FINAL REPORT

STOCKTON DEEP WATER SHIP CHANNEL DEMONSTRATION DISSOLVED OXYGEN AERATION FACILITY PROJECT

PREPARED FOR:

California Department of Water Resources
1416 9th Street
Sacramento, CA 94236-0001
Contact: Bill McLaughlin, P.E.
916.653.0628

PREPARED BY:

ICF International
630 K Street, Suite 400
Sacramento, CA 95814
Contact: Russ Brown, Ph.D.
916.737.3000

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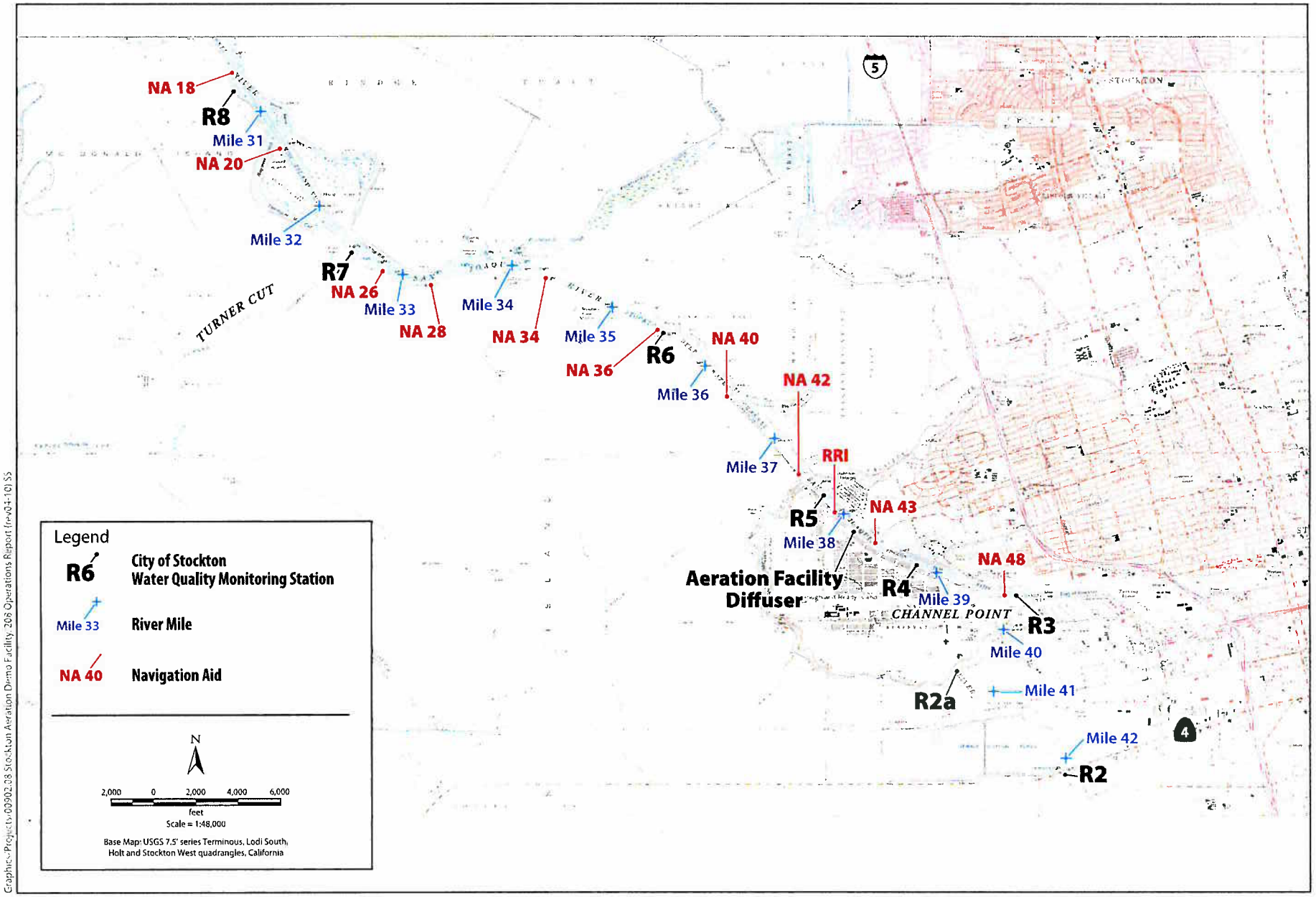

Graphics: Projects:00902-08 Stockton Aeration Demo Facility: 208 Operations Report (rev04-10) SS

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Figure 1
Stockton DWSC Water Quality Monitoring Stations

Table 5. Aeration Facility DO Increment, Efficiency, and DO Delivery Capacity (lb/day) for a Range of Operations

			Gas/Water Ratio						
			1%	2%	3%	4%	5%	6%	
Gas Supply for 1-pump (scf/hr)			900	1,800	2,700	3,600	4,500	5,400	
Gas Supply (for each tube) with 2-pumps (scf/hr)			810	1,620	2,430	3,240	4,050	4,860	
Maximum DO Increment (mg/l)			13	26	39	52	65	78	
Assumed Efficiency			90%	75%	65%	58%	53%	50%	
DO Increment (mg/l)			12	20	25	30	34	39	
DO Delivery with 1 pump (25 cfs)			1,580	2,633	3,422	4,072	4,651	5,265	
DO Delivery with 2 pumps (45 cfs)			2,843	4,739	6,160	7,329	8,371	9,477	
									Pumps only
Cost for 1-pump operation			$816	$991	$1,167	$1,342	$1,518	$1,693	$640
Cost for 2-pump operation			$1,596	$1,912	$2,228	$2,544	$2,860	$3,175	$1,280
Cost/lb for 1-pump operation			$0.52	$0.38	$0.34	$0.33	$0.33	$0.32	
Cost/lb for 2-pump operation			$0.56	$0.40	$0.36	$0.35	$0.34	$0.34	
Assumed Power Cost	0.16	$/kWh	166 kW pumps (220 hp) require 4,000 kWh per day of operation						
Assumed Oxygen Cost	0.10	$/lb							

Notes:
Assumed costs were calculated using 2010 rates for oxygen and electricity.
The most cost-effective operation is higher gas/water ratio because the pumping costs are fixed.

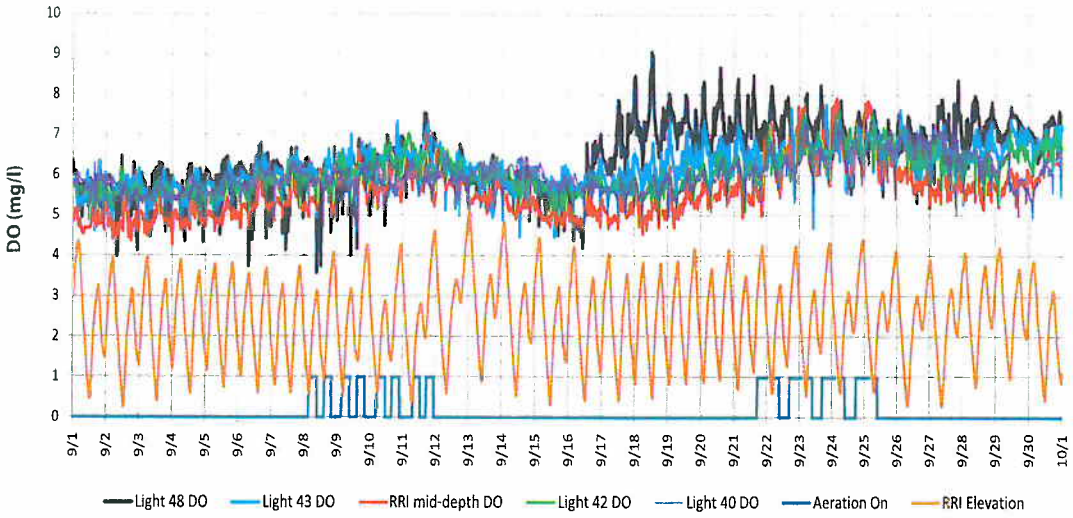


Figure 10a: Measured DO at the DWSC Monitoring Stations in the DWSC during September 2009

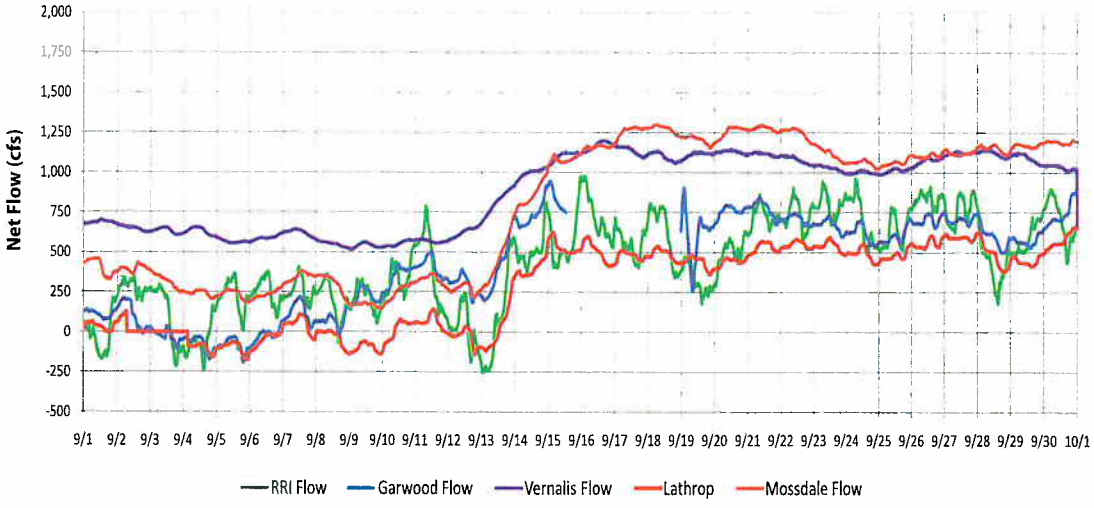


Figure 10b: Comparison of Estimated Daily Flows in the SJR and DWSC during September 2009

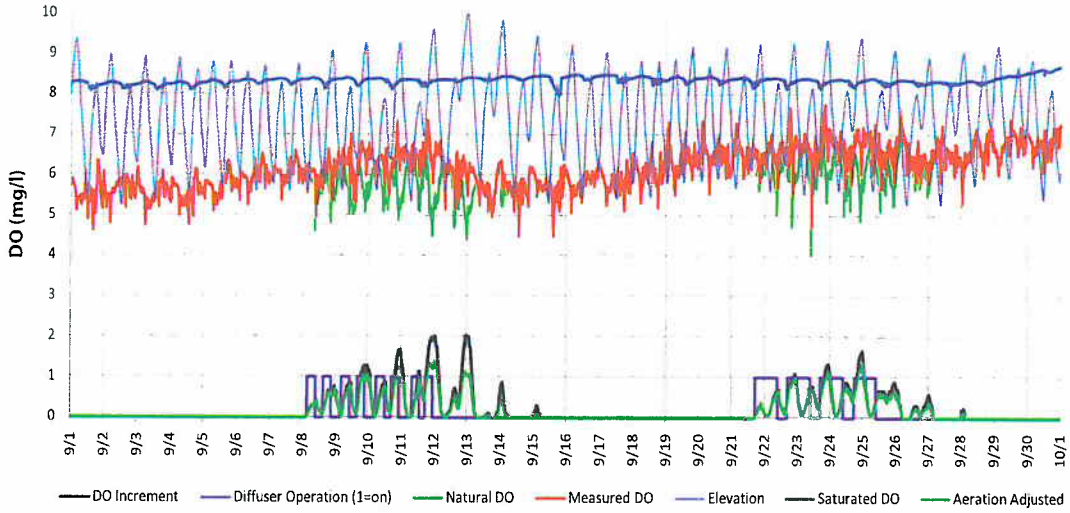


Figure 11a: Estimated DO Increments at NA 43 (0.2 Mile Upstream) from Aeration Facility Operation for September 2009

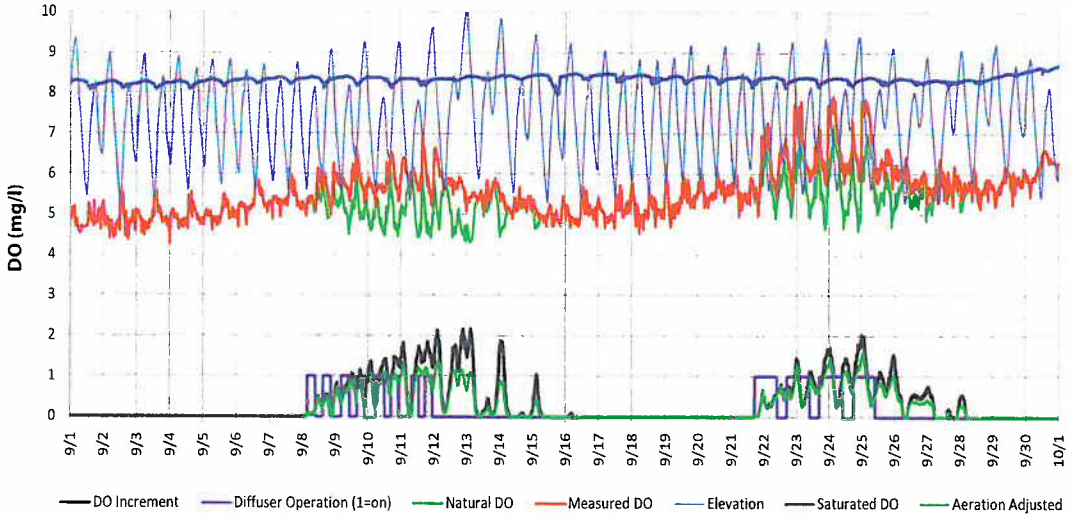


Figure 11b: Estimated DO Increments at RRI (0.2 Mile Downstream) from Aeration Facility Operation for September 2009

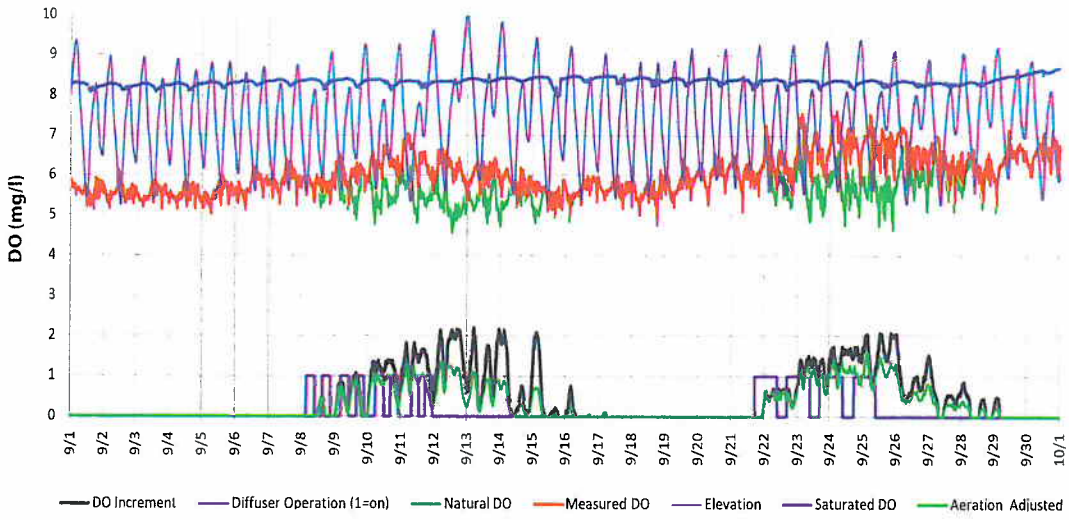


Figure 11c: Estimated DO Increments at NA 42 (0.7 Mile Downstream) from Aeration Facility Operation for September 2009

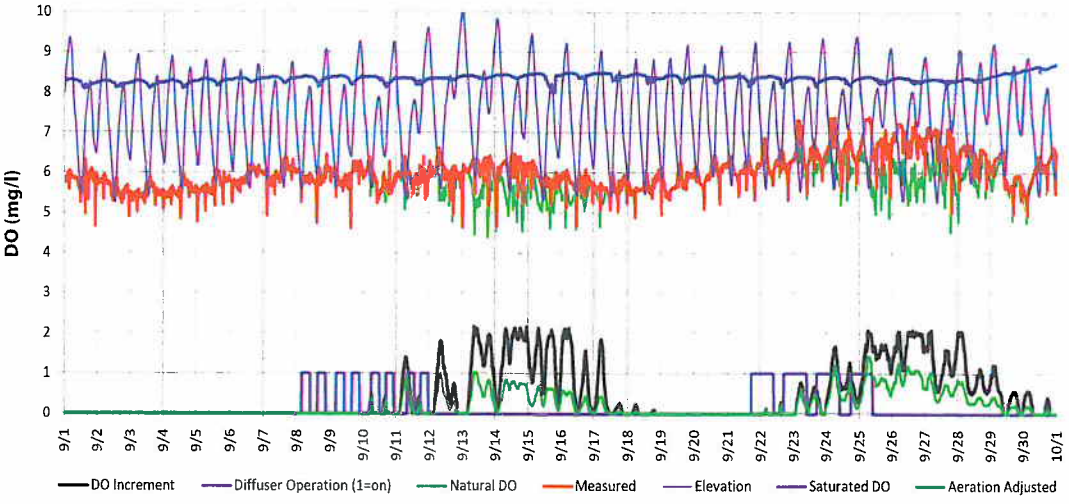


Figure 11d: Estimated DO Increments at NA 40 (1.6 Miles Downstream) from Aeration Facility Operation for September 2009

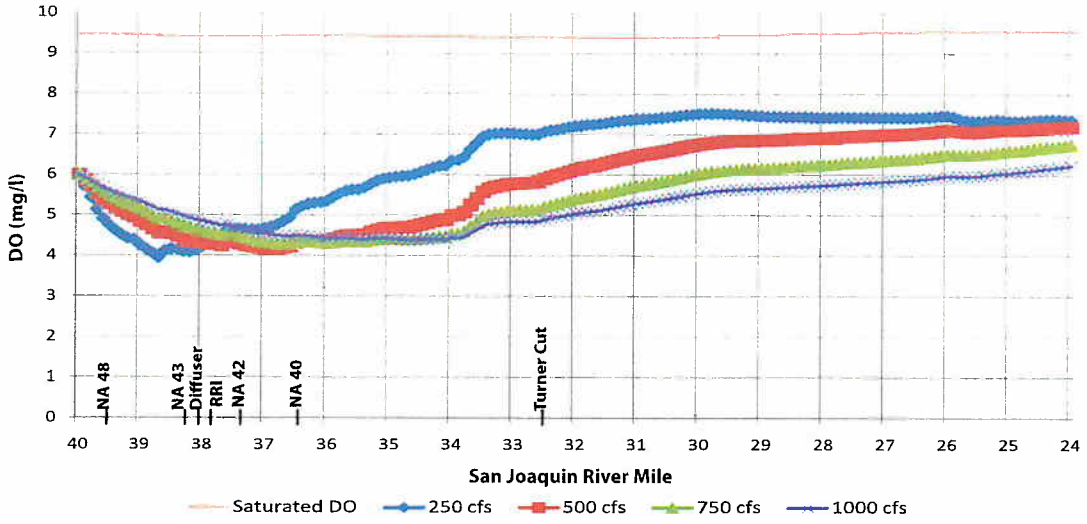


Figure 4a: Sensitivity of DWSC Longitudinal DO Profile to Flow for 250–1,000 cfs with BOD of 12 mg/l and 20% Reaeration Rate

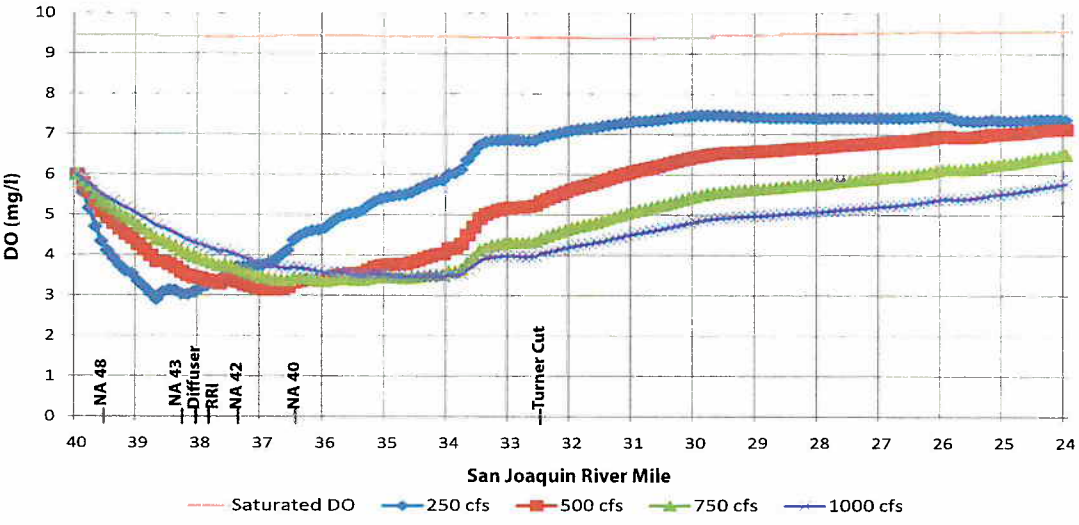


Figure 4b: Sensitivity of DWSC Longitudinal DO Profile to Flow for 250–1,000 cfs with BOD of 16 mg/l and 20% Reaeration Rate

Table 6. Calculated DO Increments in the DWSC with Reaeration for Maximum DO Diffuser Output of 7,500 lb/day

Flow (cfs)		0	250	500	750	1,000	1,250	1,500
Maximum Possible DO Increment at Diffuser (mg/l)		na	5.6	2.8	1.9	1.4	1.1	0.9
Location	San Joaquin Mile							
	40.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NA 48	39.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	39.0	1.25	0.00	0.00	0.00	0.00	0.00	0.00
NA 43	38.5	2.50	0.51	0.27	0.18	0.14	0.11	0.09
DO Diffuser	38.0	3.75	2.55	1.46	1.02	0.78	0.63	0.53
NA 42	37.5	2.50	3.24	2.12	1.55	1.22	1.00	0.85
	37.0	1.25	2.37	1.82	1.40	1.13	0.94	0.81
NA 40	36.5	0.00	1.56	1.48	1.22	1.02	0.87	0.75
	36.0	0.00	1.10	1.25	1.09	0.93	0.81	0.71
	35.5	0.00	0.77	1.05	0.97	0.86	0.75	0.67
	35.0	0.00	0.52	0.87	0.85	0.78	0.70	0.63
	34.5	0.00	0.36	0.73	0.76	0.71	0.65	0.60
	34.0	0.00	0.22	0.57	0.65	0.63	0.59	0.55
	33.5	0.00	0.10	0.39	0.50	0.52	0.51	0.48
	33.0	0.00	0.05	0.29	0.42	0.46	0.46	0.44
Turner Cut	32.5	0.00	0.03	0.23	0.35	0.40	0.41	0.41
Added DO in the DWSC (lbs)			32,500	30,000	26,000	22,500	20,000	18,000
DO Retention to Turner Cut		na	23%	40%	49%	54%	57%	59%
Travel Time to Turner Cut (days)		na	19.1	10.1	7.0	5.5	4.6	4.0

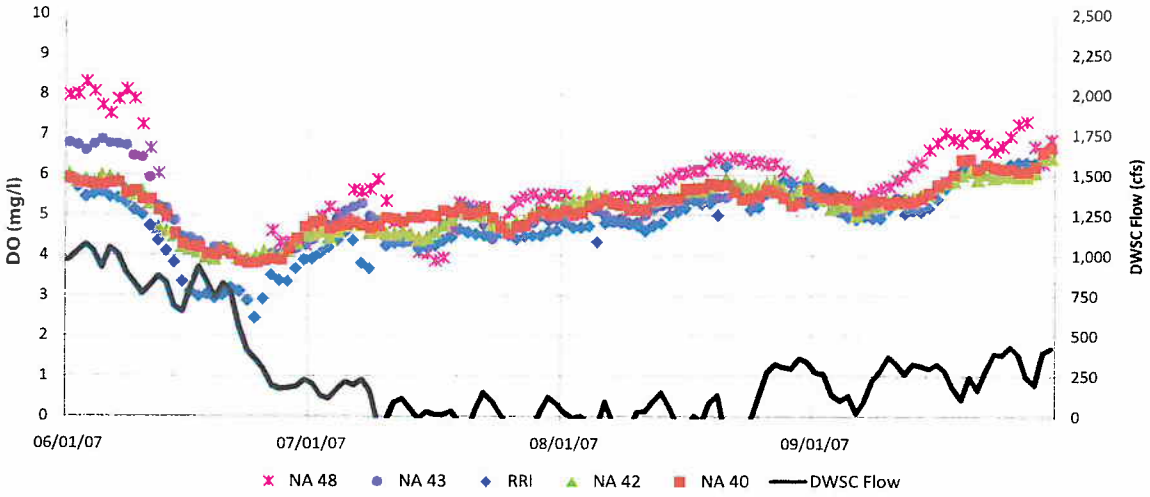


Figure 8a: Daily Average DO at the DWSC Monitoring Stations in June–September 2007

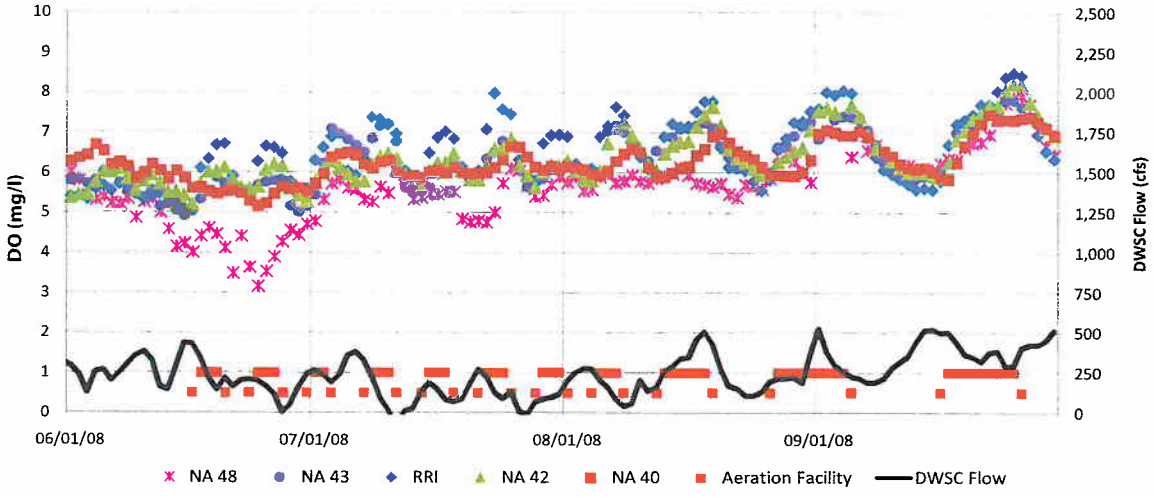


Figure 8b: Daily Average DO at the DWSC Monitoring Stations in June–September 2008

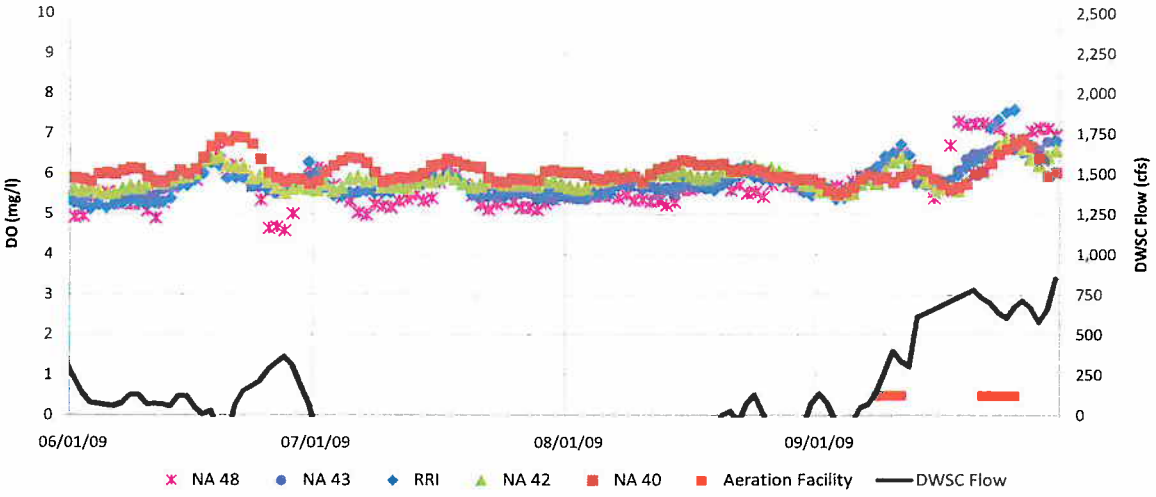


Figure 8c: Daily Average DO at the DWSC Monitoring Stations in June–September 2009

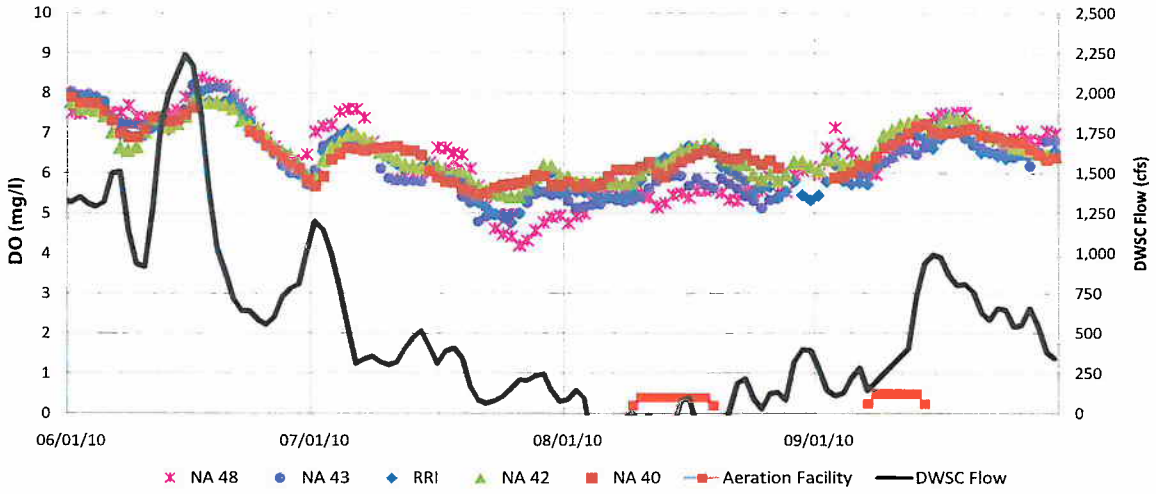
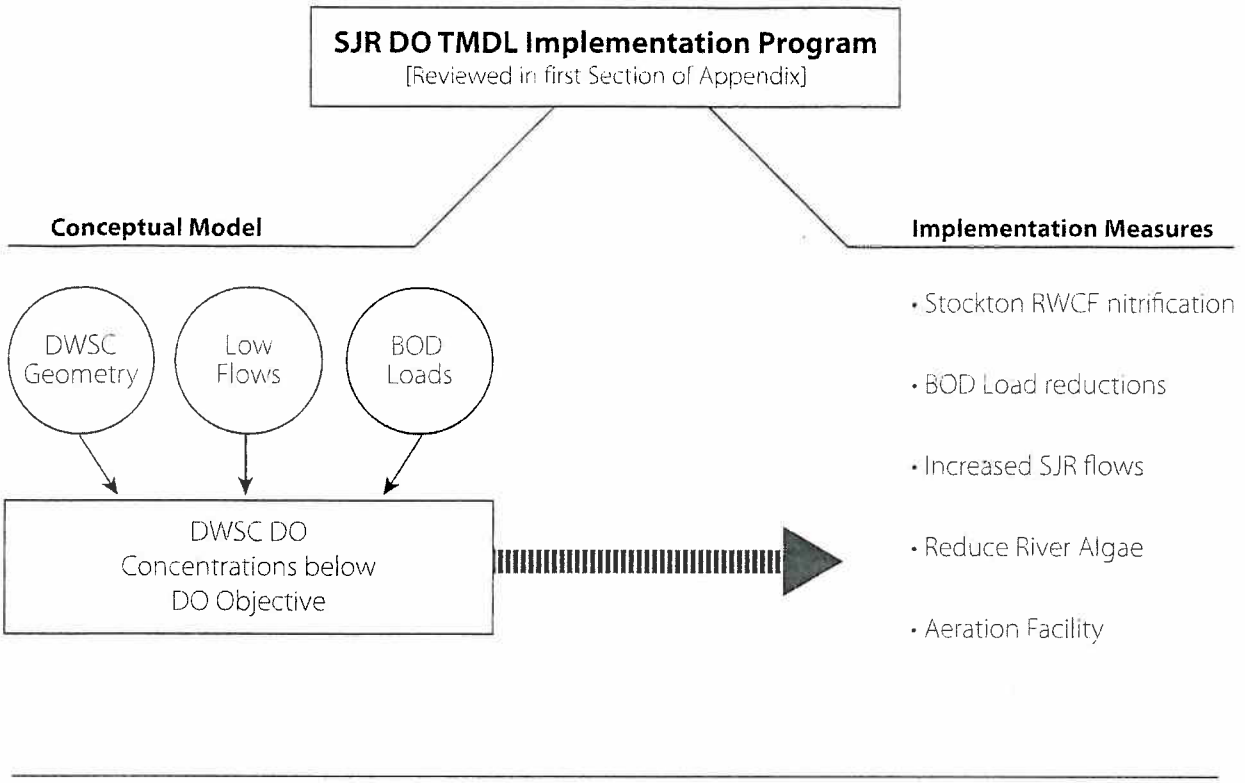


Figure 8d: Daily Average DO at the DWSC Monitoring Stations in June–September 2010

Table 9. Summary of Potential Aeration Facility Operations for Historical Conditions in June-September of 2007-2010

		Average Monthly DO Concentration (mg/l)					Potential Days of Aeration Facility Operation (days with DO less than the objective plus 0.5 mg/l)					Days of Aeration Testing
Year	Month	NA 40	NA 42	RRI	NA 43	NA 48	NA 40	NA 42	RRI	NA 43	NA 48	
2007	June	4.8	4.8	4.1	5.4	6.6	21	20	26	14	6	0
	July	4.9	4.8	4.4	4.8	5.0	31	31	31	31	25	0
	August	5.4	5.6	5.2	5.3	5.8	20	14	24	21	10	0
	September	5.8	5.7	5.7	5.2	6.3	28	30	28	12	15	0
							100	95	109	78	56	0
2008	June	5.8	5.7	5.8	5.5	4.6	6	7	12	13	28	11
	July	6.2	6.1	6.6	6.3	5.5	0	0	0	1	16	22
	August	6.2	6.6	6.7	6.7	5.8	0	0	0	0	2	20
	September	6.8	7.1	7.0	6.9	6.7	9	8	10	8	12	16
							15	15	22	22	58	69
2009	June	6.2	5.8	5.6	5.7	5.5	0	0	13	12	16	0
	July	6.1	5.8	5.6	5.7	5.4	0	0	9	5	23	0
	August	6.0	6.0	5.7	5.7	5.5	0	0	5	4	15	0
	September	6.0	6.1	6.3	6.2	6.4	25	25	21	18	15	9
							25	25	48	39	69	9
2010	June	7.1	7.2	7.3	7.3	7.4	0	0	0	0	0	0
	July	6.1	6.1	6.0	5.8	6.0	1	3	8	11	10	0
	August	6.2	6.1	5.9	5.5	5.5	0	0	7	15	12	11
	September	6.7	6.8	6.5	6.5	6.8	9	10	15	12	6	8
							10	13	30	38	28	19



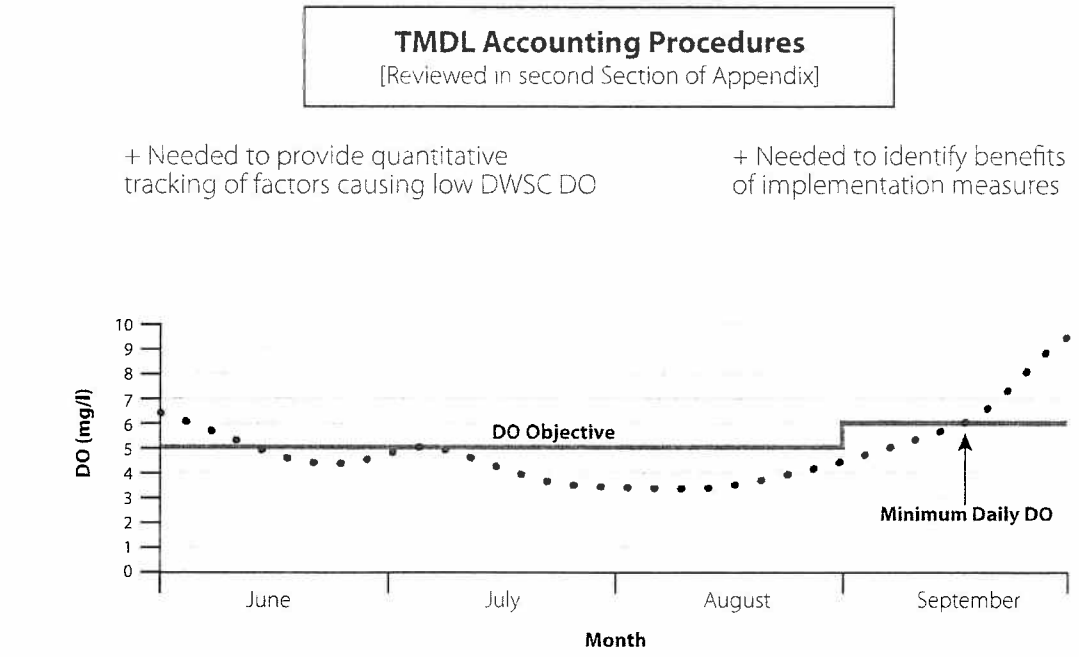


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Figure 1a
Diagram of the SJR DO TMDL Implementation Program

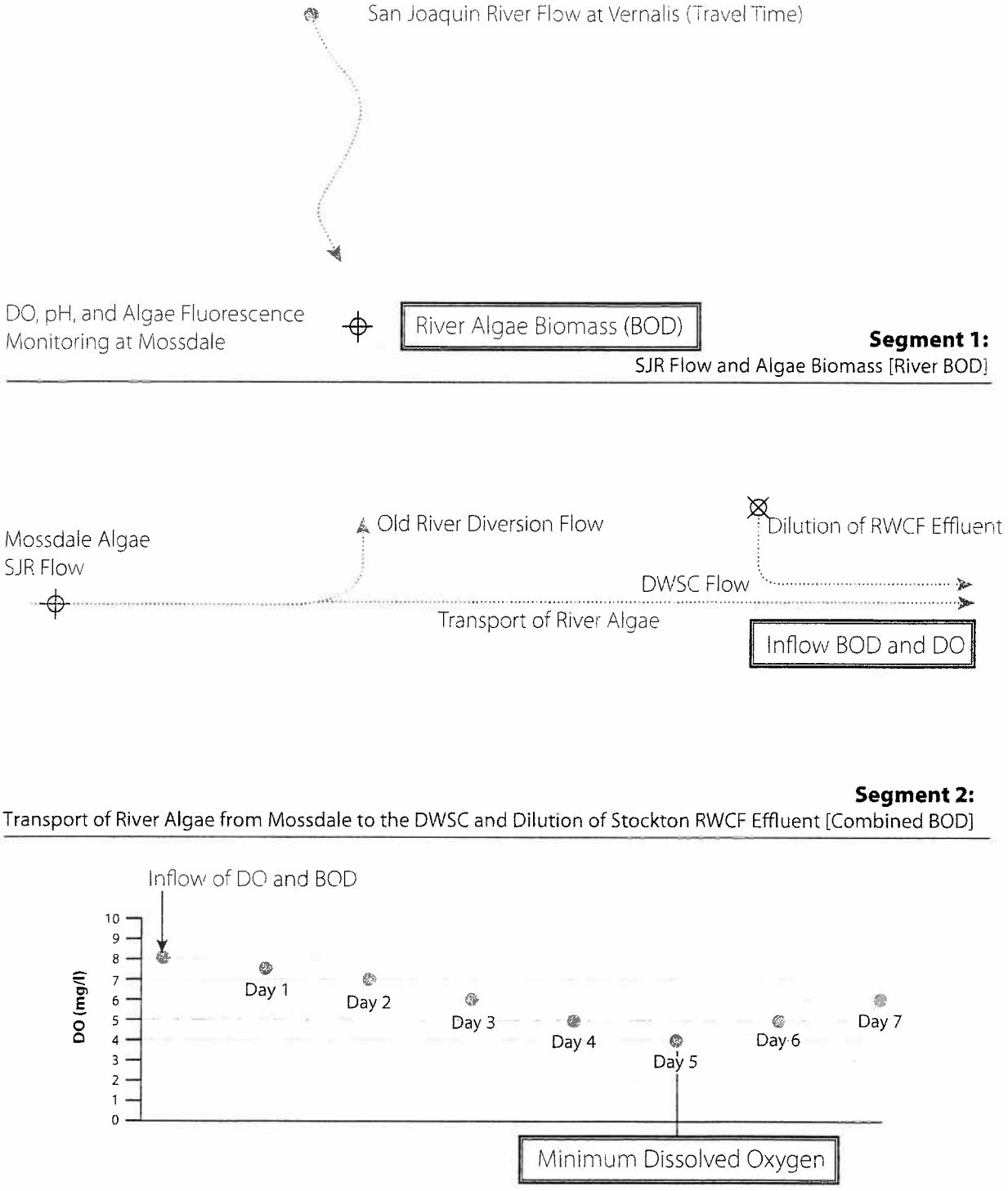

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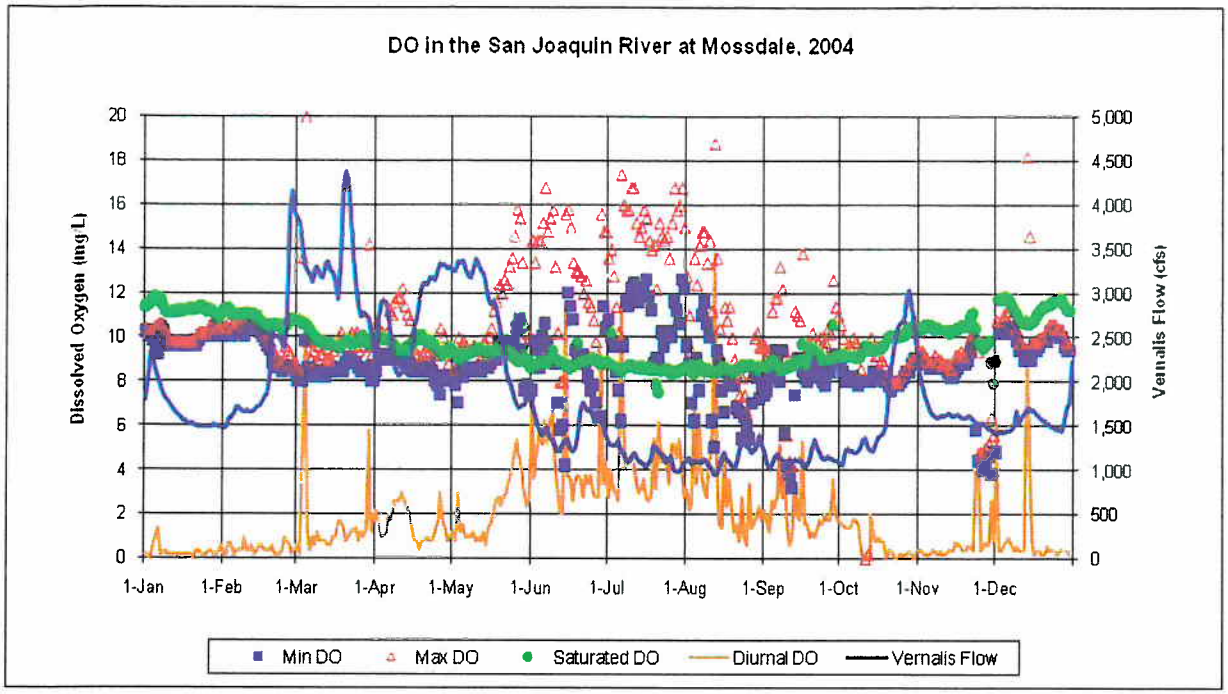
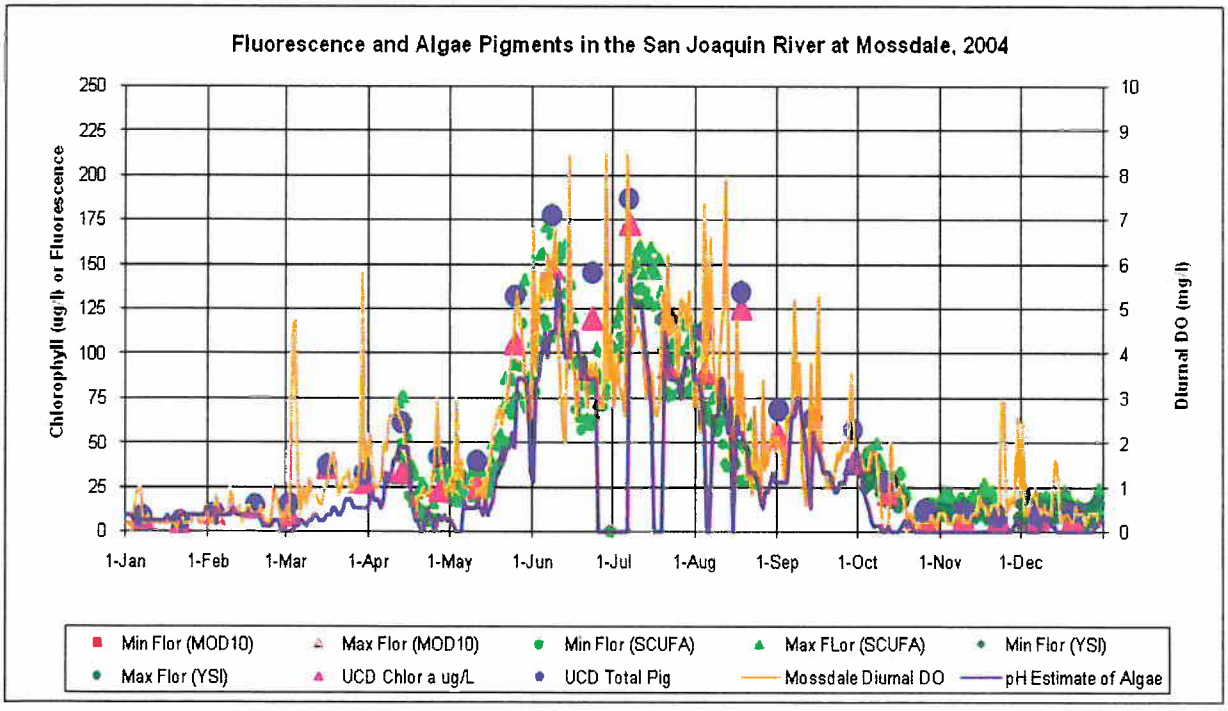
Figure 1b
Framework for the SJR DO TMDL Accounting Procedures

Table A-2. Calculated DWSC BOD and DO Concentrations for Inflow BOD of 5 mg/l 10 mg/ and 15 mg/l

Day	BOD (mg/l)	DO (mg/l)	DO Deficit (mg/l)
A. Inflow BOD of 5 mg/l			
0	5.0	7.07	0.9
1	4.5	6.76	1.2
2	4.1	6.56	1.4
3	3.6	6.44	1.6
4	3.3	6.39	1.6
5	3.0	6.38	1.6
6	2.7	6.41	1.6
7	2.4	6.46	1.5
8	2.2	6.53	1.5
9	1.9	6.61	1.4
10	1.7	6.69	1.3
B. Inflow BOD of 10 mg/l			
0	10.0	6.15	1.9
1	9.0	5.52	2.5
2	8.1	5.11	2.9
3	7.3	4.88	3.1
4	6.6	4.78	3.2
5	5.9	4.77	3.2
6	5.3	4.82	3.2
7	4.8	4.93	3.1
8	4.3	5.06	2.9
9	3.9	5.22	2.8
10	3.5	5.39	2.6
C. Inflow BOD of 15 mg/l			
0	15.0	5.22	2.8
1	13.5	4.28	3.7
2	12.2	3.67	4.3
3	10.9	3.32	4.7
4	9.8	3.16	4.8
5	8.9	3.15	4.9
6	8.0	3.23	4.8
7	7.2	3.39	4.6
8	6.5	3.59	4.4
9	5.8	3.83	4.2
10	5.2	4.08	3.9



a) Daily Minimum, Maximum, and Saturated DO Concentrations at Mossdale, with the SJR Flow at Vernalis Shown as Reference for 2004.



b) Comparison of the Daily DO Range, Estimated Algae Pigment from Maximum pH, Measured Fluorescence, and Extracted Algae Pigment (UC Davis) Concentrations at Mossdale for 2004. (Turner SCUFA fluorescence multiplied by 2.5 to match UCD pigment. YSI fluorescence (began in October) multiplied by 1.5 to match UCD pigment).

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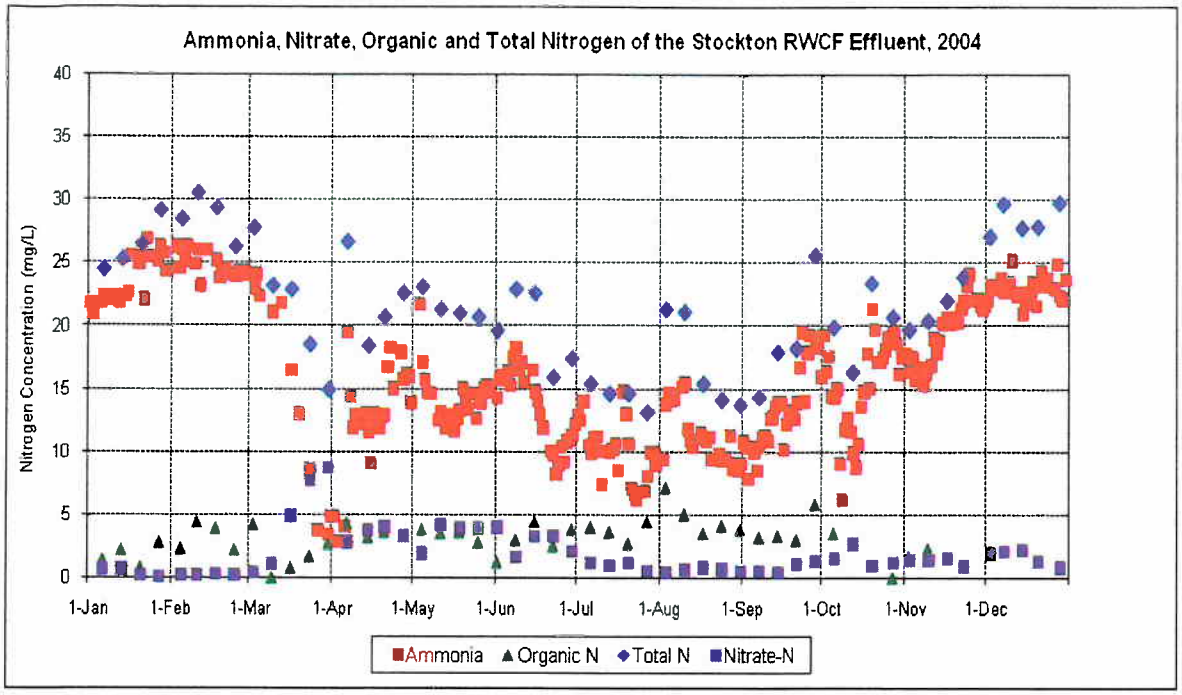
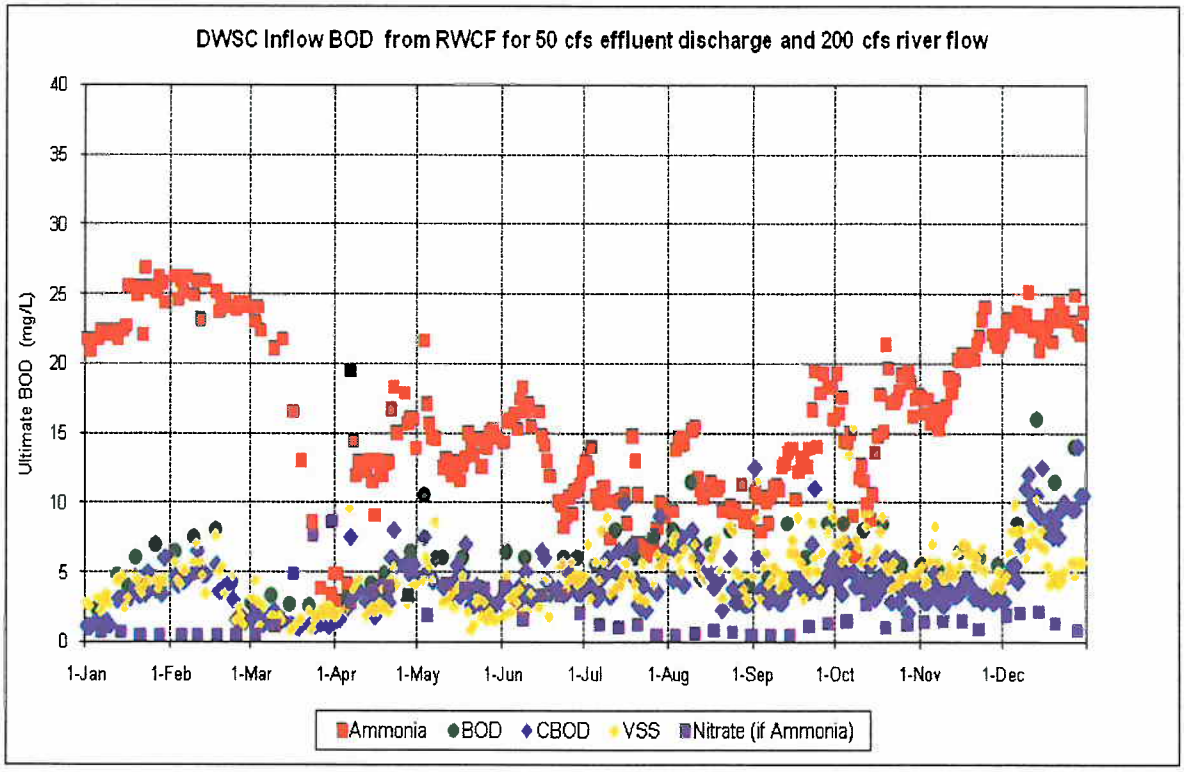
Figure 6



a) Stockton RWCF effluent nitrogen concentrations (mg/l) for 2004.



b) Calculated DWSC inflow CBOD and NBOD concentrations from the RWCF with assumed effluent discharge of 50 cfs and river flow of 200 cfs (dilution factor of 5) for 2004.

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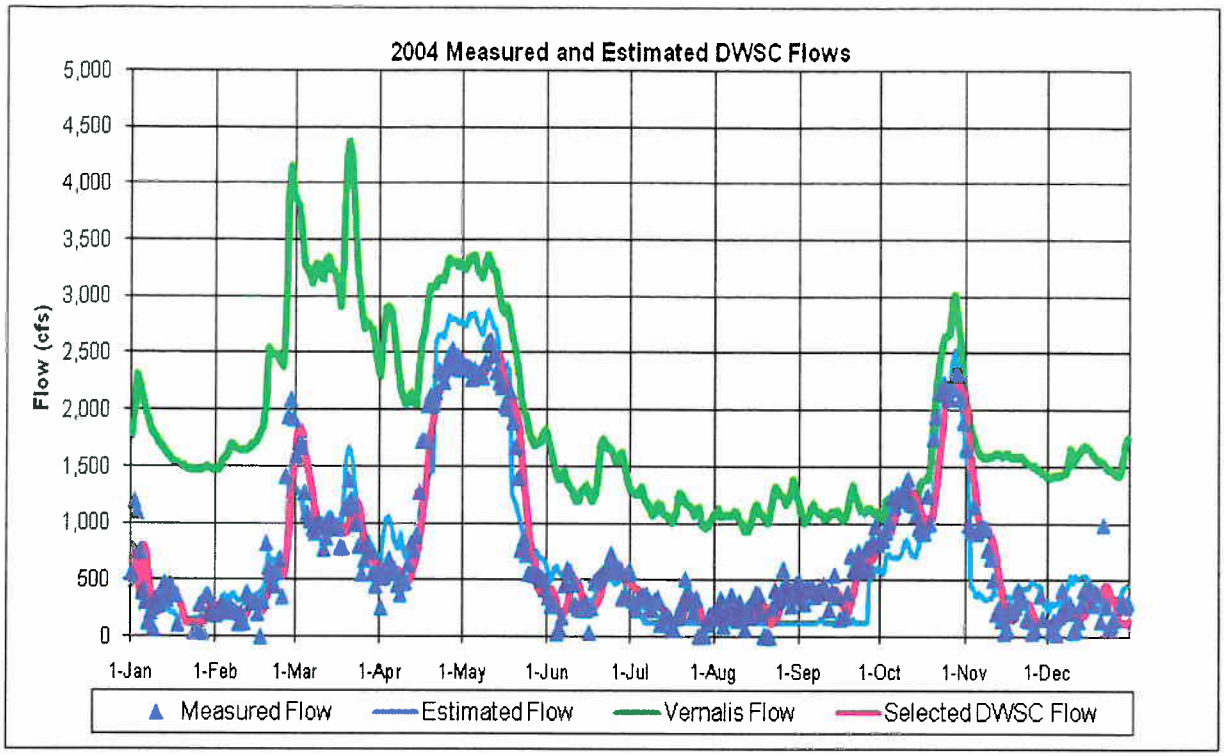
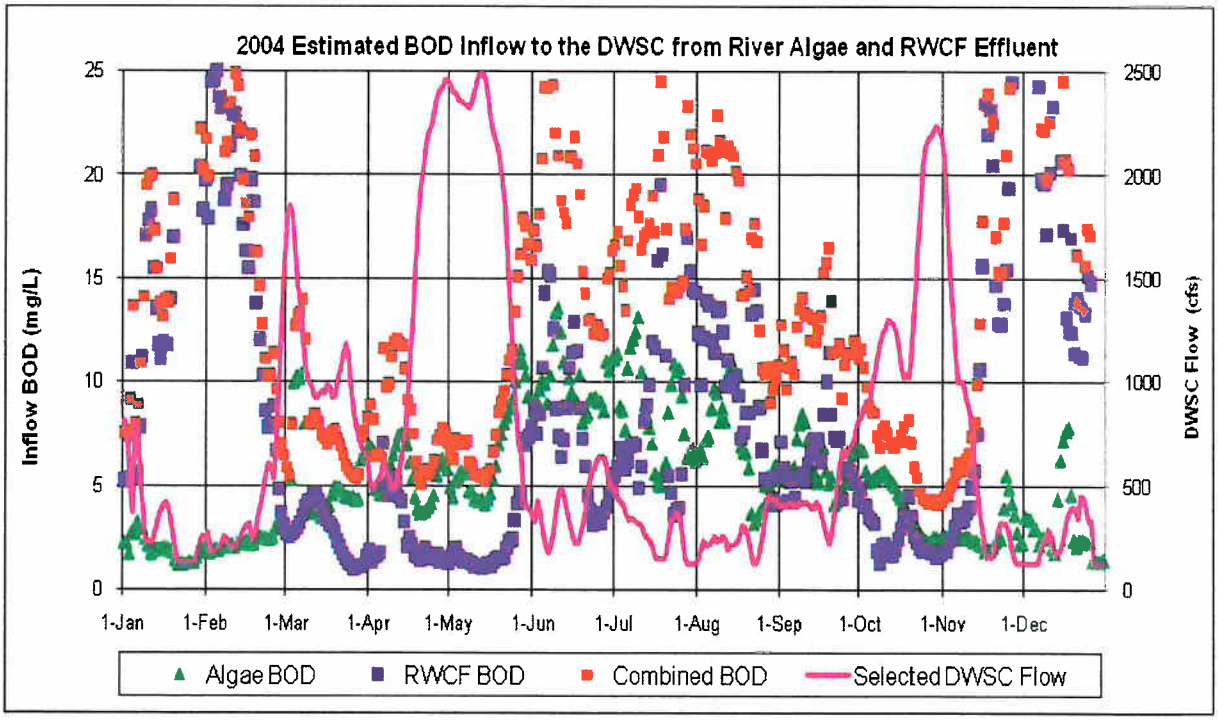
Figure 18



a) Daily Measured (Selected) and Estimated DWSC Flow with SJR Flows at Vernalis for 2004.



b) Daily Estimated Upstream River Algae BOD and Stockton RWCF BOD Entering the DWSC for 2004.

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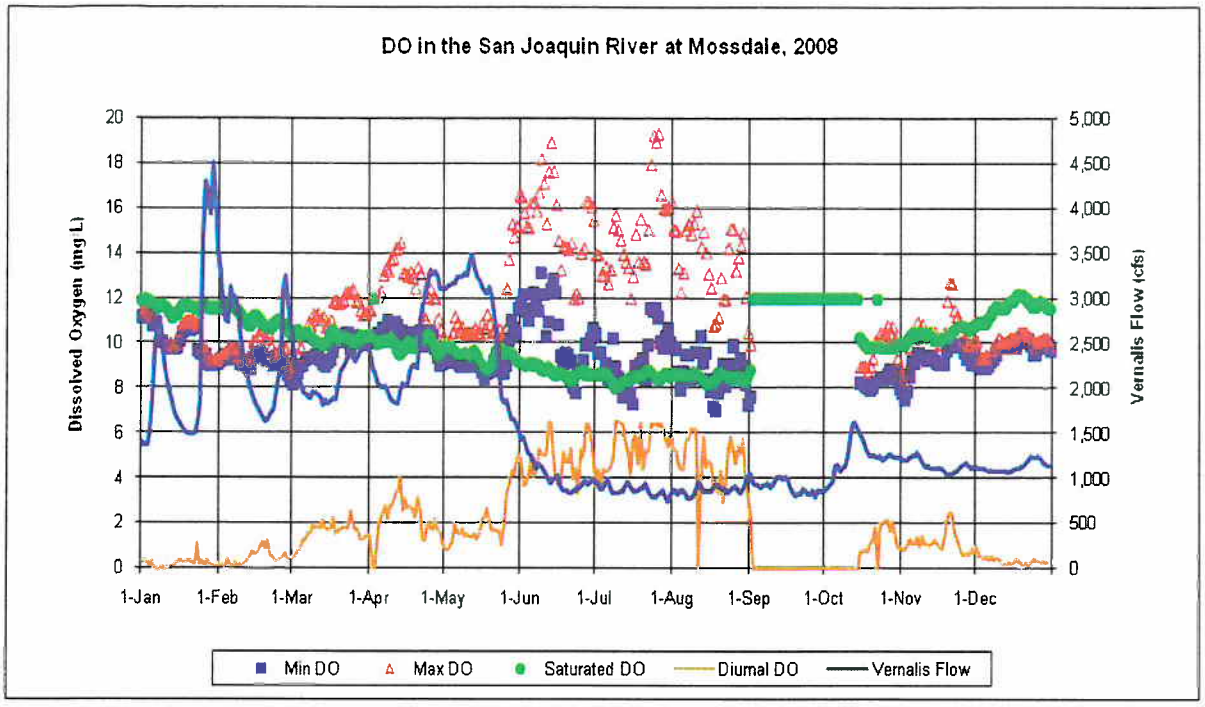
Figure 29



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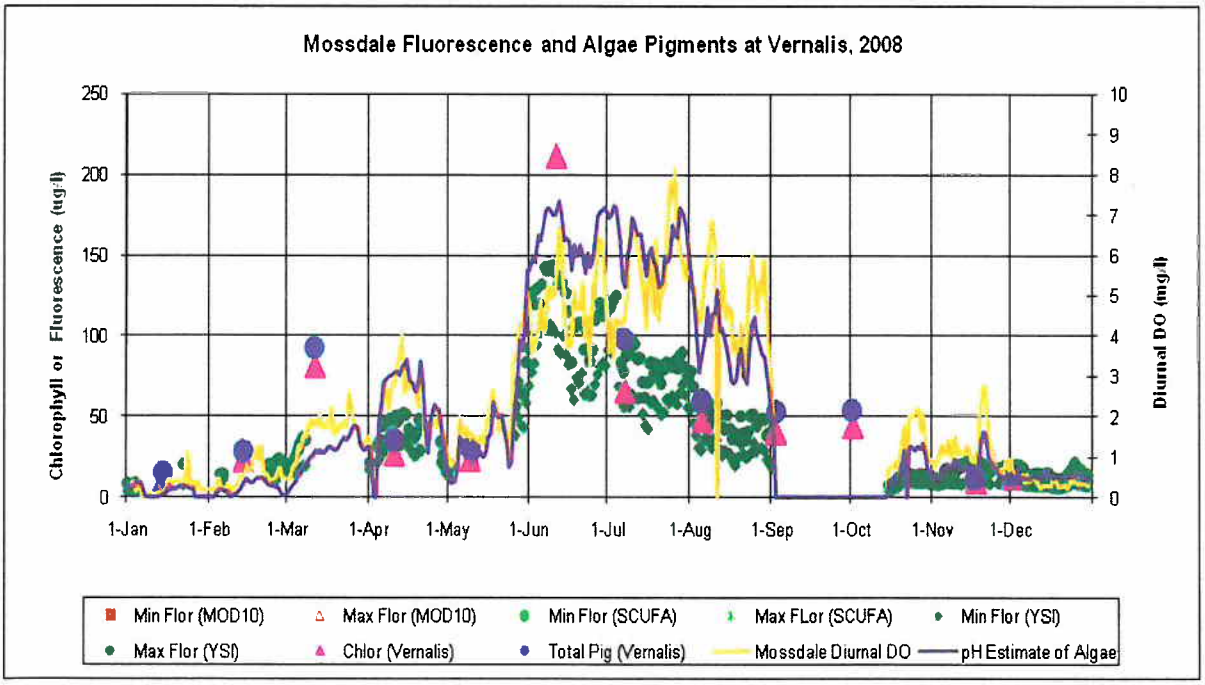

b) Comparison of the Daily DO Range, Estimated Algae Pigment from Maximum pH, Measured Fluorescence, and Extracted Algae Pigment (DWR) Concentrations at Mossdale for 2008. (YSI fluorescence multiplied by 1.5 to match DWR algae pigment).

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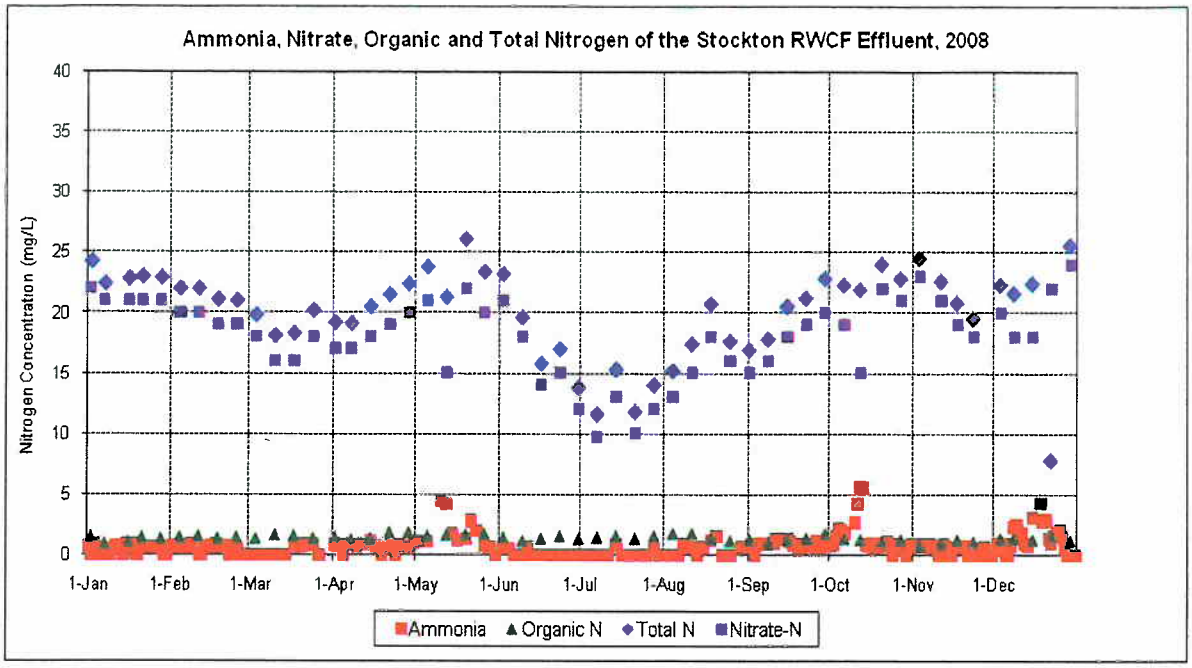
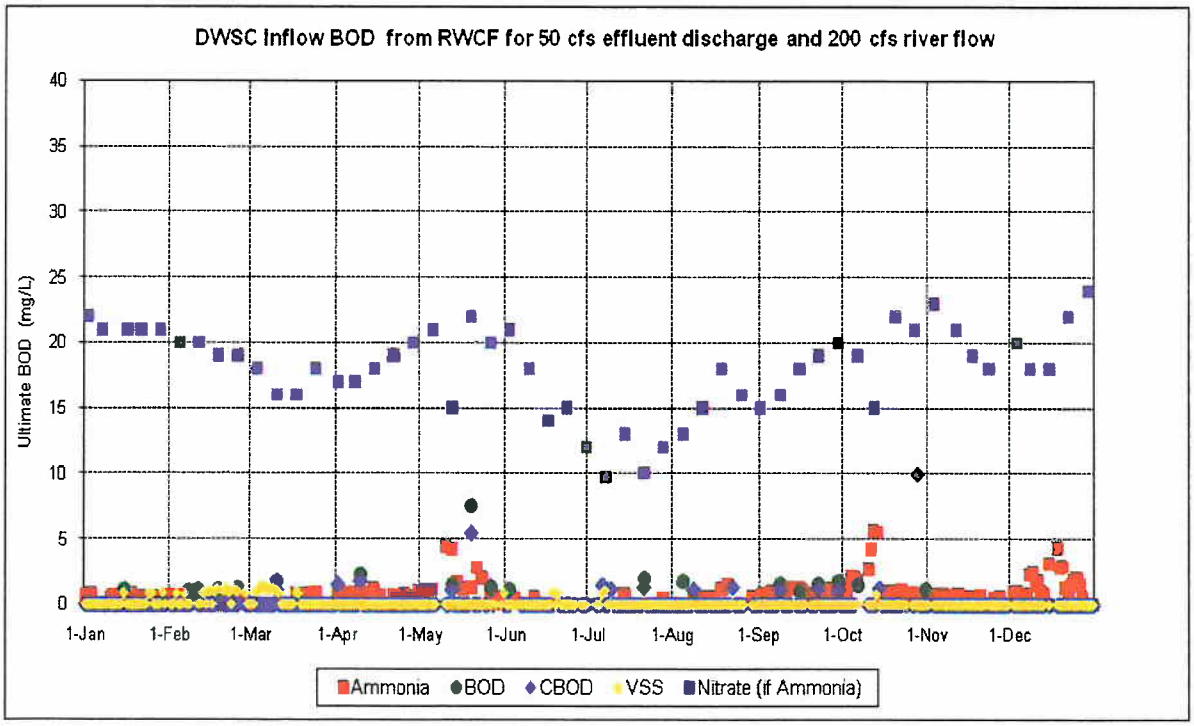
Figure 10



a) Stockton RWCF effluent nitrogen concentrations (mg/l) for 2008 [Most ammonia-N was <0.5 mg/l].



b) Calculated DWSC inflow CBOD and NBOD concentrations from the RWCF with assumed effluent discharge of 50 cfs and river flow of 200 cfs (dilution factor of 5) for 2008.

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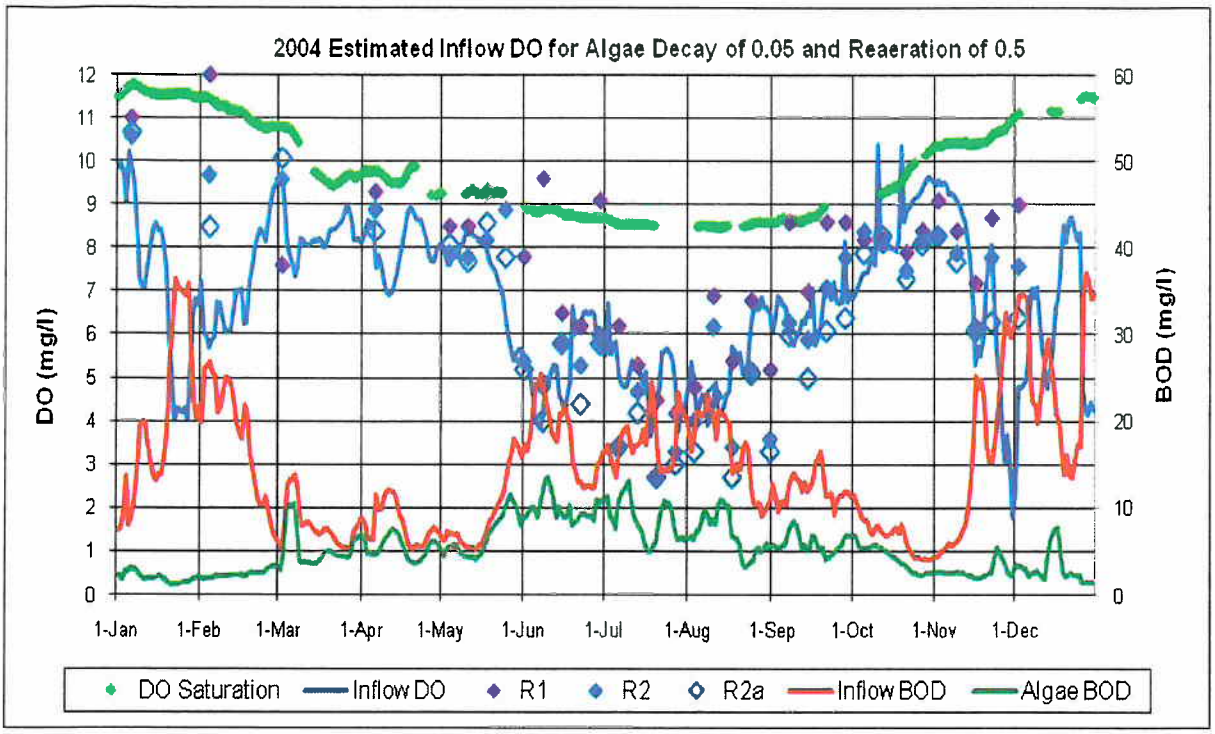
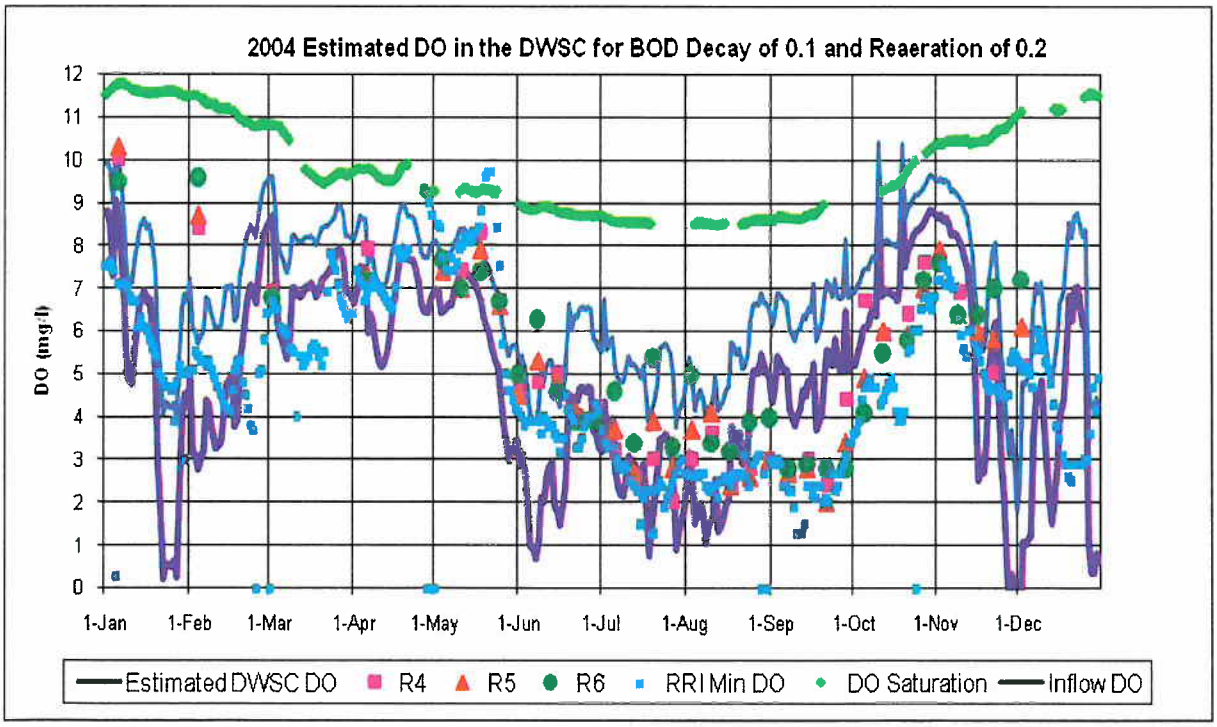
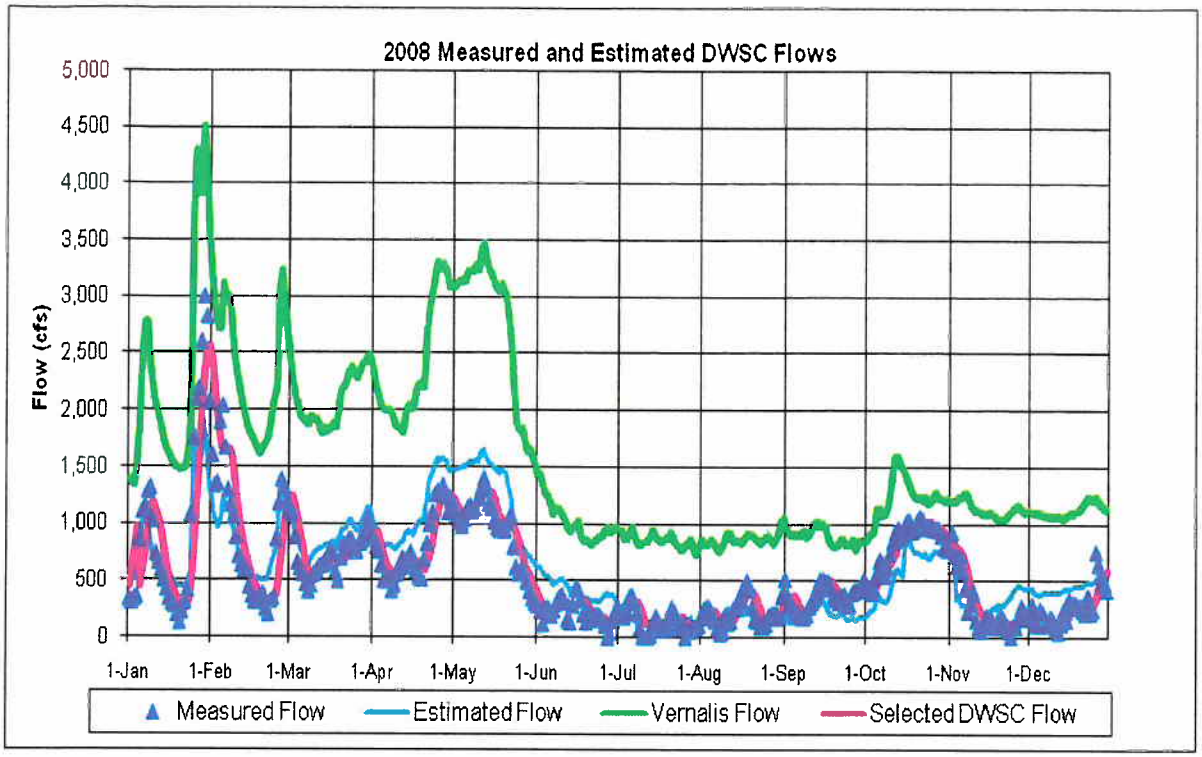
Figure 22



c) Daily Estimated Inflow DO Compared to Measured DO at Stations R1, R2, and R2a for 2004.



d) Daily Estimated Minimum DO in the DWSC Compared to Minimum DO at RRI and Measured DO at R4, R5, and R6 for 2004.



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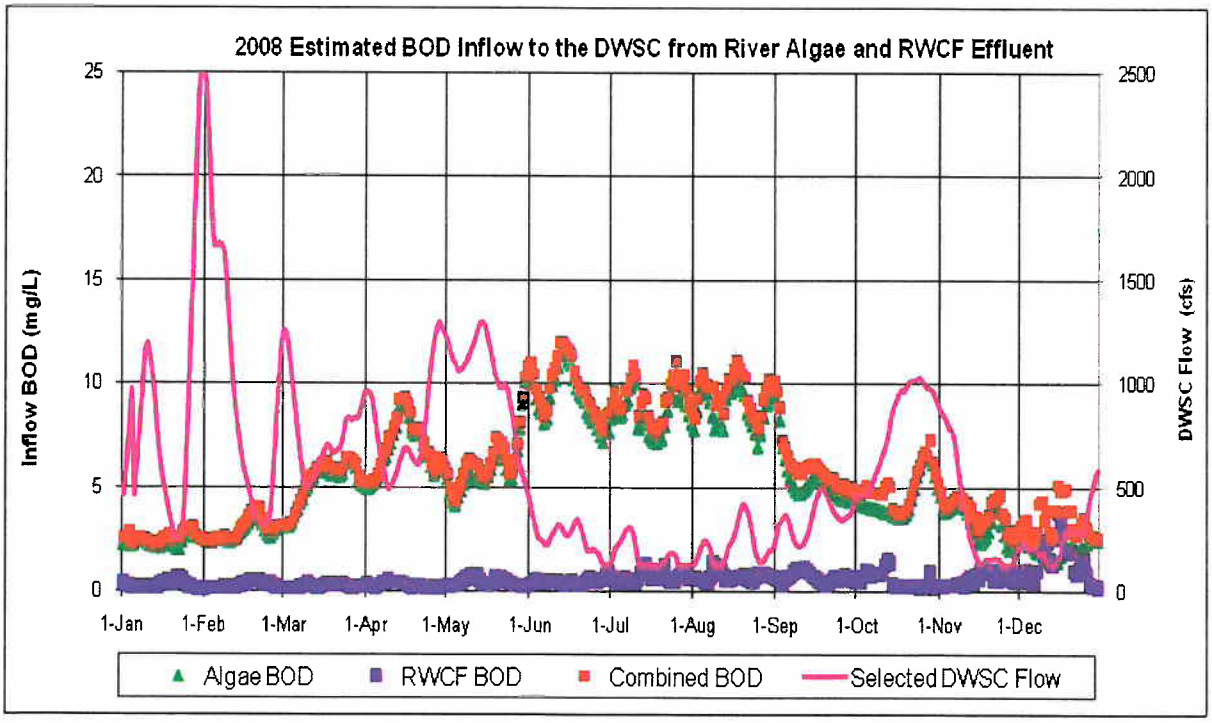

b) Daily Estimated Upstream River Algae BOD and Stockton RWCF BOD Entering the DWSC for 2008.

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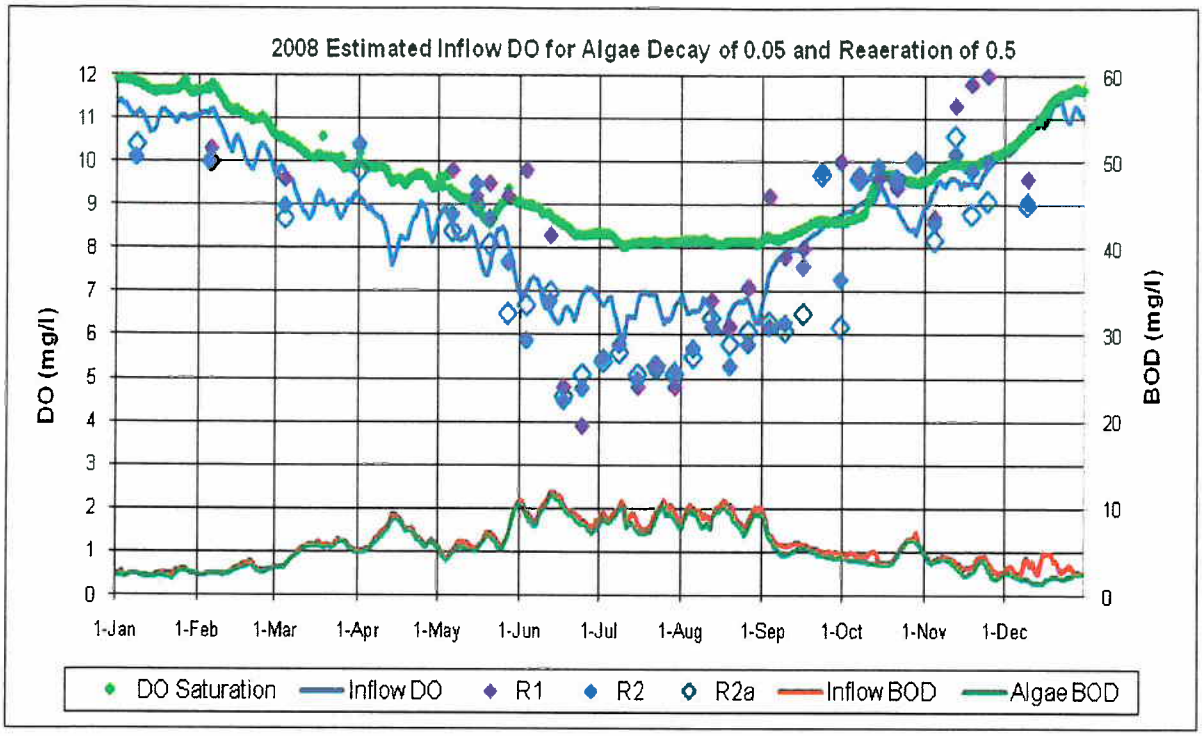
Figure 33



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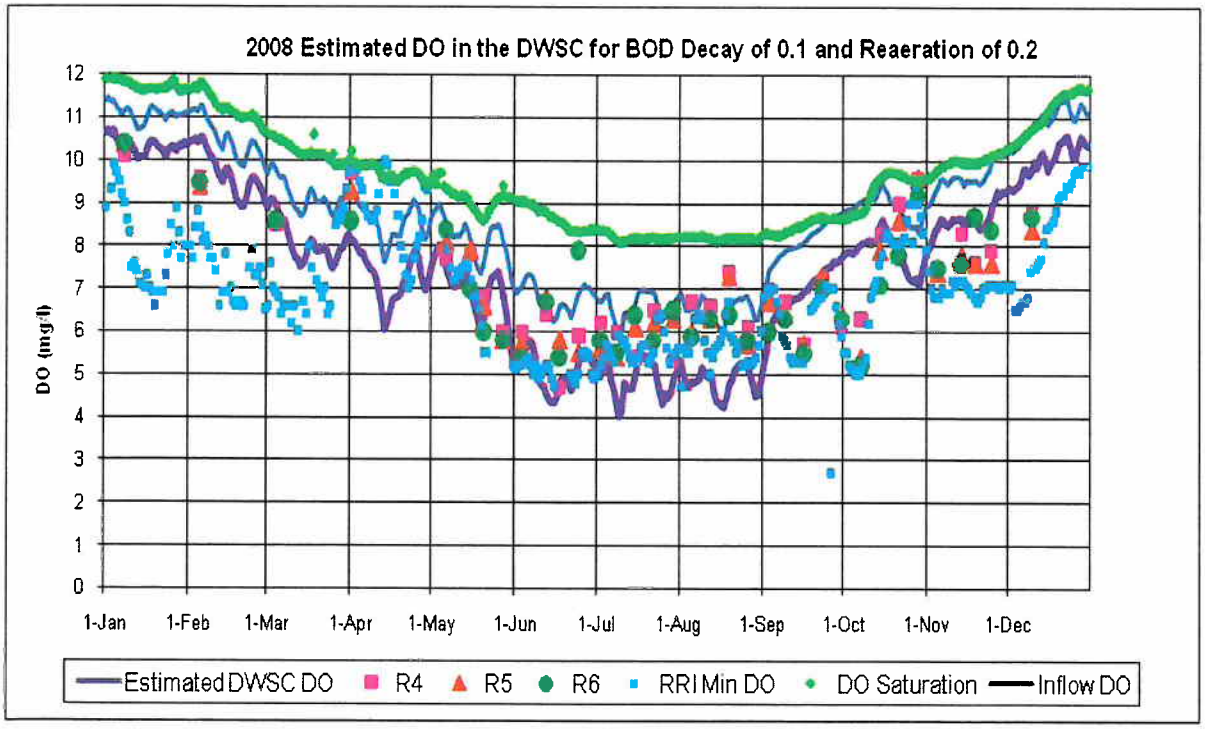

d) Daily Estimated Minimum DO in the DWSC Compared to Minimum DO at RRI and Measured DO at R4, R5, and R6 for 2008.

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Figure 33
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