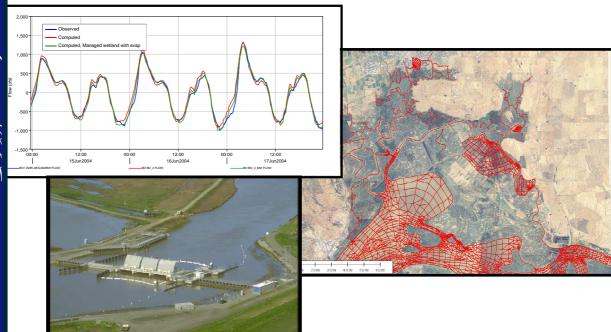
Appendix A Numerical Modeling in Support of Suisun Marsh PEIR/EIS— Technical Appendix, September 2009



NUMERICAL MODELING IN SUPPORT OF SUISUN MARSH PEIR/EIS

TECHNICAL APPENDIX, SEPTEMBER 2009



Prepared For: Jones and Stokes Associates 2841 Junction Ave, Suite 114 San Jose, CA 95134

> Contact: Kevin MacKay Project Manager 408-434-2244

Prepared By: Resource Management Associates 4171 Suisun Valley Road, Suite J Fairfield, CA 94534

> Contact: John DeGeorge 707-864-2950



Table of Contents

1.	Exe	ecutive Summary	. 1
	1.1.	Background	. 1
	1.2.	Report Summary	. 1
	1.3.	Summary of the Calibration	. 1
	1.4.	Summary of the Modeling Results	. 2
2.	RM	IA Suisun Marsh Modeling	. 5
	2.1.	Introduction	. 5
	2.2.	Background	. 5
	2.3.	General Description of Model Capabilities	
3.		odel Set-up	
	3.1.	Model Geometry	
	3.2.	Network Refinement	
	3.3.		
	3.3	1	
	3.3	J	
	3.3		
	3.3		
	3.3	\mathcal{U}	
	3.3		
4.	Mo	odel Calibration	
	4.1.	Hydrodynamics Calibration	29
	4.1	8 8	
		.2. Incorporating managed wetlands	
		.3. Results of the hydrodynamic calibration	
	4.2.	Electrical Conductivity (EC) Calibration	
	4.2		
	4.2		
	4.2	J	
	4.3.		
5.	Tid	lal Restoration Scenario Simulations	
	5.1.	Boundary Conditions	
	5.2.	Simulation Period	63
	5.3.	Mesh	63
	5.3		
	5.3	.2. Set 2 and Zone 1	63
	5.3		
	5.4.	Stage Results	67
	5.4	.1. Background	67
	5.4	.2. Results	67
	5.5.		
	5.5		
	5.5		72
	5 5	3 North Interior Marsh	73

	5.5.4.	Western Interior Marsh	
	5.5.5.	Comparison of flood flow for the scenarios	73
5	.6. EC	Results	81
	5.6.1.	Martinez to Collinsville	81
	5.6.2.	Suisun Marsh	81
	5.6.3.	Delta	83
5	.7. Ve	locity Results – Scour Potential	109
	5.7.1.	Background	109
	5.7.2.	Scouring potential for the scenarios	109
		Summary	
6.	Discuss	sion/Summary/Conclusions	128
7.	Referen	nces	131

Table of Figures

Figure 1-1 Regions flooded as tidal marsh in each of the scenarios, with the location	
breaches in levees indicated by stars.	
Figure 2-1 RMA Bay-Delta model finite element mesh	
Figure 3-1 Comparison between old and new grid details in the Suisun Marsh Area	
Figure 3-2 Base case Suisun Marsh finite element network.	
Figure 3-3 Example of computed and observed stage at Martinez	15
Figure 3-4 Model grid showing inflow and export locations, and flow control structure	res.
	16
Figure 3-5 Net Delta outflow and major boundary flows for the 2002-2003 EC	
calibration/scenario simulation period.	17
Figure 3-6 Minor boundary flows for the 2002-2003 EC calibration/scenario simulati	on
period.	
Figure 3-7 Suisun Marsh local creek flows for the 2002-2003 EC calibration/scenario)
simulation period.	
Figure 3-8 Historical exports and diversions used in the model for the 2002-2003 EC	
calibration/scenario simulation period. Note that daily averaged SWP exports are plo	
however the model uses 15-minute inputs.	
Figure 3-9 Major boundary flows for the 2004 hydrodynamic calibration period	
Figure 3-10 Minor boundary flows for the 2004 hydrodynamic calibration period	
Figure 3-11 Historical exports and diversions used in the model for the 2004	
hydrodynamic calibration period. Note that daily averaged SWP exports are plotted,	
however the model uses 15-minute inputs	
Figure 3-12 Inflow/export locations in Suisun Marsh.	
Figure 3-13 Daily EC time series used as boundary conditions for the Sacramento Ri	
and Yolo Bypass (upper) and for the San Joaquin River (lower) for the 2002-2003 EQ	
calibration/scenario simulation period.	
Figure 3-14 Aerial view of the Suisun Marsh Salinity Control Gates	
Figure 3-15 Operational schedule for the SMSCG during the 2002-2003 EC	20
calibration/scenario simulation period.	28
-	20
Figure 3-16 Operational schedule for the SMSCG during the 2004 hydrodynamic	29
calibration period	
white boxed labels indicate special continuous monitoring stations implemented during	_
spring 2004.	
Figure 4-2 Suisun Marsh LiDAR data used in the model calibration – elevations show	
the color scale are in feet (NGVD29).	35
Figure 4-3 Observed and computed flow and stage data in Boynton Slough with two	
iterations of flow results showing how addition of tidal marsh affects computed flows	
Figure 4-4 Observed and computed tidally averaged flow in Boynton Slough (B01) a	
Hill Slough (HS1), and observed stage at Hill Slough (S-4).	
Figure 4-5 Observed and computed tidally averaged flow for Boynton Slough. The re	
line is the flow for a modeled system with an adjacent managed wetland connected by	-
open culverts to Boynton Slough	38

Figure 4-6 Observed and computed flow for Boynton Slough. The red line is the flow for
a modeled system with an adjacent managed wetland connected by open culverts to
Boynton Slough
Figure 4-7 Observed tidally averaged flow for the east side Montezuma Slough stations
M04 and M03, and the Observed Stage at S71 and S7240
Figure 4-8 Observed and computed stage at monitoring station S-4 in Hill Slough during
April – May 2004 (shorter time period shown in lower plot)
Figure 4-9 Observed and computed flow at Hill Slough, station HS1 during May 2004
(shorter time period shown in lower plot)
Figure 4-10 Observed and computed stage at monitoring station S-49 at Beldon's
Landing on Montezuma Slough during April – May 2004 (shorter time period shown in
lower plot)
Figure 4-11 Observed and computed stage at monitoring station S-64 at National Steel on
Montezuma Slough April – May 2004 (shorter time period shown in lower plot) 42
Figure 4-12 Observed and computed flow at the Nurse Slough monitoring station, NS1
May 2004 (shorter time period shown in lower plot)
Figure 4-13 Observed and computed flow at the Cutoff Slough monitoring station, CO2
during June 2004
Figure 4-14 Observed and computed flow in First Mallard Slough at station FM1 during
June 2004
Figure 4-15 Observed and computed flow in Montezuma Slough at station MO1 during
May 2004 (shorter time period in lower plot) – positive values indicate flow is eastward.
44
Figure 4-16 Observed and computed flow in Montezuma Slough at monitoring locations
MO2 and MO3 – positive values indicate flow is eastward
Figure 4-17 Observed and computed flow in Montezuma Slough at monitoring location
MO4 (shorter time period shown in lower plot) – positive values indicate flow is
eastward
Figure 4-18 Observed and computed flow at the mouth of Suisun Slough, station SS1
(shorter time period shown in lower plot)
Figure 4-19 Observed and computed flow through Hunter Cut at monitoring station HC1
(shorter time period shown in lower plot)
Figure 4-20 Locations of monitoring stations used in EC model calibration
Figure 4-21 Top/bottom EC and stage at Martinez (RSAC054), and Sacramento River
flow during a high outflow, neap tide period
Figure 4-22 Top/bottom EC and stage at Martinez (RSAC054), and Sacramento River
flow during a lower outflow period, neap tide period
Figure 4-23 Tidally averaged measured (average of top and bottom) and computed EC at
Martinez station (RSAC054) 52
Figure 4-24 Tidally averaged observed and computed EC at S-49, Montezuma Slough at
Beldon's Landing. Computed shown with and without duck club withdrawals and
evaporation53
Figure 4-25 Tidally averaged observed and computed EC at station S-49, Beldon's
Landing
Figure 4-26 Tidally averaged observed and computed EC at station S-64, National Steel

Figure 4-27 Tidally averaged observed and computed EC at station S-71 Roaring River	in
eastern Montezuma Slough.	
Figure 4-28 Tidally averaged observed and computed EC at station S-54, Hunter Cut	55
Figure 4-29 Tidally averaged observed and computed EC at Collinsville (RSAC081)	56
Figure 4-30 Observed and computed EC at Collinsville (RSAC081) during a period of	
SMSCG operation.	
Figure 4-31 Tidally averaged observed and computed EC at station S-4, Hill Slough	57
Figure 4-32 Tidally averaged observed and computed EC at station S-4, Hill Slough in	
December, 2002. Computed results shown with and without local creek flow addition.	57
Figure 4-33 Tidally averaged observed and computed EC at station S-42, Volanti	58
Figure 4-34 Tidally averaged observed and computed EC at station S-42, Volanti in	
December, 2002. Computed results shown with and without local creek flow addition.	58
Figure 4-35 Tidally averaged observed and computed EC at station S-97, in Cordelia	
Slough at Ibis.	59
Figure 4-36 Tidally averaged observed and computed EC at station S-97, in Cordelia	
Slough at Ibis December, 2002. Computed results shown with and without local creek	
flow addition.	
Figure 4-37 Tidally averaged observed and computed EC at station A-96 on Goodyear	
Slough at Fleet.	60
Figure 4-38 Tidally averaged observed and computed EC at station S-37 in Suisun	
Slough at Godfather.	60
Figure 4-39 Tidally averaged observed and computed EC at station S-35 at Morrow	
Island	61
Figure 4-40 Intertidal observed and computed EC at station S-35 at Morrow Island	61
Figure 5-1 Base case grid in Suisun Marsh.	
Figure 5-2 Bottom elevation for the Base case grid.	64
Figure 5-3 Set 2 grid in Suisun Marsh.	65
Figure 5-4 Bottom elevation for the Set 2 grid.	65
Figure 5-5 Set 1 grid in Suisun Marsh	
Figure 5-6 Bottom elevation for the Set 1 grid.	66
Figure 5-7 Stage time series showing stage shifts at Collinsville monitoring station C-2	
and National Steel monitoring location S-64 for Base and Set 1 Scenarios	
Figure 5-8 Stage time series at monitoring station S-49 at Beldon's Landing when Duck	ζ.
Clubs in the Suisun Marsh region are filling in the fall.	
Figure 5-9 Color contour plots of Base case (upper) and Set 1 (lower) MHHW elevatio	ns
for April (left) and October (right) 2003	
Figure 5-10 Color contour plots of Base case (upper) and Set 1 (lower) MLLW elevatio	ns
for April (left) and October (right) 2003	
Figure 5-11 Color contour plots of Base case (upper) and Set 2 (lower) MHHW (left) ar	nd
MLLW (right) elevations for April 2003 (note scale differences for MHHW and MLLW	V).
Figure 5-12 Locations where tidal flow was calculated (Base case grid)	74
Figure 5-13 Average modeled tidal flow in the larger sloughs in central Suisun Marsh.	75
Figure 5-14 Average modeled tidal flow in the smaller sloughs in the northern interior	
region of Suisun Marsh.	76

Figure 5-15 Average modeled tidal flow in the sloughs west and north of the Zone 1 are	
Figure 5-16 Average modeled tidal flow in Goodyear Slough.	
Figure 5-17 Red arrows illustrate flow magnitude (cfs) near peak flood tide (July 11,	, 0
2003 22:00) for Base case in comparison with Set 2. Color Scale is water surface	
elevation.	79
Figure 5-18 Red arrows illustrate flow magnitude (cfs) near peak flood tide (July 11, 2003 22:00) for Base case in comparison with Set 1. Color Scale is water surface	, ,
elevation.	80
Figure 5-19 Tidally averaged computed EC at Martinez	
Figure 5-20 Tidally averaged computed EC at Chipps	
Figure 5-21 Tidally averaged observed and computed EC at Collinsville	
Figure 5-22 Tidally averaged computed EC at Beldon's Landing at monitoring station S	
49 in Montezuma Slough.	
Figure 5-23 Tidally averaged computed EC at station S-40 on Boynton Slough	
Figure 5-24 Tidally averaged computed EC at station S-97 on Ibis Slough	
Figure 5-25 Tidally averaged computed EC at station S-21 in Sunrise Slough	87
Figure 5-26 Tidally averaged computed EC at station S-35 at Morrow Island	87
Figure 5-27 Tidally averaged computed EC at station S-42 on Volanti Slough	
Figure 5-28 Tidally averaged observed and computed EC at station S-37 on Godfather	
Slough.	
Figure 5-29 Tidally averaged observed and computed EC at station S-33 on Cygnus	
Slough.	89
Figure 5-30 Tidally averaged observed and computed EC at station S-54 on Hunter Cu	t.
	89
Figure 5-31 Tidally averaged observed and computed EC at station S-4 on Hill Slough	
	90
Figure 5-32 Tidally averaged observed and computed EC at station NS-1 on Nurse	
Slough.	
Figure 5-33 Tidally averaged computed EC at the S-64 monitoring location near Nation	
Steel on Montezuma Slough.	
Figure 5-34 Tidally averaged computed EC at the S-71 monitoring location at Roaring	
ϵ	91
Figure 5-35 Tidally averaged computed EC time series at Jersey Point	
5-36 Tidally averaged computed EC time series at Old River at Rock Slough	92
5-37 Tidally averaged computed EC time series at the CCWD Victoria Canal export	
location for Los Vaqueros	
Figure 5-38 Tidally averaged computed EC time series at the CVP export location	
Figure 5-39 Tidally averaged computed EC time series at the SWP export location	
Figure 5-40 Color contour plots of EC for the Base case (left) and Zone 4 scenario (right	
at the same timing on a flood tide (upper) and ebb tide (lower)	
Figure 5-41 Set 2 EC % change from Base case – August 1, 2002	
Figure 5-42 Set 2 EC % change from Base case – September 1, 2002.	
Figure 5-43 Set 2 EC % change from Base case – October 1, 2002	
Figure 5-44 Set 2 EC % change from Base case – September 1, 2003.	
Figure 5-45 Set 2 FC % change from Base case – October 1, 2003	(10)

Figure 5-46 Set 2 EC % change from Base case – November 1, 2003	101
Figure 5-47 Zone 1 EC % change from Base case – September 1, 2002	102
Figure 5-48 Set 1 EC % change from Base case – August 1, 2002	103
Figure 5-49 Set 1 EC % change from Base case – September 1, 2002	
Figure 5-50 Set 1 EC % change from Base case – October 1, 2002	105
Figure 5-51 Set 1 EC % change from Base case – September 1, 2003	106
Figure 5-52 Set 1 EC % change from Base case – October 1, 2003	107
Figure 5-53 Set 1 EC % change from Base case – November 1, 2003	108
Figure 5-54 Location names for the areas examined for scouring potential	112
Figure 5-55 Velocity distributions for the five scenarios at Beldon's Landing, July 2	2002.
	113
Figure 5-56 Color contour plots of velocity for Base case and Zone 1 at Hunter Cut	
July 2002. Points analyzed: Point 1 on bank Point 2 mid-channel	
Figure 5-57 Hunter Cut velocity at Point 1 for Sets 1 and 2 in comparison with the l	
case	
Figure 5-58 Velocity distributions for points 1 (bank) and 2 (mid-channel) at Hunte	
	116
Figure 5-59 Color contour plots of velocity for Base case and Zone 1 near Morrow	
on July 12, 2002 14:00. Points analyzed: channel (Point 1) and bank (Point 2)	
Figure 5-60 Morrow Island velocity at Point 1 for Sets 1 and 2 in comparison with	
Base case.	118
Figure 5-61 Velocity distributions for points analyzed near Morrow Island: point 1	
(channel) and point 2 (bank).	
Figure 5-62 Color contour plots of velocity for Base case and Zone 4 near Meins La	
on July 17, 2002 1915. Points analyzed: points 1 and 3 (bank) and point 2 (mid-cha	
E' 5 (2) M ' I I' I '	
Figure 5-63 Meins Landing velocity at Point 2 for Set 1 and Zone 4 in comparison value.	
the Base case.	121
Figure 5-64 Meins Landing velocity at Point 2 for Set 2 and Zone 1 in comparison with Page 2002	
the Base case.	
Figure 5-65 Velocity distributions for Point 3 (bank) analyzed near Meins Landing.	
Figure 5-66 (Above) Color contour plot of Set 2 velocity near Cross Slough on July 2002 22:15. (Polovy) Velocity distributions in Cross Slough Points analyzed points	
2002 23:15. (Below) Velocity distributions in Cross Slough. Points analyzed: point	
and 2 mid-channelFigure 5-67 Cross Slough velocity at Point 1 for Set 1 and Set 2 in comparison with	
Base case	
Figure 5-68 Color contour plots of velocity for the Base case and set 1 scenario on .	
11, 2002 04:45 (note scale differences on contour plots). Points analyzed near the D	-
Club location are indicated.	
Figure 5-69 Velocity distributions for points analyzed near the Duck Club location.	
Lower plot shows velocity distributions for Set 1 at six points	
Figure 5-70 Velocity time series for points A - D analyzed near the Duck Club loca	
Figure 3-70 Velocity time series for points A - D analyzed hear the Duck Club loca	
Figure 5-71 Velocity time series for points E and F analyzed near the Duck Club lo	
11gare 5 /1 velocity time series for points L and I analyzed hear the Duck Club to	

List of Tables

Table 3-1 Summary of monthly DICU flows (ft ³ sec ⁻¹) for the calibration and scenario	
simulation periods. Negative values indicate Delta withdrawal	. 23
Table 3-2 EC boundary conditions for the EC calibration, Base case and scenarios	
simulations	. 26
Table 5-1 Flow magnitude (cfs) at four locations near peak flood tide (July 11, 2003	
22:00).	. 73