Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh

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Chapter 9: Developing EC for Inflows for the San Joaquin River Extension to DSM2 for Planning Studies

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9 Developing EC for Inflows for the San Joaquin River Extension to DSM2 for Planning Studies

9.1 Introduction

The DSM2 extension up the San Joaquin River from Vernalis to Bear Creek, described by Pate (2001), has been used to simulate Delta hydrodynamic and electrical conductivity (EC) conditions based upon CALSIM-derived Delta inflows and exports. These simulations required modeling various inflows and associated EC in the extended reach of the San Joaquin River. The flows for these sources were provided by CALSIM directly, generated from post-processing CALSIM results via a methodology developed by Montgomery Watson Harza (2002), or taken from average values from the San Joaquin River Input-Output Model (SJRIO). As part of this effort, EC needed to be developed for the various sources of inflow to the San Joaquin River upstream of Vernalis. This chapter presents the assumptions and methodology for generating these EC values.

9.2 Sources of Inflow to the San Joaquin River from Vernalis to Bear Creek

EC is introduced into the San Joaquin River in the reach from Vernalis to Bear Creek from various sources: the upstream boundary near Stevinson; the tributary flows from the Stanislaus, Tuolumne, and Merced rivers; flows from Orestimba Creek and Mud and Salt Sloughs; westside agricultural drainage; eastside drainage; and groundwater flow (Figure 9.1). Monthly average flows from the Stanislaus, Tuolumne, and Merced rivers are obtained directly from CALSIM studies, as is the flow in the San Joaquin River near Stevinson. Agricultural drainage from the westside consists of runoff from applied water from Delta Mendota Canal (DMC) deliveries, riparian diversions, and groundwater pumping. Runoff from applied DMC water and riparian diversions is provided by CALSIM, and runoff from applied groundwater comes from SJRIO. Eastside drainage flows are provided by CALSIM, and groundwater flows into the San Joaquin River come from SJRIO.

9.3 EC in Stanislaus, Tuolumne, and Merced Rivers

Relationships between historic flows and EC were established (Figures 9.2, 9.3, and 9.4) to assign EC to flows from the Stanislaus, Tuolumne, and Merced rivers. No significant advantage was seen in developing relationships based upon time of year. The equations generated are presented in Table 9.1.

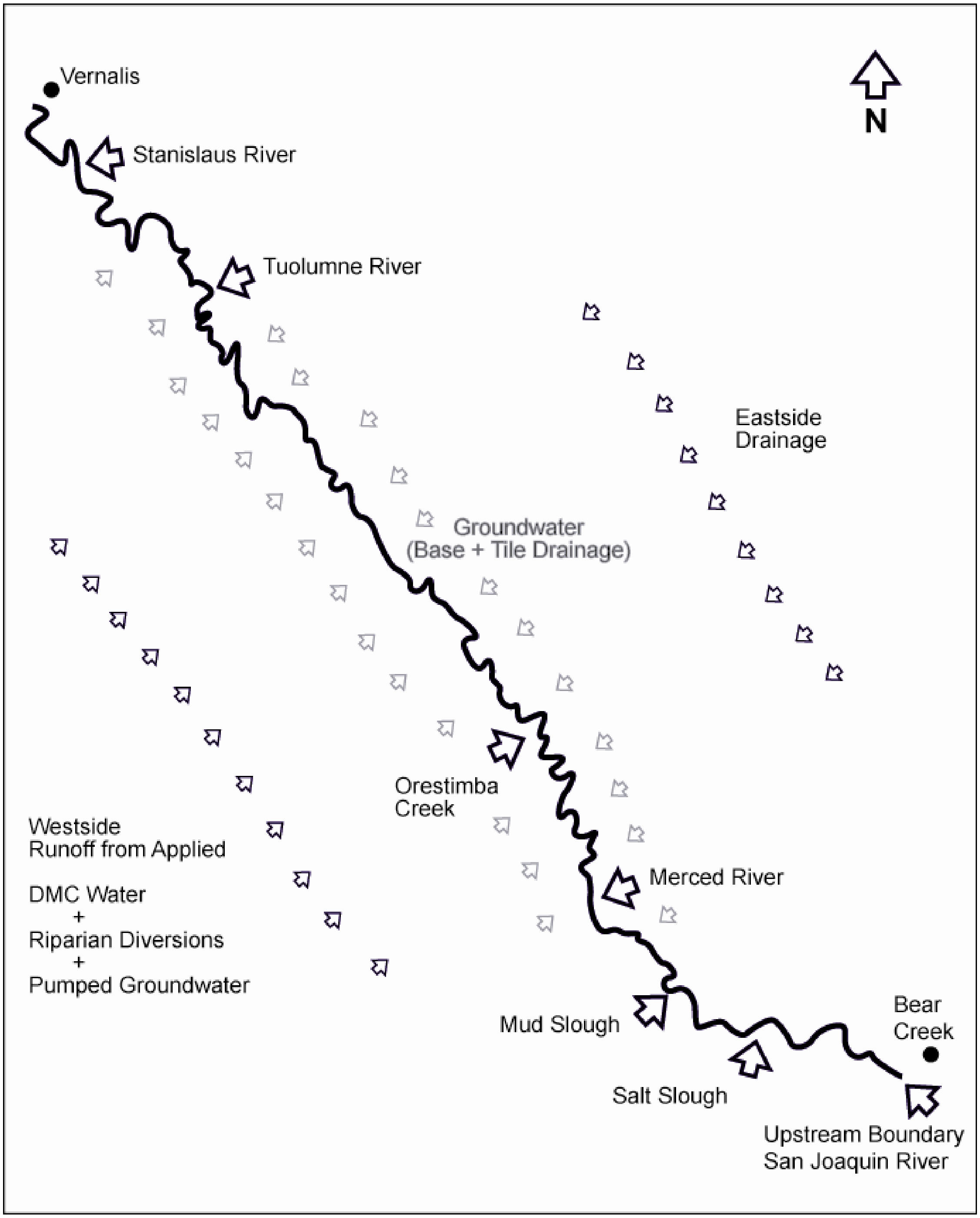

Figure 9.1: Sources of EC in Modeled Reach of San Joaquin River.

Table 9.1: Equations for EC as a Function of Flow at Various Sources of Inflow on the San Joaquin River.

EC Source	EC Equation	EC Limits	Period
Stanislaus River	$2400Q^{-0.48}$	EC>70	All
Tuolumne River	$2950Q^{-0.482}$	EC<350	All
Merced River	$-5E{-}07Q^3 + 0.0013Q^2 - 1.12Q + 384$	40<EC<350	All
SJR near Stevinson	$2440Q^{-0.305}$	EC<2000	January
	$3840Q^{-0.392}$	EC<1500	February
	$8690Q^{-0.465}$	EC<2000	March
	$5840Q^{-0.439}$		April
	$-1.21Q + 1540$	EC>100	May
	$-2.30Q + 1720$	EC>200	June
	1390		July
	$1570e^{-0.009Q}$		August
	$7100Q^{-0.600}$	EC<2000	September
	$1590e^{-0.0103Q}$	EC>50	October
	$3390Q^{-0.503}$	EC<1500	November
	$2910Q^{-0.355}$	EC<1500	December
Orestimba Creek	$-0.15Q + 655$		January-May
	$-2.58Q + 710$		June-August
	$-3.76\,Q + 710$		September
	$800e^{-0.0053Q}$		October
	$690e^{-0.0042Q}$		November
	$570e^{-0.002Q}$		December
Salt Slough	1800		January
	1640		February
	1540		March
	1600		April
	$-1.80Q + 1620$		May
	$-3.13Q + 1680$		June
	$-2.03Q + 1350$		July
	$-1.80Q + 1230$		August
	$-1.05Q + 1060$		September
	1030		October
	$-4.40Q + 2050$		November
	$-6.55Q + 2620$		December
Mud Slough	$-2.06Q + 2420$		January
	$-1.64Q + 2790$		February
	3250		March-August
	2310		September
	$-4.69Q + 2390$		October
	$-5.23Q + 2660$		November
	$-2.40Q + 2360$		December
Q in cfs, EC in uS/cm			

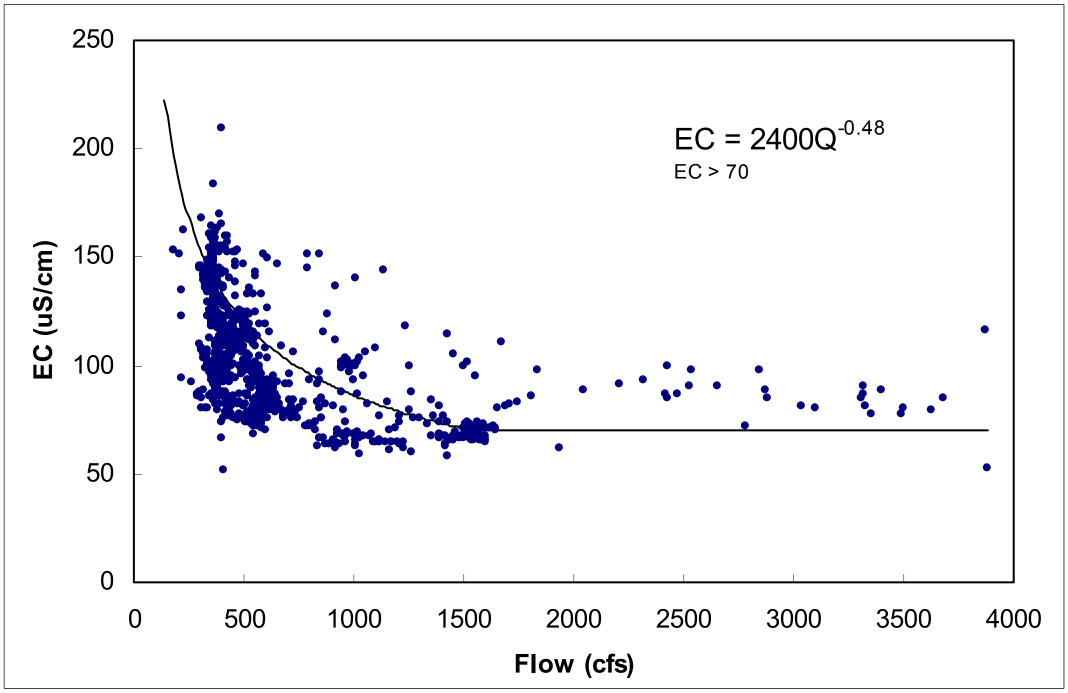

Figure 9.2: Stanislaus River, EC vs. Flow.

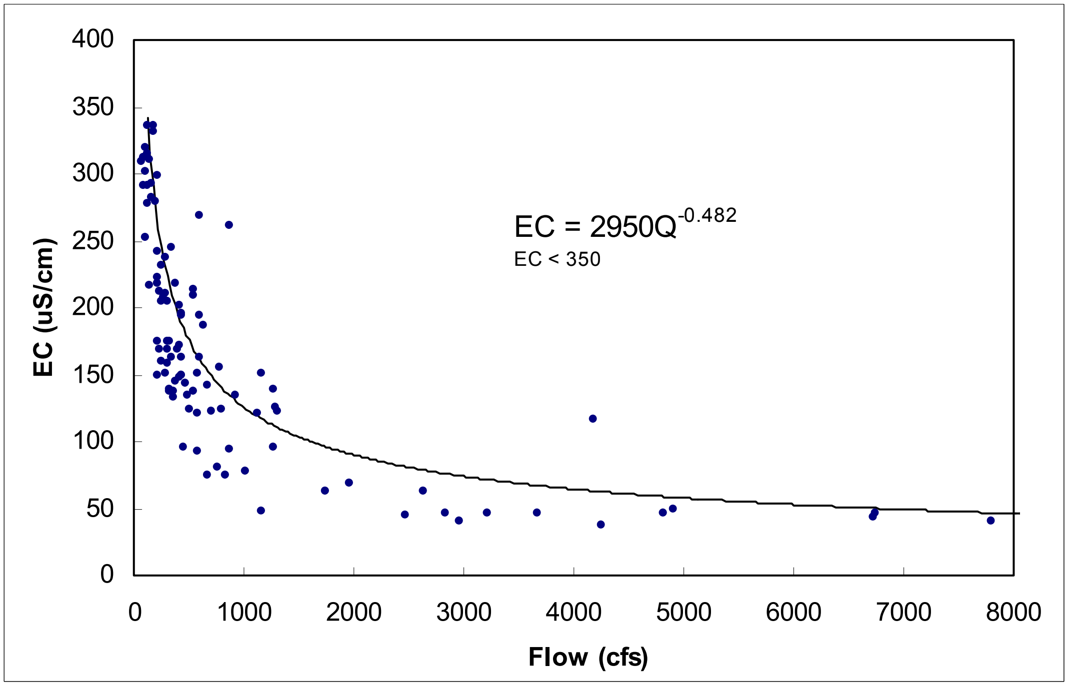

Figure 9.3: Tuolumne River, EC vs. Flow.

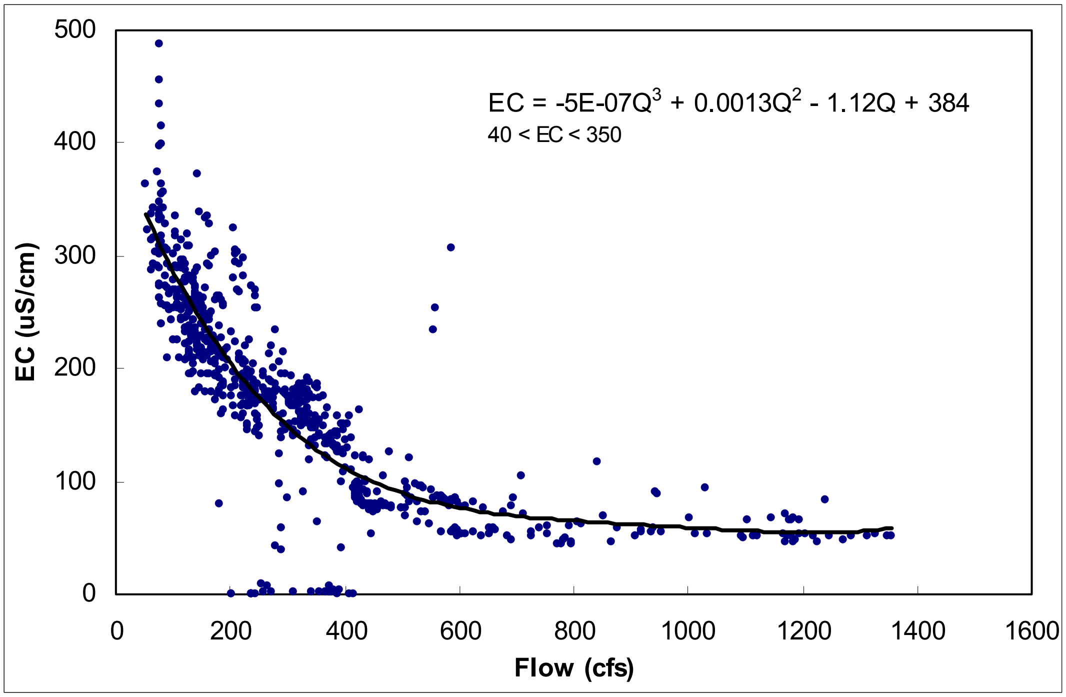

Figure 9.4: Merced River, EC vs. Flow.

9.4 EC in San Joaquin River at Upstream Boundary (near Stevinson)

To assign EC to flows from the San Joaquin River at the upstream boundary near Stevinson, relationships between historic flows and EC were established for each month (Figure 9.5). The equations generated are presented in Table 9.1.

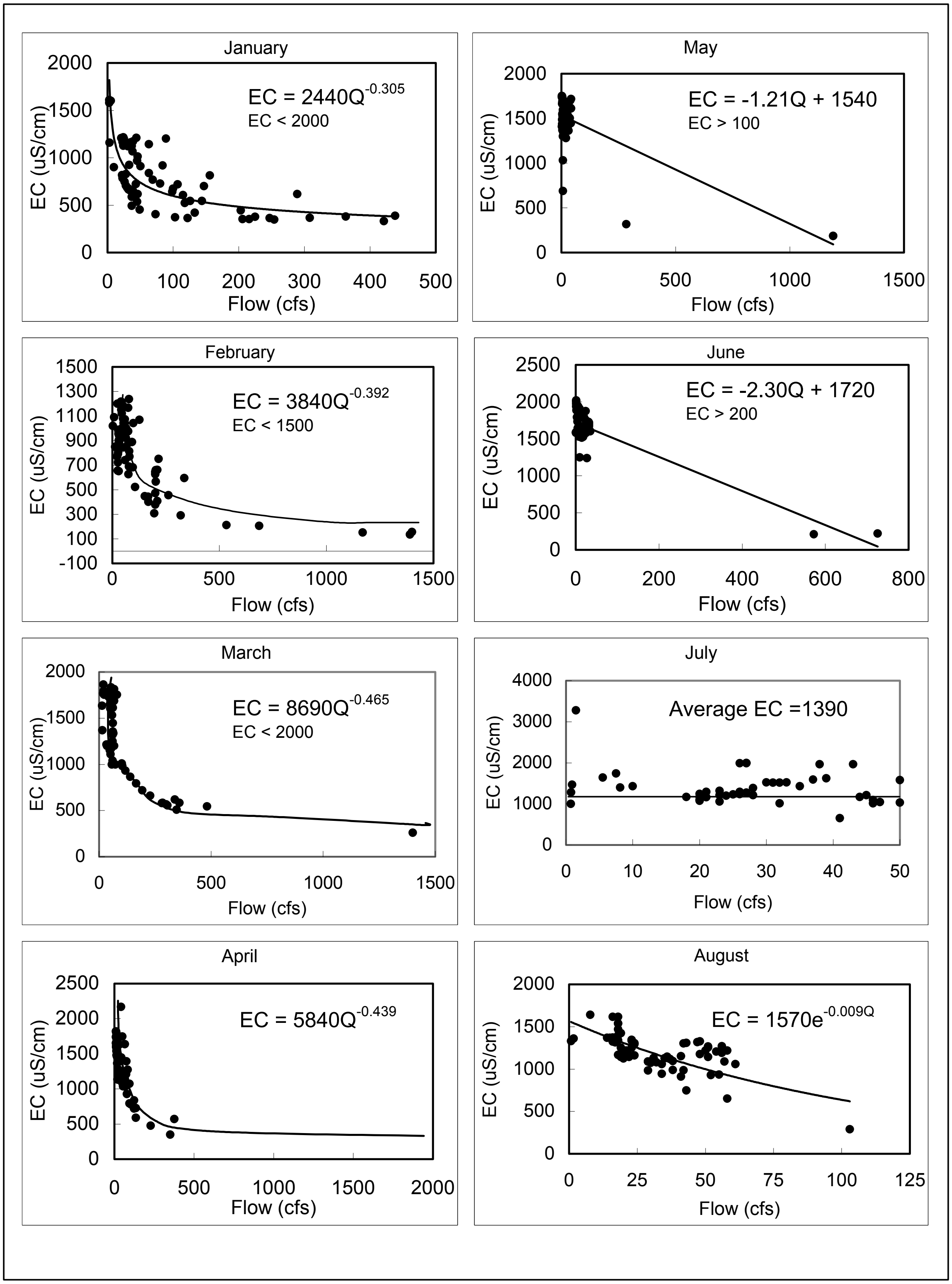

Figure 9.5: San Joaquin River near Stevinson, EC vs. Flow.

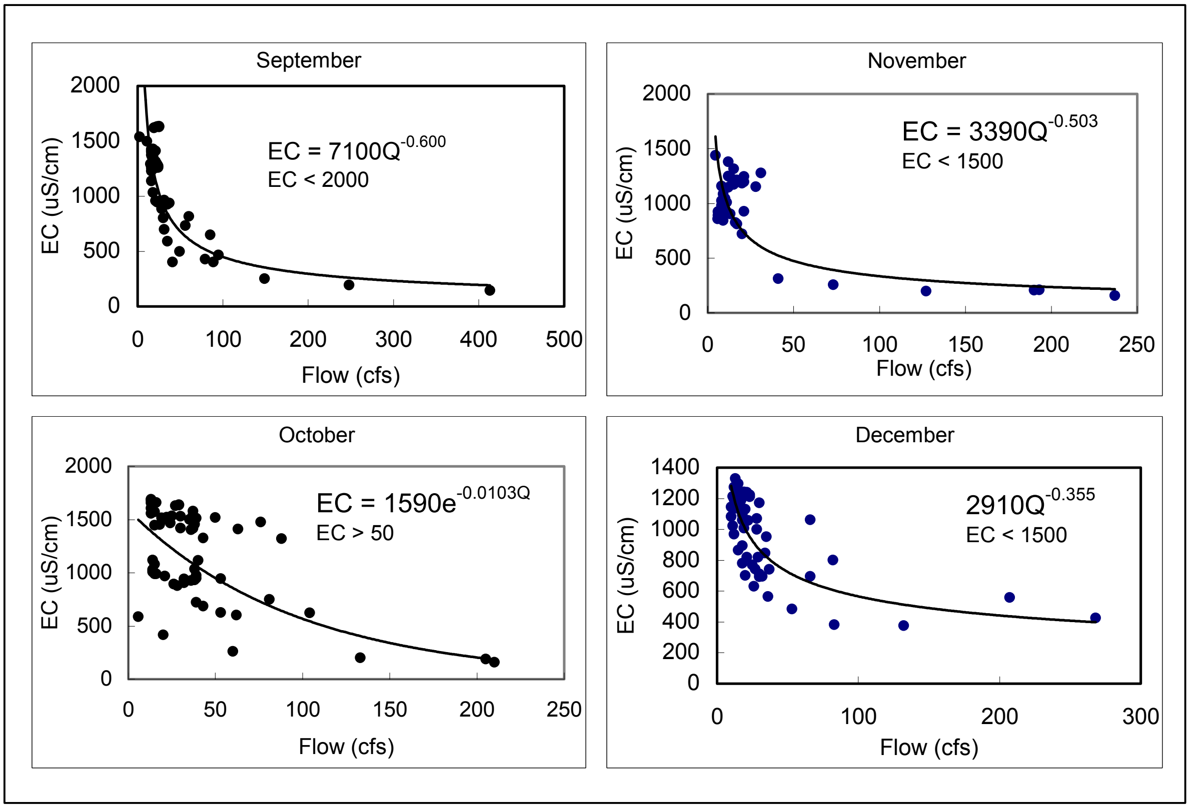

Figure 9.5 (cont.): San Joaquin River near Stevinson, EC vs. Flow.

9.5 EC in Orestimba Creek

To assign EC to flows in Orestimba Creek, relationships between historic flows and EC were developed for each of six intervals for any year: January-May, June-August, September, October, November, and December (Figure 9.6). The relationships are based upon data collected by USGS from January 1997 through February 2000. The equations generated are presented in Table 9.1.

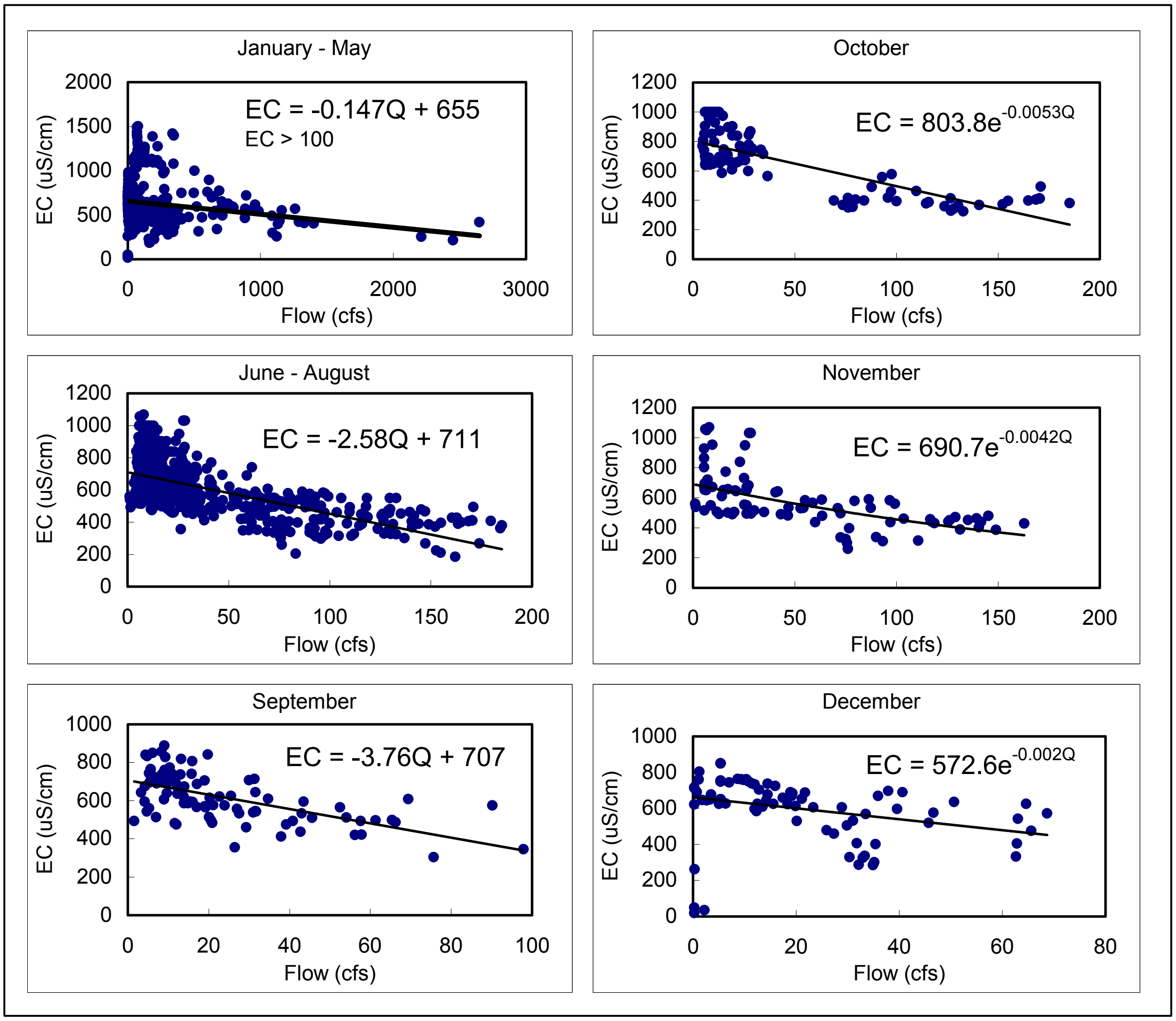

Figure 9.6: Orestimba Creek, EC vs. Flow

9.6 EC in Salt and Mud Sloughs

To assign EC to flows in Salt and Mud sloughs, relationships between historic flows and EC were developed for various intervals. For Salt Slough, relationships were developed for each month (Figure 9.7). For Mud Slough, one relationship was determined for the March-August period and individual relationships for other months (Figure 9.8). These relationships are based upon data collected by USGS from January 1997 through October 2000. The equations generated are presented in Table 9.1.

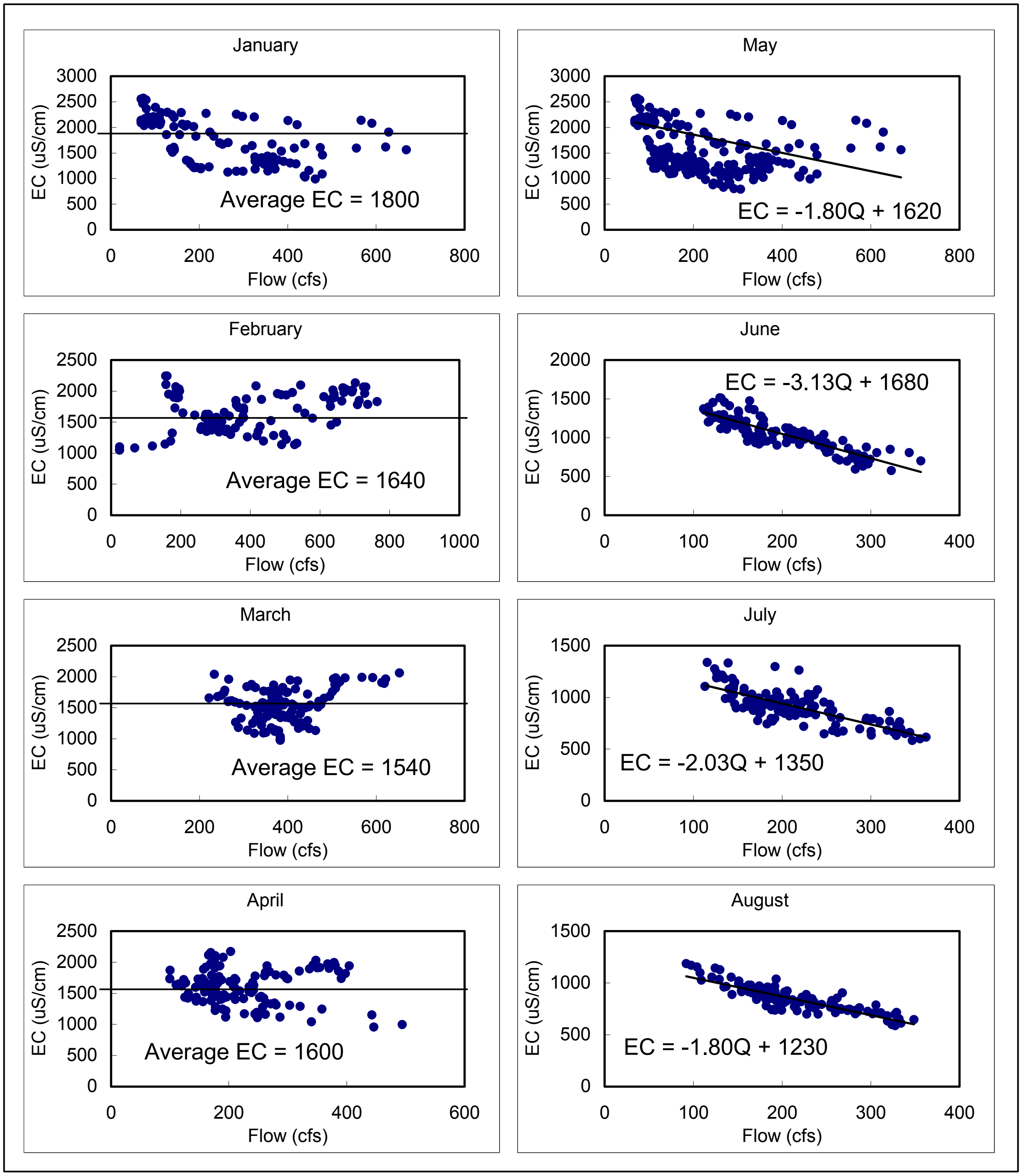

Figure 9.7: Salt Slough, EC vs. Flow.

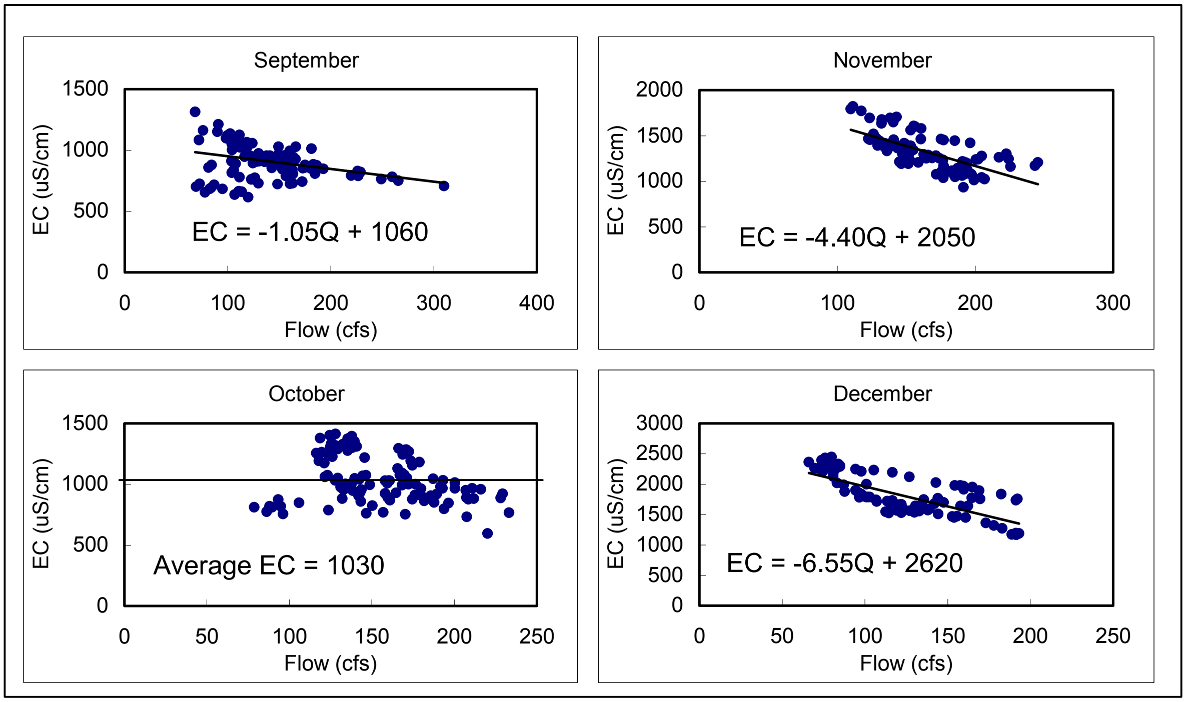

Figure 9.7 (cont.): Salt Slough, EC vs. Flow.

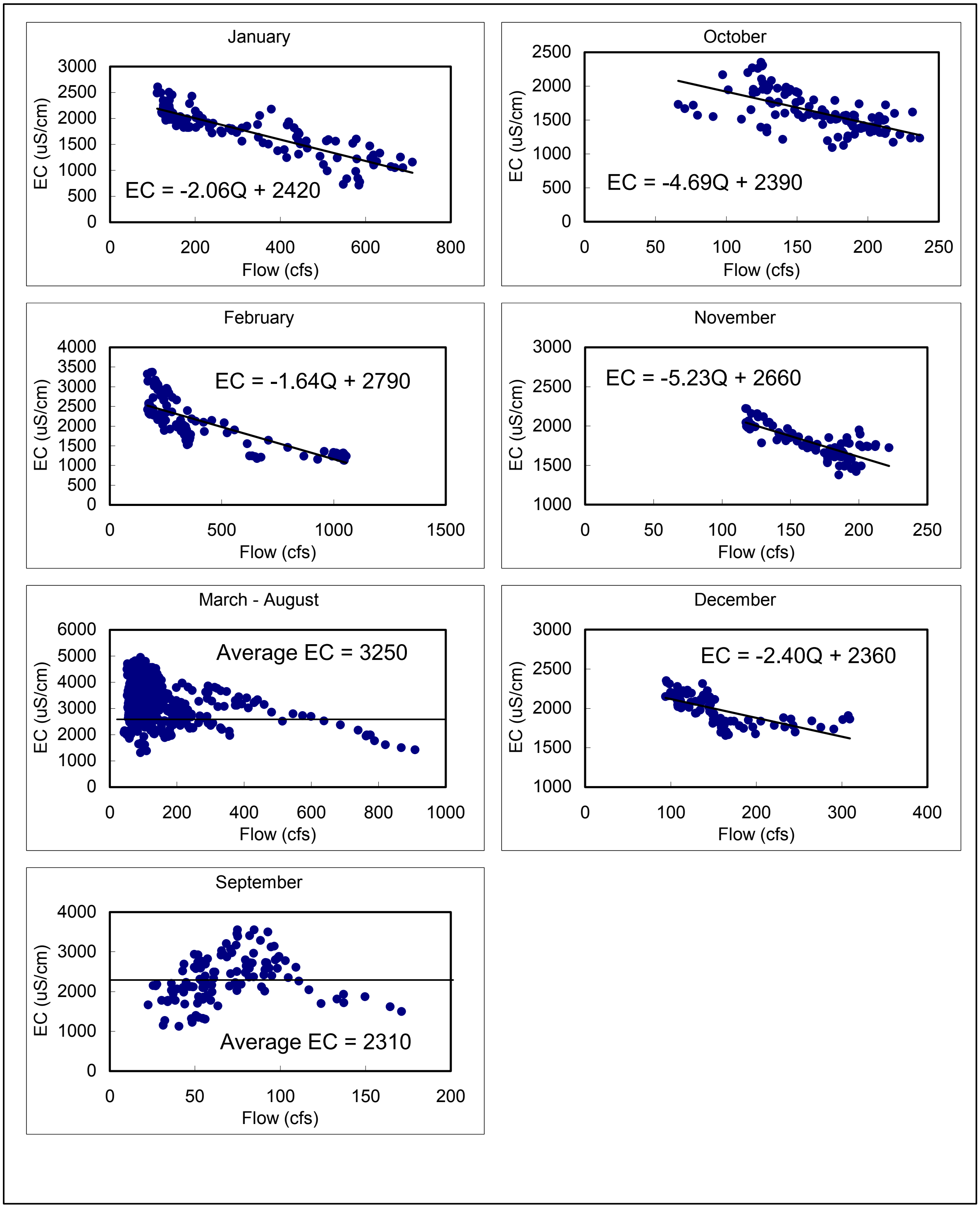

Figure 9.8: Mud Slough, EC vs. Flow.

9.7 EC in Westside Agriculture Return Flow

The agriculture return flow from the westside has three components: runoff from applied DMC water, runoff from riparian diversions, and runoff from applied groundwater. The EC in each source is estimated before the water is applied. The monthly average EC for the applied DMC water is provided by DSM2 from a previous simulation that reports the EC at DMC intake. The monthly average EC for the source of riparian water is derived by using a gross mass balance to estimate EC in the San Joaquin River at each point of modeled diversion. The time-constant EC in applied groundwater is provided by SJRIO, which varies the values along the reach of the San Joaquin River.

The accumulation of salts in each source of applied water is then modeled by increasing the EC according to Table 9.2. The EC added is the same regardless of source and does not vary from year to year. In DSM2, the three sources of westside agriculture drainage are combined and inserted at specific model nodes. The end result of this process is a monthly changing EC pattern for combined westside agriculture drainage that varies from 1,774 to 2,710 uS/cm over the 16-year sequence as shown in Figure 9.9.

Table 9.2: EC Added to Applied Agricultural Water before Modeling Accumulated Salts.

Period	Added EC (uS/cm)
October-February	1650
March-July	1500
August-September	1480

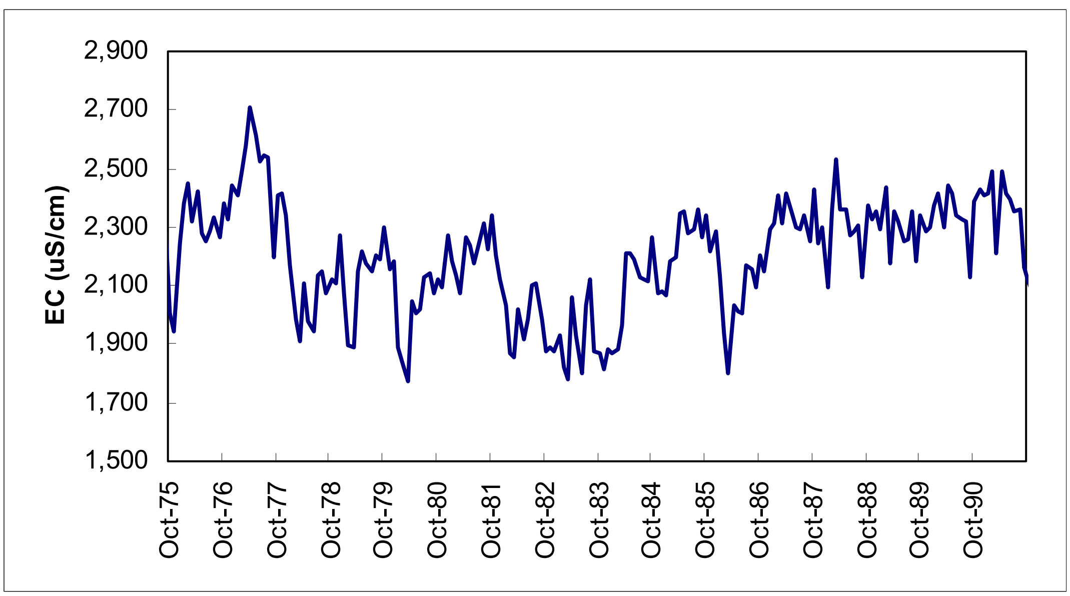

Figure 9.9: Combined EC for Westside Agricultural Return Flow.

9.8 EC in Eastside Drainage

The EC in eastside drainage was calculated from flow-salinity relationships embedded in CALSIM. These relationships do not vary by year and are expressed as:

$EC=7377.8Q^{0.4432}$ March-September

$EC=36273Q^{0.6507}$ October-February

where EC is in uS/cm and EC < 9,000 uS/cm
Q is monthly average flow in cfs

9.9 EC in Groundwater Flows

EC in groundwater flow is assigned to base flow and tile drainage. The EC values vary by reach in the San Joaquin River, but are constant for all months for all years (Figure 9.10). These values are based upon values in SJRIO with some minor modifications to better reproduce observed EC at Vernalis.

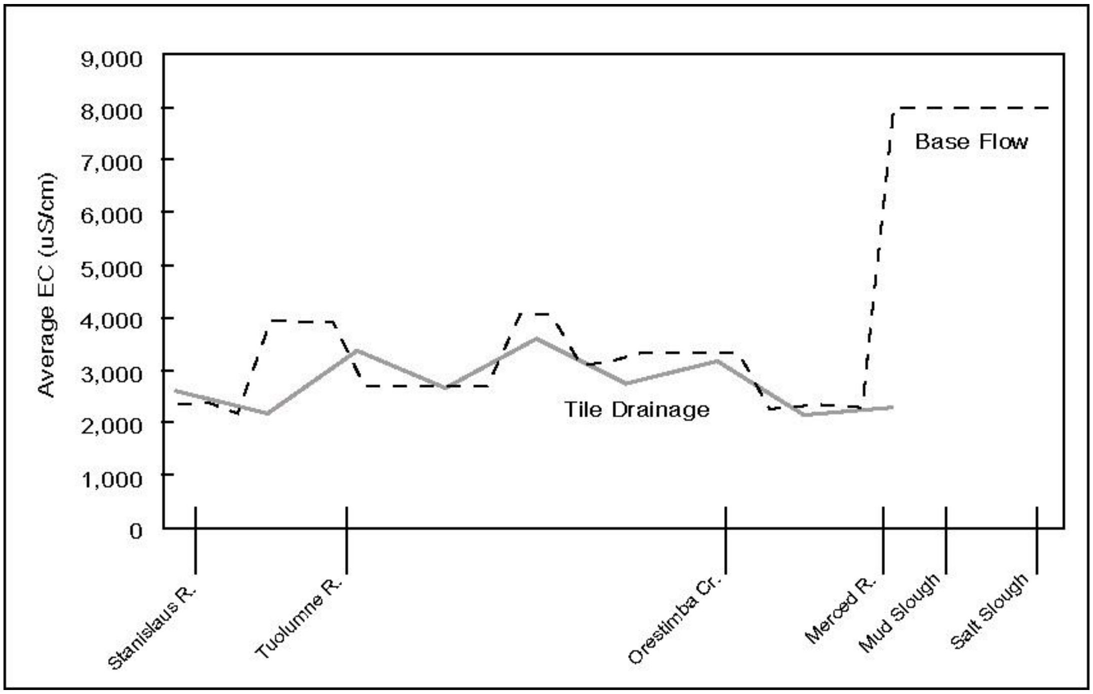

Figure 9.10: EC in Groundwater Flows to the San Joaquin River.

9.10 References

Montgomery Watson Harza. (2002). *Linking CALSIM and DSM2-SJR for Delta Mendota Canal Recirculation Study*. Technical Memorandum. Montgomery Watson Harza.

Pate, T. (2001). "Chapter 5: DSM2 San Joaquin River Boundary Extension." *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. 22nd Annual Progress Report to the State Water Resources Control Board.* California Department of Water Resources. Sacramento, CA.