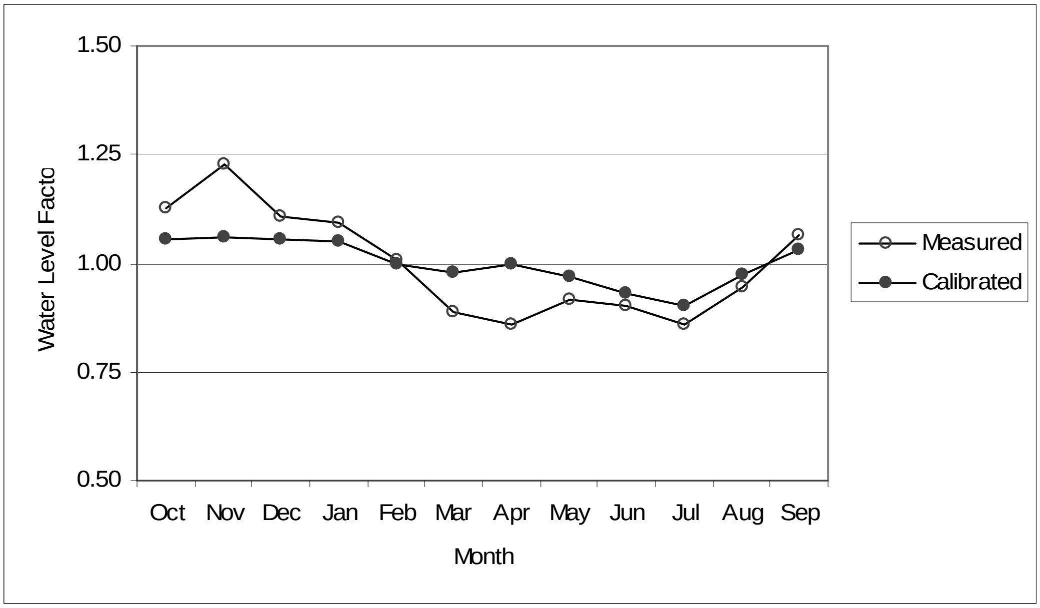


Figure 6. Measured and calibrated monthly water level factors.

D.3.2.3 Soil Salinity Model

We calculated the unsaturated zone salt balance for the No Action, Proposed Project, and the 2001 Requirements Alternatives. For each month, the salt mass in the soil water is:

$$SM_t = SM_{iw} + SM_p + SM_{t-1} - SM_r \pm Ss, \text{ where} \qquad (2)$$

SM_t is the soil water salt mass in the current month t;
SM_{iw} is the salt mass in applied irrigation water;
SM_p is the salt mass in precipitation;
SM_{t-1} is the soil water salt mass from the previous month;
SM_r is the salt mass in water table recharge; and,
Ss is the soil salt mass dissolved or precipitated in the unsaturated zone.

The concentration of soil salts was estimated as the mass of salts divided by the final soil moisture. We used the electrical conductivity of the soil saturation extract (EC_e) to represent soil water salinity. The soil moisture content above the water table was estimated as follows:

$$SW_t = SW_{t-1} + ID + Pe + Dr + ETgw - ET - R\text{, where} \qquad (3)$$

SW_t is soil moisture in the current month t;
SW_{t-1} is soil moisture from previous month; and,
ID, Pe, Dr, Etgw, ET, and R were defined previously for Equation (1).

We estimated water table recharge as the water quantity above field capacity, which we assumed was 20 percent of the soil volume.

In the western San Joaquin Valley, soil salinity exhibits a high degree of spatial variability (Deverel and Gallanthine, 1989; Fujii and others, 1989; Corwin and others, 1991, 1999), which limits our ability to establish historical and present-day soil salinity values. For example, 1991 soil core data collected at 315 locations in Broadview Water District indicated the coefficient of variation for soil EC is about 55 percent (Corwin and others, 1999). Similarly, 1987 soil core data reported for 66 Broadview samples indicated the coefficient of variation is 48 percent (Wichelns, 1989). The large coefficients of variation indicate a substantial number of samples are necessary to reliably estimate mean soil salinity; mean soil salinity estimated by the previous studies was 4.4 and 3.9 (dS/m).

A comparison of data collected in a Broadview Water District field, first by Wichelns (1989) and then by Ayars and others (1996), indicated soil salinity increased from 1987 to 1995. The field is located in the southeastern portion of the district (Township 13S and Range 13E). Wichelns (1989) reported an average soil salinity of 2.0 dS/m (sample values range from 2 to 8 dS/m), and Ayars and others (1996) reported an average soil salinity of 4.9 dS/m (sample values range from 2 to 28 dS/m). These data suggested that soil salinity was increasing under previous drainwater recycling conditions.

We estimated initial soil salinity for the Grasslands Drainage Area and SJRIP soils using soil extract data provided by Summers Engineering (Table 2). Soil salinity is spatially variable, and we utilized a soil salinity of 0.9 dS/m to represent average conditions in the primary agricultural areas of the Grasslands Drainage Area. Saturation extract data for SJRIP soils suggested a representative soil salinity of 5.2 dS/m. In 2001 and 2002, saturation extracts from 32 sampling sites located in two SJRIP fields were analyzed for major ions and electrical conductivity. We utilized these extract data to also estimate the representative constituent concentrations contributing to the total salinity in the soil.

Table 2. Initial Saturated Soil Chemical Composition.

Area	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	Cl (mg/L)	SO_4 (mg/L)	HCO_3 (mg/L)	NO_3 (mg/L)
Grasslands Drainage Area	55	10	139	78	156	202	44
SJRIP	240	87	1,125	498	2,419	91	157

Fujii and others (1989) and Deverel and Fujii (1988) indicated calcite and gypsum are the primary minerals affecting soil and groundwater salinity in the Grassland Drainage Area. Our soil salinity assessment required soil chemical composition, irrigation water composition, and rainfall composition to estimate mineral dissolution and precipitation. Table 3 reports the representative chemical composition of different water sources considered by our analysis.

Table 3a. Representative Chemical Composition of Water Sources for the Grasslands Drainage Area.

Description	pH	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	Cl (mg/L)	SO_4 (mg/L)	HCO_3 (mg/L)	NO_3 (mg/L)
Rainfall	6.4	1.2	0.7	0.0	0.8	0.7	7.0	0.0
Canal Water (Apr-Sept)	8.0	19	11	43	57	46	70	0.0
Canal Water (Oct-Mar)	8.0	24	13	53	70	56	85	0.0
Supplemental Groundwater	7.3	35	8	246	158	340	84	0.0
Recycled Drainwater	8.1	423	175	1,160	785	2,525	195	303

Table 3b. Representative Chemical Composition of Water Sources for the SJRIP Reuse Facility.

Description	pH	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	Cl (mg/L)	SO_4 (mg/L)	HCO_3 (mg/L)	NO_3 (mg/L)
Rainfall	6.4	1.2	0.7	0.0	0.8	0.7	7.0	0.0
Canal Water (Apr-Sept)	8.0	20	11	45	59	48	73	0.0
Canal Water (Oct-Mar)	8.0	24	14	55	72	58	88	0.0
Supplemental Groundwater	7.3	83	19	584	374	806	199	0.0
Drainwater (GDA)	8.0	353	135	945	668	1961	191	243
Drainwater (SJRIP)	7.6	526	308	4220	3460	6760	378	243

The applied water is a mixture of rainfall, canal water, groundwater, and recycled drainwater. Soil salinity calculations are based on average bi-annual water application rates for the periods April-September (irrigated conditions) and October-March (non-irrigated conditions). We assumed a volume-weighted average of canal water and recycled drainwater to estimate irrigation water chemistry. The percent contribution of different water sources to average applied water is summarized in Table 4.

Table 4a. Percent Contribution of Applied Water for the Grasslands Drainage Area.

Scenario	Season	Total Water (ft)	Percent Contribution to Applied Water				
			Canal	Groundwater	Drainwater	Recycled	Rain
No Action	Non-Irrigated	0.83	57	2	0	4	37
	Irrigated	2.08	84	7	0	8	1
Project	Non-Irrigated	0.83	59	3	0	1	37
	Irrigated	2.08	92	5	0	2	1

Table 4b. Percent Contribution of Applied Water for the SJRIP Reuse Facility.

Scenario	Season	Total Water (ft)	Percent Contribution to Applied Water					
			Canal	Groundwater	Drainwater GDA	Drainwater SJRIP	Recycled	Rain
No Action	Non-Irrigated	0.76	12	12	34	2	0	40
	Irrigated	3.30	16	16	63	4	0	1
Project	Non-Irrigated	0.76	18	18	23	1	0	40
	Irrigated	3.30	28	28	41	2	0	1

We performed calculations to estimate monthly changes in soil salinity using the chemical thermodynamic equilibrium program PHREEQE (Parkhurst and others, 1980). We employed PHREEQE to simulate calcite and gypsum dissolution due to changes in soil water chemical composition. Based on the soil EC results, monthly soil selenium and boron concentrations were estimated using relationships reported by Fujii and others (1988) and Wichelns (1989).

D.3.2.4 Groundwater Quality Model

We used a mass balance approach to estimate changes in groundwater quality over time. The annual mass balance of salts in the upper 50 feet of groundwater was represented as:

$$GM_t = GM_r - GM_d + GM_{t-1} \pm Sg, \text{ where} \qquad (4)$$

GM_t is the salt mass in groundwater in the current month t;
GM_r is the salt mass in water table recharge;
GM_d is the salt mass in drainage;
GM_{t-1} is the salt mass in groundwater from the previous month; and,
Sg is the salt mass dissolved or precipitated in groundwater.

We assumed no net change in salt mass from laterally flowing groundwater. The different components were estimated as follows:

- An effective groundwater depth was estimated from groundwater-flow model results. Deverel and Fio (1991) and Fio and Deverel (1991) reported that Broadview Water District drainage systems collect groundwater primarily from within 50 feet of land surface. The average annual saturated thickness of the upper 50 feet of aquifer material was calculated using average annual depth to water results from the groundwater-flow model. Belitz and others (1993) estimated a specific yield of 0.3 for the aquifer from 0 to 20 feet below land surface and 0.2 for the aquifer from 20 to 50 feet below land surface. We calculated a depth-weighted specific yield of 0.24 for the upper 50 feet of aquifer material.

- Evaporation from the shallow water table included shallow groundwater use by plants and water table evaporation. Shallow groundwater use by plants was estimated as 15-percent of the plant-water consumption during the months of June through September, and water table evaporation rates were estimated from the groundwater-flow model results.

- We used a flow-weighted average drainwater salinity (EC) and chemical data for drainwater samples to estimate initial shallow groundwater salinity in the Grasslands Drainage Area (Table 5); the drainwater samples represent a composite of about 60-percent of the drainflow production within the GDA. We used analytical results for samples from SJRIP drainage system sump samples to estimate the initial groundwater composition beneath the SJRIP (Table 5).

Table 5. Initial Groundwater Chemical Composition.

Area	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	Cl (mg/L)	SO_4 (mg/L)	HCO_3 (mg/L)	NO_3 (mg/L)
Grasslands Drainage Area	315	130	860	580	1,870	145	225
SJRIP	526	308	4,220	3,460	6,760	378	243

Deverel and Fujii (1988) determined that gypsum and calcite influence groundwater chemical composition in the Grassland Drainage Area. We used PHREEQE to simulate mineral dissolution and precipitation reactions and estimate annual groundwater chemistry. The soil salinity model results provided salt loads to the saturated zone.

Selenium and boron concentrations in western San Joaquin Valley groundwater samples are significantly correlated with salinity (Deverel and Millard, 1988). We utilized Deverel and Millard's (1988) published regression equations to estimate selenium and boron concentration changes due to simulated groundwater salinity changes. The equations describe the relationship between EC, selenium, and boron concentrations in western San Joaquin Valley alluvial-fan groundwater.

D.3.2.5 Wetlands Water Quality

Grasslands wetlands are typically seasonally flooded; inundation occurs in the fall and drainage in the early spring. Under these water management conditions, soil conditions, the salinity of the input water, and water management practices influence wetland drainage water salinity and its effects on receiving waters. Study of the Grasslands wetlands and discharge to the San Joaquin River illustrate these interacting factors (Grober and others, 1995). Approximately 10 % of the salt in the San Joaquin River is derived from these wetland discharges. Grober and others (1995) identified evapotranspiration of soil water, drainage of poorly drained soils, and leaching soil salts leftover from when the wetland received more saline agricultural drainage water as the primary processes resulting in saline discharges. Quinn and Karkoski (1998) and Quinn and Hanna (2002) demonstrated that early winter wetland discharges during high San Joaquin River flows substantially reduced salinity impacts to the river. Water quality impacts of permanently and reverse flooded wetlands have not been evaluated.

Two proposals by the California Department of Fish and Game (CDFG) and U.S. Fish and Wildlife Service (USFWS) exist to expand wetland habitat by 31.6 to 76.8. The Grasslands Area Farmers and CDFG propose the development of mitigation reverse flooded wetlands adjacent to the San Joaquin River and Mud Slough at the CDFG China Island facility. The water surface area of the ponds would be approximately 95.3 acres and the Mud Slough affected area in China

Island is 76.8 acres. The USFWS proposal establishes 31.6 areas of year-round wetland marsh habitat. The Mud Slough affected area within San Luis Unit is about 24 acres. The proposed area is in 3 units within the San Luis National Wildlife Refuge Complex as follows.

- Shallow broad and linear permanent wetland habitat for giant garter snake approximately one-mile beyond the Santa Fe Canal on the Kesterson Unit of the San Luis National Wildlife Refuge. Surface water will drain into Los Banos Creek. Water supply will be from local wells.

- Shallow permanent wetland slough giant garter snake habitat in what is now a 1-mile long drainage ditch.

- Re-establishment of approximately 2-miles of Slough habitat for giant garter snake on the Snow Goose Drain system on the West Bear Creek unit on the Great Valley Grasslands State Park.

The 95.3-acre CDFG wetland will be maintained consistently inundated and or saturated through reverse flooded water management; water deliveries will occur primarily during the spring, summer and fall. This area is naturally wet during the winter. No surface water drainage to the San Joaquin River is planned. Groundwater level information for this area indicates average depth to groundwater of about 6.0 feet based on measurements from 2002 to 2007 provided by Summers Engineering. Groundwater levels typically rise during the winter and decline during the summer. The average shallow groundwater salinity as indicated by the electrical conductivity for the Summers Engineering wells was 3.9 dS/cm. Most groundwater samples had less than detectable selenium. The San Joaquin River is mainly a gaining reach in this area (Phillips and others, 1991) and groundwater probably moves to the river. Groundwater will be delivered to the wetland from local wells. The CDFG has indicated that about 12 acre feet/year of water will be delivered to the 95.3 acres. The results of chemical analysis of well water samples that probably represent the proposed supply water indicate that water quality is good although the salinity is elevated relative to San Joaquin River water quality objectives. Selenium is consistently less than the reporting limit of 2 ppb.

D.4 ENVIRONMENTAL IMPACTS AND MITIGATION

D.4.1 No Action Alternative (No Use Agreement)

The No Action Alternative represents probable environmental conditions without the Grassland Bypass Agreement. Without a use agreement, the collection of drainwater into a single outlet for discharge ceases. Tile drainage systems probably continue to operate, but the drainwater presumably remains within the Grassland Drainage Area. Some subsurface water will continue to seep into unlined drainage ditches and could migrate uncontrolled into downslope wetlands.

We employed average 2000-07 water supply and consumptive use data to estimate groundwater and soil conditions under the No Action Alternative. We assumed conditions at the beginning of Water Year 2008 (fall of calendar year 2007) as representing existing conditions. Our analysis considers the projected changes in soil and groundwater conditions beginning in 2010, when the current use agreement expires, and ceases in 2019 when the Proposed Project is set to end. Under No Action conditions, sump flows remain within the Grasslands Drainage Area, and we assumed the water is recycled in a way that displaces an equal volume of canal water. Hence, the water application rate remains the same but the irrigation water salinity increases.

The increase in irrigation water salinity is proportional to the fractional contribution of the canal and drainage water. Excess drainwater that is not recycled within the districts was assumed to be used for irrigation in the SJRIP reuse facility. Beginning in 2010, no drainage water was allowed to leave the SJRIP facility.

D.4.1.1 Groundwater Effects

Under the No Action Alternative, the groundwater flow model projects a 0.9 foot decrease in mean water table depth beneath Grasslands Drainage Area tile drainage systems by 2019 relative to existing water table depths in 2008 (Figure 7a). Beneath the SJRIP, model results indicate the mean water table depth will decrease from about 5 feet in 2010 to less than 2.8 feet in 2019 (Figure 7b). Our simulated water table changes have the following potential groundwater effects.

- A decrease in water table depth corresponds to an increase in drainwater production (sump flow). The projected 2019 drainwater production is 1.65 feet per year and represents an increase of 0.74 feet per year relative to existing conditions. We considered the 80-percent increase in drainwater production as a significant adverse impact to the Grassland Drainage Area.

- Model results indicated a one square mile net increase in area affected by a water table within 7 feet of land surface. The rising water table increased the bare-soil evaporation rate from 0.26 feet/year in 2008 to 0.34 feet/year in 2019. We considered the 30-percent increase in evaporation rate a significant adverse impact to the Grassland Drainage Area.

- Uncontrolled discharge includes seepage and other water that cannot be recycled that enters into unlined drainage ditches. Flow model results indicate seepage into unlined ditches more than doubles relative to existing conditions. Unlike current conditions, the seepage and other discharges will not be collected and controlled. We considered this a potentially significant adverse impact to adjacent areas.

- Groundwater beneath the Grassland Drainage Area naturally moves to the northeast towards the wetlands and San Joaquin River. The subsurface flow either discharges uncontrolled to the adjacent wetlands or the San Joaquin River, or moves downward and recharges the deeper aquifer system. Model results indicate there is no significant change in subsurface flow northeast towards the wetlands and San Joaquin River. Deep aquifer recharge leaving the Grasslands Drainage Area decreases from 0.32 feet/year in 2008 to 0.29 feet/year in 2019.

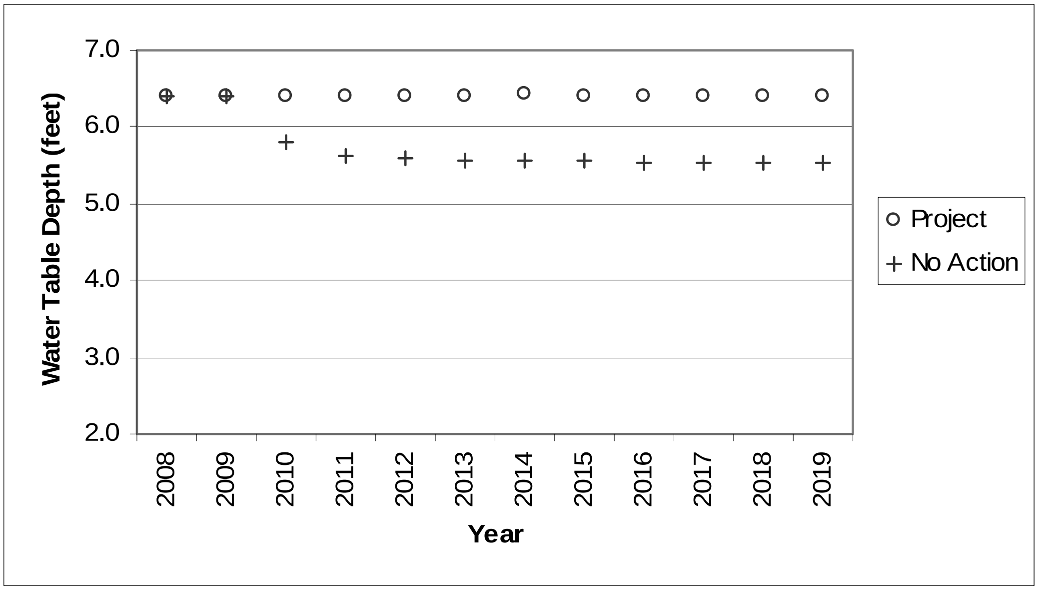


Figure 7a. Simulated mean water table depth beneath the drained areas of the Grasslands Drainage Area for Project and No Action Alternatives, 2008-2019.

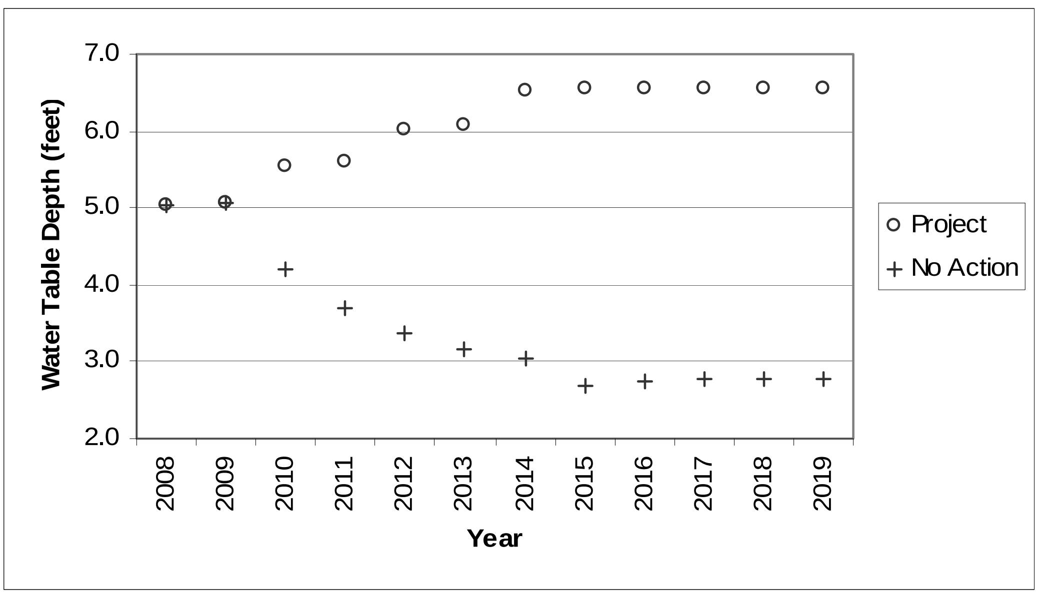


Figure 7b. Simulated mean water table depths beneath the SJRIP reuse facility for Project and No Action Alternatives, 2008-2019.

D.4.1.2 Salinity Effects

Under the No Action Alternative, soil salinity increases as a result of increased drainwater recycling.

- In the Grasslands Drainage Area, annual soil salinity increases from about 1.0 dS/m in 2008 (existing conditions) to 3.2 dS/m in 2019 (Figure 8). The corresponding estimated soil selenium concentrations increase from 11 to 35 µg/L, and boron concentrations increase from 0.9 to 1.9 mg/L. In the SJRIP, annual soil salinity increases from 6.6 dS/m in 2008 to 13.9 dS/m in 2019 (Figure 8). The SJRIP soil selenium concentrations increase from 73 to 153 µg/L, and boron concentrations increase from 3.4 to 6.6 mg/L. We considered the more than three-fold soil salinity increases as significant adverse impacts.

- In the Grasslands Drainage Area, representative annual groundwater salinity decreases from about 6 dS/m in 2008 (existing conditions) to about 5 dS/m in 2019 (Figure 9). Estimated groundwater selenium concentrations decrease from 47 µg/L in 2008 to 34 µg/L in 2019, and estimated boron concentrations decrease from 6.0 to 4.9 mg/L. The reduction in groundwater salinity, selenium, and boron concentrations would be considered a significant beneficial impact. In the SJRIP, representative annual groundwater salinity also decreases but to a lesser extent. SJRIP groundwater salinity decreases from 23 dS/m to 22 dS/m (Figure 9). Estimated SJRIP groundwater selenium concentrations decrease from 816 to 742 µg/L, and estimated SJRIP boron concentrations decrease from 38.9 to 36.5 mg/L[2]. These concentration decreases would be considered less than significant beneficial impacts.

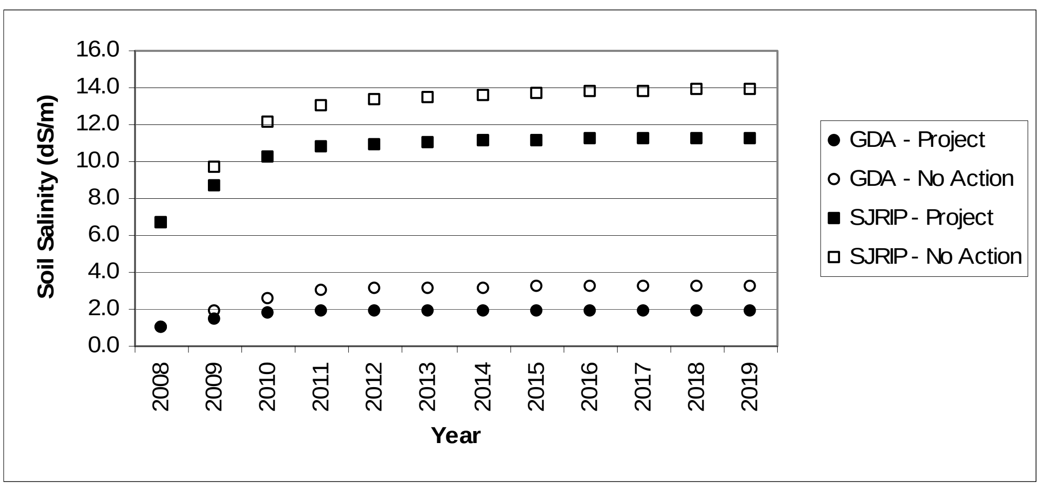


Figure 8. Simulated annual soil salinity changes for Project and No Action Alternatives, 2008-2019.

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[2] Simulated groundwater recharge salinity from the unsaturated soil increases over time, yet simulated groundwater salinity decreases beneath both the Grasslands Drainage Area and SJRIP. These results may indicate assumed initial groundwater salinity values are too high relative to the representative soil salinity levels and chemical composition of the different water sources. Observed drainflow quality may therefore over-estimate the representative groundwater salinity within the depth interval of 50 feet below land surface.

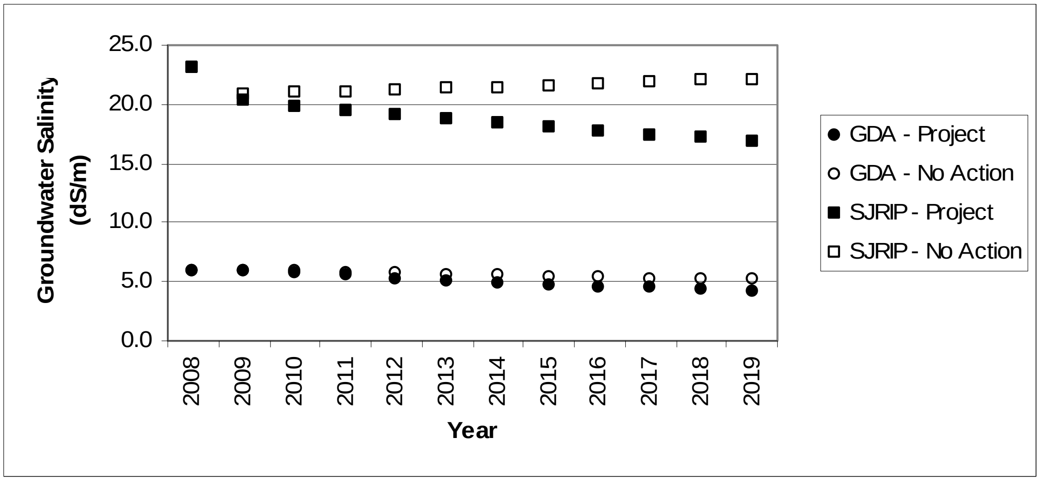

Figure 9. Simulated annual groundwater salinity changes for Project and No Action Alternatives, 2008-2019.

D.4.2 Proposed Action (Grassland Bypass Project)

The Proposed Action is the Grassland Bypass Project and is a continuation of the existing Bypass Use Agreement. The Grassland Area Farmers will continue to collect drainwater for discharge into the San Luis Drain. Some project aspects will be modified to meet increased regulatory requirements attached to the waste discharge permit.

One project modification is the SJRIP reuse facility designed to meet substantial load reductions due to revised water quality objectives that began October 1, 2005. The Proposed Action intends to increase drainage reuse and develop up to 6,900-acres for a drainwater treatment facility to help meet the new objectives. The Project grows salt tolerant crops on dedicated lands irrigated with drainwater. The treatment element is designed to reduce drainwater volume, remove salt, selenium, and boron from concentrated drainwater, and utilize in-valley salt disposal to prevent discharge to the San Joaquin River. In the groundwater-flow model, the SJRIP reuse facility begins operating in 2000 with less than 4,000 acres in operation. Only 50 % of the facility was initially simulated as having tile drains. Tile drains were added to the existing facility in 2010, 2012, and 2014 until the entire area is drained. In 2015, the facility was simulated as expanding to over 6,000 acres with tile drains existing under the entire facility.

We employed average 2000-07 water supply and consumptive use data to identify potentially significant impacts due to the Grassland Bypass Project. The analysis period is 2010-19. For the purposes of our groundwater analysis, we assumed annual water application rates are constant.

D.4.2.1 Groundwater Effects

The groundwater-flow model projects no net change in mean water table depth beneath the drained areas of the Grasslands Drainage Area during the project period (Figure 7a). The mean depth to water beneath drained areas remains at 6.4 feet below land surface. Beneath the SJRIP reuse facility, the mean depth to ground water increases 1.5 feet during the project period (Figure

7b). The increased depth to water is the result of the additional tile drainage systems added to presently undrained land areas as part of the continued project. Our simulated water table conditions have the following potential groundwater effects:

- No net change in water table depth beneath the drained areas corresponds to no net change in drainwater production rates. Simulated sump flows in 2010 and 2019 are both 0.9 feet per year, which is the same as existing (2008) conditions. In 2019, projected sump flows are about 0.75 feet per year less than estimated for the No Action Alternative. The Grassland Bypass Project is therefore considered to have a positive effect on drainwater production relative to the No Action Alternative, and a no impact relative to existing conditions.

- Model results indicate that about 138 square miles will be affected by a water table within 7 feet of land surface, which is the same as the No Action Alternative. Under simulated project conditions, the net bare-soil evaporation rate increased from 0.26 ft/yr in 2008 to 0.27 ft/yr in 2019 (an increase of 0.01 ft/yr or less than 4-percent). The Proposed Project is therefore considered to have a less than significant impact relative to existing conditions. The net bare-soil evaporation rate in 2019 is 0.07 ft/yr less for the Proposed Action than for the No Action Alternative. The Project is therefore considered to have a positive effect on bare soil evaporation rates relative to the No Action Alternative.

- Uncontrolled discharge includes seepage into unlined drainage ditches. Flow model results for the Proposed Project indicate an almost 75% decrease in seepage to unlined canals compared to existing conditions (2008), and a 90% decrease in 2019 seepage rates compared to the No Action Alternative. Unlike the No Action Alternative, seepage and other non-recyclable waters that enter the drainage ditches will be collected and discharged to the Grassland Bypass. The Grassland Bypass Project is therefore considered to have a significant beneficial impact relative to existing conditions and a positive effect relative to the No Action Alternative by reducing and controlling these discharges.

- Model results indicate there is no significant change in subsurface flow northeast towards the wetlands and San Joaquin River. Deep aquifer recharge decreases from 0.32 foot per year under current conditions (2008) to 0.30 foot/year in 2019 (a reduction of less than 7-percent), and therefore the Proposed Project is considered to have a beneficial impact. Deep aquifer recharge decreases from 0.32 foot per year to compared to 0.29 foot/year for the No Action Alternative, and therefore the Proposed Project is considered to have a positive effect relative to the No Action Alternative.

D.4.2.2 Salinity Effects

In the western San Joaquin Valley, minerals are present in the unsaturated zone. As the crop uses water, and soluble salts are evapoconcentrated, gypsum and calcite minerals are precipitated. This precipitation, salt dilution by applied water, and salt removal by drainage systems offset the salinity increases due to evapoconcentration. Soil salinity will therefore approach a constant value, and the final salinity represents a new chemical equilibrium under simulated steady-state soil moisture conditions.

For the nine-year project period (2010-2019), our analysis indicates that soil salinity increases as a result of current drainwater recycling. This conclusion is supported by data reported by Wichelns (1989) indicating average soil salinity of 2.0 dS/m for a field located in what was formerly Broadview Water District. Ayers and others (1996) reported an average soil salinity of 4.9 dS/m for the same field. These data suggest that soil salinity may have increased under the past drainwater recycling conditions practiced in that field. Presently, irrigated agriculture is no longer conducted in Broadview Water District and sump flows are not discharged to the Grasslands Bypass.

For the Proposed Action, our salinity modeling identified the following potential impacts to soil and groundwater:

- Simulated unsaturated-zone soil salinity for the Grasslands Drainage Area is shown in Figure 7. Soil salinity in the Grasslands Drainage Area increases from 1.0 dS/m in 2008 (existing conditions) to 1.9 dS/m in 2019, which is substantially less than estimated for the No Action Alternative (an estimated soil salinity of 3.2 dS/m in 2019). The increase in unsaturated-zone soil salinity relative to existing conditions is considered to be a less-than-significant impact because the soil remains productive. The unsaturated zone soil salinity increases in the GDA are substantially less than for the No Action Alternative. Therefore, the Grasslands Bypass Project is considered to have a positive affect on soil salinity relative to the No Action Alternative. Because the observed coefficient of variation in western San Joaquin Valley soil salinity is large, the simulated soil salinity increases will not be observable over short time periods (for example, ten years) without extensive sampling.

  In the Grasslands Drainage Area, estimated soil selenium concentrations increase from 11 µg/L in 2008 to 21 µg/L in 2019, and estimated boron concentrations increase from 0.9 to 1.3 mg/L. The increase in selenium and boron concentrations relative to existing conditions is considered to be a significant unavoidable impact of irrigating western San Joaquin Valley soils. The concentrations will not affect agricultural productivity, but may with time influence selenium concentrations in underlying shallow groundwater and agricultural drainwater. However, the drainwater is treated by the SJRIP, which will include as part of its Phase III development salt and selenium treatment prior to leaving the GDA. In the SJRIP during the same time period, soil selenium concentrations increase from 73 to 124 µg/L, and boron concentrations increase from 3.4 to 5.5 mg/L. The selenium and boron concentration increases are less than the No Action Alternative. The Grassland Bypass Project is therefore considered to have a positive effect on soil salinity relative to the No Action Alternative.

- Simulated groundwater salinity for the Grasslands Drainage Area is shown in Figure 8. Groundwater salinity in the Grasslands Drainage Area decreases from 6 dS/m in 2008 to 4 dS/m in 2019, which is less than the 2019 salinity concentration estimated for the No Action Alternative (5 dS/m in 2019). Under this alternative, the Grassland Bypass Project is considered to have a significant beneficial impact relative to existing conditions because the groundwater salinity decreases over time. The groundwater salinity also decreases by 2019 relative to the No Action Alternative, although not as much. Therefore, the continuation of the Grasslands Bypass Project is considered to have a positive effect on groundwater salinity relative to the No Action Alternative.

The coefficient of variation for groundwater salinity data from the Grassland Drainage Area is more than 40 percent. This means a large number of samples would be needed to detect the simulated salinity changes. Drainwater data is limited for representing groundwater quality because salt transport, mixing along groundwater-flow paths, and irrigation management practices can conceal the short term salinity changes.

In the Grasslands Drainage Area, the simulated groundwater selenium concentrations decrease from 47 to 22 µg/L and boron concentrations decrease from 6.0 to 3.7 mg/L. The continuation of the Grassland Bypass Project is, therefore, considered to have a significant beneficial impact on selenium and boron concentrations relative to existing conditions. Selenium and boron concentrations in 2019 are less than under the No Action Alternative and the Grassland Bypass Project is considered to have a potentially positive effect on groundwater quality relative to the No Action Alternative.

- Soil salinity will increase more dramatically if drainwater is applied undiluted directly to fields like in the SJRIP reuse facility. In the SJRIP, the unsaturated-zone soil salinity increases from 6.6 dS/m in 2010 to 11.2 dS/m in 2019, but the salinity increases are substantially less than estimated for the No Action Alternative (13.9 dS/m in 2019) (Figure 8). Although the soil salinity increases under Project conditions represent significant changes, they are less than what is expected under the No Action Alternative and are spatially limited to at most 6,900 acres (6-percent of the Grassland Drainage Area), and are reversible. Impacted soils could be reclaimed and saline shallow groundwater removed when an alternative means of salt disposal becomes available under Phase III. The continuation of the Grasslands Bypass project is therefore considered to have a less-than-significant adverse impact on unsaturated zone soil salinity in the GDA relative to existing conditions, and a positive effect on GDA soil salinity relative to the No Action Alternative..

- Simulated groundwater salinity concentrations beneath the SJRIP decrease under Project conditions from 23 dS/m in 2008 to 17 dS/m in 2019, and the salinity reduction is substantially greater than estimated for the No Action Alternative (23 to 22 dS/m in 2019) (Figure 9). Simulated groundwater selenium concentrations therefore also decrease from 816 to 419 µg/L and boron concentrations decrease from 38.9 to 25.2 mg/L. Compared to existing conditions, the continuation of the Grasslands Bypass Project is considered to have a positive effect on groundwater quality beneath the SJRIP. The continuation of the Grasslands Bypass project is considered to have a significant beneficial impact on groundwater quality beneath the SJRIP relative to the No Action Alternative.

  The SJRIP reuse facility objective is not agricultural production but water consumption. Treatment facility fields would be planted with salt tolerant crops and managed to limit soil salinity impacts. We therefore considered the area-limited application of undiluted drainwater as a less than significant impact to the Grassland Drainage Area. Soil and drainwater quality monitoring are being conducted to track salinity changes beneath the treatment facility.

D.4.2.2 Wetlands Effects

Water delivered to the CDFG wetland complex will initially saturate the soil and fill swales and ponds. Continued water supply will meet evapotranspiration (ET) and seepage. Water in excess of ET will move by way of the subsurface towards the San Joaquin River. Historically, this area was inundated by flood water from the San Joaquin River about every 6 years (Joseph McGahan, personal communication, 2008). This will provide periodic flushing of saline water.

The steady state water budget for the wetland area is as follows.

Water deliveries = ET + seepage – precipitation

Using 20 years of data from the Los Banos California Irrigation Management Information System (CIMIS) weather station and wetland crop coefficients generated for Delta wetlands (Anderson and Snyder, 2005), we estimated monthly wetland ET. We estimated average monthly precipitation from 20-years of data from the Kesterson CIMIS weather station data. Irrigation of the wetland will increase the salt loading to the San Joaquin River if the salinity of the wetland water increases to levels above the groundwater salinity measured by Summers Engineering. This is the primary potential effect of irrigation of the wetlands. Specifically, the well water and shallow groundwater have less than detectable selenium. Boron and arsenic concentrations are slightly elevated in the well water relative to aquatic life standards and Regional Board water quality goals but substantially less than concentrations in the shallow groundwater. Since boron is correlated with salinity in the western San Joaquin Valley, if the projected groundwater and wetland salinity does not exceed the current groundwater salinity this will probably ensure that boron concentrations will also not exceed current shallow-groundwater levels.

For estimating the concentration increase of the wetland pond and shallow groundwater, we assumed the following.

- Delivered water will saturate the soil in about 200 acres. We assumed that the porosity is about 45% for the 6 feet of current unsaturated zone.
- As a result of saturated soil conditions, wetland plants will develop and wetland ET will occur over about 200 acres.
- The average salinity (total dissolved solids) of the irrigation water will be 1,115 mg/L.

We estimated the wetland and seepage salinity as follows. The salt concentration in the wetland surface water and shallow groundwater C_w under long-term steady state conditions can be estimated by:

$$C_w = ((Q_i \times C_i - Q_{seep} \times C_{seep} + Q_{ppt} \times C_{ppt}) / Q_w) \times CF \qquad (5)$$

where,

Q_i = volume of irrigation water (acre-feet/year)
C_i = salinity of the irrigation water (mg/L)
Q_{seep} = volume of seepage (acre-feet/year) = leaching fraction (LF) x Q_i
C_{seep} = salinity of the seepage water
Q_{ppt} = precipitation volume (acre-feet/year)
C_{ppt} = salinity of precipitation (assumed as 38 mg/L)[3]
Q_w = volume of wetland surface water and shallow groundwater within 6 feet of land surface
CF = concentration factor = $1/[(Q_i + Q_w + Q_{ppt} - Q_{ET})/(Q_i + Q_w + Q_{ppt})]$
LF = fraction of irrigation and precipitation water not used for ET
= $(Q_i + Q_{ppt} - Q_{ET})/(Q_i + Q_{ppt})$

Using equation 5, we estimated the concentration of the wetland and shallow groundwater. We solved equation 5 iteratively by varying the concentration of the seepage water (C_{seep}) until C_w equaled C_{seep}. The LF expressed as a percent was 37 % for the stated planned delivery of 12 acre-feet per year to the wetland. Our calculations indicate that under these conditions, the salinity of the shallow groundwater will be less than the current average shallow groundwater salinity that probably flows to the San Joaquin River. We did not calculate the potential water quality effect of groundwater deliveries to the USFWS facility due to lack of information about irrigation water quality and water management. However, if managed similarly to the CDFG facility (large volumes of irrigation and seepage water) there will likely be no net salinity increase over the long term. The key uncertainties in our calculations are the impacts of short-term and transient changes in wetland salinity and water quality. Our calculations assume steady-state well mixed wetland water and shallow groundwater, and are thus applicable to the long term (several years to decades). Additional analysis is required to assess short term (seasonal and annual) changes.

D.4.3 2001 Requirements Alternative

The third alternative is known as the 2001 Requirements Alternative and is similar to the Proposed Action (Grasslands Bypass Project) in all aspects except the selenium and salt loads discharged to Mud Slough would be limited to those in the 2001 Use Agreement (i.e., less stringent allowances). Accordingly, estimated groundwater and soil impacts within the GDA are identical to the Grassland Bypass Project. Results shown in Figures 6, 7, and 8 for the Project Alternative are identical for the 2001 Requirements alternative.

[3] Hem, J.D.. 1985, Study and interpretation of the chemical composition of natural waters, USGS Water Supply Paper 2254.

D.4.3.1 Groundwater Effects

The groundwater-flow model projects no net change in mean water table depth beneath the drained areas of the GDA during the project period (Figure 7a). The mean depth to water beneath drained areas remains at 6.4 feet below land surface. Beneath the SJRIP reuse facility, the mean depth to ground water increases 1.5 feet during the project period (Figure 7b). The increased depth to water is the result of the additional tile drainage systems added to presently undrained land areas as part of the continued project. Our simulated water table conditions have the following potential groundwater effects:

- No net change in water table depth beneath the drained areas corresponds to no net change in drainwater production rates. Simulated sump flows in 2010 and 2019 are both 0.9 feet per year, which is the same as existing (2008) conditions. In 2019, projected sump flows are about 0.75 feet per year less than estimated for the No Action Alternative. The 2001 Requirements Alternative is therefore considered to have a positive effect on drainwater production relative to the No Action Alternative, and a no impact relative to existing conditions.

- Model results indicate that about 138 square miles will be affected by a water table within 7 feet of land surface, which is the same as the No Action Alternative. Under simulated project conditions, the net bare-soil evaporation rate increased from 0.26 ft/yr in 2008 to 0.27 ft/yr in 2019 (an increase of 0.01 ft/yr or less than 4-percent). The 2001 Requirements Alternative is therefore considered to have a less than significant impact on current evaporation rates relative to existing conditions. The net bare-soil evaporation rate in 2019 is 0.07 ft/yr less for the 2001 Requirements Alternative than for the No Action Alternative. This alternative is therefore considered to have a positive effect on bare soil evaporation rates relative to the No Action Alternative.

- Uncontrolled discharge includes seepage into unlined drainage ditches. Flow model results for the 2001 Requirements Alternative indicate an almost 75% decrease in seepage to unlined canals compared to existing conditions (2008), and a 90% decrease in 2019 seepage rates compared to the No Action Alternative. Unlike the No Action Alternative, seepage and other non-recyclable waters that enter the drainage ditches will be collected and discharged to the Grassland Bypass. The 2001 Requirements Alternative is therefore considered to have a significant beneficial impact relative to existing conditions and positive effect relative to the No Action Alternative by reducing and controlling these discharges.

  Model results indicate there is no significant change in subsurface flow northeast towards the wetlands and San Joaquin River. Deep aquifer recharge decreases from 0.32 foot per year under current conditions (2008) to 0.30 foot per year in 2019 (a reduction of less than 7 percent), and therefore the 2001 Requirements Alternative is considered to have a beneficial impact. Deep aquifer recharge decreases from 0.32 foot per year to 0.29 foot/year for the No Action Alternative, and therefore the 2001 Requirements Alternative is considered to have a positive effect relative to the No Action Alternative.

D.4.3.2 Salinity Effects

For the 2001 Requirements Alternative, our salinity modeling identified the following potential impacts to soil and groundwater:

- Simulated unsaturated-zone soil salinity for the GDA is shown in Figure 8. Soil salinity in the GDA increases from 1.0 dS/m in 2008 (existing conditions) to 1.9 dS/m in 2019, which is substantially less than estimated for the No Action Alternative (an estimated soil salinity of 3.2 dS/m in 2019). The increase in unsaturated-zone soil salinity relative to existing conditions is considered to be a less-than-significant impact because the soil remains productive. The unsaturated zone soil salinity increases in the GDA are substantially less than for the No Action Alternative. Therefore, the 2001 Requirements Alternative is considered to have a positive affect on soil salinity relative to the No Action Alternative.

  In the GDA, estimated soil selenium concentrations increase from 11 µg/L in 2008 to 21 µg/L in 2019, and estimated boron concentrations increase from 0.9 to 1.3 mg/L. In the SJRIP during the same time period, soil selenium concentrations increase from 73 to 124 µg/L, and boron concentrations increase from 3.4 to 5.5 mg/L. The increase in selenium and boron concentrations relative to existing conditions is considered to be a significant unavoidable impact of irrigating western San Joaquin Valley soils. The concentrations will not affect agricultural productivity, but may with time influence selenium concentrations in underlying shallow groundwater and agricultural drainwater. However, the drainwater is treated by the SJRIP, which will include as part of its Phase III development salt and selenium treatment prior to leaving the GDA. The selenium and boron concentration increases are less than the No Action Alternative. The 2001 Requirements Alternative is therefore considered to have a positive effect on soil salinity relative to the No Action Alternative.

- Simulated groundwater salinity for the GDA is shown in Figure 9. Groundwater salinity in the GDA decreases from 6 dS/m in 2008 to 4 dS/m in 2019, which is less than the 2019 salinity concentration estimated for the No Action Alternative (5 dS/m in 2019). Under this alternative, the 2001 Requirements Alternative is considered to have a significant beneficial impact relative to existing conditions because the groundwater salinity decreases over time. The groundwater salinity also decreases by 2019 relative to the No Action Alternative, although not as much. Therefore, the continuation of the 2001 Requirements Alternative is considered to have a positive effect on groundwater salinity relative to the No Action Alternative.

  In the GDA, the simulated groundwater selenium concentrations decrease from 47 to 22 µg/L and boron concentrations decrease from 6.0 to 3.7 mg/L The 2001 Requirements Alternative is, therefore, considered to have a significant beneficial impact on selenium and boron concentrations relative to existing conditions. Selenium and boron concentrations in 2019 and the 2001 Requirements Alternative is considered to have a potentially positive effect on groundwater quality relative to the No Action Alternative.

- Soil salinity will increase more dramatically if drainwater is applied undiluted directly to fields like in the SJRIP reuse facility. In the SJRIP, the unsaturated-zone soil salinity increases from 6.6 dS/m in 2010 to 11.2 dS/m in 2019, but the salinity increases are substantially less than estimated for the No Action Alternative (13.9 dS/m in 2019) (Figure 8). Although the soil salinity increases under this alternative represent significant changes, they are less than what is expected under the No Action Alternative and are spatially limited to at most 6,900 acres (6-percent of the GDA). The soil salinity changes are also considered reversible; impacted soils could be reclaimed and saline shallow groundwater removed when an alternative means of salt disposal becomes available under Phase III. The 2001 Requirements Alternative is therefore considered to have a less-than-significant adverse impact on unsaturated zone soil salinity in the GDA relative to existing conditions, and a positive effect on GDA soil salinity relative to the No Action Alternative.

- Simulated groundwater salinity concentrations beneath the SJRIP decrease under this alternative from 23 dS/m in 2008 to 17 dS/m in 2019, and the ending salinity is substantially lower than estimated for the No Action Alternative (22 dS/m in 2019) (Figure 9). Simulated groundwater selenium concentrations decrease from 816 to 419 µg/L and boron concentrations decrease from 38.9 to 25.2 mg/L. Compared to existing conditions, the 2001 Requirements Alternative is considered to have a positive effect on groundwater quality beneath the SJRIP. The 2001 Requirements Alternative is considered to have a significant beneficial impact on groundwater quality beneath the SJRIP relative to the No Action Alternative.

  The SJRIP reuse facility objective is not agricultural production but water consumption. Treatment facility fields would be planted with salt tolerant crops and managed to limit soil salinity impacts. We therefore considered the area-limited application of undiluted drainwater as a less than significant impact to the Grassland Drainage Area. Soil and drainwater quality monitoring are being conducted to track salinity changes beneath the treatment facility.

D.5 CUMULATIVE EFFECTS

Cumulative effects are impacts that are insignificant on their own but when combined with other incremental effects can become significant. Although the Grassland Bypass Project and 2001 Requirements Alternative are projected to have less than significant water table, soil and groundwater impacts, Grassland Drainage Area irrigation recharge contributes to on-going regional increases in water table elevation, soil salinity, and groundwater salinity (Belitz and others, 1993). Conversely, irrigation recharge in adjacent and upslope areas contribute to water table elevation, soil salinity, and groundwater salinity increases in the Grassland Drainage Area.

In the Grasslands and Westlands Sub-Basins, California Department of Water Resources reported the area underlain by a water table within 10 feet of land surface has on the average increased about 20,000 acres per year during the period 1991–97 (Department of Water Resources, 2000). The San Joaquin Valley Drainage Implementation Program (1998) reported that in 1990 alone, almost 1.5 million tons of salt were imported and deposited into western San Joaquin Valley soils and water. The water table rise and salinization of soil and groundwater is a significant regional problem.

D.6 IMPACT MITIGATION SUMMARY

The following summarizes groundwater and soil impacts. The impacts are evaluated relative to the No Action Alternative and existing conditions.

Table 6 Summary Comparison of Groundwater and Soil Impacts

Parameter or Anticipated Environmental Effect	No Action Compared to Existing Condition	Proposed Action Compared to No Action	Proposed Action Compared to Existing Condition	Alternative Action Compared to No Action	Alternative Action Compared to Existing Condition
Drainwater production	*Significant Adverse Impact* Decrease in water table depth corresponds to an increase in drainwater production	*Positive* In 2019, projected drainflow is about 45 percent of drainflow projected under No Action	*No Impact* In 2019, projected drainflow is similar to existing conditions	*Positive* In 2019, projected drainflow is about 45 percent of drainflow projected under No Action	*No Impact* In 2019, projected drainflow is similar to existing conditions
Area affected by shallow water	*Less-Than-Significant Adverse Impact* Minimal projected net increases in the area affected by a shallow water table (1 sq. mi.)	*Neutral* Minimal projected net increases in the area affected by a shallow water table (1 sq. mi.)	*Less-Than-Significant Adverse Impact* Minimal projected net increases in the area affected by a shallow water table (1 sq. mi.)	*Neutral* Minimal projected net increases in the area affected by a shallow water table (1 sq. mi.)	*Less-Than-Significant Adverse Impact* Minimal projected net increases in the area affected by a shallow water table (1 sq. mi.)
Bare-soil evaporation rate	*Significant Adverse Impact* Increase in bare-soil evaporation rate	*Positive* 20 percent decrease in the bare-soil evaporation rate	*Less-Than-Significant Adverse Impact* Small increase in the bare-soil evaporation rate	*Positive* 20 percent decrease in the bare-soil evaporation rate	*Less-Than-Significant Adverse Impact* Small increase in the bare-soil evaporation rate
Unmanaged seepage and other discharges	*Significant Adverse Impact* Seepage into unlined ditches more than doubles and unmanaged flows would not be collected and impact adjacent areas	*Positive* 90 percent decrease in seepage to unlined canals	*Significant Beneficial Impact* 75 percent decrease in seepage to unlined canals	*Positive* 90 percent decrease in seepage to unlined canals	*Significant Beneficial Impact* 75 percent decrease in seepage to unlined canals
Soil salinity*	*Significant Adverse Impact* 3 fold increase in soil salinity	*Positive* Unsaturated-zone soil salinity increases in the GDA are substantially less	*Less-Than-Significant Adverse Impact* Unsaturated-zone soil salinity in the GDA doubles but soil remains productive	*Positive* Unsaturated-zone soil salinity increases in the GDA are substantially less	*Less-Than-Significant Adverse Impact* Unsaturated-zone soil salinity in the GDA doubles but soil remains productive
Groundwater salinity*	*Significant Beneficial/ Less-Than-Significant Beneficial Impact* Groundwater salinity decreased slightly	*Positive* Salinity decreases over time	*Significant Beneficial Impact* Salinity decreases over time	*Positive* Salinity decreases over time	*Significant Beneficial Impact* Salinity decreases over time
Wetlands enhancement for continued discharge to Mud Slough	*No impact* There would be no wetlands enhancement	*Minimal/Neutral* Short-term transient changes/No net salinity increases over long term.	*Less-Than-Significant Adverse Impact/No Impact* Short-term transient changes/No net salinity increases over long term.	*Neutral* There would be no wetlands enhancement	*No Impact* There would be no wetlands enhancement

*GDA drained area/SJRIP reuse facility

In the Grassland Drainage Area, the spatial variability of constituents in soil and groundwater is high. This spatial variability must be considered when designing plans to monitor groundwater and soil salinity. This means that the soil- and groundwater salinity increases we simulated will not be observable over a short time period (ten years) without extensive sampling.

A summary of our impact analysis is provided below.

D.6.1 No Action Alternative

The No Action Alternative represents probable environmental conditions without the Grassland Bypass Agreement. Tile drainage systems probably continue to operate, but the drainwater produced presumably remains within the Grassland Drainage Area.

- A decrease in water table depth corresponds to an increase in drainwater production and a significant adverse impact to the GDA.

- Minimal projected increases in area affected by a shallow water table indicate a less–than-significant adverse impact to the GDA. The increase in bare-soil evaporation rate was considered a significant adverse impact to the GDA.

- Flow model results indicate seepage into unlined ditches more than doubles relative to existing conditions. Unlike current conditions, uncontrollable flows will not be collected and therefore represent significant new adverse impacts to adjacent areas.

- Estimated soil salinity increased 3-fold relative to existing soil salinity. We considered the increase in GDA and SJRIP soil salinity as significant adverse impacts.

- Estimated groundwater salinity decreased slightly relative to existing conditions. We considered this as possibly a less than significant to significant beneficial impact on the GDA. However, the results may indicate assumed initial groundwater salinity values are too high relative to representative soil salinity levels and the prescribed chemical composition of the different water sources.

D.6.2 Proposed Action

The Proposed Action is the Grassland Bypass Project and is a continuation of the existing Bypass Use Agreement. The Grassland Area Farmers will continue to collect drainwater for discharge into the San Luis Drain. The SJRIP reuse facility is also included. Our analysis indicated the following effects:

- In 2019, projected drainflow under the Proposed Action is similar to existing conditions and is about 45 % of the drainflow projected under the No Action Alternative. The Proposed Action is therefore considered to have no impact relative to existing conditions and a positive effect on drainwater production relative to the No Action Alternative. Not mitigation is required.

- Minimal projected net increases in area affected by a shallow water table (1 square mile) indicate that the Proposed Action has a less-than-significant impact relative to existing conditions (no mitigation is required), and no impact/neutral relative to the No Action Alternative.

- A small increase in the bare-soil evaporation rate from existing conditions is considered to be a less–than-significant impact relative to current evaporation rates. A 20% decrease in the bare-soil evaporation rate relative to the No Action Alternative is considered to be a positive effect from the Proposed Action. No mitigation is required.

- Flow model results for the Proposed Action indicate an almost 75% decrease in seepage to unlined canals compared to existing conditions (2008), and a 90% decrease in 2019 seepage rates compared to the No Action Alternative. The Grassland Bypass Project is therefore considered to have a significant beneficial impact relative to existing conditions and a positive effect compared to the No Action Alternative. No mitigation is required.

- Simulated unsaturated-zone soil salinity increases in the GDA are substantially less relative to the No Action Alternative. The Grassland Bypass Project is therefore considered to have a positive effect on soil salinity relative to the No Action Alternative. Simulated unsaturated-zone soil salinity almost doubles relative to existing conditions, but is considered a less-than-significant impact because the soil remains productive. Soil and groundwater monitoring of the GDA is recommended to identify these impacts and potential salinity changes at GDA boundaries, if any. No mitigation is required.

- Simulated groundwater salinity decreases over time and is less than simulated for the No Action Alternative. The Grassland Bypass Project is therefore considered to have a potentially beneficial impact on groundwater salinity relative to the No Action Alternative. Simulated groundwater salinity also decreases relative to existing conditions and is considered to be a significant beneficial impact. However, the results may indicate assumed initial groundwater salinity values are too high relative to representative soil salinity levels and the prescribed chemical composition of the different water sources.

- Soil and groundwater salinity will increase more dramatically where drainwater is applied directly to fields. In the SJRIP reuse facility, undiluted drainwater is applied directly to fields. Projected soil salinity increases less than under the No Action Alternative and therefore the Proposed Action is considered to have a positive effect. In the Proposed Action, groundwater salinity decreases relative to both existing conditions and the No Action Alternative, and the Proposed Action is considered to provide a significant beneficial impact/positive effect.

  Projected soil salinity concentrations at the SJRIP increase. The impacts would be limited to at most 6,900 acres (6-percent of the GDA). The treatment facility would be managed to optimize consumptive use of water, and impacted soils could be reclaimed and saline shallow groundwater removed when an alternative means for salt disposal becomes available under

Phase III. The Proposed Action is therefore considered to have a less-than-significant adverse impact relative to existing conditions. Soil and groundwater monitoring of the SJRIP reuse facility is recommended to identify impacts and potential salinity changes at facility boundaries, if any.

- The wetlands enhancement component of the 2010 Use Agreement would cause no net salinity increase over the long term. The key uncertainties in the calculations are the impacts of short-term and transient changes in wetland salinity and water quality

D.6.3 2001 Requirements Alternative

The 2001 Requirement Alternative is a continuation of the existing Bypass Use Agreement with selenium and salt loads discharged to Mud Slough limited to those in the 2001 Use Agreement. The Grassland Area Farmers will continue to collect drainwater for discharge into the San Luis Drain. The SJRIP reuse facility is also included. Our analysis indicated the following effects:

- In 2019, projected drainflow under the 2001 Requirements Alternative is similar to existing conditions and is about 45 % of the drainflow projected under the No Action Alternative. This alternative is therefore considered to have no impact relative to existing conditions and a positive effect on drainwater production relative to the No Action Alternative.

- Minimal projected increases in area affected by a shallow water table indicate that the 2001 Requirements Alternative has a less than significant adverse impact relative to existing conditions and no impact/neutral relative to the No Action Alternative. No mitigation is required.

- A small increase in the bare-soil evaporation rate compared to existing conditions is considered to be a less–than-significant impact relative to current evaporation rates. A 20% decrease in the bare-soil evaporation rate relative to the No Action Alternative is considered to be a positive effect from the 2001 Requirements Alternative. No mitigation is required.

- Flow model results for the 2001 Requirements Alternative indicate an almost 75% decrease in seepage to unlined canals compared to existing conditions (2008), and a 90% decrease in 2019 seepage rates compared to the No Action Alternative. This alternative is therefore considered to have a significant positive effect compared to relative to existing conditions and the No Action Alternative.

- Simulated unsaturated-zone soil salinity increases in the GDA are substantially less relative to the No Action Alternative. This alternative is therefore considered, therefore, to have a positive effect on soil salinity relative to the No Action Alternative. No mitigation is required. Simulated unsaturated-zone soil salinity almost doubles relative to existing conditions, but is considered a less-than-significant adverse impact because the soil remains productive. . Soil and groundwater monitoring of the GDA is recommended to identify these impacts and potential salinity changes at GDA boundaries, if any. No mitigation is required.

- Simulated groundwater salinity decreases over time and is less than simulated for the No Action Alternative. This alternative is therefore considered to have a potentially beneficial impact on groundwater salinity relative to the No Action Alternative. Simulated groundwater salinity also decreases relative to existing conditions and is considered to be a significant beneficial impact. However, the results may indicate assumed initial groundwater salinity values are too high relative to representative soil salinity levels and the prescribed chemical composition of the different water sources.

- Soil and groundwater salinity will increase more dramatically where drainwater is applied directly to fields. In the SJRIP reuse facility, undiluted drainwater is applied directly to fields. Projected soil salinity increases are less than simulated under the No Action Alternative and therefore this alternative is considered to have a positive effect. Groundwater salinity decreases relative to existing conditions and the No Action Alternative, and this alternative is considered to provide a significant beneficial impact/positive effect.

  Projected soil salinity concentrations at the SJRIP facility increase. The impacts would be limited to at most 6,900 acres (6-percent of the Grassland Drainage Area). The treatment facility will be managed to optimize consumptive use of water, and impacted soils could be reclaimed and saline shallow groundwater removed when an alternative means for salt disposal becomes available as part of Phase III. The Proposed Action is therefore considered to have a less-than-significant adverse impact relative to existing conditions. Soil and groundwater monitoring of the SJRIP reuse facility is recommended to identify impacts and potential salinity changes at facility boundaries, if any.

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APPENDIX E

Biology

APPENDIX E1

Species Lists

Table E-1a Special-Status Species with potential to occur in the project vicinity

Common Name	Scientific Name	Federal	State	CNPS	Occurrence
Mammals					
San Joaquin antelope squirrel	*Ammospermophilus nelsoni*	—	ST	—	unlikely
giant kangaroo rat	*Dipodomys ingens*	FE	SE	—	unlikely
Fresno kangaroo rat	*Dipodomys nitratoides exilis*	FE	SE	—	unlikely
Western pallid bat	*Antrozous pallidus*	—	SC	—	known
Western mastiff bat	*Eumops perotis californicus*	—	SC	—	unlikely
Western red bat	*Lasiurus blossevillii*	—	SC	—	known
Tulare grasshopper mouse	*Onychomys torridus tularensis*	—	SC	—	unlikely
American badger	*Taxidea taxus*	—	SC	—	known
San Joaquin kit fox	*Vulpes macrotis mutica*	FE	ST	—	potential
Birds					
tricolored blackbird	*Agelaius tricolor*	—	SC	—	known
bald eagle	*Haliaeetus leucocephalus*	FD	SE	—	known
burrowing owl	*Athene cunicularia*	—	SC	—	known
Greater Sandhill Crane	*Grus canadensis tabida*	—	ST		known
Lesser Sandhill Crane	*Grus canadensis canadensis*	—	ST		known
Least Bell's vireo	*Vireo belli pusillus*	FE	SE	—	likely
Loggerhead Shrike	*Lanius ludovicianus*	—	SC	—	known
mountain plover	*Charadrius montanus*	—	SC	—	known
northern harrier	*Circus cyaneus*	—	SC	—	known
Peregrine falcon	*Falco peregrinus*	FD	SE	—	known
Swainson's hawk	*Buteo swainsoni*	—	ST	—	known
western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	FC	SE	—	unlikely
willow flycatcher	*Empidonax traillii estimus*	—	SE	—	known
Reptiles					
Silvery legless lizard	*Anniella pulchra pulchra*	—	SC	—	potential
western pond turtle	*Clemmys marmorata*	—	SC	—	known
blunt-nosed leopard lizard	*Gambelia (=Crotaphytus) sila*	FE	SE	—	unlikely
San Joaquin whipsnake	*Masticophis flagellum ruddocki*	—	SC	—	unlikely
giant garter snake	*Thamnophis gigas*	FT	ST	—	known
Amphibians					
California tiger salamander	*Ambystoma californiense*	FT	SC	—	likely
California red-legged frog	*Rana aurora draytonii*	FT	SC	—	unlikely
western spadefoot	*Scaphiopus hammondii*	—	SC	—	known
Invertebrates					
conservancy fairy shrimp	*Branchinecta conservatio*	FE	—	—	likely
longhorn fairy shrimp	*Branchinecta longiantenna*	FE	—	—	likely
vernal pool fairy shrimp	*Branchinecta lynchi*	FT	—	—	likely
valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FT	—	—	known
vernal pool tadpole shrimp	*Lepidurus packardi*	FE	—	—	likely

Table E-1a Special-Status Species with potential to occur in the project vicinity

Common Name	Scientific Name	Federal	State	CNPS	Occurrence
Plants					
Alkali milkvetch	*Astragalus tener var. tener*	—	—	1B.2	no potential for impact
Heartscale	*Atriplex cordulata*	—	—	1B.2	no potential for impact
Brittlescale	*Atriplex depressa*	—	—	1B.2	no potential for impact
Lesser saltscale	*Atriplex minuscula*	—	—	1B.1	no potential for impact
Vernal pool smallscale	*Atriplex persistens*	—	—	1B.2	no potential for impact
Hispid bird's-beak	*Cordylanthus mollis ssp. hispidus*	—	—	1B.1	no potential for impact
Palmate-bracted bird's beak	*Cordylanthus palmatus*	FE	SE	1B.1	no potential for impact
Delta button celery	*Eryngium racemosum*	—	SE	1B.1	likely
Munz's tidy tips	*Layia munzii*	—	—	1B.2	no potential for impact
Panoche pepper-grass	*Lepidium jaredii spp. album*	—	—	1B.2	no potential for impact
San Joaquin wollythreads	*Monolopia congdonii*	FE	—	1B.2	no potential for impact
Prostrate vernal pool navarretia	*Navarretia prostrata*	—	—	1B.1	no potential for impact
Slender-leaved pondweed	*Potamogeton filiformis*	—	—	2.2	likely
Sanford's arrowhead	*Sagittaria sanfordii*	—	—	1B.2	likely
Chaparral ragwort	*Senecio aphanactis*	—	—	2.2	no potential for impact
Wright's trichocoronis	*Trichocoronis wrightii*	—	—	2.1	no potential for impact
Colusa grass	*Neostapfia colusana*	FT	SE	1B.1	likely
Fish					
Central Valley steelhead	Oncorhynchus mykiss	FT	SE	-	unlikely
Sacramento splittail	Pogonichthys macrolepidotus	—	CL-1	-	known
Central Valley fall-run chinook salmon	Oncorhynchus tshawytscha	FC	ST	-	not present
Hardhead	Mylopharodon conocephalus		SC	-	unlikely

Federal Status: FE - endangered, FT - threatened, FD - Federally Delisted

State Status: SE - endangered, ST - threatened, SC - State Species of Concern

CNPS = California Native Plant Society. CNPS status: 1B - rare, threatened or endangered in California and elsewhere, 2 - rare, threatened or endangered in California but not elsewhere

Project Area includes the following USGS 7.5 minute quadrangles: Broadview Farms, Crows Landing, Chaney Ranch, Charleston School, Delta Ranch, Dos Palos, Firebraugh, Gustine, Hammonds Ranch, Hatch, Ingomar, Los Banos, Oxalis, Poso Farm, San Luis Ranch, Stevinson

Table E-1b Terrestrial Species Mentioned in Section 6

Species List	*Scientific Name*
red-winged blackbird	*Agelaius phoeniceus*
tricolored blackbird	*Agelaius tricolor*
iodine bush	*Allenrolfea occidentalis*
California tiger salamander	*Ambystoma californiense*
sage sparrow	*Amphispiza belli*
cinnamon teal	*Anas cyanoptera*
mallard	*Anas platyrhinchos*
Silvery legless lizard	*Anniella pulchra pulchra*
american pipit	*Anthus rubescens*
pronghorn antelope	*Antilocapra americana*
pallid bat	*Antrozous pallidus*
great egret	*Ardea alba*
great blue heron	*Ardea herodias*
herons	*Ardea sp.*
burrowing owl	*Athene cunicularia*
shadscale	*Atriplex confertifolia*
wild oat	*Avena barbata*
rusty molly	*Bassia californica*
bitterns	*Botaurus lentiginosus*
conservancy fairy shrimp	*Branchinecta conservatio*
longhorn fairy shrimp	*Branchinecta longiantenna*
vernal pool fairy shrimp	*Branchinecta lynchi*
Aleutian Canada goose	*Branta canadensis leucopareia*
soft chess	*Bromus hordeaceus*
ripgut brome	*Bromus diandrus*
red brome	*Bromus rubens*
red-tailed hawk	*Buteo jamaicensis*
Swainson's hawk	*Buteo swainsoni*
green-backed heron	*Butorides virescens*
California quail	*Callipepla californica*
mariposa lily	*Calochortus sp.*
coyote	*Canis latrans*
gray wolf	*Canis lupus*
lesser goldfinch	*Carduelis psaltria*
American goldfinch	*Carduelis tristis*
house finch	*Carpodacus mexicanus*
owl's clover	*Castilleja sp.*
beaver	*Castor canadensis*
yellow star thistle	*Centaurea solstitialis*
mountain plover	*Charadrius montanus*
killdeer	*Charadrius vociferus*
northern harrier	*Circus cyaneus*
western pond turtle	*Clemmys marmorata*
western whiptail	*Cnemidophorus tigris*
poison hemlock	*Conium maculatum*
common raven	*Corvus corax*
samphire	*Crithmum maritimum*
western rattlesnake	*Crotalus viridis*
bermuda grass	*Cynodon dactylon*

Table E-1b Terrestrial Species Mentioned in Section 6

Species List	*Scientific Name*
valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*
opossum	*Didelphis virginiana*
Heermann's kangaroo rat	*Dipodomys heermanni*
giant kangaroo rat	*Dipodomys ingens*
Fresno kangaroo ra	*Dipodomys nitratoides exilis*
saltgrass	*Distichlis spicata*
downingia	*Downingia concolor*
snowy egret	*Egretta thula*
white-tailed kite	*Elanus leucurus*
willow flycatcher	*Empidonax traillii estimus*
horned lark	*Eremophila alpestris*
California horned lark	*Eremophila alpestris actia*
long-beaked filaree	*Erodium botrys*
redstem filaree	*Erodium circutarium*
Delta button celery	*Eryngium racemosum*
coyote thistle	*Eryngium sp.*
california poppy	*Eschscholzia californica*
Brewer's blackbird	*Euphagus cyanocephalus*
Peregrine falcon	*Falco peregrinus*
american kestrel	*Falco sparverius*
slender fescue	*Festuca*
alkali heath	*Frankenia salina*
American coot	*Fulica americana*
blunt-nosed leopard lizard	*Gambelia sila*
roadrunner	*Geococcyx californianus*
pocket gopher	*Geomys arenarius*
greater sandhill crane	*Grus canadensis*
bald eagle	*Haliaeetus leucocephalus*
low barley	*Hordeum depressum*
wild barley	*Hordeum murinum*
Pacific treefrog	*Hyla regilla*
Loggerhead Shrike	*Lanius ludovicianus*
california gull	*Larus californicus*
Western red bat	*Lasiurus blossevillii*
goldfields	*Lasthenia sp.*
vernal pool tadpole shrimp	*Lepidurus packardi*
black-tailed hare	*Lepus californicus*
meadowfoam	*Limnanthes sp.*
striped skunk	*Mephitis mephitis*
california vole	*Microtus californicus*
purple needle grass	*Nassella pulchra*
navarretia	*Navarretia sp.*
Colusa grass	*Neostapfia colusana*
riparian woodrat	*Neotoma fuscipes riparia*
muskrat	*Ondatra zibethicus*
ring-necked pheasant	*Pasianus colchicus*
San Joaquin kit fox	*Pasianus colchicus*
savannah sparrow	*Passerculus sandwichensis*
deer mouse	*Peromyscus maniculatus*

Table E-1b Terrestrial Species Mentioned in Section 6

Species List	*Scientific Name*
yellow-billed magpie	*Pica nuttalli*
gopher snake	*Pituophis catenifer*
popcornflower	*Plagiobothrys sp.*
California sycamore	*Platanus racemosa*
grebes	*Podicipediformes*
pogogyne	*Pogogyne sp.*
blue-gray gnatcatcher	*Polioptila caerulea*
cottonwood	*Populus sp.*
Slender-leaved pondweed	*Potamogeton filiformis*
racoon	*Procyon lotor*
woolly marbles	*Psilocarphus sp.*
valley oak	*Quercus lobata*
bullfrog	*Rana catesbeiana*
wild rose	*Rosa californica*
California blackberry	*Rubus ursinus*
Sanford's arrowhead	*Sagittaria sanfordii*
pickleweed	*Salicornia sp.*
willows	*Salix sp.*
blue elderberry	*Sambucus mexicana*
greasewood	*Sarcobatus sp.*
bush seepwood	*Sarcobatus sp.*
black phoebe	*sayornis nigricans*
Say's phoebe	*Sayornis saya*
western spadefoot	*Scaphiopus hammondii*
western fence lizard	*Sceloparus occidentalis*
milk thistle	*silybum marianum*
California ground squirrel	*Spermophilus beecheyi*
alkali sacaton	*Sproobolus airoides*
western meadowlark	*Sturnella neglecta*
desert cottontail	*Sylvilagus audubonii*
riparian brush rabbit	*Sylvilagus bachmani riparius*
medusa head	*Taeniatherum caput-medusae*
American badger	*Taxidea taxus*
aquatic garter snake	*Thamnophis atratus*
giant garter snake	*Thamnophis gigas*
common garter snake	*Thanophis sirtalis*
clover	*Trifolium spp.*
western kingbird	*Tyrannus verticalis*
grizzly bear	*Ursus arctos horriblis*
hoary nettle	*Urtica dioica*
side-blotched lizard	*Uta stansburiana*
California wild grape	*Vitis californica*
mourning dove	*Zenaida macroura*
white-crowned sparrow	*Zonotrichia leucophrys*

Table E-1c Fish Species Likely to be Found in the Grassland Water District or Adjacent Reaches of the San Joaquin River

Family	Species	Common Name	Native*
Atherinidae	*Menidia beryllina*	Inland silverside	I
Catostomidae	*Catostomus occidentalis*	Sacramento sucker	N
Centrarchidae	*Lepomis cyanellus*	Green sunfish	I
	Lepomis gulosus	Warmouth	I
	Lepomis hybrid	Hybrid sunfish	I
	Lepomis macrochirus	Bluegill	I
	Lepomis microlophus	Redear sunfish	I
	Micropterus punctulatus	Spotted bass	I
	Micropterus salmoides	Largemouth bass	I
	Pomoxis annularis	White crappie	I
	Pomoxis nigromaculatus	Black crappie	I
Clupeidae	*Alosa sapidissima*	American shad	I
	Dorosoma petenense	Threadfin shad	I
Cottidae	*Cottus asper*	Prickly sculpin	N
Cyprinidae	*Carassius auratus*	Goldfish	I
	Cyprinella lutrensis	Red shiner	I
	Cyprinus carpio	Common carp	I
	Lavinia exilicauda	Hitch	N
	Mylopharodon conocephalus	Hardhead	N
	Notemigonus crysoleucas	Golden shiner	I
	Orthodon microlepidotus	Sacramento blackfish	N
	Pimephales promelas	Fathead minnow	I
	Pogonichthys macrolepidotus	Sacramento splittail	N
	Ptychocheilus grandis	Sacramento pikeminnow	N
Embiotocidae	*Hysterocarpups traski*	Tule perch	N
Gobiidae	*Tridentiger bifasciatus*	Shimofuri goby	I
Ictaluridae	*Ameiurus catus*	White catfish	I
	Ameiurus melas	Black bullhead	I
	Ictalurus punctatus	Channel catfish	I
Percichthyidae	*Morone saxatilis*	Striped bass	I
Percidae	*Percina macrolepida*	Bigscale logperch	I
Petromyzontidae	*Lampetra tridentata*	Pacific lamprey	N
Poeciliidae	*Gambusia affinis*	Western mosquitofish	I
Salmonidae	*Oncorhynchus tshawytscha*	Chinook salmon	N
	Oncorhynchus mykiss	Steelhead trout	N

Source: Brown and Moyle 1992; Saiki 1984

I = Introduced
N = Native

APPENDIX E2

Selenium Ecological Risk Assessment

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FIGURES

E.2.1 Selenium Ecological Risk Guidelines[1]

The assessment of the risks that selenium poses to fish and wildlife can be difficult due to the complex nature of selenium cycling in aquatic ecosystems (Lemly and Smith 1987). Early assessments developed avian risk thresholds through evaluating bird egg concentrations and relating those to levels of teratogenesis (developmental abnormalities) and reproductive impairment (Skorupa and Ohlendorf 1991). In 1993, to evaluate the risks of the Grassland Bypass Project (GBP) on biotic resources in Mud and Salt Sloughs, a set of Ecological Risk Guidelines based on selenium in water, sediment, and residues in several biotic tissues were developed by a subcommittee of the San Luis Drain Re-Use Technical Advisory Committee (CAST 1994, Engberg et.al. 1998). These guidelines (Table E.2-1) are based on a large number of laboratory and field studies, most of which are summarized in Skorupa et al. (1996) and Lemly (1993). In areas where the potential for selenium exposure to fish and wildlife resources exists, site-specific selenium risk guidelines can be used to trigger appropriate actions by resource managers, regulatory agencies, and dischargers. For the GBP the selenium risk guidelines have been divided into three levels: No Effect, Level of Concern, and Toxicity. In the No Effect range risks to sensitive species are not likely. As new information becomes available it should be evaluated to determine if the No Effect level should be adjusted. Since the potential for selenium exposure exists, periodic monitoring of water and biota is appropriate.

Table E.2-1 Recommended Ecological Risk Guidelines for Selenium Concentrations

Medium	Effects on	Units	No Effect	Level of Concern	Toxicity
Warmwater Fish (whole body)	fish growth/condition/survival	mg/kg (dry weight)	< 4	4-9	> 9
Vegetation (as diet)	bird reproduction	mg/kg (dry weight)	< 3	3-7	> 7
Invertebrates (as diet)	bird reproduction	mg/kg (dry weight)	< 3	3-7	> 7
Sediment	fish and bird reproduction	mg/kg (dry weight)	< 2	2-4	> 4
Water (total recoverable Se)	fish and bird reproduction (via foodchain)	µg/L	< 2	2-5	> 5
Avian egg	egg hatchability	mg/kg (dry weight)	< 6	6-10	> 10

Notes:

These guidelines, except those for avian eggs, are intended to be population based. Thus, trends in means over time should be evaluated. Guidelines for avian eggs are based on individual level response thresholds (e.g., Heinz 1996, Skorupa 1998)

A tiered approach is suggested with whole body fish being the most meaningful in assessment of ecological risk in a flowing system.

The warmwater fish (whole body) Level of Concern threshold is based on adverse effects on the survival of juvenile bluegill sunfish experimentally fed selenium enriched diets for 90 days (Cleveland et al. 1993). It is the geometric mean of the "no observable effect level" and the "lowest observable effect level."

The Toxicity threshold for warmwater fish (whole body) is the concentration at which 10% of juvenile fish are killed (DeForest et al. 1999).

The guidelines for vegetation and invertebrates are based on dietary effects on reproduction in chickens, quail and ducks (Wilber 1980, Martin 1988, Heinz, 1996).

If invertebrate selenium concentrations exceed 6 mg/kg then avian eggs should be monitored (Heinz et al. 1989, Stanley et al. 1996).

Within the Level of Concern range there may be risk to sensitive species, and contaminant concentrations in water, sediment, and biota should be monitored on a regular basis. Immediate actions to prevent selenium concentrations from increasing should be evaluated and implemented if appropriate. Long-term actions to reduce selenium risks should be developed and implemented. Research on effects on sensitive or listed species may be appropriate.

[1] The section was taken from the 2001 Grassland Bypass Project, Final EIS/EIR, Appendix E and the Grassland Bypass Project Report, 2004–2005, and references cited herein are contained in that report. William Beckon, USFWS, prepared the original analysis for the 2001 EIS/EIR. URS updatedthe analysis herein.

Within the Toxicity range, adverse affects are more likely across a broader range of species, and sensitive or listed species would be at greater risk. These conditions will warrant immediate action to reduce selenium exposure through disruption of pathways, reduction of selenium loads, or other appropriate actions. More detailed monitoring, studies on site-specific effects, and studies of pathways of selenium contamination may be appropriate and necessary. Long-term actions to reduce selenium risks should be developed and implemented.

The guidelines (except those for avian eggs) are intended to be population based. Therefore they should be used for evaluating population means rather than contaminant concentrations in individuals.

E.2.1.1 Warmwater Fish

The warmwater fish guidelines (Table E.2-1) refer to concentrations of selenium in warmwater fish that adversely affect the fish themselves. The original 1993 fish guidelines have been replaced by explicitly "warmwater fish" guidelines in recognition of the evidence from the literature that coldwater fish (salmon and trout) are more sensitive to selenium than warmwater fish and that GBP monitoring data available is limited to warmwater fish. Although a coldwater fish guideline is not proposed here, a discussion of selenium effects on coldwater fish is provided in section E2.1.2 since the best information currently available happens to be very site-specific to the GBP.

The Level of Concern threshold for warmwater fish has been kept at about 4 mg/kg (all fish data are whole body, dry weight). Experimental data reported in the literature may be interpreted to support a range of thresholds around this value. In particular, bluegill sunfish dietary and waterborne toxicity data in Cleveland et al. (1993) can be used to support warmwater fish Level of Concern thresholds of 3.3 mg/kg, 3.4 mg/kg, 3.9 mg/kg, or 5.9 mg/kg. Bluegill sunfish are warmwater fish that are found in the sloughs in the GBP area, and the Cleveland et al. (1993) study yielded the best available data on warmwater fish toxicity applicable to GBP.

Cleveland et al. (1993) found no adverse effects after 59 days of exposure to concentrations of dietary selenium that resulted in a bluegill tissue concentration of 2.7 mg/kg (NOEC). Fifty nine days of exposure to dietary concentrations that resulted in tissue concentrations of 4.2 mg/kg (LOEC) caused a significant increase in mortality relative to controls. Following the USEPA method (Stephan et al. 1985) employed by DeForest et al. (1999), the tissue threshold is calculated as the geometric mean of the NOEC and the LOEC. Application of the USEPA procedure to these data yields a toxicity threshold of 3.4 mg/kg. A similar analysis of a water-borne selenium exposure experiment (Cleveland et al. 1993) yields a threshold value of 3.3 mg/kg.

Other data in Cleveland et al. (1993) may be interpreted to support a threshold closer to 4 mg/kg or a threshold of 5.9 mg/kg. The experiments of Cleveland et al. (1993) suggest that selenium concentrations in fish tissues do not reach equilibrium until at least 90 days of dietary exposure (see Figure 3 in Cleveland et al. 1993). This appears consistent with the finding, summarized below, that in the field, selenium concentrations in fish are best predicted by water concentrations averaged over the entire period of one to seven months prior to the date the fish is sampled. In deriving a tissue threshold, there then appears to be some support for using the relationship between dietary concentration and tissue concentration at 90 days rather than 59 days. After 90 days of dietary exposure bluegill with a tissue selenium concentration of 3.3 mg/kg did not exhibit adverse effects that were significantly greater than controls, but bluegill with a tissue concentration of 4.6 mg/kg experienced significantly increased mortality. Bluegill with a tissue concentration of 7.5 mg/kg had three times the mortality of controls, but that difference in mortality was not statistically significant at the 95% level of confidence (see Table 4 and Figure 3 in Cleveland et al. 1993). However, the condition factor (a measure of weight relative to length) of the fish at 7.5 mg/kg, was significantly worse than controls. Depending on whether or not the significant mortality at a tissue concentration of 4.7 mg/kg is treated as anomalous, the LOEC would be either 4.7 mg/kg or 7.5 mg/kg. Corresponding thresholds would be 3.9 mg/kg (geometric mean of 3.3 mg/kg and 4.6 mg/kg) or 5.9 mg/kg (geometric mean of 4.6 mg/kg and 7.5 mg/kg) respectively. Given the range of possible threshold values discussed above, the Level of Concern threshold of 4 mg/kg listed in Table E.2-1 was not changed from the original 1993 threshold. However, considering that these data do not include adverse effects on reproduction which may be affected at lower concentrations, this threshold may not be fully protective of sensitive warmwater fish species.

The Toxicity threshold for warmwater fish (whole body) of 9 mg/kg is recommended by DeForest et al. (1999). In the analysis of DeForest et al. (1999) the threshold represents an EC_{10}, that is, the concentration at which 10 percent of fish are affected. DeForest et al. (1999) excluded some toxicity data from their analysis that could support a lower threshold (Cleveland et al., 1993). Also, reproductive impairment may occur at lower selenium concentrations, but too few data are available to do a similar analysis on this effect. Therefore, this Toxicity threshold may not be fully protective of sensitive warmwater fish species.

E.2.1.2 Coldwater Fish

Testing fall run Chinook salmon from the Merced River, Hamilton et al. (1990) found that salmon fry growth was significantly reduced compared to controls after 30 and 60 days of being fed a diet (containing mosquitofish from the SLD) having a selenium concentration of 3.2 mg/kg dry weight. After 90 days of that diet, the selenium concentration in the salmon fry averaged 2.7 mg/kg whole body, dry weight. This fish tissue concentration was the lowest observable effect concentration (LOEC). The no observable effect concentration (NOEC) in salmon fry tissue was 0.8 mg/kg. Following the USEPA method (Stephan et al. 1985) employed by DeForest et al. (1999), the tissue threshold is calculated as the geometric mean of the NOEC and the LOEC. This procedure applied to the Hamilton et al. (1990) SLD data yields a threshold of 1.5 mg/kg (geometric mean of 0.8 and 2.7 mg/kg). It should be noted that this threshold may incorporate the interacting effects of other toxic constituents of drainwater that may have been assimilated by the SLD mosquitofish that were used as feed in the Hamilton, et al. (1990) experiments. Furthermore, at the time of these experiments (1985), the SLD held agricultural drainwater from the Westlands, an area adjacent to the Grasslands area. Therefore, although these are the most site-specific selenium toxicity data available, these data may not perfectly match the current risk of toxicity to coldwater fish in the San Joaquin River due to agricultural drainwater from the GBP. Although the sloughs affected by the GBP have coldwater beneficial uses designated by the Central Valley Regional Water Quality Control Board, the fish community principally consists of warmwater species. A temporary barrier is installed seasonally across the San Joaquin River to exclude Chinook salmon (a coldwater species) from these sloughs and from the San Joaquin River upstream of its confluence with the Merced River. Additionally, any application of the coldwater fish risk guidelines should take into account the fact that many coldwater fish are anadromous, and therefore feed in the selenium-contaminated portion of the San Joaquin River for a limited period of time-- a brief period in their juvenile stage as they migrate downstream to the ocean.

A Toxicity threshold for coldwater fish (whole body) of 9 mg/kg has been recommended by DeForest et al. (1999). In the analysis by DeForest et al. (1999) the toxicity threshold represents an EC_{10}, that is, the concentration at which 10 percent of fish are affected. DeForest et al. (1999) excluded site-specific and longer term data (Hamilton et al. 1990) which could support lower thresholds. For example, to derive their toxicity threshold for coldwater fish, DeForest et al. (1999) used only the 60 day growth data in Hamilton et al. (1999); they disregarded the 90 day mortality data in Hamilton et al. (1999) that would have yielded a toxicity threshold (corresponding to 10% mortality) of 1.7 mg/kg. In addition, the DeForest et al. (1999) analysis focused on growth and mortality. Reproductive impairment may occur at lower selenium concentrations, but too few data are available to do a similar analysis on this effect. Therefore, this threshold may not fully protect sensitive coldwater fish species.

E.2.1.3 Vegetation and Invertebrates

The guidelines for vegetation (as diet) and invertebrates (as diet) refer to selenium concentrations in plants and invertebrates affecting birds that eat these items. These guidelines are mainly based on experiments in which seleniferous grain or artificial diets spiked with selenomethionine were fed to chickens, quail or ducks resulting in reproductive impairment (Wilber 1980, Martin 1988, Heinz 1996). The Level of Concern threshold for vegetation is 3 mg/kg (dry weight) and the Toxicity threshold is 7 mg/kg. The invertebrate Level of Concern threshold and Toxicity threshold are the same as those for vegetation.

E.2.1.4 Water

Fish and wildlife are much more sensitive to selenium through dietary exposure from the aquatic food chain than by direct waterborne exposure. Therefore the guidelines for water reflect water concentrations associated with threshold levels of food chain exposure (Hermanutz et al. 1990, Maier and Knight 1994), rather than concentrations of selenium in water that directly affect fish and wildlife. The Level of Concern threshold is 2 µg/L and the Toxicity threshold is 5 µg/L.

E.2.1.5 Sediment

As with water, the principal risk of sediment to fish and wildlife is via the aquatic food chain. Therefore the sediment guidelines are based on sediment concentrations as predictors of adverse biological effects through the food chain (USFWS 1990, Van Derveer and Canton 1997). The Level of Concern threshold for sediment (dry weight) is 2 mg/kg and the Toxicity threshold is 4 mg/kg.

E.2.1.6 Bird Eggs

Bird eggs are particularly good indicators of selenium contamination in local ecosystems (Heinz 1996). However, the interpretation of selenium concentrations in bird eggs in the GBP area is complicated by the proximity of contaminated and uncontaminated sites and by the variation in foraging ranges among bird species. Relative to the guidelines originally used for the GBP, the guidelines used in the 2001 EIR/EIS and here for bird eggs have been revised upward based on recent studies of hatchability of ibis, mallard, and stilt eggs (Henny and Herron 1989, Heinz 1996, USDI-BOR/FWS/GS/BIA 1998). The Level of Concern threshold has been raised from 3 to 6 mg/kg dry weight, and the Toxicity threshold has been raised from 8 to 10 mg/kg dry weight.

E.2.2 Selenium Environmental Impacts Modeling

Estimation of the effects of changing water quality on fish and wildlife is especially difficult in flowing systems where fish and wildlife may move between waters with widely different concentrations of contaminants. For example, fish seasonal migration, dispersal and diurnal foraging movements may result in a poor correlation between the concentrations of selenium in water and in fish collected at the same location. Nonetheless, a broad relationship does emerge from the large body of data on contaminant levels in water and in biota that have been collected since 1991 by the agencies participating in Grassland Bypass Project Monitoring Program (Figure E.2-1 and Figure E.2-2) (Regional Board 2008; SFEI 2008; Beckon, Eacock, and Westman, written comm. 2008). The average concentration (whole body dry weight) of selenium in all species of fish sampled generally follows trends in selenium concentration in water, with a lag period.

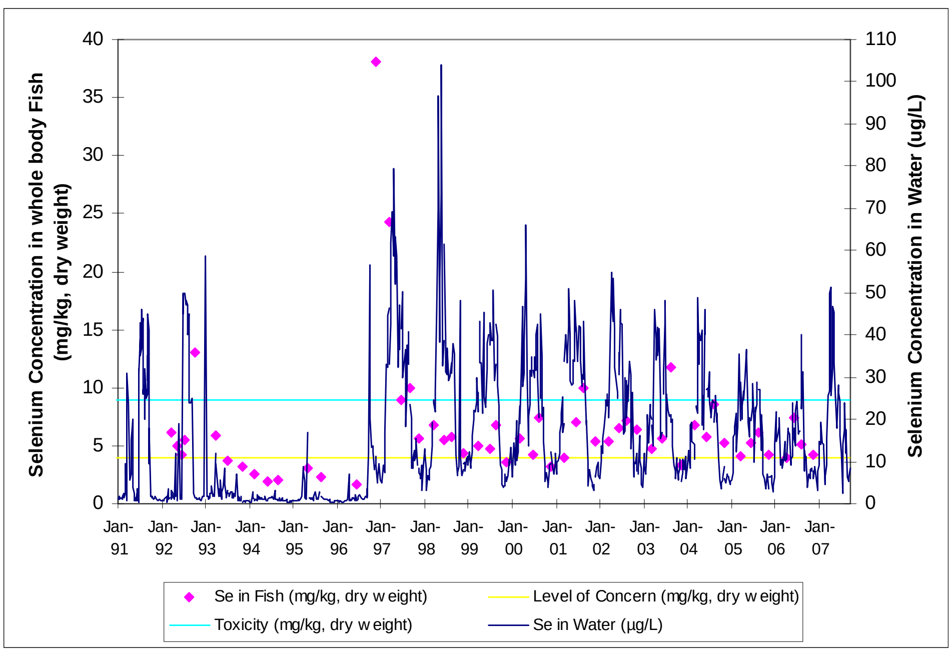

Figure E.2-1 Selenium in Water and Fish (average of all species) in Mud Slough just below the outfall of the San Luis Drain

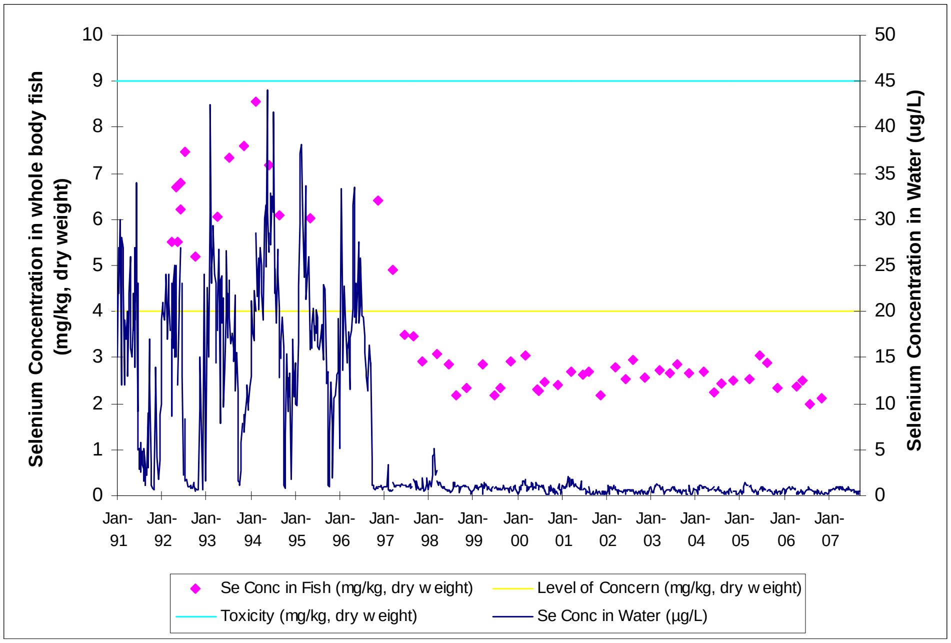

Figure E.2-2 Selenium in Water and Fish (average of all species) in Salt Slough

E.2.2.1 Fish Model

The lag in the response of fish selenium concentrations to water selenium concentrations probably results from biogeochemical processes as well as reflecting the time it takes for selenium to be assimilated and depurated (eliminated) through successive links of the food chain. The lag effect is particularly evident in the Salt Slough data (see Figure E.2-2) after the beginning of the GBP in September 1996 when the selenium concentration in water dropped abruptly, but concentrations in fish declined more gradually over a period of several months. The overall lag period is effectively a composite of the individual lag times characteristic of different fish species at various trophic levels. For example, some small fish feed directly on algae, whereas other species, such as largemouth bass, eat smaller fish that in turn feed on invertebrates that feed on algae. Catfish may feed on clams that filter detritus from previous generations of organisms.

The average lag time for all fish can be estimated by comparing the fit of linear regressions of average water selenium concentrations versus fish selenium concentrations using a variety of water averaging periods involving candidate lag times. This procedure has been used with 1991-2006 GBP data to compare several potential lag times and averaging intervals (Table E.2-2). Two data points for whole body fish collected at Station D were considered outliers. These occurred during the first few months subsequent to the first flush of the San Luis Drain and it was hypothesized that theses samples may have contained Mosquitofish which were previously living in the San Luis Drain. These outliers were removed during the 2001 and 2008 analysis.

The maximum selenium concentration in water during the prior month was also regressed against average fish selenium concentration to provide a test of an assumption underlying an ecosystem risk index for selenium developed by Lemly (1993, 1995). To evaluate ecosystem risk, Lemly's protocol uses maximum concentrations of selenium rather than averages. However, the GBP data indicate that the maximum concentration of selenium in water during the prior month is worse than any averaging interval tested as a predictor of fish selenium concentration (Table E.2-2).

Table E.2-2 Results of linear regressions of average selenium concentration in all species of fish vs. selenium concentrations in water using various averaging periods for water (n=62)

Independent variable	Dependant variable	Proportion of variance explained by linear regression (r2)
Maximum water concentration 1-30 days prior to fish sample	Average fish concentration	0.45
Average water concentration 1-30 days prior to fish sample	Average fish concentration	0.48
Average water concentration 30-60 days prior to fish sample	Average fish concentration	0.54
Average water concentration 0-3 months prior to fish sample	Average fish concentration	0.59
Average water concentration 1-4 months prior to fish sample	Average fish concentration	0.61
Average water concentration 1-7 months prior to fish sample	Average fish concentration	0.59
Log_{10} of average water concentration 1-7 months prior to fish sample	Log_{10} of average fish concentration	0.76

The best prediction of fish selenium concentrations is provided by the logarithmic transformation of selenium concentrations in water averaged over the period one to seven months prior to collection of the fish sample (Figure E.2-3). That averaging period may be used not only to predict average tissue concentrations for all fish, but also to predict the proportion of individual composite samples of fish that fall into each of the ecological risk classes: No Effect, Level of Concern, and Toxicity (see Table E.2-1). To make such predictions, logistic models are fitted to the existing (1992–2006) data on proportions of samples that have fallen into each of the risk classes (Figure E.2-4 and Figure E.2-5). These models may be combined to provide estimates of the expected effects on fish resulting from projected selenium concentrations in water in the waterways potentially affected by the GBP alternatives (Figure E.2-6).

For example, if the six-month average concentration of selenium in water is 5 µg/L, one month after the end of that averaging period, the expected average concentration of selenium (whole body dry weight) in all fish sampled at the same site would be 4.1 mg/kg (see Figure E.2-3), which is above the Level of Concern threshold for warmwater fish (4 mg/kg). However, of the composite fish samples collected at that time, 53% would be expected to have selenium concentrations below the Level of Concern threshold, 45% would be expected to be within the Level of Concern class (4-9 mg/kg), and 2% would be expected to be above the Toxicity threshold (9 mg/kg). The modeling is based on selenium analyses of composite samples, each sample usually consisting of 5 to 50 individual fish. Therefore, predictions of the models must be understood in the same terms, i.e., the model does not predict the distribution of individual fish into risk classes, but rather, the distribution of composite samples into risk classes.

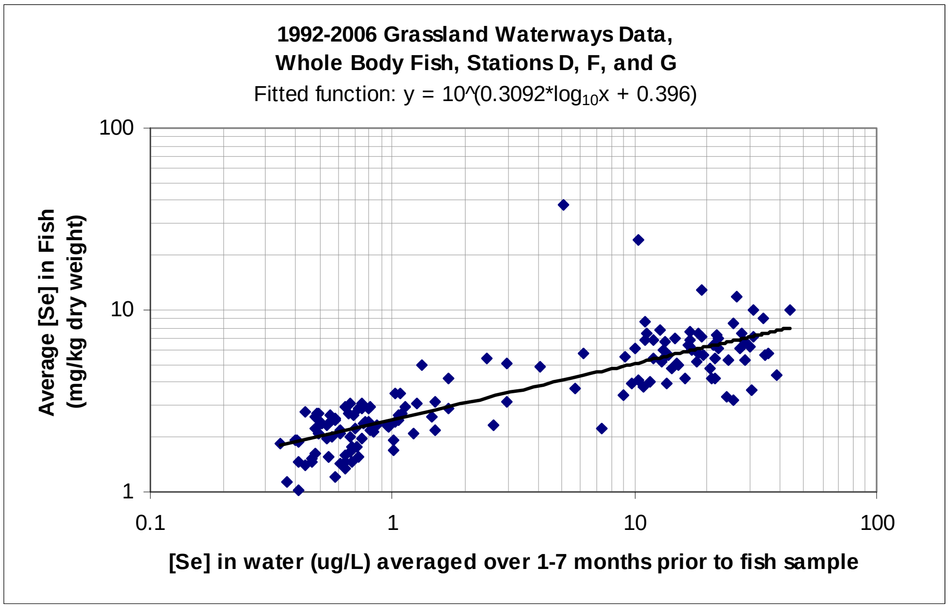

Figure E.2-3 Bioaccumulation of selenium in fish in Grassland area waterways

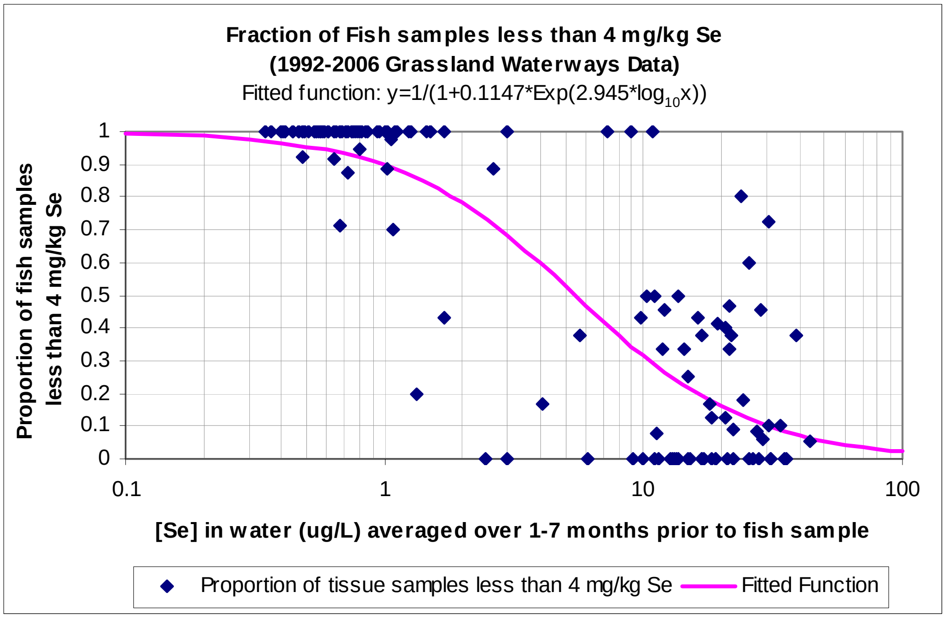

Figure E.2-4 The effect of selenium in water on the proportion of fish samples with selenium concentrations below the threshold of concern

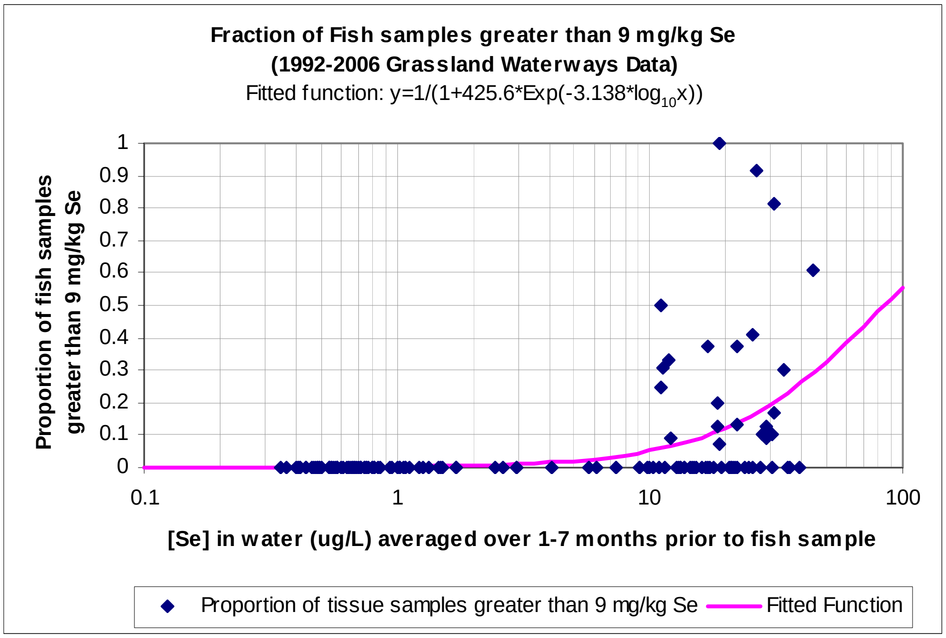

Figure E.2-5 The effect of selenium in water on the proportion of fish samples with selenium concentrations above the threshold of toxicity

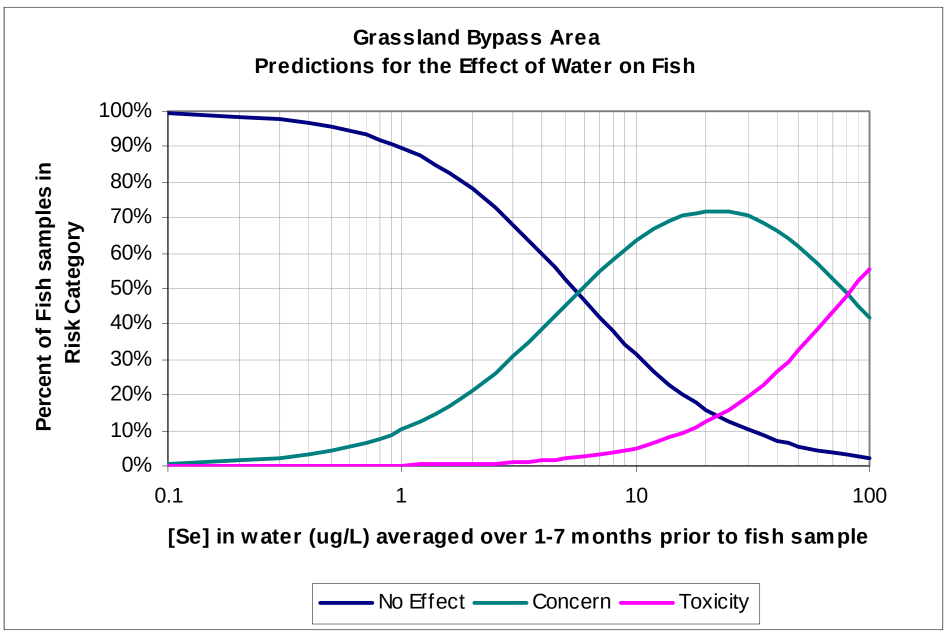

Figure E.2-6 The project effects of selenium in water on proportions of composite samples of warmwater fish falling into fish classes, based on 1992 to 1999 data from Grassland area waterways

E.2.2.2 Invertebrate Model

Grassland Bypass Project Monitoring Program data (1992–2006) suggest that the selenium levels in aquatic invertebrates as well as fish are broadly correlated with selenium concentrations in water (Figure E.2-7 and Figure E.2-8).

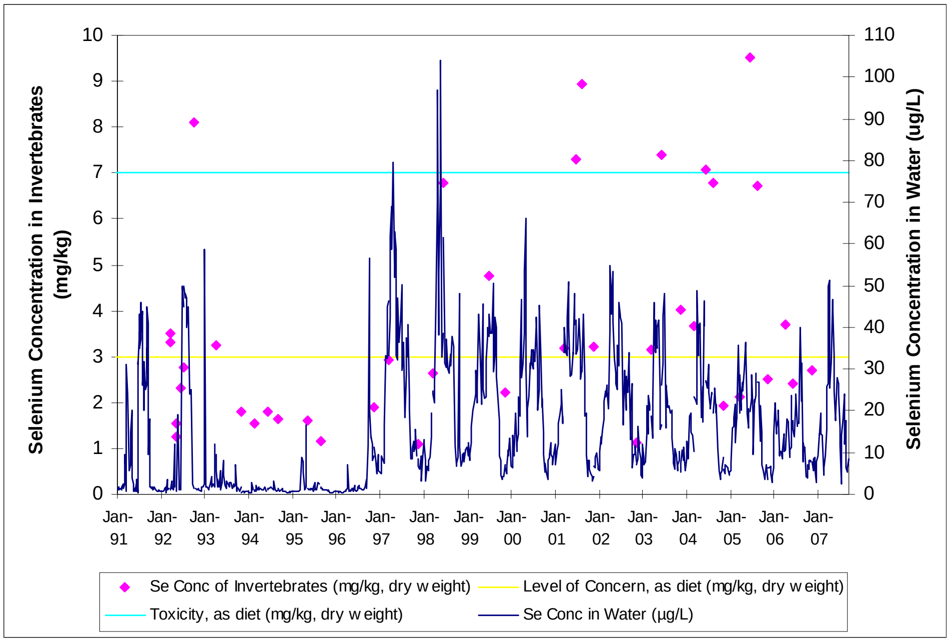

Figure E.2-7 Selenium in water and invertebrates (average of all species, mainly waterboatmen and red crayfish) in Mud Slough just below the outfall of the San Luis Drain

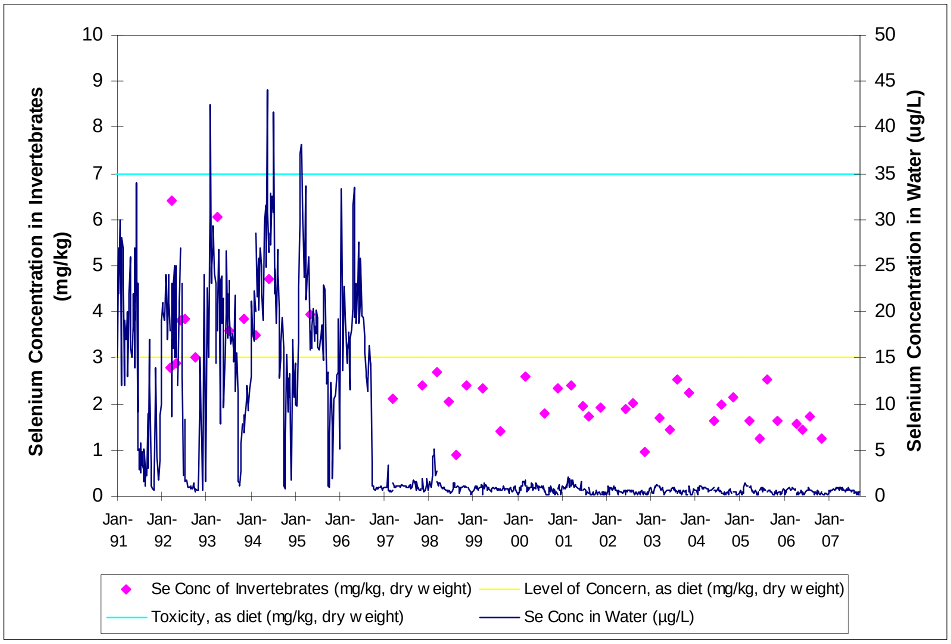

Figure E.2-8 Selenium in water and invertebrates (average of all species, mainly waterboatmen and red crayfish) in Salt Slough

As with fish, some lag time would be expected in the relationship. Generally, aquatic invertebrates are lower on food chains and have shorter life cycles than fish. Therefore, selenium concentrations in invertebrates would be expected to respond more rapidly than in fish to changes in water concentrations. In fact, an analysis similar to that done on fish (see above) confirms this expectation. Linear regressions were performed on average invertebrate selenium concentration versus water selenium concentration, successively using a selection of different water averaging time periods (Table E.2-3). Of the averaging time periods tested, the best predictor of invertebrate selenium concentration was 30 to 60 days prior to the time of collection of the invertebrate samples (Table E.2-3) in contrast to the one-to-seven-month water averaging time that best predicts selenium concentrations in fish.

Table E.2-3 Results of linear regressions of average selenium concentration in all species of invertebrates (mainly backswimmers and red crayfish) vs. selenium concentrations in water using various averaging periods for water (n=43)

Independent variable	Dependant variable	Proportion of variance explained by linear regression (r2)
Maximum water concentration 1-30 days prior to invertebrate sample	Average invertebrate concentration	0.47
Average water concentration 1-30 days prior to invertebrate sample	Average invertebrate concentration	0.52
Average water concentration 30-60 days prior to invertebrate sample	Average invertebrate concentration	0.68
Log_{10} of average water concentration 30-60 days prior to invertebrate sample	Log_{10} of average invertebrate concentration	0.52
Average water concentration 1-7 months prior to invertebrate sample	Average invertebrate concentration	0.42
Log_{10} of average water concentration 1-7 months prior to invertebrate sample	Log_{10} of average invertebrate concentration	0.48

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APPENDIX E3

Se Concentrations in Grassland Wetlands Biota

The purpose of this Appendix E3 is to describe the selenium concentrations for biota from recent studies from Grassland area wetlands to help assess the risks that selenium poses to fish and wildlife in that vicinity.

Selenium cycling in aquatic ecosystems between water, sediment, detritus, and benthic organism is complex; however, selenium concentrations in water can be linked to selenium concentrations in biota (Appendix E2). Selenium concentrations in the Grassland wetland supply channels may be influenced by natural selenium in the local environment, seepage from GDA lands and emergency stormwater releases routed through the Grassland supply channels[2]. The north and south wetland channels could potentially be influenced by the stormwater routed through supply channels, while south wetland channels may also be influence by GDA seepage. Selenium water quality impacts to Grassland area wetlands are described in detail in Sections 4.2.2 and 4.2.4, and Table 4-28 of the EIS/EIR.

Two recent studies have documented selenium concentrations in biota from Grassland area wetlands (Beckon et al. 2007, Paveglio and Kilbride 2007). In both of these studies, monitoring locations were reported to be similar to previous aquatic bird studies conducted in this area from 1986 through 1994 (Hothem and Welsh 1994, Paveglio et al. 1992, Paveglio et al. 1997). Beckon et al. (2007) specifically describes the channels and ditches that were monitored. Paveglio and Kilbride (2007) report the data as sampled from either the north or south Grasslands.

Beckon et al. (2007) monitored sediment and biota in Grasslands area wetlands to help assess the degree to which drainwater management initiatives have reduced toxicological risk to wildlife. Aquatic bird eggs, fish, aquatic invertebrates, and sediment were monitored in 2004 to help assess selenium risks to fish and wildlife.

Aquatic Bird Eggs

A total of 62 bird eggs were collected from nesting waterbirds in Grasslands area wetlands (Geis Ditch, Camp 13 Ditch, Gadwall Canal, and Fraser Ditch). Eggs collected were from mallard (*Anas platyrhynchos*), gadwall (*A. streptera*), American bittern (*Botaurus lentiginosus*), black necked stilt, American avocet (*Recurvirostra americana*), and killdeer (*Charadrius vociferus*). Four samples (or 6.5 percent) had selenium concentrations above the threshold of concern for avian eggs (6 µg/g dry wt, Table E2-1 of Appendix E2). Those four eggs ranged from 6.0 to 6.9 µg/g (Beckon et al. 2007).

Fish

A total of 89 fish tissue samples were collected from wetland channels (Geis Ditch, Camp 13 Ditch, Gadwell Canal, and Sorsky Ditch). Of the 74 whole body fish samples, 27 samples (or 36.5 percent) were above the threshold of concern for selenium in warmwater fish (4 µg/g

[2] During periods of heavy rain, bypass of the Grassland Bypass Channel into the Agatha Canal and/or Camp 13 Ditch has been necessary to meet the flow limits in the 2001 Use Agreement, protect the structural stability of the Bypass Channel, to prevent resuspension of sediment in the Drain, and to prevent introduction of a large sediment load into the Drain. The GAF modify the operation of the GDA drainage system, including turning off sumps, as much as is possible to minimize the contribution of drainage to the storm event flows. Commingled stormwater and drainage discharge are diverted and routed through wetland supply channels. These diversion flows are not discharged directly to wetlands (see Sections 4.1.5.5.4 and 4.2.2.4.2 of the EIS/EIR).

selenium, Table E2-1 of Appendix E2). All 12 samples of striped bass (*Morone saxatilis*, juveniles) were above this threshold (Beckon et al. 2007).

Aquatic Invertebrates

Thirty-two samples of invertebrates were collected in this area (Geis Ditch, Camp 13 Ditch, Gadwall Canal, Sorsky Ditch, Santa Cruz Gun Club Brood Pond, Redfern Duck Club Brood Pond, and Fraser Gun Club Brood Pond). Thirteen samples (or 40.6 percent) were at or above the threshold of concern for invertebrates as diet for birds (3 µg/g dietary selenium, Table E2-1 of Appendix E2) (Beckon et al. 2007).

Other Wildlife

A bullfrog tadpole (*Rana catesbeiana*) collected from Geis Ditch had a selenium concentration of 5.8 µg/g. The toxicity of selenium to amphibians is too poorly known for the development of specific amphibian toxicity guidelines. However, this sample is above the threshold of concern for dietary selenium for birds (as defined for vegetation and invertebrates in Table E2-1 of Appendix E2) (Beckon et al. 2007).

A common kingsnake (*Lampropeltis getulus*) collected from Mallard Road at Santa Cruz Gun Club had a carcass selenium concentration of 2 µg/g (Beckon et al. 2007). As with amphibians, established reptile-specific toxicity guidelines are not available. However, Beckon et al. (2007) maintains that this selenium concentration is below all known vertebrate effect thresholds, with the exception of cold-water fish (author referenced USFWS 2005).

Paveglio and Kilbride (2007) conducted a follow-up study to aquatic bird studies previously conducted in the north and south Grasslands from 1986 through 1988 (Paveglio et al. 1992) and from 1989 through 1994 (Paveglio et al. 1997).

Selenium was detected in liver samples from the 250 aquatic birds collected from the north and south Grasslands area in February 2005. Average selenium concentrations in liver tissue, by species, for birds collected in 2005 are presented in Table E3-1 (Paveglio and Kilbride 2007).

Table E3-1. Average concentrations (ppm dry wt) of selenium in livers of aquatic birds collected from the north and south Grasslands during February 2005

Species	Background Level[1]	North Grasslands[2]	South Grasslands[2]
Mallard	4.1	6.8	8
Northern shoveler	8.1	6.6	9.7
Northern pintail	5.5	7	6.8
American coot	3.2	5	7
Black-necked stilt	9.5	8.8	17

Source: Paveglio and Kilbride (2007)

Notes:

1 Birds collected autumn 1985.
2 Birds collected February 2005.

During 2005, only black-neck stilts from the south Grasslands had selenium levels that overlapped the threshold range for possible reproductive impairment. Paveglio and Kilbride (2007) report the range of possible reproductive impairment to aquatic birds as 20 - 30 ppm dry wt (cited by the authors: J. Skorupa, USFWS, unpublished data). The 95% confidence interval for selenium concentrations in the livers of black-neck stilts from the south Grasslands was between 15 - 20 ppm dry wt (Paveglio and Kilbride 2007).

Selenium concentrations in the liver of all birds collected from the south Grasslands during 2005 had a 95% confidence interval above the species-specific background level. For the north Grasslands, shovelers and stilts had a 95% confidence interval for liver selenium concentrations at or below the species-specific background level and mallards, pintails, and coots had a 95% confidence interval above the species-specific background level (Paveglio and Kilbride 2007).

In general, selenium concentrations were statistically lower during 2005 compared with 1986–1987 for aquatic birds, except for pintails from the north Grasslands where there was no statistical difference between 1987 and 2005 (Paveglio and Kilbride 2007).

Sediment

One sediment sample was collected from the top inch of sediment at each of four sampling locations: Geis Ditch, Fraser Gun Club Brood Pond, Santa Cruz Gun Club Brood Pond, and Redfern Club Brood Pond. Selenium concentrations were below the selenium effects threshold for sediment on fish and bird reproduction (2 μg/g, Table E2-1 of Appendix E2) (Beckon et al. 2007).

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APPENDIX F

County General Plan Goals and Policies for Fresno, Merced, Madera, and Stanislaus Counties

FRESNO COUNTY

With the exception of areas within the city limits of Mendota and Firebaugh, the *Fresno County General Plan* (Fresno County 2000) designates the entire Project Area within Fresno County (including the county's entire portion of the Grassland Drainage Area) for agricultural land uses. Land within the cities of Firebaugh and Mendota is designated for a variety of urban, commercial, recreational/open space, and agricultural uses. Only a small portion of the city of Firebaugh (south of Highway 33) is located within the GDA.

The following County goals and policies for agriculturally designated land are pertinent to the Project:

- Goal LU-A: To promote the long-term conservation of productive and potentially-productive agricultural lands and to accommodate agricultural-support services and agriculturally-related activities that support the viability of agriculture and further the County's economic development goals.
  - Policy LU-A.1: The County shall maintain agriculturally designated areas for agriculture use and shall direct urban growth away from valuable agricultural lands to cities, unincorporated communities, and other areas planned for such development where public facilities and infrastructure are available.
  - Policy LU-A.2: The County shall allow by right in areas designated Agriculture activities related to the production of food and fiber and support uses incidental and secondary to the on-site agricultural operation. Uses listed in Table F-1 are illustrative of the range of uses allowed in areas designated Agriculture.
  - Policy LU-A.3: The County may allow by discretionary permit in areas designated Agriculture, special agricultural uses and agriculturally-related activities, including value-added processing facilities, and certain non-agricultural uses listed in Table F-1. Approval of these and similar uses in areas designated Agriculture shall be subject to the following criteria:
    a) The use shall provide a needed service to the surrounding agricultural area which cannot be provided more efficiently within urban areas or which requires location in a non-urban area because of unusual site requirements or operational characteristics;
    b) The use should not be sited on productive agricultural lands if less productive land is available in the vicinity;
    c) The operational or physical characteristics of the use shall not have a detrimental impact on water resources or the use or management of surrounding properties within at least one-quarter (1/4) mile radius;
    d) A probable workforce should be located nearby or be readily available.

Table F-1: Typical Uses Allowed in Areas Designated Agriculture (Policies LU-A.2 and LU-A.3)

By Right	Special Permit Uses		
Agricultural Uses	Special Agricultural Uses	Agriculturally-Related & Value-Added Agricultural Uses	Agricultural Commercial Center Uses & Other Non-Agricultural Uses
Crop & livestock production, except as specified under special permit uses Packing, processing & sale of crops produced on premises, or where such activity is carried on in conjunction with or as part of a bonafide agricultural operation under the same ownership, except as specified under special permit uses Sale of livestock produced or raised on the premises Residences Home occupations Certain oil & gas development activities pursuant to the policies in Section OS-C, Mineral Resources, of the Open Space and Conservation Element	Cattle feed lots Dairies Goat lots Swine yards Poultry operations Fish farms	Wineries & distilleries Cotton ginning Cottonseed delinting Tree nut hulling & shelling Trucking operations servicing the agricultural community Inspection & weighing services associated with transportation of agricultural products Commercial land leveling & developing establishments Farm labor camps Commercial grain elevators Dehydration operations Commercial soil preparation service establishments Commercial packing & processing of crops Commercial meat processing plants	<u>Commercial Centers:</u> ▪ Veterinary Services & hospitals ▪ Medical & health services &#1; Irrigation systems administration offices ▪ Water-well drilling services ▪ Farm equipment & machinery sales, rental, storage & maintenance ▪ Welding & blacksmith shops ▪ Agricultural employment services ▪ Feed & farm supply sales &#1; Fertilizer sales ▪ Building materials sales ▪ Hardware stores ▪ Grocery stores ▪ Gasoline service stations ▪ Liquefied petroleum gas distribution & storage ▪ Livestock auction market <u>Other:</u> ▪ Organic & inorganic fertilizer manufacturing & mixing ▪ Boarding & training kennels ▪ Home occupations ▪ Sewage treatment plants ▪ Solid waste disposal ▪ Race tracks ▪ Pistol & rifle range ▪ Churches ▪ Schools ▪ Cemeteries ▪ Commercial stables & riding academies ▪ Golf courses ▪ Radio & television broadcasting stations ▪ Wireless communication facilities ▪ Electrical substations ▪ Liquefied petroleum gas distribution & storage ▪ Airports ▪ Detention facilities ▪ Interstate freeway commercial development ▪ Mineral extraction and oil and gas development pursuant to the policies in Section OS-C, Mineral Resources, of the Open Space and Conservation Element

 - Policy LU-A.16: The County should consider the use of agricultural land preservation programs that improve the competitive capabilities of farms and ranches, thereby ensuring long-term conservation of viable agricultural operations. Examples of programs to be considered should include: land trusts; conservation easements; dedication incentives; new and continued Williamson Act contracts; Farmland Security Act contracts; the California Farmland Conservancy Program Fund; agricultural education programs; zoning regulations; agricultural mitigation fee program; urban growth boundaries; transfer of development rights; purchase of development rights; and agricultural buffer policies.
 - Policy LU-A.18: The County shall encourage land improvement programs to increase soil productivity in areas containing lesser quality agricultural soils.
 - Policy LU-A.19: The County shall encourage landowners to participate in programs that reduce soil erosion and increase soil productivity. To this end, the County shall promote coordination between the Natural Resources Conservation Service, Resource Conservation Districts, UC Cooperative Extension, and other agencies and organizations.
 - Policy LU-A.20: The County shall adopt and support policies and programs that seek to protect and enhance surface water and groundwater resources critical to agriculture. (See Section OS-A, Water Resources; and Section PF-C, Water Supply and Delivery).

The following general plan goals and policies for Water Resources established in the Open Space and Conservation Element of the county's general plan are pertinent to the Project:

- Goal OS-A: Protect and enhance the water quality and quantity in Fresno County's streams, creeks, and groundwater basins.
  - Policy OS-A.1: The County shall develop, implement, and maintain a plan for achieving water resource sustainability, including a strategy to address overdraft and the needs of anticipated growth.
  - Policy OS-A.9: The County shall develop, implement, and maintain a program for monitoring groundwater quantity and quality within its boundaries. The results of the program shall be reported annually and shall be included in the water resource database.
  - Policy OS-A.15: The County shall, to the maximum extent possible, maintain local groundwater management authority and pursue the elimination of unwarranted institutional, regulatory, permitting, and policy barriers to groundwater recharge within Fresno County.
  - Policy OS-A.23: The County shall protect groundwater resources from contamination and overdraft by pursuing the following efforts:
    - Identifying and controlling sources of potential contamination;
    - Protecting important groundwater recharge areas;
    - Encouraging water conservation efforts and supporting the use of surface water for urban and agricultural uses wherever feasible;
    - Encouraging the use of treated wastewater for groundwater recharge and other purposes (e.g., irrigation, landscaping, commercial, and nondomestic uses);

- Supporting consumptive use where it can be demonstrated that this use does not exceed safe yield and is appropriately balanced with surface water supply to the same area;
- Considering areas where recharge potential is determined to be high for designation as open space; and
- Developing conjunctive use of surface and groundwater.

– Policy OS-A.29: In areas with increased potential for groundwater degradation (e.g., areas with prime percolation capabilities, coarse soils, and/or shallow groundwater), the County shall only approve land uses with low risk of degrading groundwater.

– Policy OS-A.30: The County shall support efforts to require the U.S. Bureau of Reclamation to provide San Joaquin Valley agricultural drainage facilities as intended in the authorization of the Central Valley Project.

Goals and policies for Water Supply and Delivery, in the Public Facilities and Services Element, that are pertinent to the Project follow:

- Goal PF-C: To ensure the availability of an adequate and safe water supply for domestic and agricultural consumption.
  - Policy PF-C.21: The County shall promote the use of surface water for agricultural use to reduce groundwater table reductions.
  - Policy PF-C.26: The County shall encourage the use of reclaimed water where economically, environmentally, and technically feasible.
  - Policy PF-C.28: The County shall encourage agricultural water conservation where economically, environmentally, and technically feasible.

Goals and policies for wetlands seek to protect riparian and wetland habitats in the county while allowing compatible uses where appropriate. Related policies are included in Section LU-C, River Influence Areas; Section OS-A, Water Resources; Section OS-E, Fish and Wildlife Habitat; and Section OS-F, Vegetation. Goals and policies germane to the Project follow:

- Goal OS-D: Conserve the function and values of wetland communities and related riparian areas throughout Fresno County while allowing compatible uses where appropriate.
  - Policy OS-D.1: The County shall support the "no-net-loss" wetlands policies of the US Army Corps of Engineers, the US Fish and Wildlife Service, and the California Department of Fish and Game. Coordination with these agencies at all levels of project review shall continue to ensure that appropriate mitigation measures and the concerns of these agencies are adequately addressed.
  - Policy OS-D.4: The County shall require riparian protection zones around natural watercourses and shall recognize that these areas provide highly valuable wildlife habitat. Riparian protection zones shall include the bed and bank of both low- and high-flow channels and associated riparian vegetation, the band of riparian vegetation outside the high-flow channel, and buffers of 100 feet in width as measured from the top of the bank of unvegetated channels and 50 feet in width as measured from the outer edge of the dripline of riparian vegetation.

- Policy OS-D.5: The County shall strive to identify and conserve remaining upland habitat areas adjacent to wetland and riparian areas that are critical to the feeding, hibernation, or nesting of wildlife species associated with these wetland and riparian areas.
- Policy OS-D.7: The County shall support the management of wetland and riparian plant communities for passive recreation, groundwater recharge, nutrient storage, and wildlife habitats.

- Goal OS-E: To help protect, restore, and enhance habitats in Fresno County that support fish and wildlife species so that populations are maintained at viable levels.
  - Policy OS-E.1: The County shall support efforts to avoid the “net” loss of important wildlife habitat where practicable. In cases where habitat loss cannot be avoided, the County shall impose adequate mitigation for the loss of wildlife habitat that is critical to supporting special-status species and/or other valuable or unique wildlife resources. Mitigation shall be at sufficient ratios to replace the function, and value of the habitat that was removed or degraded. Mitigation may be achieved through any combination of creation, restoration, conservation easements, and/or mitigation banking. Conservation easements should include provisions for maintenance and management in perpetuity. The County shall recommend coordination with the US Fish and Wildlife Service and the California Department of Fish and Game to ensure that appropriate mitigation measures and the concerns of these agencies are adequately addressed. Important habitat and habitat components include nesting, breeding, and foraging areas, important spawning grounds, migratory routes, migratory stopover areas, oak woodlands, vernal pools, wildlife movement corridors, and other unique wildlife habitats (e.g., alkali scrub) critical to protecting and sustaining wildlife populations.
  - Policy OS-E.6: The County shall ensure the conservation of large, continuous expanses of native vegetation to provide suitable habitat for maintaining abundant and diverse wildlife populations, as long as this preservation does not threaten the economic well-being of the county.
  - Policy OS-E.10: The County shall support State and Federal programs to acquire significant fish and wildlife habitat areas for permanent protection and/or passive recreation use.
  - Policy OS-E.11: The County shall protect significant aquatic habitats against excessive water withdrawals that could endanger special-status fish and wildlife or would interrupt normal migratory patterns.
  - Policy OS-E.13: The County should protect to the maximum extent practicable wetlands, riparian habitat, and meadows since they are recognized as essential habitats for birds and wildlife.
  - Policy OS-E.16: Areas that have unusually high value for fish and wildlife propagation should be preserved in a natural state to the maximum possible extent.
  - Policy OS-E.17: The County should preserve, to the maximum possible extent, areas defined as habitats for rare or endangered animal and plant species in a natural state consistent with State and Federal endangered species laws.

– Policy OS-E.18: The County should preserve areas identified as habitats for rare or endangered plant and animal species primarily through the use of open space easements and appropriate zoning that restrict development in these sensitive areas.

The property planned for the SJRIP element is zoned AE-20 by Fresno County. This zone provides for exclusive agricultural purposes and a minimum parcel size of 20 acres. Closely related agricultural uses, such as processing facilities, are also permitted under this zone. The current use of this property is a conforming use to the present zone.

MERCED COUNTY

With the exception of areas within the city limits of Los Banos, the *Merced County Year 2000 General Plan* (1990) designates the entire Project Area within Merced County (including all of the county's portion of the Grassland Drainage Area) for agricultural land uses. The county's objectives for agriculturally designated land, as outlined in the Land Use Element of the general plan, consist of the following:

- Objective 7.A: Conversion of productive agricultural and other valuable rural land to urban uses is minimized.
- Objective 8.A: Rural areas are appropriately designated to meet the agricultural, grazing, wildlife habitat, recreational, natural resource, and other open space needs of the county.

Land uses designated within the City of Los Banos include a variety of commercial, residential, industrial, agricultural, and open space/recreational uses.

The Open Space/Conservation Element of the county's general plan includes agriculturally designated land within the scope of its objectives and policies, and contains the following statement:

> *The area known as the "Grasslands" in western Merced County is especially valuable for wetland habitat as it combines marsh, open water, and grassland, a mix of characteristics especially important for migratory waterfowl.*

This element of the plan identifies wetlands and waterfowl movement pathways within the Project Area, and additionally designates much of the Project Area as a "drainage problem area," where the depth to groundwater is 5 feet or less. Public and private recreational lands are identified by the plan and, within the Project Area, include state and federal wildlife refuges and private duck hunting club land. The county's objectives and policies from the Open Space/Conservation Element that are most relevant to the Proposed Action include the following:

- Objective 1.A: Rare and endangered species are protected from urban development and are recognized in rural areas.
  – Policy 7: In wetland areas, all public utilities and facilities, such as roads, sewage disposal ponds, and gas, electrical, and water systems, should be located and constructed to minimize or avoid significant loss of wetland resources.

- Policy 8: Development approval adjacent to rare and endangered species habitats or within identified significant wetlands should include mechanisms to ensure adequate ongoing protection and monitoring occurs.
- Policy 9: Significant aquatic and waterfowl habitats should be protected against excessive water withdrawals that would endanger or interrupt normal migratory patterns.
- Objective 2.B: Surface and groundwater resources are protected from contamination, evaporation, and inefficient use.
- Policy 5: Ensure that land uses and development on or near water resources will not impair the quality or productive capacity of these resources.
- Policy 6: Methods to prevent the depletion of groundwater resources and promote the conservation and reuse of water should be encouraged.
- Policy 7: The rehabilitation of irrigation systems and other waterworks to reduce the lost water, and improve the efficient use and availability of water should be promoted.
- Objective 3.C: Open space lands are used for public protection purpose.
- Policy 13: Agriculture will be considered a compatible land use in public and private recreation areas that must be protected and buffered.

The Agriculture Element of the county's general plan addresses the drainage problem within the Project Area and includes the following statement:

> *A long-term solution to the drainage problem must be found or tens of thousands of acres of farmland in western Merced County with poor drainage may be lost to agriculture.*

The following objectives and policies with relevance to the Proposed Action are contained in the Agriculture Element:

- Objective 4.A: Measures to protect and improve water quality are supported.
  - Policy 2: The county will encourage farmers to use irrigation methods that conserve water.
  - Policy 3: The county will work with other responsible agencies to ensure that sources of water contamination (including boron, salt, selenium, and other trace element concentrations) do not enter agricultural or domestic water supplies, and will be reduced where water quality is already affected.

MADERA COUNTY

The *Madera County General Plan* (1995) designates the portion of the Project Area within the county for agricultural exclusive land uses, with the exception of the East-side Bypass, which is designated as open space. While none of the Project features are located in Madera County, it is part of the Project's economic sphere of influence.

The Agricultural and Natural Resources Element of the general plan contains the following agricultural goals and policies germane to the Proposed Action:

- Goal 5.A: To designate adequate agricultural land and promote development of agricultural uses to support the continued viability of the county's agricultural economy.
  - Policy 5.A.6: The county will encourage continued and, where possible, increased agricultural activities on lands designated for agricultural uses.
  - Policy 5.A.8: The county will encourage land improvement programs to increase soil productivity in those agriculturally designated areas containing lesser quality soils.

STANISLAUS COUNTY

The *Stanislaus County General Plan* (1994) designates the portion of the Project Area within the county for agricultural land uses. The county's goals and policies for agriculturally designated land, as outlined in the Land Use Element of the general plan, consist of the following:

- Goal 1: Provide for diverse land use needs by designating patterns that are responsive to the physical characteristics of the land as well as to environmental, economic, and social concerns of the residents of Stanislaus County.
  - Policy 2: Land designated agriculture will be restricted to uses that are compatible with agricultural practices, including natural resources management, open space, outdoor recreation, and enjoyment of scenic beauty.
  - Policy 7: Riparian habitat along the rivers and natural waterways of Stanislaus County will to the extent possible be protected.
- Goal 3: Foster stable economic growth through appropriate land use policies.
  - Policy 16: Agriculture, as the primary industry of the county, will be promoted and protected.

The Conservation/Open Space Element of the general plan contains the following goals and policies germane to the Proposed Action:

- Goal 2: Conserve water resources and protect water quality in the county.
  - Policy 5: Protect groundwater aquifers and recharge areas, particularly those critical for the replenishment of reservoirs and aquifers.
- Goal 3: Provide for the long-term conservation and use of agricultural lands.
- Goal 10: Protect fish and wildlife species of the county.
  - Policy 29: Adequate water flows should be maintained in the county's rivers to allow salmon migration.

The Agriculture Element of the general plan contains the following goals and policies germane to the Proposed Action:

- Goal 1: Strengthen the agricultural sector of the county's economy.
- Goal 2: Preserve the county's agricultural lands for agricultural uses.
- Goal 3: Protect the natural resources that sustain the county's agricultural industry.

– Policy 3.6: The county will encourage the conservation of water for both agricultural and urban uses.
– Policy 3.7: The county will continue to encourage the use of agricultural and urban practices that help reduce water quality problems.

REFERENCES

Fresno County. 2000. Fresno County General Plan. Adopted October 3.

Madera County. 1995. Madera County General Plan. Adopted October 24.

Merced County. 1990. Year 2000 General Plan. Adopted December 4.

Stanislaus County. 1994. Stanislaus County General Plan. Adopted October.

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APPENDIX G

Economic Impacts Evaluation

ECONOMIC IMPACTS OF ALTERNATIVE SELENIUM DISCHARGE LIMITS FOR THE GRASSLAND DRAINAGE AREA

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Appendix G
Economic Impacts Evaluation

G.1 INTRODUCTION

This section presents an analysis of the economic effects of alternatives proposed in response to restricted selenium (Se) discharges from the Grassland Drainage Area (GDA). Agriculture is the sector likely to be most affected by such restrictions because of the required greater re-use of subsurface drain water in order to meet the selenium standards. Because subsurface drain water in this area is saline, greater re-use will, over time, cause soil salinity to increase. Yields for salt-sensitive crops will decline, and lower-value, salt-tolerant crops will be substituted where economically feasible.

The primary impact variable of interest for the analysis is farm income, in particular net farm income or profit. Profit is affected by many factors such as crop acreages, prices, yields, government programs, water costs, and costs of fertilizers, chemicals, and other inputs. Where discharge restrictions cause yield declines and cropping pattern shifts, farm profits will decline.

As farm profits decline, so also will both farm investment and consumption. Regional economic activity will also be affected because of the many linkages between production agriculture and myriad other sectors of the economy.

G.2 AFFECTED ENVIRONMENT

G.2.1 Area

The GDA has been described thoroughly in other sections of this report. For purposes of the economic evaluation, it was necessary to utilize county-level economic and agronomic data; few data were available specifically for the GDA. The primary "zone of influence" for the GDA is the three county area comprised of Fresno, Madera, and Merced counties. While the GDA is not within the Madera County boundary, the county is important as both a source of inputs for agricultural production and a location for facilities processing the products produced in the study area.

The economy of the study area is largely dependent on agriculture, and the relative importance of agriculture in the area exceeds that for the state overall. For the entire San Joaquin Valley,[1] farming and farm-related industries account for 38 percent of all employment and generate 30 percent of total personal income.[2] Comparable 2002 figures for California were 7.3 percent and 5.6 percent, respectively. Within the GDA and the area most proximate to the GDA, the figures are likely to be at least as high as those for the entire San Joaquin Valley because of the concentration of agricultural activities in the GDA.

[1] Includes Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare Counties.
[2] Agricultural Issues Center, University of California, November 29, 2006, "The Measure of California Agriculture, 2006," Preprint Draft, Davis.

The principal industries in the area are engaged in processing agricultural products and in supplying production inputs to agriculture. In the services sector of the economy, the agricultural, forestry, and fisheries service industry produce the largest shares of output value. These industries provide the majority of private sector jobs. Transportation, communication, retail industries, educational, health, and social services, and three levels of government (local, state, and federal), also contribute to the local economy.

The GDA is on the west side of the San Joaquin Valley in parts of Merced and Fresno counties. Crops have been produced in the area for more than 100 years. Irrigation and drainage districts include Panoche and Charleston Drainage Districts; Firebaugh Canal, Broadview, Pacheco, and Widren Water Districts; and the Camp 13 portion of Central California Irrigation District. The GDA includes, collectively, 97,400 acres among these agencies. The area studied for this analysis also includes 1,100 acres of irrigated land which do not lie within an organized district.

Principal cities within the GDA area include Firebaugh and Mendota in Fresno County and Los Banos in Merced County. Within the larger zone of influence, principal cities include Chowchilla and Madera in Madera County; Fresno, Clovis, and Sanger in Fresno County; and Merced, Atwater, and Livingston in Merced County. Within the GDA, the largest city is Los Banos, which has been urbanized in the last 30 years and serves as a bedroom community for commuters to the Silicon Valley. While Los Banos relies less upon agriculture than in the 1960s, other parts of the area remain highly dependent on farming.

The three-county area is the "Functional Economic Area" that includes GDA. GDA is linked to many businesses, individuals, and government agencies in the north-central San Joaquin Valley. These linkages are important in quantifying the likely regional impacts of any changes which occur in the GDA. Such impacts are likely to occur throughout the three-county area because of these many relationships.

G.2.2 Data Sources and Issues

Several sources of data are used for the economic evaluation. Historic crop acreage, by district, is from Summers Engineering. Crop yield information is taken from the annual reports of the Fresno County Agricultural Commissioner. Demographic data are from the printed and Web-based reports of the California Department of Finance. Employment data are from the Web-based reports of the California Employment Development Department.

Information on cultural practices, water application rates, costs of production, and yields are not available for the many individual crops grown in the GDA.[3] Consequently, data on costs of production, cultural practices, and returns are drawn from data developed by Wichelns and Houston for their economic modeling of the GDA (1995a, 1995b). Data on salinity levels in the soil are for the entire GDA and the entire SJRIP reuse area rather than individual water districts; these levels are based on the results presented in Chapter 5. Consideration was given to various irrigation technologies compatible with each crop or crop category grown in the area. The methods and their compatibilities are discussed in the section describing the economic model.

[3] Wichelns and Houston (1995b) developed separate yield data and utilized district-level selenium data relationships for each district in the GDA. Updated data were not available, however, and this report does not consider individual districts within the GDA.

G.2.3 Historical and Current Indicators

G.2.3.1 Demographics

The comments which follow relate to demographic characteristics both within the GDA area and the entire three-county zone of influence which includes the GDA. While the GDA is the site of the "initial impacts" of the alternatives, the GDA is not an economically self sufficient regional economy. Rather, it has extensive linkages to the larger functional economic area through, for example, the locations of supporting industries, shopping patterns, and commuting patterns.

G.2.3.1.1 Population

For the period from 1990-2007, population in Fresno County grew at a compound annual rate of 1.9 percent; Madera County grew at a 3.2 percent annual rate; and Merced County grew at a 2.1 percent annual rate (see Table 1). Among cities within the GDA, Los Banos (Merced County) grew most rapidly, at 5.7 percent per year. Firebaugh and Mendota (both in Fresno County) grew at 2.8 percent and 1.9 percent annual rates, respectively. At January 1, 2007, population in Fresno County was 917,515, Madera County was 148,721, and Merced County was 251,510.[4] Over 78 percent of the Fresno County population was in incorporated areas, while about 44 percent of Madera and 61 percent of Merced Counties' populations were in incorporated areas.

Table G-1: Population and Population Growth in the Three-County Area

County/City	Jan. 1, 1990 Population	Jan. 1, 2007 Population	Compound Annual Growth, 1990-2007
Fresno	661,400	917,515	1.9%
Firebaugh	4,200	6,692	2.8%
Mendota	6,875	9,426	1.9%
Madera	86,400	148,721	3.2%
Merced	176,300	251,510	2.1%
Dos Palos	4,190	4,899	0.9%
Los Banos	13,750	35,211	5.7%

Source: California Department of Finance, various years, E-1, City/County Population Estimates with Annual Percentage Change; E-2, California County Population Estimates and Components of Change by Year, July 1; and E-4, Population Estimates for Cities, Counties, and the State.

G.2.3.1.2 Employment

Total three-county employment in all industries was 471,300 in 2007, an increase of 59,000 jobs between 1998 and 2007 (see Table G-2).[5] All data relate to activities taking place directly in the study area and exclude linkages to or effects from other counties. The three-county area was selected to emulate a relatively self-sufficient regional economy. The importance of farming is indicated by its share of total industry employment for the three-county area. Farming employment accounted for 15.1 percent of total 2007 employment, although down slightly from 19.8 percent in 1998. Farming accounted for only 2.5 percent of total California industry employment in 2007.

[4] California Department of Finance, May 2007, E-1, "Population Estimates for Cities, Counties and the State with Annual Percent Change — January 1, 2006 and 2007." Sacramento.
[5] Separate data are not presented for Fresno, Madera, and Merced counties.

Among industry sectors, only the service sector and state and local governments employed more people than farming in the three-county area in 2007. Services, however, have grown rapidly since 1990, and state and local governments have increased their employment by more than 20% since 1998. Federal government employment has declined slightly.

Table G-2 measures "direct employment" by showing the actual industries in which people are employed. As discussed below, many linkages occur among the sectors in a regional economy of the type evaluated here.

Table G-2: Employment and Employment Growth in the Three-County Area

Measure	1998 Employment	2007 Employment	Percent of 2007 Employment in All Industries	Percent Growth, 1998-2007
Total Farm	81,700	71,300	15.1	-12.7
Construction/Mining	16,600	27,000	5.7	62.7
Manufacturing	17,700	40,400	8.6	128.2
Service Providing	272,100	16,500	70.5	22.2
Wholesale Trade	13,700	16,000	3.4	16.8
Retail Trade	40,100	47,800	10.1	19.2
Goods Producing	58,600	67,400	14.3	15.0
Federal Government	11,400	10,900	2.3	-4.4
State/Local Government	66,400	83,700	17.8	26.1
Total Nonfarm	*330,600*	*400,000*	*84.9*	*21.0*
All Industries	*412,300*	*471,300*	*100.0*	*14.3*

Source: California Employment Development Department, 2008, Employment by Industry Data, available at http://www.labormarketinfo.edd.ca.gov/.

Note: Separate data are not presented by Fresno, Madera, and Merced counties.

G.2.3.1.3 Income

Personal income in the three counties is $32.8 billion and represents 2.3 percent of the total for California (see Table 3).[6] Fresno County is the largest of the three, followed by Merced, then by Madera. Per capita personal income is $27,081 in Fresno County, and Madera and Merced are similar at $22,580 and $23,182, respectively. Among the 58 counties in California, per capita personal income in Fresno is 43rd, Madera is 58th, and Merced is 52nd. Counties with higher figures are typically in more urbanized areas. Farm income accounted for 2.7 percent of total personal income in Fresno County in 2006, 5.4 percent in Madera County, and 7.2 percent in Merced County. In contrast, farm income accounted for half a percent of total personal income for California in that year.

6 Based on 2006, the latest year for which data have been released by the Bureau of Economic Research. See http://www.bea.gov.

Table G-3: Total and Per Capita Personal Income in the Study Area and California, 2006

County/State	Personal Income		
	Total ($1,000s)	Per Capita	Rank Among Counties1/
Fresno	$23,980,463	$27,081	43
Madera	$3,249,958	$22,580	58
Merced	$5,615,376	$23,182	52
California	$1,436,445,919	$39,626	

1/ Rank based on per capita personal income.

Source: Bureau of Economic Analysis, 2008, Regional Economic Accounts, available at http://www.bea.gov/reigonal.

[1]Rank based on per capita personal income.
[2] Based on 2006 the latest year for which data have been released by the Bureau of Economic Analysis.

G.2.3.2 Agriculture

G.2.3.2.1 Overview

Agriculture is the dominant industry within the GDA. Farmers have raised crops in the area for more than 100 years. Primary crops include cotton, melons, vegetables, alfalfa hay, other field crops, and grains. More recently, vegetables and orchards and vineyards have become increasingly important. Virtually all crops are irrigated because average annual rainfall is less than 10 inches per year and most crops require at least twice as much water for normal growth.

As agriculture has changed from land-extensive livestock and grain production to irrigated cotton, field, grain, permanent, and other intensively-farmed crops, a comprehensive infrastructure has developed around production farming. These sectors include suppliers of purchased inputs such as feed, fertilizer, irrigation equipment, chemicals, and farm machinery; banks and other financial institutions; cotton gins; food processors; warehousing and storage businesses; and transportation and shipping companies. Because each of these industries purchases from and sells to many other sectors, agriculture has widespread ripple effects throughout the regional economy.

G.2.3.2.2 Land Use and Cropping Patterns

Irrigated cropland acreage in the GDA is presented in Table G-4. Data for the GDA acreage was based on the years 2000 to 2005, while data for the SJRIP is from 2007. Cotton is the dominant crop in the area and is among the top five crops in each of the three primary surrounding counties (Merced, Madera, Fresno Counties). Cotton was grown on an average of 42 percent of GDA and SJRIP cropped land (see Table G-4). Vegetables (including tomatoes) were grown on an average of 13 percent and melons on 12 percent. Alfalfa is another primary crop, with nearly 8,600 acres accounting for 11 percent of cropped land. In addition to the acreage in the GDA presented in Table G-4, in 2007 there were approximately 3,800 acres planted in the SJRIP reuse area, of which 3,280 acres were planted to hay, 420 acres were planted to vegetables (primarily asparagus), and 115 acres were planted to wheat.

Most crops grown in the GDA are also grown in other parts of the three-county area. However, the proportions of acreages between GDA and the three counties combined differ because of many factors, including the unique salinity and Se conditions in the GDA and crop sensitivities to those conditions. In 2007, for example, cotton was grown on 6 percent percent of harvested cropland in the three counties while between 2000 and 2005 it was grown on 42 percent of the GDA. Vegetables were grown on 10 percent of land in the three counties and 21 percent of the GDA. The largest difference, however, is in land in orchards and vines, which in 2007 accounted for 29 percent of total harvested cropland in the three counties, yet only an average of 2.8 percent of cropland in the GDA between 2000 and 2005.

Table G-4: Average Cropping Pattern in the Grassland Drainage Area, 2000-2005

Crop	Acres	Percent of Total Acres
Cotton	33,397	42%
Melons	9,454	12%
Tomatoes	10,616	13%
Alfalfa Hay	8,911	11%
Sugarbeets	3,487	4%
Rice	1,705	2%
Vegetables	6,509	8%
Wheat	3,409	4%
Fallow	2,208	3%
Total	79,696	100%

[1]The data on total acres was based on acreage figures in Appendix C, while the crop mix is based on data from Summers Engineering. Acreage includes currently irrigated lands on the 2,900 acres that will be moved into the SJRIP in the Action alternative.

G.2.3.2.3 Crop Value

The total estimated value of crops grown in the GDA and the SJRIP reuse facility in 2007 is estimated to be $237.8 million based on farm-level prices (see Table G-5). This estimate is based on acreages in Table G-4 plus the 2007 acreage in the SJIRP reuse facility. Value per acre is based on data from Fresno County and represent farm level rather than retail price.[7] Values in 2007 dollars are used in order to maintain consistency with the data upon which the impact estimation model is based.

Cotton accounted for 41 percent of crop acres in 2007, but 23 percent of total crop value. Conversely, tomatoes and vegetables were cropped on 22 percent acres, but contributed 46 percent of value. The differences result from variations in value per acre and are particularly noticeable also for grains. While rice and wheat accounted for 6 percent of cropland in the GDA in 2007, they accounted for only 2 percent of total crop value. The differences are important because they represent variations in intensity of input use and in overall regional activity affected by agriculture.

[7] Price data for Fresno County are taken from Fresno Department of Agriculture, 2002-2006. Price was calculated using a normalized average, in which prices were adjusted for inflation to 2007 dollars, the high and the low values were removed, and the remaining three price years were averaged.

Table G-5: Adjusted Crop Acres, Value per Acre, and Total Crop Value, Grassland Drainage Area and SJRIP Reuse Facility, 2007

Crop/Group	Acres	Value/Acre	Total Value ($1000s)	Percent of Acres	Percent of Value
Cotton	33,397	$1,662	$55,497,650	41%	23%
Melons	9,454	$5,163	$48,808,390	12%	21%
Tomatoes	10,616	$5,219	$55,406,180	13%	23%
Alfalfa Hay	12,190	$836	$14,083,680	15%	6%
Sugarbeets	3,487	$1,620	$5,648,687	4%	2%
Rice	1,705	$956	$1,630,282	2%	1%
Vegetables	6,928	$7,489	$55,189,160	9%	23%
Wheat	3,524	$435	$1,585,613	4%	1%
Total	*81,301*		*$237,849,642*	*100%*	*100%*

[1]Acreage estimates are based on data provided by Summers Engineering.

G.2.3.2.4 Drainage Issues

Poorly-drained agricultural lands cover several hundred thousand acres in the San Joaquin Valley, including the GDA. High water tables may impede or halt crop growth because of salinity buildup and reduced aeration in the plant root zone. This is not a new subject, as agricultural drainage problems have been documented in the San Joaquin Valley for more than 100 years. During that time, irrigators have used a variety of methods to collect and dispose of agricultural drainage water. In the central and south San Joaquin Valley, there are neither natural nor artificial outlets, and many farmers have used subsurface tile drains and other methods to remove excess water from the crop root zone.

Subsurface saline water management will affect the vitality and sustainability of agriculture in the GDA. There are farm-level benefits and costs associated with such management. Benefits include the ability to continue farming with the high yields that characterize the area. Costs include those associated with the installation of drainage tiles or other methods of subsurface water collection and disposal of the water.

Consequently, irrigators must be sensitive to the quantity and contents of drainage water leaving their fields and collected at points in the GDA. The drainage water leaving a particular field may result from both irrigation on that field as well as deep percolation on neighboring fields. Hence, drain water collected in one drainage system may be generated by farms in other parts of the area. Limitations on Se discharges may limit the total amount of drainage water which may be discharged from an area and necessitate recirculation and other drain water management actions. However, as the water is recirculated, soil and water salinity build up, and crop yields are impacted.

The general effects of salinity on crop yields have been documented in several sources.[8] In some cases, the effects have been estimated from field experiments and in others from experiments under laboratory conditions. Salinity clearly is only one of many factors which may affect crop yields, the others including irrigation water quality, quantity, and timing; fertilizer and pesticide applications; and climate. Consequently, yields may differ among the fields on a farm as well as among farms in a given area.

[8] See, for example, Ayers and Branson.

In this study, the GDA and the SJRIP reuse facility are each analyzed as a single geographical unit. Data and resource limitations did not permit analysis at the individual water or drainage district, farm, or field levels. Therefore, the salinity-yield relationships taken from the literature must be assumed to apply homogeneously throughout the GDA. Differences among fields and farms in the GDA may and likely do exist, but it was not possible to account for these differences in this study.

Because of drainage issues, farmers in the GDA use various irrigation methods in attempting to limit the amount of water lost to deep percolation. Selection of the methods used depends on the crop(s) grown and the agronomic and physical compatibility of the method, costs, climate, and other factors.

The effects of salinity on crop yields have been documented for some crops grown in the GDA. Controlled laboratory setting experiments have been conducted to measure yield responses to carefully measured levels of salinity. Some field experimentation has also been conducted. Both are discussed in the section that includes the economic model used for this study.

Wichelns and Houston completed several studies on the economic effects of salinity in the Broadview Water District,[9] which is part of the GDA. During periods when a drainage outlet was not available, the District had to recycle all its drain water, and soil salinity built up dramatically. As salt levels built up, growers were forced to replace such salt-sensitive high-value crops as tomatoes and melons with lower-value, salt-tolerant crops such as cotton and sugarbeets.

Yield differences were dramatic for the periods. For example, for the five years prior to the availability of a drainage outlet in 1983, cotton yields in Broadview averaged 2.3 bales per acre. In the next four years, yields averaged 2.6 bales per acre. Similarly, tomato yields increased from 19.3 tons to 34.8 tons per acre, alfalfa seed increased from 601 pounds to 938 pounds, barley increased from 1.8 tons to 2.4 tons per acre, and sugarbeets increased from 25.5 tons to 30.1 tons per acre.

Yield data for specific districts in the GDA since 1986 or for other sub-areas of the GDA were not available for this study. However, it is reasonable to assume that the yield impacts of salinity are, within some range, symmetric for increases and reductions in salinity levels. This and other assumptions are reviewed in the discussion of the economic model used for the analysis.

G.2.3.2.5 Linkages Between Agriculture and Other Sectors

Agriculture has been the core industry in the GDA for many decades. Moreover, agricultural production contributes to significant additional outputs of goods and services in other farm-related businesses throughout the regional economy. Farmers purchase seed, chemicals, fertilizers, and other production inputs, and they and their employees purchase food, clothing, automobiles, and other household goods and services from businesses in their areas. Farmers also sell to local businesses, including food processors, commodity brokers, feedlots, export dealers, and cotton gins. As a result, changes in agricultural production trigger a series of “ripple effects” through the economy which cause changes in employment, jobs, income, and outputs in

[9] See Wichelns and Houston, 1995a and 1995b.

many other sectors. The linkages from production agriculture to other sectors are characterized as both “backward” and “forward.”

Backward linkages refer to connections between production at the farm level and purchases of production inputs such as fertilizer, feed, and machinery. For example, if the acreage of a particular crop increases, the farms producing that crop will require more inputs, hire more labor, pay more taxes, and earn more income. In turn, the increased sales by input firms cause those firms to purchase more inputs from other sectors, hire more workers, and pay more taxes. These cause-effect patterns continue throughout the economy. The effects of a decline in crop acreage are effectively a mirror image of those presented above. For either increased or reduced crop acreage, changes at the farm level may have extensive impacts on many different sectors throughout the regional economy.

Forward linkages are connections from farms to businesses that handle or process products after they leave the farm, such as cotton gins, dairy processing plants, canning plants, and shippers and brokers. Farm products represent key inputs for these forward-linked sectors. Hence, an increase in the supply of key farm products makes possible an increase in the output of products using that input. As production and sales increase, demands for the inputs used in the products (such as labor, machinery, and supplies) also increase.[10]

These linkages, each of which can be quantified as "direct," "indirect," and "induced" impacts, are quantified by use of input-output (I-O) analysis. Direct effects are changes in the activity of a sector and which result from a change in the demands for its output. Indirect effects are changes in the activity of a sector, which result from changes in the demands for outputs from other sectors. Induced effects are the changes in regional spending patterns caused by the changes in income generated from the direct and indirect effects. The measurement of the extent of these linkages begins with farm-level outputs shown in Table G-5. The steps in developing and using an I-O model are included in Appendix G-1. This analysis does not quantify the effects of forward linkages, but rather only quantifies the total economic impact associated with backward linkages.

G.3 DEVELOPMENT OF A FRAMEWORK TO MEASURE ECONOMIC IMPACTS

Estimation of the economic impacts of alternatives considered in this report rests on two separate constructs. The first is a model, which simulates farm level responses to the characteristics and constraints of each alternative. The model incorporates crop yield, revenue, cost, and profit information as well as key hydrology relationships, including amounts of drainage water and soil salinity levels. The second is a regional impact analysis model which incorporates key intersectoral linkages in the three-county area. Each is discussed below.

G.3.1 Farm Level Decision Making

The farm response model described below rests on several critical short-run and long-run assumptions. The short run is defined as a period in which adjustments are not made to “fixed” factors such as land and machinery. The long run is a period over which all production inputs

[10] Forward linkages are not quantified in this study. Sufficient data are not available to estimate the flows of products from farms in GDA to processing plants in the study area.

may be varied. For this analysis, the irrigator's key short-run decisions include which crops to plant and how much water, labor, chemicals, and other inputs to apply to those crops. Long-run decisions involve not only those issues, but also the buying or selling of machinery, land, and other long-term assets. The alternatives to be analyzed affect both the short-term and long-term horizons of farms in the GDA.

For purposes of this analysis, it is assumed that:

1. Irrigators act efficiently. They do not use more labor, machinery, chemicals, water, or other inputs more than necessary.

2. Irrigators attempt to use resources up to the point at which their respective contributions to the outputs of the farm are equivalent to their respective costs.

3. Only variable costs are relevant in short-run decision making. So long as unit price for a crop exceeds unit variable costs in the short run, production is logical. In the long run, however, all costs must be covered.

Another assumption commonly used in economic analysis is that the "goal" of irrigators is to maximize profits from their farms. This assumption is typically made because of the intangible nature of other goals or values which irrigators may have, such as being self-employed or living in a rural area. In particular, when the farm family rather than the farm entity is viewed as the relevant economic unit, net profit alone should not be used to judge the efficiency of resource use; the non-monetary satisfactions which people gain from using those resources are also important. Farmers (irrigators) do not attempt to maximize dollar profit alone. If they did, they would work seven days per week and use family labor up to a maximum amount. Data from the Census of Agriculture show that off-farm employment has increased over time.[11] However, given the unavailability of information on the "non-market" values provided by farming, profits are used in the simulation model as the best available measure of efficiency and net income.

G.3.1.1 Salinity Management in Farm-Level Decision Making

Soils commonly contain salts, as does irrigation water, and both can contribute to the overall salinity conditions in the soil. As total soil salinity increases, plants are less able to extract water from the soil, and nutrient balances may be adversely affected.[12] For salt-tolerant crops, salinity may not be a problem within some ranges. However, for salt-sensitive crops, which include many high-value vegetables, high or increasing levels of salinity may have detrimental impacts on plant growth and crop yields. Moreover, plants generally are more sensitive to salinity during particular stages, including seedling, immediately after transplanting, and when subject to other stressors.[13]

Salinity conditions can be exacerbated in poorly-drained soils. Consequently, artificial drainage is essential for plant growth and acceptable crop yields. Subsurface drainage typically incorporates pipe systems to allow rapid water table drawdown, and the lower ends of drainage laterals are then normally attached to collector drains.

[11] U.S. Department of Agriculture, 1999.
[12] Kotuby-Amacher, Jan, et.al., 1997.
[13] Ibid.

Salinity management is an additional component of overall farm-level decision making in many locations such as the GDA. Salinity management thus accompanies decisions on crop choice and input application levels in optimal farm behavior. If salinity conditions cannot be managed effectively, farmers may be forced to shift their cropping max or rotations to more salt-tolerant crops. The measured impacts are expressed, as discussed below, in the relationships between crop yields and salinity levels.

Farmers growing crops in areas with high soil salinity and high groundwater levels have several options:

- Not draining the land;
- Draining the land, disposing of drainage water in collection areas;
- Draining the land, disposing of drainage water in evaporative ponds; and
- Changing farm management practices to reduce either the amount of drainage water generated or the effects of salts on crop yields.

Salinity is typically expressed in electrical conductivity (EC) and is measured in decisiemens per meter (dS/m) or millimhos per centimeter (mmhos/cm). Table G-6 provides ranges of salinity measures over which plant responses vary from mostly negligible to extensive. It shows that for EC measures of less than 2.0, impacts on plant growth are negligible, and that at measures of 8.0 or higher, only salinity-tolerant crops grow satisfactorily. Little plant growth occurs at EC levels exceeding 16.0.

Table G-6: General Plant Responses to Varying Soil Salinity Levels

Salinity in dS/m	Plant response
0 to 2.0	Mostly negligible
2.0 to 4.0	Restricted growth of sensitive plants
4.01-8.0	Restricted growth of many plants
8.01-16	Satisfactory growth only of tolerant plants
>16.01	Satisfactory growth of very few tolerant plants

Source: Kotuby-Amacher, 2000.

In many areas, drainage water is reused as a method of managing the resource. Such reuse has both benefits and costs. Benefits include supplementing limited fresh water supplies and reducing discharges to environmentally-sensitive areas. Costs include the infrastructure required to collect, treat, and reuse the drainage water and, in some cases, modifying cropping patterns to more salt-tolerant and lower value crops.

Prior to the GBP, drainage water from farms in the GDA was discharged into channels that were used to deliver water to wetland areas. Drainage water contains high levels of salts, Se, and other constituents which are harmful to wildlife.[14] Since the GBP was initially implemented, no drainage water has been discharged into wetlands and refuges.

[14] United States Bureau of Reclamation, 2005, "Grassland Bypass Project," Internet website http://www.usbr.gov/mp/grassland, accessed December 21, 2007.

G.3.2 Farm-Level Simulation Model

G.3.2.1 Overview

A multi-period optimization model was developed to estimate the farm-level economic impacts of the two alternatives. The goal of the agricultural production model is to select the profit-maximizing mix of crops and irrigation technologies during each model period based on soil salinity levels while meeting constraints on production inputs. The model finds the best possible response, measured by profit, to changes in soil salinity. The model uses as input the soil salinity calculated for each year in Chapter 5.

Crops included in the model are those representing the largest amount of acreage in the GDA. Crop yields are calculated in the model by a dynamic equation which relates yield to the level of soil salinity throughout the analysis period (Wichelns and Houston, 1995a). The yield responses to soil salinity are based on salt tolerance relationships published by Maas (1993).

The model is written and solved using "GAMS/MINOS," or General Algebraic Modeling System/Modular In-Core Nonlinear Optimization System. The model is run annually for the 10-year analysis period from 2010 to 2019. Within each year, three intraseasonal periods are included (fall, spring, and summer) to reflect the production stages and input requirements of each crop. As a result, solution values reflect the impact of production decisions on the profit in the current year as well as all future years.

The key relationships in the model are the objective function and the constraints. The "objective function" captures the goal of the model, i.e., to maximize total discounted annual profits from 2010 through 2019 as follows:

$$\begin{aligned} Max \sum_T profit_T = \Big(\sum_Z \sum_C \sum_I acres_{C,I,T} * (price_C * yield_{C,T} - fc_C - phc_C \\ - (hc_C * yield_C) - cirr_{C,I}) - wpc * \sum_M canal_{T,M} - wpr * \sum_M recyc_{T,M} \\ - wpt * \sum_M treat_{T,M} - \sum_M groundwater_{T,M} * groundpower \Big) \end{aligned}$$

Where: Z indexes zones (SJRIP and GDA);

C indexes crops;
I indexes irrigation technologies;
T indexes years;
M indexes intraseasonal period;
fc is total fixed cost per acre;
phc is total pre-harvest cost per acre;
hc is harvest cost per unit of output;
cirr is the total non-water cost of irrigation per acre;
wpc is the cost of canal water per acre-foot;
wpr is the cost of recycled water per acre-foot;
wpt is the cost of treated water per acre-foot;

groundwater is the acre-feet of groundwater pumped;

groundpower is the cost of groundwater pumping per acre-foot;.

The constraints are equations or inequalities that place discrete limits on various resources and measures. For example, the aggregate amount of land allocated to all crops in a solution is constrained to the maximum amount of land available. Similarly, the summation of fresh water used by all crops in a solution is limited to the amount available from the canal. The model allows such adjustments as changing crops, changing irrigation technologies, and fallowing land, all of which are captured in the constraints. It implicitly assumes that current technological or structural characteristics within the agricultural production sector will not change over the simulation period ending in 2019.

G.3.2.2 Water

Sources of applied water include canal water, recycled drain water, treated drain water, and groundwater. The total amount of applied water during each model period is determined by crop evapotranspiration and irrigation efficiency. Applied water that is not consumed by the crop or lost to evaporation or collected by the drains[15] becomes drain water. Drain water can be recycled, treated, and mixed with canal water to be applied to crops, or discharged from the area.

Total CVP contractual water available during normal water years was estimated at 172,470 acre-feet (AF).[16] CVP deliveries are priced at $55 per AF, which represents the weighted average water charge in the GDA. Recycled water volume is based on the quantity of drain water produced during each season as estimated in Section 4 and Appendix C, and is priced at $67 per AF to reflect capital and operating costs of recycling equipment.[17]

Water treatment is included as a mitigation option in all alternatives. Drainwater can be recycled, applied directly to salt-tolerant crops, or treated prior to being mixed with canal water. During the project period, the SJRIP reuse area which is planted with salt-tolerant plants may be expanded by 6,230 acres in No Action and up to 6,900 acres in the Action Alternatives. Maximum irrigated acreage is 4,800 in No Action and 5,520 in the Action Alternatives (see Section 2). The volume of drainwater applied is based on the estimates in Section 4 an Appendix C, and is priced the same as recycled water, $67 per AF. In addition to the increase acreage in the SJRIP, the Action Alternatives include the construction of a water treatment facility. It is anticipated that construction will be complete in 2015 and that approximately 6,500 AF can be treated annually. [18] The cost of water treatment in the model is based on treatment volumes projected in Appendix C; the cost per acre-foot of treatment is estimated at $1,500.[19]

G.3.2.3 Crop Yield Equations

Crop yields are determined within the agricultural production model. Yields are reduced from maximum achievable levels by the threshold salt tolerance level and yield response coefficient for each crop. The following equation describes this relationship.[20]

$$Yield_{C,Z} = Yield_{C,Z,MAX}\,((100 - B_C * (ECe_Z - A_C))\ /100)$$

[15] Estimated to be five percent of recharge to the saturated zone.
[16] See Appendix C.
[17] Value updated using CPI from Wichelns and Houston, 1995.
[18] See Appendix C.
[19] Summers Engineering, August 2008.
[20] See Maas, 1993.

C represents crop type, while *A* and *B* are the intercept and slope coefficients, respectively, of the yield-salinity relationship for the particular crop type. *ECe* is the average soil salinity (in mmhos/cm) during the growing season.

The yield equation thus determines the proportion of the maximum yield attainable for a given soil salinity level. As soil salinity rises above intercept level A_C, crop yield falls according to slope coefficient B_C. Additional equations are included in the model to ensure that yield cannot exceed the maximum or fall below zero. Figure G-1 illustrates the yield response curves for three of the crops included in the model.

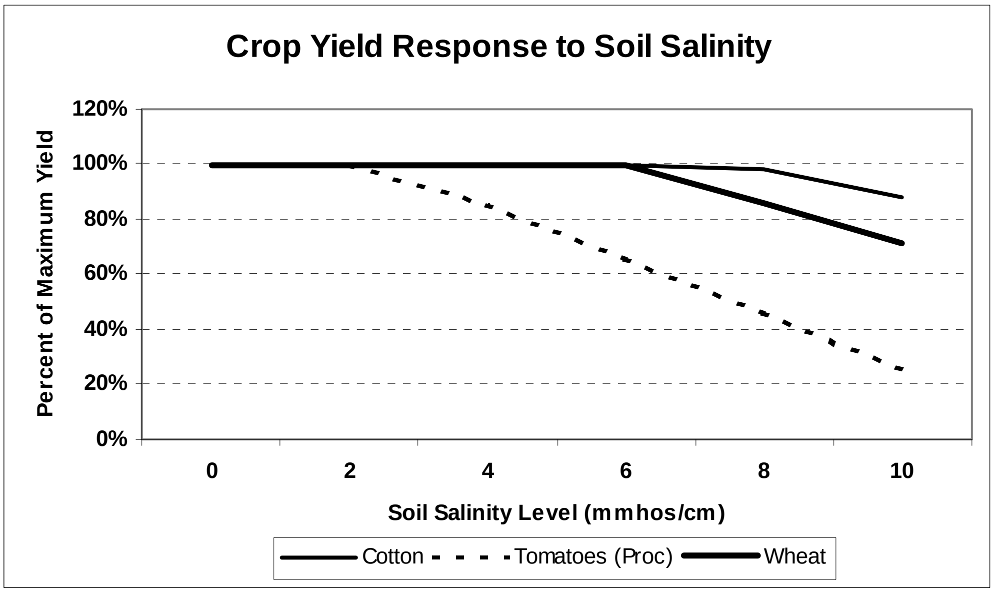

Figure G-1: Crop Yield Response to Soil Salinity

As shown on the graph, tomato yields begin to decline fairly rapidly at soil salinity levels greater than 2.5 mmhos/cm. Cotton and wheat, on the other hand, are relatively salt tolerant, and yields therefore do not decline until soil salinity reaches much higher levels. Table G-7 provides the maximum yield, threshold salinity level, and yield response coefficient for each of the crops included in the model.

Table G-7: Maximum Yield and Response to Soil Salinity

Crop	Maximum Yield[1/]	Units	Threshold Level (A)	Yield Response (B)
Cotton	1,760.0	Lbs.	7.7	5.2
Tomatoes (Proc.)	23.0	Tons	2.5	9.9
Tomatoes (Fresh)	44.5	Tons	2.5	9.9
Melons	1059	Ctns.	1.0	6.4
Wheat	3.21	Tons	6.0	7.1
Alfalfa Hay	8.92	Tons	2.0	7.9
Sugarbeets	39.3	Tons	7.0	5.0
Rice	75.0	Cwt.	3.0	12.0
Vegetables	17.65	Tons	2.0	2.0

[1/] Maximum yield is the highest yield observed in Fresno County between 2002 and 2006.

Source: Fresno County Agricultural Commissioner Reports (2002-2006) and Maas (1993).

G.3.2.4 Crop Revenues, Costs, and Net Returns

Nine crop types are included in the model based on historical crop production in the area. They are alfalfa hay, cotton, melons, rice, sugarbeets, processing tomatoes, fresh tomatoes, vegetables, and wheat. Together, these crops represent nearly 95 percent of the crop acreage in the GDA.

The initial crop mix specified in the model is based upon reported crop production in 2000-2005. The mix which can generate the highest profits determines the change from the initial crop mix in subsequent years. The change in acreage of each crop between years is restricted to a maximum percentage based on historical patterns. These “flexibility” limits are formed as follows.

$$(1-b_{C,MIN})\sum_{I} acres_{C,I,T-1} \leq \sum_{I} acres_{C,I,T} \leq (1+b_{C,MAX})\sum_{I} acres_{C,I,T-1}$$

In the above relationship, *b* represents the flexibility limit. It is the maximum percentage by which acres of each crop may change from year to year. The constraint is consistent with the cropping pattern changes farmers make, which are typically incremental. Such changes in turn are consistent with farmers’ desire to continue use of existing machinery and equipment rather than purchasing entirely new complements for crops not previously grown.

In addition to the flexibility limits, the maximum percent of total acreage in each crop is driven by historical patterns and market limits (namely for specialty crops such as processing and fresh tomatoes). They range from 3 percent for rice to 52 percent for cotton.

Crop price were obtained from Fresno County agriculture reports and crop production information was drawn from data developed by Wichelns and Houston (1995a and 1995b). Crop prices used in the model are the average county-level price reported from 2002 through 2006. Production costs were allocated to fixed, pre-harvest, and harvest categories. Pre-harvest and fixed costs are entered on a per acre basis while harvest costs vary according to crop yield. Table G-8 provides crop price, average yield, production costs, and gross returns for each crop included in the economic model. The figures shown do not include irrigation labor, irrigation water, or land rent charges.

Net returns for a given crop consist of gross revenue (yield multiplied by crop price) less harvest, pre-harvest, and fixed costs, as well as costs for water and irrigation system fixed and operational costs. Net returns are variable and for each crop in each year depend upon the costs of the crop irrigation technology selected by the model and salinity levels and their impacts on crop yields.

Table G-8: Crop Price, Max Yield, and Production Costs Used in the Economic Model (2007 $)

Crop	Units	Price ($/Unit)	Max Yield per Acre	Gross Return Per Acre	Preharvest Cost ($/Unit)	Harvest Cost ($/Acre)	Fixed Cost ($/Acre)
Alfalfa	Tons	116.50	8.92 Tons	$982	$308	$12.12	$217.46
Cotton	Lbs.	0.80	1,760 Lbs	$1,171	$418	$.25	$138.07
Melons	Ctns.	4.09	1,059 Ctns	$2,949	$297	$2.87	$131.48
Rice	Cwt.	8.35	75.0 Cwt	$826	$365	$2.60	$161.00
Sugarbeets	Tons	37.75	39.3 Tons	$1,269	$453	$6.17	$93.66
Tomatoes (Proc.)	Tons	52.50	44.5 Tons	$2,173	$800	$6.91	$188.75
Tomatoes (Fresh)	Tons	436.00	23.0 Tons	$10,137	$733	$377.81	$243.55
Vegetables	Tons	339.50	17.65 Tons	$6,378	$2647	$233.45	$56.94
Wheat	Tons	142.25	3.21 Tons	$343	$109	$30.19	$49.64

Sources: Wichelns and Houston 1995a, 1995b; Fresno County Agricultural Commissioner Reports (2020-2006).

G.3.2.5 Crop Water Requirements

The monthly water evapotranspiration (ET) requirements for each crop were obtained from URS (May, 2008). Monthly evapotranspiration was allocated to each of the three intraseasonal model periods as shown in Table G-9.

Table G-9: Crop Evapotranspiration by Season[1/] (acre-feet/acre)

Crop	Fall	Spring	Summer	Total
Cotton	0	0.17	1.64	1.81
Melons	0	0.62	0.32	0.94
Fresh Tomatoes	0	0.39	0.98	1.37
Processed Tomatoes	0	0.15	1.4	1.55
Alfalfa Hay	0	0.53	1.71	2.24
Rice	0	1.01	1.67	2.68
Vegetables	0.18	0.2	0.72	1.1
Wheat	0	0.62	0.32	0.94

[1/] Fall (October through February); Spring (March through May); Summer (June through September).

Source: URS, May 2008.

ET needs are assumed to be met through applied water, rainfall, and shallow groundwater use. Rainfall averages were obtained from URS. Rainfall (in feet) averages 0.46 in the fall, 0.17 in the spring, and 0.02 in the summer. The percent of total rainfall that is used by the crop (effective rainfall) varies by crop and season and ranges from 0 to 90 percent.[21] The ET calculations assume that 15 percent of crop water needs during the summer months (June through September) are met by shallow groundwater use.

G.3.2.6 Irrigation Methods

There are 14 irrigation methods included in the model. Beneficial use, recharge, surface runoff, and evaporation factors were initially obtained from data compiled by Wichelns and Houston

[21] Wichelns and Houston, 1995b.

(1995a, 1995b). These factors were then adjusted to calibrate the model to actual conditions in the GDA and to reflect the average application efficiency obtained in the area. In general, drainage conditions and water availability prevent the irrigation technologies with low beneficial use fractions from entering the model solution despite lower costs. Table G-10 provides the water distribution fractions for each irrigation method after empirical adjustments were made. The fractions are constant across all crops for a given irrigation method.

Table G-10: Water Distribution Fractions (Percent of Delivered Water)

Irrigation Method	Beneficial Use	Recharge to Saturated Zone	Runoff
½ mile furrows (L)	0.63	0.24	0.10
½ mile furrows (M)	0.75	0.21	0.03
¼ mile furrows (L)	0.65	0.20	0.14
¼ mile furrows (M)	0.77	0.19	0.03
¼ mile furrows (H)	0.86	0.11	0.02
Hand Move Sprinklers (L)	0.70	0.17	0.06
Hand Move Sprinklers (M)	0.82	0.12	0.02
Hand Move Sprinklers (H)	0.87	0.10	0.01
Bordered Check (L)	0.64	0.20	0.10
Bordered Check (M)	0.78	0.17	0.04
Bordered Check (H)	0.85	0.12	0.02
Rice Flow-Through	0.58	0.18	0.20
Rice Recirculating	0.66	0.18	0.12
Rice Static	0.71	0.18	0.07

Source: Wichelns and Houston (1995a and 1995b).

Some irrigation methods are unsuitable for the production of certain crops. To account for these limitations, constraints are included in the model to limit the irrigation methods to those practical for each crop. For example, alfalfa hay can be grown with bordered-check methods, while cotton, alfalfa seed, sugarbeets, melons, and vegetables cannot. The volume of water applied to each crop/technology combination is calculated as the difference between crop ET and effective rainfall divided by the beneficial use fraction of the irrigation method.

G.3.2.7 Soil Salinity and Selenium Discharge

The soil salinity in each model period is based on the projections in Chapter 5, while the total Se load discharge is based on projections in Appendix D. Table G-11 presents the soil salinity used in the model. Table G-12 presents the annual Se load values under the Proposed Action and under the 2001 Use Requirements. The values for the 2010 Use Agreement presented in Table G-12 are an average of the “below normal” and “above normal” water year type load limits, while the values for the 2001 Requirements Alternative are an average of the wet and dry year load limits for 2009.

Table G-11: Annual Soil Salinity, 2008-2019 (mmhos/cm)

Water Year	No Action		Proposed Action / Alternative Action	
	GDA	SJRIP reuse area	GDA	SJRIP reuse area
2008	1.0	6.6	1.0	6.6
2009	1.9	9.6	1.5	8.7
2010	2.6	12.1	1.7	10.3
2011	3.0	12.9	1.9	10.7
2012	3.1	13.3	1.9	10.9
2013	3.1	13.5	1.9	11.0
2014	3.2	13.6	1.9	11.1
2015	3.2	13.7	1.9	11.1
2016	3.2	13.8	1.9	11.2
2017	3.2	13.8	1.9	11.2
2018	3.2	13.9	1.9	11.2
2019	3.2	13.9	1.9	11.2

Source: Chapter 5

Table G-12: Annual Selenium Load Restrictions, 2010-2019

Pounds Discharged Grassland Bypass Project and 2001 Requirements Alternative		
Year	Proposed Action Draft Use Agreement	2001 Requirements Alternative
2010	3513	2755
2011	3329	2755
2012	3329	2755
2013	3329	2755
2014	3329	2755
2015	2590	2755
2016	1852	2755
2017	1114	2755
2018	375	2755
2019	375	2755

Source: Summers Engineering 2008; Appendix A.

G.3.3 Recreation

As discussed elsewhere in this document, the recreational impacts of all three alternatives are likely to be quite small. Under No Action, no land is removed from production, and no change is expected in recreational opportunities in the area. Similarly under the action alternatives, all land remains in production and no change is expected relative to baseline conditions. The treatment facility may improve fishing opportunities slightly because of improved water quality. However, none of the possibilities under the three alternatives has been quantified and for that reason the economic impacts are not estimated. The consequence is that the cumulative impacts for each of the alternatives may be slightly understated.

G.3.4 Regional Impact Analysis Model

Input-Output (I-O) analysis is a procedure for describing the structure of inter-industry dependencies in a regional economy. I-O analysis is based upon the interdependence of the production and consumption sectors of the economy in the area being studied. Industries must purchase inputs from other industries, as well as from primary sources (i.e., natural resources), for use in the production of outputs that are either sold to other industries or to final consumers.

A set of I-O accounts can be thought of as a snapshot of the economic structure of an impact area at one point in time. For this analysis, 2006 data were used to develop a model of the three-county area. Later data were not available at the time of preparation of the report. The steps used in constructing the model are discussed in Appendix A of this report.

The I-O model was developed for a three-county area rather than one or two counties because of the logical relationships between the study area and the neighboring counties. Fresno, Madera, and Merced counties are all very likely to be affected by activities in the GDA. Farmers in the GDA purchase inputs, such as machinery, chemicals, and, seed from suppliers throughout the area. Hired laborers on farms and in other industries in the GDA likely reside in all three counties. Products from GDA farms, such as cotton, tomatoes, and melons, are shipped, brokered, and processed in all three counties.

The primary inputs for the I-O model are taken from the outputs of the farm-level optimization model discussed previously. For each alternative, the optimization model provides estimates of the acreage and production of each crop and total and net revenues. The IMPLAN model is used for each alternative to translate agricultural production levels first into changes in final demand expenditures by sector, then into levels of employment and income. The changes in relation to baseline conditions represent the direct impacts that are input into the IMPLAN model.

For the IMPLAN analysis, the agricultural production values used are those of the agricultural products as they leave the farm and as the products are either exported from the impact area or consumed there by intermediate industries or final consumers. The I-O model then provides an estimate of the production required from every other industry in the region as needed to satisfy the changes in final demands. The inputs and outputs can then be traced via the I-O accounts to determine the overall impacts on various industries making up the regional economy. Through mathematical matrix manipulations, the estimated direct, indirect, and induced impacts can be evaluated. The impacts concerning most people in the local economy are jobs and income.

The Minnesota IMPLAN Group in Stillwater, Minnesota developed the 2006 IMPLAN database. A data reduction method was employed to develop the IMPLAN model for the study area based on national technology matrices and the economic accounts for the three counties. The method used is documented and referenced in Appendix A.

Table G-13 summarizes the baseline conditions for 2006. The data are from the IMPLAN database, which contains information on up to 528 sectors in each county. Some of the sectors are not represented in all counties. For example, tobacco production and automobile manufacturing are absent in each of the three counties in the study area.

Data shown in the table are aggregated over the three counties. All data relate to activities taking place directly in the study area and exclude linkages to or effects from other counties. The three-county study area was selected to emulate a regional economy which is relatively self sufficient. Total industry output in 2006 was $70.8 million, of which agriculture was 12.2 percent, manufacturing was 21.1 percent, and services were 19.7 percent. Total employment was 598,100. Agriculture was 15.0 percent of the total, manufacturing was 7.1 percent, trade (wholesale and retail) was 12.8 percent, and services were 33.1 percent. Government was also a major employer in the area and accounted for 14.7 percent of employment.

Table G-13: 2006 Economic Conditions, Three-County I-O Model

	Output, Employment and Value Added Measures						
Industry	Industry Output[1]	Employment	Employee Compensation[1]	Proprietor Income[1]	Other Property Income[1]	Indirect Business Tax[1]	Total Value Added[1]
Ag, Forestry, Fish & Hunting	$8,659	89,227	$1,896	$863	$1,505	$145	$4,408
Mining	$68	223	$13	$1	$22	$3	$38
Utilities	$1,169	2,023	$163	$33	$206	$119	$522
Construction	$5,276	39,847	$1,534	$589	$299	$32	$2,454
Manufacturing	$14,960	42,603	$2,028	$258	$1,159	$139	$3,584
Wholesale Trade	$2,744	18,115	$962	$77	$406	$406	$1,850
Transportation & Warehousing	$2,275	20,388	$725	$264	$219	$50	$1,258
Retail trade	$4,268	58,668	$1,498	$276	$450	$595	$2,819
Information	$1,722	6,824	$379	$27	$278	$79	$763
Finance & insurance	$3,010	17,488	$801	$121	$776	$67	$1,765
Real estate & rental	$2,988	16,443	$210	$254	$1,163	$304	$1,931
Professional- scientific & tech svcs	$2,484	22,377	$694	$372	$160	$23	$1,249
Management of companies	$722	5,288	$263	-$1	$70	$5	$338
Administrative & waste services	$1,412	26,065	$578	$107	$136	$22	$844
Educational svcs	$272	6,109	$103	$14	$15	$3	$136
Health & social services	$5,032	60,886	$2,285	$393	$355	$36	$3,070
Arts- entertainment & recreation	$268	6,880	$86	$32	$22	$17	$157
Accommodation & food services	$1,733	33,802	$539	$35	$176	$93	$843
Other services	$2,030	36,687	$650	$181	$130	$76	$1,037
Government & Other	$9,761	88,115	$5,355	$0	$3,130	$382	$8,866
Totals	$70,853	598,059	$20,763	$3,897	$10,678	$2,596	$37,934

[1]Millions of dollars.

G.3.5 Summary of Framework to Measure Economic Impacts of Alternatives

Two separate models are used to estimate the economic impacts of the alternatives considered in this analysis. The first is an optimization model which simulates farm-level decision making, and is run for each alternative. It considers the cost and hydrologic specifications, namely no discharges from GDA under No Action; discrete Se load restrictions for both the Grassland Bypass and 2001 Use Requirements action alternatives; water treatment costs at the planned In-Valley Treatment facility and fees for Se discharge associated with the Proposed Action and the 2001 Requirements Alternatives. The model selects the combination of crops and irrigation technologies that maximize the value of farm profits in the GDA from 2010 to 2019. The model includes a variety of constraints, such as yield-salinity relationships on crops grown in the area, and maximum percentages by which crop acreages may change between years. Outputs from the model for each alternative include the acreage, production, gross revenues, costs, and profits for each crop.

The second model is an I-O framework developed for the three-county area. The three counties, Fresno, Madera, and Merced, together represent the "area of influence" of the GDA. For each year and each alternative, changes in gross revenues are taken from the optimization model. The changes are converted to categories which match the arrangement of industry sectors within the IMPLAN database. The nine crops included in the optimization model are converted to five pertinent IMPLAN sectors: cotton, grains (wheat, rice), hay (alfalfa hay), vegetables (melons, fresh and processing tomatoes, and vegetables), and sugar (sugarbeets). These converted figures are then input directly into the I-O model as changes in final demands for the respective crop sectors.

For the specified changes in final demands, the I-O model provides estimated production levels required from every other industry in the region in order to meet those changes. The inputs and outputs can then be traced via the I-O accounts to determine the overall impacts on various industries making up the regional economy.

The estimation of regional impacts is based on the 2006 IMPLAN database as the baseline condition; later data are not currently available. It is implicitly assumed that the economic structure of the three-county economy and the technical relationships and production processes in the I-O model will be unchanged between 2006 and 2019.

Changes in economic structure would require consideration of the ways in which shares of economic activity change over time. Variations in technology, trade patterns, relative crop prices and other measure cause changes in regional economic structure in ways which cannot be predicted by I-O models.

G.4 ENVIRONMENTAL CONSEQUENCES

This chapter describes the environmental consequences of the alternative maximum Se discharges from the GDA. Economic consequences are presented for each alternative for each year of the projection period, 2010 to 2019. The alternatives analyzed are the No Action, Grassland Bypass, and 2001 Use Requirements.

The assumptions underlying the alternatives will affect production, consumption, and investment decisions in agriculture.[22] As a result, outputs and final demands for the goods and services produced in these sectors will change. The changes in final demands are utilized to compute direct impacts, measured as changes in output, employment, and income in the agricultural sector. In addition, changes in final demands will produce indirect and induced impacts in agriculture and many other sectors of the regional economy because of the linkages and interdependencies among industries.[23]

The agricultural and regional economic impacts of the various alternatives are presented. The direct impacts on agriculture are presented first. The indirect and induced impacts associated with each alternative are estimated using a regional I-O model. For the No Action Alternative, the environmental consequences for each year of the projection period are presented relative to the "baseline" estimated for 2007. For the two action alternatives, impacts are presented relative to No Action and to existing 2007 conditions. In this analysis, No Action instead reflects the

[22] The economic impacts of changes in recreation activity will be estimated in the revised draft.
[23] United States Bureau of Reclamation, 1997.

assumption that GDA will no longer be able to use the Drain and that there will be no In-Valley Treatment facility constructed (although the reuse facility will operate).

A "Normal" water year is assumed throughout the projection period for each alternative.

In the subsequent discussion, an assessment is made of changes in different variables. There were no convenient yardsticks to assess the significance of changes noted in any of the variables or issues analyzed. It was not possible to perform statistical tests of significance on such variables as percentages of acres in various crops, since information on individual landholdings was not available. It was therefore decided on the basis of professional judgment that any change of five percent or greater in the annualized present value of net farm income or regional variables was significant.

G.4.1 No Action Alternative

G.4.1.1 Salinity of the Soil

Under No Action, because producers must recycle all drain water, the average soil salinity is projected to increase from 1.0 mmhos/cm in 2009 to 3.2 mmhos/cm in 2019 as explained in Chapter 5 (see Figure G-2). Soil salinity within the SJRIP reuse facility is expected to increase from 6.6 mmhos/cm in 2008 to 13.9 mmhos/cm in 2019.

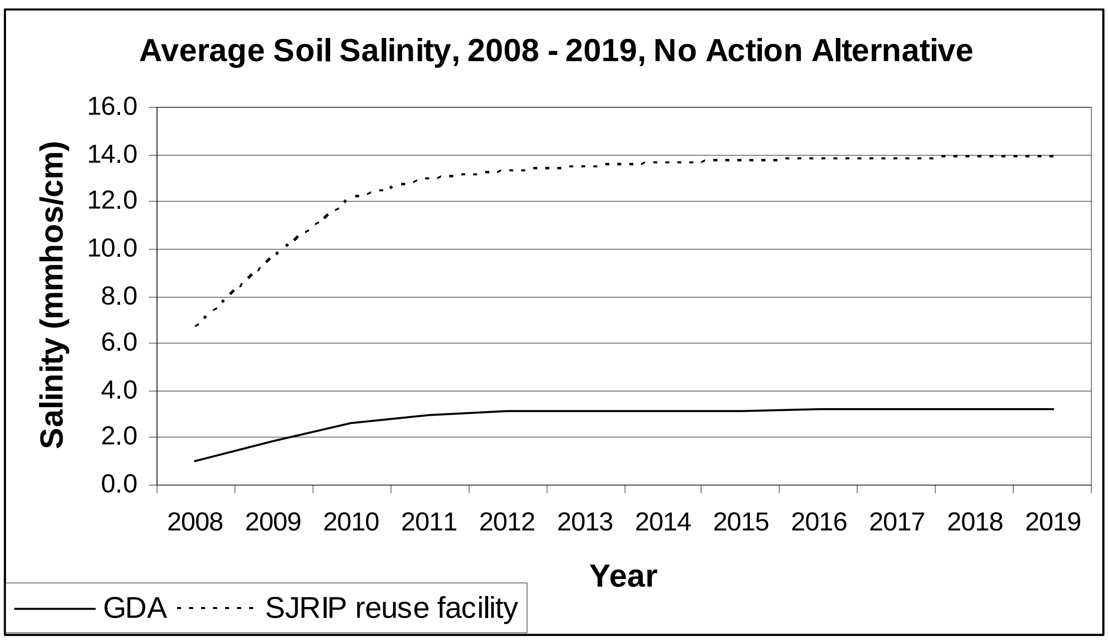

Figure G-2: Average Soil Salinity, 2008–2019, No Action Alternative

G.4.1.2 Optimization Model Results

The optimization model is structured to solve for the crop acreages and irrigation technologies which provide maximum profit for the GDA under specific constraints. The results suggest that farmers seeking to maximize profits under these conditions will first choose irrigation methods which produce low levels of drain water, then plant more salt-tolerant crops.

G.4.1.2.1 Crop Yields and Crop Acreage

Under No Action, all crop yields except cotton, sugarbeets, and wheat are expected to decline because of the buildup in soil salinity (see Table G-14). The rate at which yields decline depends directly on the salt sensitivities of the individual crops. For example, cotton yields are unaffected because cotton is salt tolerant with a threshold level of 7.0 mmhos/cm. The maximum percentage yield declines are in tomatoes and vegetables, which each decline by six percent. Yield declines in the SJRIP reuse area are higher due to its higher soil salinity.

Table G-14: GDA Crop Yield per Acre, by Year, No Action Alternative

Year	Cotton (Lbs)	Melons (Ctns)	Tomatoes (Fresh, Tons)	Tomatoes (Processing, Tons)	Alfalfa Hay (Tons)	Sugarbeets (Tons)	Rice (Cwt.)	Vegetables (Tons)	Wheat (Tons)
2010	1760	951	22.8	44.1	8.5	39.3	75.0	16.7	3.2
2011	1760	924	21.9	42.3	8.2	39.3	75.0	16.0	3.2
2012	1760	917	21.6	41.9	8.1	39.3	74.1	15.8	3.2
2013	1760	917	21.6	41.9	8.1	39.3	74.1	15.8	3.2
2014	1760	910	21.4	41.4	8.1	39.3	73.2	15.7	3.2
2015	1760	910	21.4	41.4	8.1	39.3	73.2	15.7	3.2
2016	1760	910	21.4	41.4	8.1	39.3	73.2	15.7	3.2
2017	1760	910	21.4	41.4	8.1	39.3	73.2	15.7	3.2
2018	1760	910	21.4	41.4	8.1	39.3	73.2	15.7	3.2
2019	1760	910	21.4	41.4	8.1	39.3	73.2	15.7	3.2

All other factors unchanged, when the yield for a given crop falls to the point that profit is lower than for an alternative crop, the model selects the more profitable product. However, because the profit for a given product also depends on the amount of water purchased, the acreage of even relatively salt-tolerant crops which require large amounts of water declines. As shown in Table G-15, virtually all rice acreage is projected to either be switched to other crops by 2019.[24] Similarly, the acreage of alfalfa hay is expected to decline because of yield impacts, but also because alfalfa requires large amounts of water.[25] In addition to the acreage in table G-15, cropped acreage in the SJRIP reuse area is projected to rise from approximately 3,800 acres in 2007 (existing conditions) to approximately 4,800 acres in 2010, with 4,130 acres in alfalfa hay, 530 acres in vegetables, and 140 acres in wheat.

[24] The figures shown exclude fallowed land, assumed to be three percent of irrigated land or 2,208 acres.
[25] Experiments are being conducted in the GDA involving application of high-saline recycled water to alfalfa.

Table G-15: GDA Crop Acres by Year, No Action Alternative

Year	Cotton	Melons	Tomatoes (Fresh)	Tomatoes (Proc)	Alfalfa Hay	Sugarbeets	Rice	Vegetables	Wheat	Total
2010	32,465	9,190	2,109	8,210	8,662	3,390	1,657	6,327	3,314	75,325
2011	33,322	9,190	2,109	8,210	8,316	3,525	1,309	6,327	3,016	75,325
2012	34,060	9,190	2,109	8,210	7,983	3,666	1,034	6,327	2,745	75,325
2013	34,744	9,190	2,109	8,210	7,664	3,766	817	6,327	2,498	75,325
2014	35,447	9,190	2,109	8,210	7,357	3,766	645	6,327	2,273	75,325
2015	36,081	9,190	2,109	8,210	7,063	3,766	510	6,327	2,068	75,325
2016	36,657	9,190	2,109	8,210	6,781	3,766	403	6,327	1,882	75,325
2017	37,182	9,190	2,109	8,210	6,509	3,766	318	6,327	1,713	75,325
2018	37,663	9,190	2,109	8,210	6,249	3,766	251	6,327	1,559	75,325
2019	38,106	9,190	2,109	8,210	5,999	3,766	199	6,327	1,418	75,325

The acreages of rice and alfalfa hay are projected to decline uniformly throughout the analysis period. The patterns for other crops are less uniform, however, because the selection of crops is based on relative profitability. In some years, while the yield for a given crop may be very low because of salinity, the crop will be planted nonetheless because it is relatively more profitable than others. For example, while fresh tomato yield in 2019 is projected to be less than the 2010 level, acres of the crop are expected to be held constant throughout the analysis period because of relative profitability. Furthermore, modeling results indicate no land would be removed from production despite the increase in soil salinity. If the analysis period were extended beyond 2019, all other factors unchanged, it is expected that land would begin to be removed from production as the SJRIP reuse facility becomes more saline and water logged and additional water is recirculated onto the GDA.

The model emulates normal farm-level decision making in comparing the relative profits of growing different crops suitable for the enterprise. For example, if because of yield declines due to increased salinity the profit of crop falls below that of another crop, the second crop will be selected rather than the first. The model, however, also includes both upper and lower limits on the acreage of various crops because of rotation requirements and the total market size for those crops.

The model also emulates farm-level decision making in the implicit assumption that all farmers are price takers. Crop prices are input into the model as exogenous variables, calculated, for example, as five-year averages. While crop prices could be changed to other levels to test the sensitivity of results, this was not done for this study.

G.4.1.2.2 Farm Revenues

The changes in crop yields and acreages cause changes in farm revenues within the GDA and the SJRIP reuse facility. Table G-16 shows total revenues by crop and year from 2010 to 2019 under No Action. These revenues are compared to existing 2007 revenues of $237.8 million. Total revenue under No Action is expected to drop by 2010, both because yields are expected to decline throughout the Project Area between 2007 and 2010 due to rising salinity levels, and because over 2,000 acres of land are moved from irrigated production in the GDA to the reuse facility. Total revenue in 2010 under No Action is estimated at $224.6 million, but falls to $218.0

in 2014 before rising slightly to $219.8 by 2019 (as farmers switch to more salt tolerant crops). Revenues for cotton increase steadily as that crop is substituted for less salt-tolerant crops. However, the increase in cotton revenues offsets only part of the declines in other crops. Revenues from melons, alfalfa hay, rice, tomatoes, vegetables, and wheat all would drop between 2010 and 2019.

Table G-16: Crop Revenues by Crop Type and Year under No Action Alternative (Grasslands Drainage Area and Reuse Area, Millions $)

Year	Cotton	Melons	Tomatoes	Alfalfa Hay	Sugarbeets	Rice	Vegetables	Wheat	Total
2010	56.60	42.59	53.33	12.63	5.94	0.99	51.24	1.27	224.58
2011	57.74	41.37	51.19	11.76	6.10	0.78	49.23	1.16	219.33
2012	58.90	41.07	50.66	11.33	6.10	0.61	48.74	1.05	218.46
2013	59.96	41.07	50.66	11.00	6.10	0.48	48.73	0.96	218.96
2014	60.91	40.77	50.13	10.62	6.10	0.38	48.24	0.88	218.02
2015	61.79	40.77	50.13	10.32	6.10	0.30	48.23	0.80	218.43
2016	62.59	40.77	50.13	10.04	6.10	0.24	48.23	0.73	218.82
2017	63.32	40.77	50.13	9.78	6.10	0.19	48.23	0.67	219.18
2018	64.00	40.77	50.13	9.51	6.10	0.15	48.23	0.61	219.49
2019	64.63	40.77	50.13	9.27	6.10	0.12	48.23	0.56	219.80

* Individual crop revenues may not sum to total due to rounding.

G.4.1.2.3 Farm Profits

Compared to existing 2007 farm profits of $61.4 million, projected farm profits under the No Action Alternative would decline despite increased acreage in the reuse area. Farm profits in 2010 under No Action are estimated at $55.3 million, and would drop further in the next several years as yields decline due to salts building up in the soil. As farmers begin adjusting from the initial crop mix to increased acreage of more salt-tolerant crops, profits begin to recover and remain at approximately $52 million until 2019 (see Figure G-3). The net present value of estimated annual profits for 2010 through 2019 is $433.7 million, using a 3 percent discount rate. This is a 15 percent reduction from the net present value of farm profits that would be expected if existing profits of $61.4 million were to be realized each year from 2010 to 2019.

Although the time period for this analysis is 2010 to 2019, it is important to note that reductions in farm profits and revenue impacts of the No Action alternative would likely increase substantially in later years. As noted in Chapter 2, over time the reuse capacity of the SJRIP would diminish as salt accumulates within the root zone and the ability of the SJRIP to support salt tolerant crops declines. This would impact the profitability of farmlands throughout the GDA as fields in the lower portion of the region would become waterlogged and unfarmable and would be abandoned. Additionally, once the reuse facility became inoperative, individual districts and farmers would have to recycle drainwater “on farm and within districts”, resulting in increased salinity levels and associated crop yield and revenue declines throughout the GDA.

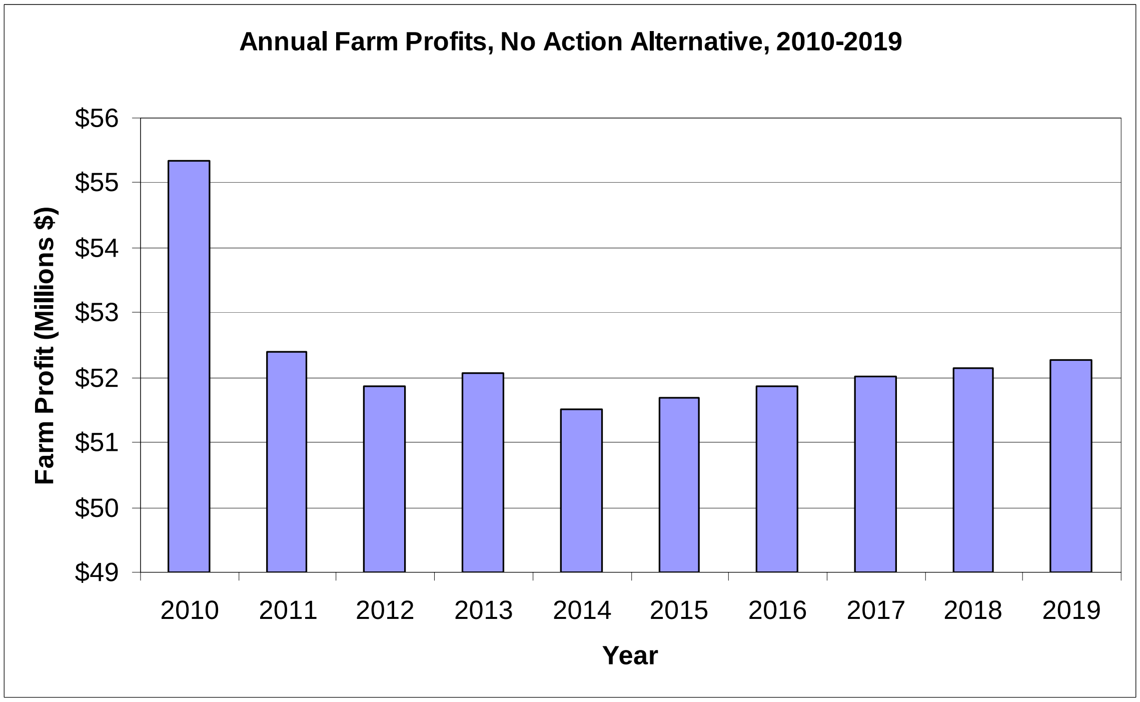

Figure G-3: Annual Farm Profits, 2010-2019, No Action Alternative

G.4.1.3 Regional Economic Impacts

Under No Action, soil and water salinity increases, crop yields and revenues decline, acreages shift among crops, but total cropped acreage would remain very similar between 2010 and 2019. Due to the 2,230 acres that are being moved from the GDA into the SRJIP, the total irrigated acreage is expected to drop by approximately 1,000 acres, or a decline of approximately 1.5 percent.

The gross revenue change for each year is found by subtracting existing 2007 revenue from the value for each project year. For example, the direct output effect for 2010 is estimated at $13.3 million, and is the difference between the existing 2007 total crop revenues of $237.8 million and the 2010 total crop revenue of $224.6 million shown in Table G-16. Those differences, when used as input into the I-O model, generate the regional economic impacts.

Table G-17 shows the impacts of No Action, by year. Both direct and total impacts are shown for output, personal income, and employment. Direct impacts are the effects on the agricultural sector of the alternative, while total impacts reflect the effects of the direct impacts on all sectors of the economy. In the year 2010, the direct output in agriculture is reduced by $13.3 million. The total output impact in 2010, taking into account the effects of agricultural output on economic activity in other sectors and of associated increased employment and consumer income, is a reduction of $19.7 million.

Under No Action, output impacts are expected to be negative in all years compared to existing conditions. It is projected that the largest impact would be felt in 2014, with roughly $28.8 million reduction in total output, $19.1 million reduction in total income, and reduction of approximately 180 full and part-time jobs. As growers begin responding to rising salinity levels by changing their cropping pattern, the expected total output impact is reduced by 11 percent and the total income impact is reduced by 8 percent between 2014 and 2019.

Table G-17: Regional Output, Personal Income, and Employment Impacts, No Action Alternative

	Output ($Million)		Personal Income ($Million)		Employment	
Year	Direct	Total	Direct	Total	Direct	Total
2010	-$13.3	-$19.7	-$8.9	-$12.6	-60	-127
2011	-$18.5	-$27.4	-$12.5	-$17.7	-82	-173
2012	-$19.4	-$28.5	-$13.3	-$18.5	-88	-180
2013	-$18.9	-$27.6	-$13.1	-$18.1	-89	-174
2014	-$19.8	-$28.8	-$13.9	-$19.1	-95	-181
2015	-$19.4	-$28.1	-$13.7	-$18.7	-95	-175
2016	-$19.0	-$27.3	-$13.6	-$18.4	-94	-170
2017	-$18.7	-$26.7	-$13.5	-$18.1	-94	-165
2018	-$18.4	-$26.1	-$13.4	-$17.8	-93	-160
2019	-$18.1	-$25.5	-$13.3	-$17.6	-93	-155

G.4.2 Grassland Bypass Alternative, 2010–2019 (Proposed Alternative)

Under this alternative, it is assumed that the 2001 Use Agreement will be revised and extended through 2019. The GDA would continue to use the San Luis Drain to discharge drain water collected from irrigators and upslope drainers. Se load in the discharge is constrained to be less than or equal to the Se loads listed in Table G-10.

The Grassland Bypass Alternative includes construction of a water treatment facility at the SJRIP. Costs to process water at the facility were estimated at $1,500 per acre-foot (AF)[26] (Summers Engineering, pers. comm., 2008). Total treatment costs were assessed based on the volume of water sent to the facility in each year, as presented in Appendix C. An average of the above normal and below normal/dry expected annual volume was used in this analysis to calculate treatment costs. It is anticipated that the treatment facility would be operational in 2015 and would treat approximately 5,750 AF of water at a cost of $8.6 million. Treatment costs are expected to rise to $9.8 million in 2019. The total present value of expected treatment costs between 2015 and 2019, using a three percent discount rate, is $35.2 million.

Under the Proposed Action, soil salinity builds up, but at a much slower rate than under No Action. Crop yields remain at or near their maximum respective values. Water is recycled, but the optimal amount of recycling as well as crop acreages and irrigation methods are determined based on the allowable Se load (from Table G-10) and other constraints.

G.4.2.1 Salinity of the Soil Water

Soil salinity increases as the amount of salt added through applied water exceeds the amount removed through deep percolation. The rate of increase, however, is much slower than for No

[26] It is expected that this estimate is on the high end of what treatment costs may be, thereby providing a conservative estimates of benefits of the Proposed Action as appropriate for an EIR/EIS.

Action. Salinity results for the proposed Se load limits for the Proposed Alternative are presented below.

Figure G-4 shows the average soil salinity and average salinity of applied water during each analysis year under the Proposed Se Load Values. Soil salinity is projected to increase from the current 1.0 mmhos/cm to a high of 1.9 mmhos/cm in 2015. Soil salinity is expected to remain stable at 1.9 mmhos/cm until 2019. Soil salinity within the SJRIP reuse facility is expected to increase from 6.6 mmhos/cm in 2008 to 11.2 mmhos/cm in 2019.

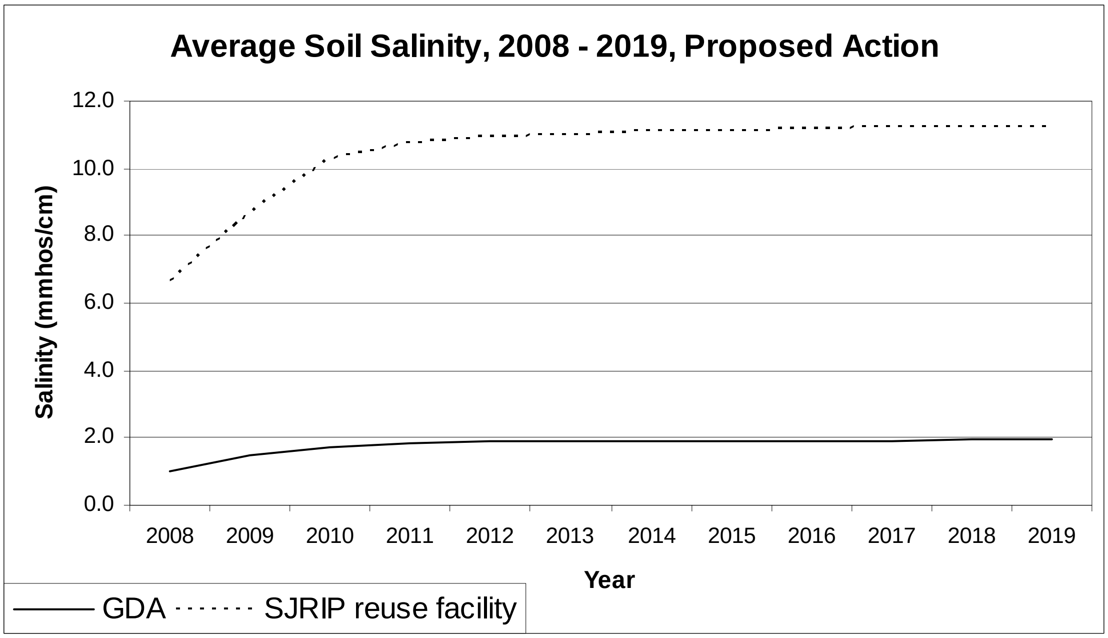

Figure G-4: Average Soil Salinity, 2008–2019, Proposed Action

G.4.2.2 Optimization Model Results

The model selects crop acreages and irrigation technologies that maximize the present value of profits. As previously discussed, the model selects the profit maximizing crop mix based on relative crop profits, water availability, and soil salinity levels.

G.4.2.2.1 Crop Yields and Crop Acreage

The crops included in the model are largely unaffected by the increase in soil salinity expected under this alternative. Melons, the most salt-sensitive crop, is the only crop with expected decreased yields, and its yields are expected to decline by less than two percent Table G-18 shows annual crop yields for the proposed Se load values. Yields in the SJRIP reuse facility would decline in the Proposed Action, but by less than in the No Action Alternative.

Table G-18: GDA Crop Yield per Acre, by Year, Grassland Bypass Alternative

Year	Cotton (Lbs)	Melons (Ctns)	Tomatoes (Fresh, Tons)	Tomatoes (Processing, Tons)	Alfalfa Hay (Tons)	Sugarbeets (Tons)	Rice (Cwt.)	Vegetables (Tons)	Wheat (Tons)
2010	1760	1012	23.0	44.5	8.9	39.3	75.0	17.7	3.2
2011	1760	998	23.0	44.5	8.9	39.3	75.0	17.7	3.2
2012	1760	998	23.0	44.5	8.9	39.3	75.0	17.7	3.2
2013	1760	998	23.0	44.5	8.9	39.3	75.0	17.7	3.2
2014	1760	998	23.0	44.5	8.9	39.3	75.0	17.7	3.2
2015	1760	998	23.0	44.5	8.9	39.3	75.0	17.7	3.2
2016	1760	998	23.0	44.5	8.9	39.3	75.0	17.7	3.2
2017	1760	998	23.0	44.5	8.9	39.3	75.0	17.7	3.2
2018	1760	998	23.0	44.5	8.9	39.3	75.0	17.7	3.2
2019	1760	998	23.0	44.5	8.9	39.3	75.0	17.7	3.2

The optimal acreages of various crops reflect changes in crop yields, costs, available inputs, and soil salinity. Table G-19 shows expected crop acreage by year. Cotton acreage is projected to increase, while acreage in alfalfa hay, rice, and wheat are projected to decline from existing levels. In addition to the GDA acreage in Table G-19, it is expected that 5,520 acres will be cropped and irrigated in the SJRIP drainage area, with the same crop proportions as under No Action. In total, GDA acreage in production is projected to remain at 74,645 throughout the analysis period (not adjusting for the 1,100-acre potential annex action area).

Table G-19: GDA Crop Acres by Year, Grassland Bypass Alternative

Year	Cotton	Melons	Tomatoes (Fresh)	Tomatoes (Proc)	Alfalfa Hay	Sugarbeets	Rice	Vegetables	Wheat	Total
2010	32,185	9,110	2,091	8,140	8,588	3,360	1,643	6,273	3,286	74,675
2011	33,035	9,110	2,091	8,140	8,244	3,495	1,298	6,273	2,990	74,675
2012	33,766	9,110	2,091	8,140	7,914	3,635	1,025	6,273	2,721	74,675
2013	34,444	9,110	2,091	8,140	7,598	3,734	810	6,273	2,476	74,675
2014	35,141	9,110	2,091	8,140	7,294	3,734	640	6,273	2,253	74,675
2015	35,770	9,110	2,091	8,140	7,002	3,734	506	6,273	2,050	74,675
2016	36,340	9,110	2,091	8,140	6,722	3,734	399	6,273	1,866	74,675
2017	36,861	9,110	2,091	8,140	6,453	3,734	315	6,273	1,698	74,675
2018	37,338	9,110	2,091	8,140	6,195	3,734	249	6,273	1,545	74,675
2019	37,778	9,110	2,091	8,140	5,947	3,734	197	6,273	1,406	74,675

The figures in Table G-19 reflect both the characteristics of the study area and the operation of the model used for the analysis. The total crop acreage is, by definition, limited to the available land in the area. The acreages of the various crops are taken from the optimal solution of the model, which compares the relative profits of each of the crops. As discussed previously, when the yield of one crop declines to a point that the profit from that product is less than that of a second, more profitable crop, the second crop will be substituted for the first. The extent of substitution, however, also depends on other constraints in the model, for example rotation requirements and market limits.

G.4.2.2.2 Farm Revenues

Although acreage is expected to remain the same as in the No Action Alternative, yields, revenues, profits, and regional impacts increase compared to No Action. Table G-20 shows total projected revenues from the GDA and SJRIP by crop and year under the proposed 2010 Use Agreement Se load values. Total revenue is estimated at $230.9 million in 2010, an increase of $6.3 million over 2010 revenues in No Action. Revenues rise to a peak of $233.8 million in 2019. Although yields of salt sensitive crops decline slightly during this time period, it is anticipated that farmers will switch to higher valued crops, which outweighs the revenue impacts of the slightly higher salinity levels. In general, the revenues in each crop type remain level throughout the 10-year period, although increased cotton and reduced grain acreages are expected. Over the course of the 10-year use agreement, the present value of revenues in the Proposed Action is expected to exceed the present value of crop revenue in No Action by $107.7 million, or 6 percent.

Table G-20 Revenue by Crop Type and Year under Proposed Action (Grassland Drainage Area and Reuse Area, Millions $)

Year	Cotton	Melons	Tomatoes	Alfalfa Hay	Sugarbeets	Rice	Vegetables	Wheat	Total	Increase from No Action
2010	56.1	44.9	53.4	14.0	5.9	1.0	54.4	1.3	230.9	6.3
2011	57.2	44.3	53.4	13.5	6.0	0.8	54.3	1.2	230.8	11.5
2012	58.4	44.3	53.4	13.1	6.0	0.6	54.3	1.1	231.3	12.8
2013	59.4	44.3	53.4	12.8	6.0	0.5	54.3	1.0	231.7	12.8
2014	60.4	44.3	53.4	12.4	6.0	0.4	54.3	0.9	232.1	14.1
2015	61.3	44.3	53.4	12.1	6.0	0.3	54.3	0.8	232.5	14.1
2016	62.0	44.3	53.4	11.8	6.0	0.2	54.3	0.7	232.9	14.0
2017	62.8	44.3	53.4	11.5	6.0	0.2	54.3	0.7	233.2	14.0
2018	63.5	44.3	53.4	11.2	6.0	0.1	54.3	0.6	233.5	14.0
2019	64.1	44.3	53.4	11.0	6.0	0.1	54.3	0.6	233.8	14.0

G.4.2.2.3 Farm Profits

It is expected that farm profits from crop production under the Proposed Action Alternative are higher than under the No Action Alternative in each year from 2010 to 2019. Total Proposed Action farm profits in 2010 are $58.7 million and rise slowly to approximately $60.0 million by 2019 (Figure 8-2). The net present value of annual profits for 2010 through 2019 is $505.5 million, which compares to $433.7 million under the No Action Alternative, an increase of 17 percent.

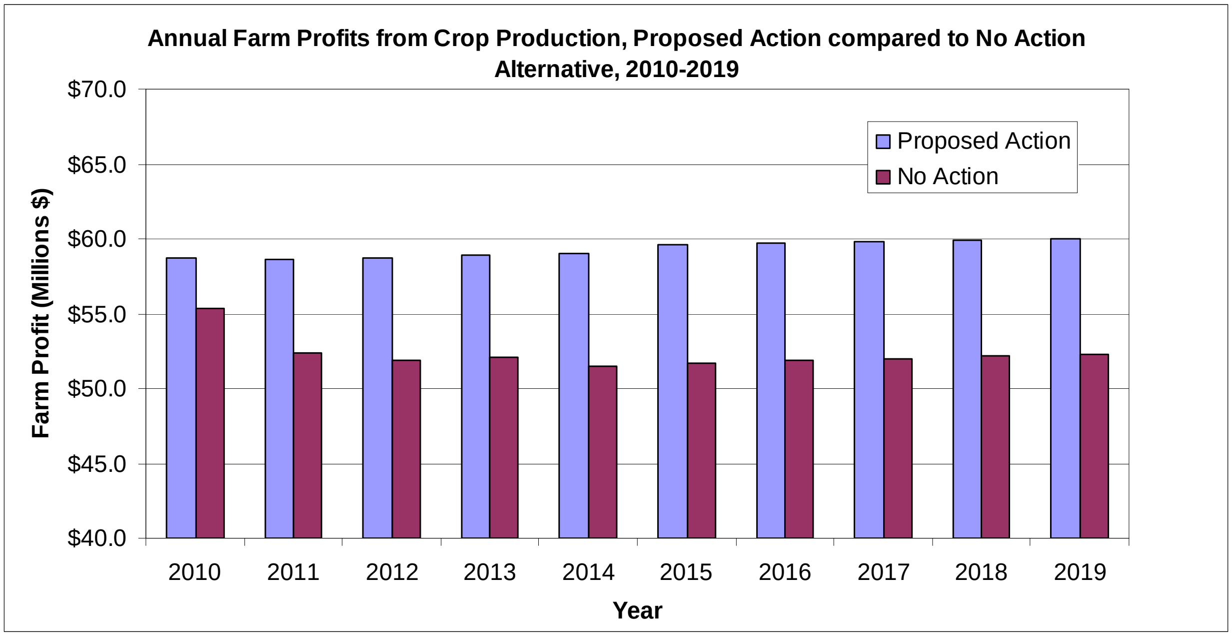

Figure 8-2 Annual Farm Profits from Crop Production in Proposed Action compared to No Action, 2010–2019

However, once treatment costs and fees for Se discharge are included, farm profits are only higher for the first five years. In 2015, when treatment of drainage water is expected to start, the estimated treatment costs of approximately $9 million annually cause profits under the Proposed Action to fall slightly below profits from No Action. These costs are based on estimated per acre-foot treatment costs of $1,500 [27] (Summers Engineering, pers. comm., 2008). Using these figures, total Proposed Action farm profits in 2010 are $58.7 million and rise slowly to $59.0 million in 2014 before falling to approximately $50 million in years 2015 to 2019 due to drainwater treatment costs (Figure 8-3). The net present value of annual profits for 2010 through 2019 is $455.7 million, which compares to $433.6 million under the No Action Alternative, an increase of 5 percent.

[27] It is expected that this estimate is on the high end of what treatment costs may be, thereby providing a conservative estimates of benefits of the Proposed Action as appropriate for an EIR/EIS.

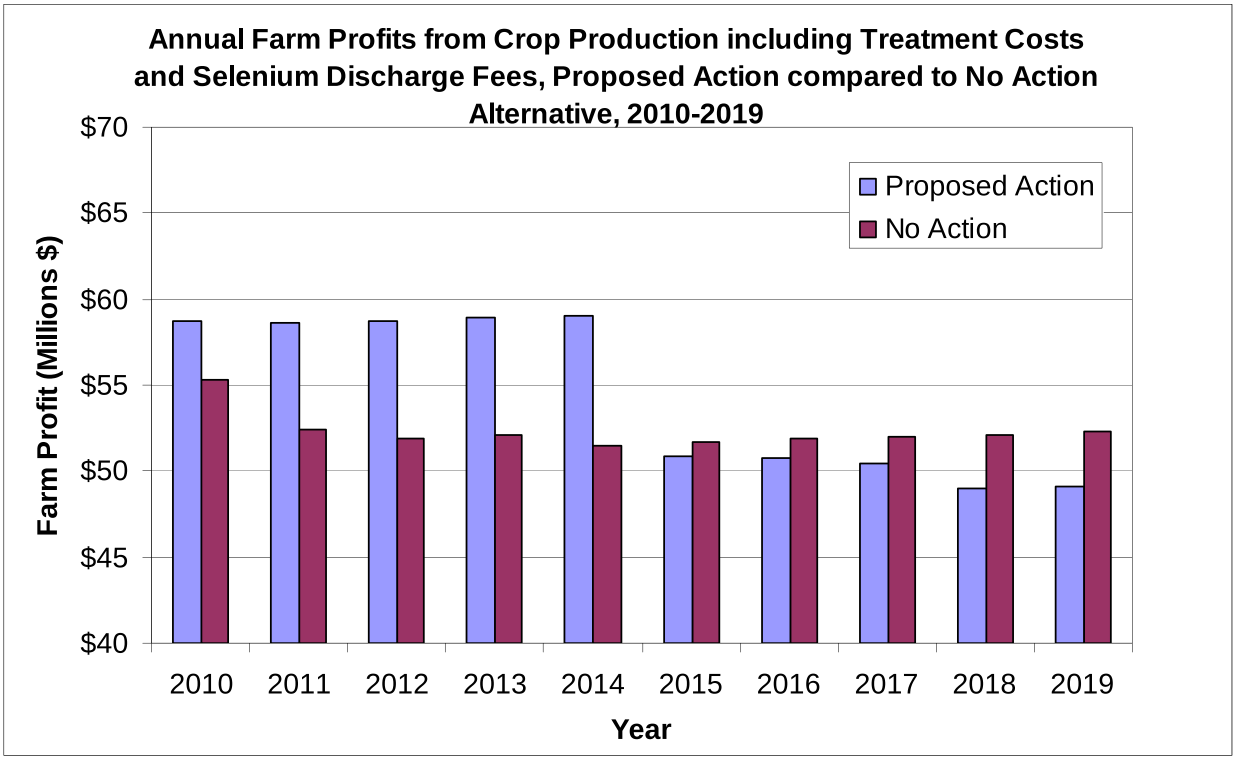

Figure 8-3 Annual Farm Profits from Crop Production, Treatment Costs, and Discharge Costs in Proposed Action compared to No Action, 2010–2019

G.4.2.3 Regional Economic Impacts

Under the Grassland Bypass Alternative, soil and water salinity increases, but at a slower rate than under No Action. As a result, yields for most crops would not decline, while those for others fall by only a small amount. Total cropped acreage would not decline, but the composition of the crops grown would slightly change, particularly for the additional 670 acres moved into the reuse facility. The gross revenue under the No Action compared to the corresponding year under the Proposed Action was used as the basis for estimating regional economic impacts. For example, in 2010, the No Action project revenue is projected at $224.6 million and the Proposed Action revenue is $230.9 million. The difference between these, $7.3 million, is the basis for estimating the regional economic impact of the Proposed Action in 2010. The differences were used as inputs in the I-O model to determine the regional impacts for each of the Se load values considered.

Table G-21 shows the regional economic impacts of crop production under the Proposed Action compared to No Action by Project year. Impacts are expressed as direct and total for output, personal income, and employment. Economic impacts relative to No Action are projected to be positive for all years, with the smallest increase occurring in 2010 and rising in each year until leveling off in years 2015 to 2019. The total regional gain in output between 2014 and 2019 is approximately $22.8 million annually, while the gain in person income is approximately $14.2 million and the gain in employment is approximately 145 full and part-time jobs. Netting out the decrease in personal income due to increased incentive fees and drainwater treatment, the direct increase in personal income from 2015 to 2019 drops from $9.8 million to an average of zero, while the average total increase in personal income drops from $14.2 million to approximately $4.0 million.

Table G-21 Regional Economic Output, Personal Income, and Employment Impacts, Grassland Bypass Project 2010–2019 compared to No Action (Millions $)

Year	Output		Income		Employment	
	Direct	Total	Direct	Total	Direct	Total
2010	$7.3	$11.1	$4.6	$6.8	30	70
2011	$12.5	$18.8	$8.0	$11.7	51	119
2012	$13.8	$20.9	$8.9	$13.0	57	133
2013	$13.8	$20.8	$8.9	$13.0	56	132
2014	$15.2	$22.9	$9.8	$14.3	62	145
2015	$15.2	$22.9	$9.8	$14.3	62	146
2016	$15.1	$22.8	$9.8	$14.2	62	145
2017	$15.1	$22.8	$9.8	$14.2	62	145
2018	$15.1	$22.8	$9.8	$14.2	62	145
2019	$15.1	$22.8	$9.8	$14.2	62	145

In addition to the regional economic benefits of increased crop production under the Proposed Action, construction of the SJRIP reuse facility would result in additional economic activity. As noted above, the costs of the facility reduce farm profitability, but would be at least partially offset by the construction activity that would spur job creation and increase local income. As the costs of the facility are not known and may be covered by a grant (Summer Engineering, pers. comm., 2008),, these positive regional economic impacts are not estimated.

G.4.3 Alternative Action (2001 Requirements)

The 2001 Requirements Alternative is nearly identical to the Grassland Bypass Project, but extends the limits of Se and salt loads discharged to Mud Slough to those in the 2001 Use Agreement (i.e., less stringent allowances). It is anticipated that soil salinity levels throughout the GDA would be the same as under the Proposed Action, so there are no anticipated differences in crop acreage, revenues, or profits. Additionally, it is anticipated that the treatment facility would be constructed under this alternative, resulting in the same costs being incurred as under the Proposed Action. The only expected economic difference between the Proposed Action and the 2001 Requirements Alternative Action is that there would be a slight decrease in the value of the fees that would be paid by the GDA for discharge of Se. Based on the Se load discharges projected in Appendix C (average of above normal and below normal/dry years), it is anticipated that under the Alternative Action the present value of incentive fees paid by GDA farmers would be $991,000. This compares to expected mitigation and incentive fee payments of $2.3 million under the Proposed Action.

In summary, the farm revenue and regional economic impacts of the Alternative Action would not differ from the Proposed Action, but would result in increased present value of farm profit of $1.3 million over the 10-year project period.

G.4.4 Summary of Impacts

Table 8-11 compares the projected farm revenue and profits, as well as regional output, personal income, and employment impacts for each of the three alternatives from 2010 to 2019. Impacts are presented in both average annual value and present value for that period in current dollars. All are measured relative to the year 2007 values (which represent the existing condition). All Alternatives result in negative economic impacts due to the movement of acreage from the GDA to the reuse facility.

Over the 10 years, the No Action Alternative has the largest adverse impacts because of the additional effects of reduced crop yields. By 2019 under No Action, soil salinity is projected to rise by 2.2 mmhos/cm, while under the Action Alternative it only rises by 0.9 mmhos/cm. Because of the rise in soil salinity and the increased acreage in the GDA, under No Action average annual farm revenues would decline from existing conditions by $18.3 million and average annual farm profits would decline by $9.1 million. The total present values of farm revenue and profit declines over the 10 years are $151.4 million and $74.9 million, respectively.

Table 8-11 Comparison of 2010-2019 Present Value and Average Annual Impacts Among Alternatives Relative to 2007 Existing Conditions

Economic Measure	No Action	Proposed Action	Alternative Action
Average Annual			
Farm Revenue ($ Millions)	-18.3	-5.6	-5.6
Farm Profit ($ Millions)	-9.1	-7.0	-6.8
Regional Output ($ Millions)	-26.6	-5.7	-5.7
Regional income ($Millions)	-17.7	-9.6	-9.5
Regional employment (jobs)	-165.9	-33.4	-33.4
Irrigated acres (GDA + SJRIP)	-1,181	-1,113	-1,113
Present Value ($ Millions)			
Total farm revenue	-151.4	-46.9	-46.9
Total farm profit	-74.9	-55.2	-54.0
Total regional output	-226.2	-50.2	-50.2
Total regional income	-150.0	-77.9	-76.7

The impacts projected under the two Action Alternatives are equal over the 10 years, other than farm profit and regional income, which are slightly higher under the Alternative Action because of lower discharge fees. Impacts of the two Action Alternatives are negative compared to existing conditions, but the adverse effects are less than under the No Action Alternative. From 2010 to 2019 under the Proposed Action, annual farm revenues and profits would decline from existing conditions by an average of $5.6 million and annual farm profits would decline by an average of $7.0 million. The present values of these declines are $46.9 million and $55.2, respectively. The decline in farm profits from existing conditions is primarily because of the costs to treat drainwater from 2015 through 2019.

Nearly 99 percent of land in the GDA is projected to remain in production during the project period, although the cropping mix will likely change as farmers attempt to maximize profit and as land is moved from the GDA into the SJRIP. Farm-level revenues and profits would decline under the No Action Alternative because of the increased soil salinity associated with not allowing any Se load discharge. Farm-level revenues and profits would decline under the Action

Alternative because of both acreage being moved into the SJRIP and the cost of treating drainwater.

G.4.4.1 Significance of Impacts

The key farm-level variable for measurement of significance is farm profit because this summarizes the effects of an alternative on the long-run viability of farming. Impacts are measured relative to projected 2007 baseline conditions. The key regional variables for measurement of significance are total employment, personal income and total industry output. All are for the entire three-county impact area, i.e., Fresno, Madera, and Merced Counties.

The No Action Alternative generates the most significant impacts among the alternatives analyzed. Under No Action, annual farm profit would fall fifteen percent from $61.4 million under existing 2007 conditions to an average of $52.3 million from 2010 to 2019. The total present value of farm profits over the 10-year period is also expected to be reduced by 11 percent compared to existing conditions. This adverse impact is significant based on the criterion discussed previously, a change of at least five percent. Mitigation of the impacts within the study area would be very difficult given drainage conditions and the limited availability of alternative farmland not subject to those conditions.

The regional impacts of the No Action alternative would be insignificant. The baseline personal income of the three-county area is $33.5 billion (see section G3.4), and the baseline total industry output of the area is $70.8 billion (see section G3.4). Under No Action, total annual income would average $17.7 million below the baseline level, a decline of less than 0.1 percent. Total annual industry output would average $26.6 million below the baseline level, also a decline of less than 0.1 percent.

Under the Proposed Grassland Bypass Alternative, annual farm profit would decline by eleven percent from $61.4 million in 2007 to an annual average of $54.4 million from 2010 to 2019. The total present value of farm profits over the 10-year period is also expected to decline by 11 percent compared to existing conditions. This adverse impact is significant based on the criterion discussed in Section 8.2.1, a change of at least 5 percent. The regional impacts of the Grassland Bypass alternative would be adverse but insignificant. Under this alternative, total annual personal income from 2010 to 2019 would decrease by an average of $9.6 million and annual regional output would decline by $5.7 million compared to existing conditions. Both would be within 0.1 percent of the existing level.

Under the Alternative Action (2001 Requirements), annual farm profit would decline by eleven percent from $61.4 million in 2007 to $54.6 million From 2010 to 2019. The total present value of farm profits over the 10-year period are also expected to decline by 11 percent compared to existing conditions. This adverse impact is significant based on the criterion discussed in Section 8.2.1, a change of at least 5 percent. The regional impacts of the Grassland Bypass Project would be adverse but not significant. Under this alternative, total personal income would decrease by an annual average of $9.5 million and regional output would decline by $5.7 million compared to existing conditions. Both would be within 0.1 percent of the existing level.

G.5 BIBLIOGRAPHY

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THE USE OF INPUT-OUTPUT ANALYSIS

IMPLAN is a system of software and databases used to construct regional economic models. It is based on input-output (I-O) methodology, which quantitatively measures the interdependence among economic sectors. Each sector not only produces goods and services, but also purchases goods and services for use in the production process. Quesnay originally conceptualized these relationships in 1758. Leontief published an I-O system of the United States economy in 1936.

The IMPLAN approach is based on I-O methodology that has been modified for regional data retrieval, model development, and impact analyses. It can be used to analyze the distinct regional characteristics or impacts associated with broad-level policy changes or economic problems. IMPLAN is a "non-survey" I-O system, as it does not require primary, survey-based data. IMPLAN is an important tool to analyze regional impacts of policy changes because of the ease with which specific regional or local information can be incorporated into a model. A regional I-O model is used in this study to estimate multipliers, input purchases, local product usage, and other quantitative measures pertaining to agriculture.

IMPLAN was developed for the U.S. Forest Service by the University of Minnesota to assist in land and resource management planning issues. It has been used since 1979, initially as a mainframe-based, batch-mode program. It was converted to an interactive, menu-based microcomputer program in 1989 and has been refined continually since then. Details may be found in [Alward, et. al. 1989]; [Minnesota IMPLAN Group 1994]; and [MIG Inc. 1996].

Regional Analysis

Regional analysis is a form of economic analysis that recognizes the distinctness of a geographical area in terms of its resources, industries, and relationships with other areas. In general, smaller regional economies are more dependent on trade with other regions for "imports" and "exports" of goods and services than are larger regions. Regional growth is enhanced by the outputs of its export industries. In this study, agriculture and sectors related to agriculture export many of their products outside the region and are consequently important contributors to growth in the area.

Regional I-O analysis is based directly on the Leontief framework developed for the national economy. Regional I-O models are extensions of that basic structure to reflect regional differences in production processes. As an application tool, IMPLAN is able to capture these relationships in straightforward fashion. The matrix algebra is cumbersome, though relatively quick with high-speed microcomputers. The matrix steps are discussed in [MIG 1996].

Computational Process

The steps in the development and use of an IMPLAN model are relatively straightforward because of the software itself. However, logic and interpretation are required at each stage to minimize the potential for inaccuracies and to maximize the usefulness of the model.

Define Problem

IMPLAN can be used to analyze such diverse issues as the impacts of changes in regional agriculture, the closure of military bases, entrance of new industries into an area, construction of recreational facilities, and changes in national or local government policies. The specific problem must be defined in terms of the resources it will affect, in which industries, and in which locations.

Define Study Area

IMPLAN is a county-based application, and a study area can include one or more counties or entire states. The study area defined for a problem is important because the impacts related to the problem depend directly on the size of the area and linkages among the industries. The study area should center around the location of activities for which impacts are to be measured. The area should include the locations of principal buyers and sellers of the goods and services central to the analysis. If household purchases of the goods and services are important, the study area should also include the locations of consumers. The area should be sufficiently large to include the industries and consumers which will be affected by the events being analyzed, but not so large as to lose resolution of the most-impacted sectors.

The study area may include the locations of key backward and forward-linked industries to the sectors of interest. Backward linkages are those between an industry and its suppliers, e.g., between vegetable growers and farm chemical dealers. Forward linkages are those between an industry and other industries which use or add value to the product, e.g., between rice growers and rice mills. I-O models capture backward linkages only. For that reason, regional models should account for any important forward linkages within the study area. For this analysis, the study area was defined as the three counties of Fresno, Madera, and Merced.

Compile and Edit Regional Data and I-O Accounts

The IMPLAN database includes 21 economic and demographic variables for 528 sectors for all counties in the United States. The analysis in this study utilizes the 2006 IMPLAN database. The data are taken from numerous state and federal sources such as the National I-O accounts, the National Income and Product Accounts, Census data, and a host of other published sources. However, many components must be estimated because disaggregated economic data are frequently unavailable at the county level.

Because of the required estimation, the key data for the counties in a region must be reviewed and validated. For this study, the principal IMPLAN database variables analyzed were employment, agricultural output, regional purchase coefficients, and production functions.

Derive Multipliers

A multiplier measures the difference between an initial change and the final effects of that change. Multipliers can express the direct or combined direct and indirect effects of a change. Direct effects are those that occur in regional industries from which a particular sector purchases and are sometimes called first-round changes. Indirect effects incorporate two measures: (1) the regional production necessary to support changes in a given industry’s direct requirements; and

(2) the regional production that is stimulated by consumer demand caused by payments for labor by a given industry. The second of these is sometimes referred to as induced effects.

"Type I" multipliers include direct effects and "Type II" multipliers represent the latter. Type I multipliers include only the effects of inter-industry purchases. Type II multipliers include the effects on household spending induced by the changes being analyzed. As industry outputs change, income payments to workers in those industries change, and these in turn induce changes in consumer spending. These effects work through the economy in a series of rounds, and are summarized by the Type II multipliers.

Analyze Impacts

Impact analysis involves the measurement of direct, indirect, and induced output, employment, and income effects of changes in final demand in sectors of the regional economy. Impacts are calculated using estimated multipliers and the changes in final demand. Impact analysis is used in this study to measure both direct and indirect effects of changes in agricultural output in the Region.

References

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APPENDIX H

Public Scoping Report

Report on Public Scoping for EIS/EIR

Continuation of the Grassland Bypass Project, 2010–2019

July 2008

Prepared for:

US Bureau of Reclamation
South Central California Area Office
1243 N Street
Fresno, CA 93721

and

San Luis & Delta-Mendota Water Authority
P.O. Box 2157
Los Banos, CA 93635

Prepared by:

ENTRIX

One Concord Center
2300 Clayton Road, Suite 200
Concord, CA 94520

PROJECT NO. 3197001

Table of Contents

ATTACHMENTS

SECTION 1

Commenting Agencies and Individuals

The Bureau of Reclamation (Reclamation) and the San Luis and Delta-Mendota Water Authority (Authority) distributed a Notice of Preparation of a joint Environmental Impact Statement/Environmental Impact Report (EIS/EIR) on the Continuation of the Grassland Bypass Project, 2010–2019, on December 20, 2007, to 205 agencies and individuals. On December 21, 2007, a Notice of Intent to prepare a joint EIS/EIR was published in the Federal Register. The notices announced the public scoping meeting and requested that comments on the content of the EIS/EIR and the project be submitted by January 25, 2008. Furthermore, notices were placed in two newspapers of general circulation in the project area: the *Merced Sun-Star* on December 22, 2007, and the *Fresno-Bee* on December 23, 2007. The scoping meeting was held at the San Luis & Delta-Mendota Water Authority boardroom on January 17, 2008, from 1:30 pm to 3:30 pm.

This report summarizes the oral and written comments received during the scoping period. Section 1 lists the commenting agencies and individuals. Section 2 summarizes the comments that affect the scope or content of the EIS/EIR. Summary minutes of and attendance at the scoping meeting are included as Attachment A. Written comments are included as Attachment B.

The following agencies, organizations, and individuals provided written comments during the scoping period; those also providing oral comment at the scoping meeting are noted in italics:

FEDERAL AGENCIES

- National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Rodney R. McInnis

STATE AGENCIES

- Department of Water Resources, Christopher Huitt

LOCAL AND REGIONAL AGENCIES

- Stockton East Water District, Karna E. Harrigfeld
- South Delta Water Agency, John Herrick
- Central Delta Water Agency, Dante John Nomellini, Sr.
- Contra Costa Water District, Leah Orloff
- Stanislaus County Environmental Review Committee, Raul Mendez

ORGANIZATIONS AND INDIVIDUALS

- The Bay Institute, Gary Bobker
- Pacific Coast Federation of Fishermen's Associations, W.F. "Zeke" Grader, Jr.
- Patrick Porgans & Associates, Inc., Patrick Porgans
- Roy L. Thomas, DDS

SECTION 2

Summary of Comments

Comments included in this section are those that affect the content of the upcoming EIS/EIR, including concerns about potential impacts and the scope of the analysis covered under the EIS/EIR. Some of the comments were informational about the history of the project. These informational comments are not repeated or summarized here, but are included in the minutes of the meeting in Attachment A or the written comments in Attachment B.

2.1 GENERAL COMMENTS ON PROPOSED PROJECT

- Cease discharges to Mud Slough, San Joaquin River, and the Sacramento–San Joaquin Delta.
- Stop irrigating lands with known drainage problems.
- Concern about use of public funds.
- Do not extend the project date for compliance in meeting water quality objectives.
- Cease all discharges until they meet or exceed the water quality standards set in 1988.
- Include the following in the Use Agreement (UA) extension:
  - Emphasize the need to eliminate discharges of agricultural drainage from the Grassland area as soon as possible,
  - Include monthly and annual selenium and salinity load limits that incrementally decrease such that zero discharge is achieved well before 2019 (e.g. three to five years),
  - Increase penalties for exceeding load limits (up to agreed maxima) or failing to achieve other elements of the UA,
  - Require additional mitigation to address current and future degradation of Mud Slough,
  - Increase annual payment per pound of discharged selenium over time, and
  - Include new mitigation elements with funding of mitigation to increase each year.
- Consult with South Delta Water Agency in the development of the EIS/EIR.

2.2 PROJECT ALTERNATIVES

Consider project alternatives that would:

- Improve irrigation techniques,
- Implement crop substitution,
- Provide for disposal of the selenium and saline water by means other than via Mud Slough and into the San Joaquin River,
- Reduce the number of acres of land irrigated,

- Retire lands, especially those that contribute significant levels of selenium and other salts to the groundwater and directly or indirectly to the San Joaquin River, to reduce the amount of water applied in the Grassland Drainage Area,
- Reduce applied water by reducing diversions from the Delta and not by transfer to other exporters, and
- Consider all other feasible alternatives to the project extension.

2.3 ENVIRONMENTAL IMPACT ANALYSIS

2.3.1 Water Quality/Hydraulics/Water Supply

- Evaluate impacts on New Melones operations to address the salinity in the San Joaquin River, including:
  - Reclamation's plan to meet standards and other obligations under HR 2828 (PL 108-361), and
  - Whether releases or increased releases from New Melones Reservoir would be required to meet the Vernalis salinity objective.
- Analyze direct, indirect, and long-term effects of the proposed project on San Joaquin River water quality, including the potential effects of the concentration of salinity in water disposed after repeated reuse.
- Describe project's effects on salt loads and salt concentrations in the San Joaquin River, and what happened to the salt not discharged into the San Joaquin River under the prior project.
- Address the project's effects on downstream flows, particularly in the South Delta.
- Include the assessment of "farfield" impacts interrelated to the discharge of selenium from the Project to the San Joaquin River system via Mud Slough downstream through the Delta.
- Describe how project will help or hinder Reclamation's obligations to meet both the Total Maximum Daily Load obligation and compliance with downstream water quality obligations, including but not limited to Vernalis.
- Ensure regulatory and permitting compliance with State Water Code Sections 8534, 8608, 8609, and 8710-8723 concerning encroachment on a State-Adopted Plan of Flood Control.
- Develop a list of all projects implemented since initiation of the project that produce water quality impacts and evaluate cumulative impacts of those projects.

2.3.2 Biological Resources

- Include the following mitigation measures:
  - Augment water deliveries to local wildlife refuges,
  - Improve riparian habitat downstream of Mud Slough, and/or
  - Improve wildlife habitat in refuge areas adjacent to Mud Slough.

- Assess impacts related to selenium discharge from Project, particularly to Central Valley steelhead and North American green sturgeon who make use of the Delta for rearing and migratory purposes.
- Concern about discharges of toxic selenium exacerbating the condition of the Delta ecosystem and the depressed returns of the fall-run Chinook salmon to the Central Valley.
- Review points brought forth in Lemly and Skorupa paper (2006) on selenium monitoring.

2.3.3 Cumulative Impacts

- Evaluate the cumulative impact of water transfers from the San Joaquin River Exchange Contractors to the wildlife refuges and other Central Valley Project contractors, in particular:
  - Increased salinity from these transfers,
  - Increased saline groundwater accretions resulting from these transfers, and
  - Concentration of the salts by reuse of water.
- Evaluate the cumulative impact of all projects that have been implemented since the initiation of the project and produce water quality impacts.

A T T A C H M E N T A

Summary Minutes of Public Scoping Meeting and Attendance January 17, 2008

Summary Minutes

Public Scoping Meeting, January 17, 2008

Los Banos, California

1:30-3:30 PM

AGENDA:

- Presentation (20 minutes)
  - Project History Overview
  - Project Performance 2001-2009
  - Proposed Project and No Project
  - Environmental Review Process
- Public Comments
- Informal Discussion with Staff and Consultants

Meeting called to order:	1:35 PM
Meeting adjourned:	2:20 PM
Attendance:	17

The formal presentation included a brief overview of the meeting purpose and agenda, a history of the project, current project performance, issues to be resolved, and the purposes and objectives of the proposed project. Next steps were explained, including the procedures and deadline for submitting comments (January 25, 2008). The meeting was then opened for public comment. One individual – Patrick Porgans, representing Patrick Porgans & Associates – commented orally. Mr. Porgans' comments are summarized below:

- Compliments to people on this project for reducing the selenium loads in the discharge.
- The west side of the San Joaquin River should not be irrigated.
- The project is not sustainable.
- There is a salt imbalance; there are only three ways to address this:
  - Stop bringing water in,
  - Dry farm, or
  - Don't farm.
- Salts mobilize with heavy rain.
- San Joaquin River basin is the single largest water–impaired area.
- Salt load is doubling every five years.

- The drainage solution proposed by the Bureau will cost more than the Central Valley Project cost to build. The solution was good in the 1930s, but it is not good now.
- I am going to try to stop this project.
- Cut out ½ of acreage of irrigated agriculture.
- You don't own the water. It's the public's water. Free up water.
- Plant grasses such as wheat grass. Show that it is sustainable.
- Mesopotamia and the Euphrates went down with salt. Rome salted Carthaginian land so that nothing would grow. We're paying to put salt on lands that should have never been irrigated.
- Keep the State of California sustainable!

MEETING SIGN-IN SHEET

Project: Grassland Bypass Project Extension **Location:** Los Banos, CA
Facilitator: SLDMWA **Meeting Date:** 01/17/08

Name	Title	Company	Phone	Fax	E-Mail
Bill Luce	Resources MgR	FWA	325-2415		
Jeff Bryant	MgR	FCWD	655-4761		
Ralph Logan	Solutionist	R+A	916-630-8734		
Chris Eacock	Proj Mgr	USBR	559 487 5133		
John Beam	Sr. Biol.	CDFG	559 908 6059		
Mike Delamore	"	USBR	559 487 5039		
Phil McMurray	attorney	SLDMWA	209.392.2141.		
Lisa Hunt	Engineer	URS	(510)874-1795		
Gail Cismowski	G S	CVRWQB	916 464 4708		
Victoria Westman	ES	CVRWQCB	916 464 4659		
Dennis Falaschi	Gen Mgr	Panoche W.D. & Grassland			209 704 0038
Dan Nelson	Exec Dir.	SLDMWA	209 826 9296		
Diane V. Rathmann	Counsel	SLDMWA	209 392-2141		

MEETING SIGN-IN SHEET

Project: GRASSLAND BYPASS PROJECT EXTENSION

Location: LOS BANOS, CA

Facilitator: SLDMWA

Meeting Date: 01/17/08

Name	Title	Company	Phone	Fax	E-Mail
Susan Hootkins	Sr. Planner	ENTRIX	925-988-1228	925-935-5368	shootkins@entrix.com
M. Kate Lewis	Env. Planner	ENTRIX	925-988-1286	925-935-5368	klewis@entrix.com

ATTACHMENT B

Written Comments from Public Scoping

Written comments as provided in the following order:

- National Oceanic and Atmospheric Administration, National Marine Fisheries Service
- Department of Water Resources
- Stanislaus County Environmental Review Committee
- Stockton East Water District
- South Delta Water Agency
- Central Delta Water Agency
- Contra Costa Water District
- The Bay Institute
- Pacific Coast Federation of Fishermen’s Associations
- Patrick Porgans & Associates, Inc.
- Roy L. Thomas, DDS

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

February 28, 2008

Joseph C. McGahan
Drainage Coordinator
San Luis and Delta –Mendota Water Authority
P.O. Box 2157
Los Banos, CA 93635

Dear Mr. McGahan:

Thank you for requesting agency participation in the review of the December 20, 2007, Notice of Preparation for an Environmental Impact Statement/ Environmental Impact Report (NOP – EIS/EIR) for the Extension of the Use Agreement for the Grasslands Bypass project (Project) for the period 2010 through 2019. NOAA's National Marine Fisheries Service (NMFS) welcomes the opportunity to comment on this project.

The Bureau of Reclamation (Bureau) and the San Luis and Delta-Mendota Water Authority (Authority) jointly manage the Grasslands Bypass project. The Project utilizes the San Luis Drain to consolidate and convey subsurface drainage flows on a regional basis from the Grasslands Drainage Area (GDA); applies the drainage water to salt tolerant crops to reduce the volume of the discharge; utilizes a 4-mile channel to place the remaining drainage into the San Luis Drain at a point near Russell Avenue which then conveys it northwards through a 28-mile reach of the San Luis Drain. The agricultural drain water is subsequently discharged into the northern section of Mud Slough which terminates at the San Joaquin River just upstream of Hills Ferry.

The current authorization to discharge the subsurface flows from the GDA to the San Luis Drain is set to expire on December 31, 2009. The Bureau and Authority are proposing to enter into an agreement to extend the current authorization to use the San Luis Drain until 2019. Under the initial agreement and authorization, the drainage flows to Mud Slough (northern section) were to have been compliant with water quality objectives by October 1, 2010, as required by the Central Valley Regional Water Quality Control Board's (Regional Board) 1998 Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins. Currently, due to difficulties in obtaining funding and technical issues encountered in developing treatment technology, the goal of meeting the basin plan objectives by October 10, 2010 appear to be unlikely. The Bureau and Authority believe that an extension of the compliance deadline to 2019 will allow sufficient time to acquire additional funding and develop the necessary technology to meet the Basin Plan objectives and Waste Discharge Requirements. In addition to the agreement extension with the Bureau, the Authority would have to extend or amend its Memorandum of Understanding with the California Department of Fish and Game and seek a revision to the 2010 Basin Plan objectives and an amendment to the Waste Discharge

Requirements with the Regional Board to allow the continued discharge of drainage waters to Mud Slough (north section). Furthermore, the Bureau and Authority would have to remove existing and future sediments from the affected portions of the San Luis Drain. The Bureau and Authority are planning to issue an EIS/EIR for the proposed project and are considering a range of alternatives in addition to the no project/no action alternative. The EIS/EIR would evaluate potential environmental impacts to the following resources and concerns: surface water, groundwater and soils, biological resources, land uses including Indian Trust Assets, socioeconomics, cultural resources, energy resources, climate change, and environmental justice.

These subsurface drainage flows originating in the GDA contain elevated levels of selenium, as well as other marine derived elements (*i.e.*, boron, molybdenum, arsenic, and chromium). Selenium is a naturally occurring mineral found in the ancient marine sediments that predominate on the western side of the San Joaquin Valley. Selenium is considered to be an essential micronutrient for many animals, but rapidly becomes toxic at levels beyond just trace amounts in the animal's diet or environment. As a result of irrigating lands within marine based alluvium deposits on the western side of the valley, selenium is mobilized into the agricultural drainage water that is collected by the region's subsurface drains and conveyed into the drainage system emptying the GDA. The drainage water, which contains dissolved and particulate-bound selenium, is discharged into the San Joaquin River, where dilution with the greater volumes of the San Joaquin River is expected to reduce the selenium concentrations to acceptable levels.

NMFS is concerned that the continual discharge of selenium into the San Joaquin River still has the potential to adversely impact aquatic biota downstream of the confluence with Mud Slough. Although water column concentrations are currently being reduced significantly, compared to historical levels, the continual loading of the system with an element that is tightly recycled in the aquatic environment is cause for concern. The current project relies on dilution flows from not only the upper San Joaquin River to achieve dilution, but also makes use of the diluting effects of the discharge from the east-side tributaries which include the Merced River, Tuolumne River, and Stanislaus River. However, once waterborne concentrations of selenium become elevated, as is the case in the northern section of Mud Slough, it can bioaccumulate in the food chain and reach levels that are toxic to fish and wildlife (Hamilton 2004). A recent article by Lemly and Skorupa (2007) illustrates the difficulty of implementing selenium standards for effluent discharges containing selenium. These authors point out the potential biases that may be encountered in the monitoring of selenium bearing waters. These biases include: the selection of fish species to test, their age dependent sensitivities to selenium, life history characteristics that may influence sensitivity to selenium, survivor bias created by sampling only "living fish" in the test area, sampling locations resulting in bias of the samples, tissue selection, site specific bioaccumulation factors, incorporation of average values and exceedances in the data set, temporal and spatial variances in the mixing or dilution zone, and the size of the data set used to draw conclusions.

NMFS has examined previous reports submitted for the Grasslands Bypass Project. In particular, episodic spikes in water column concentrations of selenium during winter valley floor precipitation events continue to occur. These spikes are not necessarily diluted by increased east side tributary flows due to the numerous reservoirs on these watersheds which mute the hydrological response of valley floor precipitation events in the lower elevations of the tributary watersheds. This would be particularly true in water years classified as critical, dry, or below normal when upstream reservoir volumes are available to contain winter precipitation events. Furthermore, winter precipitation events that create runoff spikes on the western side of the valley are likely to result in snow pack accumulation on the eastern side of the valley as the storms cross the Sierra Nevada mountain range. This disconnects the temporal increases in runoff seen between the east and west side watersheds. The elevated spikes have approached or exceeded the water column concentration targets proposed under the Basin Plan and with little dilution flow from the east side tributaries would be expected to carry further down into the Delta.

Since the most recent agreement between the Bureau and the Authority was entered into (2001), several significant changes have occurred in the Central Valley in regards to Endangered Species Act listed fish species. In September 2005, designated critical habitat for the Central Valley steelhead (*Oncorhynchus mykiss*) Distinct Population Segment (DPS) was finalized and includes the mainstem San Joaquin River downstream of Hills Ferry and the waters of the San Joaquin Delta. In addition, in January 2006, the threatened listing for Central Valley steelhead was reaffirmed by NMFS and the southern DPS of North American green sturgeon (*Acipenser medirostris*) was listed as threatened in April 2006. Both the Central Valley steelhead and the Southern DPS green sturgeon make use of the Delta for rearing and migratory purposes. Individuals of the Central Valley steelhead DPS also ascend the mainstem of the San Joaquin River and enter into the east side tributaries to spawn, including the Merced River just downstream from the confluence of Mud Slough with the San Joaquin River. Eventually, listed steelhead may also ascend the mainstem of the San Joaquin River to Friant Dam following the proposed increases in the flows within the mainstem and reestablishment of suitable salmonid spawning habitat in the tailwater reaches below the dam. Green sturgeon are believed to reside in the Delta for the first 2 to 4 years of their life before moving into marine environments offshore as subadults. This prolonged rearing time in the Delta exposes these individuals to increased levels of selenium (particularly through their dietary prey selection) as well as other chemical constituents derived from the marine sediments. Based on diet sampling of the sympatric white sturgeon (*Acipenser transmontanus*), juvenile sturgeon feed primarily on macrobenthic invertebrates, including both species of non-native Asiatic clams. These benthic invertebrates, particularly the clams (Linville *et al.* 2002), present an avenue of exposure to listed green sturgeon that has not been previously analyzed in environmental documents for this ongoing project. Significant levels of selenium in the clam's tissues were accumulated in relatively low ambient water concentrations in San Pablo Bay and Suisun Bay. Studies at the University of California, Davis (Tashjian *et al.* 2006) have indicated that juvenile white sturgeon fed diets high in selenium for 8 weeks exhibited pathological effects in their internal organs (kidneys) but did not exhibit significant changes in survival rates. However, growth decreased and body composition was altered in a dose dependent fashion. Swimming activity was also depressed in those diets with higher selenium concentrations. White sturgeon appeared to express a higher tolerance to selenium toxicity than other species of fish, however the ramifications of a prolonged exposure (2 to 4 years) has not been evaluated.

In light of these issues, NMFS recommends that any environmental documents developed for this project include the assessment of "farfield" impacts interrelated to the discharge of selenium from the Grasslands Bypass Project to the San Joaquin River system via Mud Slough (northern section) downstream through the Delta. NMFS also believes review of the points brought forth in the Lemly and Skorupa paper is germane to a thorough and supportable environmental document for the extension of this agreement.

Please contact Jeffrey Stuart at (916) 930-3607, or via e-mail at J.Stuart@noaa.gov, if you have any questions concerning these comments, or require additional information.

Sincerely,

Rodney R. McInnis
Regional Administrator

cc: Copy to file: ARN151422SWR2001SA5967
NMFS-PRD, Long Beach, CA
Ms. Laura Myers, Bureau of Reclamation, South-Central California Area Office, 1243 N Street, Fresno, California 93721

References:

Hamilton, S.J. 2004. Review of selenium toxicity in the aquatic food chain. Science of the Total Environment. 326:1-31.

Lemly, A.D. and J.P. Skorupa, 2006. Technical issues affecting the implementation of the U.S. Environmental Protection Agency's proposed fish tissue-based aquatic criterion for selenium. Integrated Environmental Assessment and Management. 3(4): 552-558.

Linville, R.G., S.N. Luoma, L. Cutter, and G.A. Cutter. 2002. Increased selenium threat as a result of invasion of the exotic bivalve *Potamocorbula amurensis* into the San Francisco Bay-Delta. Aquatic Toxicology. 57: 51-64.

Tashlian, D.H., S.J. The, A. Sogomonyan, and S.S.O. Hung. 2006. Bioaccumulation and chronic toxicity of dietary L-selenomethionine in juvenile white sturgeon (*Acipenser transmontanusi*). Aquatic Toxicology. 79: 401-409.

STATE OF CALIFORNIA – THE RESOURCES AGENCY

ARNOLD SCHWARZENEGGER, Governor

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 942360001
(916) 653-5791

RECEIVED
JAN 19 2008
SUMMERS ENGINEERING, INC.

January 9, 2008

Joe McGahan
San Luis and Delta-Mendota Water Authority
Post Office Box 2157
Los Banos, California 93635

Grassland Bypass Project
State Clearinghouse (SCH) Number: 2007121110

The project corresponding to the subject SCH identification number has come to our attention. The limited project description suggests your project may be an encroachment on the State Adopted Plan of Flood Control. You may refer to the California Code of Regulations, Title 23 and Designated Floodway maps at http://recbd.ca.gov/. Please be advised that your county office also has copies of the Board's designated floodways for your review. If indeed your project encroaches on an adopted food control plan, you will need to obtain an encroachment permit from the Reclamation Board prior to initiating any activities. The attached Fact Sheet explains the permitting process. Please note that the permitting process may take as much as 45 to 60 days to process. Also note that a condition of the permit requires the securing all of the appropriate additional permits before initiating work. This information is provided so that you may plan accordingly.

If after careful evaluation, it is your assessment that your project is not within the authority of the Reclamation Board, you may disregard this notice. For further information, please contact me at (916) 574-1249.

Sincerely,

Christopher Huitt
Staff Environmental Scientist
Floodway Protection Section

Enclosure

cc: Governor's Office of Planning and Research
State Clearinghouse
1400 Tenth Street, Room 121
Sacramento, CA 95814

Encroachment Permits Fact Sheet

Basis for Authority
State law (Water Code Sections 8534, 8608, 8609, and 8710 – 8723) tasks the Reclamation Board with enforcing appropriate standards for the construction, maintenance, and protection of adopted flood control plans. Regulations implementing these directives are found in California Code of Regulations (CCR) Title 23, Division 1.

Area of Reclamation Board Jurisdiction
The adopted plan of flood control under the jurisdiction and authority of the Reclamation Board includes the Sacramento and San Joaquin Rivers and their tributaries and distributaries and the designated floodways.

Streams regulated by the Reclamation Board can be found in Title 23 Section 112. Information on designated floodways can be found on the Reclamation Board's website at http://recbd.ca.gov/designated_floodway/ and CCR Title 23 Sections 101 - 107.

Regulatory Process
The Reclamation Board ensures the integrity of the flood control system through a permit process (Water Code Section 8710). A permit must be obtained prior to initiating any activity, including excavation and construction, removal or planting of landscaping within floodways, levees, and 10 feet landward of the landside levee toes. Additionally, activities located outside of the adopted plan of flood control but which may foreseeable interfere with the functioning or operation of the plan of flood control is also subject to a permit of the Reclamation Board.

Details regarding the permitting process and the regulations can be found on the Reclamation Board's website at http://recbd.ca.gov/ under "Frequently Asked Questions" and "Regulations," respectively. The application form and the accompanying environmental questionnaire can be found on the Reclamation Board's website at http://recbd.ca.gov/forms.cfm.

Application Review Process
Applications when deemed complete will undergo technical and environmental review by Reclamation Board and/or Department of Water Resources staff.

Technical Review
A technical review is conducted of the application to ensure consistency with the regulatory standards designed to ensure the function and structural integrity of the adopted plan of flood control for the protection of public welfare and safety. Standards and permitted uses of designated floodways are found in CCR Title 23 Sections 107 and Article 8 (Sections 111 to 137). The permit contains 12 standard conditions and additional special conditions may be placed on the permit as the situation warrants. Special conditions, for example, may include mitigation for the hydraulic impacts of the project by reducing or eliminating the additional flood risk to third parties that may caused by the project.

Additional information may be requested in support of the technical review of your application pursuant to CCR Title 23 Section 8(b)(4). This information may include but not limited to geotechnical exploration, soil testing, hydraulic or sediment transport studies, and other analyses may be required at any time prior to a determination on the application.

Environmental Review
A determination on an encroachment application is a discretionary action by the Reclamation Board and its staff and subject to the provisions of the California Environmental Quality Act (CEQA) (Public Resources Code 21000 et seq.). Additional environmental considerations are placed on the issuance of the encroachment permit by Water Code Section 8608 and the corresponding implementing regulations (California Code of Regulations – CCR Title 23 Sections 10 and 16).

In most cases, the Reclamation Board will be assuming the role of a "responsible agency" within the meaning of CEQA. In these situations, the application must include a certified CEQA document by the "lead agency" [CCR Title 23 Section 8(b)(2)]. We emphasize that such a document must include within its project description and environmental assessment of the activities for which are being considered under the permit.

Encroachment applications will also undergo a review by an interagency Environmental Review Committee (ERC) pursuant to CCR Title 23 Section 10. Review of your application will be facilitated by providing as much additional environmental information as pertinent and available to the applicant at the time of submission of the encroachment application.

These additional documentations may include the following documentation:

- California Department of Fish and Game Streambed Alteration Notification (http://www.dfg.ca.gov/1600/),
- Clean Water Act Section 404 applications, and Rivers and Harbors Section 10 application (US Army Corp of Engineers),
- Clean Water Act Section 401 Water Quality Certification, and
- corresponding determinations by the respective regulatory agencies to the aforementioned applications, including Biological Opinions, if available at the time of submission of your application.

The submission of this information, if pertinent to your application, will expedite review and prevent overlapping requirements. This information should be made available as a supplement to your application as it becomes available. Transmittal information should reference the application number provided by the Reclamation Board.

In some limited situations, such as for minor projects, there may be no other agency with approval authority over the project, other than the encroachment permit by Reclamation Board. In these limited instances, the Reclamation Board may choose to serve as the "lead agency" within the meaning of CEQA and in most cases the projects are of such a nature that a categorical or statutory exemption will apply. The Reclamation Board cannot invest staff resources to prepare complex environmental documentation.

Additional information may be requested in support of the environmental review of your application pursuant to CCR Title 23 Section 8(b)(4). This information may include biological surveys or other environmental surveys and may be required at anytime prior to a determination on the application.

Stanislaus County
Striving to be the Best

CHIEF EXECUTIVE OFFICE
Richard W. Robinson
Chief Executive Officer

Patricia Hill Thomas
Chief Operations Officer/
Assistant Executive Officer

Monica Nino-Reid
Assistant Executive Officer

Stan Risen
Assistant Executive Officer

1010 10th Street, Suite 6800, Modesto, CA 95354
P.O. Box 3404, Modesto, CA 95353-3404
Phone: 209.525.6333 Fax 209.544.6226

RECEIVED
FEB 07 2008
SLDMWA

STANISLAUS COUNTY ENVIRONMENTAL REVIEW COMMITTEE

January 30, 2008

RECEIVED
FEB 9 2008
SUMMERS ENGINEERING, INC.

Joseph C. McGahan
San Luis & Delta-Mendota Water Authority
842 Sixth Street, Suite 7
Los Banos, CA 93635

SUBJECT: **ENVIRONMENTAL REFERRAL – SAN LUIS AND DELTA MENDOTA WATER AUTHORITY – NOTICE OF PREPARATION (NOP) OF A DRAFT ENVIRONMENTAL IMPACT STATEMENT/ENVIRONMENTAL IMPACT REPORT FOR THE GRASSLAND BYPASS PROJECT EXTENSION**

Mr. McGahan:

The Stanislaus County Environmental Review Committee (ERC) has reviewed the subject project and has the following comment(s):

- Applicant shall determine, to the satisfaction of the Department of Environmental Resources (DER), that a site containing (or formerly containing) residences or farm buildings, or structures, has been fully investigated (via Phase I study and Phase II study if necessary) prior to the issuance of a grading permit. Any discovery of underground storage tanks, former underground storage tank locations, buried chemicals, buried refuse, or contaminated soil shall be brought to the immediate attention of DER.

- Applicant should contact the Department of Environmental Resources regarding appropriate permitting requirements for hazardous materials and/or wastes. Applicant and/or occupants handling hazardous materials or generating hazardous wastes must notify the Department of Environmental Resources relative to: (Calif. H&S, Division 20)

ENVIRONMENTAL REFERRAL – SAN LUIS AND DELTA MENDOTA WATER AUTHORITY – NOTICE OF PREPARATION (NOP) OF A DRAFT ENVIRONMENTAL IMPACT STATEMENT/ENVIRONMENTAL IMPACT REPORT FOR THE GRASSLAND BYPASS PROJECT EXTENSION
Page 2

A. Permits for the underground storage of hazardous substances at a new or the modification of existing tank facilities.
B. Requirements for registering as a handler of hazardous materials in the County.
C. Submittal of hazardous materials Business Plans by handlers of materials in excess of 55 gallons or 500 pounds of a hazardous material or of 200 cubic feet of compressed gas.
D. The handling of acutely hazardous materials may require the preparation of a Risk Management Prevention Program that must be implemented prior to operation of the facility. The list of acutely hazardous materials can be found in SARA, Title III, Section 302.
E. Generators of hazardous waste must notify the Department of Environmental Resources relative to the: (1) quantities of waste generated; (2) plans for reducing wastes generated; and (3) proposed waste disposal practices.
F. Permits for the treatment of hazardous waste on-site will be required from the Hazardous Materials Division.
G. Medical waste generators must complete and submit a questionnaire to the Department of Environmental Resources for determination if they are regulated under the Medical Waste Management Act.

- Contaminated soil and groundwater sites within Stanislaus County may be located at areas within the project site. Please contact Vicki Jones at (209) 525-6710 with addresses or APNs to determine the location of nearby contaminated sites.

The ERC appreciates the opportunity to comment on this project.

Sincerely,

Raul Mendez, Senior Management Consultant
Environmental Review Committee

cc: ERC Members

HERUM CRABTREE BROWN
Attorneys At Law

Karna E. Harrigfeld
kharrigfeld@herumcrabtree.com

January 25, 2008

VIA ELECTRONIC AND U.S. MAIL

Ms. Laura Myers
Bureau of Reclamation
South-Central California Area Office
1243 N Street
Fresno, California 93721
lmyers@mp.usbr.gov

Mr. Joseph C. McGahan
Drainage Coordinator
San Luis Delta Mendota Water Authority
P.O. Box 2157
Los Banos, California 93635
jmcgahan@summerseng.com

Re: Grasslands Bypass Project Extension/Notice of Preparation

Dear Ms. Myers and Mr. McGahan:

These comments are submitted on behalf of Stockton East Water District (SEWD) to the Bureau of Reclamation (Reclamation) and San Luis and Delta-Mendota Water Authority (Authority) Notice of Preparation of an Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the Grassland Bypass Project extension.

In order to set the context for the following comments, it is important to note that SEWD's primary interest is in improving water quality on the San Joaquin River. SEWD's interest in water quality arises because of its contract with Reclamation for water from the New Melones Reservoir on the Stanislaus River. As Reclamation is well aware, substantial releases of water for water quality purposes are made from New Melones Reservoir throughout the year to meet the salinity water quality objective at Vernalis. SEWD believes that the use of high quality water for dilution flows is an unreasonable use of water and in violation of state and federal law. The effect of these releases and other actions taken by the Reclamation has been to deprive SEWD of its full contractual entitlement for water from New Melones Reservoir.

Alternatives Analysis

The EIS/EIR must contain a comprehensive analysis of alternatives to the Grassland Bypass Extension project, including alternatives for disposal of the selenium and saline water other than via Mud Slough and into the San Joaquin River, reduction in the number of acres of land irrigated to reduce the amount of selenium and saline water applied and contributing to the drainage into Mud Slough and the San Joaquin River and all other feasible alternatives to the project.

Ms. Laura Myers
Mr. Joseph C. McGahan
January 25, 2008
Page 2 of 2

Environmental Effects

The EIS/EIR must contain a comprehensive discussion and analysis of how implementation of the proposed project will affect San Joaquin River water quality. It must evaluate the direct, indirect and long term effects this drainage will have on water quality in the San Joaquin River. In particular, the potential affects of the increase in salinity due to the concentration of it by the repeated reuse of water prior to disposal. The analysis must include an evaluation of the impacts to New Melones operations to address the salinity in the San Joaquin River caused by continuation of the project and whether releases or increased releases from New Melones Reservoir will be required to meet the Vernalis salinity objective.

Fundamental to implementation of a project pursuant to NEPA and CEQA must be to properly evaluate the environmental impacts of a project and implement appropriate mitigation measures. The EIS/EIR must mitigate the effects of the project including requiring dilution flows from sources other than New Melones Reservoir. The EIS/EIR must propose mitigation measures to mitigate all impact to San Joaquin River water quality caused by the project.

Cumulative Impacts

The EIS/EIR must evaluate the cumulative impacts associated with implementation of this project. Since initiation of this project many other projects have come on line that have impacted water quality in the San Joaquin River. New projects impacting water quality in the river include water transfers from the San Joaquin River Exchange Contractors to the wildlife refuges and other Central Valley Project contractors, increased saline groundwater accretions resulting from these transfers and the concentration of the salts by reuse of the water. Reclamation and Authority must develop a list of all projects implemented since initiation of the project that produce water quality impacts and evaluate the cumulative impacts of these projects.

We appreciate the opportunity to provide these comments and look forward to reviewing the Draft EIS/EIR.

Very truly yours,

KARNA E. HARRIGFELD
Attorney-at-Law

KEH:lm

cc: Kevin Kauffman, Stockton East Water District

SOUTH DELTA WATER AGENCY
4255 PACIFIC AVENUE, SUITE 2
STOCKTON, CALIFORNIA 95207
TELEPHONE (209) 956-0150
FAX (209) 956-0154
E-MAIL Jherrlaw@aol.com

Directors:
Jerry Robinson, Chairman
Robert K. Ferguson, Vice-Chairman
Natalino Bacchetti, Secretary
Jack Alvarez
Mary Hildebrand

Engineer:
Alex Hildebrand
Counsel & Manager:
John Herrick

January 25, 2008

Via E-Mail lmyers@mp.usbr.gov

Ms. Laura Myers
Bureau of Reclamation
South-Central California Area Office
1243 N Street
Fresno, CA 93721

Re: Notice of Preparation of a DEIS/EIR for Grassland Bypass Project Extension

Dear Ms. Myers:

The South Delta Water Agency ("SDWA") makes the following comments with regard to the above-referenced Notice of Intent. SDWA interests are closely associated with salinity problems and flow needs on the San Joaquin River.

The Draft EIS/EIR should comprehensively describe the project's effects on not only the salt load but on salt concentrations of the San Joaquin River. It should also describe what has happened to the salt purportedly not discharged into the River under the prior project. Any salt not reaching the river through surface drainage must be either contributing to subsurface accretions to the river or increased groundwater concentration. The Draft EIS/EIR must also describe how the project will help or hinder USBR's obligations to meet both the TMDL obligation and compliance with downstream water quality obligations including but not limited to Vernalis. Such things as the Bureau's plan to meet standards and other obligations under HR 2828 (PL 108-361) must also be addressed.

In addition, the project's effects on downstream flows must also be addressed. The Bureau is currently involved in various processes to address water quality and water level needs in the South Delta, and changes in upstream flows can adversely affect these efforts.

Ms. Laura Myers
January 25, 2008
Page Two

In the development of the DEIS/EIR, the Bureau should consult with SDWA in order to fully address these and other issues.

Please call me if you have any questions or comments.

Very truly yours,

JOHN HERRICK

JH/dd

From: "Nomellini, Grilli & McDaniel PLCs" <ngmplcs@pacbell.net>
To: <lmyers@mp.usbr.gov>
Date: 1/24/2008 2:05:38 PM
Subject: Scoping for EIS/EIR Grassland Bypass Project Extension

Attn: Ms. Laura Myers, Bureau of Reclamation

The Central Delta Water Agency remains concerned that the Project is resulting in the accumulation of Selenium and other salts in the land and groundwater which will contribute to the contamination of the San Joaquin River for years and years and will otherwise aggravate the salt balance in the San Joaquin Valley. We understand that the Project has facilitated or resulted in the transfer of large quantities of water which would have otherwise been used in the grassland area. Prior to the project such water helped dilute the concentration of Selenium and other salts in the land, groundwater and direct and indirect discharge to the San Joaquin River. The continued irrigation of the same area with less water would appear to increase concentrations and negatively impact salt balance.

The EIS/EIR should address such concerns and consider alternatives to the Project which would reduce the amount of water applied in the area by retiring lands, especially those which contribute significant levels of selenium and other salts to the groundwater and directly or indirectly to the San Joaquin River. The reduction in applied water should be accomplished by reducing diversions from the Delta and not by way of transfer to other exporters. The reduction in exports from the Delta could reduce the harm to endangered fish and reduce the draw on water which is not truly surplus to the needs for salinity control and an adequate water supply in the Delta.

Thank you for the opportunity to comment.

Dante John Nomellini Sr. Manager and co-counsel for the Central Delta Water Agency

CONTRA COSTA
WATER DISTRICT

1331 Concord Avenue
P.O. Box H20
Concord, CA 94524
(925) 688-8000 FAX (925) 688-8122

January 25, 2008

Joseph C. McGahan
Drainage Coordinator
San Luis & Delta-Mendota Water Authority
P.O. Box 2157
Los Banos, CA 93635

Ms. Laura Myers
U.S. Bureau of Reclamation
South-Central California Area Office
1243 N Street
Fresno, CA 93721

RE: Grassland Bypass Project Extension Scoping Comments

Dear Mr. McGahan and Ms. Myers:

Contra Costa Water District (CCWD) appreciates the opportunity to provide scoping comments on the Notice of Preparation for a Draft Environmental Impact Statement/Report for an extension of the Use Agreement for the Grassland Bypass Project. CCWD depends on the Sacramento-San Joaquin Delta to supply water to over half a million people in eastern and northern Contra Costa County, and therefore works to protect Delta water quality from degradation. CCWD participated in the development of both the first Use Agreement in 1995 and the existing Use Agreement in 2001, and is currently involved in the stakeholder group discussions for extending the current Use Agreement, which expires at the end of 2009.

CCWD recognizes that, despite good faith efforts by the Grassland area farmers to manage and reduce their drainage and meet the selenium and salinity load targets, difficulty in acquiring funding has delayed the development of treatment and disposal technology required to reduce selenium loads to meet the existing deadline of zero discharge by the end of 2009. Therefore, the Grassland area drainers are proposing an extension of the Use Agreement for an additional ten years beyond 2009.

The goal of zero discharge by the end of 2009 set forth in the existing Use Agreement was motivated by concern about Delta water quality and the Mud Slough fish and wildlife ecosystem. In order to remain consistent with the existing Use Agreement, any Use Agreement extension needs to emphasize the need to eliminate discharges of agricultural drainage from the Grassland area as soon as possible. Reclamation must include monthly and annual selenium and salinity load limits that continue to decrease loads below current Use Agreement and Basin Plan requirements such that zero discharge is reached well before the expiration of what should be the last extension of the Use Agreement. The drainers must be required to provide additional mitigation to address the current and continued degradation of Mud Slough, with the annual payment per pound of discharged selenium increasing over time, in order to encourage the farmers to discontinue discharges to the river as soon as possible. Since salinity loads are closely correlated with selenium loads in the drainage water, these payments will also serve to protect the San Joaquin River and the Delta from salinity impacts due to continued use of the Grassland Bypass.

Grassland Bypass Project Extension Scoping Comments
January 25, 2008
Page 2

CCWD looks forward to continuing to work with the Grassland area drainers and other stakeholders to finalize a new Use Agreement for the Grassland Bypass Project which will enable the Grassland area drainers to succeed in eliminating drainage impacts that are a concern to us all. If you would like to discuss any of these issues, please do not hesitate to call me at (925) 688-8083, or Lucinda Shih at (925) 688-8168.

Sincerely,

Leah Orloff
Water Resources Manager

LO/LHS:wec

cc: Gary Bobker, The Bay Institute
Hal Candee, Natural Resources Defense Council
Tom Graff, Environmental Defense Fund
John Kopchik, Contra Costa County

Joe McGahan

From: Gary Bobker [bobker@sbcglobal.net]
Sent: Thursday, January 17, 2008 5:34 PM
To: Joe McGahan; lmyers@mp.usbr.gov; ggartrell@ccwater.com; rdenton06@comcast.net; terry_young@mindspring.com; bobker@bay.org; Hal Candee; tgraff@environmentaldefense.org; jkopc@cd.cccounty.us
Subject: Grassland Bypass extension scoping comments

> attached and pasted below are TBI's scoping comments.
>
>
>
> By email and mail
>
> January 17, 2008
>
>
> Joseph C. McGahan
> Drainage Coordinator
> San Luis & Delta-Mendota Water Authority P.O. Box 2157 Los Banos, CA
> 93635
> jmcgahan@summerseng.com Ms. Laura Myers
> U.S. Bureau of Reclamation
> South-Central California Area Office
> 1243 N Street
> Fresno, CA 93721
> lmyers@ mp.usbr.gov
>
> RE: Draft EIS/EIR for the Grassland Bypass Project
> Extension
>
> Dear Mr. McGahan and Ms. Myers,
>
> This letter is submitted as the scoping comments of the Bay Institute
> (TBI) on the Notice of Preparation for a Draft Environmental Impact
> Statement/ Environmental Impact Report on the proposed extension of
> the Grassland Bypass Project. As you know, TBI was actively involved
> in development of the original November 1995 Use Agreement and
> negotiation of the second September 2001 Use Agreement, and is
> currently participating in stakeholder discussions regarding extending
> use of the Grassland Bypass beyond the current December 31, 2009,
> termination date..
>
> We appreciate the significant progress the Grassland area has made
> since 1995 in managing and reducing its drainage and in meeting the
> selenium and salinity load targets. Substantial progress has also
> been made in developing in-Valley drainage solutions through source
> control and recirculation, interception of groundwater, and irrigation
> of salt tolerant crops in the new reuse area as part of the San
> Joaquin River Improvement Project.
>
> The Grassland area drainers are seeking the extension to allow time to
> implement treatment and disposal options to allow the Grassland area
> to go to, and sustain, zero discharge. Keeping in mind the good faith
> efforts of these Grassland area parties, we are concerned regarding a
> number of issues associated with the proposed extension:
>
> • Extending use of the Grassland Bypass will
> continue
> degradation of water and habitat quality in Mud Slough and adjacent

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> areas. Allowing these continuing impacts for a 10-year period is
> highly problematic for us.
> Any
> agreement to extend use should include:
> (1) a more aggressive schedule (e.g., 3 to 5 years)
> for achieving zero discharge;
> (2) the adoption of new discharge requirements based
> on achieving incremental progress in moving toward zero discharge
> (e.g., below the values in the current
> TMDL) in the latter part of any new timeline; and
> (3) increased penalties for exceeding load limits
> (up
> to agreed maxima) or failing to achieve other elements of the
> agreement.
>
> • If the use of the Grassland Bypass is extended,
> the
> continuing water and quality impacts will need to be mitigated by the
> Grassland area drainers. Any agreement to extend use should include
> new mitigation elements, such as augmenting water deliveries to local
> wildlife refuges, improving riparian habitat in the area immediately
> downstream of Mud Slough, and/or improving wildlife habitat in refuge
> areas adjacent to Mud Slough. The amount of money provided by the
> Grassland area farmers to fund these mitigation elements should
> increase each year (on a per pound of selenium discharged basis) to
> encourage the farmers to achieve zero discharge earlier than may be
> scheduled.
>
> • The timely development of treatment and disposal
> options is contingent on a number of factors, some outside of the
> drainers' control. In order to justify extending use of the Bypass,
> any new agreement should also consider implementing alternatives or
> complementary actions to treatment, such as irrigation improvements,
> crop substitutions, land retirement, and markets for salt byproducts
> of reuse, that are not so reliant on outside funding or the
> development of new technologies. In any event, the requirement to
> achieve zero discharge if use of the Bypass is extended must be
> complied with by the new date certain, whether or not any particular
> drainage management approach selected by the drainers has been funded,
> implemented or proven effective.
>
> We are confident that a new agreement to extend the use of the
> Grassland Bypass that fully addresses these concerns will maintain the
> success toward managing and eliminating drainage impacts experienced
> in the twelve years ago since negotiation of the first Grassland
> Bypass Use Agreement.
>
> Sincerely,
>
>
> Gary Bobker
> Program Director
>
> cc: Hal Candee, NRDC
> Tom Graff, Environmental Defense Fund
> Greg Gartrell, CCWD
> John Kopchik, Contra Costa County
>
>
>
> Gary Bobker, Program Director
> The Bay Institute
> 500 Palm Drive #200
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>

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By Electronic Mail and Fax (559) 487-5397

25 January 2008

Ms. Laura Myers, U.S. Bureau of Reclamation
Mr. Joseph McGahan, Drainage Coordinator, San Luis & Delta Mendota Water Authority

RE: Opposition to Preparation of a Draft Environmental Impact Statement/Environmental Impact Report for the Grassland Bypass Project Extension

Dear Ms. Myers and Mr. McGahan

The Pacific Coast Federation of Fishermen's Associations (PCFFA), represents working men and women in the U.S. west coast commercial fishing fleet. Among our members are all of California's organized commercial salmon fishermen, along with Dungeness crab and herring fishermen. All three of these fisheries depend on the health of the Sacramento-San Joaquin Delta and San Francisco Bay.

The purpose of this letter is to notify you of PCFFA's <u>opposition to any extension</u> of the date for compliance for meeting water quality objectives, established by the Regional Board for the Central Valley Region's 1988 Water Quality Control Plan for the Sacramento River and San Joaquin River Basins, specifically selenium loads from subsurface discharges into Mud Slough. The dischargers have had ten (10) years to comply, 10 years during which toxic discharges were made into the San Joaquin and ultimately the Delta. That is long enough.

For the past two years returns of fall-run chinook salmon to the Central Valley, and the San Joaquin in particular, have been depressed despite the fact there has been almost no ocean fishing on these stocks due to restrictions imposed to protect Klamath runs. Preliminary numbers indicate we did not even reach the minimum spawning escapement goals for 2007. Obviously degraded water quality resulting from the discharges of toxic selenium is not the only factor contributing to the collapse of the Delta ecosystem and rapidly declining populations of Central Valley chinook salmon. The degraded water quality, however, exacerbates the situation for the Delta ecosystem and these fish in a period of record levels of diversions from the Delta; for 2007 that amount was in excess of 7 million acre-feet of water.

Ms. Laura Myers
Mr. Jospeh McGahan
25 January 2008
Page Two

For the reasons stated above, PCFFA recommends an immediate cessation of all discharges until such time as the discharges meet or exceed the water quality standards set in 1988. If your agencies have any questions regarding these comments, please do not hesitate to contact us.

Sincerely,

W.F. "Zeke" Grader, Jr.
Executive Director

cc: The Honorable Barbara Boxer, Chair, Senate Environment & Public Works Committee
The Honorable Grace Napolitano, Chair, House Subcommittee on Water & Power
The Honorable George Miller
The Honorable Mike Thompson
The Honorable Pat Wiggins, Chair, Joint Committee on Fisheries & Aquaculture
State Water Resources Control Board
California Fish & Game Commission

To: **U.S. Bureau of Reclamation, Laura Myers, email lmyers@mp.usbr.gov Fax (559) 487-5397**

Joseph McGahan, Drainage Coordinator, San Luis & Delta Mendota Water Authority Fax (559-582-9237

From: Patrick Porgans & Associates, Inc. (*De facto Public Trustee*) **25 January 2008**

Project: U.S. Bureau of Reclamation's ***Notice of Preparation (NOP) of a Draft Environmental Impact Statement/Environmental Impact Report for the Grassland Bypass Project Extension***

Subject: Written Comments and Supporting Information to Formal Oppose the GBP and Suggest the No Alternative

INTRODUCTORY STATEMENT

Before it is possible for P&A to intelligently respond to yet another request by the Authority and Reclamation for an additional 10-year extension of the Grasslands Bypass Project (GBP), it is noteworthy to reflect on the fact that they assured the public more then 10-years ago that the use of the San Luis Drain would terminate in December 31, 2009, and that subsurface drainage flows to Mud Slough would have met water quality objectives by October 1, 2010, as required by the Regional Board's 1998 Basin Plan and they would have a solution in place. Now, however, according to the GBP proponents, at this time, they neither have the solution nor the funds to make good on their agreed upon deadlines/promises. In fact, according to Mr. J. McGahan, Drainage Coordinator, when question by P&A, he could not provide either the ultimate costs to develop a drainage/treatment solution, or a specific time frame for its development and/or implementation! Mr. McGahan did concede that the GBP has already expended more than $65 million to date, and has recently received another $25 million grant from Proposition 50 funds, totaling nearly $90 million; more than 60 percent are public grant monies.

The following statement are excerpts from the U.S. Bureau of Reclamation's *Notice of Preparation (NOP) of a Draft Environmental Impact Statement/ Environmental Impact Report for the Grassland Bypass Project Extension*, dated 20 Dec. 2007.

"__Summary__ The Bureau of Reclamation (Reclamation) and the San Luis & Delta-Mendota Water Authority (Authority) are preparing a joint EIR/EIS to evaluate effects of extending the Grassland Bypass Project (Project) until December 31, 2019. The Project's use of the San Luis Drain was authorized only until December 31, 2009. ***Subsurface drainage flows discharged to Mud Slough (North) were to have met water quality objectives by October 1, 2010, as required by the Regional Water Quality Control Board, Central Valley Region's (Regional Board) 1998 Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.*** *While Project participants have drastically reduced subsurface drainage discharges and have met current water quality objectives and milestones,* ***difficulty in acquiring final funding has delayed the development and availability of treatment and disposal technology necessary to reduce selenium loads to meet 2010 deadline. It is anticipated that the extension to 2019 would allow enough time to acquire funds and develop feasible technology to meet Basin Plan objectives and Waste Discharge Requirements.***

An interim project was implemented in November 1995 through an "Agreement fir Use of the San Luis Drain" (Use Agreement) (Agreement No. 6-07-w1319) between the Bureau of Reclamation and the Authority. A Mitigated Declaration was approved by the Authority for the interim project, and the environmental commitments set forth in the Mitigated Negative Declaration was made an integral component of the initial Use Agreement. The Use Agreement and its renewal in 1999 allowed for use of the San Luis Drain for a five-year period that concluded September 30, 2001.

A new Use Agreement (Agreement No. 01-WC-20-2075) was completed on September 28, 2001, for the period through December 31, 2009. This original project, as well as the proposed Project, consolidates subsurface drainage flows on a regional basis (from 97,000 acres GDA), applies the drainage to salt tolerant crops to reduce the volume, utilizes a 4-mile channel to place the drainage into the San Luis Drain at a point near Russell Avenue; and uses a 28-mile segment of the San Luis Drain to convey the remaining drainage flows around the wetland habitat area, and discharges it to Mud Slough (North) and subsequently to the San Joaquin River."

To: **U.S. Bureau of Reclamation, Laura Myers, email lmyers@mp.usbr.gov Fax (559) 487-5397**
Joseph McGahan, Drainage Coordinator, San Luis & Delta Mendota Water Authority Fax (559-582-9237
From: Patrick Porgans & Associates, Inc. (*De facto Public Trustee*) 2

Project: U.S. Bureau of Reclamation's ***Notice of Preparation (NOP) of a Draft Environmental Impact Statement/Environmental Impact Report for the Grassland Bypass Project Extension***
Subject: Written Comments and Supporting Information to Formal Oppose the GBP and Suggest the No Alternative

P&A WARNED OF GBP MOVING-TARGET-DEADLINE AND ENDLESS DELAYS IN COMPLIANCE: On the surface it appears that BOR and its GBP agricultural water contractors would have had nearly 14 years to develop and implement a solution to the government-induced drainage dilemma in the Central Valley Project's San Luis Unit via the Grasslands Bypass Project; however, the record indicates that the water quality objectives were initially scheduled to have been met in 1993:

> *Ironically, in the* [CVRWQCB] ***board's 1988 report,[1] it states that WDRs for Grassland Drainers would have occurred in 1989, and compliance with water quality objectives would have occurred in 1993. (Refer to Figure 1.) Now the compliance schedules for the water quality objectives for the San Joaquin River have been pushed out to the year 2005-2010, and that may change.***[2] [Emphasis Added.]

> **GBP is the Quintessential Stop-gap Measure:** *Since its inception, P&A has stated for the record that the GBP is nothing more than a stop-gap measure (salt banking) by the government and its water dependents to sanction the unreasonable use of the public's water resources and promote unsustainable agricultural practices, while they are allowed to exceed federal selenium objectives and continue to contribute to the destruction of public trust resources and the degradation of the surface and ground waters of the state.*[3]

PORGANS & ASSOCIATES APPRISES GOVERNMENT OF ITS FAILURE TO PERFORM:

> *Since the 1960's, government has developed laws, policies, plans, water quality objectives/standards and programs intended to reconcile the state's single largest water quality problem --- agricultural drainage. Albeit, the record, and the current conditions of the surface and subsurface waters in the Valley are at a crisis.* ***The government has not only failed to develop a viable plan to reconcile its self-imposed water-quality-drainage dilemma, it's actions and/or failures to act have exacerbated the problem*** *by threatening the state's long-term economic viability and agricultural sustainability, destroying public trust resources and impairing the beneficial use of the public's water supply. In the past 33 years,* ***Patrick Porgans & Associates (P&A), Inc.****, has worked relentlessly using all of the available tools, and our personal resources to assist, and when necessary force the government to recognize and deal with its self-imposed*

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[1]CVRWQCB's "***Staff Report on the Program of Implementation of Agricultural Subsurface Drainage Dischargers in the San Joaquin Basin (5C)***, Figure 1:, August, 1998, p.21.

[2]Patrick Porgans & Associates, Inc., Oral and Written Presentation to and Before All Member of the Central Valley Regional Water Quality Control Board, ***"Informal Public Hearing, Re: Waste Discharge Requirements - San Luis & Delta Mendota Water Authority and U.S. Bureau of Reclamation – Grassland Bypass Project – Fresno and Merced Counties***, July, 24, 1998.

[3]Patrick Porgans & Associates correspondences to Regional Director, U.S. Fish & Wildlife Service, Art Baggett, Chairman, State Water Resources Control Board and Chairman, Central Valley Reg. Water Quality Control Board, RE: ***Formal Request that the U.S. Fish and Wildlife Service Pursue Administrative Relief Through the Central Valley Regional Water Quality Control Board and the State Water Resources Control Board to Compel the U.S. Bureau of Reclamation et al to Cease Violating the Selenium Objective for the Wetland Channels, within the San Luis Nat Wildlife Refuge Complex, CA., Which Threatens Public Trust Resources and Permitted Water Right Usage***, Nov. 12, 2002, **pp. 3 and 4.**

To: **U.S. Bureau of Reclamation, Laura Myers, email lmyers@mp.usbr.gov Fax (559) 487-5397**
Joseph McGahan, Drainage Coordinator, San Luis & Delta Mendota Water Authority Fax (559-582-9237
From: Patrick Porgans & Associates, Inc. (*De facto Public Trustee*)

Project: U.S. Bureau of Reclamation's ***Notice of Preparation (NOP) of a Draft Environmental Impact Statement/Environmental Impact Report for the Grassland Bypass Project Extension***
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drainage dilemma.[4]

Synoptic Reflection of the USBR's Ongoing-Unaccountable Destruction of Public Trust Resources

The USBR is "responsible" for administering the federal Central Valley Project (CVP), the single largest provider and purveyor of water in California, which exports on average four-million acre-feet of water from the Sacramento-San Joaquin Delta, primarily to its agricultural contractors in the San Joaquin Valley (SJV) service area. The historical record attest to the fact that the USBR is rife with conflicting interests and self-serving directives as water purveyor and public trustee, rendering it ineffective in reconciling its intrinsic regulatory, administrative and resource trust conundrum. Its "Catch -22" conundrum is compounded by a fragmented regulatory and self-serving administrative process that attempts to maintain a status quo profile when confronted with one of its own self-induced resource-related crises. Ironically, during such episodes, it tends to have a preoccupation with image-related damage control geared towards reasserting its commitment to the protection of its water contractors at the expense and to the demise of trust resources, which are illustrated by some of the following examples:

❶ *The USBR and its respective water contractors are the primary parties responsible for the massive contamination and deplorable condition of the surface and ground water throughout the entire San Joaquin Valley (SJV). This condition was graphically evidenced in a U.S. Environmental Protection Agency's (EPA) June 1997 National Watershed Characterization, Index of Watershed Indicators, which list the SJV as a "More Serious Water Quality Problems – High Vulnerability" area,. According to EPA's map/index, it illustrates the SJV as the* ***single largest contiguous high water quality vulnerable area in the United States****. The evidence points to the discharge of agricultural drainage water as the primary source of the degradation of the SJR and the ongoing demise and destruction of the San Francisco Bay-Sacramento-San Joaquin Delta Estuary.*

❷ *Their respective actions are also a primary contributing factor to 120 miles of the San Joaquin River (SJR) classified as a water quality impaired body by the State of California.*

❸ *Water deliveries from the CVP are the primary factor contributing to water quality degradation in the wetland water supply channel, and exceedences of EPA's 2 ppb selenium water quality standard for the protection of acoustic life, including wildlife refuge water supply, within the San Luis Nat Wildlife Refuge Complex, which threatens public trust resources and permitted water right usage.* ***According to the CVRWQCB, P&A confirmed, USBR has not been cited for violating the 2 ppb selenium standard.***

❹ *The SWRCB's Bay-Delta Water Right hearings, also attest to the fact that the USBR/CVP are primarily responsible for the "doubling of salt loads every five years" in the SJV resulting from water deliveries and agricultural drainage.*

[4] Porgans & Associates, Inc. ***Transmittal of Its Agricultural Drainage Alleviation Plan (ADAP) — Solution to Government-Induced Drainage Dilemma***, to Art Baggett, Chair, SWRCB, Robert Schneider, Chair, CVRWQCB and Kirk Rodgers, Regional Director, U.S. Bureau of Reclamation, August 2004.

❹ *In the mid-1980s, the San Luis Unit of the CVP that supplies water to the Westland Water District (WWD), the single largest water district in the United States, was the source of the selenium-laden agricultural drainage return flows responsible for the destruction of tens-of-thousands of migratory birds at the Kesterson National Wildlife Refuge. The Kesterson debacle was the subject of an SWRCB hearing/decision (WQ 85-01), that was promulgated not by a government entity, rather via a petition by a private citizen, who appealed a CVRWQCB decision that essentially attempted to downplay the severity of the government-induced selenium-agricultural drainage catastrophe. Ironically, Kesterson was closed by the SWRCB's WQ 85-01 as a nuisance; however, the USBR was not fined by the SWRCB for its action. Kesterson National Wildlife Refuge was closed by an order from the Secretary of the Interior.* ***The USBR was not held accountable for the deaths of those birds as it was not pursued as a Migratory Bird Treaty Act violation by the USFWS.***

❺ *In the late 1980's and early 1990s, it illegally exported hundreds-of-thousands acre-feet of water from the delta, in violation of the terms and conditions of its water right permits.*[5] *SWRCB's Exhibits 19 and 20, Summary of Recent Decision 1485 Violations, documented over 200 days of violations between Water-Year 1998 through Water Year 1992. The SWRCB's record also states that the USBR and the California Department of Water Resources (DWR), collectively illegally impounded and/or exported approximately 325,000 acre-feet of water during that period, valued at 29 million dollars. P&A's fought for three years to have the SWRCB hold that hearing to hold the USBR and DWR accountable for violating the terms and conditions of their respective water right permits. Albeit, the* ***SWRCB held the hearing, but opted not to take an enforcement action against the USBR/DWR for violating terms and conditions of their respective water right permits.***

❻ *The CVRWQCB reports document the fact that the* ***USBR's*** *groundwater sumps, that are discharged into the Delta Mendota Canal (DMC) have* ***exceeded California's hazardous waste threshold for selenium*** *(1,000 ppb); However, according to Dennis Westcott, Eng., CVRWQCB the USBR has* ***not been cited for this ongoing discharge.***

❼ *In 2002, in excess of 30,000 fish were killed on the Klamath/Trinity River system(some of which are state/federally listed as threatened species) resulting from a USBR water-related management issue. P&A contacted the USBR to ask if it had been cited for the fish kill. USBR's spokesperson said, no, as no one knows who, if anyone, is at fault.*

The USBR's ongoing contribution to the impairment of the waters, resulting from agricultural drainage return flows into the rivers and bay-delta, of the State and the destruction of fish and wildlife trust resources are without question unquantifiable; however, there is no question regarding its magnitude and/or severity of devastating impacts, despicable, unconscionable, contemptible, inexcusable, out-of-control and heretofore without meaningful regulatory

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[5] Public Hearing, State Water Resources Control Board, Division of Water rights, Public Hearing, Subject: Consideration of Compliance with Water Right Requirements for the Sacramento-San Joaquin Delta and Suisun Marsh, Nov. 20, 1992.

To: U.S. Bureau of Reclamation, Laura Myers, email lmyers@mp.usbr.gov Fax (559) 487-5397 5
Joseph McGahan, Drainage Coordinator, San Luis & Delta Mendota Water Authority Fax (559-582-9237
From: Patrick Porgans & Associates, Inc. (*De facto Public Trustee*)

Project: U.S. Bureau of Reclamation's ***Notice of Preparation (NOP) of a Draft Environmental Impact Statement/Environmental Impact Report for the Grassland Bypass Project Extension***
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accountability.[6]

EXCERPTS FROM THE CENTAL VALLEY REGIONAL WATER CONTROL BOARD'S BASIN PLAN — USE OF GRASSLANDS CHANNEL OVER 30-YEARS:

> ***The present use of the Grassland channels has developed over a 30-year period through agreements between the dischargers, water and irrigation districts, the U.S. Bureau of Reclamation, the California Department of Water Resources, the U.S. Fish and Wildlife Service, the California Department of Fish and Game, the Grassland Water District and the Grassland Resource Conservation District.*** *Because each entity shared in the development o the present drainage routing system, each shares the responsibility for implementation of a wetlands bypass.*[7]

BIG-PICTURE SCENARIO AND THE GOVERNMENT-INDUCED DRAINAGE DILEMMA IMPACT ON CALIFORNIA'S CREDIT RATING, NATIONAL RESOURCES AND LONG-TERM ECONOMIC SUSTAINABILITY AND/OR RECOVERY: It is imperative that the project proponents get a grasp of the national and state economic financial crises that we are facing, trillions of dollars in debt, many of our fellow Americans are losing their homes, our financial and natural resources are being drained at an unparalleled rate, the Central Valley Project and San Luis Unit agricultural contractors still owe approximately $1 billion dollars in outstanding capital costs; in the past they have already been forgiven more than $1.5 billion of the initial $3 billion of capital costs, because of either their ability to pay or willingness to pay. The costs to clean up the Kesterson Wildlife Refuge catastrophe, which received drainwater from CVP/SLU agricultural contractors, amounted to more money then had been repaid by the agricultural contractors for the initial 50 years of water deliveries. A significant portion of the Kesterson cleanup and $100s of million in drainage studies was paid for by the public. Hundreds of millions of additional funds derived from General Obligation Bonds; i.e., Proposition 50, 13 and others billion dollar bond acts have and continued to drain the public's resources in an attempt to reconcile a government-water-contractor-induced drainage cabal, in a futile attempt to keep an unsustainable agricultural area, serviced by the CVP/SLU, from dying on the vine. Every billion dollars issued in GO Bonds, cost the taxpayers additional hundreds of millions in interest charges, and lowers the State's declining credit rating, making it even more expensive to borrow money for essential services and much needed infrastructure.

The secondary and primary adverse impacts on other beneficial uses and users of the publicly owned water attributable to CVP water deliveries and toxic drainwater discharges have yet to be quantified, qualified and/or mitigated; historically high water exports from the Sacramento-San Joaquin Delta by CVP and California State Water Project (SWP); more than 100 million acre-feet of water delivered to the agricultural contractors; disastrous and significant declines in endangered and threatened species of fish, destruction of the commercial and sport fishing industry, partially attributable to both pumping and return flows of toxic agricultural drainage water from GBP and other agricultural sources. Salt loads discharges from the San Joaquin Valley have been doubling about every five years. Total amount of salts stockpiling in the soil profile and shallow groundwater are estimated at 85 million tons, enough salt to fill 850,000 railroad gondola cars. The Delta is on the near brink of an ecological collapse, the only saving grace preventing it from doing so, is attributable to the fact that by and large California has not suffered from an extended dry/drought period since the 1987-1992 event. According to data published by the California State Water Resources Control Board, at its 303(d) listings website [http://www.swrcb.ca.gov/tmdl/303_lists.html] more than 140 miles of the San Joaquin River is currently listed as a Water Quality Impaired Segment;, and according to the U.S. Environmental Protection Agency's National Watershed Classification, Index of Watershed Indicators [www.epa.gov/surf]June 1997, the San Joaquin Valley appears to be the single largest contiguous area classified as a "More Serious Water Quality - High Vulnerability" in the nation.

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[6]Patrick Porgans & Associates correspondences to Regional Director, U.S. Fish & Wildlife Service, Art Baggett, Chairman, State Water Resources Control Board and Chairman, Central Valley Reg. Water Quality Control Board, RE: ***Formal Request that the U.S. Fish and Wildlife Service Pursue Administrative Relief Through the Central Valley Regional Water Quality Control Board and the State Water Resources Control Board to Compel the U.S. Bureau of Reclamation et al to Cease Violating the Selenium Objective for the Wetland Channels, within the San Luis Nat Wildlife Refuge Complex, CA., Which Threatens Public Trust Resources and Permitted Water Right Usage***, Nov. 12, 2002, pp. 1 and 2.

[7]California Regional Water Quality Control Board, Central Valley Region, ***Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River San Joaquin River Basins***, Implementation, 27 January 2005, p. IV-30.01.

To: **U.S. Bureau of Reclamation, Laura Myers, email lmyers@mp.usbr.gov Fax (559) 487-5397**
Joseph McGahan, Drainage Coordinator, San Luis & Delta Mendota Water Authority Fax (559-582-9237
From: Patrick Porgans & Associates, Inc. (*De facto Public Trustee*)

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HISTORICAL INFORMATION RELATIVE TO THE 100-YEAR-IN-THE-MAKING GOVERNMENT-CONTRACTOR-INDUCED-DRAINAGE DILEMMA:

> ***Agricultural Drainage Discharges in the San Joaquin River Basin: Water quality in the San Joaquin River has degraded significantly since the late 1940s. During this period, salt concentrations in the River, near Vernalis, have doubled. Concentrations of boron, selenium, molybdenum and other trace elements have also increased. These increases are primarily due to reservoir development on the east side tributaries and upper basin for agricultural development, the use of poorer quality, higher salinity, Delta water in lieu of San Joaquin River water on west side agricultural lands and drainage from upslope saline soils on the west side of the San Joaquin Valley.*** *Point source discharges to surface waters only contribute a small fraction of the total salt and boron loads in the San Joaquin River.* [Emphasis added.]
>
> ***The water quality degradation in the River was identified in the 1975 Basin Plan and the Lower San Joaquin River was classified as a Water Quality Limited Segment.*** *At that time, it was envisioned that a Valley-wide Drain would be developed and these subsurface drainage water flows would then be discharged outside the Basin, thus improving River water quality. However, present day development is looking more toward a regional solution to the drainage water discharge problem rather than a valleywide drain.*
>
> *Because of the need to manage salt and other pollutants in the River, the Regional Water Board began developing a Regional Drainage Water Disposal Plan for the Basin. The development began in FY 87/88 when Basin Plan amendments were considered by the Water Board in FY 88/89. The amendment development process included review of beneficial uses, establishment of water quality objectives, and preparation of a regulatory plan, including a full implementation plan. The regulatory plan emphasized achieving objectives through reductions in drainage volumes and pollutant loads through best management practices and other on-farm methods.*
>
> *The 88/89 amendment emphasized toxic elements in subsurface drainage discharges.* ***The Regional Water Board however still recognizes salt management as the most serious long-term issue on the San Joaquin River. Salinity impairment in the Lower San Joaquin River remains a persistent problem as salinity water quality objectives continue to be exceeded.*** *The Regional Water Board adopted the following control program for salt and boron in the Lower San Joaquin River to address salt and boron impairment and to bring the river into compliance with water quality objectives. Additionally, the Regional Water Board will continue as an active participant in the San Joaquin River Management Program implementation phase, as authorized by AB 3048, to promote salinity management schemes including time discharge releases, real time monitoring and source control.*[8] [Emphasis added.]

SALT AND DRAINAGE RELATED PROBLEMS IN THE SAN JOAQUIN VALLEY IDENTIFIED BACK IN THE 1800S, ACCORDING TO U.S. BUREAU OF RECLAMATION REPORT:

> ***Soil Salinity*** *Soil salinity problems occur primarily in the western and southern portions of the San Joaquin Valley. Most soils in this region are derived from marine sediments of the Coast Range. which*

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[8] California Regional Water Quality Control Board, Central Valley Region, ***Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River San Joaquin River Basins***, Implementation, 27 January 2005, p. IV-30.01.

contain salts and potentially toxic trace elements such as arsenic, boron, molybdenum, and selenium. Soil salinity problems in the San Joaquin Valley are intensified by poor soil drainage, insufficient water supply for adequate leaching, poor quality (high salinity) irrigation water, high water table, and an arid environment.

Soil salinity has been recognized as a problem in the San Joaquin Valley since the 1800s. The first problems were encountered between 1870 and 1915, when a rapid increase in irrigated acreage coincided with increasingly poor drainage and elevated salinity levels in the western and southern portions of the San Joaquin Valley. Between 1915 and the 1930s, an agricultural boom and formation of irrigation districts increased drainage and salinity problems to a community level. *It was not until the 1920s that deep well pumping lowered the water table below the root zone of plants on the east side of the valley. Dry farming practices were replaced with irrigated agriculture on the west side in the 1940s, leading to the advent of drainage problems on the west side of the valley and near the valley trough in the 1950s.* [Emphasis added.]

Drainage and soil salinity problems have persisted in the San Joaquin Valley. A 1984 study (Backlund and Hoppes) estimated that about 2.4 million of the 7.5 million acres of irrigated cropland in the Central Valley were salt-affected. *These saline soils generally exist in the valley trough and along the west side of the San Joaquin Valley. Additional studies, including the San Joaquin Valley Drainage Program studies, have recognized that a comprehensive salt management program is needed for the San Joaquin Valley.* ***The 1990 San Joaquin Valley Drainage Program Management Plan projected that by year 2000 918,000 acres of San Joaquin Valley farmland would be affected by a high water table existing less than five feet from the ground surface. This projection indicates a 20 percent increase in acreage affected by high groundwater table from 1990 acreage levels.*** *The increase was most prominent in the Westlands, Kern, and Tulare areas of the San Joaquin Valley. In addition, the 1991 San Luis Unit Drainage Program Draft Environmental Impact Statement projected losses of between 5,000 to 10,000 acres to increase in salinity by the year 2007 if current irrigation, farming, and drainage practices were to continue. Soil salinity occurs when salts, concentrated in the high groundwater table, are left behind as water evaporates from the soil surface. The drainage and soil salinity problem is discussed in the Groundwater Technical Appendix.* [Emphasis added.]

Soil Selenium Soil selenium is primarily a concern on the west side of the San Joaquin Valley. *When the soils on the west side are irrigated, selenium and other salts and trace elements dissolve and leach into the shallow groundwater. Figure 11-2 shows selenium levels in the top 12 inches of soil as determined by a survey in the mid 1980s. Soils derived from the Sierra Nevada on the east side of the valley are less salty and contain much less selenium. Over the past 30 to 40 years of irrigation, soluble selenium has been leached from the soils into shallow groundwater (San Joaquin Valley Drainage Program, 1990).*[9] ◘

EXCERPTS FROM THE SWRCB'S WATER RIGHT DECISION 1641 RECORD 10.2.1.2 THE EFFECT OF DISCHARGES IN THE CVP SERVICE AREA ON VERNALIS SALINITY:

Although water quality problems on the San Joaquin River began with the reduction of flows due to upstream development and the advent of irrigated agriculture, they were exacerbated with construction of the CVP. [Emphasis added.] *(R.T. pp. 3988, 4781; SDWA 39; SWRCB 1e, pp. II-15, VIII-2.) The CVP consist of 18 federally operated reservoirs and four reservoirs operated jointly with the DWR. (SWRCB 1e, p. III-5, SWRCB 167.) The Delta-Mendota Canal and pumping plant first were began operating in*

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[9] U.S. Bureau of Reclamation, ***Draft Programmatic Environmental Impact Statement, Soil Salinity, Soil and Geology, September 1997***, p 11-9.

1951. (SDWA 48, pp. 10-11.) The San Luis Drain [sic] and the California Aqueduct were completed in 1967. (SWRCB 167, Technical Appendix, pp. [II-11] - [II-13].) SDWA's witness testified that between 1930 and 1950 the average salt load at Vernalis was 750,000 tons per year. ***Between 1951 and 1997, the salt load has averaged more than 950,000 tons per year. Peak loads have exceeded 1.5 million tons per years following extended droughts.*** *(SWDA 34A.) Central Valley RWQCB staff testified that from the 1960s onward there has been an increase in salt load and concentrations. (R.T. pp. 4835-4836.) The April through August salt load in the 1980s was 62 percent higher than the load in the 1960s and the corresponding annual load increase was 38 percent.*[10] [Emphasis added.]

Note: According to P&A's discussions with SWRCB personnel, on January 24, 2008, we have been informed that Reclamation is NOT meeting the salinity objectives in the Delta.

Central Valley RWQCB staff described geographic sources of salinity based on historical data from the 1977 through 1997. (R.T. p. 4891.) The Central Valley RWQCB staff concluded that high salinity at Vernalis is caused by surface and subsurface dischargers to the river of highly saline water. The sources of the dischargers are agricultural lands and wetlands. [Emphasis added.] *R.T. pp. 4857-4858; SEWD 17, p. 5.) Approximately 35 percent of the salt load comes from the northwest side of the San Joaquin River, and approximately 37 percent of the salt load comes from the Grasslands area. (SEWD 7a.) These areas received approximately 70 percent of their water supply from the CVP, 20 percent from precipitation and 10 percent from groundwater. (SWRCB 8, p. V-11.) The TDS concentration of agricultural drainage water from the Grasslands area that discharges ti the river through Mud Slough is approximately 4,000 mg/L (R.T. p. 4869; SWRCB 8, p. VIII-27.)* ***In some cases, drainage water is more than ten times the concentration of the Vernalis salinity standard.*** *(R.T. pp. 7850-7851.)* [Emphasis added.]

IN 1998 PORGANS & ASSOCIATES FORMALLY APPEALED WDRs AND OPPOSED GBP AGREEMENT:

*It is with all due respect that I am compelled to inform you of my objections to the manner in which the board conducted its "public hearing" pertinent to the Waste Discharge Requirements - San Luis & Delta Mendota Water Authority and U.S. Department of the Interior, Bureau of Reclamation, Grassland Bypass Channel Project - Fresno and Merced Counties. In addition, I took strong exception to the chairman's demeanor toward me, and the board's blatant disregard of my civil rights and due process requirements. As a citizen, taxpayer and a professional, I would be remiss not to state that I was shocked. The "Hearing Procedure," related restrictions, and the time limits the board imposed during its "****informal hearing****" could be construed as a "gag order," as it preempted me from meaningfully participating in the "hearing process." What is more important, it denied me the opportunity to provide all members of the board with factual information relevant to the WDRs, which the board members could have used at their respective discretion to make a fair and impartial decision.*

As to the matter of the board's approval of the Waste Discharge Requirements, ***this letter is formal notification requesting an appeal of the board's decision for the reasons stated herein, please advises me if this letter is not enough, and/or what else is required, if anything, to initiate the appeal process.*** [Emphasis added.] *In addition, I am making a formal request for copies of the taped-recordings of agenda item seven (7), which I am prepared to pay for the reproduction costs. In the interest of expediting the process, please advised me when this information will be available, and I will make arrangements for my*

[10] State Water Resources Control Board's (SWRCB) ***Water Right Decision 1641***: *SWRCB 1e, p. VIII-11; SWRCB 97.*

staff to pick the copies m up at your office at 3443 Routier Road.[11]

2004 Porgans & Associates, Inc. Provides Government with a Viable Solution to the Drainage Cabal:

This letter contains a proposal to remediate California's government-induced-longstanding-unresolved-drainage dilemma and a request that you exercise your administrative discretion and temporarily hold ALL Central Valley Project water supply contract scheduled for long-term renewal in the San Joaquin Valley in temporary abeyance until a specific plan is developed and approved to remedy the drainage problem. In the absence of such a plan, Porgans & Associates (P&A) would be left with no alternative but to oppose all future water contracts renewals and actively pursue petitioning the California State Water Resources Board to further condition and/or revoke the Bureau's water right permits. Ironically, while Interior Secretary Norton is promoting the "Water 2025" program to prevent crisis and conflicts in the West, the Bureau is without question a major source of the ongoing conflict!

*Since 1973, P&A has worked relentlessly to reduce and/or eliminate the socioeconomic and ecological impacts attributable to toxic agricultural drainage. Although our efforts have provided some relief to the problem; heretofore, the effort has been reactive, symptomatic and piecemeal. Furthermore, circumstances were not such that a plan such as the one we are submitting would have been considered. However, as stated in our proposed plan --- **The Agricultural Drainage Alleviation Plan** (ADAP) --- there are several converging factors that provide a unique opportunity to shift the proverbial paradigm. Needless to say, your participation and commitment is an essential component to its success.*

P&A's request is consistent with Congressman George Miller's request to Commission Keys, in his August 20, 2004, letter, Re: Review of Central Valley Project long-term water contracts. In Congressman Miller's letter, it states, "....we believe that it is essential that taxpayers be given full opportunity to comment on these new contracts after the Bureau first makes public its rationale for waiving all capital costs and restoration charges for many of the new contracts...." As a taxpayer, I am in complete support of Congressman Miller's request. It would be an understatement to catagorize P&A's request as a real challenge to the Bureau. Albeit, there are times in history that necessitate the need for public trustees to make an exception from the business-as-usual practices and reinstate the protection of the general public, in the interest of the common good. All of the existing conditions, in the San Joaquin Valley and the Colorado River Basin, are a testimony that the time to act is now. As it stands now, the Bureau is between a rock and the hardpan. We appeal to you as public servants and as other planet-dependent human beings to give this request and the ADAP your prompt attention and full consideration. P&A awaits your reply.

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[11] Patrick Porgans & Associates, Inc., Letter [**Certified Mail: Z 574 422 963**] to Ed Schnabel, Chairman, California Regional Water Quality Control Board, Central Valley Region, Sacramento, California, 95827-309 **Faxed to: (916) 255-3015 ,** ***Re: ❶ The Board's "Public Hearing" on the Waste Discharge Requirements - San Luis & Delta Mendota Water Authority and U.S. Department of the Interior, Bureau of Reclamation, Grassland Bypass Channel Project-Fresno and Merced Counties. ❷ Formal Appeal of the Board's Decision to Approve the Waste Discharge Requirements. ❸ Formal Public Act Request for Copies of the Taped-Recordings of Agenda Item Number Seven,*** August 7, 1998, p. 1.

Thank you.[12]

The government not only failed to consider ADAP as a viable alternative solution, it never responded to this free offer. Conversely, it continued in pursuit of it historical practices, procedures and policies to exacerbate its 50- to 100-year in the making self-imposed drainage dilemma!

The agricultural drainage problem in California's San Joaquin Valley was recognized for more than 100 years. Hundreds of millions of dollars have been expended on a plethora of studies, programs, plans and methods designed to reduce the impacts associated with agricultural drainage-salt deposition. Nevertheless, the record reveals that the drainage dilemma is worst now than ever before, and there is no long-term solution to deal with this problem with the exception of the ludicrous out-of-valley – valley wide drain. Unfortunately government's failures have been at the taxpayers expense and to the demise of public trust resources.[13]

[12] Patrick Porgans & Associates, Inc. Correspondences [Certified Mail 7003 1010 0005 4427 1515] to John Keys, III, Commissioner, U.S. Bureau of Reclamation, Washington, D.C. and [Hand Delivered] Kirk Rodgers, Regional Director, U.S. B. R. Mid-Pacific Region, Sacramento, ***Re: Submittal of A Plan to Remediate California's Longstanding-Unresolved-Drainage Dilemma and a Request that You Exercise Your Administrative Discretion and Hold ALL Central Valley Project Water Supply Contracts Scheduled for Long-Term Renewal in the San Joaquin Valley in Temporary Abeyance Until a Specific Plan is Developed and Approved to Remedy the Drainage Problem,*** August 31, 2004.

[13] Patrick Porgans & Associates, Inc., Testimony To and Before All Members of the Central Valley Regional Water Quality Control Board's, "Informal Public Hearing" ***Re: Waste Discharge Requirements - San Luis & Delta Mendota Water Authority and U.S. Department of the Interior - Bureau of Reclamation - Grassland Bypass Channel Project - Fresno and Merced Counties,*** July 24, 1998.

Government's Self-Induced Drainage Dilemma Draining Taxpayers Resources

4. The Legislature should consider putting additional bond issues before the voters to provide low interest loans for agricultural water conservation and water quality projects and incorporating provisions that would allow recipients to be private landowners, and that would allow irrigation efficiency improvement projects that reduce drainage discharges to be eligible for both water conservation funds and water quality facilities funds. [14]

ESTIMATED COSTS OF AGRICULTURAL WATER QUALITY CONTROL PROGRAMS AND POTENTIAL SOURCES OF FINANCING:

San Joaquin River Subsurface Agricultural Drainage Control Program

The estimates of capital and operational costs to achieve the selenium objective for the San Joaquin River range from $3.6 million/year to $27.4 million/year (1990 dollars). The cost of meeting water quality objectives in Mud Slough (north), Salt Slough, and the wetland supply channels is approximately $2.7 million /year (1990 dollars).

Potential funding sources include:

1. Private financing by individual sources.

2. Bonded indebtedness or loans from governmental institutions.

3. Surcharge on water deliveries to lands contributing to the drainage problem.

4. Ad Valorem tax on lands contributing to the drainage problem.

5. Taxes and fees levied by a district created for the purpose of drainage management.

6. State or federal grants or low-interest loan programs.

7. Single-purpose appropriations from federal or State legislative bodies (including land retirement programs).

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[14] California Regional Water Quality Control Board, Central Valley Region, ***Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River San Joaquin River Basins***, Implementation, 27 January 2005, p. IV-3-.00.

Lower San Joaquin River Salt and Boron Control Program

The estimates of capital and operational costs to implement drainage controls needed to achieve the salt and boron water quality objectives at the Airport Way Bridge near Vernalis range from 27 to 38 million dollars per year (2003 dollars).

Potential funding sources include:

1. Those identified in the San Joaquin River Subsurface Agricultural Drainage Program and the Pesticide Control Program.

2. Annual fees for waste discharge requirements.

Pesticide Control Program

Based on an average of $15 per acre per year for 500,000 acres of land planted to rice and an average of $5 per acre per year for the remaining 3,500,000 acres of irrigated agriculture in the Sacramento and San Joaquin River Basins, the total annual cost to agriculture is estimated at $25,000,000. Financial assistance for complying with this program may be obtainable through the U.S.D.A. Agricultural Stabilization and Conservation Service and technical assistance is available from the University of California Cooperative Extension Service and the U.S.D.A. Soil Conservation Service.

Sacramento and Feather Rivers Orchard Runoff Control Program

The total estimated costs for management practices to meet the diazinon objectives for the Sacramento and Feather Rivers are from a $0.3 million/ year cost savings to a $3.8 million/year cost (2001 dollars). The estimated costs for discharger monitoring, planning, and evaluation are from $0.5 to $9.3 million/year (2003 dollars).

Potential funding sources include:

1. Those identified in the San Joaquin River Subsurface Agricultural Drainage Control Program and the Pesticide Control Program.

San Joaquin River Dissolved Oxygen Control Program

The Control Program for Factors Contributing to the Dissolved Oxygen Impairment in the Stockton Deep Water Ship Channel (DWSC) requires agricultural and municipal dischargers to perform various studies.

The total estimated cost of the studies to be performed as part of this control program is approximately $15.6 million. The preferred alternative also includes a prohibition of discharge if water quality objectives are not achieved by 31December 2011. The estimated cost to cease discharge of water from irrigated lands ranges from $95 to $133 million per year. The estimated cost to provide minimum flows that would remove the need for the prohibition is approximately $37 million dollars per year to eliminate the impairment through provision of purchased water. The cost of construction of an aeration device of adequate capacity to eliminate the impairment, in conjunction with point source load reductions already required, is estimated to be $10 million, with yearly operation and maintenance costs of $200,000 per year.

Potential funding sources:

1. Proposition 13 includes $40 million in bond funds to address the dissolved oxygen impairment in the DWSC. Approximately $14.4 million of this $40 million has been identified to fund the oxygen demanding substance and precursor studies. An additional $1.2 million is being provided from various watershed stakeholders. Approximately $24 million of Proposition 13 funds are available to pay for projects such as the design and construction of an aeration device.

2. The State Water Contractors, Port of Stockton, San Luis and Delta Mendota Water Authority, San Joaquin Valley Drainage Authority, and the San Joaquin River Group Authority have proposed to develop an operating entity for an aeration device and have indicated their commitment to execute a funding agreement among themselves and other interested parties, (subject to ultimate approval of *respective governing boards) that would provide the mechanism to support operation of a permanent aerator at a cost expected to be in the annual range of $250,000 to $400,000.*

Diazinon and Chlorpyrifos Runoff into the San Joaquin River Control Program

The total estimated costs for management practices to meet the diazinon and chlorpyrifos objectives for the San Joaquin River range from $56,000 to $2.5 million for the dormant season, and from $3.9 million to $5.3 million for the irrigation season.

The estimated costs for discharger compliance monitoring, planning and evaluation range from $600,000 to $3.1 million. The estimated total annual costs range from $4.4 million to $10.9 million (2004 dollars).

Potential funding sources include:

1. Those identified in the San Joaquin River Subsurface Agricultural Drainage Control Program and the Pesticide Control Program.

Diazinon and Chlorpyrifos Runoff into the Sacramento-San Joaquin Delta Waterways

The total estimated costs for management practices to meet the diazinon and chlorpyrifos objectives for the Delta Waterways range from $5.9 to $12.7 million. The estimated costs for discharger compliance monitoring, planning and evaluation range from $600,000 to $1.8 million. The estimated total annual costs range from $6.5 to $14.4 million (2005 dollars).

Potential funding sources include:

1. Those identified in the San Joaquin River Subsurface Agricultural Drainage Control Program and the Pesticide Control Program.

San Joaquin River Dissolved Oxygen Control Program

The Control Program for Factors Contributing to the Dissolved Oxygen Impairment in the Stockton Deep Water Ship Channel (DWSC) requires agricultural and municipal dischargers to perform various studies.

The total estimated cost of the studies to be performed as part of this control program is approximately $15.6 million. The preferred alternative also includes a prohibition of discharge if water quality objectives are not achieved by 31 December 2011. The estimated cost to cease discharge of water from irrigated lands ranges from $95 to $133 million per year. The estimated cost to provide minimum flows that would remove the need for the prohibition is approximately $37 million dollars per year to eliminate the impairment through provision of purchased water. The cost of construction of an aeration device of adequate capacity to eliminate the impairment, in conjunction with point source load reductions already required, is estimated to be $10 million, with yearly operation and maintenance costs of $200,000 per year.

Potential funding sources:

1. Proposition 13 includes $40 million in bond funds to address the dissolved oxygen impairment in the DWSC. Approximately $14.4 million of this $40 million has been identified to fund the oxygen demanding substance and precursor studies. An additional $1.2 million is being provided from various watershed stakeholders. Approximately $24 million of Proposition 13 funds are available to pay for projects such as the design and construction of an aeration device.

2. The State Water Contractors, Port of Stockton, San Luis and Delta Mendota Water Authority, San Joaquin Valley Drainage Authority, and the San Joaquin River Group Authority have proposed to develop an operating entity for an aeration device and have indicated their commitment to execute a funding agreement among themselves and other interested parties, (subject to ultimate approval of respective governing boards) that would provide the mechanism to support operation of a permanent aerator at a cost expected to be in the annual range of $250,000 to $400,000.

To: **U.S. Bureau of Reclamation, Laura Myers, email lmyers@mp.usbr.gov Fax (559) 487-5397**
Joseph McGahan, Drainage Coordinator, San Luis & Delta Mendota Water Authority Fax (559-582-9237
From: Patrick Porgans & Associates, Inc. (*De facto Public Trustee*)

Project: U.S. Bureau of Reclamation's ***Notice of Preparation (NOP) of a Draft Environmental Impact Statement/Environmental Impact Report for the Grassland Bypass Project Extension***
Subject: Written Comments and Supporting Information to Formal Oppose the GBP and Suggest the No Alternative

Diazinon and Chlorpyrifos Runoff into the San Joaquin River Control Program

The total estimated costs for management practices to meet the diazinon and chlorpyrifos objectives for the San Joaquin River range from $56,000 to $2.5 million for the dormant season, and from $3.9 million to $5.3 million for the irrigation season.

The estimated costs for discharger compliance monitoring, planning and evaluation range from $600,000 to $3.1 million. The estimated total annual costs range from $4.4 million to $10.9 million (2004 dollars).

Potential funding sources include:

1. Those identified in the San Joaquin River Subsurface Agricultural Drainage Control Program and the Pesticide Control Program.

Diazinon and Chlorpyrifos Runoff into the Sacramento-San Joaquin Delta Waterways

The total estimated costs for management practices to meet the diazinon and chlorpyrifos objectives for the Delta Waterways range from $5.9 to $12.7 million. The estimated costs for discharger compliance monitoring, planning and evaluation range from $600,000 to $1.8 million. The estimated total annual costs range from $6.5 to $14.4 million (2005 dollars).

Potential funding sources include:

1. Those identified in the San Joaquin River Subsurface Agricultural Drainage Control Program and the Pesticide Control Program.[15]

Summary Statement, Comments and Recommendations: Introductory Statement: It is with great disdain and yet with all due that P&A respectfully submits the following comments and suggestions. After 37 years of participatory involvement in California's 100-year-in-the-making government-induced-drainage dilemma, which has and continues to be the leading unresolved water contamination threat facing the Golden State, it would be disingenuous if P&A did not state that your request to extend this dilemma for yet another decade is reprehensible, irresponsible and unconscionable and extremely disconcerting.

❶ Cease discharges to Mud Slough, San Joaquin River and the Sacramento-San Joaquin Delta.

❷ Stop irrigating lands with known drainage problems.

❸Cease obtaining and spending public funds to feed your "dead horse drainage farms."

Please be advised as a de facto public trustee P&A will, by God's grace, use the quasi-administrative process to appeal and/or deter your efforts. As stated during the Scoping Session, P&A commended Reclamation and the Authority for their efforts, however, we cannot, in good conscience, sit and watch your seemingly never-ending efforts to condemn public trust resources and the waters of the State. The Mesopotamians' inadvertently brought down their civilizations, in part, because of salts building up in their soils on the Tigris and Euphrates Rivers, the Romans after the 100-year war with the Carthaginians had salts placed in the lands around Carthage, as a means to ensure that the Carthaginians would not rise up as a future threat. Conversely, Reclamation and its agricultural contractors are being paid and using the public's money to double the salt loads in the once-great and fertile San Joaquin Valley as the expense and to the demise of the river and Delta. Please stop draining the public of its essential resources. Thank you.

P.S. Time did not permit me to provide all of the documentation that this project requires; however, you can appreciate that this is quite draining. Please confirm receipt of this fax and email.

cc: Interested Parties ***fnl:grasslands2007final***

[15]California Regional Water Quality Control Board, Central Valley Region, ***Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River San Joaquin River Basins.*** Implementation, 27 January 2005, p. IV-38.00 and IV-39.00.

To: **U.S. Bureau of Reclamation, Laura Myers, email lmyers@mp.usbr.gov Fax (559) 487-5397** 15
Joseph McGahan, Drainage Coordinator, San Luis & Delta Mendota Water Authority Fax (559-582-9237
From: Patrick Porgans & Associates, Inc. (*De facto Public Trustee*)

Project: U.S. Bureau of Reclamation's ***Notice of Preparation (NOP) of a Draft Environmental Impact Statement/Environmental Impact Report for the Grassland Bypass Project Extension***
Subject: Written Comments and Supporting Information to Formal Oppose the GBP and Suggest the No Alternative

January 18, 2008

Roy L. Thomas, DDS
26535 Carmel Rancho Blvd, Ste 5-A
Carmel, CA 93923

Ms. Laura Myers
Bureau of Reclamation
South-Central California Office
1243 N Street
Fresno, CA 93721

Re: NOP of a Draft Environmental Impact Statement/Environmental Impact Report for the Grassland Bypass Project Extension

Dear Ms. Myers;

I would like to strongly protest this extension of the use agreement for the Grassland Bypass Project. The continued damage and destruction of the mud slough and the San Joaquin River needs to stop. Damage to all aquatic wildlife that still survives is ongoing. Frog species, the Giant Garter Snake [Thamnophis], and all the other wildlife that need surface water are suffering.

There appears to have been no serious effort to solve this dangerous pollution problem over the last series of extensions. Why would we think they would do anything this time? The polluters should not be allowed to export their waste to the mud slough, the river, or the greatly impacted Delta.

Sincerely,

Roy L. Thomas, DDS