DSM2 Modeling Evaluation
City of Tracy and Mountain House CSD
29 March 2007

Introduction

This document presents a summary and evaluation of a modeling effort performed for the City of Tracy and Mountain House Community Services District (MHCSD) discharges. Modeling was performed to better understand the salinity impacts of the new and expanded discharges from the Tracy and MHCSD wastewater treatment facilities for development of NDPES permits for discharges to Old River, within the south Delta. Water quality modeling using the Department of Water Resources (DWR) Delta Simulation Model II (DSM2) was performed under reasonable worst-case conditions. This document provides a discussion of the modeling assumptions and input parameters, a description of the modeling results, an evaluation of the results, and recommendations on how to use the information as part of the NPDES permitting process.

Background

The *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (Bay-Delta Plan) was adopted in May 1995 by the State Water Board. The Bay-Delta Plan identifies the beneficial uses of the estuary and includes objectives for flow, salinity, and endangered species protection. In December 1999 and March 2000, the State Water Board adopted and revised D-1641 as part of the State Water Board's implementation of the 1995 Bay-Delta Plan. For the south Delta, the 1995 Bay-Delta Plan contains water quality objectives for electrical conductivity (EC) of 700 µmhos/cm from 1 April – 31 August and 1000 µmhos/cm from 1 September – 31 March. These salinity objectives must be met by DWR and USBR as a requirement of Water Rights permits and licenses issued by the State Water Board for operation of the State Water Project (SWP) and Central Valley Project (CVP).

The City of Tracy and MHCSD NPDES permits are up for renewal with salinity impacts a significant concern. Wastewater discharges from the City of Tracy and MHCSD wastewater treatment facilities are high in salinity, exceeding the Bay-Delta standards for the south Delta. Therefore, discharges from these facilities have a reasonable potential to cause or contribute to an in-stream excursion of these objectives. Final water quality-based effluent limitations (WQBELs) based on the Bay-Delta standards would likely require construction and operation of reverse osmosis or other salt removal technologies. The State Water Board, in Water Quality Order 2005-005 (for the City of Manteca), states, *"…the State Board takes official notice [pursuant to Title 23 of California Code of Regulations, Section 648.2] of the fact that operation of a large-scale reverse osmosis treatment plant would result in production of highly saline brine for which an acceptable method of disposal would have to be developed. Consequently, any decision that would require use of reverse osmosis to treat the City's municipal wastewater effluent on a large scale should involve thorough consideration of the expected environmental effects."* Based on this ruling by the State Water Board, at the 4 August 2006 Regional Water Board meeting, staff recommended for adoption NPDES permits for the City of Tracy and MHCSD that addressed salinity, but fell short of requiring final WQBELs. The proposed Orders included interim performance-based effluent limitations for EC and required the dischargers to implement measures to reduce the salinity of its discharge to Old River, which could take several years. The Regional Water Board held a lengthy hearing on these permits at their August 2006 Board meeting, with salinity issues being the major topic of testimony and Board discussion. The hearings were continued pending a better assessment of the impacts of the discharges on Delta salinity and development of alternative means of regulating salinity for Board consideration. The Regional Water Board directed staff to work with the dischargers and other stakeholders to model the affects of the discharge in the south Delta. It was suggested that DWR's DSM2 model, which has been used extensively for the South Delta Improvements Project, could be used for this purpose. A stakeholder group that included representatives from the City of Tracy, MHCSD, South Delta Water Agency (SDWA), California Sportfishing Protection Alliance, DWR, and the Regional Water Board met to develop appropriate reasonable worst-case scenarios for running the DSM2 model.

Modeling Assumptions and Input Parameters

The purpose of the modeling effort was to evaluate the effects of the wastewater discharges under reasonable worst-case conditions, specifically salinity impacts. Several assumptions had to be made to provide the input parameters to run the model. On 14 September 2006 the stakeholder group met to establish reasonable worst-case scenarios to run the DSM2 model. The input parameters discussed during the meeting included Delta tides, export pumping, San Joaquin River flow, temporary barriers or permanent gates and their configurations, critical times of the year, and wastewater characteristics (i.e. discharge flow rates and effluent EC).

Delta Tides

The flows and dilution in the south Delta are influenced significantly by the tides, especially when the temporary barriers or permanent gates are considered. During neap tides, which are low energy tides, critical low flow situations can occur in the south Delta. The combination of low energy neap tides and hot summer conditions can result in critical conditions for farmers that rely on the south Delta for irrigation. During this period, agricultural use is very high and due to the low flushing affect of neap tides, agricultural return water and wastewater flows buildup in the south Delta channels resulting in elevated salinity. The DWR modelers suggest that the tides from 1985 be used as a reasonable worst-case scenario. The 1985 tides included two neap tides in the tidal cycle in August, which would represent a worst-case condition.

Export Pumping

Export pumping from the CVP and SWP significantly influences the flow patterns in the south Delta. The river flow direction changes as the export pumping increases or decreases, especially in Old River and Grant Line Canal. Reasonable worst-case high and low export pumping rates were included in the model runs as follows:

High Export Pumping: SWP = 6,680 cfs, CVP = 4,600 cfs

Low Export Pumping: SWP = 1,500 cfs, CVP = 1,000 cfs

The high export pumping rates are based on the maximum allowable pumping rates for the CVP and SWP. The low export pumping rates are based on a reasonable worst-case scenario, which may occur during very dry conditions.

San Joaquin River Flow

Flows from the San Joaquin River (SJR) enter the south Delta at the Head of Old River (HOR). The amount of flow in Old River depends on the flow in the SJR, the operation of the HOR fish control structure, and export pumping rates. The Bay-Delta Plan provides flow objectives in the SJR at Vernalis, which is just upstream of the HOR. The flow objective is 1,000 cfs, therefore, a SJR flow rate of 1,000 cfs at Vernalis was used a reasonable worst-case condition for the DSM2 modeling. Lower River flows reduce available dilution in the South Delta. River flows at Vernalis should be met except during extreme droughts.

Temporary Barriers/Permanent Gates and Critical Periods

Temporary barriers are currently installed at several locations in the south Delta to mitigate impacts caused by the CVP and SWP. The configurations of the barriers change during different times of the year to mitigate impacts to the beneficial uses of south Delta. For example, the HOR fish control structure is typically installed in the spring to reduce impacts to anadromous fish species and in the fall to promote higher dissolved oxygen concentrations in the Deep Water Ship Channel near Stockton. Agricultural barriers are installed in the summer at three locations in the south Delta to provide adequate channel levels for agricultural irrigation. The reasonable worst-case barrier configurations coincide with the critical periods. The critical periods and barrier configurations used in the modeling were during August when the agricultural barriers are in place and in October when the agricultural barriers and HOR fish control structure are in place. The model was run with temporary barriers to evaluate current conditions and with the SDIP permanent gates to represent future conditions.

Wastewater and Ambient Receiving Water Characteristics

To significantly reduce the number of model runs, which are very time consuming, the DWR modelers proposed that the modeling not directly predict receiving water salinity concentrations. Instead, it was recommended that the model be used to predict the effluent volume fraction or effluent “finger printing” in the receiving water at given locations. The salinity in the receiving water could then be estimated by weighting the fraction of effluent and receiving water with their respective salinities. This approach was selected due to its flexibility to input different effluent flow rates and EC along with varying ambient EC. The modeling was performed for current and future conditions to evaluate effects with temporary barriers and the SDIP permanent gates, as discussed above. For the current discharges, wastewater discharge rates of 9 mgd and 1 mgd were used for Tracy and MHCSD, respectively. The future wastewater discharge rates were 16 mgd and 5.4 mgd, the proposed effluent flow limits for Tracy and MHCSD, respectively.

Description of Modeling Results

The DSM2 model can output information at numerous nodes and channel segments throughout the south Delta. The stakeholder group selected 14 locations to evaluate the impacts of the discharges. The locations were selected to capture the critical areas in the south Delta. For example, the group selected the three south Delta D-1641 salinity compliance locations, the channels immediately upstream and downstream of the discharges, and the channels near the drinking water intakes. See Attachment A for the entire list of channel locations selected by the group. The daily average wastewater volume fractions and the 15-minute flow and stage within the channels were estimated at each location. The DWR modelers recommended evaluating the model output data on a minimum monthly average basis. This was recommended because several inputs to the model have been set constant, such as SJR flow, agricultural inflow/outflow, and wastewater discharge rates and EC concentrations. Therefore, the monthly average outputs are likely to be more accurate than shorter averaging periods (e.g. daily or weekly). Although the model may under predict the weekly average volume fractions, the DWR modelers are confident that weekly average estimations are relatively accurate, however, they do not recommend using averaging periods shorter than weekly.

The stakeholder group considered the appropriate averaging periods to evaluate critical conditions. The SDWA recommended that averaging periods of a week or less be evaluated. They expressed concern that during neap tides the Delta channels could become stagnant resulting in high concentrations of EC on a weekly average basis. Evaluating monthly average concentrations could dampen these effects. For this evaluation, the model output has been evaluated on a monthly average and weekly average basis. Specifically, the monthly average output for the months of August and October were evaluated, as well as, the maximum running weekly average for these months.

The monthly average and maximum weekly average model output is included in Attachment B. Tables B-1 through B-4, display the monthly average volume fraction of effluent from the Tracy and MHCSD wastewater treatment facilities at select locations within the south Delta. Tables B-5 through B-8 display the maximum weekly average volume fraction of effluent. Equations 1 through 4, below, can be used to calculate the predicted monthly average EC increases caused by the discharges for various effluent and ambient receiving water conditions using the modeled volume fractions. Examples of how the equations can be used to estimate EC concentrations are displayed in Tables B-9 through B-14 (Attachment B).

Equation 1 (Tracy current discharge)

$$\text{R/W EC Increase} = (\text{Effluent EC} - \text{Ambient EC}) \times \text{Volume Fraction} \times \text{Effluent Flow (mgd)} / 9$$

Equation 2 (Tracy future discharge)

R/W EC Increase = (Effluent EC – Ambient EC) x Volume Fraction x Effluent Flow (mgd) / 16

Equation 3 (MHCSD current discharge)

R/W EC Increase = (Effluent EC – Ambient EC) x Volume Fraction x Effluent Flow (mgd)

Equation 4 (MHCSD future discharge)

R/W EC Increase = (Effluent EC – Ambient EC) x Volume Fraction x Effluent Flow (mgd) / 5.4

The modeling predicted monthly average volume fractions of the Tracy discharge at 9 of the 14 output locations. The predicted monthly average volume fractions for Tracy ranged from 0% to 5.29% for the current 9 mgd discharge with temporary barriers. The areas of greatest impact were downstream of the Tracy discharge, Old River at Tracy Blvd, Grant Line Canal, and near Tom Pain Slough. For the MHCSD discharge, the modeling predicted monthly average volume fractions at 5 of the 14 output locations. The predicted monthly average volume fractions ranged from 0% to 4.18% for a 1 mgd discharge with temporary barriers. The areas of greatest impacts from the MHCSD discharge were limited to the section of Old River between Tracy Blvd and the Delta Mendota Canal.

Modeling of the future conditions with the SDIP permanent gates showed greater circulation in the south Delta. The wastewater from the treatment facilities was spread more evenly between the output locations, resulting in lower volume fractions in many cases even though the effluent discharge rates had increased significantly. The model was run using the operating protocols for the permanent gates used in the modeling performed for the SDIP environmental impact report. DWR has been continuously modifying the operating protocols to maximize circulation. Therefore, the output in this modeling effort may have over predicted volume fractions for the future conditions.

Evaluation of Modeling Results

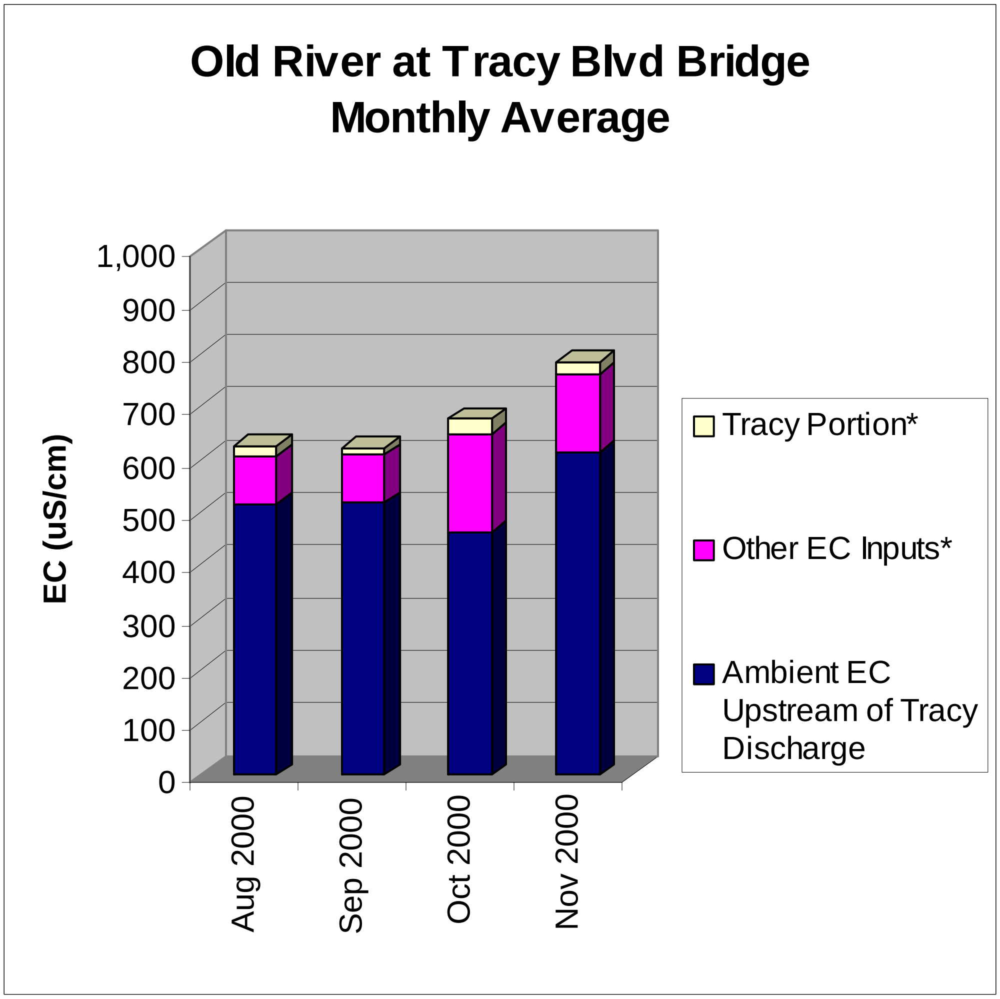
The modeling runs have been designed to predict effluent volume fractions. The DWR modelers recommended this approach because it allows flexibility in evaluating the results, significantly reduces the number of modeling runs, and the DSM2 model can more accurately predict effluent volumes than the salinity, because salinity inputs from agricultural practices, groundwater accretions, etc. are difficult to quantify. Furthermore, the purpose of the modeling was to better understand the impacts caused by the wastewater discharges.

By predicting the effluent volume fraction, the receiving water EC increases caused by the wastewater discharges can be estimated by weighting the fraction of effluent and receiving water with their respective salinities. Equations 1 through 4, above, require values for the effluent wastewater characteristic (i.e. flow and EC) and upstream ambient EC to estimate the receiving water EC at a particular location downstream of the discharges. Evaluations of modeling predictions can be made using actual measured effluent and receiving water data to evaluate the relative impact of the Tracy discharge using the reasonable worst-case model predictions. Three evaluations have been made using actual measured data; 1) an evaluation of the monthly average impacts, 2) a comparison of monthly average vs. weekly average impacts, and 3) an evaluation of different regulatory levels for EC.

Monthly Average Evaluation

Figures 1 and 2, below, show actual monthly average Old River EC data measured in 2000 and 2001 upstream of the Tracy discharge at Union Island and downstream of the discharge at the Tracy Blvd Bridge, which is one of the D-1641 salinity compliance locations. DSM2 modeling output was used to predict a reasonable worst-case monthly average EC increment at the Tracy Blvd Bridge caused by the Tracy discharge. As shown in Figures 1 and 2, the monthly average reasonable worst-case Tracy impacts are approximately an order of magnitude less than impacts caused by other salinity sources in the area. The “other sources” of salinity likely are a result of the consumptive uses downstream of the Tracy discharge. The farmers in the area use the river water for irrigation, any salinity in the water is concentrated through agricultural practices and returned to the river. The sources of salinity include the ambient salinity entering from the San Joaquin River, groundwater accretions, and the City of Tracy discharge. So, essentially, a small portion of the “other sources” of salinity can also be attributed to the Tracy discharge. Although there was no discharge from MHCSD in 2000 and 2001, the modeling predicts that there would have been no impact at the Tracy Blvd Bridge when exports are high, as was assumed in this evaluation. High exports were assumed, because the largest impacts from the Tracy discharge are predicted in Old River at the Tracy Blvd Bridge under that scenario.

Figure 1: 2000 Actual and Modeled Salinity Impacts



* The Tracy Portion is DSM2 model predictions using reasonable worst-case conditions. The Other EC Inputs were calculated based on the measured EC at Tracy Blvd Bridge – Tracy Portion – measured ambient EC upstream of Tracy discharge at Union Island.

Table 1: 2000 Actual and Modeled Salinity Impacts (data for Fig. 1)

	Actual Measured Data (Monthly Average)				Modeled Worst Case Conditions Old River at Tracy Blvd Bridge[1] (Monthly Average)		
Month-Yr	Old at Union Island EC (uS/cm)	Tracy Flow (mgd)	Tracy EC (uS/cm)	Old at Tracy Blvd EC (uS/cm)	Tracy Volume[2] (%)	Tracy EC Portion (uS/cm)	Other Sources of EC (uS/cm)
Aug 2000	515	7.34	1,579	626	2.37	21	91
Sep 2000	517	7.26	1519	622	1.71	14	91
Oct 2000	461	6.75	1648	677	3.14	28	188
Nov 2000	614	6.00	1620	786	3.62	24	148

[1] Assumes high exports and temporary barriers.

[2] Based on a Tracy discharge of 9 mgd.

Figure 2: 2001 Actual and Modeled Salinity Impacts

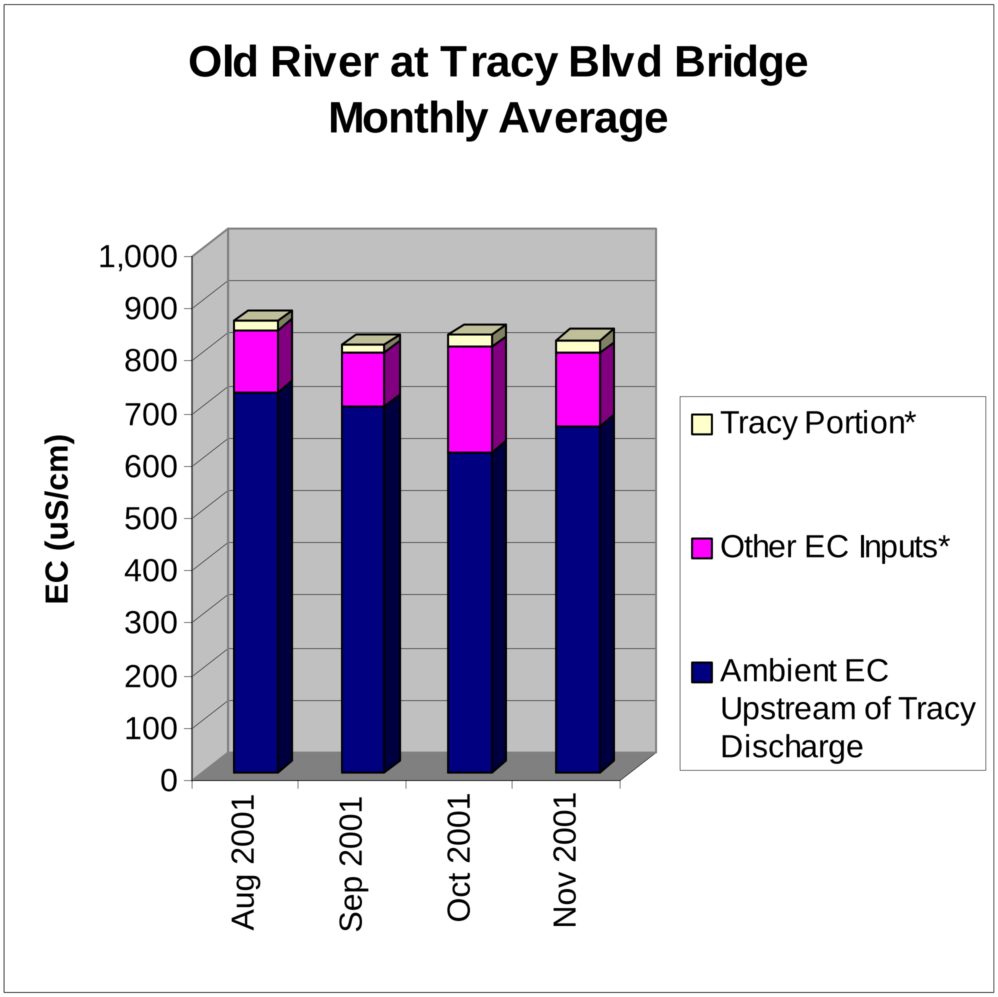


Table 2: 2001 Actual and Modeled Salinity Impacts (data for Fig. 2)

	Actual Measured Data **(Monthly Average)**				**Modeled Worst Case Conditions Old River at Tracy Blvd Bridge[1]** **(Monthly Average)**		
Month-Yr	Old at Union Island EC (uS/cm)	Tracy Flow (mgd)	Tracy EC (uS/cm)	Old at Tracy Blvd EC (uS/cm)	Tracy Volume[2] (%)	Tracy EC Portion (uS/cm)	Other Sources of EC (uS/cm)
Aug 2001	726	6.95	1,687	861	2.37	18	118
Sep 2001	698	6.73	1659	815	1.71	12	104
Oct 2001	610	6.24	1656	835	3.14	23	202
Nov 2001	660	6.24	1603	824	3.62	24	140

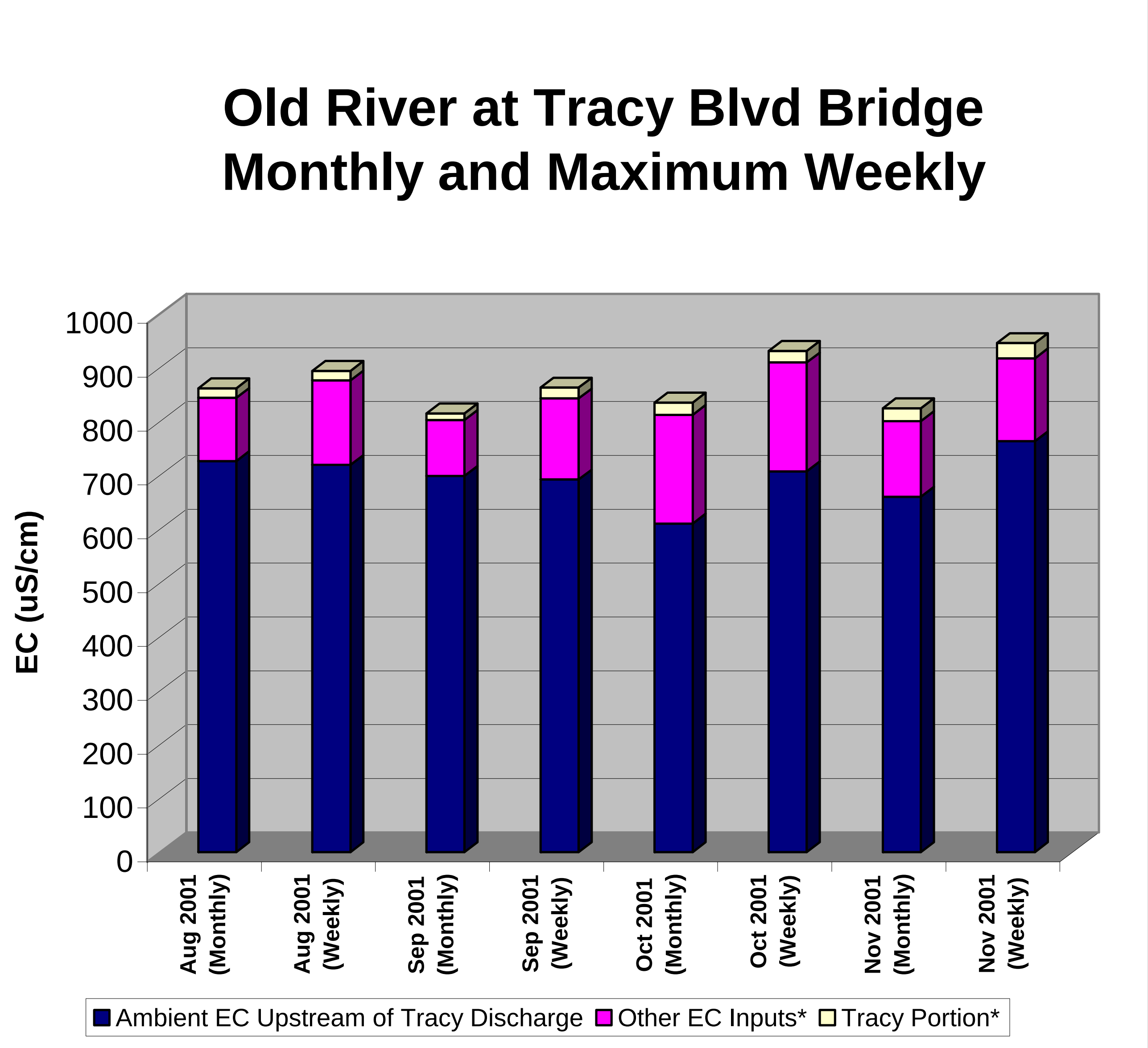
[1] Assumes high exports and temporary barriers.

[2] Based on a Tracy discharge of 9 mgd.

Monthly Average vs. Weekly Average

To evaluate the weekly average conditions, the maximum running weekly average modeled volume fractions were calculated for the months of August through November. Actual measured data from 2001 was used to compare the monthly average conditions to the maximum weekly conditions. Although it is evident that the maximum weekly EC concentrations in Old River exceed the monthly average EC concentrations, it appears that the Tracy discharge is not the cause of these increases. As shown in Figure 3, the modeled worst-case maximum weekly EC increases caused by the Tracy discharge are essentially the same as the monthly average increases.

Figure 3: 2001 Actual and Modeled Salinity Impacts – Monthly vs. Weekly



Evaluation of EC Regulatory Levels

Another evaluation that was performed was to compare different regulatory levels for EC and their relative impacts in the receiving water. This has been done for August and October 2001. Based on the monthly average evaluation, above, we have estimated the amount of “other sources” of EC. Therefore, we can modify the effluent wastewater characteristics and compare the relative impacts in the receiving water. Three regulatory levels were evaluated for August and October 2001, including no discharge, WQBELs (i.e. 700 uS/cm and 1000 uS/cm for August and October, respectively), and performance-based effluent limitations. Figures 4 and 5 show the relative impacts of the Tracy discharge under different regulatory levels for EC. In Figures 6 and 7, the MHCSD discharge has been included. An assumption of low exports has been made in these cases, because the modeling does not predict any MHCSD impacts at Tracy Blvd with high exports. To calculate the MHCSD portion, EC data from “upstream” of the MHCSD discharge is required. Data was found for Old River near the Delta Mendota Canal, which under low export conditions represents the “upstream” EC for the MHCSD discharge. There was incomplete data for October 2001, so data for September 2001 was used to represent the situation where the 1000 uS/cm standard applies.

Figure 4: Comparison of EC Regulatory Levels – High Exports (August 2001)

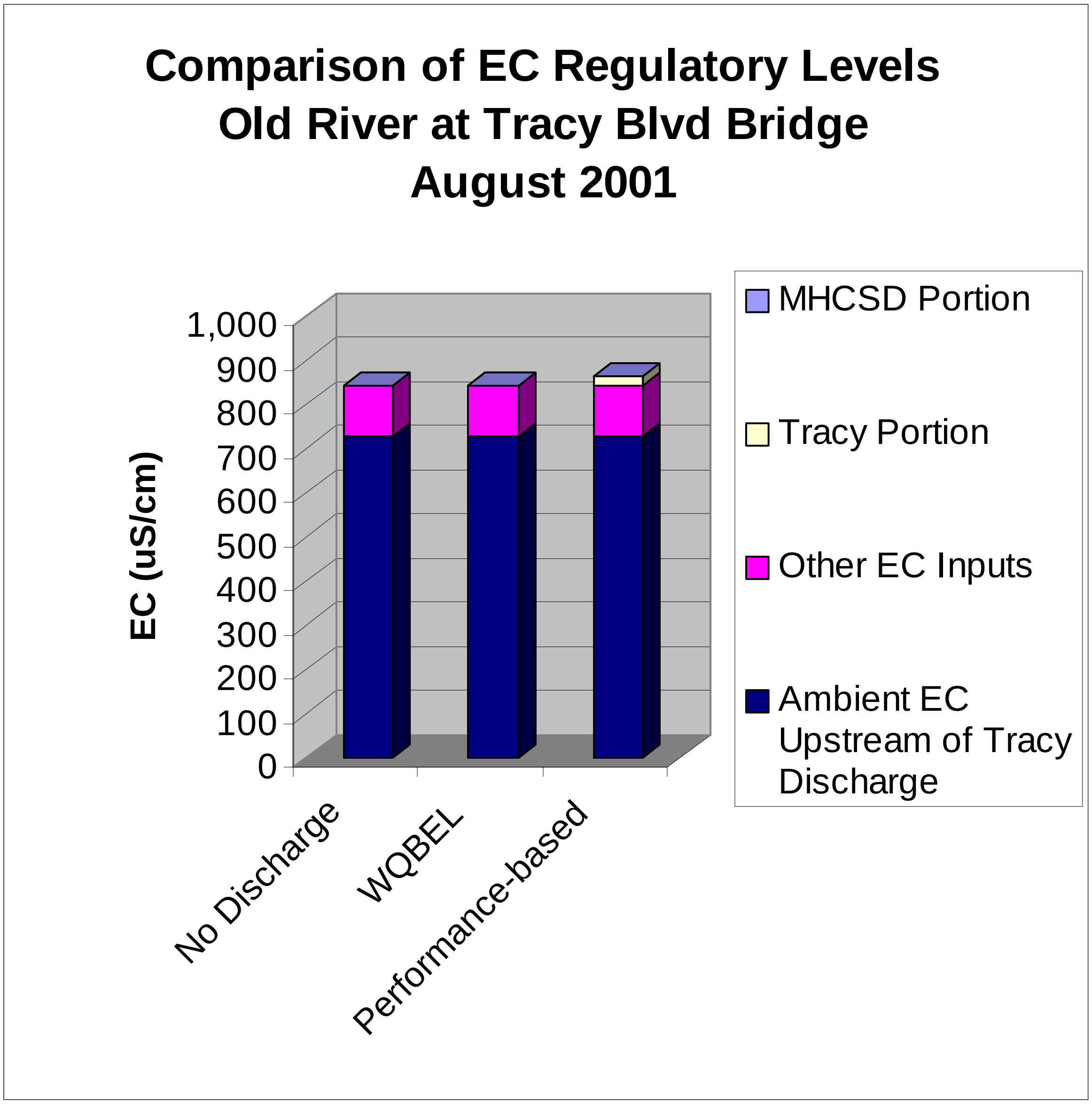


Figure 5: Comparison of EC Regulatory Levels – High Exports (October 2001)

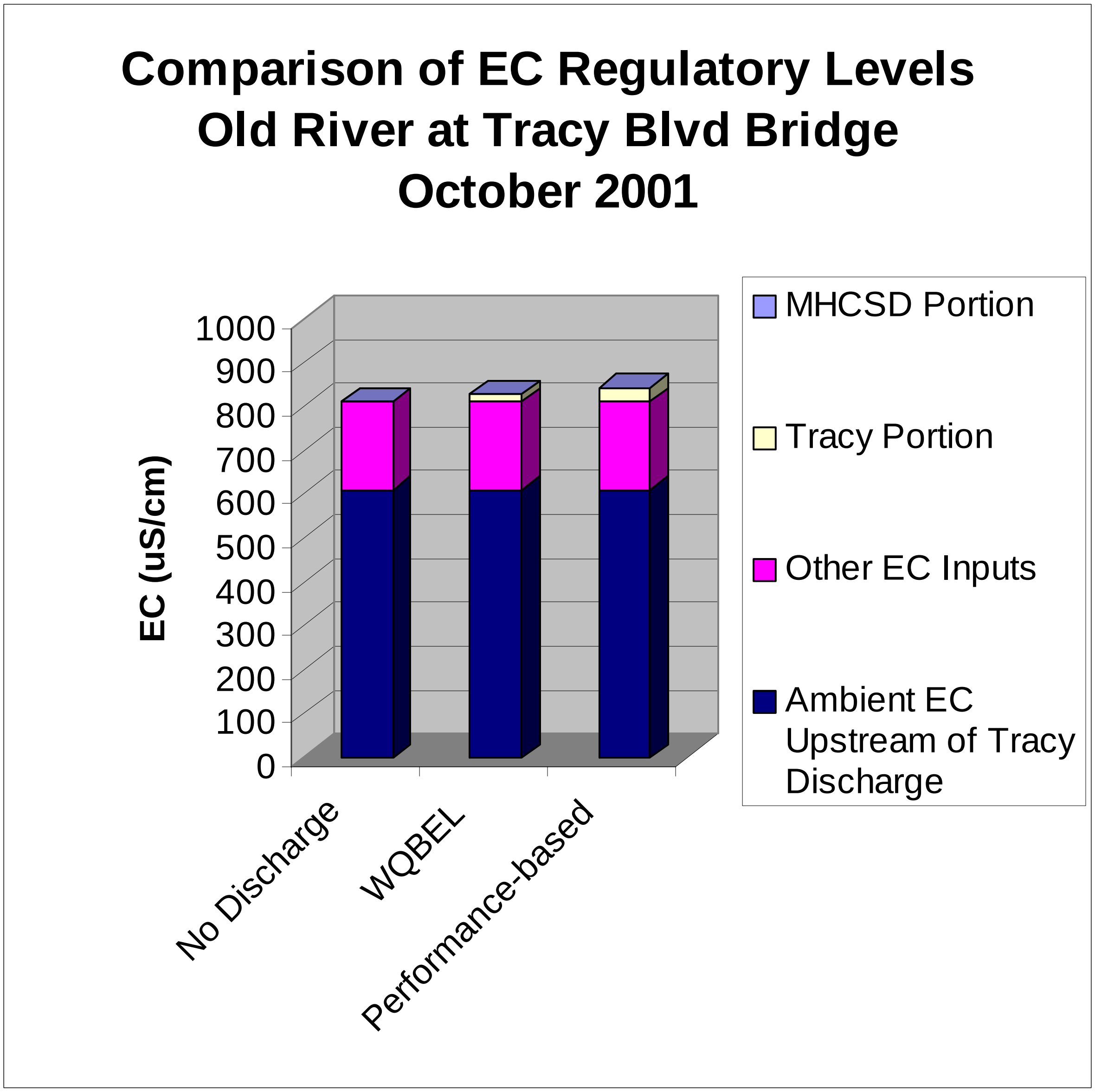


Figure 6: Comparison of EC Regulatory Levels – Low Exports (August 2001)

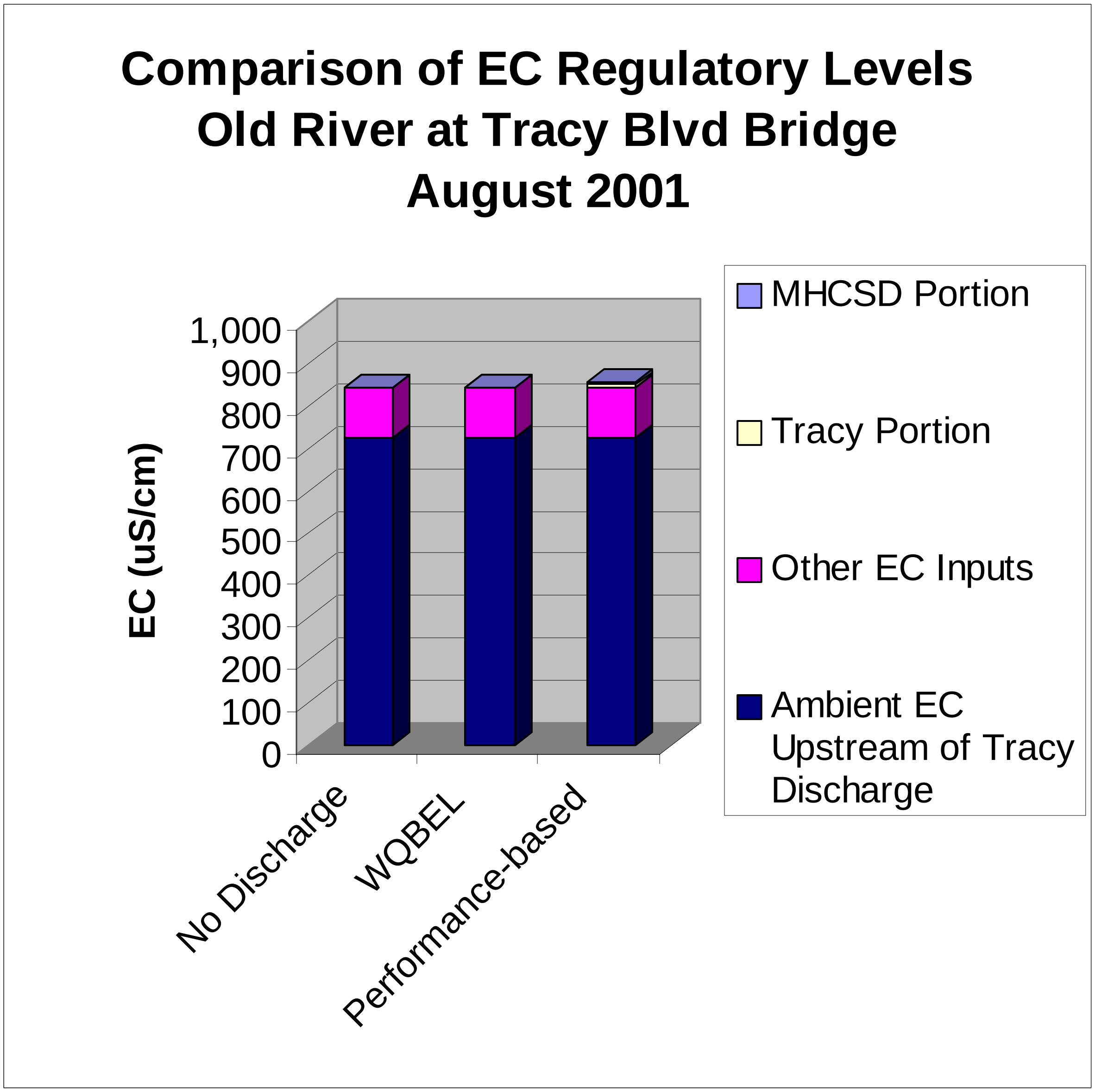


Figure 7: Comparison of EC Regulatory Levels – Low Exports (September 2001)

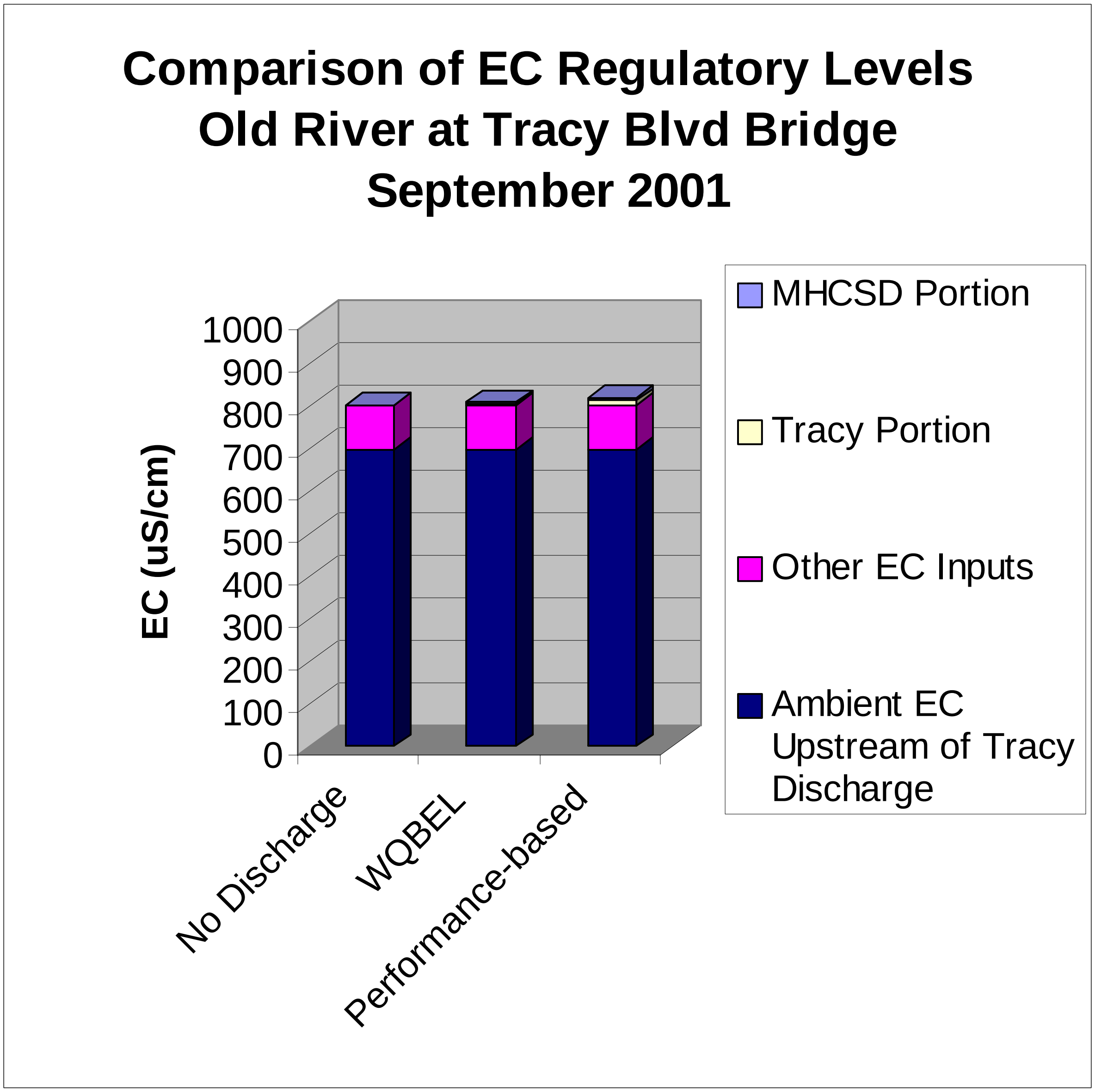


Table 3: Comparison of Regulatory Levels (data for Figures 4 and 5)

						Modeled Worst Case Conditions[1]			
	Regulatory Levels	Old at Union Island EC (uS/cm)	Tracy Flow (mgd)	Tracy EC Eff Limits (uS/cm)	Calced Old at Tracy Blvd EC (uS/cm)	Tracy Volume[2] (%)	Tracy EC Portion (uS/cm)	MHCSD EC Portion (uS/cm)	Other Sources of EC (uS/cm)
Aug-01	No Discharge	726	0.0	0	844	2.37	0	0	118
	WQBEL	726	10.8	700	844	2.37	0	0	118
	Performance-based	726	10.8	1,416	864	2.37	20	0	118
Oct-01	No Discharge	610	0.0	0	812	3.14	0	0	202
	WQBEL	610	10.8	1,000	827	3.14	15	0	202
	Performance-based	610	10.8	1,416	842	3.14	30	0	202

[1] Assumes high exports and temporary barriers.

[2] Based on a Tracy discharge of 9 mgd.

Table 4: Comparison of Regulatory Levels (data for Figures 6 and 7)

						Modeled Worst Case Conditions Old River at Tracy Blvd Bridge[1]		
	Regulatory Levels	Old at Union Island EC (uS/cm)	Tracy Flow (mgd)	Tracy EC Eff Limits (uS/cm)	Calced Old at Tracy Blvd EC (uS/cm)	Tracy Volume[2] (%)	Tracy EC Portion (uS/cm)	Other Sources of EC (uS/cm)
Aug-01	No Discharge	726	0.0	0	726	0.65	0	118
	WQBEL	726	10.8	700	726	0.65	0	118
	Performance-based	726	10.8	1,416	737	0.65	5	118
Sep-01	No Discharge	698	0.0	0	698	1.3	0	104
	WQBEL	698	10.8	1,000	704	1.3	5	104
	Performance-based	698	10.8	1,416	715	1.3	11	104

[1] Assumes low exports and temporary barriers.

[2] Based on a Tracy discharge of 9 mgd.

Table 5: Comparison of Regulatory Levels (data for Figures 6 and 7)

					Modeled Worst Case Conditions Old River at Tracy Blvd Bridge[1]	
	Regulatory Levels	Old at DMC EC (uS/cm)	MHCSD Flow (mgd)	MHCSD EC Eff Limits (uS/cm)	MHCSD Volume[2] (%)	MHCSD EC Portion (uS/cm)
Aug-01	No Discharge	759	0.0	0	0.42	0
	WQBEL	759	3.0	700	0.42	0
	Performance-based	759	3.0	1,200	0.42	6
Sep-01	No Discharge	929	0.0	0	0.77	0
	WQBEL	929	3.0	1,000	0.77	2
	Performance-based	929	3.0	1,200	0.77	6

[1] Assumes low exports and temporary barriers.

[2] Based on a MHCSD discharge of 1 mgd.

Summary and Conclusion

As part of the NPDES permitting process, modeling has been performed using DWR's DSM2 model to better understand the salinity impacts of the Tracy and MHCSD discharges in the south Delta. Reasonable worst-case conditions have been assumed to represent critical conditions. The model was used to predict the reasonable worst-case effluent volume fraction in the receiving water at given locations. The model was run for both the current condition with temporary barriers and the future condition with permanent gates. This evaluation focused on the modeling with temporary barriers, which will likely occur during the next 5 years (NPDES permit term). Furthermore, the modeling showed the permanent gates would provide better circulation in the south Delta channels, reducing the impacts caused by the discharges.

The DWR modelers recommended that the results be evaluated on a monthly average basis, which are likely more accurate than shorter averaging periods. However, representatives from the SDWA were concerned about the weekly average impacts, due to channel stagnation during neap tides. Therefore, this evaluation looked at both the monthly average and maximum weekly average impacts. Furthermore, since the model output allows for the flexibility of adjusting effluent wastewater characteristics, this evaluation compared the impacts from the Tracy and MHCSD discharges under different regulatory levels for EC.

The monthly average impacts were estimated using actual measured EC data from 2000 and 2001 upstream and downstream of the Tracy discharge. Using the model results it was possible to calculate the reasonable worst-case EC increases caused by the Tracy discharge downstream of the discharge using actual measured effluent data. The increases by the Tracy discharge only made up a small portion of the difference between actual measured EC upstream and downstream of the discharge, so it was assumed that the remainder of the increases must have been caused by "other sources" of EC (e.g. agricultural activities, groundwater accretions, etc.). The EC increases by these "other sources" represent a minimum increase, because the actual conditions in the south Delta were better than the modeled reasonable worst-case conditions. The increases caused by the Tracy discharge were about an order of magnitude less than the "other sources". The maximum weekly average conditions were also evaluated. The estimated impacts caused by the Tracy discharge were not significantly different than the monthly impacts. Since the model was run with constant inputs (e.g. SJR flow, agricultural inflow/outflow, etc.) the weekly average impacts may be under predicted. In any event, the increase in South Delta salinity caused by Tracy's discharge is small when compared to other sources of salinity.. Therefore, even if the weekly average results were off by 50% the Tracy impacts on salinity are still much less than the impacts from "other sources".

The final evaluation was to compare different regulatory levels for EC in the wastewater discharges. If the NPDES permits include WQBELs for EC, it would likely require the construction and operation of reverse osmosis (RO) or similar salt removal technologies for a large portion of the wastewater flows. RO is costly, energy intensive, and concentrated brines are produced with limited and costly disposal options. By comparing different regulatory levels for EC, we were able to evaluate the difference in EC impacts in Old River at Tracy Blvd. Although the estimated EC in the river may not be 100% accurate, the comparison of different model output is likely accurate. This evaluation showed that requiring WQBELs, compared to limiting the discharge to current levels, did not provide substantial reductions in EC.

At the 4 August 2006 Regional Water Board meeting, staff proposed that the NPDES permits for the City of Tracy and MHCSD require performance-based effluent limitations for EC. The Regional Water Board requested that modeling be performed to better understand the impacts of this regulatory level. The modeling that has been performed shows that the wastewater discharges cause salinity impacts in the south Delta. However, the impacts are small even under reasonable worst-case conditions. In addition, the modeling showed that imposing WQBELs would have little affect on the salinity problem in the south Delta. The information and evaluations presented in this document will be incorporated into documents for further Regional Board consideration of salinity limitations for the Tracy and MHCSD NPDES Permits. .

Attachment A
DSM2 Modeling Scenarios for City of Tracy and Mountain House CSD (MHCSD) Discharges
20 September 2006

This document provides the necessary information to run the Department of Water Resource's Delta Simulation Model 2 (DSM2) for evaluation of the salinity impacts in the south Delta from the City of Tracy and MHCSD discharges. The modeling input parameters and assumptions, modeling scenarios, and the requested model outputs are identified below. This modeling will not directly predict receiving water salinity. Rather, the assumed 100 µmhos/cm salinity will be used as a tracer, with the model output predicting the volume fraction effluent in the water at a given location. Predicted salinity in the receiving water is then calculated by weighting the fraction of effluent and receiving water with their respective salinities.

Table 1: Input Parameters and Assumptions

Season and Temporary Barriers/Permanent Gates Operations	**October-November** – All four barriers/gates in place **July-August** – Only the 3 agricultural barriers/gates in place, HOR open.
San Joaquin River Flow	The flow in the San Joaquin River (SJR) is to be set at 1,000 cfs for all model runs. This represents a reasonable worst-case condition.
WWTP Discharge Flow Rates and EC Concentrations	Each scenario evaluates the affect of the discharges in the near term and at project build-out by varying the discharge flow rate (see Tables 2 and 3). The WWTP effluent EC concentrations are expressed as an increment above the ambient EC. The ambient EC is set to zero and effluent EC set to 100.
SWP and CVP Pumping Operations	Two scenarios for the SWP and CVP export pumping operations to be evaluated, high pumping and low pumping, defined as follows: **High Export Pumping**: SWP = 6,680 cfs, CVP = 4,600 cfs **Low Export Pumping**: SWP = 1,500 cfs, CVP = 1,000 cfs
Tracy and MHCSD Outfall Locations	Inputs from the Tracy outfall will be added at Node 55. Inputs from the MHCSD outfall will be added at Node 67.
Head of Old River Inflow	During the October-November period the Head of Old River barrier/gate will be closed. However, some flow is allowed to enter Old River from the SJR and varies based on export pumping rates. Flow output from the Channel downstream of the HOR barrier/gate (Channel 54) will be provided to show the flow entering Old River.
Tidal Inputs	The tidal inputs from July - August and October - November 1985 will be used for the model runs. This represents a reasonable worst-case tidal pattern.

Attachment A
DSM2 Modeling Scenarios for City of Tracy and Mountain House CSD (MHCSD) Discharges
20 September 2006

Table 2: Scenario 1

October – November
SJR Flow at 1,000 cfs

Model Run	Barrier/Gates Operations	SWP and CVP Pumping Operations	WWTP Discharges	
			Flow	Increment Above Ambient EC
1.1a	(a)	High Pumping	Tracy: 9 mgd	Tracy: 100 µS/cm
1.1b	(a)	High Pumping	MHCSD: 1 mgd	MHCSD: 100 µS/cm
1.2a	(a)	Low Pumping	Tracy: 9 mgd	Tracy: 100 µS/cm
1.2b	(a)	Low Pumping	MHCSD: 1 mgd	MHCSD: 100 µS/cm
1.3a	(b)	High Pumping	Tracy: 16 mgd	Tracy: 100 µS/cm
1.3b	(b)	High Pumping	MHCSD: 5.4 mgd	MHCSD: 100 µS/cm
1.4a	(b)	Low Pumping	Tracy: 16 mgd	Tracy: 100 µS/cm
1.4b	(b)	Low Pumping	MHCSD: 5.4 mgd	MHCSD: 100 µS/cm

(a) Temporary Barriers – Head of Old River Barrier and 3 Agricultural Barriers (w/ notched weirs)
(b) SDIP – Head of Old River gate partially closed and 3 Agricultural Gates

Table 3: Scenario 2

July – August
SJR Flow at 1,000 cfs

Model Run	Barrier/Gates Operations	SWP and CVP Pumping Operations	WWTP Discharges	
			Flow	Increment Above Ambient EC
2.1a	(c)	High Pumping	Tracy: 9 mgd	Tracy: 100 µS/cm
2.1b	(c)	High Pumping	MHCSD: 1 mgd	MHCSD: 100 µS/cm
2.2a	(c)	Low Pumping	Tracy: 9 mgd	Tracy: 100 µS/cm
2.2b	(c)	Low Pumping	MHCSD: 1 mgd	MHCSD: 100 µS/cm
2.3a	(d)	High Pumping	Tracy: 16 mgd	Tracy: 100 µS/cm
2.3b	(d)	High Pumping	MHCSD: 5.4 mgd	MHCSD: 100 µS/cm
2.4a	(d)	Low Pumping	Tracy: 16 mgd	Tracy: 100 µS/cm
2.4b	(d)	Low Pumping	MHCSD: 5.4 mgd	MHCSD: 100 µS/cm

(c) Temporary Barriers – 3 Agricultural Barriers installed
(d) SDIP – Operated with Head of Old River gate open and 3 Agricultural Gates closed

Attachment A
DSM2 Modeling Scenarios for
City of Tracy and Mountain House CSD (MHCSD) Discharges
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Model Output/Evaluation

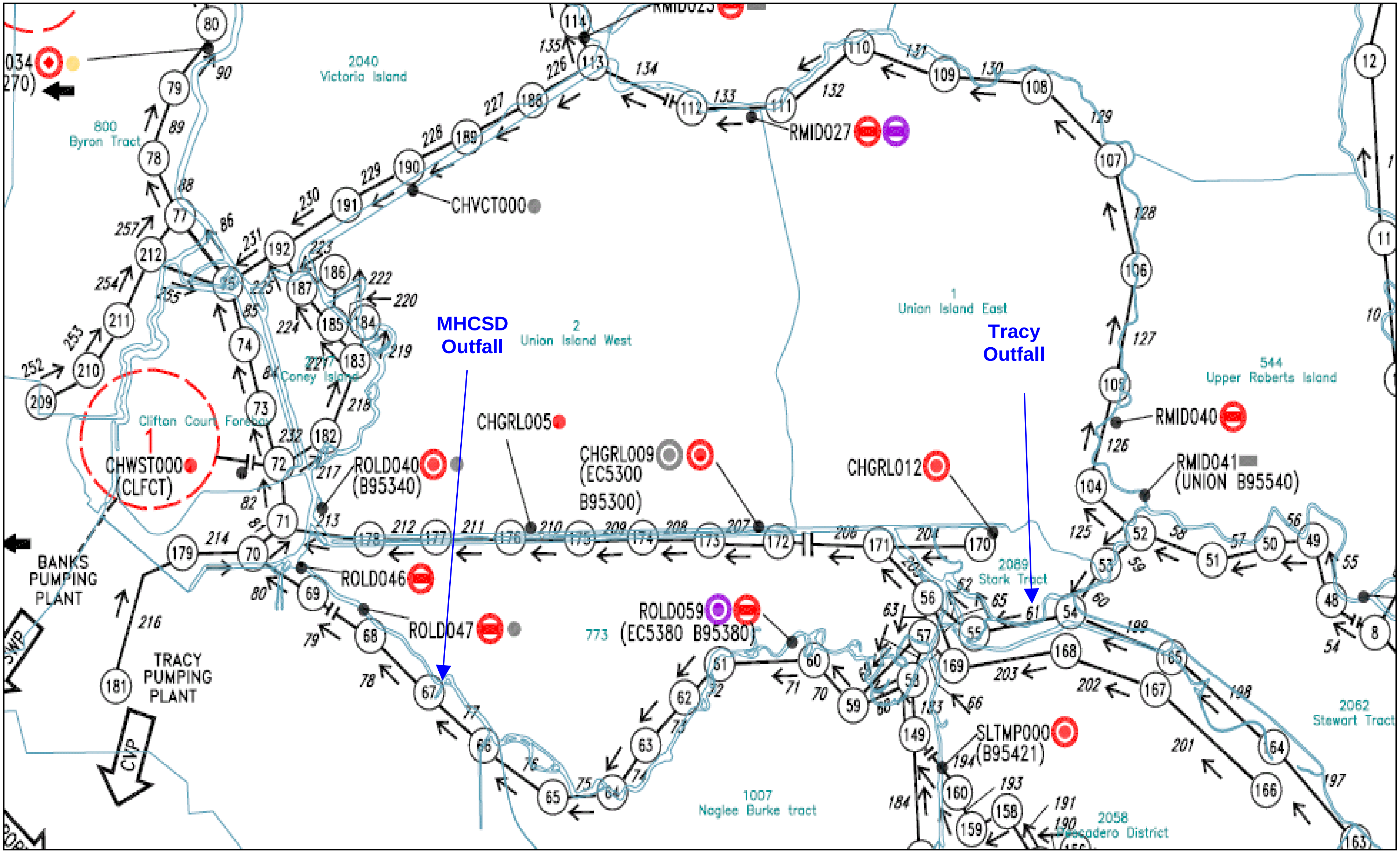
- 60-day period to be modeled for each modeling run. The focus will be on the output from the second 30-days to allow the model to be populated. Modeling output includes the following at the selected locations identified in Table 4:
    - Daily average volume fraction of wastewater from Tracy and MHCSD
    - 15-minute river flow and elevation
- The volume fraction of the effluent in the receiving water at the modeled discharge flow rates is presumed to vary directly with the incremental increase of the effluent EC verses the ambient EC. Therefore, increases in ambient EC caused by the effluent discharges can be estimated for multiple effluent and ambient EC concentrations using the output from the model runs.
- Ambient EC increases caused by the Tracy and MHCSD discharges are presumed to be additive.

Table 4: DSM2 Channels to Evaluate

Channel	Location	Significance
61 (upstream end)	Old River	Upstream of Tracy discharge
62 (downstream end)	Old River	Downstream of Tracy discharge
71	Old River	D-1641 Salinity Compliance Location (Tracy Rd. Bridge, C-8)
77 (upstream end)	Old River	Upstream of MHCSD discharge
78 (downstream end)	Old River	Downstream of MHCSD discharge
126	Middle River	D-1641 Salinity Compliance Location (Middle River, P-12)
213 (upstream end)	Grant Line Canal	Downstream of Tracy discharge, near Clifton Court Forebay
206	Grant Line Canal	Downstream of Tracy discharge
1	Clifton Court	Clifton Court Forebay Salinity Compliance Location
216		Channel to CVP Pumps
10	San Joaquin River	Brandt Bridge D-1641 Salinity Compliance Location
80	Old River	Downstream end of Old River at Tracy barrier/gate
54 (downstream end)	Old River	Downstream of Head of Old River barrier/gate
194	Tom Paine Slough	Near large agricultural siphon in Tom Paine Slough

Attachment A
DSM2 Modeling Scenarios for
City of Tracy and Mountain House CSD (MHCSD) Discharges
20 September 2006

Figure 1: DSM2 Grid



Attachment B
DSM2 Modeling Results

Table B-1: Tracy Discharge with Temporary Barriers (Current Condition)

	Temporary Barriers Tracy Current Discharge (9 mgd)			
	High Exports		Low Exports	
	August	October	August	October
	Monthly Average	Monthly Average	Monthly Average	Monthly Average
Upstream of Tracy Discharge	0.00	0.00	0.00	0.00
Downstream of Tracy Discharge	2.32	3.15	4.43	4.94
Old River at Tracy Blvd	2.37	3.14	0.65	1.13
Upstream of MHCSD Discharge	0.02	2.81	0.99	2.00
Downstream of MHCSD Discharge	0.02	2.61	1.24	2.52
Middle River at Mowery Bridge	0.00	0.00	0.00	0.00
Grant Line Canal Near Tracy Bridge	2.78	3.50	4.59	5.29
Grant Line Canal Near Clifton Court Forebay	2.20	2.74	2.72	3.40
Clifton Court Forebay	0.00	0.00	0.00	0.00
Channel Near CVP Pumps	0.20	0.23	0.80	1.05
SJR at Brandt Bridge	0.00	0.00	0.00	0.00
Downstream of Tracy Barrier	0.03	2.42	0.84	2.46
Downstream of Head of Old River Barrier	0.00	0.00	0.00	0.00
Near Tom Paine Slough	2.70	3.26	1.94	3.46

Table B-2: Tracy Discharge with Permanent Barriers (Future Condition)

	Permanent Gates Tracy Future Discharge (16 mgd)			
	High Exports		Low Exports	
	August	October	August	October
	Monthly Average	Monthly Average	Monthly Average	Monthly Average
Upstream of Tracy Discharge	0.29	0.47	0.23	0.48
Downstream of Tracy Discharge	3.62	4.83	3.29	4.34
Old River at Tracy Blvd	0.10	0.12	1.96	2.77
Upstream of MHCSD Discharge	0.09	0.11	2.24	2.64
Downstream of MHCSD Discharge	0.06	0.08	1.90	2.62
Middle River at Mowery Bridge	0.00	0.00	0.00	0.00
Grant Line Canal Near Tracy Bridge	3.20	4.20	3.21	4.57
Grant Line Canal Near Clifton Court Forebay	2.91	3.30	2.83	3.63
Clifton Court Forebay	0.00	0.00	0.14	0.19
Channel Near CVP Pumps	0.47	0.50	1.56	1.87
SJR at Brandt Bridge	0.00	0.00	0.00	0.00
Downstream of Tracy Barrier	0.05	0.02	1.89	2.62
Downstream of Head of Old River Barrier	0.00	0.00	0.00	0.00
Near Tom Paine Slough	0.85	0.15	1.63	2.48

Attachment B
DSM2 Modeling Results

Table B-3: MHCSD Discharge with Temporary Barriers (Current Condition)

	Temporary Barriers			
	MHCSD (1 mgd)			
	High Exports		**Low Exports**	
	August	**October**	**August**	**October**
	Monthly Average	Monthly Average	Monthly Average	Monthly Average
Upstream of Tracy Discharge	0.00	0.00	0.00	0.00
Downstream of Tracy Discharge	0.00	0.00	0.00	0.00
Old River at Tracy Blvd	0.00	0.00	0.42	1.43
Upstream of MHCSD Discharge	0.36	0.00	0.55	4.18
Downstream of MHCSD Discharge	0.00	2.25	0.00	0.47
Middle River at Mowery Bridge	0.00	0.00	0.00	0.00
Grant Line Canal Near Tracy Bridge	0.00	0.00	0.01	0.00
Grant Line Canal Near Clifton Court Forebay	0.00	0.00	0.01	0.00
Clifton Court Forebay	0.00	0.00	0.00	0.00
Channel Near CVP Pumps	0.00	0.03	0.00	0.00
SJR at Brandt Bridge	0.00	0.00	0.00	0.00
Downstream of Tracy Barrier	0.00	2.16	0.00	0.01
Downstream of Head of Old River Barrier	0.00	0.00	0.00	0.00
Near Tom Paine Slough	0.00	0.00	0.19	0.21

Table B-4 MHCSD Discharge with Permanent Barriers (Future Condition)

	Permanent Gates			
	MHCSD Future Discharge (5.4 mgd)			
	High Exports		**Low Exports**	
	August	**October**	**August**	**October**
	Monthly Average	Monthly Average	Monthly Average	Monthly Average
Upstream of Tracy Discharge	0.00	0.00	0.00	0.00
Downstream of Tracy Discharge	0.03	0.21	0.25	0.73
Old River at Tracy Blvd	1.39	3.04	1.45	2.55
Upstream of MHCSD Discharge	1.23	3.03	1.60	2.75
Downstream of MHCSD Discharge	0.00	0.02	0.21	0.64
Middle River at Mowery Bridge	0.00	0.00	0.00	0.00
Grant Line Canal Near Tracy Bridge	0.17	0.82	0.40	1.08
Grant Line Canal Near Clifton Court Forebay	0.11	0.58	0.31	0.87
Clifton Court Forebay	0.00	0.00	0.01	0.04
Channel Near CVP Pumps	0.02	0.09	0.17	0.46
SJR at Brandt Bridge	0.00	0.00	0.00	0.00
Downstream of Tracy Barrier	0.00	0.00	0.21	0.64
Downstream of Head of Old River Barrier	0.00	0.00	0.00	0.00
Near Tom Paine Slough	1.02	2.97	1.48	2.66

Attachment B
DSM2 Modeling Results

Table B-5: Tracy Discharge with Temporary Barriers (Current Condition)

	Temporary Barriers Tracy Current Discharge (9 mgd)			
	High Exports		Low Exports	
	August	October	August	October
	Maximum Weekly	Maximum Weekly	Maximum Weekly	Maximum Weekly
Upstream of Tracy Discharge	0.00	0.00	0.00	0.00
Downstream of Tracy Discharge	2.65	3.41	4.91	5.88
Old River at Tracy Blvd	2.50	3.43	1.01	1.18
Upstream of MHCSD Discharge	0.02	3.22	1.40	2.30
Downstream of MHCSD Discharge	0.04	3.03	1.62	2.81
Middle River at Mowery Bridge	0.00	0.00	0.00	0.00
Grant Line Canal Near Tracy Bridge	3.07	3.66	5.03	5.53
Grant Line Canal Near Clifton Court Forebay	2.35	2.91	2.97	3.71
Clifton Court Forebay	0.00	0.00	0.00	0.00
Channel Near CVP Pumps	0.25	0.28	1.03	1.17
SJR at Brandt Bridge	0.00	0.00	0.00	0.00
Downstream of Tracy Barrier	0.05	2.84	1.30	2.89
Downstream of Head of Old River Barrier	0.00	0.00	0.00	0.00
Near Tom Paine Slough	2.97	3.40	2.14	3.82

Table B-6: Tracy Discharge with Permanent Barriers (Future Condition)

	Temporary Barriers Tracy Current Discharge (16 mgd)			
	High Exports		Low Exports	
	August	October	August	October
	Maximum Weekly	Maximum Weekly	Maximum Weekly	Maximum Weekly
Upstream of Tracy Discharge	0.49	0.75	0.38	0.70
Downstream of Tracy Discharge	3.86	5.33	3.45	4.69
Old River at Tracy Blvd	0.12	0.14	2.14	3.05
Upstream of MHCSD Discharge	0.12	0.16	2.35	2.92
Downstream of MHCSD Discharge	0.13	0.17	2.38	3.19
Middle River at Mowery Bridge	0.00	0.00	0.00	0.00
Grant Line Canal Near Tracy Bridge	3.70	4.82	3.57	4.85
Grant Line Canal Near Clifton Court Forebay	3.36	3.64	3.05	3.82
Clifton Court Forebay	0.00	0.00	0.16	0.22
Channel Near CVP Pumps	0.51	0.55	1.66	2.03
SJR at Brandt Bridge	0.00	0.00	0.00	0.00
Downstream of Tracy Barrier	0.09	0.04	2.30	3.29
Downstream of Head of Old River Barrier	0.00	0.00	0.00	0.00
Near Tom Paine Slough	1.34	0.17	2.04	2.77

Attachment B
DSM2 Modeling Results

Table B-7: MHCSD Discharge with Temporary Barriers (Current Condition)

	Temporary Barriers **MHCSD (1 mgd)**			
	High Exports		**Low Exports**	
	August	**October**	**August**	**October**
	Maximum Weekly	Maximum Weekly	Maximum Weekly	Maximum Weekly
Upstream of Tracy Discharge	0.00	0.00	0.00	0.00
Downstream of Tracy Discharge	0.00	0.00	0.01	0.01
Old River at Tracy Blvd	0.00	0.00	0.48	2.20
Upstream of MHCSD Discharge	0.45	0.00	0.63	4.77
Downstream of MHCSD Discharge	0.00	2.65	0.01	0.60
Middle River at Mowery Bridge	0.00	0.00	0.00	0.00
Grant Line Canal Near Tracy Bridge	0.00	0.00	0.02	0.01
Grant Line Canal Near Clifton Court Forebay	0.00	0.00	0.01	0.00
Clifton Court Forebay	0.00	0.00	0.00	0.00
Channel Near CVP Pumps	0.00	0.04	0.00	0.00
SJR at Brandt Bridge	0.00	0.00	0.00	0.00
Downstream of Tracy Barrier	0.00	2.57	0.00	0.01
Downstream of Head of Old River Barrier	0.00	0.00	0.00	0.00
Near Tom Paine Slough	0.00	0.00	0.26	0.27

Table B-8 MHCSD Discharge with Permanent Barriers (Future Condition)

	Temporary Barriers **MHCSD (5.4 mgd)**			
	High Exports		**Low Exports**	
	August	**October**	**August**	**October**
	Maximum Weekly	Maximum Weekly	Maximum Weekly	Maximum Weekly
Upstream of Tracy Discharge	0.00	0.00	0.00	0.00
Downstream of Tracy Discharge	0.05	0.27	0.28	0.80
Old River at Tracy Blvd	1.69	3.52	1.57	2.81
Upstream of MHCSD Discharge	1.74	4.80	1.91	3.38
Downstream of MHCSD Discharge	0.01	0.03	0.30	0.78
Middle River at Mowery Bridge	0.00	0.00	0.00	0.00
Grant Line Canal Near Tracy Bridge	0.25	0.95	0.43	1.20
Grant Line Canal Near Clifton Court Forebay	0.15	0.69	0.34	0.94
Clifton Court Forebay	0.00	0.00	0.02	0.05
Channel Near CVP Pumps	0.03	0.12	0.20	0.52
SJR at Brandt Bridge	0.00	0.00	0.00	0.00
Downstream of Tracy Barrier	0.00	0.01	0.29	0.81
Downstream of Head of Old River Barrier	0.00	0.00	0.00	0.00
Near Tom Paine Slough	1.40	3.50	1.66	2.91

Attachment B
DSM2 Modeling Results

Table B-9 – Modeled Electrical Conductivity

Tracy Discharge (Temporary Barriers)				
		Ambient EC	**600** umhos/cm	
		Tracy Effluent EC	**1600** umhos/cm	
		Tracy Discharge Flow	**9.0** mgd	
	High Exports		**Low Exports**	
	August Average EC	October Average EC	August Average EC	October Average EC
Upstream of Tracy Discharge	600	600	600	600
Downstream of Tracy Discharge	623	632	644	649
Old River at Tracy Blvd (D-1641)	624	631	606	611
Upstream of MHCSD Discharge	600	628	610	620
Downstream of MHCSD Discharge	600	626	612	625
Middle River at Mowery Bridge (D-1641)	600	600	600	600
Grant Line Canal Near Tracy Bridge	628	635	646	653
Grant Line Canal Near Clifton Court Forebay	622	627	627	634
Clifton Court Forebay	600	600	600	600
Channel Near CVP Pumps	602	602	608	611
SJR at Brandt Bridge (D-1641)	600	600	600	600
Downstream of Tracy Barrier	600	624	608	625
Downstream of Head of Old River Barrier	600	600	600	600
Near Tom Paine Slough	627	633	619	635

Table B-10 – Modeled Electrical Conductivity

Tracy Discharge (Permanent Gates)				
		Ambient EC	**600** umhos/cm	
		Tracy Effluent EC	**1000** umhos/cm	
		Tracy Discharge Flow	**16.0** mgd	
	High Exports		**Low Exports**	
	August Average EC	October Average EC	August Average EC	October Average EC
Upstream of Tracy Discharge	601	602	601	602
Downstream of Tracy Discharge	614	619	613	617
Old River at Tracy Blvd (D-1641)	600	600	608	611
Upstream of MHCSD Discharge	600	600	609	611
Downstream of MHCSD Discharge	600	600	608	610
Middle River at Mowery Bridge (D-1641)	600	600	600	600
Grant Line Canal Near Tracy Bridge	613	617	613	618
Grant Line Canal Near Clifton Court Forebay	612	613	611	615
Clifton Court Forebay	600	600	601	601
Channel Near CVP Pumps	602	602	606	607
SJR at Brandt Bridge (D-1641)	600	600	600	600
Downstream of Tracy Barrier	600	600	608	610
Downstream of Head of Old River Barrier	600	600	600	600
Near Tom Paine Slough	603	601	607	610

Table B-11 – Modeled Electrical Conductivity

MHCSD Discharge (Temporary Barriers)	Ambient EC **600** umhos/cm MHCSD Effluent EC **1000** umhos/cm MHCSD Discharge Flow **3.0** mgd			
	High Exports		**Low Exports**	
	August Average EC	October Average EC	August Average EC	October Average EC
Upstream of Tracy Discharge	600	600	600	600
Downstream of Tracy Discharge	600	600	600	600
Old River at Tracy Blvd (D-1641)	600	600	605	617
Upstream of MHCSD Discharge	604	600	607	650
Downstream of MHCSD Discharge	600	627	600	606
Middle River at Mowery Bridge (D-1641)	600	600	600	600
Grant Line Canal Near Tracy Bridge	600	600	600	600
Grant Line Canal Near Clifton Court Forebay	600	600	600	600
Clifton Court Forebay	600	600	600	600
Channel Near CVP Pumps	600	600	600	600
SJR at Brandt Bridge (D-1641)	600	600	600	600
Downstream of Tracy Barrier	600	626	600	600
Downstream of Head of Old River Barrier	600	600	600	600
Near Tom Paine Slough	600	600	602	603

Table B-12 – Modeled Electrical Conductivity

MHCSD Discharge (Permanent Gates)	Ambient EC **600** umhos/cm MHCSD Effluent EC **1000** umhos/cm MHCSD Discharge Flow **5.4** mgd			
	High Exports		**Low Exports**	
	August Average EC	October Average EC	August Average EC	October Average EC
Upstream of Tracy Discharge	600	600	600	600
Downstream of Tracy Discharge	600	601	601	603
Old River at Tracy Blvd (D-1641)	606	612	606	610
Upstream of MHCSD Discharge	605	612	606	611
Downstream of MHCSD Discharge	600	600	601	603
Middle River at Mowery Bridge (D-1641)	600	600	600	600
Grant Line Canal Near Tracy Bridge	601	603	602	604
Grant Line Canal Near Clifton Court Forebay	600	602	601	603
Clifton Court Forebay	600	600	600	600
Channel Near CVP Pumps	600	600	601	602
SJR at Brandt Bridge (D-1641)	600	600	600	600
Downstream of Tracy Barrier	600	600	601	603
Downstream of Head of Old River Barrier	600	600	600	600
Near Tom Paine Slough	604	612	606	611

Attachment B
DSM2 Modeling Results

Table B-13 – Modeled Electrical Conductivity

Combined Tracy and MHCSD Discharges (Temporary Barriers)				
	MHCSD Effluent EC		**1000** umhos/cm	
	MHCSD Discharge Flow		**3.0** mgd	
	Tracy Effluent EC		**1600** umhos/cm	
Ambient EC **600** umhos/cm	Tracy Discharge Flow		**10.8** mgd	
	High Exports		**Low Exports**	
	August Average EC	October Average EC	August Average EC	October Average EC
Upstream of Tracy Discharge	600	600	600	600
Downstream of Tracy Discharge	628	638	653	659
Old River at Tracy Blvd (D-1641)	628	638	613	631
Upstream of MHCSD Discharge	605	634	619	674
Downstream of MHCSD Discharge	600	658	615	636
Middle River at Mowery Bridge (D-1641)	600	600	600	600
Grant Line Canal Near Tracy Bridge	633	642	655	664
Grant Line Canal Near Clifton Court Forebay	626	633	633	641
Clifton Court Forebay	600	600	600	600
Channel Near CVP Pumps	602	603	610	613
SJR at Brandt Bridge (D-1641)	600	600	600	600
Downstream of Tracy Barrier	600	655	610	630
Downstream of Head of Old River Barrier	600	600	600	600
Near Tom Paine Slough	632	639	626	644

Table B14 – Modeled Electrical Conductivity (Permanent Gates)

Combined Tracy and MHCSD Discharges (Permanent Gates)				
	MHCSD Effluent EC		**1000** umhos/cm	
	MHCSD Discharge Flow		**5.4** mgd	
	Tracy Effluent EC		**1000** umhos/cm	
Ambient EC **600** umhos/cm	Tracy Discharge Flow		**16** mgd	
	High Exports		**Low Exports**	
	August Average EC	October Average EC	August Average EC	October Average EC
Upstream of Tracy Discharge	601	602	601	602
Downstream of Tracy Discharge	615	620	614	620
Old River at Tracy Blvd (D-1641)	606	613	614	621
Upstream of MHCSD Discharge	605	613	615	622
Downstream of MHCSD Discharge	600	600	608	613
Middle River at Mowery Bridge (D-1641)	600	600	600	600
Grant Line Canal Near Tracy Bridge	613	620	614	623
Grant Line Canal Near Clifton Court Forebay	612	616	613	618
Clifton Court Forebay	600	600	601	601
Channel Near CVP Pumps	602	602	607	609
SJR at Brandt Bridge (D-1641)	600	600	600	600
Downstream of Tracy Barrier	600	600	608	613
Downstream of Head of Old River Barrier	600	600	600	600
Near Tom Paine Slough	607	612	612	621