



Memorandum

DATE: February 22, 2014

TO: Michael Johnson, LSJRC Manager

COPY TO: Lower San Joaquin River Committee (LSJRC)
Larry Walker Associates (LWA) Team

SUBJECT: **Development of a Basin Plan Amendment for Salt and Boron in LSJR:**
Task 2a: Compile and Update Water Quality and Salt Loading Data

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This memorandum is being submitted on behalf of the LWA Team¹ and fulfills the requirement of Task 2a of the Development of a Basin Plan Amendment (BPA) for Salt and Boron in the Lower San Joaquin River (LSJR) Workplan (Workplan).

The primary purpose of Task 2a is to identify, compile, and develop into a database, the available water quality and salt loading data needed to:

- Determine baseline salt loading to the LSJR²;
- Evaluate current water quality conditions within the LSJR³; and
- Estimate compliance with the water quality objectives being considered for the river³.

In order to complete this task, the LWA Team assembled the available surface water quality data and information for the LSJR project area (**Figure 1**) as identified by the LSJRC members. The Team updated the existing data compilations within the Watershed Analysis Risk Framework (WARMF) database⁴ with data from 1968 to present [the primary focus being on the time period from 1995 to present (through September or December 2013, depending on the database)].

¹ The LWA Team consists of the following firms: Larry Walker Associates, Luhdorff and Scalmanini Consulting Engineers, Kennedy/Jenks Consultants, PlanTierra, Systech Water Resources, Carollo Engineers, Ascent Environmental, and Dr. Richard Howitt.

² This will be completed as a part of Task 2b: Update Analysis of Baseline Salt Loading to LSJR.

³ This will be completed as a part of Task 3b: Conduct Evaluation and Analysis of Existing Water Quality and Compliance with Water Quality Objectives Being Considered in the LSJR.

⁴ The LWA Team proposed, and LSJRC members agreed that the WARMF database would serve as the overall database and would be updated with the data collected for this work effort.

As required by the Workplan, the data from the 2004 LSJR Salt and Boron TMDL report (CVRWQCB, 2004) were integrated and updated with more recent data (1995 to present) from the same sources drawn upon by the TMDL. The WARMF database was used for the integration. This effort was also supplemented with data from other relevant sources as described in more detail below.

Use of the WARMF database provides several advantages for the current BPA effort including:

- WARMF model inputs and outputs will meet the project's data needs,
- WARMF model inputs have already undergone an extensive Quality Assurance/Quality Control (QA/QC) review,
- Regular data updates to WARMF through its use in other projects associated with the San Joaquin River provides the LSJRC with a larger and more comprehensive dataset compared to the dataset used for the 2004 LSJR Salt and Boron TMDL.
- Tools already exist in WARMF that provide rapid and efficient updating of its database through the access of major online databases including:
 - United States Geological Survey National Water Information System (USGS NWIS)
 - California Department of Water Resources (DWR) Water Quality Library (DWR Library)
 - California Environmental Data Exchange Network (CEDEN)
 - California Department of Water Resources California Data Exchange Center (CDEC).

To the extent practicable, future tasks and data needs were considered during the database update. This memorandum accompanies the database as a deliverable and provides a summary of the data collected as well as the sources of the data for the Task 2a effort.

This memorandum is organized as follows:

- Section I WARMF Background – This section provides a brief description of WARMF
- Section II Prior WARMF Application to the San Joaquin River – This section provides a description of how WARMF was used in prior investigations of the San Joaquin River Watershed
- Section III Data Gathering Overview – This section provides a brief description of the data gathering effort and the data obtained, along with other data sources
- Section IV WARMF Database Updates – This section provides a description of the new data added to the WARMF database, the QA/QC process used to validate these data and the data already in the database
- Section V Conclusions

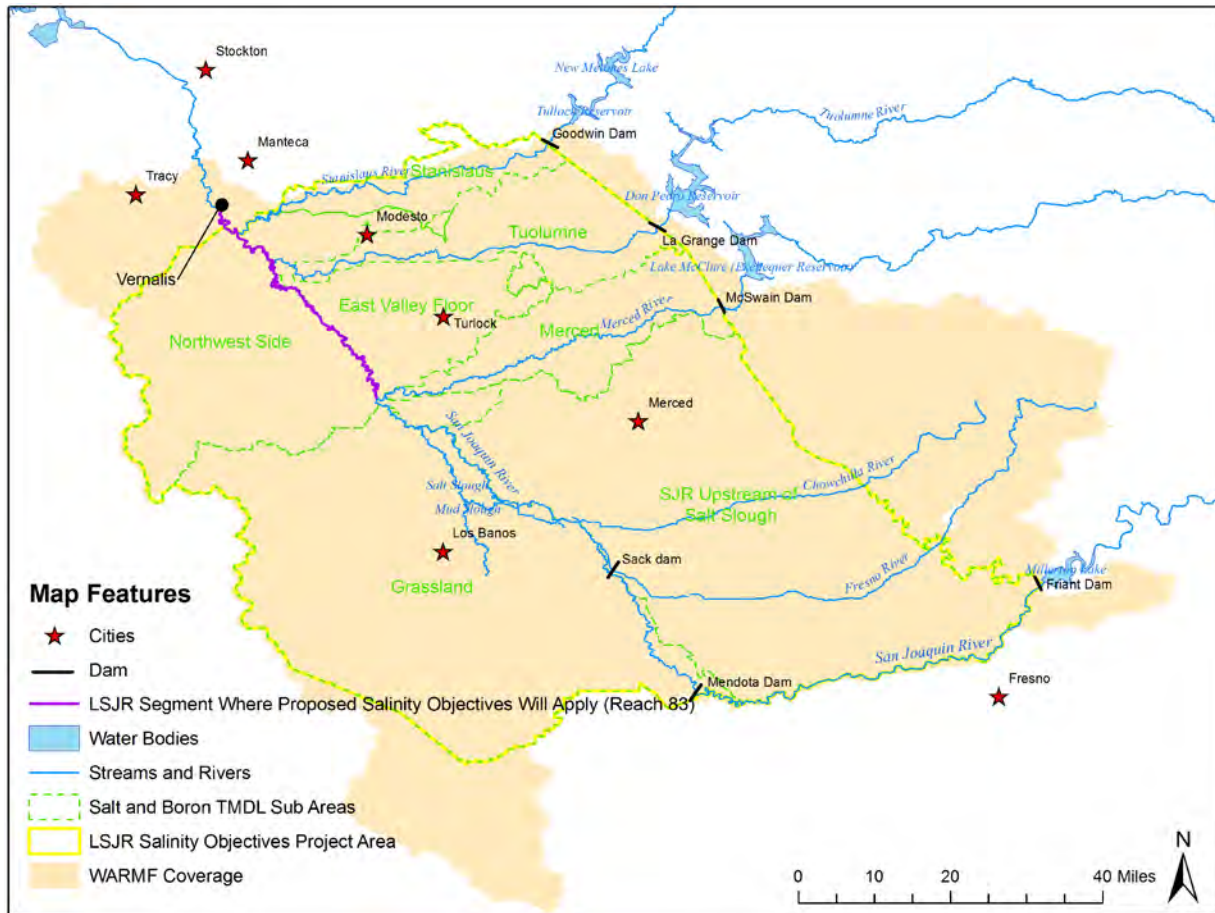


Figure 1: Lower San Joaquin River Basin Salinity Objectives Project Area

I. WARMF BACKGROUND

As noted above, it was agreed that the WARMF database would serve as the overall database for this work effort and that it would be updated with additional data. WARMF as a model will also be used as part of Task 2b to update the analysis of baseline salt loading to the LSJR. The WARMF model simulates flow and loading from shallow groundwater accretion which are measured indirectly by difference between monitoring stations in the San Joaquin River. To focus the data gathering efforts, the LWA Team needed to gather parameters and constituents currently built into WARMF. This section provides a brief description of WARMF, inputs and outputs, and its capabilities.

WARMF is a physically-based watershed model capable of simulating watershed hydrology and water quality on a daily or shorter time step. In WARMF, a watershed is divided into land catchments, river segments, and layered reservoirs. Catchments are further divided into land uses on the surface and soil layers below the surface. The network of catchments, rivers, and reservoirs is linked together by a flow path into a seamless watershed model. WARMF simulates watershed processes while maintaining mass and heat balance to calculate flow and water quality to the land, from the land to surface water, and recharging to the groundwater aquifer. WARMF only simulates the near-surface groundwater which interacts with surface water down to a depth of approximately 8 feet; recharge is considered to be lost from the model domain.

The WARMF Technical Documentation describes the algorithms and methods used to simulate watershed processes (Chen et. al. 2001).

WARMF uses five types of time series data to drive simulations: meteorology, air and rain chemistry, point sources, boundary inflows, and diversions. Measured in-stream flow and water quality data are used to create boundary inflows where tributaries flow into the model domain from upstream, but the primary purpose of measured in-stream data is to evaluate how well the model can predict flow and water quality. Groundwater quality data are used to estimate the concentration of chemical constituents in pumped irrigation water, which enters the WARMF model domain as point sources. Because WARMF calculates near-surface groundwater flow and chemistry as a function of watershed characteristics and model inputs, groundwater data are not needed by WARMF and are not included in its database.

WARMF simulates flow using a water balance. Precipitation, irrigation, and flow are inputs to the land. The model calculates evapotranspiration from the land and canopy and lateral surface and subsurface flow to surface water. WARMF simulates over 30 water quality parameters including temperature, pH, major cations and anions (Ca, Mg, K, Na, SO₄, Cl), nutrient components (NH₄, NO₃, PO₄), inorganic carbon, organic carbon, dissolved oxygen, phytoplankton, and suspended sediment. Total phosphorus, total kjeldahl nitrogen, and total nitrogen are calculated by adding up the respective dissolved, adsorbed, and organic forms of the applicable chemical species. Total dissolved solids (TDS) are calculated by adding the concentrations of all ionic species. Electrical conductivity (EC) is calculated from total dissolved solids using a multiplier of 1.67 developed using concurrent TDS and EC data measured at Vernalis. Boron is not included within the model, but can be calculated from EC using site specific ratios found in Table A-5 of the 2004 LSJR Salt and Boron TMDL.

II. PRIOR APPLICATION OF WARMF TO THE SAN JOAQUIN RIVER

As required by the Workplan, the data from the 2004 LSJR Salt and Boron TMDL report would be integrated into the database and updated with more recent data (1995 to present) from the same sources drawn upon by the TMDL. This section provides an overview of the data and data sources added to WARMF prior to the start of the current work effort.

In 2003, CALFED funded the directed action project for monitoring and investigations of the San Joaquin River and tributaries related to dissolved oxygen. As a part of this project, a comprehensive field program was established to measure flow and water quality in the San Joaquin River and its tributaries from Lander Avenue (near Stevinson) to the Old River. USGS and University of California Davis (UCD) collaborated to measure sources and transport of nutrients and algae during summer and fall of 2000 and 2001 (Kratzer et al. 2004). Jones & Stokes (Jones and Stokes, 2005) created a Data Atlas by compiling all these data and publicly available databases into a compact disk CD to support data analysis and modeling. The data used for the 2004 LSJR Salt and Boron TMDL was contained within the created Data Atlas, which was then incorporated into WARMF.

The WARMF model was initially created for the San Joaquin River in parallel with field data collection efforts (Herr, Chen, and van Werkhoven 2008). The model was used to simulate pollutant loading sources which could not be measured, such as diffuse near-surface groundwater flow in agricultural areas, and transformations which occur in the land and surface water such as chemical reactions and phytoplankton growth.

The initial model domain extended from the San Joaquin River at Lander Avenue to the San Joaquin River at the Old River junction, but excluded gaged tributaries of the San Joaquin River. The data collected by the aforementioned CALFED-funded study was incorporated into the WARMF model database along with publicly available downloadable data.

Downloadable data sources whose data were incorporated into the WARMF model database as part of this initial study are shown in **Table 1**. Additional project specific and discontinued databases incorporated into WARMF are listed in **Table 2**.

Table 1. Online Databases Used for Initial Application of WARMF to the San Joaquin River.

Data Source	Online Link
USGS NWIS	http://maps.waterdata.usgs.gov/mapper/index.html
DWR Library	http://www.water.ca.gov/waterdatalibrary/
CDEC	http://cdec.water.ca.gov/queryCSV.html

Table 2. Project and Discontinued Data Sources Incorporated into the WARMF Database.

Data Source	Online Link or Reference Document
SJR Data Atlas	http://sjrdomdl.org/rsrscs-datasets.html
SJR DO TMDL Upstream Studies	Stringfellow et. al. 2008
SJR DO TMDL Downstream Studies	(1)
Bay Delta and Tributaries Project (BDAT)	http://www.water.ca.gov/iep/products/data/bdatnotice.cfm

(1) Data for the SJR DO TMDL Downstream Studies have not been published as of the drafting of this technical memorandum. Contact Dr. Will Stringfellow of the University of the Pacific for more information.

In 2008, under sponsorship from the Bureau of Reclamation, the WARMF model was expanded to include the river and watershed upstream to Friant Dam (Herr & Chen 2008). Flow and water quality data from the sources listed in **Table 1** were added to the WARMF database for the expanded model domain. Although the expansion area was not fully parameterized and calibrated, it provided a basis for future work.

Under a contract with the California Urban Water Agencies acting on behalf of the Central Valley Drinking Water Policy Work Group, the San Joaquin River WARMF model was used to evaluate the sources and transport of organic carbon and nutrients (Systech Water Resources 2011a). The databases in **Table 1** were searched to ensure that the WARMF database included all the available data for the water quality parameters of concern.

The Central Valley Salinity Coalition (CV-SALTS) sponsored a project to upgrade the WARMF model as part of a pilot study to account for and track salinity and nitrate movement between land, shallow groundwater, deeper groundwater, and surface water (Larry Walker Associates 2010). The project brought detailed land use representation to the watershed lands east of the San Joaquin River and linked WARMF to a MODFLOW groundwater model to calculate the transfer of salt and nitrate to the deeper groundwater aquifer. Some of the flow and water quality data were extended through 2009 for this project using the data sources listed in **Table 1**.

The Bureau of Reclamation’s Westside Salt and Nitrate Assessment Study brought an analysis similar to the CV-SALTS pilot study to the west side watersheds of the San Joaquin River (Bureau of Reclamation 2012a, Bureau of Reclamation 2012b).

As part of this project, the WARMF model domain was expanded to include all tributary lands west of the San Joaquin River. Land use with similar detail to the east side tributary lands was applied to the west side. The project also added a linkage to the WestSim model to track salt and nitrate recharged into the deeper groundwater. Some additional data were collected from the sources in **Table 1** to expand the database forward to 2010 at certain key locations, particularly west side tributaries.

In 2011, the Metropolitan Water District of Southern California sponsored upgrades to the WARMF model so that it could track winter flows through the watershed lands and rivers in the region between Friant Dam and the San Joaquin River at Lander Avenue (Systech Water Resources 2011b). To accomplish this, the model was calibrated for winter storms and seepage losses were added to estimate the persistence of flow through the Eastside Bypass to the lower San Joaquin River. Turbidity data collected by the **Table 1** sources were added to the WARMF database, and additional measured flow data were collected for key gauging stations on the San Joaquin River. Turbidity data was updated at selected locations through the beginning of 2013 in subsequent studies the winters of 2011-2012 and 2012-2013.

Also in 2011, the California Department of Fish and Game sponsored a detailed study on the Orestimba Creek Watershed which is ongoing as of this time. This heavily monitored watershed was used to quantify agricultural practices and watershed characteristics such as applied water rates, land application rates, the quality of groundwater used for irrigation, and groundwater interactions on a local scale to improve the modeling of the entire west side watershed lands. The model's flow and water quality databases were updated with data from the Orestimba Creek region.

The resulting WARMF model domain produced by the various San Joaquin River WARMF projects described above is shown in **Figure 2**.

- The area shown in yellow has been fully parameterized (contains all of the parameter inputs for WARMF).
- The salmon colored area has been calibrated for winter conditions, but has not been fully parameterized with irrigation for summer conditions. However, this area has limited impact on the lower San Joaquin River because water does not generally flow all the way through this area to the lower river.
- The light blue area shows the watersheds of the east side tributaries upstream of their most downstream gauges, which is not currently part of the WARMF model domain.

The WARMF database includes data from all three colored areas on the map. Although as described above, the data coverage is not uniform throughout.

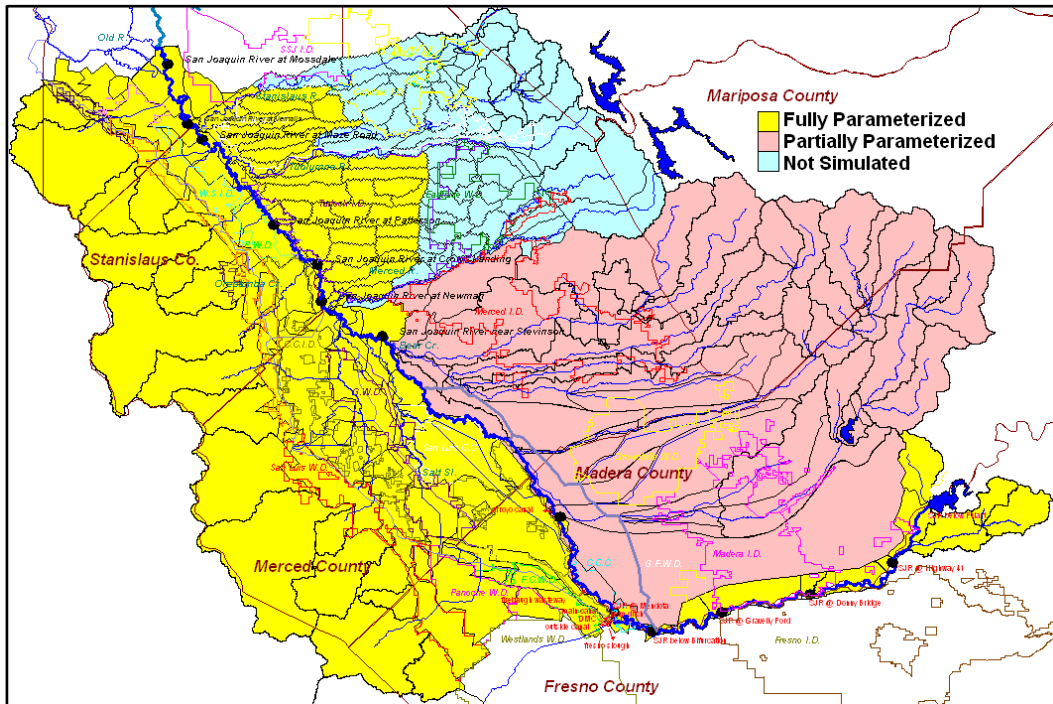


Figure 2: San Joaquin River WARMF Status Map

Since the WARMF database was expanded each time the model was used, a very large flow and water quality database has been created that is well-suited to meet the modeling needs of the LSJR BPA effort. As a result, and to maximize the utility of limited resources, the existing WARMF database will be used as a basis for the LSJR work effort. For this project, the database will be used to determine baseline salt loading, water quality conditions, and the state of compliance with proposed salinity water quality objectives. To upgrade the WARMF database for these new uses, it was expanded to incorporate additional data beyond those that were needed for the earlier modeling efforts. The new data added to WARMF extend back to October 1, 1976⁵, and forward through 2013.

III. DATA GATHERING EFFORT

As was noted earlier, the WARMF database is fairly comprehensive and is routinely updated from major online resources (USGS NWIS, DWR Library, CEDEN, and CDEC). In order to supplement these ongoing updates and obtain additional data that may not already be within the WARMF database, a data request was distributed to the LSJRC on October 28, 2013. The data request provided an overview of data that were already accounted for within WARMF and identified additional data that were requested. The purpose of the data request was to identify new data sources that may not exist in the WARMF database and would not be available in the major online databases.

⁵ Although the date range for this work effort was initially identified as 1968 – present, this is currently undergoing review by the LSJRC. It is anticipated that the date range may be modified to 1977 – present.

As a result of the data request, five (5) resources were brought to the attention of the LWA Team and investigated to determine if these data were new to WARMF and should be incorporated or were already included in WARMF.

Of these five (5) new data resources:

- Two (2) contained data already included in WARMF;
 - Department of Water Resources (DWR)
 - 2004 Salt and Boron TMDL
- One (1) contained a small amount of data that was already included in WARMF with additional data available but could not be incorporated due to the timing of the data request to the stakeholder
 - Turlock Irrigation District
- One (1) contained data not included in WARMF, but were outside of the 1968 – present time range of this work effort; and
 - 1980 SDWA/USBR Report on the Effects of the Central Valley Project on the Southern Delta
- One (1) contained data that were identified as new to the WARMF database, but could not be incorporated into WARMF at this time due to the time that would be necessary in order to obtain and reformat the data.
 - Grassland Water District Monitoring Sites

The following sections document the data available from the data sources that were received as part of the general data request.

Department of Water Resources

The WARMF database with inclusion of the major online databases contained data from 1/1/1984 to present so there was a need for additional data from the period 10/1/1968 to 12/31/1983.

At a number of locations, EC and flow data were available and were provided by Ernie Taylor of DWR⁶. Attributes of the new data provided by DWR are listed in **Table 3**. A comparison of these DWR data to the data in WARMF revealed that these data were already included in the San Joaquin River Data Atlas (Jones and Stokes, 2005), which had previously been incorporated into the WARMF database. Therefore, this data was already included in the WARMF database.

⁶ Personal Communication, 11/15/2013

Table 3 Summary of Data Received from DWR

CDEC Code	San Joaquin River Mainstem Stations	Flow (cfs)		EC (uS/cm)	
		Start	End	Start	End
SJS	San Joaquin R. near Stevinson (or Lander Ave)	10/2/1961	Present	1/5/2002	Present
SJP	San Joaquin R. at Patterson Bridge	10/2/1969	Present	10/2/1964	Present
MRB	San Joaquin R. at Maze Road Bridge	10/2/1960	Present	1/2/1965	Present
	Tributary River Stations				
	Salt Slough near Stevinson	3/1/1968	1/3/2010	NA	NA
	Merced River				
CRS	Merced R. at Cressey	10/20/1960	Present	1/8/2001	Present
	Merced R. at Millikin Bridge	NA	NA	7/25/1962	10/1/1991
MST	Merced R. near Stevinson	10/2/1995	Present	4/16/2002	Present
	Tuolumne River				
	Tuolumne R. at Tuolumne City	10/2/1960	10/1/1981	10/2/1985	9/12/1991
	Stanislaus River				
OBB	Stanislaus R. at Orange Blossom Bridge	1/1/1961	Present	8/1/2002	Present
KTZ	Stanislaus R at Koetitz Ranch	10/2/1962	Present	10/2/1964	10/1/1992

2004 Salt and Boron TMDL

As required by the Workplan, the WARMF database update started with a verification that the data used in the 2004 LSJR Salt and Boron TMDL (CVRWQCB, 2004) were included in WARMF and then updated with more recent data (1995 to present) from the same sources as those used in the TMDL. While projects mentioned in Section I led to the incorporation of these data into WARMF, the LWA Team verified that the critical data from the 2004 TMDL were in the WARMF database. During this verification it was noted that the data in the original 2004 report and its appendices were data that had already undergone processing such as averaging and summation (e.g., daily averages summed to monthly data), thus they were not raw data. WARMF runs are daily, adds new data as it becomes available, and updates its own database as old data undergoes QA/QC in the online databases. This makes a direct comparison of the WARMF database and the TMDL data in the report in feasible. Replicating the processing (summation or averaging) would not guarantee the same result as reported in the 2004 report because the raw data may have changed due to QA/QC or additional data.

As a result, the locations, station names, and time frames for the data in the TMDL report, tables, and figures were compared to the data in WARMF.

- TMDL report Table A-1: Flow Data Sources which are standard USGS gages. Comparison showed data location and date ranges were already in WARMF.
- TMDL report Table A-2: More Flow Data Sources which are standard USGS gages. Comparison showed data location and date ranges were already in WARMF.

- TMDL report Figure A-1: Locations of WQ stations. 3 stations with unfamiliar names were identified (Stanislaus River at Koetitz Ranch, Tuolumne River at Tuolumne City, and Merced River at Milliken Bridge). The first two lined up with Stanislaus River at Caswell State Park and Tuolumne River at Shiloh Road, which are the monitoring points with the most data on each of the two rivers and comparison showed data location and date ranges were already in WARMF. The Milliken Bridge location doesn't line up with any modern sampling point, and raw data were not able to be located.
- TMDL report Table A-3: The table cites (Kratzer, 1987) and (Grober, 1998) as data sources for EC and TDS data. Kratzer is a reference to the SJRIO model which was previously incorporated into WARMF. The raw data used by Grober were located at the Water Board's website and comparison showed data location and date ranges were already in WARMF.

This evaluation confirmed that the data collected for the 2004 Salt and Boron TMDL report were not included in the major online databases. However, these data had already been incorporated into the WARMF database via the San Joaquin River Data Atlas (Jones and Stokes, 2005).

Turlock Irrigation District Data

The LWA Team was contacted by Debbie Liebersbach⁷ of the Turlock Irrigation District with clarifying questions regarding the initial data request. This included questions regarding how much data WARMF already includes from listed databases, what constituents were being requested, timestep information, and what types of QA/QC were needed. Some Turlock Irrigation District data has already been incorporated into the WARMF database, and additional data was identified as new to the database. However, further communications did not yield any additional data. Due to the timing of when the data was brought to our attention and time constraints retrieving the data from the stakeholder, these data were not compared to, or included in, the updates to the WARMF database.

1980 SDWA/USBR Report on the Effects of the Central Valley Project on the Southern Delta

The 1980 SDWA USBR report of the effects of the Central Valley Project on the Southern Delta (SDWA & USBR, 1980) was provided to the LWA Team⁸. The report contained useful data in .pdf format on flow and salinity at a number of key locations in the LSJR. However, the data record (1930 – 1969) was outside the date range of the evaluation, with the exception of 1968 and 1969. With the focus of the data update being 1995 to present, these data were not included in the updates to the WARMF database, but can provide useful information for future efforts that include pre-1968 data. The data is embedded within the report which can be provided upon request.

⁷ Personal Communication, 11/15/2013

⁸ Personal Communication, 11/26/2013

Grassland Water District Monitoring Sites

Five drainage sites that were not part of the current WARMF database or included in the major online databases were identified in the Grasslands Water District at the following locations: Mud Slough (Gun Club Road), Fremont Canal (Drain), S-lake Drain, Hollow Tree Drain, and Los Banos Creek. Raw data on a fifteen minute time intervals for flow, temperature, EC, and TDS at these locations were available online at <http://www.ysieconet.com/public/WebUI/Default.aspx?hidCustomerID=99>. Time and budget constraints associated with obtaining and reformatting the data prevented the incorporation of the raw data directly from the site. The data from these stations are published in an annual report by the Water District after undergoing QA analysis and daily averaging and is provided to the U.S. Bureau of Reclamation. Due to the timing of when the data was brought to our attention and time constraints retrieving the data from the stakeholder, these data were not compared to, or included in, the updates to the WARMF database.

IV. WARMF DATABASE UPDATES

The WARMF database was updated with all available information that could be gathered and incorporated within the time constraints of the work effort. The general data request did not provide any new data. The data received had either already been incorporated into WARMF, was outside the time range of the work effort, or could not be incorporated due to timing. As a result, the updates to the WARMF database come from four major online databases: USGS NWIS, DWR Library, CEDEN, and CDEC. The following sections describe the structure of the WARMF database and document the sources as well as the QA/QC between obtaining the data from online and its incorporation into the WARMF database.

Database Format

The WARMF San Joaquin River (SJR) Model database is comprised of two file types related to hydrology and water quality. In the database, observed river hydrology (ORH) files contain discharge and water surface elevation data; observed river chemistry (ORC) files contain data for many water quality parameters, including dissolved ions, pH, temperature, suspended sediment, dissolved oxygen, EC, and TDS. The WARMF SJR Model database currently contains 61 ORH files and 91 ORC files. Each of these files corresponds to one sampling site within the SJR watershed. Many locations have both observed hydrology and observed chemistry data. The WARMF database was originally populated with data from 1984 through 2007. As a result of this effort, the WARMF database was updated with more recently collected data from 2008-2013.

There were no new data available for some of the ORH and ORC files. Of the 61 ORH files, new discharge data were only available at 44 locations. Of the 91 ORC files, 29 were in the Delta downstream of Vernalis and were not updated. New water quality data were available at 48 of the 62 remaining locations. A comprehensive list of data sources, location, and date ranges for each station is attached to this document in **Attachment A - Table 5a - g**. ORH and ORC files that were updated with new data are identified by underlines titles or red font respectively.

The WARMF flow and water quality database is in the form of column format text files. These files are read and presented in tabular and graphical format in the WARMF Data Module. To make the WARMF database accessible without installing the WARMF software, macros were created to export the WARMF data files into Excel format.

Because of the large quantity of data, hydrology and water quality data files were grouped into multiple Excel files with one tab per monitoring location. Each Excel file has a tab listing all the files whose data is included and a tab translating the WARMF data codes to parameter names and units. Separate index Excel files for hydrology and water quality were generated indicating in which file the data of each monitoring location is stored.

Data Sources and QA/QC

The files in the WARMF database were reviewed and updated with available data within the time period of October 1, 1976 to December 2013/January 2014 when the data were retrieved. To update the ORH and ORC files, four online databases that contain SJR hydrology and water quality datasets were consulted. They include USGS NWIS, DWR Library, CDEC, and CEDEN. CEDEN is a data aggregator which did not exist when WARMF was originally applied to the San Joaquin River. CEDEN data can be accessed at <http://www.ceden.us/AdvancedQueryTool>. The websites for the other three sources are listed in **Table 1**.

The USGS NWIS and the CDEC databases contain the most comprehensive hydrologic data and were used to update the ORH files. River discharge, or flow, was the only constituent updated in the ORH files. To update the ORC files, all four databases (NWIS, DWR, CEDEN, and CDEC) were searched for water quality data not already in the WARMF database. Many parameters were updated in the ORC files, including but not limited to: electrical conductivity, total dissolved solids, dissolved calcium, magnesium, chloride, ammonia, nitrate, phosphate, organic carbon, pH, temperature, dissolved oxygen, and alkalinity.

Some of the databases used to update these files contain duplicate data and care was taken to avoid duplicating the data in the WARMF database. CDEC data are known to have data quality problems, so where these data overlapped with data from other sources, the other source was used. When there was doubt if a dataset was already incorporated in the database, the data were included to ensure that all currently available observed data from the above four databases are within the WARMF database. In most cases, new data incorporated into the WARMF database were available from the source databases as grab samples or a daily average. In cases where continuous monitoring data was available on an hourly or more frequent basis, results were converted to daily mean results before being integrated into an ORC or ORH file.

CDEC data quality is often poor because the data is often not verified before being uploaded to the online database. During the update of the WARMF database it was visually inspected and outliers were removed. The quality of data from USGS NWIS, DWR Library, and CEDEN is good because most of this data goes through a quality control process before being uploaded to their respective databases. Less quality assurance effort was spent incorporating those databases into the WARMF databases, which had already undergone a quality assurance process. Flagged or estimated data was included in the database as long as they were not outliers.

Some of the databases used to update the ORH and ORC files are comprised of data from multiple entities, agencies, or programs. The data from the USGS NWIS and the DWR Library databases indicate that they are only from those respective agencies. However, data from CEDEN and CDEC come from multiple sources. For example, CEDEN data include samples collected by the Surface Water Ambient Monitoring Program (SWAMP), the Grassland Bypass Project, from various TMDL studies, the Irrigated Lands Regulatory Program, and the Westside San Joaquin River Watershed Coalition.

CDEC data include stations maintained by a few agencies, including the California Department of Fish and Wildlife as well as the USGS. Each line of data that was updated in the ORH and ORC files includes a data source field with the database and station identifier from which the data were taken. A summary of all sources within the database and links or references are included in **Attachment A - Table 4**. Continuous monitoring data collected within the Grassland Water District was not available for the database.

V. CONCLUSIONS

The data collected for Task 2a, as summarized above, consist of a massive amount of surface water quality and flow information that will be used for determining baseline salt loading to the San Joaquin River, evaluating current surface water quality conditions, and estimating compliance with surface water quality objectives being considered for the LSJR. Data are housed within WARMF .ORC and .ORH files, which contain site name, site location in latitude and longitude, flow and/or constituent data that are available, and a data source field detailing the database and station identifier from which the data were taken.

The data compiled and described in this memorandum will be used to analyze the baseline salt loading to the LSJR through the use of the WARMF model. While this memorandum conveys and describes the data that are contained within the accompanying database, further analysis of the data will be detailed as part of Task 2b. The additional analysis includes identifying significant salt sources in the LSJR basin, quantifying salt loading from those sources, describing the timing of salt loading to the river, as well as providing a water balance and salt budget.

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ATTACHMENT A: DATA SOURCE LIST

Information regarding each of the data sources whose data has been incorporated into the ORH and ORC observed data files in the WARMF San Joaquin River database is provided in **Table 4**. The table includes the full name of each data source as well as the shortened name that is referenced in the data source field on each data line in the actual ORH and ORC files. The table includes a weblink or a reference document that provides metadata for each data source.

Documentation of what data sources were incorporated into the ORH and ORC files in the WARMF San Joaquin River database is provided in **Table 5a through 5g**. Each of the ORC and ORH files corresponds to a specific location in the San Joaquin River watershed and these locations are listed in **Table 5a through 5g** along with their respective latitude and longitude. In WARMF each ORC and ORH file is assigned to a specific river segment and is given a WARMF River ID which is also listed in the table. Two locations, the Delta-Mendota Canal at Head and the Smith Canal, do not have a WARMF River ID listed and this is because this station is currently not being used in the model. The dates of the first and last data point associated with the location are listed in **Table 4**. Finally, all data sources for each station are listed.

Table 4. Sources of Observed Data used to Create WARMF ORH and ORC Files.

Data Source	ORH/ORC File Abbreviation	Weblink or Reference Document	Description of Source
California Data Exchange Center	CDEC	http://cdec.water.ca.gov/queryCSV.html	Online state database for Department of Water Resources
United States Geological Survey National Water Information System	USGS	http://maps.waterdata.usgs.gov/mapper/index.html	Online federal database for United States Geological Survey
California Department of Water Resources Water Data Library	DWR	http://www.water.ca.gov/waterdatalibrary/	Online state database for Department of Water Resources
California Environmental Data Exchange Network	CEDEN	http://www.ceden.us/AdvancedQueryTool	Online state database for the State Water Board
Bay Delta and Tributaries Project	BDAT	http://www.water.ca.gov/iep/products/data/bdatnotice.cfm	A online state database for DWR and the Interagency Ecological Program that has been archived.
Surface Water Ambient Monitoring Program	SWAMP	http://www.waterboards.ca.gov/water_issues/programs/swamp/	Online state database for the State Water board for surface waters
San Joaquin River Data Atlas	SJR Data Atlas	http://sjr.dotmdl.org/rsrscs-datasets.html	A compiled database of all available data on the SJR and DWSC flow and water quality conditions for 1984 – 2003. Part of the San Joaquin River Dissolved Oxygen Study. Database is housed on a CD.
California Department of Water Resources Interagency Ecological Program Monitoring	DWR-IEP Monitoring	http://www.water.ca.gov/iep/activities/monitoring.cfm#	Online state database for Department of Water Resources
Dissolved Oxygen Total Maximum Daily Load Upstream Studies Water Quality Data	DO TMDL WQ Data	Stringfellow et. al. 2008	Stockton Deep Water Ship Channel Dissolved Oxygen TMDL Upstream Studies
Dissolved Oxygen Total Maximum Daily Load Estuary Studies	DO TMDL Estuary Studies	Contact Dr. Will Stringfellow, University of the Pacific, for more information	This data has not been published as of this time
Central Valley Regional Water Quality Control Board	CVRWQCB	In CEDEN: http://www.ceden.us/AdvancedQueryTool	One of the references within CEDEN
City of Stockton	City of Stockton	Contact Dr. Will Stringfellow, University of the Pacific, for more information	This data has not been published as of this time
Dissolved Oxygen TMDL Upstream Studies Continuous Monitoring	Continuous Monitoring	Stringfellow et. al. 2008	Stockton Deep Water Ship Channel Dissolved Oxygen TMDL Upstream Studies
EPA National Aquatic Resource Survey Data	EPA National Aquatic Resource Survey Data	http://www.epa.gov/watertrain/monitoring/nationalsurveys.html	Compilation of survey data from the federal EPA
Fresno River Water Quality Monitoring	Fresno River Water Quality Monitoring	http://ofmpub.epa.gov/apex/STORETSummary/f?p=101:4:0::NO::P4_HUC,P4_ORG_ID,P4_CHAR_TYPE:18040007,CAFRESNO,	Data can be obtained from EPA STORET data warehouse
Dissolved Oxygen TMDL Upstream Studies Task 4 March 06 Report	Task 4 March 06 Report	Stringfellow et. al. 2008	Stockton Deep Water Ship Channel Dissolved Oxygen TMDL Upstream Studies
Dissolved Oxygen TMDL Upstream Studies Task 8 Report	Task 8 Report	Stringfellow et. al. 2008	Stockton Deep Water Ship Channel Dissolved Oxygen TMDL Upstream Studies

Table 5a.⁹ Sources of Data and Locations of WARMF San Joaquin River Database Hydrology and Water Quality Stations.

Location	<u>Bear Creek at McKee Road</u>	Bear Creek near Bert Crane Road	CA DWR site SJ051E/SJ051M (Dos Reis)	CA DWR site TB (Turning Basin)	Calaveras River at UOP	<u>Chowchilla Bypass / Eastside Bypass</u>	<u>Chowchilla R. blw Buchanan Dam nr Raymond CA</u>	Coarse Gold Creek near Fresno River	<u>Cottonwood Creek near Friant</u>	<u>Del Puerto Creek at Vineyard Road near Patterson</u>	<u>Delta-Mendota Canal at head</u>	<u>Dry Creek near Snelling CA</u>	<u>Dry Creek at Modesto</u>	<u>Eastside Bypass near El Nido</u>
WARMF River ID	65	23	693	884	903	278	72	34	55	339		342	303	396
Latitude	37.309	37.2555	37.8306	37.95	37.9813	36.774	37.2156	37.1683	37.0023	37.5208	37.8161	37.555	37.657	37.1475
Longitude	-120.444	-120.652	-121.312	-121.31	-121.314	-120.285	-119.99	-119.836	-119.722	-121.149	-121.56	-120.462	-120.923	-120.605
Min Date	12/31/1996	10/26/2000	3/30/1994	6/20/2000	5/5/2011	10/1/1997	10/1/1976	6/4/2003	2/4/1998	10/1/1976	10/1/1976	10/1/1976	3/21/1997	1/1/1984
Max Date	12/22/2013	5/9/2011	5/31/2007	10/25/2001	12/13/2012	12/26/2013	9/30/1990	3/31/2004	12/26/2013	12/29/2013	12/26/2013	9/30/1992	12/29/2013	12/26/2013
Source 1	SJR Data Atlas	CEDEN Bear Creek near Bert Crane Road	DWR	DWR	DO TMDL Estuary Studies	CDEC CBP	USGS 11259000	Fresno River Water Quality Monitoring CG	CDEC CTK	SJR Data Atlas	USGS 11313000	USGS 11271320	CDEC DCM	CDEC ELN
Source 2	CDEC MCK	CVRWQCB MER007	DO TMDL WQ Data 2007	DO TMDL Estuary Studies	--	--	--	--	--	USGS 11274630	CDEK TRP	--	--	--
Source 3	--	--	DO TMDL Estuary Studies	--	--	--	--	--	--	USGS 11274653	--	--	--	--
Source 4	--	--	--	--	--	--	--	--	--	CDEC DPC	--	--	--	--
Source 5	--	--	--	--	--	--	--	--	--	DO TMDL WQ Data 2005	--	--	--	--
Source 6	--	--	--	--	--	--	--	--	--	DO TMDL WQ Data 2006	--	--	--	--
Source 7	--	--	--	--	--	--	--	--	--	DO TMDL WQ Data 2007	--	--	--	--
Source 8	--	--	--	--	--	--	--	--	--	CVRWQCB STC516	--	--	--	--
Source 9	--	--	--	--	--	--	--	--	--	DO TMDL Estuary Studies	--	--	--	--
Source 10	--	--	--	--	--	--	--	--	--	CEDEN Del Puerto Creek at Vineyard Ave.	--	--	--	--
Source 11	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Source 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Source 13	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Source 14	--	--	--	--	--	--	--	--	--	--	--	--	--	--

⁹ Underline – updated .ORH files; Red Font – updated .ORC files

Table 5b.¹⁰ Sources of Data and Locations of WARMF San Joaquin River Database Hydrology and Water Quality Stations.

¹⁰ Underline – updated .ORH files; Red Font – updated .ORC files

Location	Fourteen Mile Slough	French Camp Slough	<u>Fresno R blw Hidden Dam nr Daulton CA</u>	Fresno River above the confluence with Miami Creek	Fresno River below Coarse Gold Creek above Hensley Reservoir	<u>Hensley Lake inflow</u>	Hospital Creek	Ingram Creek	<u>Little Dry Creek (USBR)</u>	Los Banos Creek at Highway 140	Mariposa Creek	Marshall Road Drain	Merced R at McConnell State Park nr Livingston CA	Merced River at River Road near Newman	Merced River at Shaffer Bridge near Cressy
WARMF River ID	923	851	45	9	35	35	305	313	50	444	1	201	124	108	129
Latitude	38.006	37.9161	37.0975	37.3352	37.1519	37.1585	37.6103	37.6003	36.942	37.2755	37.46	37.4361	37.4139	37.3511	37.4542
Longitude	-121.397	-121.304	-119.889	-119.707	-119.856	-119.862	-121.231	-121.225	-119.683	-120.955	-119.94	-121.036	-120.709	-120.961	-120.608
Min Date	6/9/2011	10/19/2006	10/1/1976	5/28/2003	6/3/2003	12/1/1988	10/24/2000	10/24/2000	2/3/1998	1/1/1984	8/27/2002	1/1/2005	7/29/1992	6/13/1985	10/1/1976
Max Date	11/8/2012	9/27/2012	9/30/1990	3/31/2004	3/31/2004	12/26/2013	9/9/2012	1/7/2013	12/26/2013	10/12/2013	8/27/2002	10/15/2012	7/17/2002	9/20/2012	12/26/2013
Source 1	DO TMDL Estuary Studies	DO TMDL WQ Data 2006	USGS 11258000	Fresno River Water Quality Monitoring FR	Fresno River Water Quality Monitoring FR	CDEC HID	CDEC HSP	CDEC ING	CDEC LDC	SJR Data Atlas	EPA National Aquatic Resource Survey Data	DO TMDL WQ Data 2005	USGS 37245012042 3300	SJR Data Atlas	SJR Data Atlas
Source 2	--	DO TMDL WQ Data 2007	--	--	--	--	DO TMDL WQ Data 2005	DO TMDL WQ Data 2005	--	Task 4 March 06 Report	--	DO TMDL WQ Data 2006	--	USGS 11273500	USGS 11271290
Source 3	--	DO TMDL Estuary Studies	--	--	--	--	DO TMDL WQ Data 2006	DO TMDL WQ Data 2006	--	DO TMDL WQ Data 2006	--	CE DEN Marshall Road Drain near River Road	--	DO TMDL WQ Data 2005	CDEC CRS
Source 4	--	--	--	--	--	--	DO TMDL WQ Data 2007	DO TMDL WQ Data 2007	--	Continuous Monitoring	--	CDEC MSR	--	DO TMDL WQ Data 2006	--
Source 5	--	--	--	--	--	--	CVRWQCB STC042	CVRWQCB STC040	--	CE DEN Los Banos Creek @ Hwy 140	--	--	--	DO TMDL WQ Data 2007	--
Source 6	--	--	--	--	--	--	CE DEN Hospital Creek at River Road	DO TMDL Estuary Studies	--	--	--	--	--	CVRWQCB MER546	--
Source 7	--	--	--	--	--	--	--	CE DEN Ingram Creek at River Road	--	--	--	--	--	DO TMDL Estuary Studies	--
Source 8	--	--	--	--	--	--	--	--	--	--	--	--	--	CE DEN Merced River at River Road	--
Source 9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Source 10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Source 11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Source 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Source 13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Source 14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 5c.¹¹ Sources of Data and Locations of WARMF San Joaquin River Database Hydrology and Water Quality Stations.

Location	<u>Merced River below Merced Falls Dam near Snelling</u>	<u>Merced River near Stevinson</u>	<u>Modesto Irrigation District Lateral 4 Spill</u>	Modesto Irrigation District Lateral 5 Spill	Modesto Irrigation District Lateral 6 Spill	Modesto Irrigation District Main Canal Spill	Moran Drain	Mosher Slough	Mud Slough above San Luis Drain (Gun Club Road)	<u>Mud Slough near Gustine</u>	Newman Wasteway at Brazo Road	<u>Orestimba Creek at River Road near Crows Landing</u>	Orestimba Creek near Newman	Panoche Crk at I-5 nr Silver Crk CA
WARMF River ID	123	107	208	207	210	209	199	937	969	387	259	165	164	14
Latitude	37.522	37.371	37.6306	37.6145	37.7038	37.6703	37.4355	38.0325	37.2542	37.2625	37.3038	37.4136	37.3156	36.6525
Longitude	-120.331	-120.931	-121.159	-121.143	-121.141	-121.219	-121.036	-121.365	-120.907	-120.906	-120.996	-121.015	-121.124	-120.631
Min Date	10/1/1976	10/1/1940	11/22/2003	3/1/2005	3/1/2005	3/1/2005	1/1/2005	5/5/2011	10/27/1995	8/2/1985	9/23/1985	4/15/1992	10/1/1976	12/1/1997
Max Date	12/26/2013	12/26/2013	11/25/2007	11/25/2007	11/25/2007	8/18/2011	12/29/2007	12/13/2012	12/26/2012	12/27/2013	2/11/2013	12/27/2013	12/28/2013	12/27/2013
Source 1	SJR Data Atlas	SJR Data Atlas	DO TMDL WQ Data 2005	Task 4 March 06 Report	DO TMDL WQ Data 2005	Task 4 March 06 Report	DO TMDL WQ Data 2005	DO TMDL Estuary Studies	SWAMP	SJR Data Atlas	DO TMDL WQ Data 2005	CDEC OCL	SJR Data Atlas	USGS 11255575
Source 2	USGS 11270900	USGS 11272500	DO TMDL WQ Data 2007	DO TMDL WQ Data 2005	DO TMDL WQ Data 2007	DO TMDL WQ Data 2005	DO TMDL WQ Data 2007	--	CEDEN Mud Slough Upstream of SLD Terminus	CDEC MSG	DO TMDL WQ Data 2006	SJR Data Atlas	USGS 11274500	--
Source 3	CDEC MSN	CDEC MST	Task 4 March 06 Report	DO TMDL WQ Data 2006	--	DO TMDL WQ Data 2006	CDEC MON	--	--	USGS 11262900	USGS 371903120585400	USGS 11274538	--	--
Source 4	DWR Merced River below Merced Falls Dam	DWR - MERCED R NR STEVINSON	CEDEN MID Lateral 4 @ Paradise Rd	DO TMDL WQ Data 2007	--	DO TMDL WQ Data 2007	--	--	--	DWR - Mud SI @ Hwy 140	CEDEN: Newman Wasteway near Hills Ferry Road	DO TMDL WQ Data 2005	--	--
Source 5	--	DO TMDL WQ Data 2005	--	--	--	DO TMDL Estuary Studies	--	--	--	DWR - MUD SLU NR STEVINSON	--	DO TMDL WQ Data 2006	--	--
Source 6	--	--	--	--	--	--	--	--	--	DO TMDL WQ Data 2005	--	DO TMDL WQ Data 2007	--	--
Source 7	--	--	--	--	--	--	--	--	--	Task 4 March 06 Report	--	CVRWQCB STC019	--	--
Source 8	--	--	--	--	--	--	--	--	--	DO TMDL WQ Data 2006	--	DO TMDL Estuary Studies	--	--
Source 9	--	--	--	--	--	--	--	--	--	DO TMDL WQ Data 2007	--	CEDEN Orestimba Creek @ River Road	--	--
Source 10	--	--	--	--	--	--	--	--	--	CVRWQCB MER542	--	--	--	--
Source 11	--	--	--	--	--	--	--	--	--	Continuous Monitoring	--	--	--	--
Source 12	--	--	--	--	--	--	--	--	--	DO TMDL Estuary Studies	--	--	--	--
Source 13	--	--	--	--	--	--	--	--	--	CEDEN Mud Slough downstream of San Luis Drain	--	--	--	--
Source 14	--	--	--	--	--	--	--	--	--	--	--	--	--	--

¹¹ Underline – updated .ORH files; Red Font – updated .ORC files

Table 5d.¹² Sources of Data and Locations of WARMF San Joaquin River Database Hydrology and Water Quality Stations.

¹² Underline – updated .ORH files; Red Font – updated .ORC files

Location	Salado Creek at Highway 33	Salt Slough at Highway 165	San Joaquin R blw Friant CA	San Joaquin R near Mendota CA	San Joaquin River 500 yards upstream of Lights 33 and 34	San Joaquin River at Brandt Bridge	San Joaquin River at Buckley Cove	San Joaquin River at Crows Landing Bridge	San Joaquin River at Donny Bridge	San Joaquin River at Fremont Ford	San Joaquin River at Gravelly Ford	San Joaquin River at Highway 41	San Joaquin River at Jersey Point	San Joaquin River at Laird Park
WARMF River ID	344	249	381	60	913	769	912	733	67	747	69	68	541	714
Latitude	37.4816	37.248	36.9844	36.8106	37.9899	37.8647	37.9782	37.4283	36.8335	37.301	36.798	36.8762	38.053	37.5595
Longitude	-121.135	-120.851	-119.723	-120.377	-121.402	-121.323	-121.382	-121.003	-119.966	-120.93	-120.16	-119.793	-121.688	-121.153
Min Date	10/24/2000	1/1/1984	10/1/1921	12/6/1999	9/17/1984	1/1/1984	1/1/1984	1/1/1984	6/23/2004	4/1/1937	6/27/1997	8/25/2005	1/1/1984	1/1/1977
Max Date	9/6/2007	12/27/2013	12/28/2013	12/27/2013	11/8/2012	11/8/2012	12/14/2010	12/27/2013	12/27/2013	12/27/2013	12/27/2013	1/7/2014	12/31/2005	10/20/2010
Source 1	BDAT Project 541STC515	SJR Data Atlas	USGS 11251000	USGS 11254000	BDAT Project 911MWT	SJR Data Atlas	SJR Data Atlas	SJR Data Atlas	CDEC DNB	SJR Data Atlas	CDEC GRF	CDEC H41	SJR Data Atlas	BDAT Project 373324121090 401
Source 2	DO TMDL WQ Data 2007	CDEC SSH	DWR WQ Library	--	DO TMDL Estuary Studies	City of Stockton R1	DWR-IEP Monit. & Anal.	USGS 11274550	--	DO TMDL WQ Data 2005	--	USGS 11252275	BDAT Project B9D80311413	DO TMDL WQ Data 2005
Source 3	CVRWQCB STC515	USGS 11261100	CDEC SJF	--	--	DO TMDL Estuary Studies	City of Stockton R6	CEDEN SJR @ Crows Landing	--	DO TMDL WQ Data 2006	--	CEDEN SJR at Wildwood Native Park	CDEC SJJ	Task 4 March 06 Report
Source 4	CEDEN: Salado Creek @ Hwy 33	DWR WQ Library	--	--	--	--	BDAT Project P8	CDEC SCL	--	DO TMDL WQ Data 2007	--	--	--	DO TMDL WQ Data 2006
Source 5	--	DO TMDL WQ Data 2005	--	--	--	--	BDAT Project R6	DO TMDL WQ Data 2005	--	USGS 11261500	--	--	--	DWR:SAN JOAQUIN R NR GRAY A LAIR SLU
Source 6	--	DO TMDL WQ Data 2006	--	--	--	--	--	DO TMDL WQ Data 2006	--	CVRWQCB STC538	--	--	--	CEDEN SJR at Grayson
Source 7	--	DO TMDL WQ Data 2007	--	--	--	--	--	DO TMDL WQ Data 2007	--	CDEC FFB	--	--	--	--
Source 8	--	Continuous Monitoring	--	--	--	--	--	Continuous Monitoring	--	CEDEN SJR @ Fremont Ford	--	--	--	--
Source 9	--	CVRWQCB MER531	--	--	--	--	--	CVRWQCB STC504	--	DWR San Joaquin R at Fremont Ford Bridge	--	--	--	--
Source 10	--	DO TMDL Estuary Studies	--	--	--	--	--	--	--	--	--	--	--	--
Source 11	--	CEDEN: Salt Slough @ Lander Avenue	--	--	--	--	--	--	--	--	--	--	--	--
Source 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Source 13	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Source 14	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 5e.¹³ Sources of Data and Locations of WARMF San Joaquin River Database Hydrology and Water Quality Stations.

Location	San Joaquin River at Light 18	San Joaquin River at Light 24	San Joaquin River at Light 45	<u>San Joaquin River at Maze Road (Highway 132)</u>	San Joaquin River at Mile 33.2	San Joaquin River at Mossdale	<u>San Joaquin River at Newman</u>	<u>San Joaquin River at Patterson</u>	<u>San Joaquin River at Rough & Ready Island</u>	San Joaquin River at Sack Dam	<u>San Joaquin River at Stockton (Garwood Bridge)</u>	<u>San Joaquin River at Vernalis</u>	<u>San Joaquin River below Friant</u>	<u>San Joaquin River below Old River near Lathrop</u>
WARMF River ID	920	916	894	703	915	310	739	725	899	349	870	184	381	691
Latitude	38.0173	37.9967	37.9549	37.64	37.9937	37.786	37.3506	37.494	37.963	36.9836	37.935	37.667	36.984	37.81
Longitude	-121.459	-121.445	-121.352	-121.228	-121.433	-121.306	-120.976	-121.081	-121.365	-120.5	-121.329	-121.267	-119.723	-121.323
Min Date	9/17/1984	9/17/1984	6/20/2000	12/12/1976	6/9/2011	1/1/1984	1/1/1984	1/1/1984	1/1/1984	10/26/2000	1/1/1984	10/1/1976	10/1/1921	10/13/2004
Max Date	11/8/2012	12/13/2007	11/8/2012	12/27/2013	11/8/2012	12/13/2012	12/28/2013	12/27/2013	5/3/2011	12/1/2012	12/28/2013	12/28/2013	12/28/2013	2/1/2012
Source 1	BDAT Project R8	BDAT Project R7	BDAT Project R4	SJR Data Atlas	DO TMDL Estuary Studies	SJR Data Atlas	SJR Data Atlas	SJR Data Atlas	SJR Data Atlas	BDAT Project 541MAD007	City of Stockton R2	DWR - VERNALIS	CDEC SJF	CDEC SJL
Source 2	DWR	BDAT Project 910MWT	City of Stockton R4	DWR San Joaquin R. @ Maze Rd. Bridge	--	CDEC MSD	BDAT Project	CDEC SJP	CDEC RRI	CEDEN SJR @ Sack Dam	DWR - SAN JOAQUIN R NR STE	SJR Data Atlas	USGS 11251000	DO TMDL WQ Data 2007
Source 3	BDAT Project 909MWT	City of Stockton R7	DO TMDL Estuary Studies	DO TMDL WQ Data 2005	--	BDAT Project B9D74711184	USGS 11274000	SJDOTMDL DO71	--	--	BDAT Project P8A	USGS 11303500	DWR San Joaquin R Blw Friant BO788500	--
Source 4	City of Stockton R8	--	--	DO TMDL WQ Data 2006	--	DWR - SJRMOSSDALE	--	DO TMDL WQ Data 2005	--	--	DO TMDL WQ Data 2006	DO TMDL WQ Data 2005	--	--
Source 5	DO TMDL Estuary Studies	--	--	DO TMDL WQ Data 2007	--	DWR - SAN JOAQUIN R A MOSS	--	DO TMDL WQ Data 2006	--	--	BDAT Project B9D75571196	DO TMDL WQ Data 2006	--	--
Source 6	--	--	--	Continuous Monitoring	--	Task 8 Report / SJR 5	--	DO TMDL WQ Data 2007	--	--	SJR Data Atlas	DO TMDL WQ Data 2007	--	--
Source 7	--	--	--	CDEC MRB	--	DO TMDL WQ Data 2005	--	BDAT Project 11274570	--	--	USGS 11304810	Task 8 Report / SJR 1	--	--
Source 8	--	--	--	USGS 11290500	--	DO TMDL WQ Data 2006	--	Continuous Monitoring	--	--	CDEC SJG	BDAT Project CDEC-VNS	--	--
Source 9	--	--	--	CEDEN San Joaquin River above Maze Blvd.	--	DO TMDL WQ Data 2007	--	CDEC SJP	--	--	--	BDAT Project C10A	--	--
Source 10	--	--	--	CEDEN San Joaquin River at Maze Boulevard near Vernalis	--	BDAT Project C7A	--	DO TMDL Estuary Studies	--	--	--	Continuous Monitoring	--	--
Source 11	--	--	--	--	--	DO TMDL Estuary Studies	--	USGS 11274570	--	--	--	CDEC SJR	--	--
Source 12	--	--	--	--	--	--	--	CEDEN SJR @ Patterson	--	--	--	DO TMDL Estuary Studies	--	--
Source 13	--	--	--	--	--	--	--	CEDEN San Joaquin River at PID Pumps	--	--	--	DWR B0702000	--	--
Source 14	--	--	--	--	--	--	--	DWR B0720000	--	--	--	--	--	--

¹³ Underline – updated .ORH files; Red Font – updated .ORC files

Table 5f.¹⁴ Sources of Data and Locations of WARMF San Joaquin River Database Hydrology and Water Quality Stations.

¹⁴ Underline – updated .ORH files; Red Font – updated .ORC files

Location	San Joaquin River between Hog Island and Turner Cut	<u>San Joaquin River near Dos Palos</u>	<u>San Joaquin River near Stevinson ("at Highway 165")</u>	San Joaquin River upstream of the Merced River (Hill's Ferry)	San Luis Drain Site B nr Stevinson CA	Smith Canal	Spanish Grant Drain	Stanislaus River at Caswell State Park	Stanislaus River at confluence with San Joaquin River	Stanislaus River at Gambini Property	<u>Stanislaus River at Goodwin</u>	Stanislaus River at Jacob Myers Park	Stanislaus River at Oakdale	Stanislaus River at Oakdale Recreation Area	<u>Stanislaus River at Orange Blossom Bridge</u>
WARMF River ID	919	350	752	742	970		196	161	158	168	172	167	170	169	171
Latitude	38.0008	36.994	37.295	37.3331	37.2408	37.9674	37.4358	37.7025	37.67	37.772	37.8517	37.743	37.7775	37.771	37.783
Longitude	-121.449	-120.501	-120.851	-120.955	-120.877	-121.307	-121.036	-121.177	-121.225	-120.888	-120.637	-120.942	-120.853	-120.867	-120.75
Min Date	7/3/1984	12/3/2009	6/24/1985	5/2/1985	1/1/1984	5/5/2011	1/1/2005	1/28/1998	1/1/2001	1/1/2001	10/1/1976	1/1/2001	1/1/1984	1/1/2001	1/1/1984
Max Date	8/23/2004	12/27/2013	12/28/2013	7/9/2012	9/20/2012	12/13/2012	10/9/2007	8/18/2011	3/1/2004	8/29/2011	9/30/2012	7/23/2003	1/7/2014	4/17/2011	12/28/2013
Source 1	BDAT Project 910TNS	CDEC SDP	SJR Data Atlas	BDAT Project 372006120 571701	SJR Data Atlas	DO TMDL Estuary Studies	DO TMDL WQ Data 2005	SJR Data Atlas	CDEC SBC	CDEC GMB	SJR Data Atlas	CDEC JMP	SJR Data Atlas	CDEC ORA	CDEC OBB
Source 2	--	--	CDEC SJS	CVRWQCB STC512	CVRWQCB	--	DO TMDL WQ Data 2006	DWR - Stanislaus River @ Caswell Park	--	--	USGS 11302000	--	CDEC SOK	--	--
Source 3	--	--	USGS 11260815	CEDEN SJR @ Hills Ferry	SWAMP	--	DO TMDL WQ Data 2007	DO TMDL WQ Data 2005	--	--	CDEC SNS	--	USGS 11302500	--	--
Source 4	--	--	DWR - SJR@Hwy165	--	USGS 11262895	--	--	DO TMDL WQ Data 2006	--	--	DWR B3113000	--	--	--	--
Source 5	--	--	DWR San Joaquin River near Stevinson B0740000	--	DO TMDL Estuary Studies	--	--	DO TMDL WQ Data 2007	--	--	--	--	--	--	--
Source 6	--	--	DO TMDL WQ Data 2005	--	CEDEN 541MER535	--	--	CVRWQCB STC514	--	--	--	--	--	--	--
Source 7	--	--	DO TMDL WQ Data 2006	--	--	--	--	DO TMDL Estuary Studies	--	--	--	--	--	--	--
Source 8	--	--	DO TMDL WQ Data 2007	--	--	--	--	USGS 3742091211038 00	--	--	--	--	--	--	--
Source 9	--	--	Continuous Monitoring	--	--	--	--	CEDEN 535STC514	--	--	--	--	--	--	--
Source 10	--	--	DO TMDL Estuary Studies	--	--	--	--	--	--	--	--	--	--	--	--
Source 11	--	--	CEDEN San Joaquin River at Lander Ave 541MER522	--	--	--	--	--	--	--	--	--	--	--	--
Source 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Source 13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Source 14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 5g.¹⁵ Sources of Data and Locations of WARMF San Joaquin River Database Hydrology and Water Quality Stations.

Location	<u>Stanislaus River at Ripon</u>	<u>Tuolumne at Modesto USGS</u>	Tuolumne River at Modesto	Tuolumne River at Shiloh Road	<u>Tuolumne River below La Grange Dam</u>	Turlock ID Harding Drain	Turlock ID Lateral 6 & 7 at Levee	Turlock ID Westport Drain Flow Station	Turlock Irrigation District Lateral 2	<u>Turner Cut near Holt</u>	Westley Wasteway Flow Station
WARMF River ID	162	141	149	141	306	202	198	204	205	921	206
Latitude	37.73	37.627	37.6271	37.6031	37.6664	37.4643	37.3977	37.5424	37.5652	37.9928	37.5582
Longitude	-121.109	-120.986	-120.987	-121.131	-120.441	-121.031	-120.96	-121.094	-121.138	-121.454	-121.164
Min Date	10/1/1940	4/1/1940	4/1/1940	10/9/1979	10/1/1976	10/25/2000	8/15/1977	3/24/1993	8/15/1977	2/15/2006	1/1/2005
Max Date	12/28/2013	12/28/2013	12/28/2013	8/18/2011	12/28/2013	9/20/2012	12/31/2007	12/31/2007	12/31/2007	12/28/2013	12/10/2012
Source 1	SJR Data Atlas	DO TMDL WQ Data 2005	USGS 11290000	SJR Data Atlas	SJR Data Atlas	SJR Data Atlas	Task 4 March 06 Report	DO TMDL WQ Data 2005	DO TMDL WQ Data 2005	CDEC TRN	DO TMDL WQ Data 2005
Source 2	USGS 11303000	DO TMDL WQ Data 2006	--	CDEC TSB	DWR - Station Tuolumne River @ Shiloh	USGS 11289660	DO TMDL WQ Data 2005	DO TMDL WQ Data 2006	DO TMDL WQ Data 2006	DO TMDL Estuary Studies	BDAT Project 541STC029
Source 3	DO TMDL WQ Data 2005	DO TMDL WQ Data 2007	--	USGS 11290000	DO TMDL WQ Data 2005	DO TMDL Estuary Studies	DO TMDL WQ Data 2006	DO TMDL WQ Data 2007	DO TMDL WQ Data 2007	--	DO TMDL WQ Data 2006
Source 4	CDEC RIP	SJR DO TMDL Data	--	DO TMDL Estuary Studies	DO TMDL WQ Data 2006	CECEN TID 5 Harding Drain @ Carpenter Road 535STC501	DO TMDL WQ Data 2007	USGS 373232121053 900	DWR: TURLOCK ID LATERAL DR NO 2	--	DO TMDL WQ Data 2007
Source 5	--	USGS 11290000	--	CECEN 535STC513	DO TMDL WQ Data 2007	--	CECEN TID Lateral 6&7 @ Central	--	CECEN: Lower Lateral 2 at Grayson Road	--	CDEC WSW
Source 6	--	--	--	--	CVRWQCB STC513	--	DWR: Turlock ID Lateral Drain No 6 & 7	--	--	--	CECEN 541XWWNCR
Source 7	--	--	--	--	USGS 11290200	--	--	--	--	--	--
Source 8	--	--	--	--	--	--	--	--	--	--	--
Source 9	--	--	--	--	--	--	--	--	--	--	--
Source 10	--	--	--	--	--	--	--	--	--	--	--
Source 11	--	--	--	--	--	--	--	--	--	--	--
Source 12	--	--	--	--	--	--	--	--	--	--	--
Source 13	--	--	--	--	--	--	--	--	--	--	--
Source 14	--	--	--	--	--	--	--	--	--	--	--

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