2009 Monitoring Report

Shasta Water Association Dam Demobilization And Water Quality Enhancement Project

SWQCB Agreement #06-249-551-0
And SWQCB Agreement #07-541-550-0 Component #2.19

Shasta Valley Resource Conservation District

Submitted
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Introduction

The Shasta Valley Resource Conservation District (SVRCD) is contracted to implement the Shasta Water Association Dam Demobilization and Water Quality Enhancement Project for the State Water Resources Control Board. This project is also funded by California Department of Fish and Game, Natural Resources Conservation Service, U.S. Fish and Wildlife Service, and National Oceanic and Atmospheric Administration.

The monitoring of pre-construction and post-construction water quality and fish passage parameters is outlined in the Monitoring Plan submitted as part of the contract. Monitoring is an essential component of improvement projects by providing documentation and quantitative measures of the success of the project.

Project Background

The Shasta Water Association Dam Demobilization and Water Quality Enhancement Project is located on the Shasta River, a tributary to the Klamath River, in Siskiyou County, California. The Shasta River channel is typically low-gradient and meandering, with flows dominated by upper cold-water springs. Agricultural use is common throughout the Shasta River Watershed; flow is highly influenced by irrigation diversions and tailwater return flow during the irrigation season.

The Shasta River Water Association (SRWA), one of four irrigation districts in the Shasta Valley, utilized a summer flashboard diversion structure with an associated impoundment to serve approximately 140 water users. This Shasta Water Association Dam was identified as a high priority project for remediation in the North Coast Regional Water Quality Control Board (NCRWQCB) Total Maximum Daily Load (TMDL) for the Shasta River (2006) and the Recovery Strategy for California Coho Salmon (2004). The dam created poor water quality conditions in the river including low dissolved oxygen content and high water temperatures, both of which are critical factors in fish survival. The dam also obstructed upward and downward movement by juvenile salmonids seeking cold refuge during the hot summer months and could provide a barrier to adults as they move upstream looking for spawning habitat. Implementation of the flashboard dam removal project will assist the SVRCD, NCRWQCB and California Department of Fish and Game (CDFG) in meeting their goals of improving water quality and restoring coho, Chinook, and steelhead in the Shasta River.

The Shasta Water Association Dam project implementation included replacing the existing dam with two boulder weirs that reduced the volume of impounded water necessary to supply agricultural water to the landowners as well as provide fish passage to juvenile and adult salmonids. The pre-project pumping system utilized a fish screen that did not meet current fish screen criteria as well as a pump intake bay and bypass pipe which could have been deleterious to fish as they were redirected into the pipe. This system was replaced by a new fish screen and pumping station that eliminated the need for the pump intake bay and bypass pipe. Eventually, the new pumping system will assist the SRWA with creating financial incentives to encourage water use efficiency by charging users for the amount of water they use instead of a flat share based fee system.

In addition, this project included replacement of a leaky irrigation ditch with underground piping in order to eliminate ditch losses, allow the water users to better manage their irrigation water, and avoid the use of herbicides that was used to maintain the ditch.

Project-specific pre-construction monitoring data was collected during the irrigation seasons beginning in June 2007 through September 2008. The construction phase of the project began in July of 2008. Post-construction monitoring began just prior to the start of irrigation season, in late March 2009, and continued through August 2009. This monitoring report presents post-construction data collected in 2009 with some comparisons to 2007 and 2008 data where applicable. Details on pre-construction data can be found in the 2008 Monitoring Report submitted to the NCRWQCB by the SVRCD. The collection of pre- and post-construction data will help establish baseline conditions to aid the SVRCD in determining the degree to which the water quality and fish passage goals have been met.

Monitoring procedures in 2009 were followed as directed in the contract monitoring plan and the Quality Assurance Project Plan, and all Quality Assurance/ Quality Control protocol were followed.

Monitoring Details and Methods

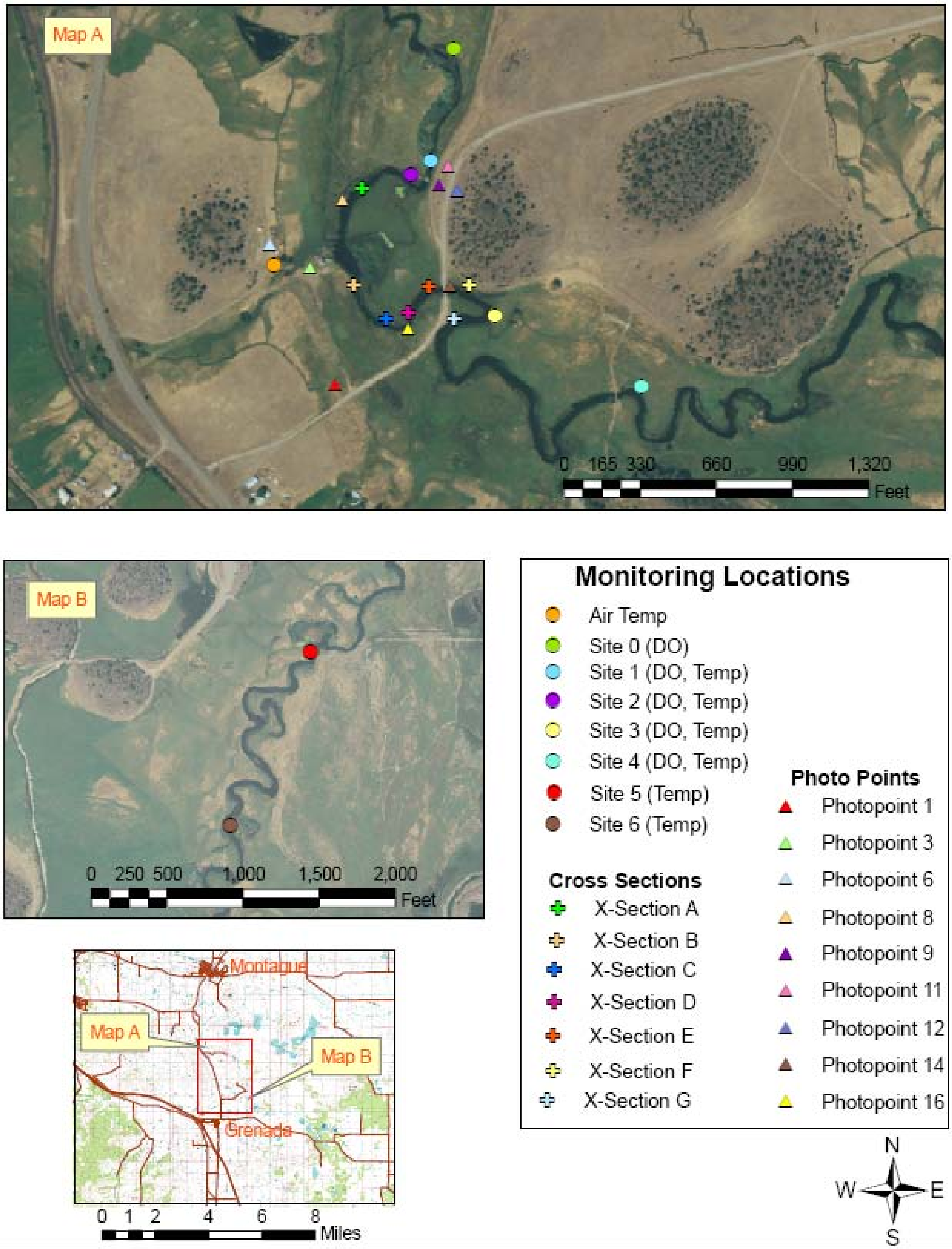
Parameters that were monitored include water temperature, dissolved oxygen, and cross sectional width of wetted channel within the project area. Fish passage was also monitored, as well as costs for water usage and ditch maintenance. Digital photos were taken annually at established photo points. Data collection in 2009 took place from late March through August. See Figure 1 for the monitoring locations.

Water temperature

Continuous water temperature data was collected at six sites. In order to make direct comparisons, the six monitoring sites used in 2009 were the same as those used in 2008. Zebra-Tech D-Optologgers, which record both dissolved oxygen and temperature, were installed at four sites within the project area in March 2009. These sites are numbered sequentially going upstream, beginning with Site 1 approximately fifty feet downstream of the old dam site, Site 2 approximately one hundred feet upstream the old dam site, Site 3 upstream of the new pumping station and approximately 1500 feet upstream of Site 2, and Site 4 approximately 1500 feet upstream of Site 3. The D-Optologgers were not used in 2007 due to funding delays and unavoidable interference to the devices from construction activities. See Figure 1 for monitoring locations.

The two remaining temperature collection sites were located outside of the project area, approximately 4.5 river miles upstream, in order to document changes due to project implementation. Two Onset/ HOBO Tidbit temperature probes were deployed in March 2009. Both probes were installed in the Shasta River at a single landowner's property near De Soza Lane and Highway A-12. One probe was placed at Site 5 at the downstream end of the property. The remaining probe was placed approximately 2000 feet upstream at Site 6. See Figure 1 for monitoring locations.

Figure 1. Shasta Water Association Dam Removal Project Monitoring Locations



The D-Optologgers and HOBO probes recorded continuous hourly water temperature readings throughout the irrigation season. The probes were housed in a shading device where they were not exposed to direct sunlight, and were closely monitored to best assure submersion during low flow periods. As directed in the monitoring plan, the Fish, Farms, and Forest Communities protocol was followed for calibration of the Onset/ HOBO instruments. Calibration and maintenance procedures from the manufacturer's manual were followed for the D-Optologgers. The accuracy of the Onset/ HOBO probe is +/- 0.2 °C while the accuracy of the D-Optologger is +/- 0.1 °C.

In addition, an Onset/HOBO temperature probe was installed at the project site on a tree near the pumping station to collect continuous air temperature data. This probe recorded hourly readings in a shaded location from April 2009 through August 2009. As directed in the monitoring plan, the Fish, Farms, and Forest Communities protocol was followed for calibration of the instrument.

Dissolved Oxygen
Dissolved oxygen (DO) data was collected by the four Zebra-Tech D-Optologgers that were simultaneously recording water temperature data. Installed in 2008 and 2009 at Sites 1, 2, 3, and 4, the D-Optologgers recorded continuous hourly dissolved oxygen levels. These sites are numbered sequentially going upstream, beginning with Site 1 approximately fifty feet downstream of the old dam site, Site 2 approximately one hundred feet upstream the old dam site, Site 3 upstream of the new pumping station and approximately 1500 feet upstream of Site 2, and Site 4 approximately 1500 feet upstream of Site 3 (Figure 1). The D-Optologger utilizes fluorescence to measure dissolved oxygen which provides accurate readings over a long period of time, particularly as compared to membrane-type DO meters. The D-Optologgers were not installed in 2007 due to funding delays and unavoidable interference to the devices from construction activities; therefore, limited dissolved oxygen data was collected in 2007 with which to make comparisons. Calibration and maintenance procedures from the D-Optologger manual were followed. The accuracy of the D-Optologger is +/- 0.02 ppm.

Dissolved oxygen grab sample data was collected several times in 2009 by using a Yellow Springs Instruments YSI-55 meter. In order to compare results, these measurements were taken at the same four sites, Sites #0, 2, 3, and 4, during 2007, 2008, and 2009. Calibration and maintenance procedures outlined in the YSI-55 manual were followed. Measurements were taken in areas where water was flowing at a level recommended by the manufacturer for accurate sampling. The accuracy of the YSI-55 meter is +/- 0.5 ppm.

Width of Wetted Channel
Permanent cross-sections were established in 2008 throughout the project area by installing T-posts at six streambank locations. Measurements were taken in 2008 and again in 2009. Using a horizontal string-line as a reference point, coupled with a tape measure for horizontal distance, depth measurements were taken of the channel depth, including the top and bottom of any sediment deposits. The locations of the cross-sections are shown in Figure 1. Aerial photos were also used to compare changes in

wetted channel as a result of the project. Pre-construction aerial photos consist of NRCS National Agriculture Imagery Program (2005) photos and 2008 LiDAR data. Post-construction images were obtained from aerial photos provided courtesy of the California Department of Fish and Game and the Pacific States Marine Fish Commission.

Photo Points

Nine photo points in the project area were documented and tagged in 2008. Pre-construction digital photographs were taken both upstream and downstream at the nine established photopoints in 2008. A set of post-construction digital photographs were taken on August 15, 2009. Annual photos at each photopoint will help document changes in channel configuration, flow characteristics, and vegetation due to the implementation of the project. Photo point protocol followed the Photopoint Monitoring Handbook (PNW-GTR-526, USFS 2005).

Improved Fish Passage

One of the main goals of the project was to remove the SRWA's flashboard dam in order to provide for year-round fish passage. Project implementation plans included the construction of two boulder weirs, one at the old dam site and one approximately 1,000 feet upstream of the lower boulder weir and below the pumping station, in order to provide a minimum amount of ponding at the new pump and screen site to assure proper pump operation and to reduce the area of impoundment as much as possible. Digital photographs taken before, during and after the construction phase of the boulder weirs will document a maximum jump height of twelve inches.

Ditch Maintenance/ Water Usage Costs

Prior to project implementation, the irrigation ditches throughout the project area were open, earthen ditches. These ditches required maintenance by the landowner, including herbicide treatment to minimize vegetation growth. One element of the project included installing piping in one of the leakiest irrigation ditches to improve water delivery efficiency and water management and to eliminate the amount of herbicides needed to maintain the ditches. The ranchers within the project area were asked to record ditch labor and herbicide costs during 2007, 2008, and 2009 to monitor changes in maintenance costs for their delivery system.

The pre-construction pumping system was limited in that it could only deliver a fixed amount of water (42 cfs) to the users all season long. This project replaced the existing pumping system with four new variable frequency drive pumps and three small individual irrigation pumps. The four new pumps will eventually assist the Shasta Water Association with establishing a rate structure based on the amount of water used instead of a flat rate. This future conversion to a fee system will provide financial incentive to conserve water during times of the year when water is not in as high of a demand (spring and fall). In the meantime, water usage costs to the diverters were tracked both pre- and post-project in order to help quantify the fiscal effect of the improved system.

Monitoring Results

All data is stored on a Shasta Valley Resource Conservation District (SVRCD) computer hard drive and back-up drive, as well as on a CD stored at the main SVRCD office. The 2009 data and photos are provided with this report, either as electronic files or on a CD. Results of each parameter are summarized in this report. The pre-construction monitoring data provides a short but valuable baseline to which post-construction monitoring data can be compared. Post-construction monitoring data, while limited to just one year to date, provides information that facilitates the evaluation of success of the project.

Continuous monitoring data was collected throughout the 2009 irrigation season and verified for accuracy. Some data gaps occurred due to normal download and calibration procedures. Other data gaps occurred due to extremely low flows, causing the meters to be exposed to air for a period of time, or occurred when a meter was fouled by vegetation which was wrapped around the meter, temporarily impeding its performance.

Water temperature

Water temperature data from the four D-Optologgers and the two Onset/ HOBO temperature probes is summarized in Table 1 and shown graphically in Appendix A. In comparing the six sites in 2009, the highest seasonal maximum temperature readings of 25.9°C and 26.0°C were recorded at the three most downstream sites, Sites 1, 2 and 3. Site 4, at the upstream end of the project area, had a slightly lower seasonal maximum temperature of 25.6°C. The remaining two sites which are upstream outside of the project area, Sites 5 and 6, had lower seasonal maximum readings of 24.5°C and 25.5°C, respectively. Irrigation practices including tailwater input may influence the difference in temperature between Sites 5 and 6; however, both sites had a lower maximum temperature than the four sites within the project area. This is consistent with the expected results, as river temperature generally increases in a downstream direction from the headwaters to the mouth.

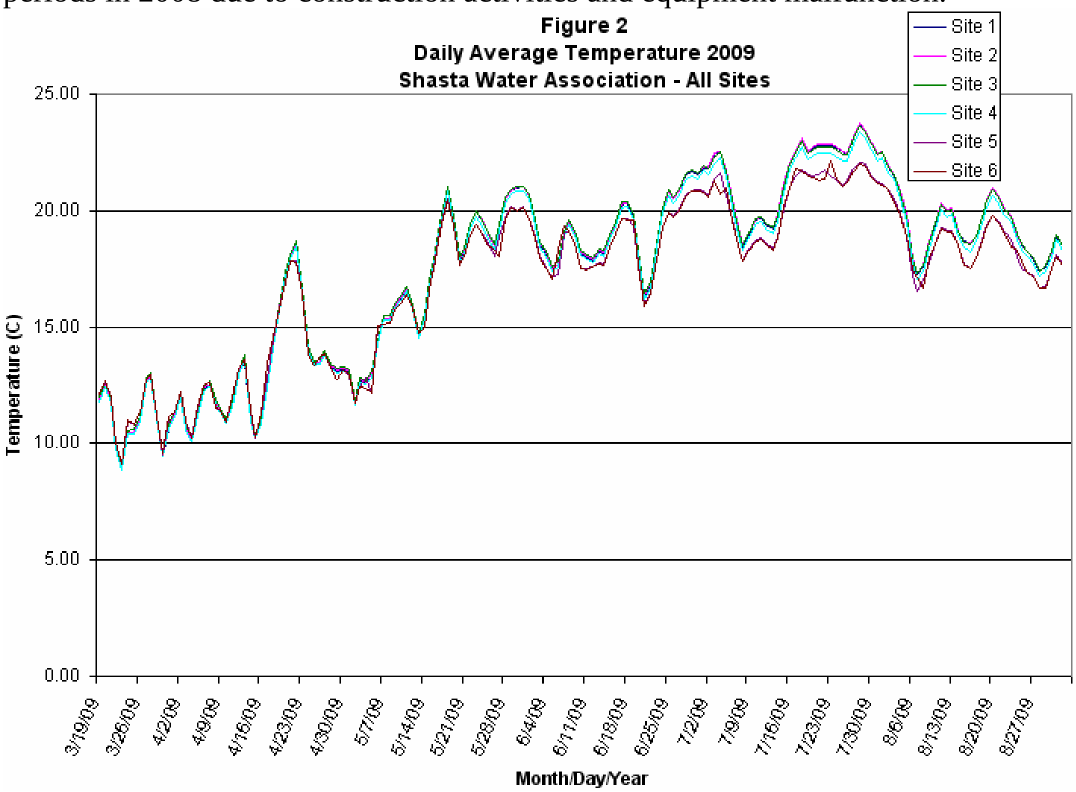
Table 1
2009 WATER TEMPERATURE SUMMARY
Shasta Water Association Project

Site #	Continuous Monitoring Location	Latitude	Longitude	2009 Season		2008 Season	
				Maximum Temp °C	Maximum Daily Avg Temp °C	Maximum Temp °C	Maximum Daily Avg Temp °C
1	50 ft Downstream of Dam	41.687735	-122.529959	26.0	23.71	NS	NS
2	Upstream of Dam	41.687570	-122.530267	26.0	23.76	NS	NS
3	Upstream of Pump and Bridge at Bend	41.685861	-122.528944	25.9	23.63	25.1	22.81
4	Upstream of Small Bridge	41.685028	-122.526667	25.6	23.34	24.9	22.63
5	Off DeSoza Ln. - Dnstrm Property Line	41.657722	-122.500972	24.5	22.07	25.0	21.66
6	Off DeSoza Ln. - Upstrm Property Line	41.654417	-122.503056	25.5	22.15	25.2	21.55

NS *Not Sampled for entire season*

In comparing the maximum temperature readings in 2009 to those measured in 2008, three out of the four sites were lower in 2008, including the two sites outside of the project area (Table 1). This may be due to annual differences in air temperature and irrigation practices. In 2008, Sites 1 and 2 were only monitored from April through June due to construction activities. Since the warmest months were not monitored at Sites 1 and 2 in 2008, they are excluded from peak temperature comparisons. It should be noted that water temperatures have been near and above upper lethal thresholds for both coho and Chinook (>25°C)[1], which indicates the need for further investigations to identify other contributors to high water temperatures.

Daily average temperatures were calculated for each site for 2008 and 2009. The maximum daily average temperatures for both years are shown in Table 1. In 2009, the three most downstream sites, Sites 1, 2 and 3, showed the highest maximum daily averages of 23.63°C to 23.76°C, followed by Site 4 at 23.34°C and Sites 5 and 6 at 22.07°C and 22.15°C, respectively. This pattern is similar to that seen above with the seasonal maximum temperature comparison. The 2009 maximum daily averages were also compared to those measured in 2008, and were found to be slightly lower in 2008. Again, since this difference was seen at all sites, it may be due to annual differences in air temperature and irrigation practices. Figure 2 shows the daily average water temperatures for all six sites in 2009. Plots comparing 2008 and 2009 daily average temperatures for all six sites are included in Appendix A. Note that sites 1 and 2 had limited sampling periods in 2008 due to construction activities and equipment malfunction.



[1] NCRWQCB, *Draft Klamath TMDL. Appendix 4 "Effects of Temperature, Dissolved Oxygen/ Total Dissolved Gas, Ammonia, and pH on Salmonids"*. July 2008.

Air temperature was measured near the existing pump station throughout the 2009 irrigation season. This data is shown graphically in Appendix A.

Dissolved Oxygen

Dissolved oxygen (DO) measurements were taken continuously at hourly increments with the four Zebra-Tech D-Optologgers within the project area at Sites 1, 2, 3, and 4 during the 2009 season. This data is shown for each site in graphed form in Appendix B. A summary of the minimum, maximum, and average DO concentration measured at each site during the entire season is shown in Table 2. The 2009 overall lowest minimum reading of 4.19 ppm was recorded upstream of the dam at Site 2, while the lowest minimum reading measured at Site 4 was just slightly higher at 4.20 ppm. The minimum readings at the remaining two sites, Sites 1 and 3, were 4.69 ppm and 4.67 ppm, respectively. The average DO level for the season was lowest at Site 4 at the upstream end of the project area at 9.09 ppm, and the highest average of 9.60 ppm was at Site 1, the site downstream of the old dam.

Table 2
DISSOLVED OXYGEN SUMMARY FOR 2008 AND 2009 SEASON
Shasta Water Association Project

Site #	Location	Latitude	Longitude	Post-Construction 2009 Continuous Data Collection			Pre-Construction 2008 Continuous Data Collection		
				2009 Minimum DO ppm	2009 Maximum DO ppm	2009 Average DO ppm	2008 Minimum DO ppm	2008 Maximum DO ppm	2008 Average DO ppm
1	Downstrm SWA Dam *	41.687735	-122.529959	4.69	3.65	9.60	6.58	12.89	9.92
2	Upstream SWA Dam **	41.687570	-122.530267	4.19	35.99	9.28	3.17	33.48	10.79
3	Upstrm Pump & Bridge at Bend	41.685861	-122.528944	4.67	35.90	9.43	5.26	34.77	9.41
4	Upstream Small Bridge	41.685028	-122.526667	4.20	34.70	9.09	5.30	33.62	9.90

** Limited sampling period 2008, removed 6/26/08*
*** Limited sampling period 2008, removed 6/20/08*

Table 2 includes pre-construction continuous dissolved oxygen data collected in 2008 and post-construction continuous dissolved oxygen data collected in 2009. Although the meters were removed at the end of June 2008 at Sites 1 and 2 due to construction, some comparisons can be made between the two years. The minimum DO readings in 2009 ranged from 4.19 to 4.69 ppm, a range of 0.50 ppm. In 2008 the lowest minimum DO reading, which was at Site 2 in the impounded area above the dam, was more than 2.0 ppm lower than the minimums measured all season long at Sites 3 and 4. This suggests a more consistent level of DO throughout the project area after implementation. Comparing only Sites 3 and 4, which were in place all season during both years, the minimum DO level decreased in 2009 while the average DO decreased slightly at one site and stayed about the same at the other from 2008 to 2009. This could be due to annual climate variations, low flow levels, and/or other channel and flow characteristics. Daily average dissolved oxygen concentrations for the 2009 season were calculated for each site and are shown graphically in Figure 3. Daily minimum dissolved oxygen readings for 2009 were also graphed for each site and are shown in Figure 4.

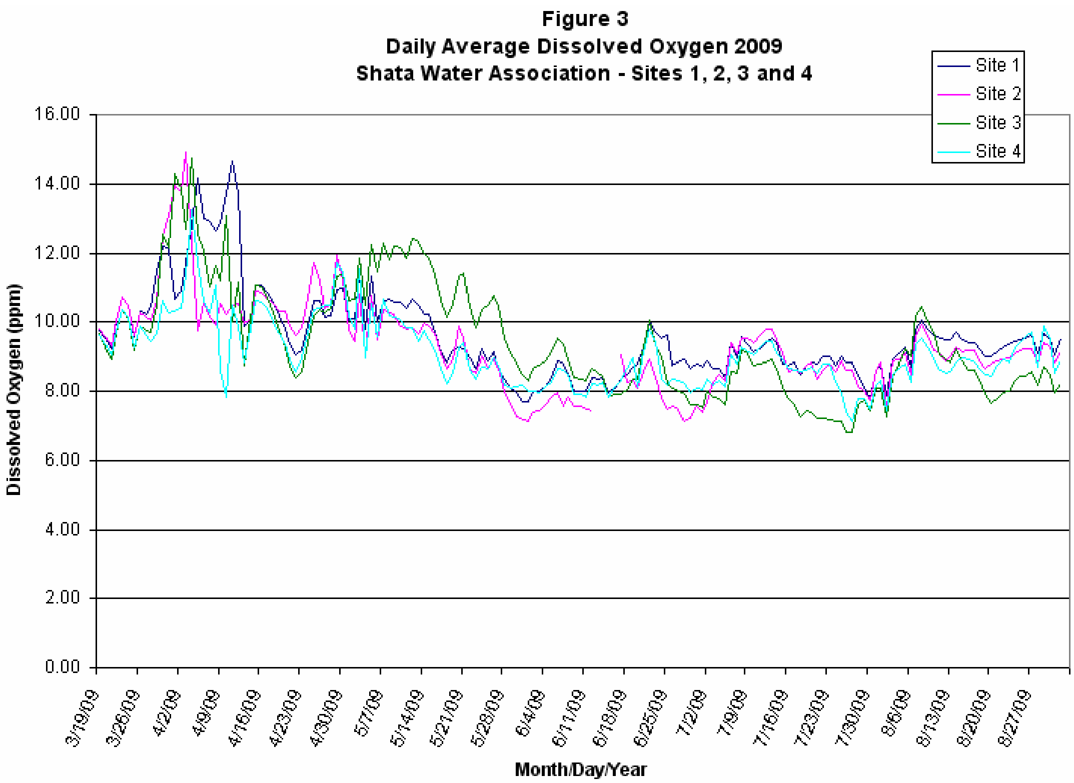


Figure 3
Daily Average Dissolved Oxygen 2009
Shata Water Association - Sites 1, 2, 3 and 4
Site 1
Site 2
Site 3
Site 4
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Dissolved Oxygen (ppm)
3/19/09
3/26/09
4/2/09
4/9/09
4/16/09
4/23/09
4/30/09
5/7/09
5/14/09
5/21/09
5/28/09
6/4/09
6/11/09
6/18/09
6/25/09
7/2/09
7/9/09
7/16/09
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8/20/09
8/27/09
Month/Day/Year

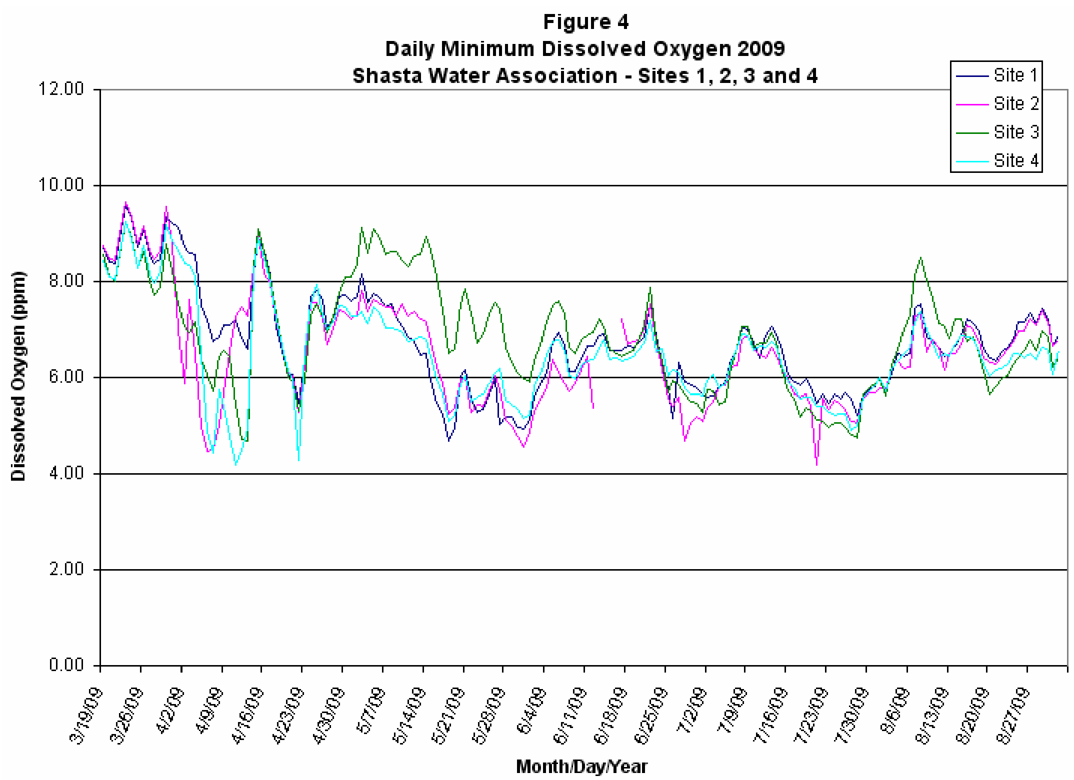


Figure 4
Daily Minimum Dissolved Oxygen 2009
Shasta Water Association - Sites 1, 2, 3 and 4
Site 1
Site 2
Site 3
Site 4
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Dissolved Oxygen (ppm)
3/19/09
3/26/09
4/2/09
4/9/09
4/16/09
4/23/09
4/30/09
5/7/09
5/14/09
5/21/09
5/28/09
6/4/09
6/11/09
6/18/09
6/25/09
7/2/09
7/9/09
7/16/09
7/23/09
7/30/09
8/6/09
8/13/09
8/20/09
8/27/09
Month/Day/Year

The minimum, maximum, and average dissolved oxygen concentrations per month for the four sites are summarized in Table 3. In 2009, the lowest monthly minimum DO concentrations occurred in April, May, and July while the lowest monthly average occurred in June. Monthly minimum, maximum, and average DO concentrations measured in 2008 are also presented in Table 3. Many of the 2009 dissolved oxygen values shown in Table 3 are lower than the corresponding 2008 values, but this trend is not consistent throughout the table.

Table 3
2009 DISSOLVED OXYGEN SUMMARY BY MONTH
Shasta Water Association Project

Site #	Continuous Monitoring Location	Year	April				May				June				July				August			
			Month Min	Month Max	Month Avg	# Days DO < 6 ppm at least 1 hr	Month Min	Month Max	Month Avg	# Days DO < 6 ppm at least 1 hr	Month Min	Month Max	Month Avg	# Days DO < 6 ppm at least 1 hr	Month Min	Month Max	Month Avg	# Days DO < 6 ppm at least 1 hr	Month Min	Month Max	Month Avg	# Days DO < 6 ppm at least 1 hr
1	Downstrm Dam Site	2008	8.51	12.89	10.40	0	INC	INC	INC	INC	6.58	12.84	9.24	0	NS	NS	NS	NS	NS	NS	NS	NS
		2009	5.48	33.65	11.27	1	4.69	16.34	9.61	15	5.11	14.15	8.60	8	5.23	13.53	8.86	20	5.73	13.71	9.31	2
2	Upstrm Dam Site	2008	6.04	33.48	11.87	0	3.17	31.91	10.64	20	5.64	16.09	9.59	INC	NS	NS	NS	NS	NS	NS	NS	NS
		2009	4.47	35.99	10.91	6	4.57	17.01	9.27	14	4.68	11.00	7.77	16	4.19	14.57	8.74	21	5.76	13.64	9.03	2
3	Upstrm Pump at Bend	2008	6.93	29.19	10.83	0	5.53	34.77	10.14	5	5.27	14.68	9.28	7	5.26	13.13	8.63	17	5.60	12.55	8.50	6
		2009	4.67	35.90	10.94	8	5.96	19.01	10.96	1	5.48	13.56	8.52	7	4.76	12.33	7.87	21	5.63	13.39	8.64	4
4	Upstrm Small Bridge	2008	6.35	33.62	10.91	0	5.71	27.02	10.46	3	5.30	17.98	9.42	5	5.48	20.82	8.96	19	INC	INC	INC	INC
		2009	4.20	34.69	10.23	9	5.10	19.02	9.29	13	5.22	17.09	8.34	6	4.91	17.68	8.51	20	5.72	17.52	8.87	2

INC *Incomplete record for month*
NS *Not sampled*

Although a dissolved oxygen lethal threshold for salmonids is also dependent on other habitat conditions, studies have shown that juvenile and adult salmonids show symptoms of DO deprivation at DO levels below 6.0 ppm[2]. The number of days per month that had at least one DO reading below 6.0 ppm is shown in Table 3 to facilitate comparisons and to determine when critical levels are more likely to occur. In 2009, DO concentrations below 6.0 ppm occurred most frequently in July, and, over the course of the season, most frequently at Site 2, the site upstream of the old dam.

Dissolved oxygen grab sample data was collected in 2009 in order to compare readings between the YSI-55 and the D-Optologger continuous meter. This data is presented in Table 4, comparing the grab samples to the nearest sample in time taken by the D-Optologger. Considering an accuracy of +/- 0.5 ppm with the YSI-55 meter and +/- 0.02 ppm with the D-Optologger, the readings from the two instruments are very similar, providing validity to the dissolved oxygen monitoring methods.

[2] Bjornn, T.C. and D.W. Reiser, 1991. "Habitat requirements of salmonids in streams". *American Fisheries Society Special Publication 19: 83-138.*

Table 4
2009 CONTINUOUS DATA AND GRAB SAMPLE DATA COMPARISON
Shasta Water Association Project

Sampling Date 7/24/09

Site #	Location	Continuous Hourly Data			YSI-55 Grab Samples		
		Time	DO ppm	Temp °C	Time	DO ppm	Temp °C
1	Downstream SWA Dam	4:00 AM	5.59	21.2	4:09 AM	5.72	21.2
2	Upstream SWA Dam	4:00 AM	5.43	21.2	4:20 AM	5.41	21.2
3	Upstrm Pump/Bridge At Bend	4:00 AM	5.12	21.3	4:27 AM	5.72	21.1
4	Upstream Small Bridge	5:00 AM	5.27	20.9	4:34 AM	5.68	21.0

Width of Wetted Channel

Cross-sections of the river channel, including depth of sediment deposits, were measured in the summer of 2009 at six permanent locations throughout the project area. The resulting profiles of the riverbank were then graphed over the corresponding profiles measured in 2008 and are shown in Appendix C. An additional cross-section was measured in 2008, Cross-section B, which was not measured in 2009 due to its location within the pump station construction area. Measuring a change in width of wetted channel, or ponded surface area, will help determine whether a reduction in surface area available to aquatic vegetation and fine sediment, both of which reduce dissolved oxygen in the river, has occurred as a result of the project. However, the cross-section profile is only a snapshot in time and may not reflect long-term changes in the project area.

Aerial photos were used to visually examine changes in wetted channel as a result of the project (Figure 5). The pre-construction photo is from NRCS National Agriculture Imagery Program (2005). The post-construction photo was provided courtesy of the California Department of Fish and Game and Pacific States Marine Fish Commission. Direct changes to the channel due to the removal of the dam and project construction are apparent in those areas of the photos.

Figure 5. Pre-construction and Post-construction Aerial Photos

2005 NAIP Aerial Photograph

2009 Aerial Photograph
Photo courtesy of CA Dept. of Fish and Game and Pacific States Marine Fish Commission.

Photopoints

Post-construction photographs were taken from the established photopoints on August 15, 2009. Photos were taken both upstream and downstream. A pre- and post-construction comparison from three photopoints is shown in Figure 6. Visual documentation of the project site before and after construction is useful in determining post-construction changes in the channel configuration, flow characteristics, and vegetation growth.

Figure 6. Photo Monitoring 2008 and 2009


Photo Point 8: Upstream 2008


2009


Photo Point 9: Upstream 2008


2009


Photo Point 14: Downstream 2008


2009

Improved Fish Passage

Digital photographs were taken during the construction phase of the two boulder weirs as well as upon completion to document a maximum jump height of twelve inches. Photos were taken on August 15, 2009 of the completed boulder weirs during a period of low flow (20 cfs) as shown in Figure 7.

Figure 7. Boulder Weirs at Low Flow

Lower Boulder Weir   August 15, 2009

Upper Boulder Weir   August 15, 2009

Ditch Maintenance/ Water Usage Costs
Prior to project implementation, the individual diverters utilized gravity-fed irrigation systems, which incurred no pumping costs. The pre-project systems utilized open, earthen ditches that required ditch maintenance including herbicide treatment and heavy equipment work. After implementation, the pumped system created electric power pumping costs that did not exist pre-project. However, replacing the main open ditches with buried pipeline reduced or eliminated the costs of ditch maintenance. Pre- and post-construction costs of ditch maintenance and water usage were reported by the individual diverters, and while costs varied depending on their use during the 2009 season of their individual systems, they generally showed a modest increase in operational costs for a more efficient delivery system.

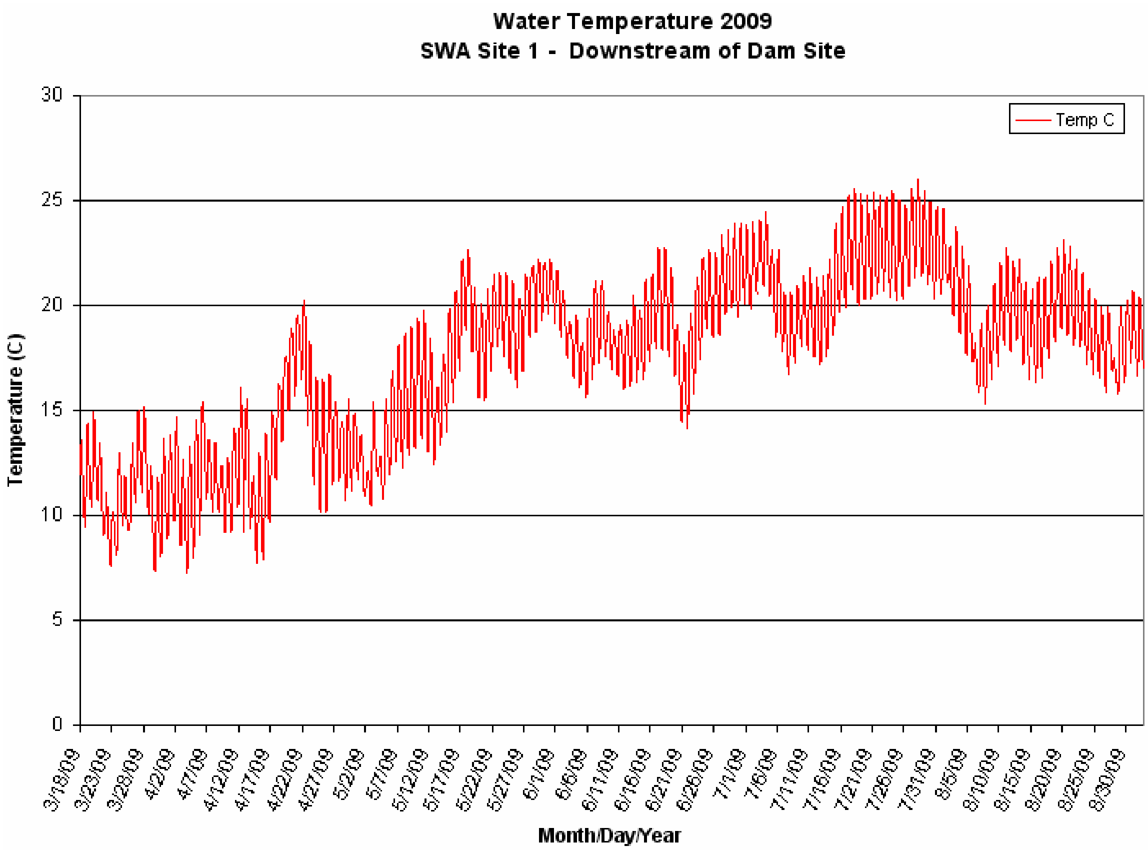
Pre-project and post-construction electric power costs were reported by the 140-user irrigation district, the Shasta Water Association, in order to document changes in costs with the new system. Many variables can influence a comparison in costs from one year to another, including cost per kilowatt-hour and frequency of pump usage. In order to make a valid comparison, a 33-day period of full-time pump usage in 2008 was compared to the same in 2009. It was determined that the number of kilowatt-hours used in 2009, after project implementation, decreased by 3.24%. Eventually the system will be set up to allow users within the district to be billed for the amount they use, which will provide a financial incentive to further reduce energy use and associated costs.

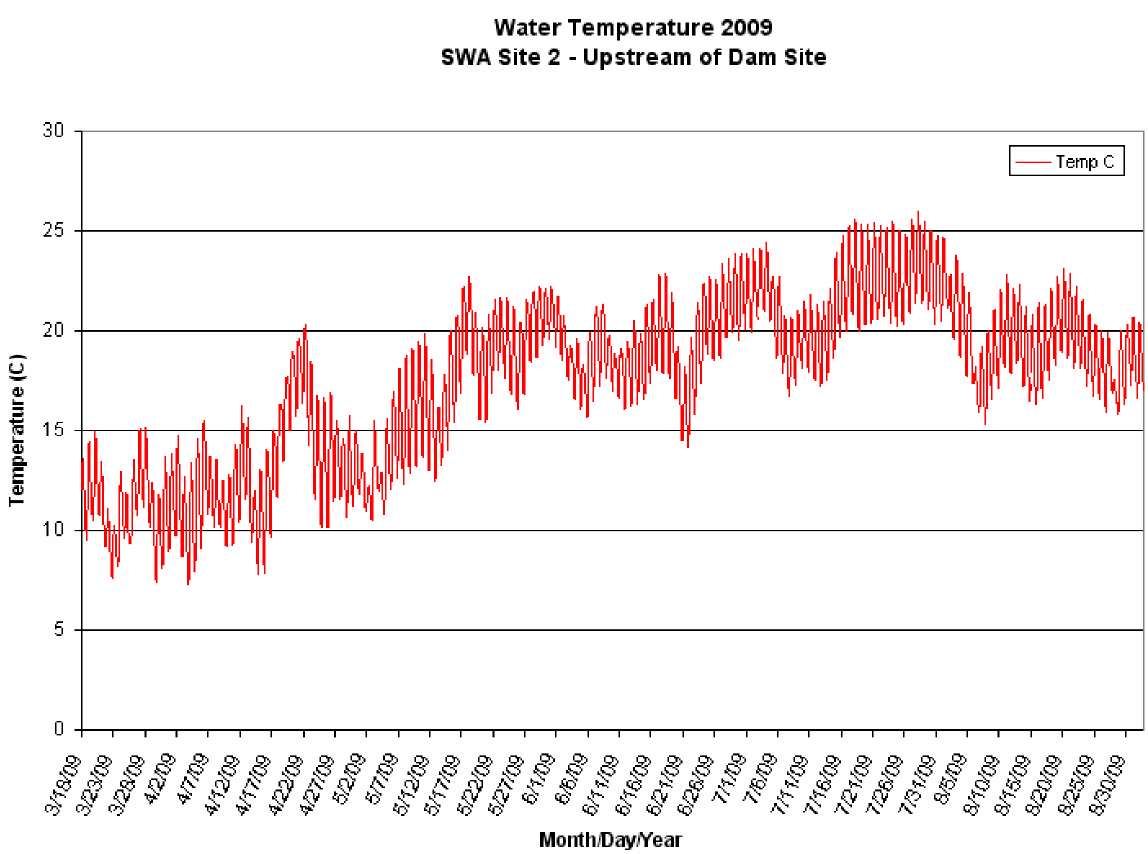
Future Monitoring
Recognition of the value of continued monitoring of the Shasta Water Association Dam Demobilization and Water Quality Enhancement Project has prompted the NCRWQCB and SVRCD to pursue possibilities to monitor during 2010 and beyond. The river water quality parameters to monitor would include water temperature and dissolved oxygen as well as photopoint monitoring. Monitoring protocol as outlined in the current Quality Assurance Project Plan will be followed. Changes to the Monitoring Plan for future monitoring will be approved by the NCRWQCB prior to implementation.

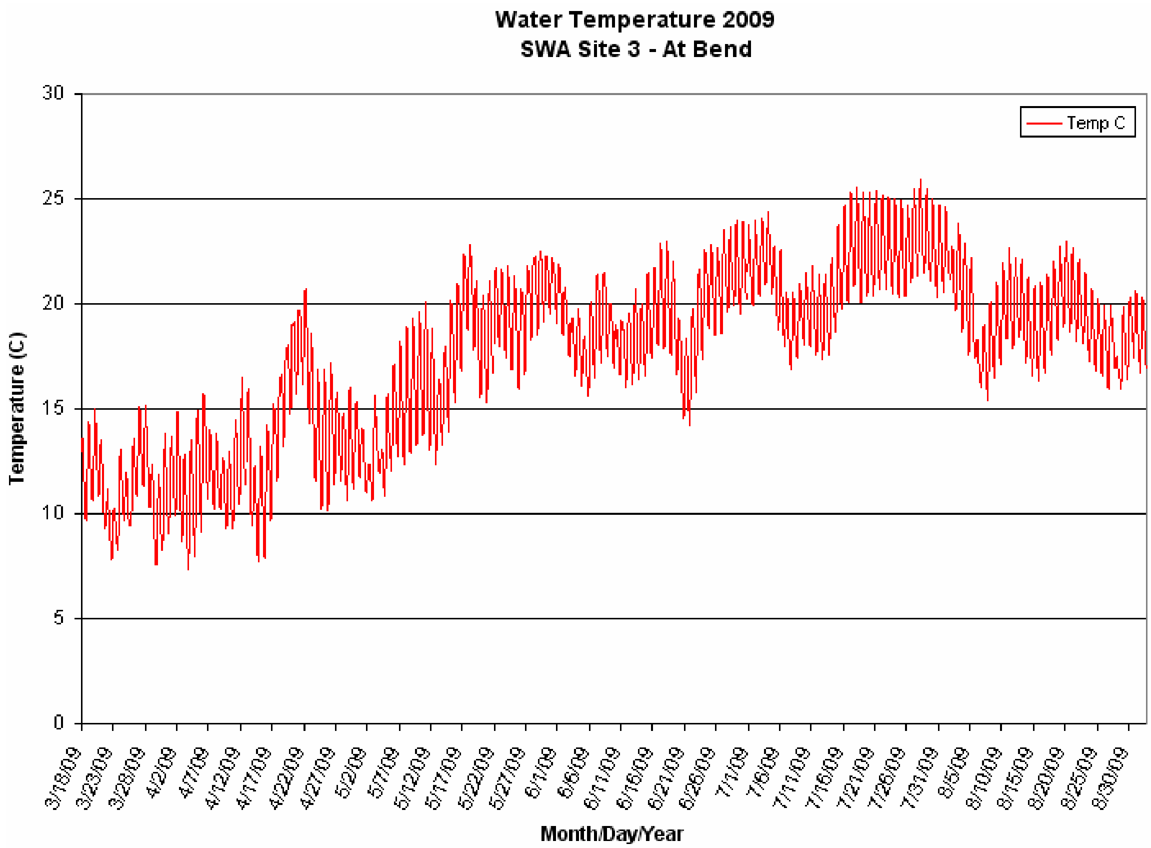
Summary
Pre-construction monitoring data collected in 2007 and 2008 and post-construction monitoring data collected in 2009 for the Shasta Water Association project has helped facilitate evaluation of the success of the project. While only two years of continuous data collection has occurred to date, general trends in improved water quality may be emerging from the interpretation of the data. The removal of the flashboard dam and the associated impoundment appear be improving the flow pattern through the project area. Fish passage was clearly improved after the replacement of the dam with the boulder weir. The new diversion and delivery systems meet current standards for fish safety as well as improve water-use efficiency. The Shasta Water Association projects plays an important role in restoration efforts as a significant step towards improving water quality and identifying further restoration needs.

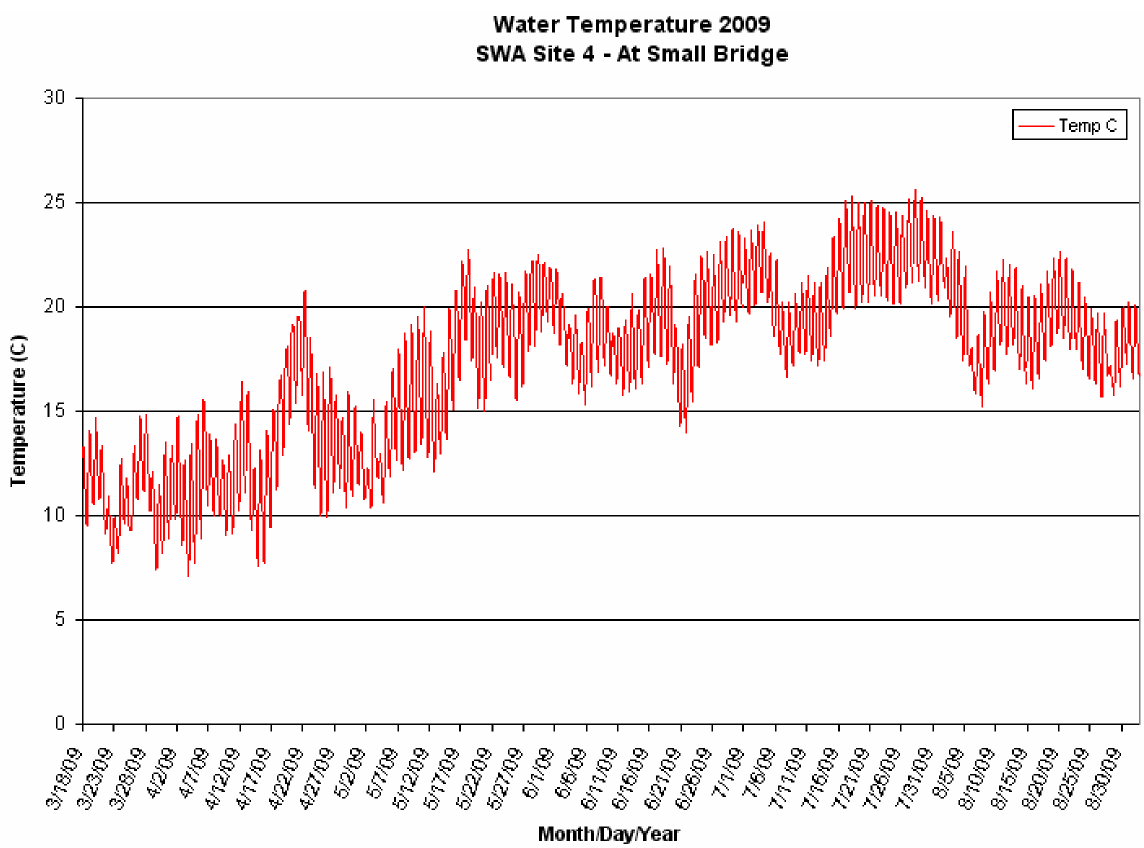
While monitoring during the one-year post-construction period has been useful for beginning to document trends and immediate changes within the project area, many river processes occur slowly over time and may not be measurable for many years. Continued monitoring by the SVRCD will help determine the effects of the flashboard diversion removal project on the river system and the habitat it provides.

Appendix A. Temperature Graphs

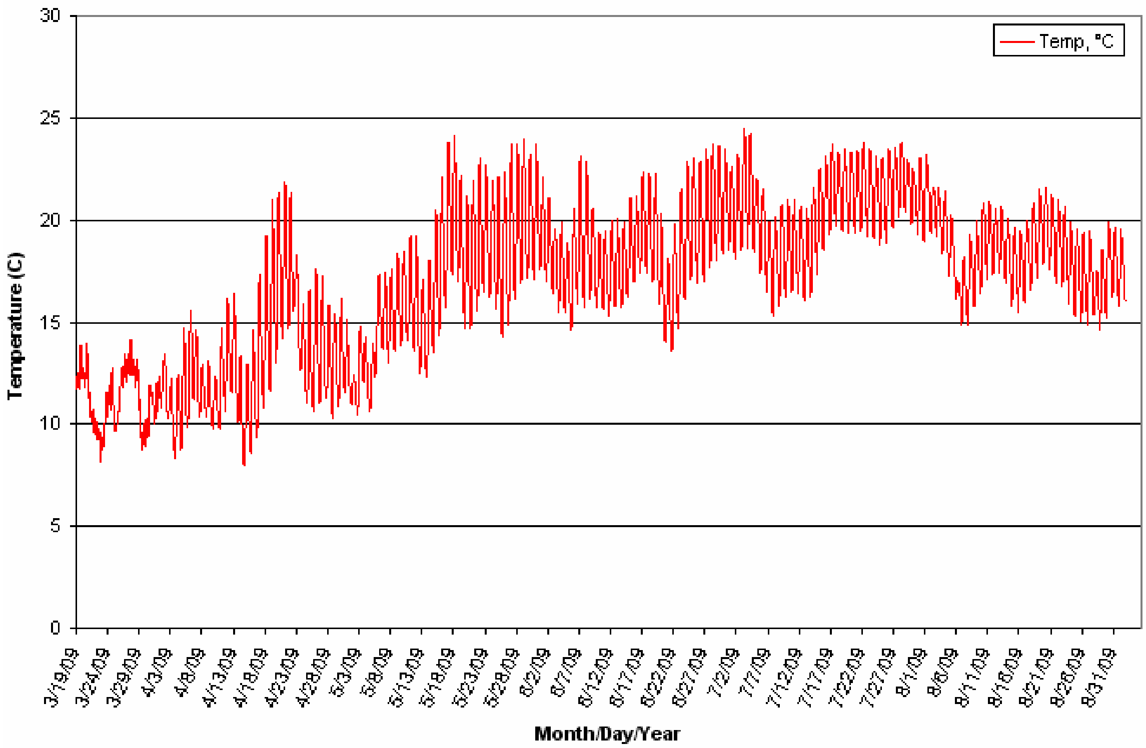




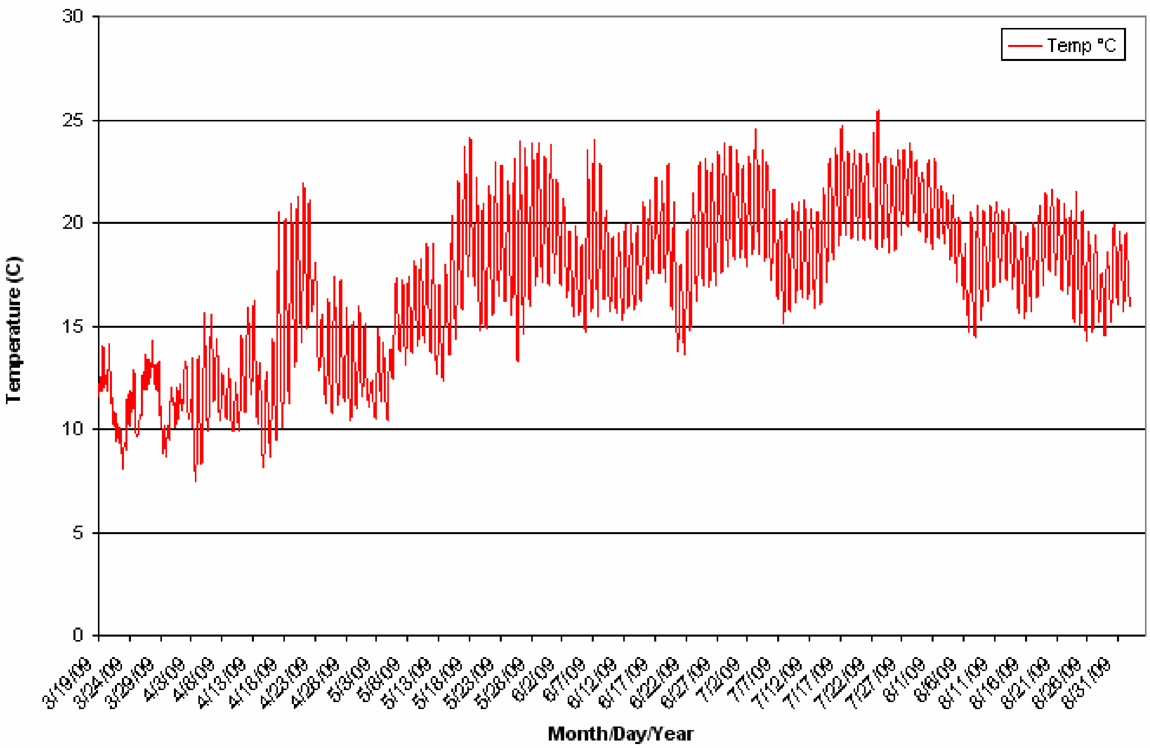

Water Temperature 2009
SWA Site 3 - At Bend
Temp C
Temperature (C)
Month/Day/Year
0
5
10
15
20
25
30
3/18/09
3/23/09
3/28/09
4/2/09
4/7/09
4/12/09
4/17/09
4/22/09
4/27/09
5/2/09
5/7/09
5/12/09
5/17/09
5/22/09
5/27/09
6/1/09
6/6/09
6/11/09
6/16/09
6/21/09
6/26/09
7/1/09
7/6/09
7/11/09
7/16/09
7/21/09
7/26/09
7/31/09
8/5/09
8/10/09
8/15/09
8/20/09
8/25/09
8/30/09

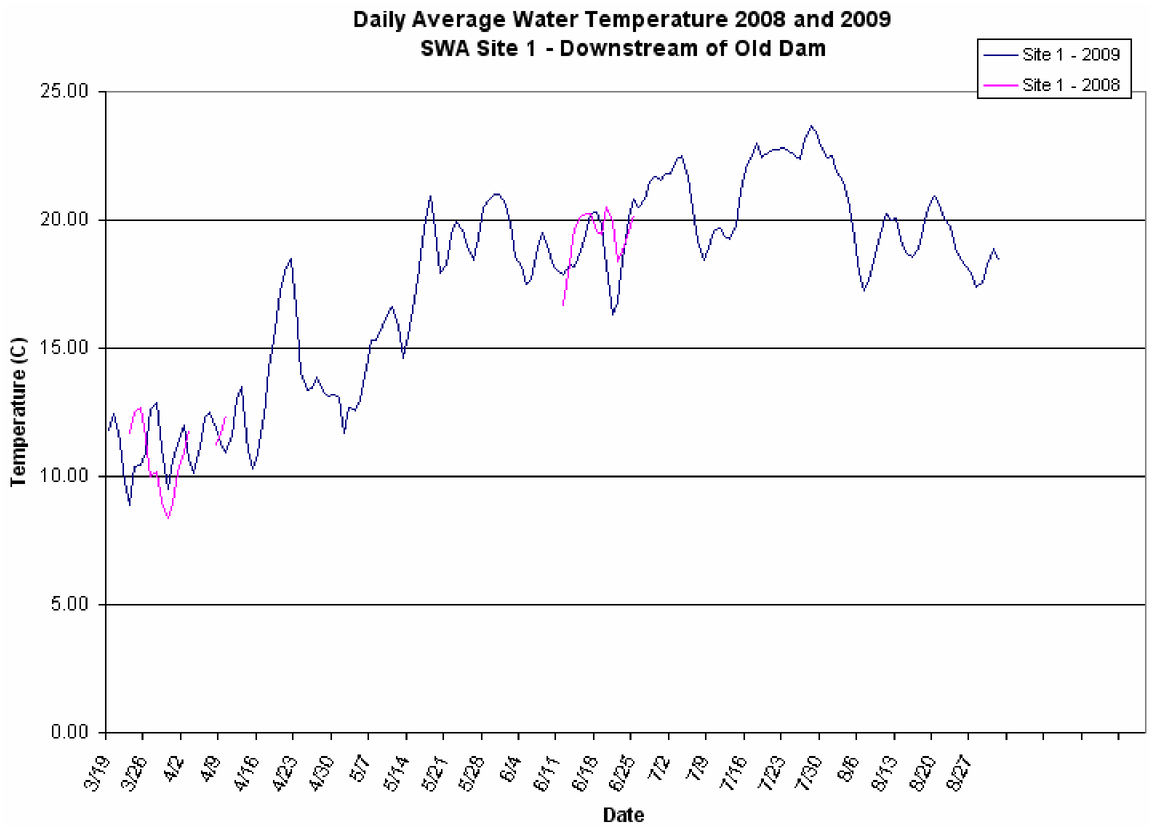

Water Temperature 2009
SWA Site 4 - At Small Bridge
Temp C
Temperature (C)
Month/Day/Year
0
5
10
15
20
25
30
3/18/09
3/23/09
3/28/09
4/2/09
4/7/09
4/12/09
4/17/09
4/22/09
4/27/09
5/2/09
5/7/09
5/12/09
5/17/09
5/22/09
5/27/09
6/1/09
6/6/09
6/11/09
6/16/09
6/21/09
6/26/09
7/1/09
7/6/09
7/11/09
7/16/09
7/21/09
7/26/09
7/31/09
8/5/09
8/10/09
8/15/09
8/20/09
8/25/09
8/30/09

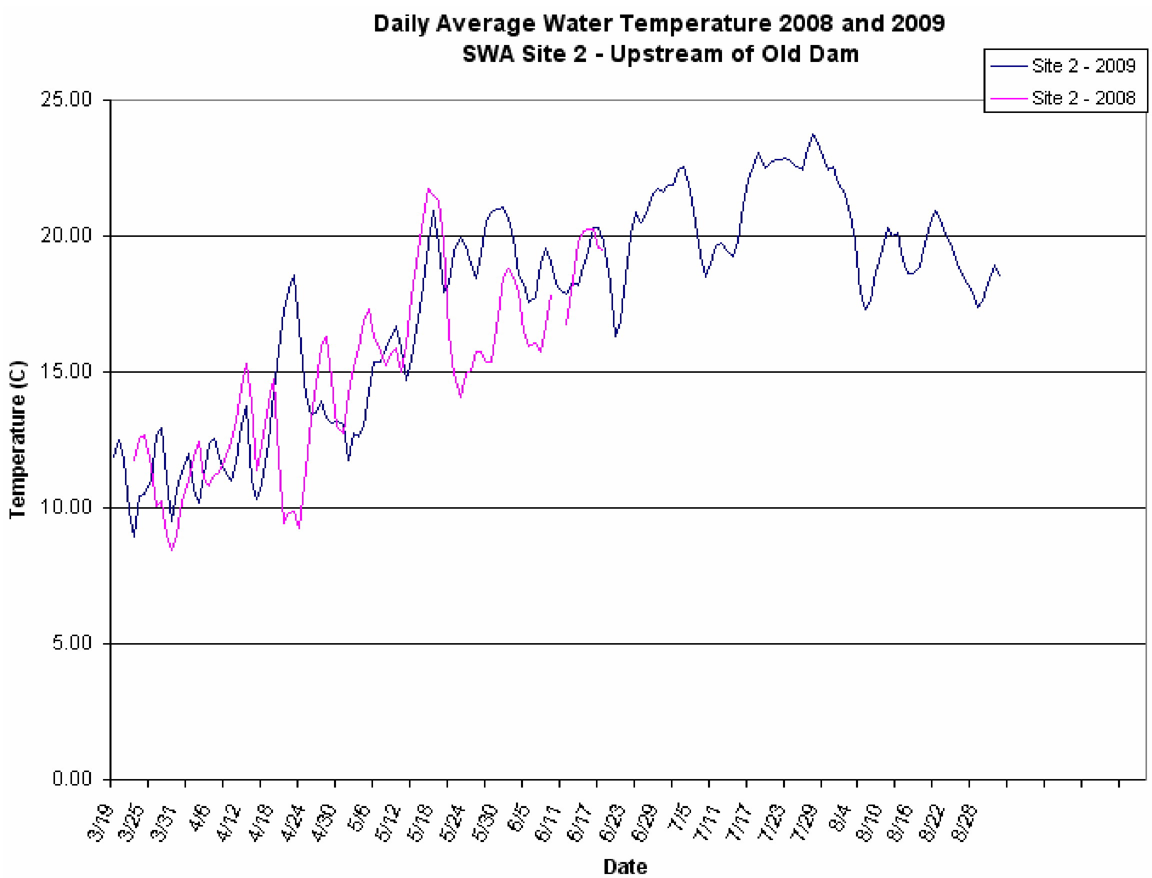
Water Temperature 2009
SWA Site 5 - Near DeSoza Lane, Lower End

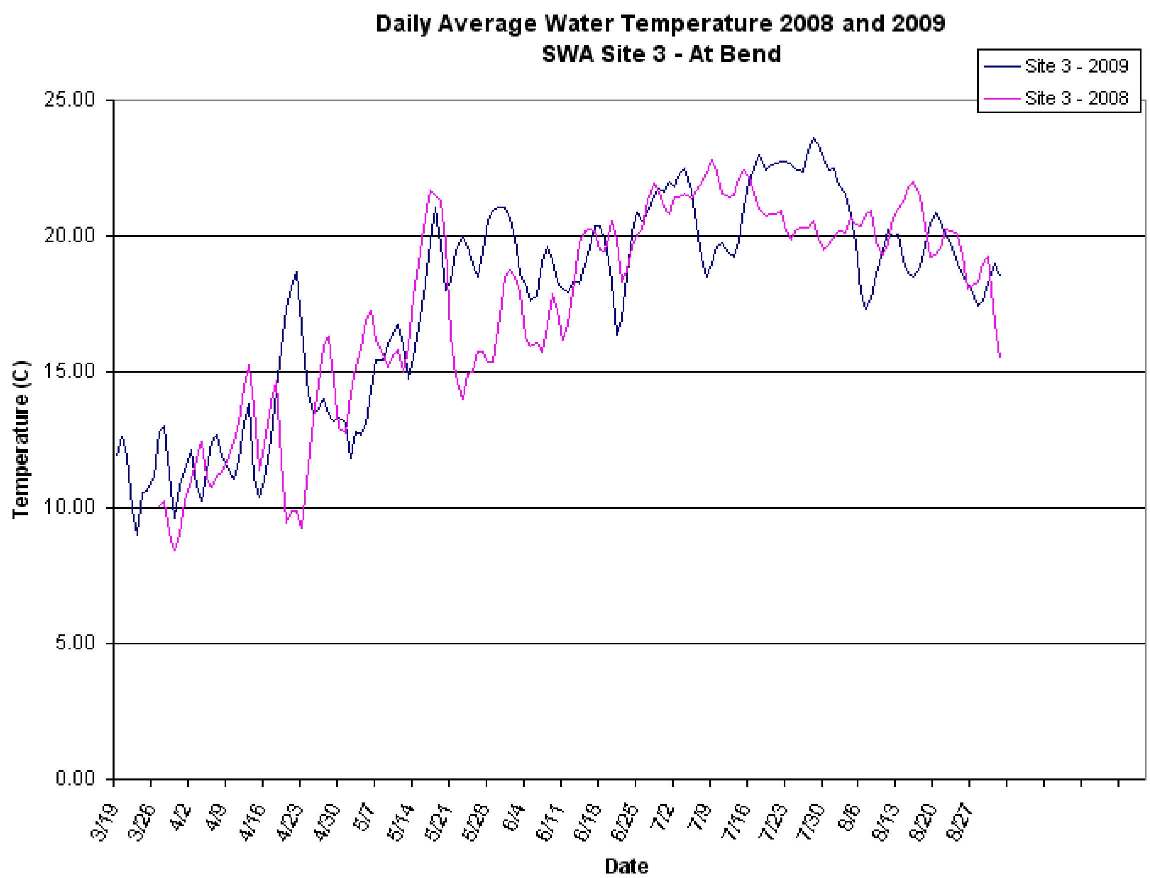


Water Temperature 2009
SWA Site 6 - Near De Soza Lane, Upper End

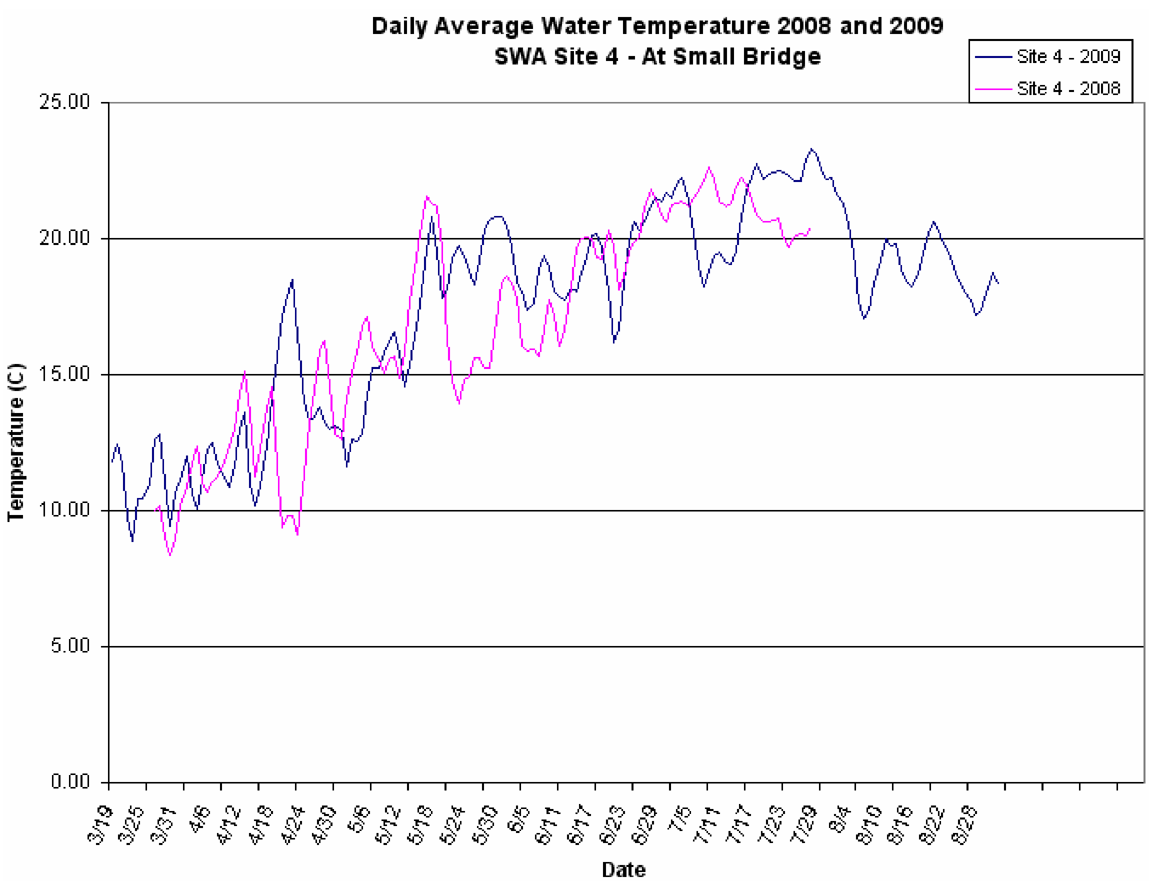



Daily Average Water Temperature 2008 and 2009
SWA Site 1 - Downstream of Old Dam
Site 1 - 2009
Site 1 - 2008
Temperature (C)
25.00
20.00
15.00
10.00
5.00
0.00
3/19
3/26
4/2
4/9
4/16
4/23
4/30
5/7
5/14
5/21
5/28
6/4
6/11
6/18
6/25
7/2
7/9
7/16
7/23
7/30
8/6
8/13
8/20
8/27
Date

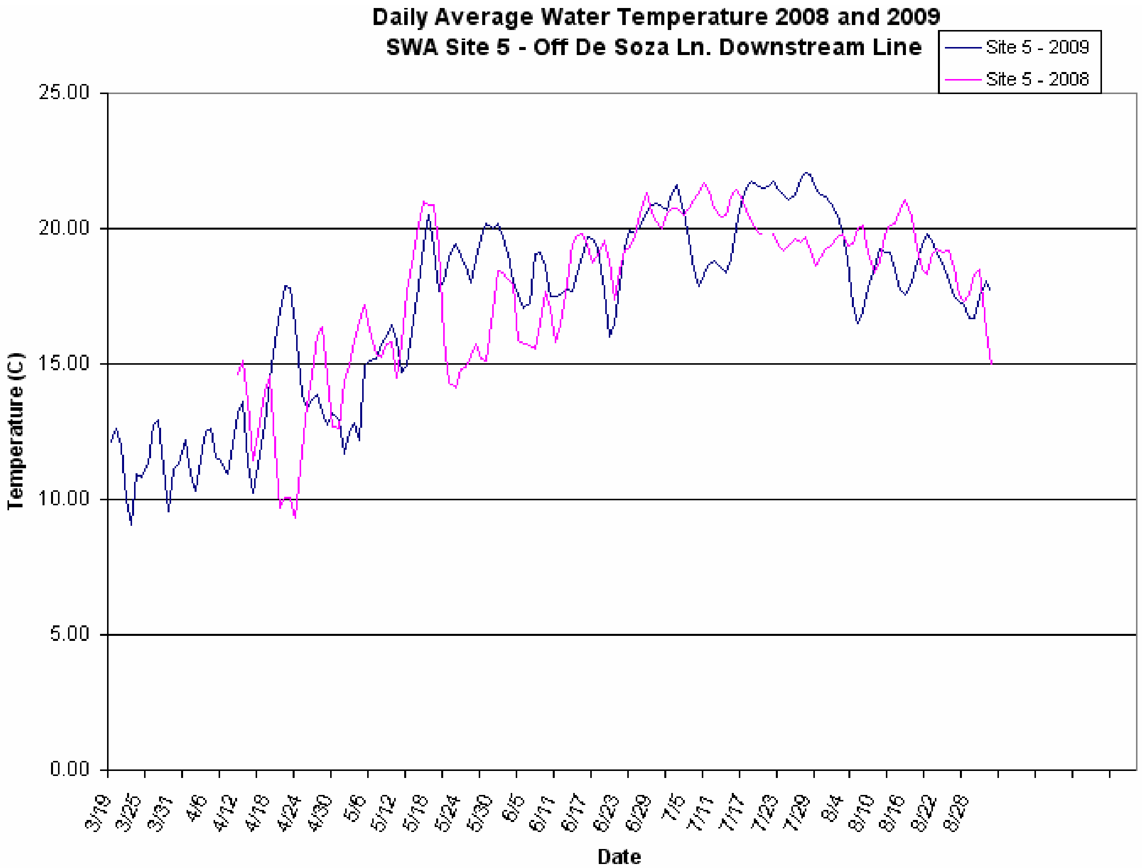

Daily Average Water Temperature 2008 and 2009
SWA Site 2 - Upstream of Old Dam
Site 2 - 2009
Site 2 - 2008
Temperature (C)
25.00
20.00
15.00
10.00
5.00
0.00
3/19
3/25
3/31
4/6
4/12
4/18
4/24
4/30
5/6
5/12
5/18
5/24
5/30
6/5
6/11
6/17
6/23
6/29
7/5
7/11
7/17
7/23
7/29
8/4
8/10
8/16
8/22
8/28
Date

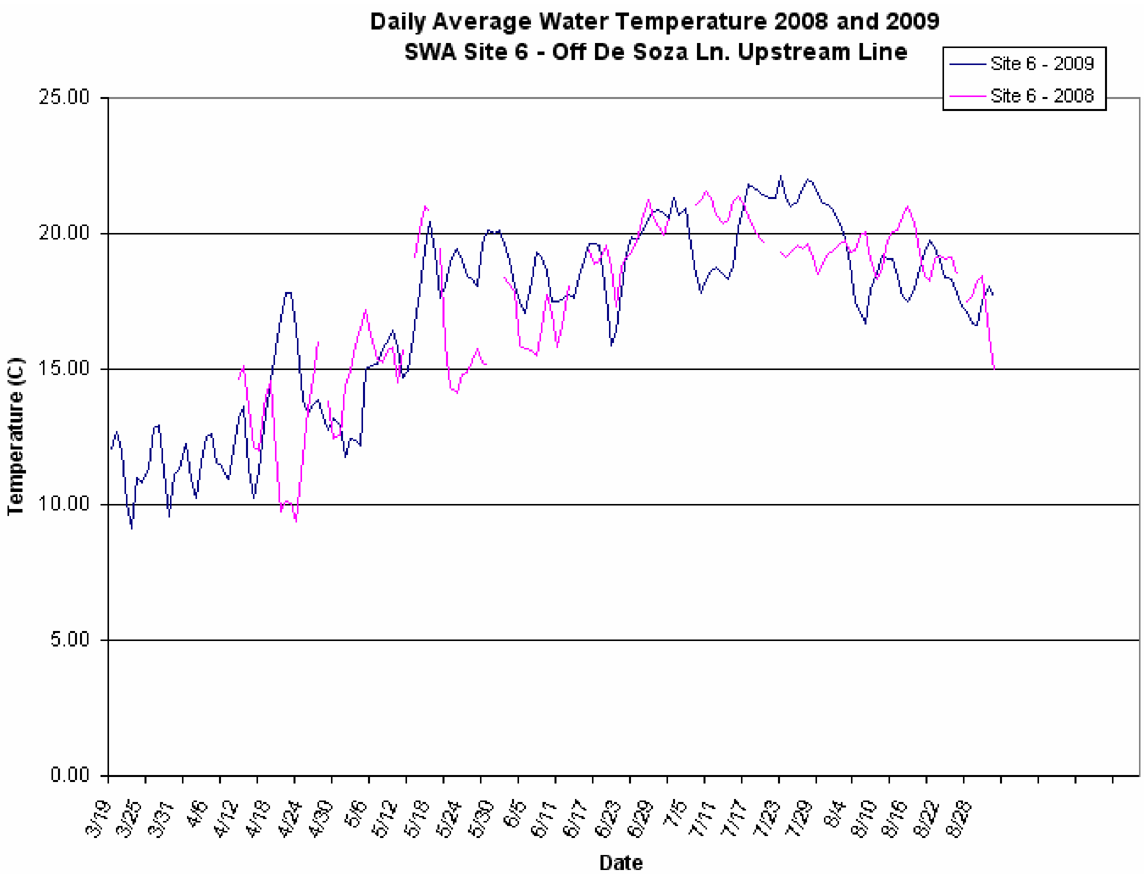


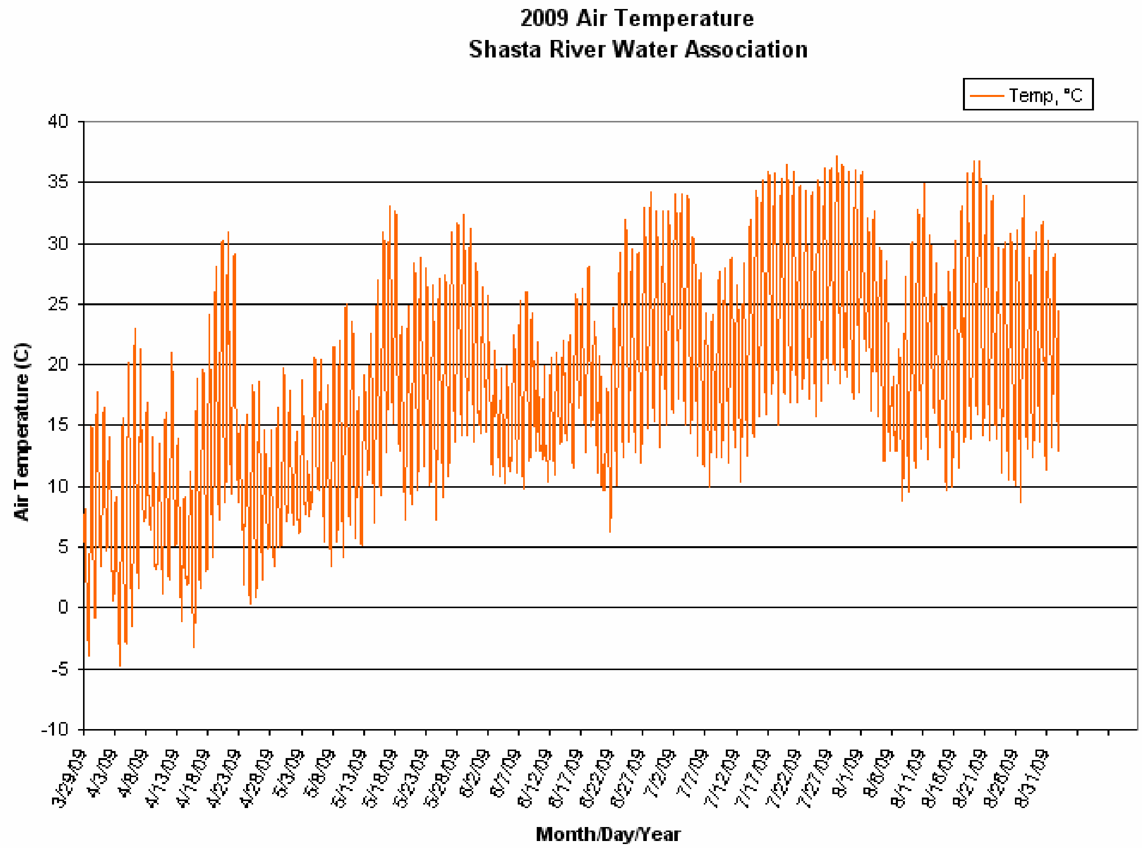
Daily Average Water Temperature 2008 and 2009
SWA Site 3 - At Bend
Site 3 - 2009
Site 3 - 2008
Temperature (C)
25.00
20.00
15.00
10.00
5.00
0.00
3/19
3/26
4/2
4/9
4/16
4/23
4/30
5/7
5/14
5/21
5/28
6/4
6/11
6/18
6/25
7/2
7/9
7/16
7/23
7/30
8/6
8/13
8/20
8/27
Date



Daily Average Water Temperature 2008 and 2009
SWA Site 4 - At Small Bridge
Site 4 - 2009
Site 4 - 2008
Temperature (C)
25.00
20.00
15.00
10.00
5.00
0.00
3/19
3/25
3/31
4/6
4/12
4/18
4/24
4/30
5/6
5/12
5/18
5/24
5/30
6/5
6/11
6/17
6/23
6/29
7/5
7/11
7/17
7/23
7/29
8/4
8/10
8/16
8/22
8/28
Date

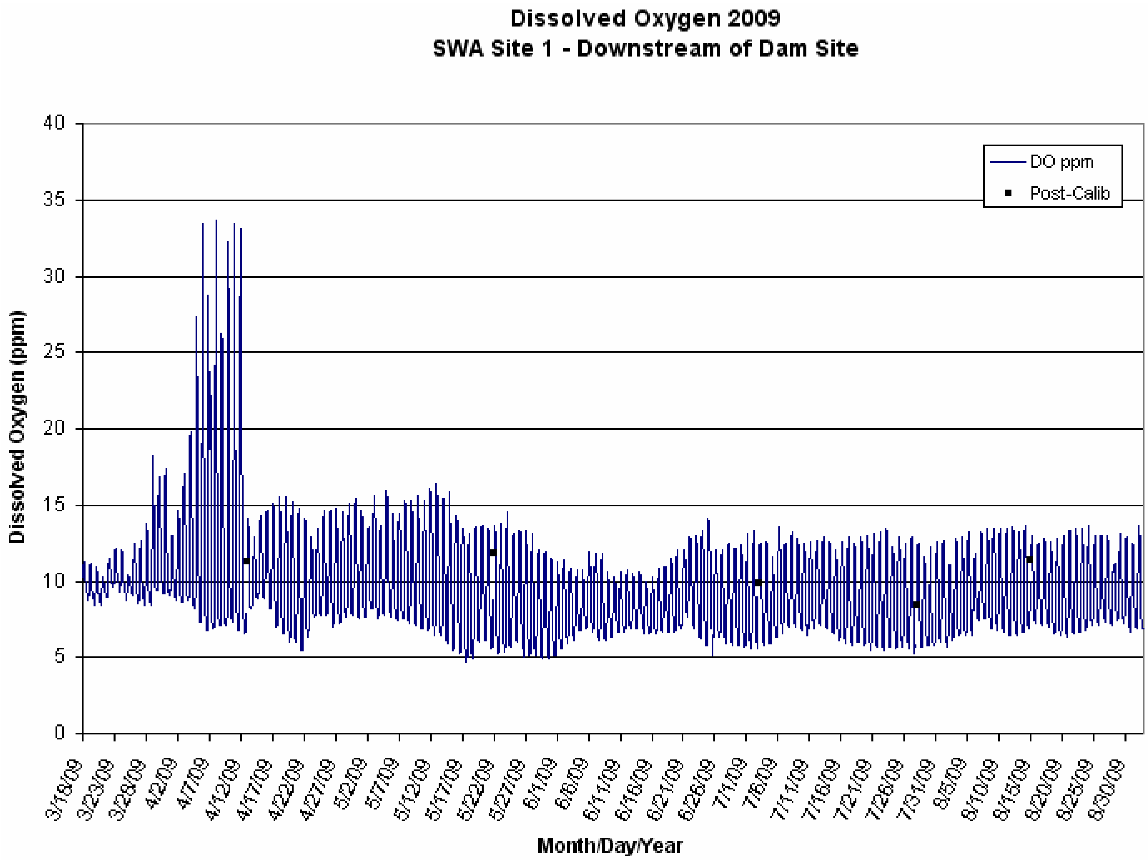

Daily Average Water Temperature 2008 and 2009
SWA Site 5 - Off De Soza Ln. Downstream Line
Site 5 - 2009
Site 5 - 2008
Temperature (C)
Date
25.00
20.00
15.00
10.00
5.00
0.00
3/19
3/25
3/31
4/6
4/12
4/18
4/24
4/30
5/6
5/12
5/18
5/24
5/30
6/5
6/11
6/17
6/23
6/29
7/5
7/11
7/17
7/23
7/29
8/4
8/10
8/16
8/22
8/28

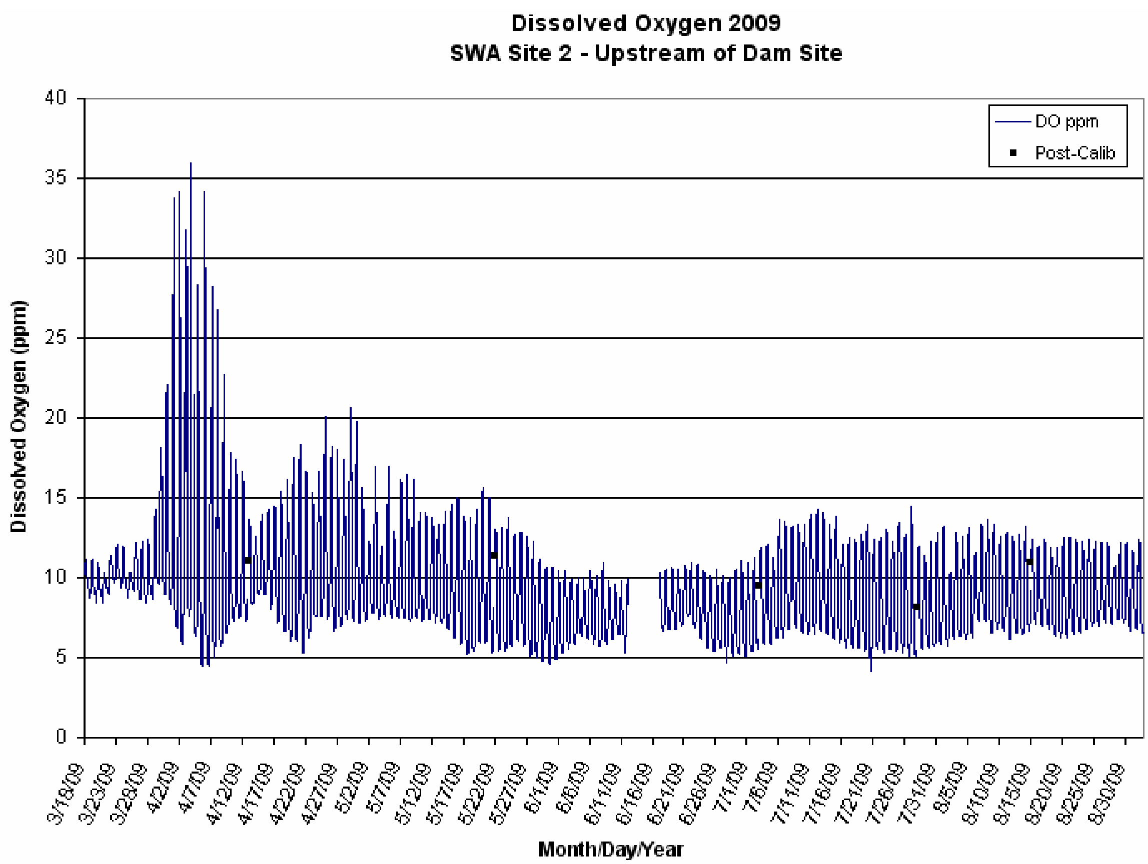

Daily Average Water Temperature 2008 and 2009
SWA Site 6 - Off De Soza Ln. Upstream Line
Site 6 - 2009
Site 6 - 2008
Temperature (C)
Date
25.00
20.00
15.00
10.00
5.00
0.00
3/19
3/25
3/31
4/6
4/12
4/18
4/24
4/30
5/6
5/12
5/18
5/24
5/30
6/5
6/11
6/17
6/23
6/29
7/5
7/11
7/17
7/23
7/29
8/4
8/10
8/16
8/22
8/28

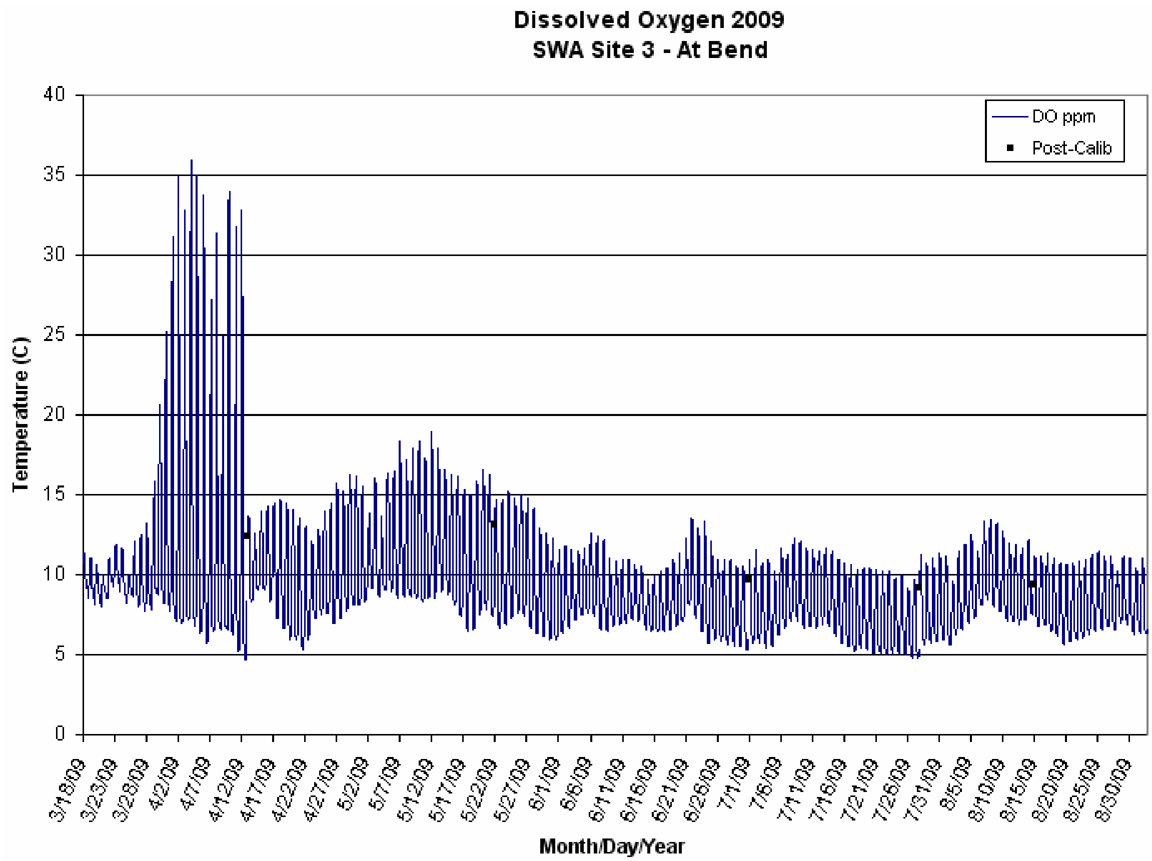


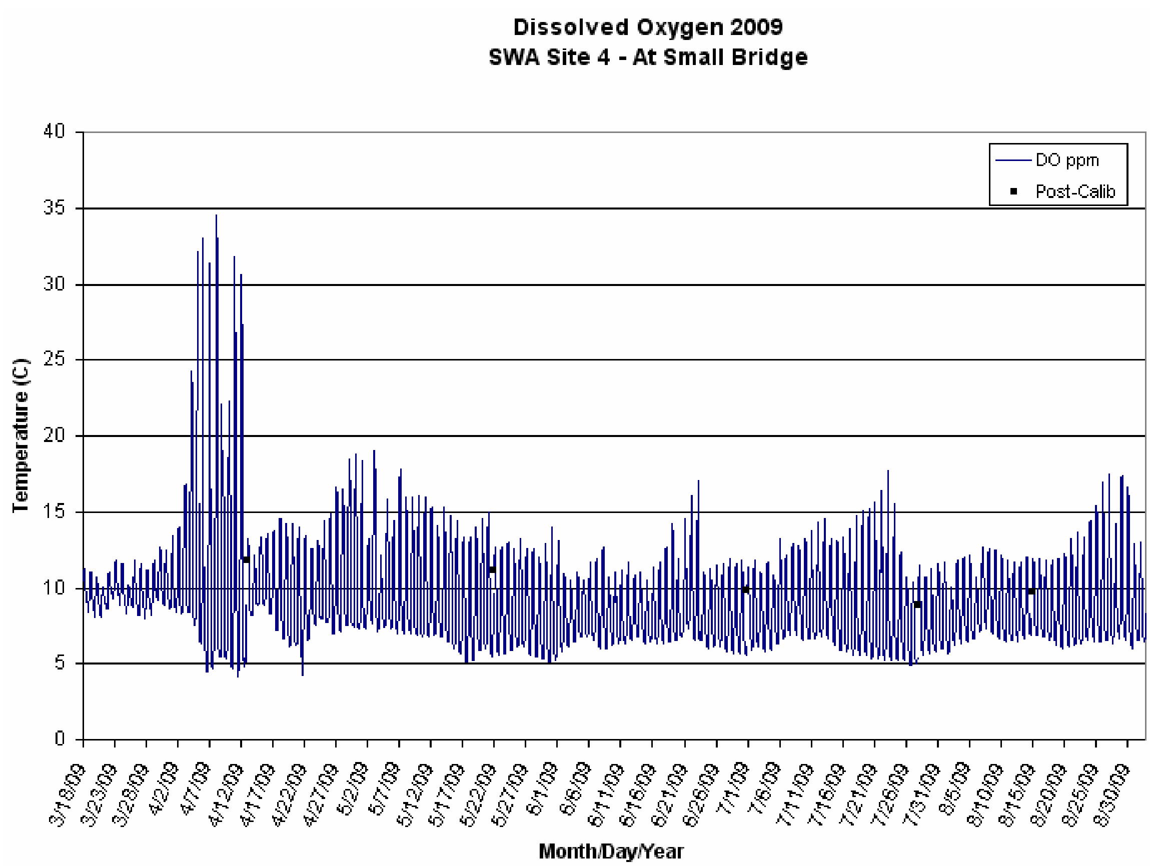
2009 Air Temperature
Shasta River Water Association
Temp, °C
Air Temperature (C)
40
35
30
25
20
15
10
5
0
-5
-10
3/29/09
4/3/09
4/8/09
4/13/09
4/18/09
4/23/09
4/28/09
5/3/09
5/8/09
5/13/09
5/18/09
5/23/09
5/28/09
6/2/09
6/7/09
6/12/09
6/17/09
6/22/09
6/27/09
7/2/09
7/7/09
7/12/09
7/17/09
7/22/09
7/27/09
8/1/09
8/6/09
8/11/09
8/16/09
8/21/09
8/26/09
8/31/09
Month/Day/Year

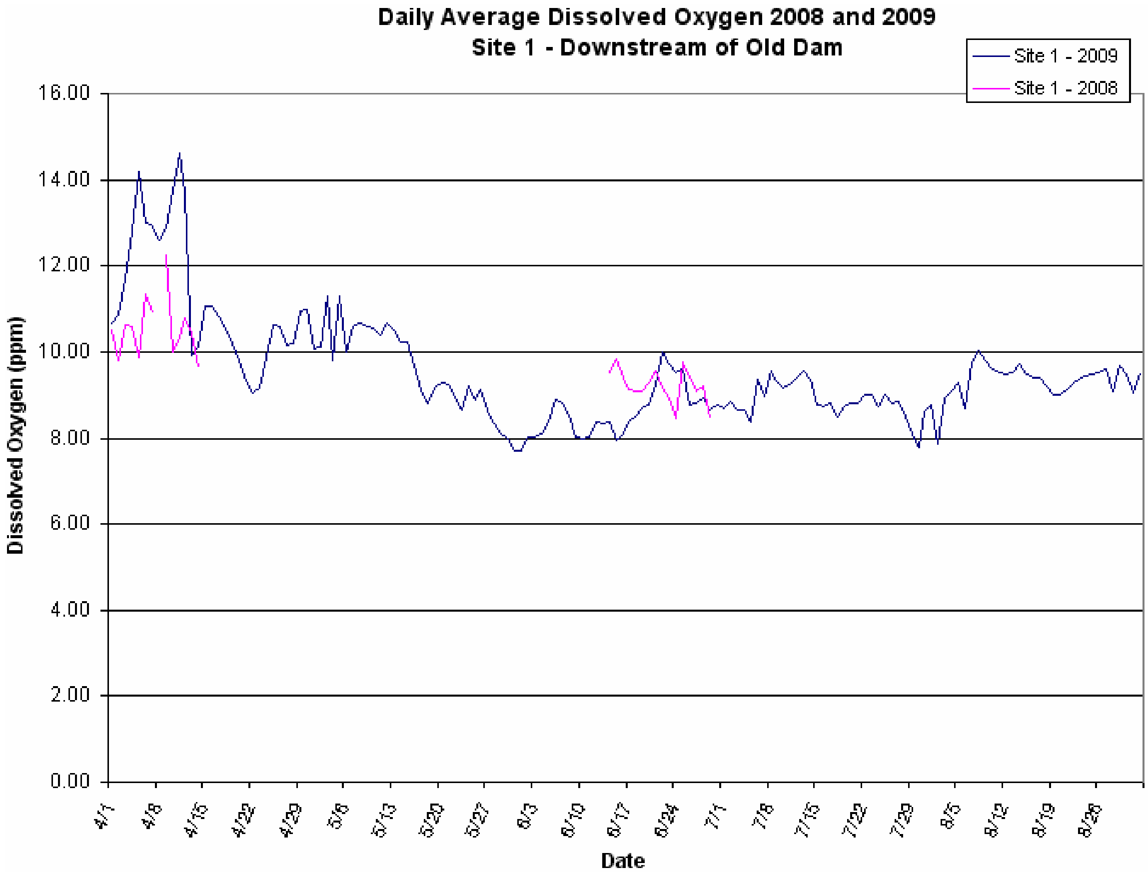
Appendix B. Dissolved Oxygen Graphs



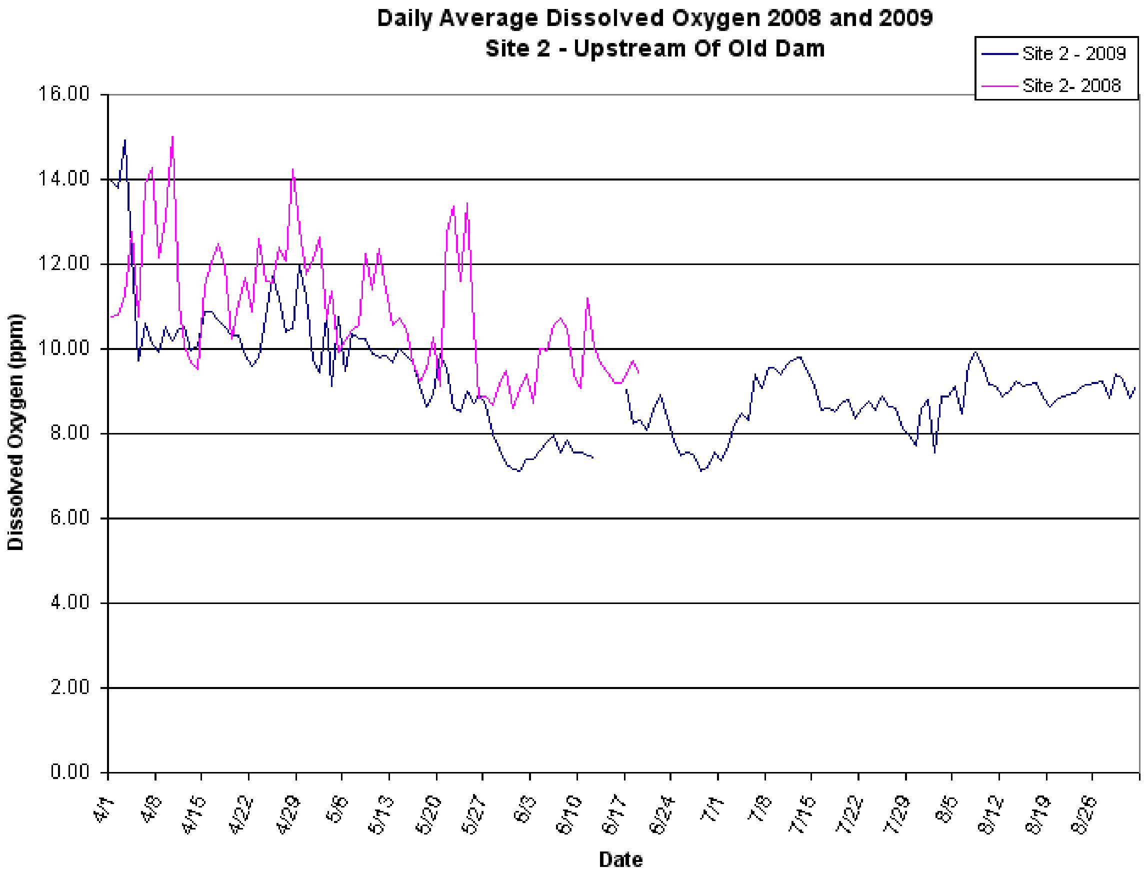



Dissolved Oxygen 2009
SWA Site 3 - At Bend
Temperature (C)
Month/Day/Year
DO ppm
Post-Calib
0
5
10
15
20
25
30
35
40
3/18/09
3/23/09
3/28/09
4/2/09
4/7/09
4/12/09
4/17/09
4/22/09
4/27/09
5/2/09
5/7/09
5/12/09
5/17/09
5/22/09
5/27/09
6/1/09
6/6/09
6/11/09
6/16/09
6/21/09
6/26/09
7/1/09
7/6/09
7/11/09
7/16/09
7/21/09
7/26/09
7/31/09
8/5/09
8/10/09
8/15/09
8/20/09
8/25/09
8/30/09

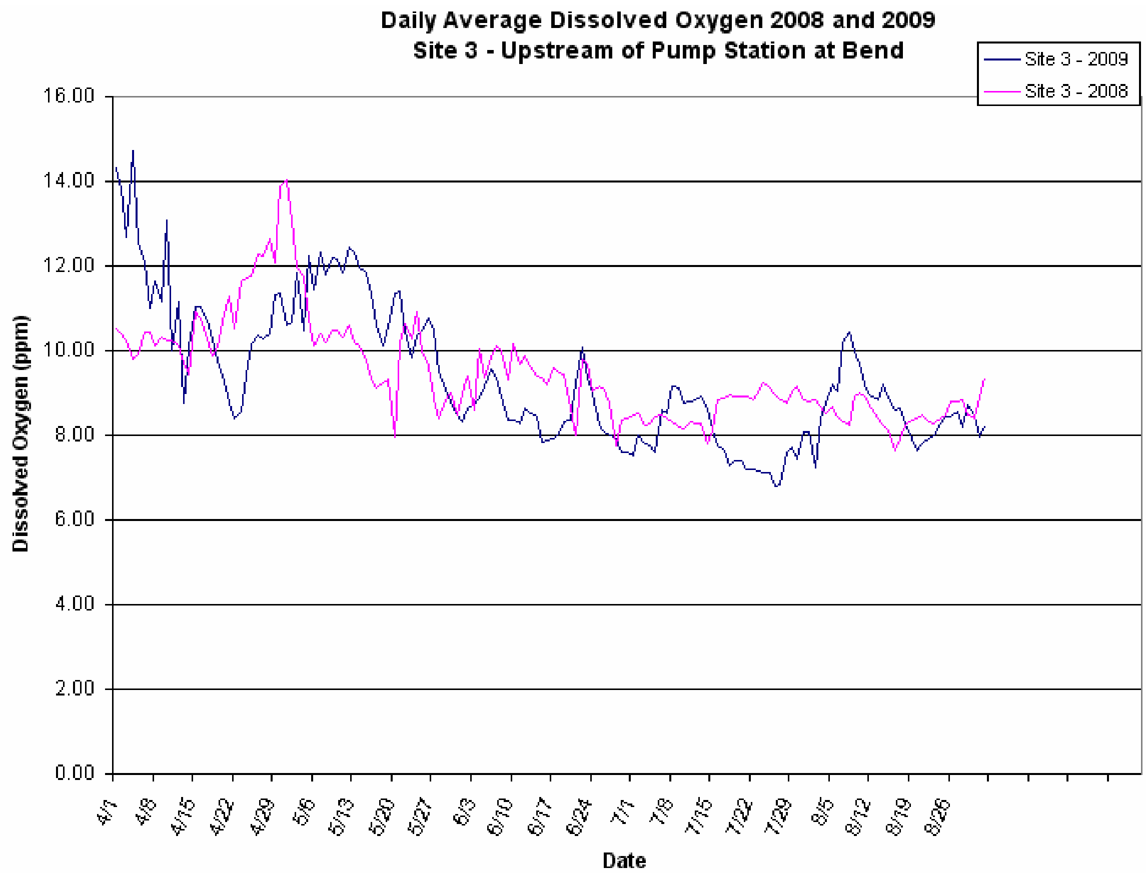

Dissolved Oxygen 2009
SWA Site 4 - At Small Bridge
Temperature (C)
Month/Day/Year
DO ppm
Post-Calib
0
5
10
15
20
25
30
35
40
3/18/09
3/23/09
3/28/09
4/2/09
4/7/09
4/12/09
4/17/09
4/22/09
4/27/09
5/2/09
5/7/09
5/12/09
5/17/09
5/22/09
5/27/09
6/1/09
6/6/09
6/11/09
6/16/09
6/21/09
6/26/09
7/1/09
7/6/09
7/11/09
7/16/09
7/21/09
7/26/09
7/31/09
8/5/09
8/10/09
8/15/09
8/20/09
8/25/09
8/30/09

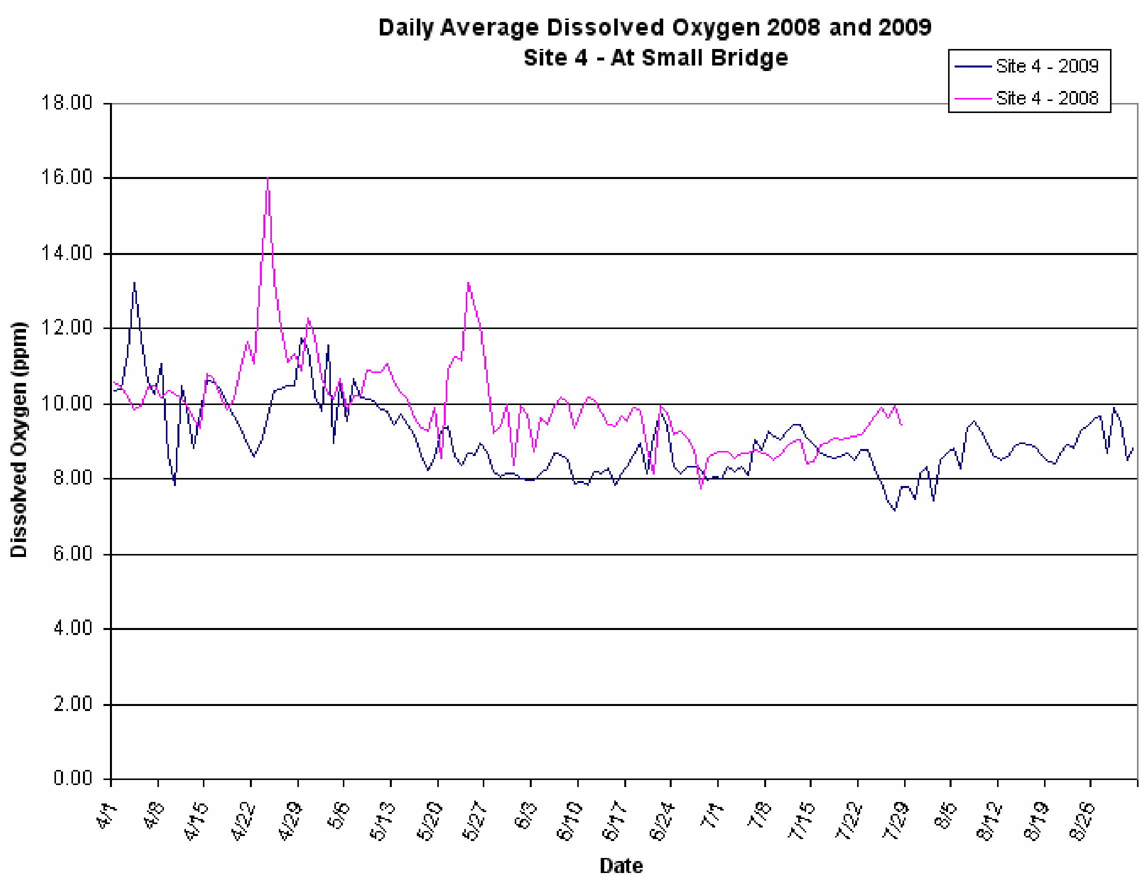


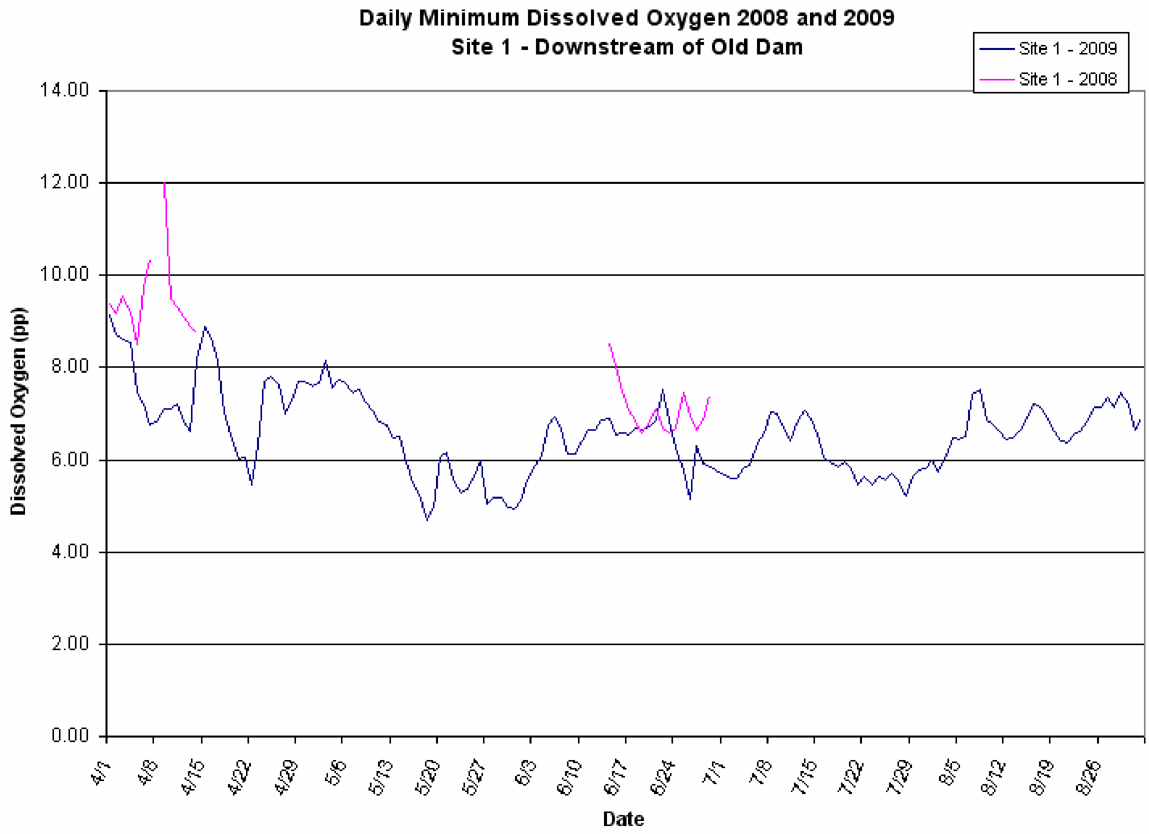
Daily Average Dissolved Oxygen 2008 and 2009
Site 1 - Downstream of Old Dam
Site 1 - 2009
Site 1 - 2008
Dissolved Oxygen (ppm)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
7/8
7/15
7/22
7/29
8/5
8/12
8/19
8/26
Date



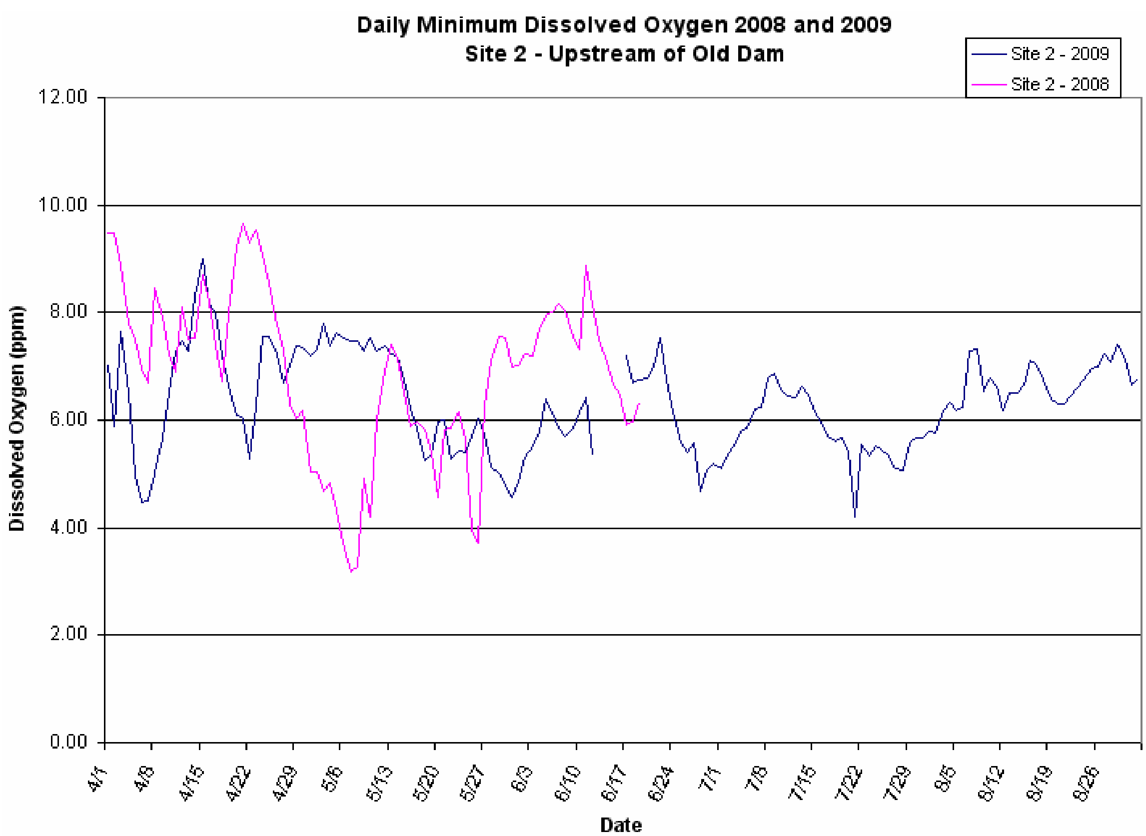
Daily Average Dissolved Oxygen 2008 and 2009
Site 2 - Upstream Of Old Dam
Site 2 - 2009
Site 2- 2008
Dissolved Oxygen (ppm)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
7/8
7/15
7/22
7/29
8/5
8/12
8/19
8/26
Date


Daily Average Dissolved Oxygen 2008 and 2009
Site 3 - Upstream of Pump Station at Bend
Site 3 - 2009
Site 3 - 2008
Dissolved Oxygen (ppm)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
7/8
7/15
7/22
7/29
8/5
8/12
8/19
8/26
Date

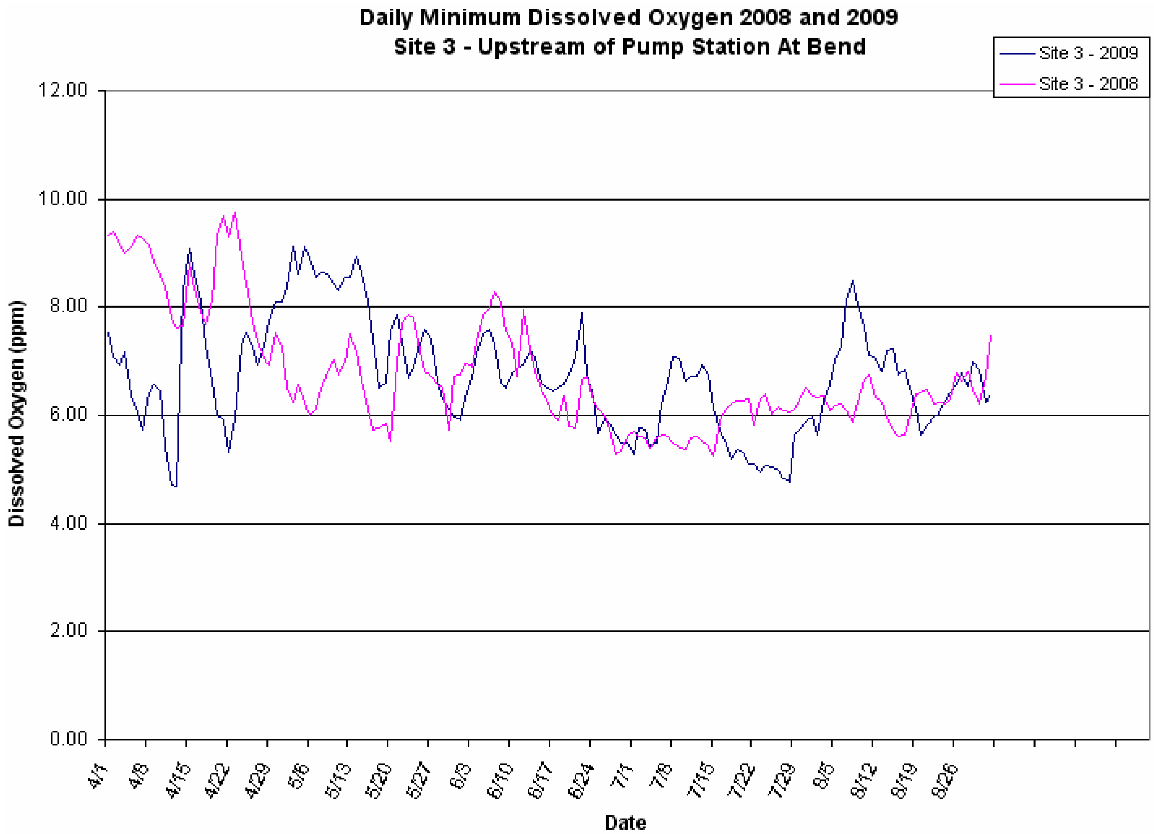

Daily Average Dissolved Oxygen 2008 and 2009
Site 4 - At Small Bridge
Site 4 - 2009
Site 4 - 2008
Dissolved Oxygen (ppm)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
7/8
7/15
7/22
7/29
8/5
8/12
8/19
8/26
Date



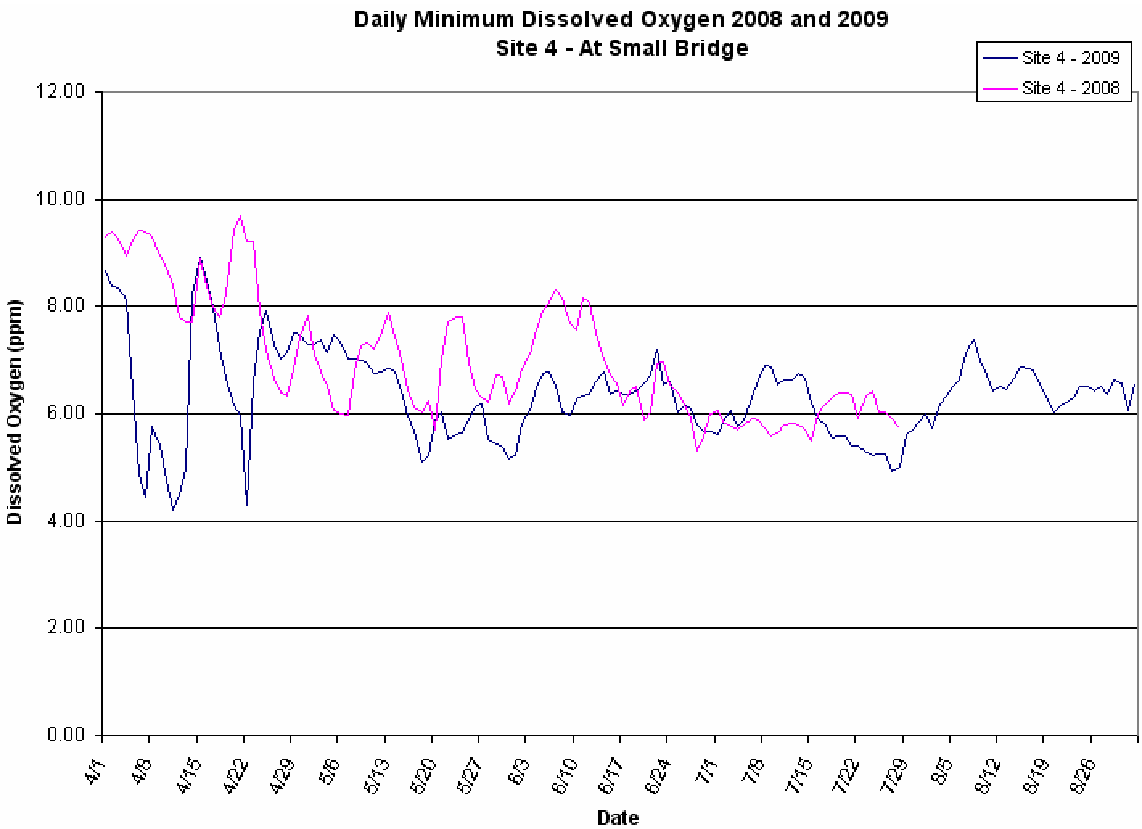
Daily Minimum Dissolved Oxygen 2008 and 2009
Site 1 - Downstream of Old Dam
Site 1 - 2009
Site 1 - 2008
Dissolved Oxygen (pp)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
7/8
7/15
7/22
7/29
8/5
8/12
8/19
8/26
Date



Daily Minimum Dissolved Oxygen 2008 and 2009
Site 2 - Upstream of Old Dam
Site 2 - 2009
Site 2 - 2008
Dissolved Oxygen (ppm)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
7/8
7/15
7/22
7/29
8/5
8/12
8/19
8/26
Date

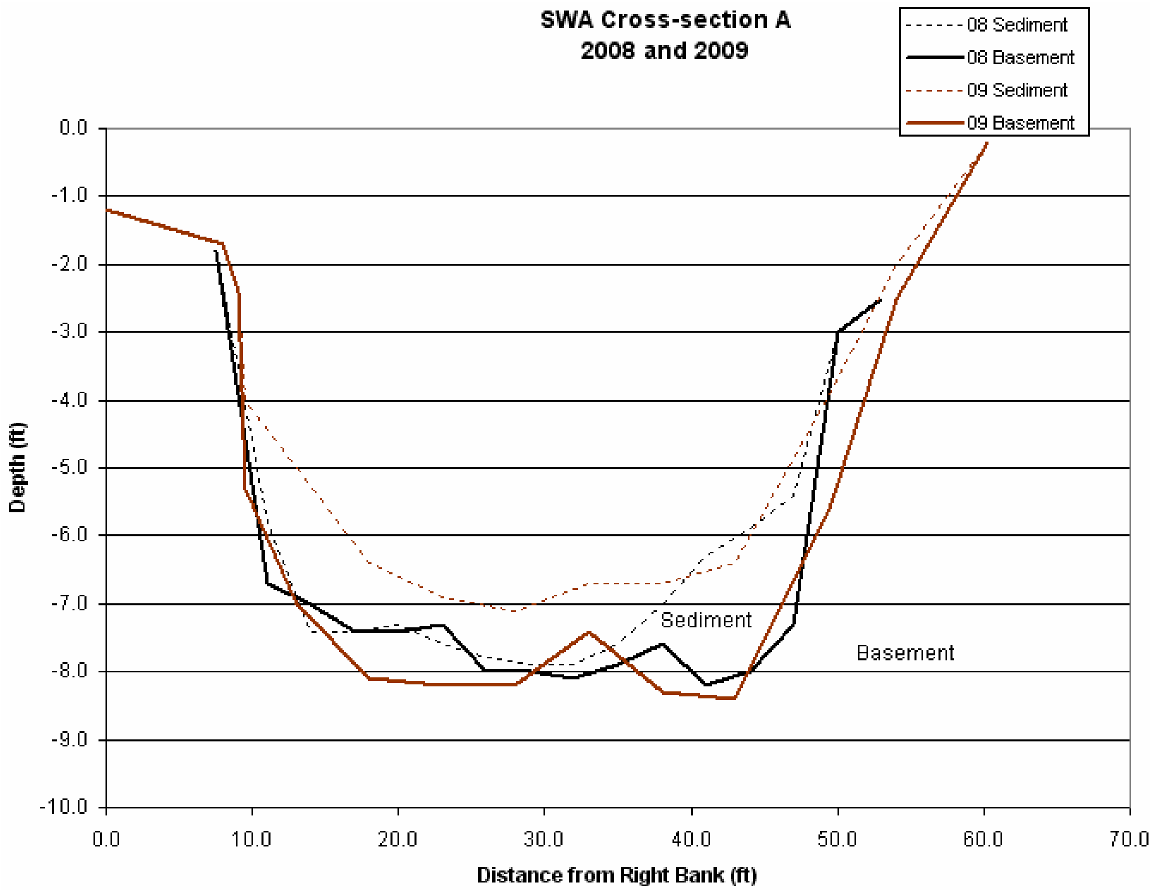


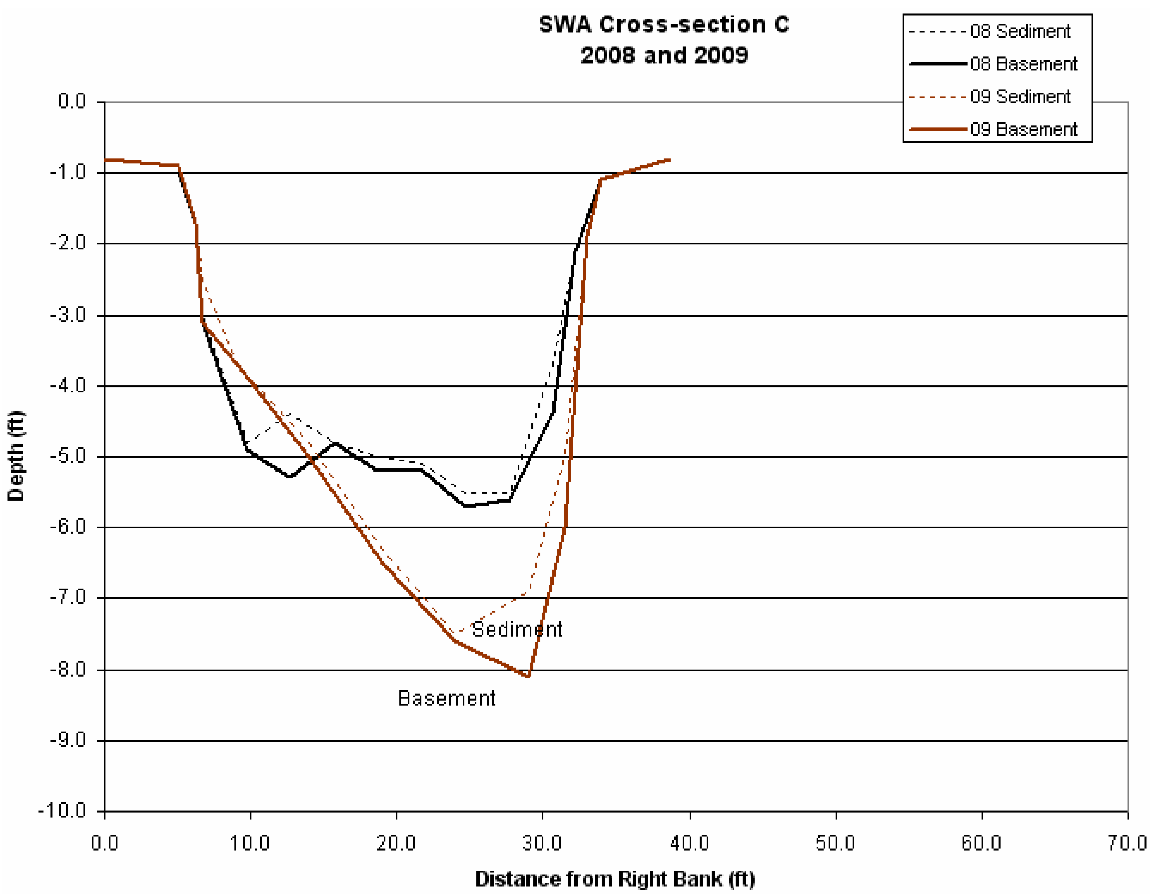
Daily Minimum Dissolved Oxygen 2008 and 2009
Site 3 - Upstream of Pump Station At Bend
Site 3 - 2009
Site 3 - 2008
Dissolved Oxygen (ppm)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
7/8
7/15
7/22
7/29
8/5
8/12
8/19
8/26
Date

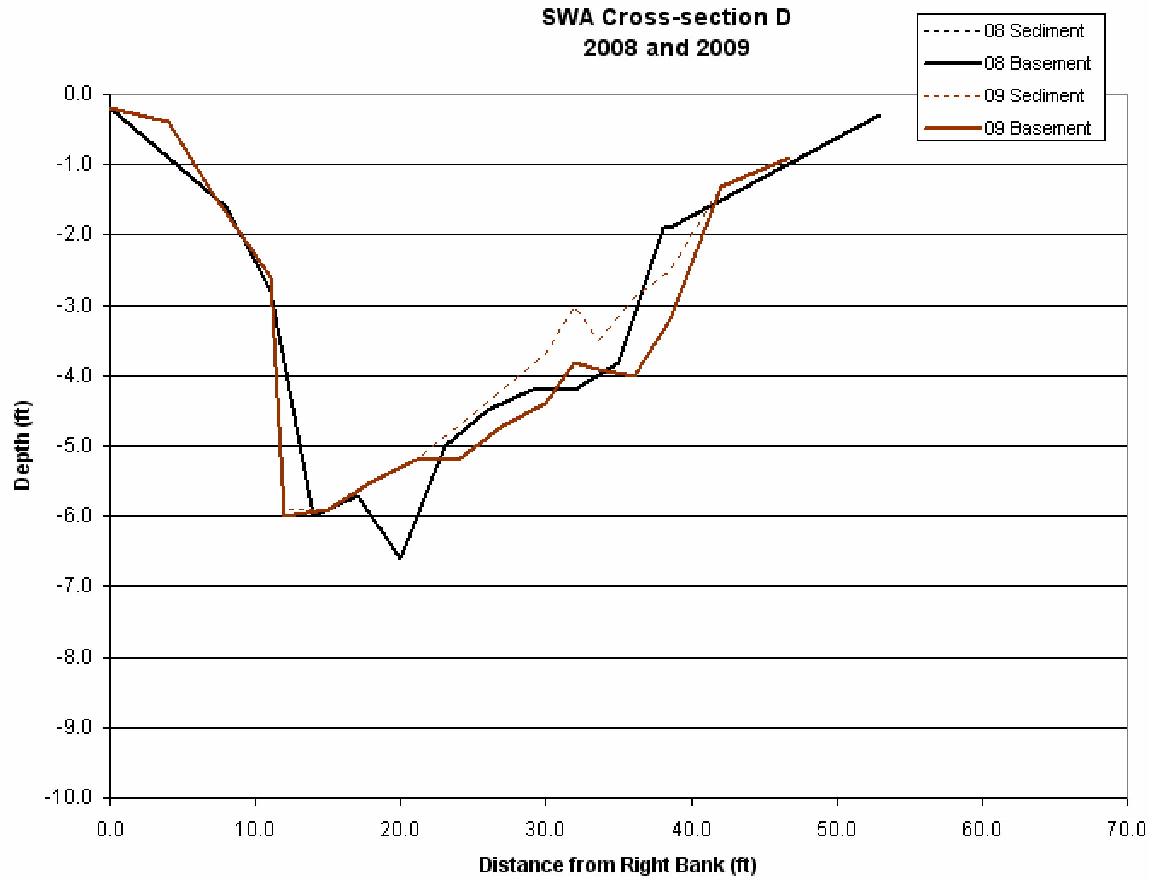


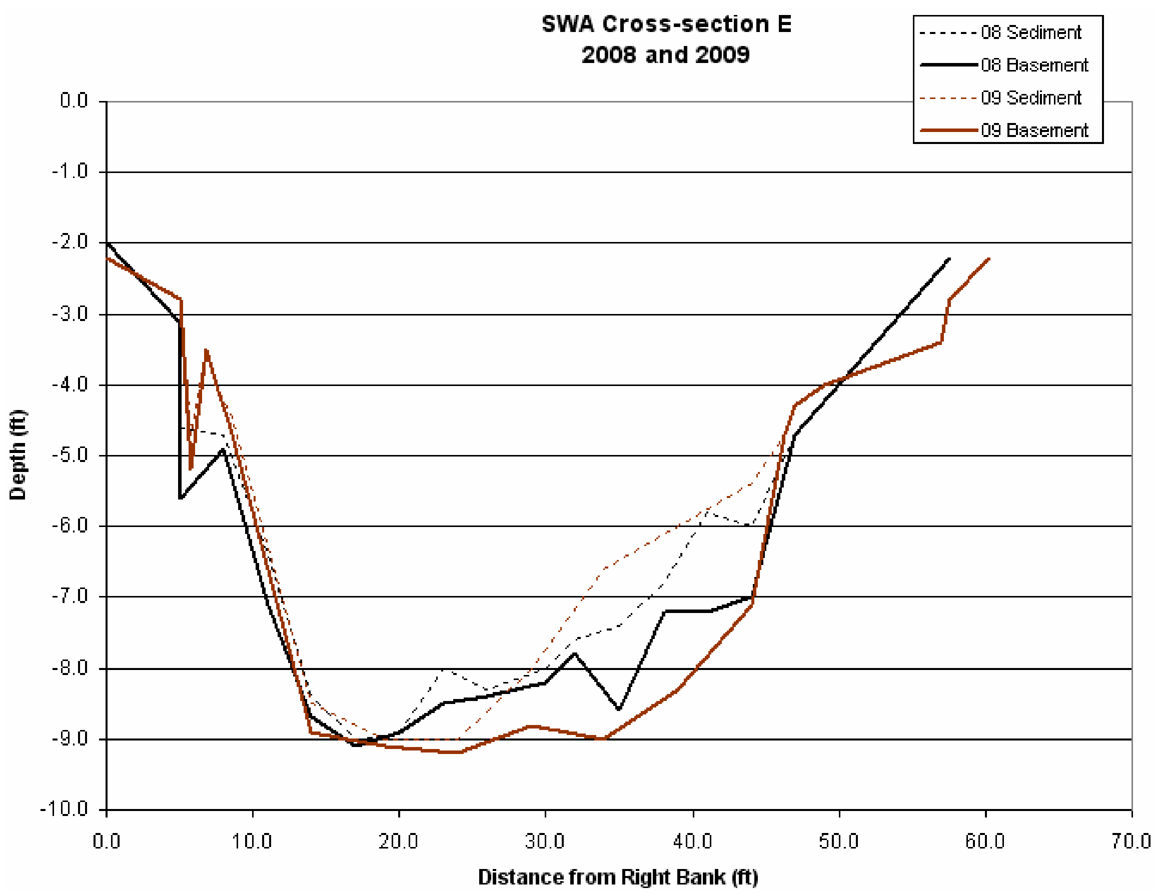
Daily Minimum Dissolved Oxygen 2008 and 2009
Site 4 - At Small Bridge
Site 4 - 2009
Site 4 - 2008
Dissolved Oxygen (ppm)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
4/1
4/8
4/15
4/22
4/29
5/6
5/13
5/20
5/27
6/3
6/10
6/17
6/24
7/1
7/8
7/15
7/22
7/29
8/5
8/12
8/19
8/26
Date

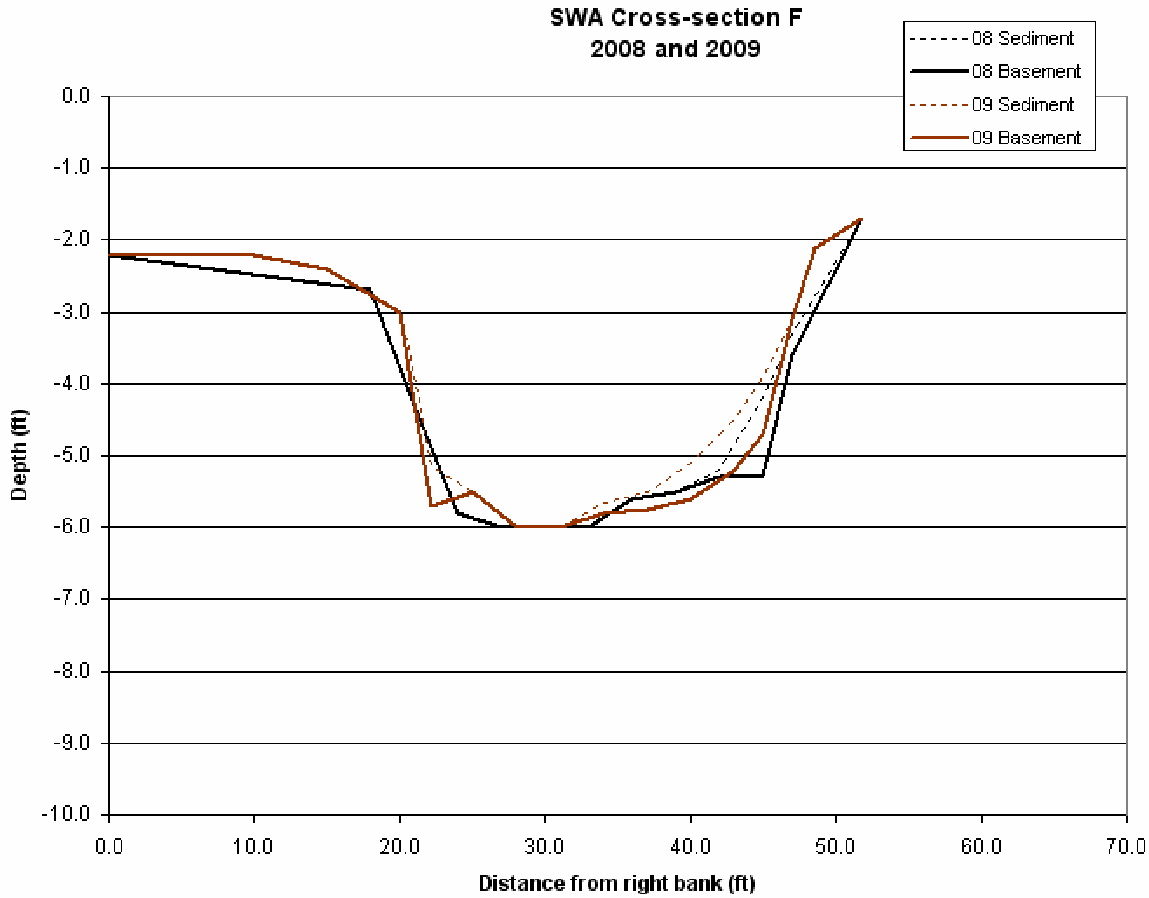
Appendix C. Cross Sections



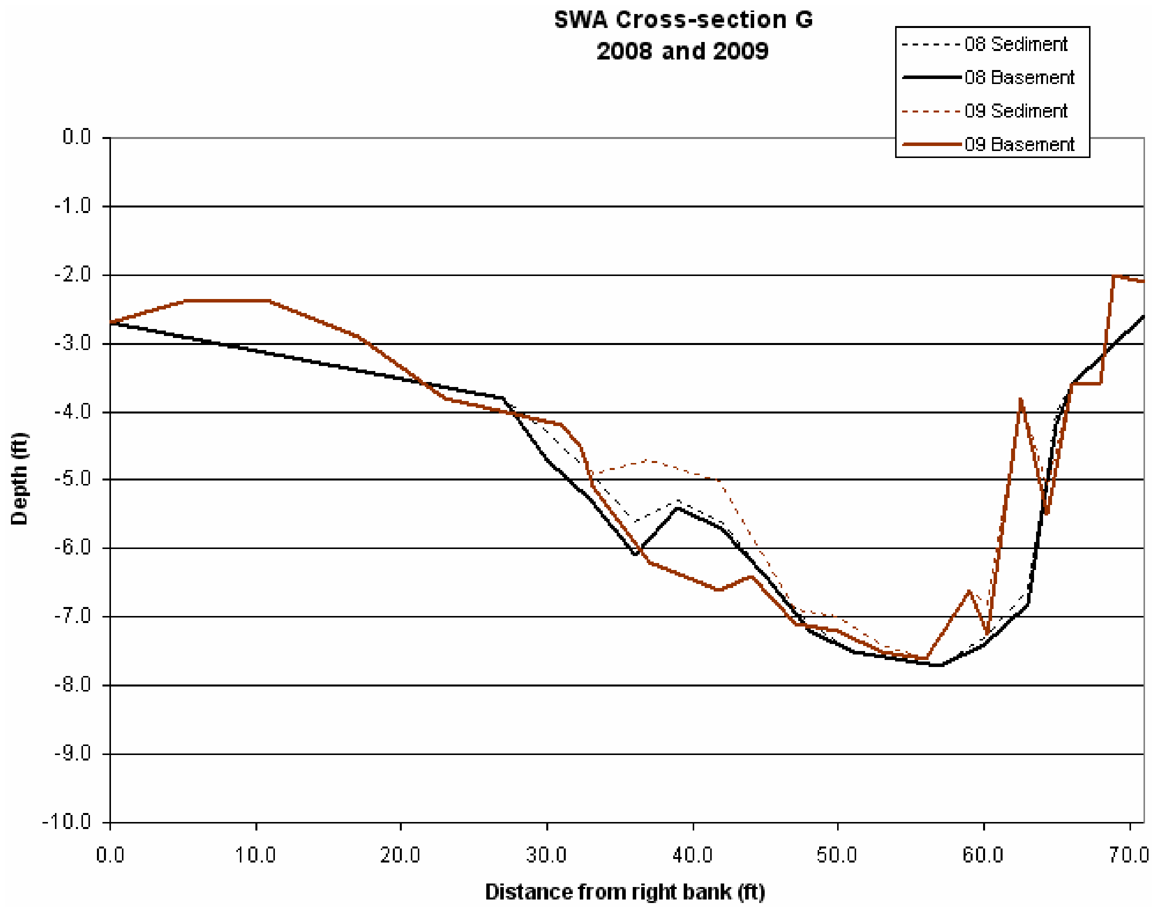



SWA Cross-section D
2008 and 2009
08 Sediment
08 Basement
09 Sediment
09 Basement
Depth (ft)
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0
-9.0
-10.0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
Distance from Right Bank (ft)


SWA Cross-section E
2008 and 2009
08 Sediment
08 Basement
09 Sediment
09 Basement
Depth (ft)
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0
-9.0
-10.0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
Distance from Right Bank (ft)



SWA Cross-section F
2008 and 2009
08 Sediment
08 Basement
09 Sediment
09 Basement
Depth (ft)
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0
-9.0
-10.0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
Distance from right bank (ft)



SWA Cross-section G
2008 and 2009
08 Sediment
08 Basement
09 Sediment
09 Basement
Depth (ft)
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0
-9.0
-10.0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
Distance from right bank (ft)