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

27th Annual Progress Report
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Chapter 5:
A Relationship between Vernalis and Brandt Bridge Electrical Conductivity

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5 A Relationship between Vernalis and Brandt Bridge Electrical Conductivity

5.1 Introduction

A relationship between the measured electrical conductivity in the San Joaquin River (SJR) at Vernalis and Brandt Bridge has been developed. This relationship may be used to estimate target San Joaquin River salinity, as measured and expressed by electrical conductivity (EC), at Vernalis to ensure meeting the Brandt Bridge salinity (EC) standard of 700 μS/cm during April through August and 1000 μS/cm during September through March. The relationship was based on Department of Water Resources and US Bureau of Reclamation 1994 – 2002 monthly-averaged EC data measured at Vernalis, Mossdale, and Brandt Bridge. The preliminary compilation and analysis of data from these three locations were done by Andy Chu (Project Operations Planning Branch, DWR).

5.2 Data Characteristics

For Vernalis, Mossdale, and Brandt Bridge (Figure 5.1), box plots of monthly averaged EC data were generated (Figure 5.2). Table 5.1 summarizes some of the descriptive statistics for the historical EC data at those periods.

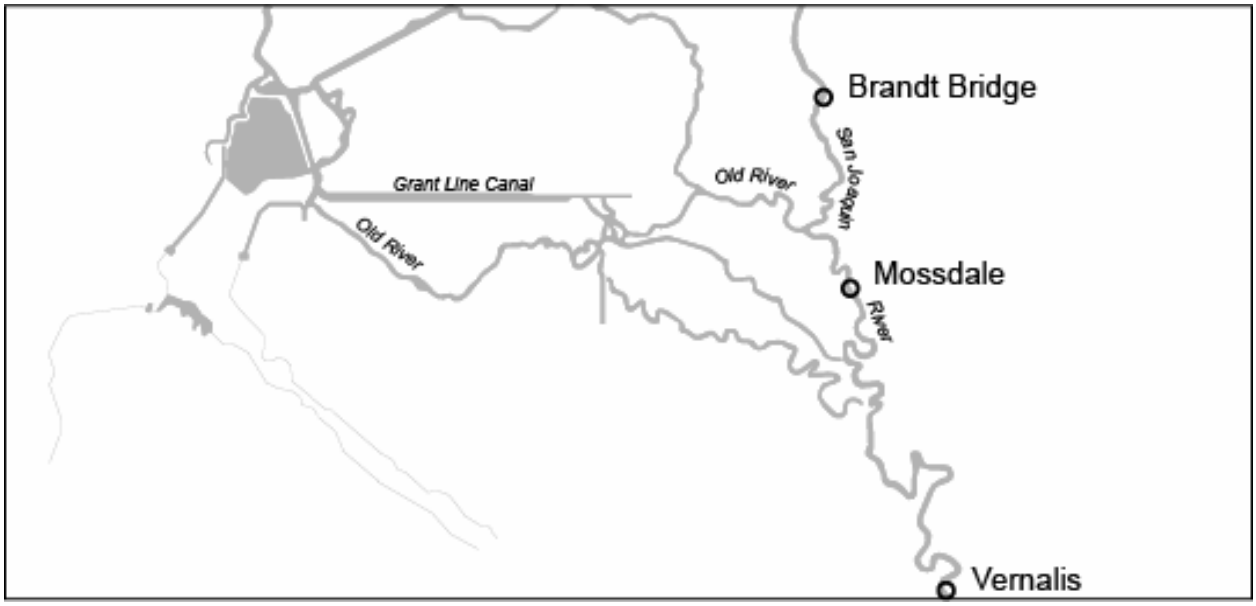

Figure 5.1: Locations of Vernalis, Mossdale, and Brandt Bridge on the San Joaquin River.

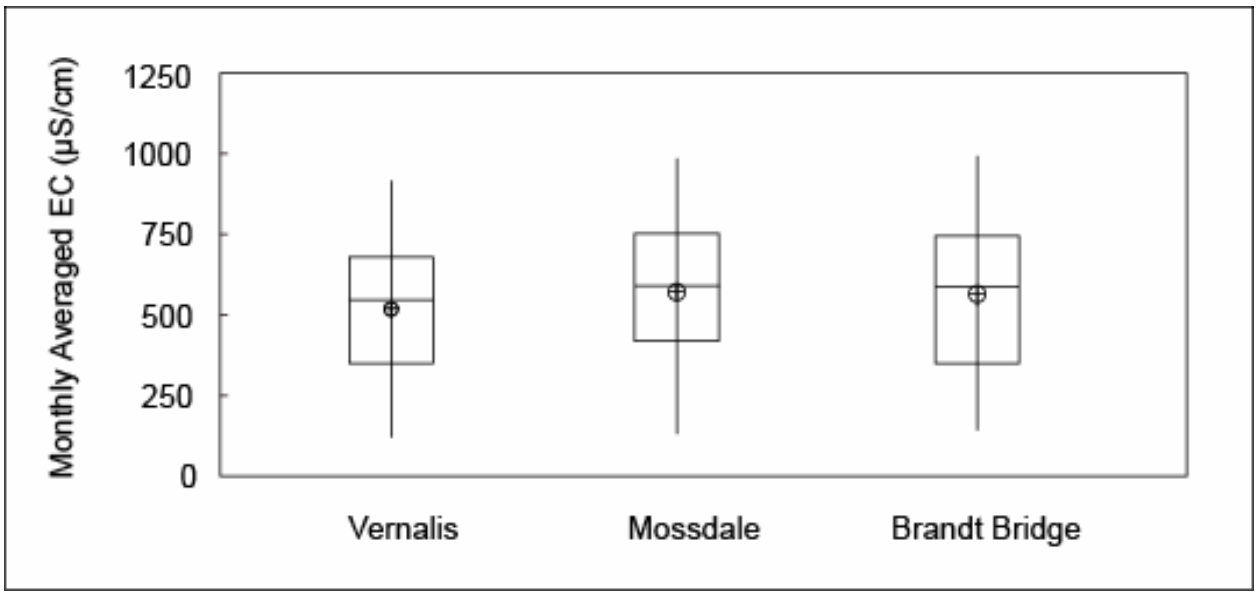

Figure 5.2: Box plots of Monthly-average EC at Vernalis, Mossdale and Brandt Bridge.

Table 5.1: Descriptive statistics of monthly EC at Vernalis, Mossdale and Brandt Bridge.

Location	Number of Data Points	Mean (µS/cm)	Standard Deviation (µS/cm)	Range (µS/cm)	
				Min	Max
Vernalis	108	518	206	121	917
Mossdale	86	570	222	133	982
Brandt Bridge	103	566	225	146	991

The monthly averaged EC from all three locations had a similar statistical distribution that was characterized by a large spread of values and an even distribution of lower and higher EC values. There were no outliers in the monthly average values.

5.3 Statistical Analysis

As shown in the scatter plot in Figure 5.3, monthly averaged EC at Vernalis and Brandt Bridge are strongly correlated, with a Pearson's correlation[1] of 0.97. A regression analysis of EC shows Brandt Bridge EC to be 1.08 times the Vernalis EC, indicating an 8% water quality degradation (as measured by EC) between Vernalis and Brandt Bridge.

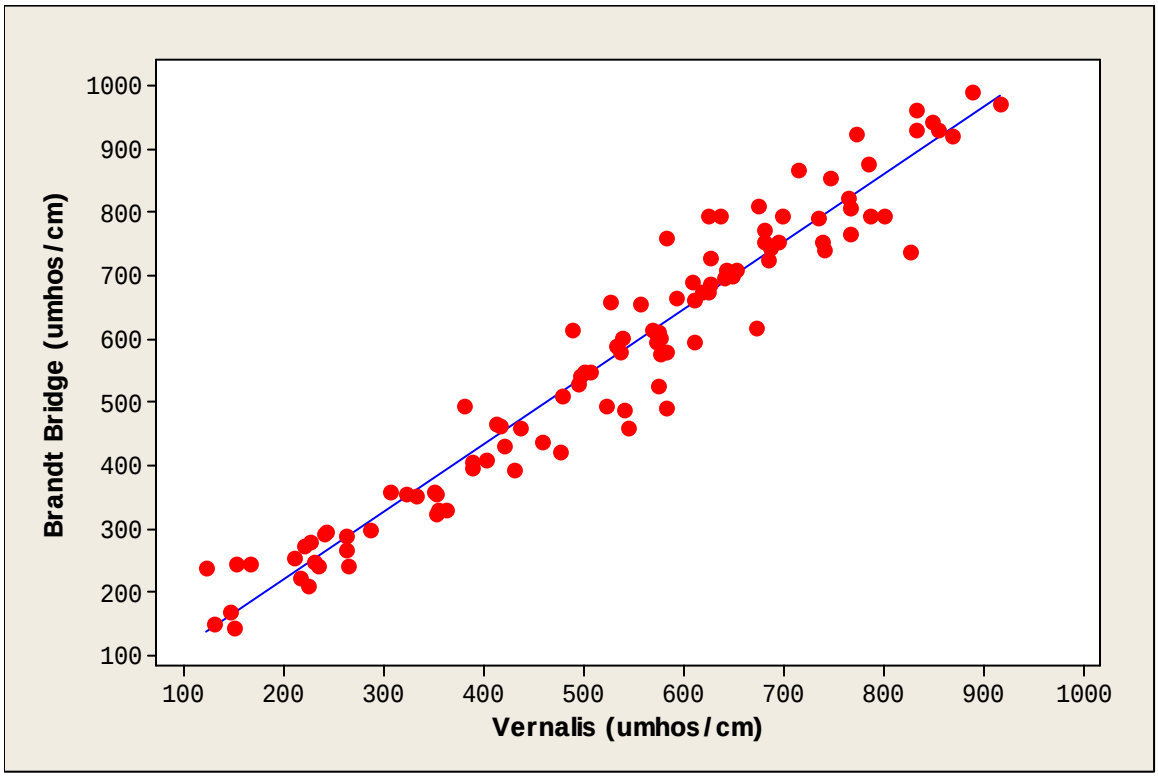

Figure 5.3: Brandt Bridge vs. Vernalis Monthly-averaged EC.

Using the standard error of regression and sum of squares, one can predict the Brandt Bridge EC as a function of Vernalis EC for a given confidence level. Figure 5.4 shows the required Vernalis EC to ensure a target Brandt Bridge EC (700 umhos/cm during Apr-Aug and 1000 EC for the rest of the months) at different confidence levels. The numerical values are provided in Table 5.2.

[1] The Pearson correlation r, measures the strength of the linear relationship between the X and Y variables. R^2, the coefficient of determination (a popular measure in regression analysis) is the fraction of the variance explained by the regression. In the least square regression, $R^2 = r^2$.

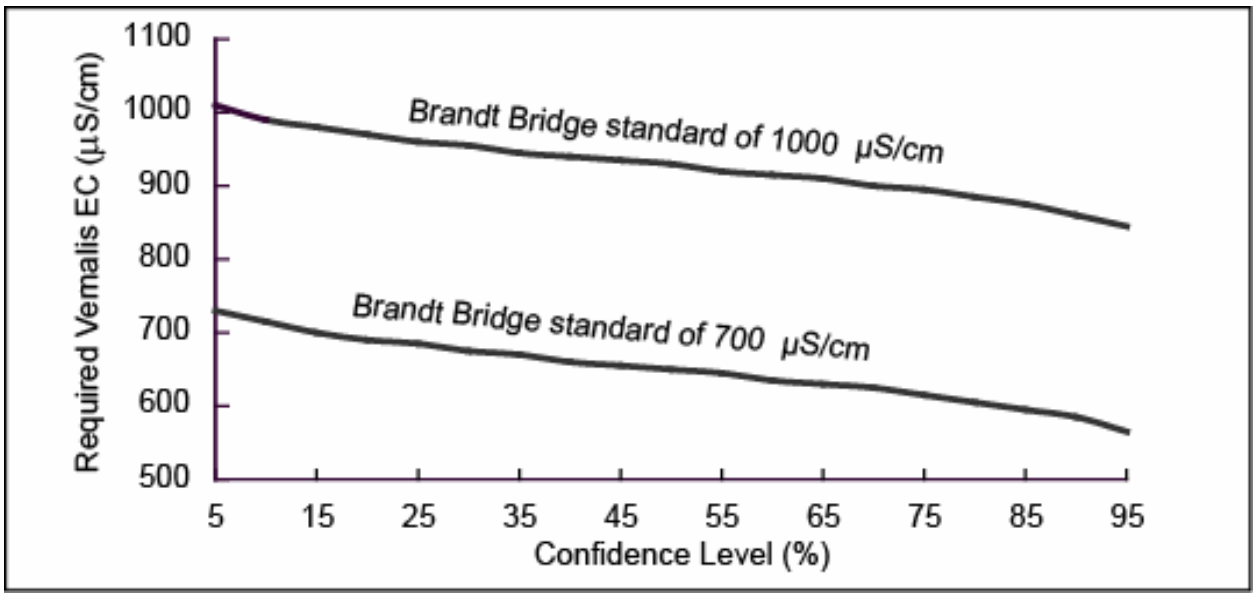

Figure 5.4: Required Vernalis EC to ensure target Brandt Bridge EC at different confidence levels.

An attempt was made to break down the salinity (EC) degradation estimate into two parts:

a) From Vernalis to Mossdale
b) From Mossdale to Brandt Bridge

Initial analysis indicates an average EC degradation of 7% between Vernalis and Mossdale and 1% between Mossdale and Brandt Bridge. Figure 5.5 shows the strong correlation between Vernalis EC and Mossdale EC, with a Pearson's correlation of 0.98.

Table 5.2: Required monthly-averaged EC at Vernalis to ensure compliance with the Brandt Bridge EC standards.

Required Vernalis EC to Ensure Brandt Bridge Standard is Met					
	Brandt Bridge Standard			Brandt Bridge Standard	
Confidence level	700 µS/cm	1000 µS/cm	Confidence level	700 µS/cm	1000 µS/cm
95	565	845	45	655	935
90	585	860	40	660	940
85	595	875	35	670	945
80	605	885	30	675	955
75	615	895	25	685	960
70	625	900	20	690	970
65	630	910	15	700	980
60	635	915	10	715	990
55	645	920	5	730	1010
50	650	930			

The EC at Brandt Bridge was at times lower than the EC at Mossdale, typically during net reverse flow conditions on the San Joaquin River between the two sites. Under these conditions, better quality water from downstream travels upstream in the San-Joaquin River as far as the head of Old River. Net reverse flows at Brandt Bridge usually occur during low San-Joaquin River flows at Vernalis (below 1,000 cfs) and high State Water Project and Central Valley Project pumping. Sometimes the EC at Brandt Bridge was lower than the EC at Mossdale even when the San-Joaquin River flow at Vernalis was 2,000 cfs or higher. This was especially noticeable for 1999 and later years.

In a separate analysis, the EC data was divided into two parts: data from prior to 1999 and data from 1999 to present. Regressional analysis from the earlier period suggested an average 4% EC degradation between Mossdale and Brandt Bridge, which is about half of the total EC degradation between Vernalis and Brandt Bridge. The second period suggested an average 1% EC improvement at Brandt Bridge relative to Mossdale. Developing an accurate estimate for the degradation of water quality in individual reaches requires a fairly accurate data set to within a few percent. Based on the analysis mentioned above, the measured EC data used may not have had the level of accuracy required for water quality analysis by separate reaches in the San Joaquin River.

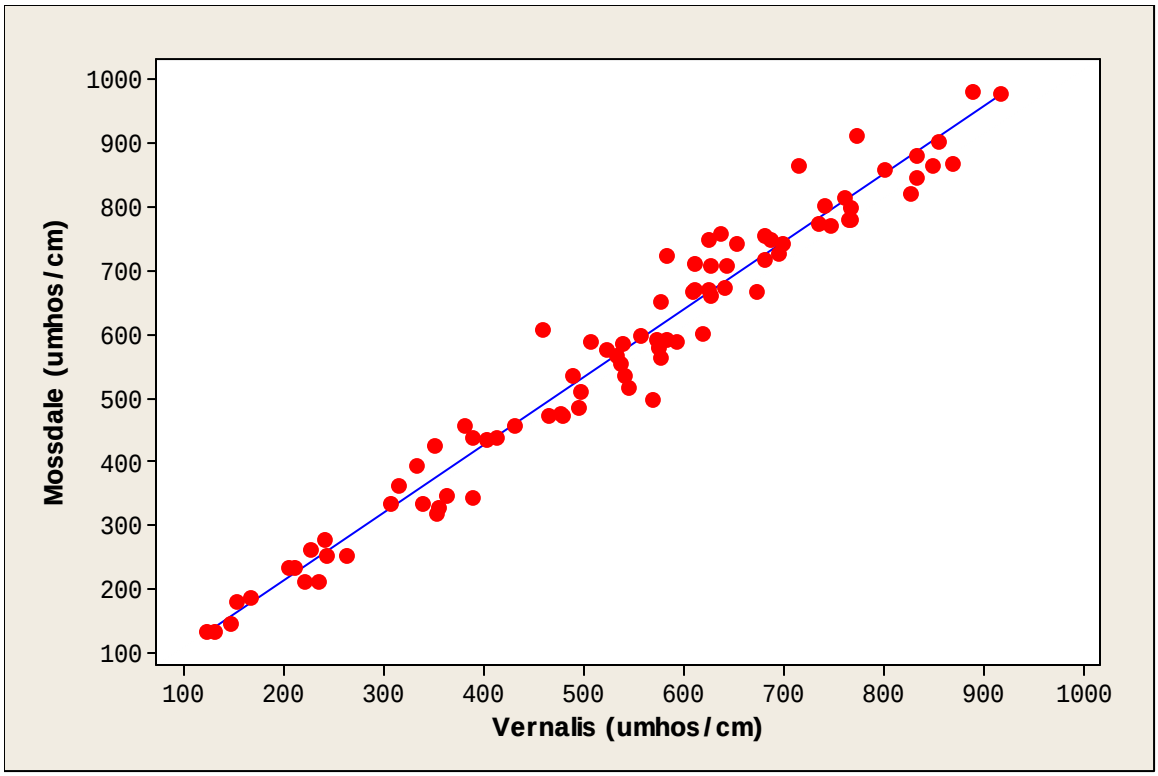

Figure 5.5: Monthly-averaged EC at Mossdale vs. Vernalis.

Since Mossdale is about 2.8 miles upstream of the confluence of Old and San Joaquin Rivers, it can be concluded the EC degradation between the head of the Old River and Brandt Bridge is less than half the total degradation between Vernalis and Brandt Bridge, and possibly much smaller. The reasons for this may be higher tidal flows in the San-Joaquin River downstream of the head of the Old River and possibly less agricultural drainage impact in the lower reach.