BUREAU OF RECLAMATION

2020 Management Agency Agreement Annual Report

October 1, 2019 – September 30, 2020

U.S. Department of the Interior 2020

Mission Statements

The Department of the Interior (DOI) conserves and manages the Nation's natural resources and cultural heritage for the benefit and enjoyment of the American people, provides scientific and other information about natural resources and natural hazards to address societal challenges and create opportunities for the American people, and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities to help them prosper.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Table of Contents

List of Tables

List of Figures

This page intentionally left blank

Abbreviations and Acronyms

Action Plan	Actions to Address the Salinity and Boron TMDL Issues for the Lower San Joaquin River November 2008
Basin Plan	Water Quality Control Plan for the Sacramento and San Joaquin River Basins, 5th Edition
BMP	Best Management Practices
BO	Biological Opinion
CALFED	California Bay-Delta Authority
CVO	Central Valley Operations
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CV Water Board	Central Valley Regional Water Quality Control Board
CV-SALTS	Central Valley Salinity Alternatives for Long Term Sustainability Stakeholder Group
D-1641	State Water Resources Control Board Decision 1641
DF	Base Design Flow
DMC	Delta-Mendota Canal
EC	Electrical Conductivity
GBP	Grassland Bypass Project
GDA	Grassland Drainage Area
GDF	Goodwin Dam Flow
GWD	Grassland Water District
LSJR	Lower San Joaquin River
LSJRC	Lower San Joaquin River Committee
MAA	Management Agency Agreement
MID	Modesto Irrigation District

MOU	Memorandum of Understanding
NOAA	National Oceanic and Atmospheric Administration
mg/L	milligram(s) per liter (parts per million)
PTMS	Program to Meet Standards
Reclamation	United States Bureau of Reclamation
Regression Model	inverse gradient regression model
RFC	California-Nevada River Forecast Center
RTMP	Real Time Management Program
SJR	San Joaquin River
SJRIP	San Joaquin River Water Quality Improvement Project
State Water Board	State Water Resources Control Board
TAF	Thousand Acre-Feet
TDS	Total Dissolved Solids
TID	Turlock Irrigation District
Title XVI	Title XVI of the Reclamation Projects Authorization and Adjustment Act of 1992 (P.L. 102-575), provides funding specifically for water reuse projects in 17 western states and Hawaii.
TMDL	Total Maximum Daily Load
VAMP	Vernalis Adaptive Management Plan
WARMF	Watershed Analysis Risk Management Framework
WQO	Water Quality Objective
WRDP	Westside Regional Drainage Plan
WSI	Water Supply Index

2020 MAA Summary of Reclamation Activities

Purpose

The Central Valley Regional Water Quality Control Board's (CV Water Board) Control Program for Salt and Boron Discharges into the Lower San Joaquin River (LSJR), also known as the Salt and Boron Total Maximum Daily Load (TMDL), was approved and placed into effect on September 10, 2004. In response to the Salt and Boron TMDL, the U.S. Bureau of Reclamation (Reclamation) developed the salinity management plan titled *Actions to Address the Salinity and Boron TMDL Issues for the Lower San Joaquin River* (Action Plan) and entered into a Management Agency Agreement (MAA) with the CV Water Board on December 22, 2008. The MAA described Reclamation's actions to meet the obligations allocated to it by the Salt and Boron TMDL for the Lower San Joaquin River. In the MAA, Reclamation agreed to implement the Action Plan. Figure 1 shows seven TMDL subareas for salt load management in the LSJR Basin.

Reclamation and the CV Water Board revised the MAA on December 4, 2015. The revised MAA does not reference the Action Plan. However, Section 2.3d of the revised MAA states that "Reclamation actions will be detailed in an Annual Work Plan and submitted along with a Status of Activities to Date from the previous year."

This report summarizes activities conducted by Reclamation in 2020 in conjunction with the related elements outlined in the revised MAA. The original Action Plan described Reclamation's past practices and procedures to mitigate and manage adverse impacts of salt and boron imported into the San Joaquin Basin via the Delta-Mendota Canal (DMC) to help achieve compliance with the objectives contained in the CV Water Board's *Water Quality Control Plan for the Sacramento River and the San Joaquin River Basins – 5th Edition* (Basin Plan). Reclamation reported the activities in quarterly reports as agreed to in the 2008 MAA. In the 2015 revised MAA (referred to as the MAA from here forward), Reclamation activities are now reported at the end of each calendar year in the Annual Report and activities planned for the next fiscal year (FY) are proposed in the Annual Work Plan.

Organization of the Annual Report

The Annual Report provides a synopsis of the various activities performed by Reclamation in accordance with the MAA. Action categories include Providing Flows to the System, Salt Load Reductions, and Phased Program Activities. For each action a brief description and list of activities are provided. The Annual Report includes calculations of salt loads based on DMC deliveries and calculations of assimilative capacity provided through dilution flows. The *Compliance Monitoring and Evaluation Plan,* dated May 2010 and submitted in 2010, outlines the criteria and methodology for determining DMC loads and credits.

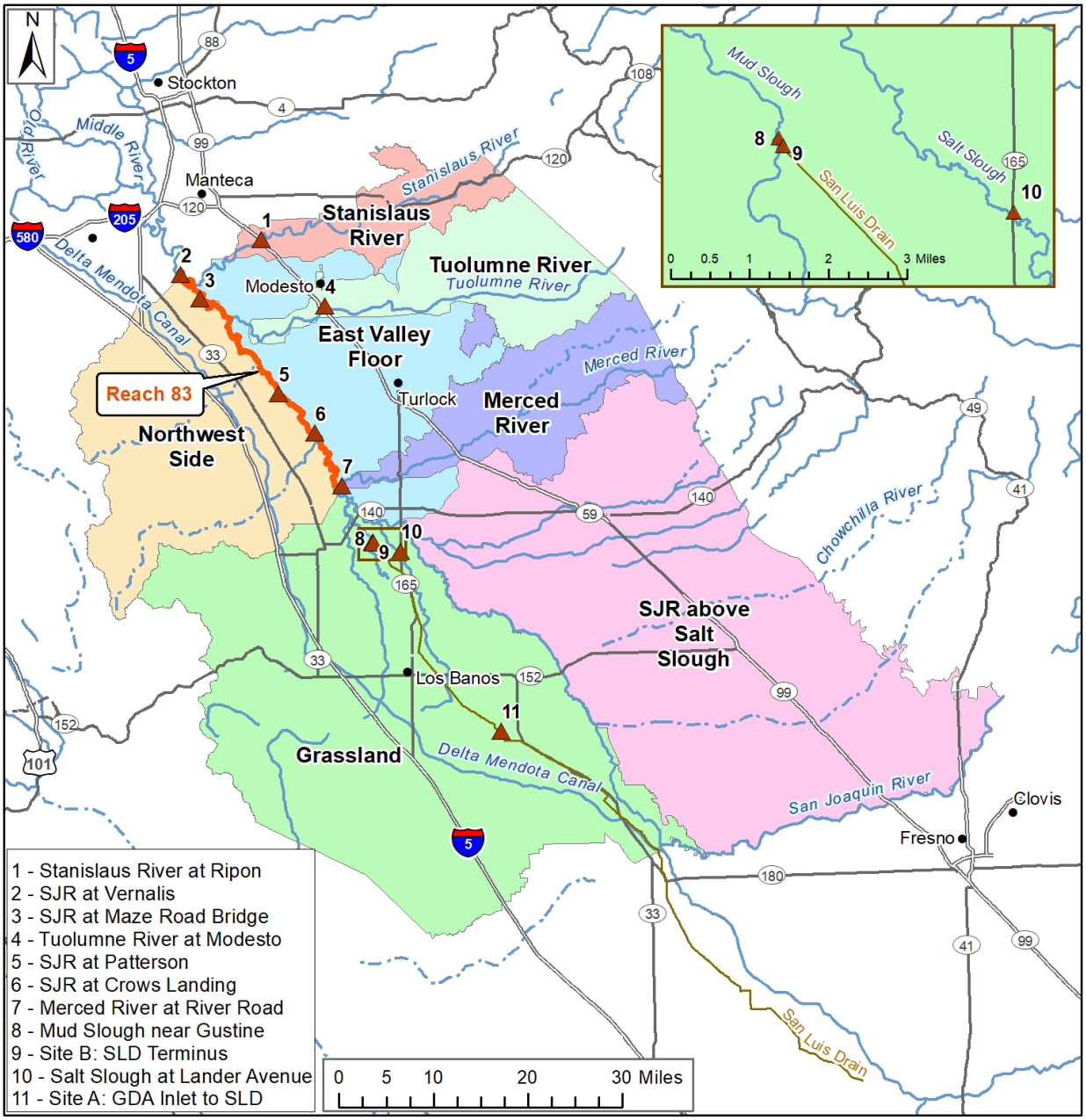

Figure 1. TMDL Subareas for Salt Load Management in the LSJR Basin

Providing Flows to the System

In 2000, Reclamation agreed to the provisions in the State Water Resources Control Board's (State Water Board) revised Decision 1641 (D-1641), which require the release of flows from New Melones Reservoir (Figure 2) to meet the Vernalis salinity objectives. Historically, Reclamation has provided both fishery and water quality dilution flow to the San Joaquin River from New Melones Reservoir and through purchases for the Vernalis Adaptive Management Plan (VAMP) or the Central Valley Project Improvement Act (CVPIA). The San Joaquin River Agreement, which included provisions to acquire spring and fall pulse flows for the VAMP, expired on December 31,

2011. Reclamation continued to provide interim spring pulse flows for the San Joaquin River through a two-year agreement with Merced Irrigation District, which expired on December 31, 2013. During this timeframe, stakeholders within the watershed, including Reclamation, initiated the San Joaquin Tributary Settlement Process to formulate a collaborative solution to present to the State Water Board as an alternative to the State Water Board's new proposed San Joaquin River flow standard.

New Melones Reservoir Operations – Provision of Dilution Flow

In the Flood Control Act of October 1962, Congress reauthorized and expanded the function of the Melones Reservoir (P.L. 87-874) to become a multipurpose reservoir constructed by the U.S. Army Corps of Engineers and operated by the Secretary of the Interior as part of the Central Valley Project (CVP), thus creating the New Melones Reservoir. Reclamation signed a Memorandum of Understanding (MOU) with the CV Water Board in 1962 to schedule water releases from New Melones to maintain a dissolved oxygen level of 5 milligrams per liter (mg/L) in the Stanislaus River downstream of the reservoir at the Ripon monitoring station. The multipurpose objectives of the reservoir now include flood control, irrigation, municipal and industrial water supply, power generation, fishery enhancement, water quality improvement, and recreation. Since June of 2009, New Melones Reservoir has been operated by Reclamation to meet the National Marine Fisheries Service Biological Opinion (BO). The BO addresses the effects of the continued operation of the CVP and the California State Water Project on the various runs of Chinook salmon, Central Valley steelhead, and green sturgeon, and their designated critical habitats.

Figure 2. New Melones Reservoir

The Basin Plan was amended in 2004 to include a control program for salt and boron discharges into the LSJR. The control program dictated that through the MAA between Reclamation and the Regional Water Board, Reclamation would either a) meet DMC salinity load allocations or b) provide dilution flows to create additional salt load assimilative capacity in the LSJR equivalent to

DMC salt loads in excess of their allocation. Items 12 and 13 in the Salt and Boron Water Quality Control Program include the following statements:

> **Item 12**. Salt loads in water discharged into the LSJR or its tributaries for the express purpose of providing dilution flow are not subject to load limits described in this control program if the discharge:
>
> a) Complies with salinity Water Quality Objectives (WQOs) for the LSJR at the Airport Way Bridge near Vernalis;
>
> b) Is not a discharge from irrigated lands; and
>
> c) Is not provided as a water supply to be consumptively used upstream of the San Joaquin River at the Airport Way Bridge near Vernalis.
>
> **Item 13**. Entities providing dilution flows, as described in item 12, will obtain an allocation equal to the salt load assimilative capacity provided by this flow. This dilution flow allocation can be used to: 1) Offset salt loads discharged by this entity in excess of any allocation or; 2) trade, as described in item 10. The additional dilution flow allocation provided by dilution flows will be calculated as described in Table IV-8 (CV Water Board 2018).

Activities

Reclamation continues to operate its New Melones facilities to comply with State Water Board D-1641, New Melones Interim Plan of Operations, the applicable Biological Opinions, and the Stanislaus River at Ripon monitoring station dissolved-oxygen criteria.

Quantification Methodology: Table IV-4.4 (CV Water Board 2017) states that dilution flow allocations should be calculated as follows:

$A_{dil} = Q_{dil} \times (C_{dil} - WQO) \times 0.8293$ Where:

A_{dil} = Monthly assimilative capacity provided by a dilution flow (expressed as salt load) in tons per month

Q_{dil} = Dilution flow rate in thousand acre-feet (TAF) per month [above base flows]

C_{dil} = Electrical conductivity (EC) of the dilution flow in micro-Siemens per centimeter (µS/cm)

WQO = Salinity water quality objective for the LSJR at Airport Way Bridge near Vernalis in µS/cm

Table 1 lists data and monthly calculations for the past year. Data for flow releases from Goodwin Dam, the Stanislaus River, "design flows," and salinity at Orange Blossom Bridge are used to calculate the monthly dilution flow allocations. When Goodwin Dam flows are less than base design flows, the flows are adjusted to equality to set assimilative capacity for the month to zero. The water-year type is estimated based on the 75% probability of exceedance found in California Department of Water Resources Water Supply Index Forecasts (https://cdec.water.ca.gov/reportapp/javareports?name=WSI) for the San Joaquin Valley. The 75%

exceedance flow forecast for May 1, 2020, is 2.2, which classifies 2020 as a "dry" year. In 2020 the San Joaquin River Valley floor received 67% of the average seasonal rainfall.[1]

Table 1. Salt Load Assimilative Capacity of Goodwin Dam Releases to the San Joaquin River, Water Year 2020

	Goodwin Dam Flow (GDF)[a] TAF	Base Design Flow (DF)[b] TAF	Qdil =GDF-DF TAF	WQO[c], µS/cm	Monthly Average EC at Orange Blossom Bridge (Cdil)[d] µS /cm	Monthly Assimilative Capacity Adil, tons
October 2019	47	8	39	1,000	61	30,370
November 2019	31	12	19	1,000	61	14,796
December 2019	108	13	95	1,000	61	73,978
January 2020	53	12	41	1,000	66	31,757
February 2020	77	19	58	1,000	71	44,684
March 2020	39	17	22	1,000	70	16,967
April 2020	36	28	8	700	85	4,074
May 2020	70	61	9	700	87	4,575
June 2020	73	2	71	700	61	37,625
July 2020	12	3	9	700	63	4,754
August 2020	12	12	0	700	66	0
September 2020	12	15	0	1,000	73	0
Total						263,582

[a] https://www.usbr.gov/mp/cvo/reports.html

[b] Reclamation 2010 Compliance Monitoring and Evaluation Plan

[c] State Water Board Decision 1641

[d] http://cdec.water.ca.gov/dynamicapp/staSearch

[1] https://www.cnrfc.noaa.gov/monthly_precip_2020.php

Water Resources and Water Quality Regulation

The CVPIA, signed into law on October 30, 1992, modified priorities for managing water resources of the CVP. The CVPIA altered the management of the CVP to elevate fish and wildlife protection, restoration, and enhancement as a co-equal priority with water supply for agriculture and municipal and industrial purposes while recognizing other associated benefits such as power generation. To meet water acquisition needs under CVPIA, the U.S. Department of the Interior developed a Water Acquisition Program as a joint effort between Reclamation and the U.S. Fish and Wildlife Service. The program's purpose is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve the Department of the Interior's ability to meet regulatory water quality requirements.

Activities

Reclamation did not acquire any additional water for water quality purposes in 2020.

Salt Load Reductions

Reclamation is under a court order to provide drainage to the San Luis Unit on the west side of the Lower San Joaquin Valley. As part of this effort, Reclamation historically supported the Westside Regional Drainage Plan (WRDP) through grants and in-kind services. Incidental salt load reduction actions include the Grassland Bypass Project (GBP), implementation of the WRDP, and the following conservation programs: Water Conservation Field Services Program, WaterSMART Water and Energy Efficiency Grants (formerly Water 2025 Grants Program), and the California Bay-Delta Authority (CALFED) Bay-Delta Water Use Efficiency Program. Although most of these programs were not proposed as salt load reduction efforts, their successful implementation has resulted in measurable reduced salt loading to the lower San Joaquin River.

Grassland Bypass Project (GBP)

The GBP is a multi-agency stakeholder project currently based upon the 2009 Use Agreement[2] between Reclamation and the San Luis and Delta-Mendota Water Authority to manage and reduce the volume of agricultural drainage water produced within the Grassland Drainage Area (GDA), and to use a 28-mile section of the San Luis Drain to convey this drainage water to Mud Slough, a tributary of the San Joaquin River. The GBP removed agricultural drainage water from most wetland water supply conveyance channels, facilitated drainage management that maintains the viability of agriculture in the GDA, and promoted continuous improvement in water quality in the San Joaquin River. In 2019, the conveyance of agricultural drainage was disallowed by Reclamation under the GBP. The progress and feasibility of attaining this goal has been assessed by the Interagency Data Collection and Review Team that has been responsible for implementing the GBP environmental monitoring program.

[2] U.S. Bureau of Reclamation and the San Luis and Delta-Mendota Water Authority, December 22, 2009. Agreement for Continued Use of the San Luis Drain for the Period January 1, 2010, through December 31, 2019. Agreement No. 10-WC-20-3975.

Activities

- The load of salts and boron discharged from the GDA to the Lower San Joaquin River have been significantly reduced through the implementation of the GBP in 1996 and the development of the San Joaquin River Improvement Project (SJRIP) in 2002. The GBP was concluded on December 31, 2019, which was the date on which all selenium-contaminated subsurface drainage discharge to Mud Slough and the San Joaquin River was to cease. All subsurface drainage from the GDA is now is diverted into the SJRIP.
- Prior to Water Year 1996, more than 191,000 tons of salts and 357 tons of boron were discharged annually from the GDA to the Lower San Joaquin River.
- During Water Year 2020, 17,000 tons of salts and 91 tons of boron were discharged from the GDA to the San Luis Drain.
- These significant reductions are the result of selenium-reduction activities conducted by the Grassland Area Farmers with the support of Reclamation to develop and operate the SJRIP reuse area.
- During Water Year 2020, approximately 261,000 tons of salts and 638 tons of boron were displaced to the SJRIP. Absent the collaboration between Grassland Area Farmers and Reclamation, these loads would have been discharged to the Lower San Joaquin River.

Figure 3 shows the progressive reduction of salts discharged from the GDA[3] due to agricultural flow diversion to the SJRIP.

Figure 4 shows the progressive reduction of boron discharged from the GDA. For Water Year 2020, 91 tons of boron was discharged to the Lower San Joaquin River from the GDA and approximately 638 tons were displaced to the SJRIP.

[3] Data Sources: Regional Board (pre-project), Reclamation, and Summers Engineering

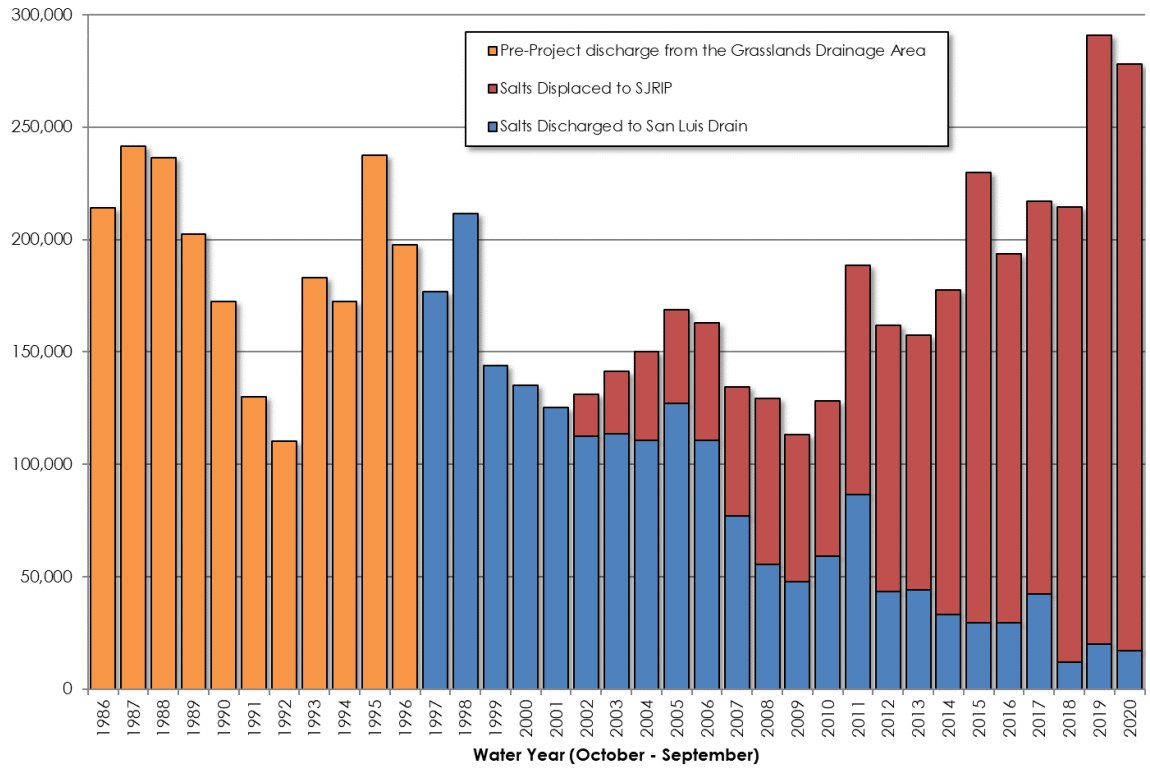

Figure 3. Salts Discharged from the Grassland Drainage Area (tons)

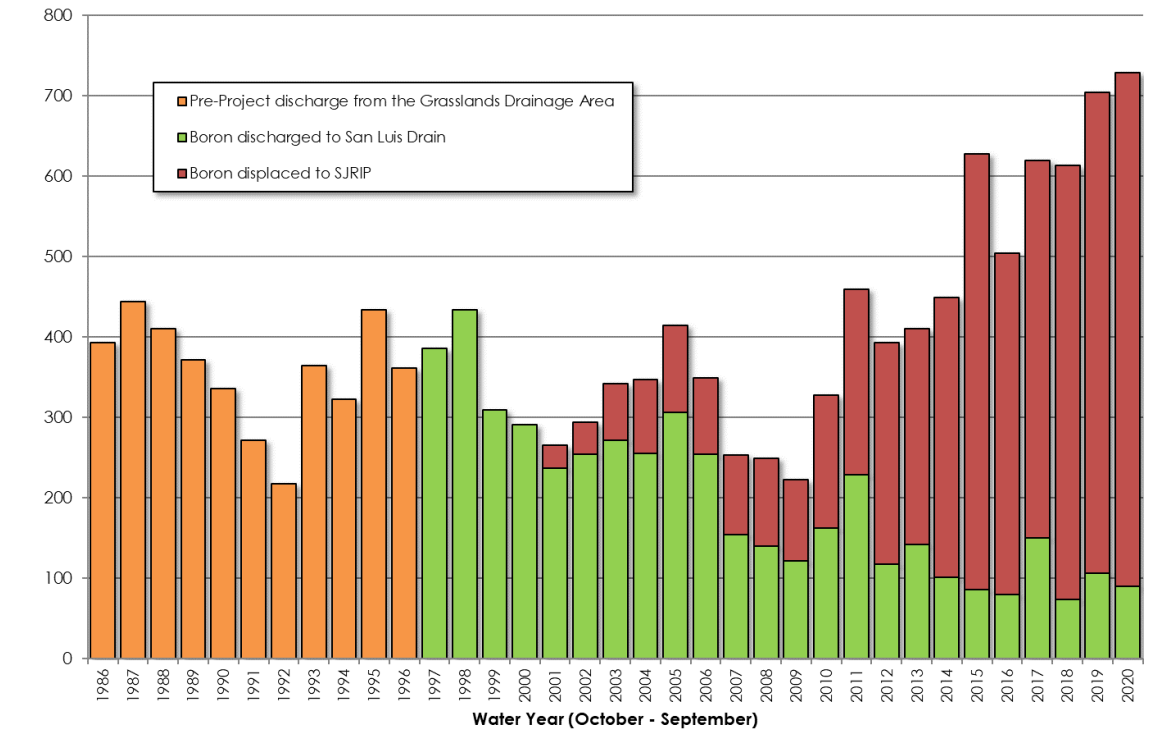

Figure 4. Boron Discharged from the Grassland Drainage Area (tons)

- A small amount of subsurface drainage from adjacent agricultural and wetlands in Grassland Water District (GWD) seeps into the San Luis Drain along its 28-mile length and is discharged into Mud Slough. These seepage flows are monitored by Reclamation at Site B on the San Luis Drain. This seepage does not contain selenium concentrations above the 2 ppb threshold. After December 31, 2019, the only inflow to the San Luis Drain is from these sources.
- The current GBP operates as a storm water management project under the Central Valley Regional Water Quality Control Board Order R5-2019-0077, which has recently been updated. Runoff from winter rainstorms on the GDA has been conveyed through the San Luis Drain.
- On September 5, 2019, the CV Water Board adopted revised waste discharge requirements (R5-2015-0094) for surface discharges from the Grassland Bypass Project, enacting a 4-day average water quality objective of 5 μg Se L^{-1} in Mud Slough downstream of San Luis Drain as of January 1, 2020. The Grassland Area Farmers are implementing a long-term stormwater management plan to control stormwater discharge into San Luis Drain and prevent exceedances of the 4-day average Se WQO.
- Reclamation continues to collect and analyze water samples from nine sites for selenium, boron, salts, nutrients, and molybdenum, and continues to operate auto-samplers in the San Luis Drain and in the river at Crows Landing.

Westside Regional Drainage Plan

The WRDP is a local stakeholder program developed by integrating all consistent elements of drainage management developed by government and local agencies and private partnerships. The original efforts of the WRDP focused on reducing selenium discharges to the San Joaquin River. Success of the original effort prompted a proposal to expand the WRDP to go beyond regulatory requirements and eliminate selenium, boron, and salt discharges to the San Joaquin River while maintaining productivity of agricultural lands in the San Joaquin Valley and enhancing water supplies for the region.

Additional Activities Benefiting Salt Management

- The Grassland Drainage Authority continues to implement activities associated with the WRDP and SJRIP. The SJRIP reuses subsurface agricultural drain water from the Grassland Drainage Area to irrigate salt-tolerant crops such as Joes tall wheatgrass, alfalfa, and pistachios.
- The San Luis Demonstration Treatment Facility Plant was shut down for renovations in December 31, 2018. Reclamation posted a solicitation to retrofit the feed pumps and the solids waste handling system at the demonstration plant on July 22, 2019. Construction is ongoing.
- Reclamation has provided approximately $45 million in past funding to the SJRIP and continues to support reuse activities at the facility.
- Reclamation will continue to fund activities in the Grassland Drainage Area as funding becomes available.

- Del Puerto Water District (DPWD) has been granted $12.075 million though the Title XVI program to reimburse expenditures for a recycled water project, North Valley Regional Recycled Water Project. DPWD is a Reclamation water contractor for CVP water and member of the San Luis & Delta-Mendota Water Authority.
- For Water Year 2020 (October 2019 through September 2020), Grassland Basin Drainers report a displacement of 31,988 acre-feet of agricultural drainage water to the SJRIP, containing 261,000 tons of salts and 638 tons of boron. Absent the SJRIP, these salt and boron loads would have been discharged into the Lower San Joaquin River.

Water Conservation Efforts Benefiting Salt Management

The water use efficiency program includes several grant programs which fund actions to assure efficient use of existing and new water supplies. Activities to improve water use efficiency can alter the magnitude and scheduling of water diversions from Reclamation canals providing additional benefits. These activities can also result in reduced discharge of agricultural drainage and associated pollutants, improving water quality in receiving waters such as the San Joaquin River. Although Reclamation is not always able to quantify the benefits of the various funded projects with respect to salt load reduction, these projects all contribute to the agency's water conservation efforts in the Basin. Funding for approximately 100 projects in the San Joaquin Valley have been awarded through programs such as WaterSMART, the Reclamation/Natural Resources Conservation Service partnership, and the CALFED Bay-Delta Restoration Program. Most of these programs have required quantifiable benefits and measurable performance measures since 2006.

The funding Reclamation provided in FY 2020 is listed in Table 2.

Table 2. Fiscal Year 2020 Reclamation Funding

No.	Funding Program	FY 2020 Allocation
I.	Program to Meet Standards • Provided financial assistance to GWD for providing support in the real time management program by collecting and providing data to Reclamation and for providing stakeholder coordination • Under a contract, Systech Water Resources Inc. developed new auto-data retrieval and process tools for WARMF model input in FY20 • University of California at Merced provided technical support and stakeholder coordination via a Cooperative Ecosystem Studies Unit agreement • Reclamation staff provided technical support and project management activities	$750,000
II.	Title XVI funding	$12,075,000

Phased Program Activities

The MAA lists several actions that are intended to improve management of salt and boron loads in the San Joaquin River. These actions have been phased in coordination with San Joaquin River Basin stakeholders, and each of these phases has been associated with primary goals. These phases and goals were recognized in the most recent Work Plans developed jointly with the San Joaquin Real-Time Management Program (RTMP) Steering Committee (Reclamation 2018; 2019; 2020). This reorganization of the description of activities has helped to make the annual reporting of program activities and accomplishments easier to follow and understand. The RTMP Steering Committee meets quarterly and includes both East- and Westside San Joaquin Basin stakeholders, agency personnel, and consultants.

Phases 1 and 2 of the RTMP were focused on initiation (Phase 1) and an early development phase (Phase 2) that tackled monitoring station design, installation, and operation (Goal 1); engaging stakeholder participation (Goal 2); stakeholder cooperation to seek grants and other external funding (Goal 3); and initial development of a watershed-level water quality simulation and water quality forecasting tool that would provide essential decision support for salt load assimilative capacity determination and salt load management (Goal 4). Phase 2 of the San Joaquin RTMP occurred during March 31, 2015, to March 31, 2016. Some goal elements from Phase 2 have been carried forward into Phases 3 and 4.

Phase 3 of the RTMP was the Early Implementation Phase, which concluded in March 2018. Goals under this phase included programmatic weekly forecasting of assimilative capacity in the San Joaquin River (SJR) by one or more cooperating RTMP entities (Goal 1); initiation of data-sharing activities between and among stakeholder entities and information technology innovations to facilitate secure and reliable data flows (Goal 2); periodic analysis of additional infrastructure needs and funding requirements through feedback from the MOU Steering Committee (Goal 3); development and recommendation of specific additional management practices needed to better coordinate the real-time operation of discharges to the SJR (Goal 4); and proactive outreach to current and prospective stakeholder entities in the Basin, specifically those who have not participated in the RTMP to date.

Phase 4 of the RTMP is the Implementation Phase, in which activities begun in Phases 2 and 3 become fully realized and are formalized as part of an ongoing RTMP. There are technical and institutional components to Phase 4 of the RTMP. Under Phase 4, RTMP participants continue to implement and upgrade monitoring, data networking, and management practices as needed. The WARMF salt load assimilative capacity forecasting model is expected to be utilized by stakeholders to coordinate the timing of drainage discharges to the river with available salt load assimilative capacity (Goal 1); RTMP participants also continue to address long-term funding and project needs (Goal 2); and the RTMP current membership may expand to include all regulated parties that includes both direct and indirect dischargers of salt to the San Joaquin River (Goal 3). Ongoing implementation may bring about technical improvements to data processing, quality assurance, and the SJR assimilative capacity forecast modeling (Goal 4).

Ongoing Phase 3 Activity Summary (April 2016 – March 2018)

Goal 1: Model-Based Forecasting of Salt Assimilative Capacity

Reclamation has actively supported the development of the San Joaquin River Salinity Forecasting Model, which utilizes the WARMF model to estimate daily river salt assimilative capacity and to provide decision support for real-time salinity management at the watershed level. The model provides a framework for analysis of flow and salinity data from tributaries and water district diversions. Salt assimilative capacity forecasts require both the provision of real-time flow and salinity data and anticipated actions impacting flow and salinity over a two-week forecast period. The accuracy of these forecasts is a function of the level of stakeholder involvement and the sharing of information.

Starting in FY 2018 and continuing through FY 2020, Reclamation has been using the data-driven regression model for estimating EC at two compliance monitoring stations (Vernalis and Crows Landing) on the San Joaquin River. A third compliance monitoring station at Maze Road was added midyear 2020, recognizing that the upstream salinity objectives to protect riparian diverters in Reach 83 on the lower San Joaquin River applied at both stations. One advantage of this data-driven approach is that forecasts can be more easily automated. The basis for the inverse gradient regression model is the relationship between the river's flow and its EC such that: 1) EC decreases when stream flow increases, and vice versa; and 2) the EC's rate of change is proportional to the river's change in flow rate. The inverse gradient regression model has provided good forecast accuracy, as shown in a recent internal report produced by Dr. Michael Tansey that compares the daily regression forecasts and weekly WARMF model forecasts with observations of flow and EC. Results of the analysis for the years 2018 to 2019 indicate that the regression model performs as well as the WARMF model for forecasting EC at the Vernalis and Crows Landing compliance monitoring stations. A detailed description of the regression model was shared with the CV Water Board and presented to the San Joaquin Valley Drainage Authority RTMP Subcommittee during early summer 2019, including statistical measures of its accuracy compared to the WARMF model that are repeated in the Tansey report. The conclusion drawn from the analysis is that the regression model can provide reliable forecasts that are easier and less time-consuming to perform and that provide a valid alternative to WARMF model forecasts of salinity in the San Joaquin River. However, as a tool for stakeholder decision support in the case of a sustained overage of river salinity objectives at any of the compliance monitoring sites, the WARMF model provides a more comprehensive understanding of the current state of the system that is necessary to manage salinity load management actions.

Goal 2: Data Assimilation Automation and Centralization

Continued development work was undertaken in FY 2020 to improve data assimilation from State, Federal, and private water and water quality data web portals. The updated data assimilation software, first developed in late 2019, runs from within the WARMF model graphical user interface (GUI) and both simplifies and makes more reliable the creation of WARMF model input files for flow and salinity forecasting. The work in FY 2020 was undertaken with the view of encouraging greater stakeholder involvement in the salt load assimilative capacity forecasting process.

Goal 3: Identification of Necessary Funding for Additional Infrastructure

Reclamation continues to participate in work on two Proposition 84 grants led by GWD and the San Joaquin River Drainage Authority (SJVDA) entitled: (a) "Optimizing Real-Time Management of

Combined Surface and Subsurface Drainage Return Flows From Seasonally Managed Wetlands in the San Joaquin River Basin" and (b) "Real-time Management of Surface and Subsurface Drainage Return Flows to Benefit Sustainable San Joaquin River Flow and Water Quality." The main objective of both grants has been to upgrade the monitoring hardware and cyberinfrastructure needed to move the real-time salinity management program into the implementation phase. Site installation upgrades have been completed in GWD. Site upgrades are underway at drainage stations within the Patterson and West Stanislaus Irrigation Districts. Monitoring of flow and EC at San Joaquin River diversion sites into both districts were also included in the SJVDA Proposition 84 projects. The installation in Patterson Irrigation District is complete, and diversion flow and EC data as well as a weekly data report from the district's SCADA system is being provided on the district website. This report contains daily flow, EC, and salt loading imported into the district as well as hourly data for flow and EC and several other water quality parameters of interest to district landowners that include turbidity, nitrate, and pH/oxidation reduction potential. The installation at West Stanislaus Irrigation District should be completed before December 31, 2020.

Goal 4: Development and Recommendation of Specific Additional Management Practices to Better Coordinate the Real-Time Operation of Discharges to the SJR

The RTMP is described in the TMDL as a stakeholder-driven effort to use real-time water quality and flow data to support water salinity management decisions to maximize the use of assimilative capacity in the San Joaquin River. Reclamation has been working with San Joaquin River stakeholders and participants in the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) initiative to support the development of a stakeholder-driven RTMP. Ongoing work on Goal 4 has been performed following the CV-SALTS Lower San Joaquin River Committee's development of salinity objectives for Reach 83 of the Lower San Joaquin River (Merced River inflow to Vernalis). Patterson Irrigation District and GWD currently use real-time sensor technology to both reduce drainage export to the San Joaquin River and reuse agricultural and wetland return flows, reducing DMC diversions. A multimillion-dollar drainage reuse system was completed in GWD in 2020 that is now operational. The real-time monitoring network monitors drainage EC continuously to limit reuse of wetland drainage with EC concentrations that might negatively impact wetland moist-soil plant habitat. Similarly, monitoring upgrades underway in Patterson Irrigation District are moving drainage monitoring sites at the Spanish Land Grant Drain and Marshall Road Drain further upslope. These new locations allow the district to more accurately monitor flow and EC, and make operational decisions to capture all or part of this outflow for reuse, provided the EC doesn't cause harm to crops grown in the subarea served by the drainage reuse water supply distribution system. There are other instances being documented where stakeholders are already practicing or have the infrastructure to begin to practice real-time salinity management on-farm that adds to program outreach.

Goal 5: Continued Outreach for Additional Stakeholders

Although the Turlock Irrigation District (TID) and Modesto Irrigation District (MID) became subject to salt load allocations in accordance with the Basin Plan's Salt and Boron Control Program in 2018, it wasn't until 2019 that TID and MID agreed to report operational spill and drainage return flow and EC data routinely for the eight discharge locations into the San Joaquin River and its major tributaries, the Stanislaus and Tuolumne Rivers. These return flows can add significant salt load assimilative capacity to the San Joaquin River and are critical for the development of accurate forecasts, especially during certain times of the year when the flow/EC regression relationship is less reliable. In these instances, the WARMF model could provide better forecasts if reliable flow and

EC data from these monitoring sites are available. MID has participated in the RTMP by providing daily operational spill and EC data for three sites each quarter. In the case of TID, flow data has been provided since 2018. However, it wasn't until 2020, with the completion of EC sensor upgrades, that TID became able to provide both flow and EC data. These data are also being provided quarterly upon request. The flow and EC data from MID and TID has been used to update WARMF model input files.

Reclamation continues to receive daily flow forecasts at Vernalis, Crows Landing, and Maze Road Bridge from the California-Nevada River Forecast Center (RFC) operated by National Oceanic and Atmospheric Administration (NOAA). NOAA analysts in the RFC receive daily updates on reservoir release schedules from East-side reservoir operators and maintain a simple flow model for estimating reliable tributary outflow to the San Joaquin River. Although the RFC model does not include EC forecasts, the RFC flow forecasts significantly improve the reliability of 14-day projections made with both the regression and WARMF models. Interaction with the RFC has also informed both Central Valley Operations (CVO) staff and NOAA analysts on the MAA water quality forecasting activities. This coordination led CVO to continue support for several important long-term San Joaquin Basin monitoring stations, including those at Mud Slough, Salt Slough, Crows Landing, and Fremont Ford.

Reclamation's salinity management program includes participation in CV-SALTS. The CV-SALTS stakeholder group, which includes representatives from industry, agriculture, environmental justice communities, municipalities, and State and Federal regulatory agencies, is a collaborative basin-planning effort aimed at developing and implementing a comprehensive salinity and nutrient management program for the Central Valley. The Salt and Nitrate Control Program for the Central Valley, a Basin Plan amendment crafted by CV-SALTS, was adopted by the CV Water Board in 2018 and the State Water Board in 2019. The plan uses regulation to 1) create management zones to control and reduce nitrate in Central Valley groundwater while supplying potable water to impacted communities; and 2) implement a phased Salt Control Program with the 10-year long Prioritization and Optimization Study, currently underway, to identify projects and management practices to best achieve salt sustainability in the Central Valley. The Control Program for Salt and Boron Discharges into the Lower San Joaquin River will remain in effect as an element of the overall Salt and Nitrate Control Program for the Central Valley.

Reclamation staff has participated in 14 CV-SALTS Executive Committee meetings during FY 2020. In prior years, Reclamation also participated in CV-SALTS sub-committees, including the Technical Advisory Committee and Lower San Joaquin River Committee (LSJRC).

The Reclamation RTM Program was approached by GWD, which has an interest in developing its own salinity management plan under the Conservative Salinity Permitting Approach outlined in the CV-SALTS Prioritization and Optimization Planning Study. Part of the motivation for taking this approach was to more closely align salinity management actions with the Groundwater Sustainability Plan developed for the Grassland Ecological Area and Grassland Subarea and to have a modeling tool capable of simulating surface and groundwater hydrology as well as salt loading to provide the basis for future decision-making. The WARMF model, initially developed for the San Joaquin River Dissolved Oxygen TMDL and significantly enhanced under Reclamation's Program to Meet Standards (PTMS), has been suggested as a suitable tool for this initiative. Reclamation has offered technical support to GWD and is developing a suite of training materials in support of this effort.

Phase 4 Activity Summary (April 2018 to Present)

Phase 4 activities include actions initiated during Phase 3 of the program that have been continued, as described above. In Phase 4 additional actions are being encouraged and supported that will lead to more widespread adoption of RTMP practices and better cooperation and coordination among stakeholders.

Goal 1: Continue to implement/upgrade monitoring and data networks and to support real-time management practices. Use salt load assimilative capacity forecasting to coordinate the timing of discharges to the river.

A successful RTMP requires telemetered networks of flow and salinity sensors along the main stem of the San Joaquin River and within watersheds draining to the San Joaquin River. The networks allow easy access to data, promote data sharing, and provide knowledge of scheduled releases from the reservoirs that discharge to the Lower San Joaquin River watershed. Real-time quality assurance of this data is essential to avoid posting erroneous data and to encourage data sharing.

- Reclamation has continued to provide funding and technical support to GWD for the continued development of its real-time management program. GWD operates approximately 40 real-time web-based flow and water quality monitoring stations within the district. With the help of additional grant funding through Proposition 84, the district has been able to restore and upgrade monitoring with state-of-the-industry instrumentation. The previous sensor network was more than a decade old and relied on the Yellow Springs Instrument Company's EcoNet telemetry system, discontinued in 2018. GWD now use HydroMetCloud Data Services available through Sutron Corporation. The GWD instrumentation upgrade parallels the rehabilitation of a similar sensor network operated by the SJVDA along the San Joaquin River. By design, the same state-of-the-art sensor instrumentation and data collection platforms are being used by both projects.
- Reclamation continues to support an online web portal where river flow and EC forecasts can be accessed. The site was redesigned to allow easy access from a smartphone by entering "Reclamation PTMS" in a search engine such as Google.com. This web application was demonstrated at two stakeholder meetings during 2019 and additional meetings in 2020.

Goal 2: Continue to address long-term funding and project needs.

In 2018, Reclamation assisted UC Merced and wetland stakeholders in the writing of a Delta Ecosystem Restoration Grant to improve mercury and salt monitoring and management in the Grassland Ecological Area. The proposal, entitled "Integrated Science and Management of Nutrient, Salt, and Mercury Export from San Joaquin River Wetland Tributaries to the Delta," received funding in 2019 and is ongoing. The project focuses on salt and mercury loading from two wetland impoundments in the Los Banos Wildlife Management Area along with management strategies to optimize control of both pollutants. The project is characteristic of the type of collaboration and data sharing envisaged at the onset of the RTMP. Results of the three-year study will be applicable to all wetlands within the Grassland Ecological Area. GWD has provided support for this project by allowing additional water quality sensors, provided by UC Merced, to be mounted on their AquaTroll sonde at site SL1, which measures the flow and EC of supply water to the Los Banos refuge. This type of cooperation is an example of what we aim to achieve with the Real-Time Management Program.

Goal 3: Expand RTMP membership to include all regulated parties, including both direct and indirect dischargers of salt to the San Joaquin River.

The RTMP has, to date, focused on those subareas of the San Joaquin River Basin that directly discharge salt loads to the San Joaquin River. Grant funding over the past decade has supported flow and salinity loading monitoring at eight agricultural drainage monitoring stations on the westside of the San Joaquin River Basin and from seasonally managed wetlands. The California Department of Fish and Wildlife and the Grassland Resource Conservation District operate under Best Management Practices (BMP) to reduce the salt loads in discharges from managed wetlands into the San Joaquin River. Reclamation has provided resources to support the development of a real-time monitoring network and other potential BMPs within Federal, State, and private managed wetlands. We anticipate greater involvement from the State and Federal refuges during FY 2021 through stakeholder outreach efforts.

- Reclamation continues to support the network of real-time flow and water quality monitoring stations that provide flow and EC data at major GWD inlets and outlets as well as along the water distribution network.
- Reclamation funding for the Grassland Bypass Project from 2017 through 2019 was $860,000,[4] including $200,000 annually to the U.S. Geological Survey (USGS) to monitor five stations on the LSJR and tributary sloughs.
- Reclamation is currently working with the USGS to obtain quotes for flow monitoring upgrades to Mud and Salt Slough stations. The USGS has agreed to work off the same monitoring contract if Reclamation provides funding to procure SONTEK acoustic Doppler transducers and complete the installation. The use of these instruments will eliminate problems due to occasional backwater conditions since they measure stream velocity directly.
- Reclamation has asked the USGS to perform reconnaissance and provide a cost estimate for the addition of flow and EC monitoring at the San Joaquin River Maze Road Bridge site. Acoustic Doppler would also be installed at this site for the same reasons as above. This site was monitored by the USGS more than 20 years ago and subsequently by the California Department of Water Resources. The site was abandoned several years ago. This site is important, not only for compliance monitoring but also for EC forecasting since it is the most upstream station for EC prior to the Stanislaus River inflow. Accurate salt load assimilative capacity forecasts at this station will provide better information for decision support purposes since the Stanislaus River already potentially includes Reclamation's operation for water quality purposes.

Although, as described above, TID and MID provide quarterly flow and EC data reports electronically that can be used to update the relevant files in the WARMF model, we continue to work on protocols and an agreement with these entities that will allow provision of the data on a near real-time basis. The long-term goal is to be able to completely automate data updating from these sources to the WARMF model.

[4] The funding allocation is not specifically a part of the MAA RTMP but yields salinity benefits in the LSJR.

One significant challenge for accurate SJR salt load assimilative capacity forecasting is the estimation of SJR diversions. The three largest diverters have the capability of removing more than half the flow in the SJR when flow at Vernalis is less than 1,000 cfs. Changes in diversion volume at the Patterson, West Stanislaus, and El Solyo pumps on the west side of the SJR can significantly impact forecast accuracy. The SJVDA Proposition 84 grant has made flow and EC data readily available at the Patterson ID stations during FY 2020, with data for West Stanislaus ID stations anticipated in FY 2021, as previously described.

Goal 4: Continue technical improvements to data processing, quality assurance, and the SJR assimilative capacity forecast modeling.

Reclamation has begun investigation into further automating data acquisition to reduce the data processing steps needed for forecasts as well as simplifying the WARMF model GUI to reduce the model's learning curve while retaining model reliability. The RTMP has worked with both districts to automate data collection and has developed a web portal hosted by HostGator.com to allow eventual migration of these data to the WARMF model input data files in advance of weekly forecast development.

Data quality assurance has always been a major constraint to implementation of the RTMP. Stakeholders are reluctant to share erroneous data for potential liability reasons. Poor data quality assurance also has potential to diminish stakeholder trust in the data and their willingness to utilize the data and the forecast model results for decision support. GWD was using the hydrologic data management software WISKI for their own internal data quality assurance (QA) needs; however, the maintenance of the WISKI server and system oversight is a financial challenge for a small water district that cannot afford dedicated personnel assigned to this task.

Ongoing work includes developing CRON job scripts on HostGator.com to process raw data to produce daily mean flow and EC data files for direct import to the WARMF model and working with Sutron Corporation to develop Python scripts that might be able to perform rudimentary data QA.

The latest generation of dataloggers has been equipped with Python scripting capability, which may potentially allow alerts and basic data flagging to occur for out-of-range values or when the rate of data value increase or decrease exceeds a value related to sensor drift.

Central Valley Project Deliveries Load Calculation

Brief Description: The CVP delivers water to both the Grassland and Northwest subareas, as described in the Basin Plan, through the DMC, the San Luis Canal, and the San Joaquin River/Mendota Pool. Most CVP water is pumped from the Delta into the DMC through the Jones Pumping Plant located near Tracy, California. CVP water is conveyed south to DMC Check 13 near Santa Nella, California, where water is either mixed with the State Water Project in O'Neill Forebay and then either pumped into San Luis Reservoir for later delivery through the DMC or San Luis Canal, or conveyed further south to the DMC terminus at the Mendota Pool. During periods of drought, groundwater and river water are pumped into the DMC at several locations. The calculation methods used in this report are provisional, and some elements in this report do not include estimations of benefits at this time. Reclamation submitted the *Compliance Monitoring and Evaluation Plan* (Reclamation 2010), which outlines the criteria and methodology for determining DMC loads and credits, to the CV Water Board.

Quantification Methodology: The monthly amount of CVP water supply delivered to each district is prorated according to the area of each district within either the Grassland subarea, Northwest subarea, or outside of these subareas. The monthly mean salinity of CVP water is calculated from average daily measurements taken at three locations along the DMC. The salinity of CVP water delivered to each district is associated with the salinity monitoring site closest to the district's turnout along the DMC.

The Basin Plan allocates a salt load to Reclamation for water delivered to the Grassland and Northwest subareas. This background load allocation is calculated according to Table IV-8 as shown in the following equation:

$$LA_{DMC} = Q_{DMC} \times 52 \text{ mg/L} \times 0.00136$$

Where:

LA_{DMC} = Load Allocation of salts, in tons

Q_{DMC} = monthly amount of CVP water delivered to Grassland and Northwest subareas, in acre-feet

52 mg/L = "background" salinity of water in the San Joaquin River released at Friant Dam (per the Basin Plan) measured as total dissolved solids (TDS)

0.00136 = factor for converting units into tons

Actual DMC salt loads are calculated by the following equation:

$$L_{DMC} = Q_{DMC} \times C_{DMC} \times 0.00136$$

Where:

L_{DMC} = Actual DMC Load, in tons

Q_{DMC} = monthly amount of water delivered to Grassland and Northwest Subareas, in acre-feet

C_{DMC} = monthly average of salinity of the water delivered to Grassland and Northwest subareas, in mg/L TDS

0.00136 = factor for converting units into tons

Each subarea's Q_{DMC} is calculated and then paired with the associated monthly average TDS for that reach, so the equation becomes:

$$L_{DMC} = 0.00136 \times \Sigma(Q_{DMC} \times C_{DMC})_{\text{Subareas}}$$

This equation is then broken into calculations for each subarea based on the source of CVP water. Table 3 lists the salt loads of CVP water delivered to the Grassland and Northwest subareas and an estimate of the salts delivered in excess of the Monthly Load Allocation.

Table 3. Calculation of DMC Allocations and Loads

Water Year	Water Year Type	San Joaquin River and Mendota Pool Salt Load from CVP (Grassland Subarea; 1,000 tons)	Delta- Mendota Canal Salt Load from CVP (Grassland Subarea; 1,000 tons)	San Luis and Cross Valley Canal Salt Load from CVP (Grassland Subarea; 1,000 tons)	Total Flow (Grassland Subarea; 1,000 acre-feet)	Load Allocation (Grassland Subarea; 1,000 tons)	Actual Load - Load Allocation (Grassland Subarea; 1,000 tons)	San Joaquin River and Mendota Pool Salt Load from CVP (Northwest Subarea; 1,000 tons)	Delta- Mendota Canal Salt Load from CVP (Northwest Subarea; 1,000 tons)	Total Flow (Northwest Subarea; 1,000 acre-feet)	Load Allocation (Northwest Subarea; 1,000 tons)	Actual Load - Load Allocation (Northwest Subarea; 1,000 tons)	Total Excess Load from CVP (1,000 tons)
2015	Critical	285.7	57.0	46.7	611.8	43.2	346.2	21.9	32.5	84.0	5.9	48.5	394.7
2016	Dry	275.4	89.9	36.2	873.4	61.7	339.8	20.5	15.5	92.8	6.6	29.5	369.2
2017	Wet	147.5	57.8	20.1	1,031.4	72.9	152.6	9.3	11.0	122.8	8.7	11.6	164.1
2018	Below Normal	219.7	117.6	41.6	1,112.1	78.6	300.4	16.9	18.5	114.9	8.1	27.3	327.7
2019	Wet	167.2	75.7	27.7	1,023.0	72.3	198.3	12.1	11.8	109.6	7.7	16.2	214.5
2020	Dry	224.5	99.2	39.4	1,006.1	71.1	293.6	17.8	20.2	110.9	7.8	30.5	324.1

Report of Annual Work Plan Activity Performance

Reclamation has met schedule milestones for the MAA and performance of actions for assisting San Joaquin River stakeholders in managing salt loads and offsetting the DMC salt load into the San Joaquin River. New Melones Reservoir continues to be operated in accordance with D-1641 water quality requirements.

During 2020, Reclamation continued to support the development and use of the WARMF-based 14-day forecasts for EC and discharge. The regression model provides 14-day forecasts for Vernalis and Crows Landing that are updated daily. As previously stated, preliminary results based on flow and EC data for the years 2018 to 2019 indicate that the regression model performs as well, if not better, than the WARMF model.

Reclamation has complied with the TMDL, which requires that excess salt loads delivered to the LSJR via the DMC be offset by its dilution flows. New Melones Reservoir releases added 264,000 tons of salt assimilative capacity to the San Joaquin River (Table 1). Combined with the 261,000 tons salt load displacement to SJRIP, the salt assimilative capacity was greater than the total excess salt load associated with 2020 CVP operations, 324,000 tons of salt (Table 3).

Furthermore, the Salt and Boron Control Program states that "Participation in a Regional Water Board approved real-time management program and attainment of salinity and boron water quality objectives will constitute compliance with this control program." Compliance with the EC WQO is also a good indicator of compliance with the boron WQO. Figure 5 shows that Reclamation has maintained annual compliance with the salinity WQO at Vernalis. In Figure 5, the 30-day running average of San Joaquin River EC at Vernalis exceeded the regulatory limit of 700 uS/cm during April 1-23, 2020. Compliance with the regulatory EC limit at Vernalis is determined starting 30 days after a change in regulatory limit (e.g., beginning May 1, 2020). San Joaquin River EC at Vernalis was therefore in full compliance with regulatory limits throughout Water Year 2020.

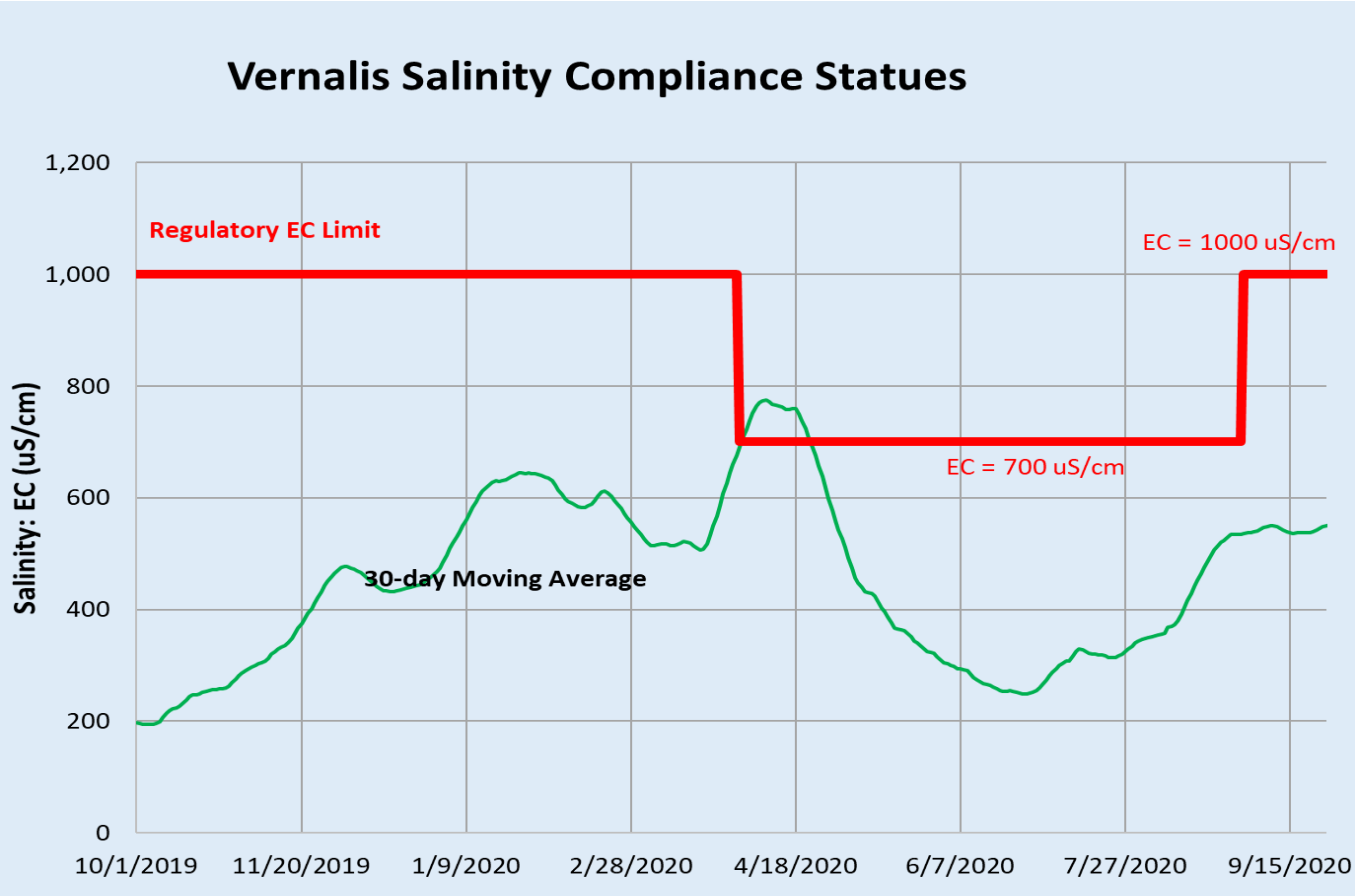

Figure 5. Water Year 2020 30-Day Average EC (uS/cm) and WQO

References

CV Water Board 2017	Proposed Amendments to The Water Quality Control Plan for the Sacramento River and San Joaquin River Basins to Establish Salinity Water Quality Objectives in the Lower San Joaquin River (Mouth of Merced to Vernalis) Final Staff Report. Table IV-4.4 Summary of Allocations and Credits, Dilution Flow Allocations, Regional Water Quality Control Board Central Valley Region, June 9, 2017.
CV Water Board 2018	The water quality control plan (basin plan) for the California Regional Water Quality Control Board, Central Valley Region, fifth edition. Revised May 2018 (with approved amendments).
Reclamation 2010	Compliance Monitoring and Evaluation Plan, In Compliance with the "Management Agency Agreement between the Central Valley Regional Water Quality Control Board and the Bureau of Reclamation" executed on December 22, 2008. U.S. Bureau of Reclamation, November 2010.
Reclamation 2018	Annual Work Plan, FY 2019, October 1, 2018 – September 30, 2019. U.S. Bureau of Reclamation, August 2018.
Reclamation 2019	Management Agency Agreement (MAA) FY 2020 Annual Work Plan, October 1, 2019 – September 30, 2020. U.S. Bureau of Reclamation, August 2019.
State Water Board D-1641	Implementation of Water Quality Objectives for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary; A petition to Change Points of Diversion of the Central Valley Project and the State Water Project in the Southern Delta; and A Petition to Change Places of Use and Purposes of Use of the Central Valley Project. State Water Resources Control Board, March 15, 2000.
Tansey Report 2020	PTMS Framework Forecast Analysis. Michael K. Tansey, 2020.