2008 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
March 2009

Introduction

The Shasta Valley Resource Conservation District (RCD) has 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, one of four irrigation districts in the Shasta Valley, utilizes a summer flashboard diversion structure with an associated impoundment to serve approximately 140 water users. This Shasta Water Association Dam is 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 creates poor water quality conditions in the river that include low dissolved oxygen content and high water temperatures, both of which are critical factors in fish survival. The dam also obstructs upward and downward movement by juvenile salmonids seeking cold refuge during the hot summer months and can provide a barrier to adults as they move upstream looking for spawning habitat. Implementation of the flashboard dam removal project will assist the RCD, NCRWQCB and California Department of Fish and Game 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 includes replacing the existing dam with two boulder weirs that will reduce 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 existing pre-project pumping system utilizes a fish screen that does not meet current fish screen criteria as well as a pump intake bay and bypass pipe which can be deleterious to fish as they are redirected into the pipe. This system will be replaced by a new fish screen and pumping station that will eliminate the need for the pump intake bay and bypass pipe. Eventually, the new pumping system will create a financial incentive for efficient water use by allowing users to be billed for the amount they use, as the existing pumping system only allows users to be billed for a fixed amount of water all season. Key sections of the existing irrigation ditches used to transport water will be replaced with underground piping or lined in order to reduce ditch losses and avoid the use of herbicides that are used to maintain the ditches.

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 is scheduled to be implemented in the fall of 2008. Therefore, this report contains pre-construction data only, which will help establish baseline conditions to aid the RCD

in determining the degree to which the water quality and fish passage goals have been met.

Monitoring procedures in 2007 and 2008 were followed as directed in the contract monitoring plan and the Quality Assurance Project Plan, and all Quality Assurance/ Quality Control protocol were followed. As agreed to in the contract, continued monitoring is to be conducted through the field season of 2009.

Monitoring Details and Methods

Parameters that were monitored include water temperature, dissolved oxygen, and 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 2007 took place from June through August. Continuous data collection began in March 2008 and extended through September 2008. See Figure 1 for the monitoring locations and Appendix C for photos of four monitoring sites.

Water temperature

Continuous water temperature data was collected at six sites. Four of these sites, labeled Sites #1 – 4, were within the project area. Zebra-Tech D-Optologgers, which record both dissolved oxygen and temperature, were installed at these four sites in March 2008. The D-Optologgers were not used in 2007 due to funding delays and unavoidable interference to the devices from construction activities.

The two remaining temperature collection sites were located upstream outside of the project area in order to document changes due to project implementation. Two Onset/ HOBO Tidbit temperature probes were deployed in April 2008. 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 at Site 6 at the upstream property line.

Both types of water temperature devices 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 extremely 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 existing pumping station to collect continuous air temperature data. This probe recorded hourly readings in a shaded location from mid-April through September. As directed in the monitoring plan, the Fish, Farms, and Forest Communities protocol was followed for calibration of the instrument.

Water temperature data collection in 2007 within the project area consisted of only a few readings taken in conjunction with dissolved oxygen grab samples using a Yellow Springs Instruments YSI-55 meter.

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 at Sites #1, 2, 3 and 4, the D-Optologgers recorded continuous hourly dissolved oxygen readings. 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. It will be also useful to compare the readings collected by the continuous meter to the 2008 grab sample data.

Dissolved oxygen grab sample data was collected several times in 2007 and 2008 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 both years. Measurements were also taken at Site #1 in 2008. 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 seven streambank locations. 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 will also be used to compare changes in wetted channel as a result of the project. Pre-construction aerial photos include USGS orthoquads (1998 and 2003) and NRCS National Agriculture Imagery Program (2005) photos.

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 on June 26, 2008. 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 major goals of the project is to remove a flashboard dam at the Shasta Water Association site in order to provide for improved fish passage. Project implementation

plans include the construction of two boulder weirs, one at the old dam site and one farther upstream 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. 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 existing irrigation ditches to improve water delivery efficiency and 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 existing pumping system is limited in that it can only deliver a fixed amount of water (42 cfs) to the users all season long. Upon completion, the project will replace the existing pumping system with four new variable frequency drive pumps and various pumping station improvements. These pumps will assist the Shasta Water Association with eventually establishing a rate structure based on the amount of water used instead of a flat rate. This eventual conversion to a fee system will provide financial incentive to conserve water during times of the year when water is not needed. In the meantime, water usage costs to the diverters will be 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 computer hard drive and back-up drive, as well as on a CD stored at the main SVRCD office. The 2008 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.

Continuous monitoring data was collected throughout the 2008 irrigation season and verified for accuracy. Some data gaps occurred due to normal download and calibration procedures. Others were due to equipment malfunction caused by a battery connection failure in several D-Optologgers, which was remedied upon diagnosis. Other data gaps occurred due to extremely low flow levels resulting from irrigation practices, causing the meters to be exposed to air for a period of time.

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. The two D-Optologgers that were immediately downstream and upstream of the dam, at Sites 1 and 2, were removed from the river at the end of June 2008 due to in-stream construction activities. Therefore, data is compared for all six sites during the early

season, prior to June 20, when all instruments were deployed. Data is also compared for the entire season among the four sites that had instruments in place all season.

In comparing the six sites during the early season, the two highest maximum temperature readings of 25.2°C and 25.1°C were measured immediately upstream of the dam and upstream of the pump station. These two sites also had the highest maximum daily average temperatures, 21.73°C and 21.71°C. The site below the dam had the lowest maximum and maximum daily average temperatures, but that site had a large data gap during the sampling period, limiting reliable comparisons.

Among the four sites that were monitored for the entire season, the maximum temperatures showed little variation, with the maximum temperature varying from 25.2°C at the most upstream site outside of the project area (Site 6) to 24.9°C at Site 4, the most upstream site within the project area. The maximum daily average temperatures showed slightly more variation between sites, with the site upstream of the pump station (Site 3) and the site at the upstream end of the project area (Site 4) showing the highest values of 22.81°C and 22.63, respectively. The lowest maximum daily averages were measured at the two sites outside of the project area, Sites 5 and 6, with readings of 21.66°C and 21.55°C, respectively. This result is consistent with the expected results, as the river temperature generally increases in a downstream direction from the headwaters to the mouth. A graph of the daily average water temperatures for all six sites in 2008 is included in Appendix A.

Air temperature was measured near the existing pump station throughout the 2008 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 2008 season. This data is shown for each site in graphed form in Appendix A. A summary of the minimum, maximum, and average DO concentration measured at each site during the entire season is shown in Table 2. The lowest minimum of 3.167 ppm was recorded upstream of the dam at Site 2. The highest minimum, 6.584 ppm, was measured at site 1, the site just downstream of the dam. This site, however, had a limited sampling period. The average DO level for the season was lowest at the site upstream of the pump station, Site 3, at 9.406 ppm, and the highest average of 10.794 ppm was at Site 2, the site upstream of the dam. The dissolved oxygen graphs in Appendix A provide an overall visual display of the data readings throughout the season. Graphs of the daily minimum DO readings and the daily average DO values for sites 3 and 4, the two sites that had the longest data collection periods, are also included in Appendix A.

The minimum, maximum, and average dissolved oxygen concentrations per month for the four sites are summarized in Table 3. The lowest monthly minimum DO reading occurred in May while the lowest monthly average occurred in August. Based on the data presented in the summary, DO concentrations appear to be lowest at Site 3, upstream of the pump station.

Table 2 includes DO grab sample data that was collected in 2007 using a YSI-55 meter at pre-dawn on two different days. Dissolved oxygen fluctuates diurnally, and at pre-dawn photosynthesis by aquatic vegetation is at a minimum, resulting in minimum dissolved oxygen levels. The days during which grab samples were taken were chosen based on extended hot summer days during the mid to late irrigation season in order to capture some of the lowest DO measurements for the season. However, these few data points provide for limited comparisons to the 2008 data, as many variables affect daily dissolved oxygen levels and no direct comparisons can be made between the 2007 grab samples and the 2008 grab samples or continuous measurements. To graphically show this comparison, the DO measurements for each site during the month of July 2008 are plotted along with a point for the corresponding grab sample taken during July 2007 (Appendix A). Measurements taken with the YSI-55 meter were collected at the same sites as the continuous meter with the exception of the area below the dam. Grab samples were taken at Site 0, which is 500 feet downstream of the dam, while continuous measurements were taken at Site 1, a site 50 feet below the dam.

Dissolved oxygen grab sample data was also collected in 2008 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, and is shown graphically in Appendix A. 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 generally very similar, providing validity to the dissolved oxygen monitoring methods.

Width of Wetted Channel

Cross-sections of the river channel, including depth of sediment deposits, were measured in the summer of 2008 at seven permanent locations throughout the project area. The resulting profiles of the riverbank were then graphed and are shown in Appendix B. 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.

Photopoints

Pre-construction photographs were taken from the established photopoints on June 26, 2008. Photos were taken both upstream and downstream. Visual documentation of the project site before and after construction will be useful in determining post-construction changes in the channel configuration, flow characteristics, and vegetation growth.

Improved Fish Passage

Digital photographs will be taken during the construction phase of the boulder weirs as well as upon completion to document a maximum jump height of twelve inches. These photos will be included in the post-construction monitoring reports.

Ditch Maintenance/ Water Usage Costs
Pre-project and post-project costs of ditch maintenance and water usage will be compared in the post-project monitoring report.

Future Monitoring
As outlined in the project's Monitoring Plan, post-construction monitoring will take place during the 2009 irrigation season. While the one-year post-construction period will help document immediate changes within the project area, many river processes occur slowly over time and may not be measurable for many years. The Shasta Valley RCD intends to continue to pursue funding to allow continued monitoring within the basin to increase the base of knowledge about the Shasta River and to document continued improvements due to restoration projects. Continued monitoring of the parameters measured in 2007 and 2008 will be performed in 2009 as specified in the monitoring plan for this project.

Water Temperature
Post-construction water temperature will continue to be measured at the same six sites that were measured in 2008. Four Zebra-Tech D-Optologgers will again be installed at the four sites within the project area, which will store continuous records of hourly water temperature readings. Continuous temperature data will again be collected at the two sites upstream of the project area using two Onset/ HOBO temperature probes. As in 2008, an Onset/ HOBO temperature probe will be placed near the Shasta Water Association pumping station to record air temperature throughout the field season. All equipment will be installed in a shaded area or housed in a shading device, and instream devices will be monitored regularly to ensure submersion during periods of low flow.

Dissolved Oxygen
Post-construction dissolved oxygen measurements will also be taken using the four Zebra-Tech D-Optologgers at the four sites within the project area. The D-Optologger utilizes fluorescence to measure dissolved oxygen, providing accurate readings over a long period of time. The meters will record hourly readings, resulting in a continuous record throughout the field season. Calibration and maintenance procedures from the D-Optologger manual will be followed. In addition, grab sample readings with the YSI-55 hand-held meter will be taken several times during the season in order to compare results.

Width of Wetted Channel
The six permanent pre-construction cross-sections established in 2008 will be revisited and measured. This data will be collected at the same time of year as in 2008. New aerial photos will be utilized as available to compare to pre-construction aerial photos in order to help document changes in width of wetted channel due to the project.

Photopoints
Digital photographs will be taken in August 2009 at the established photopoints to create a continuous visual record of the project area.

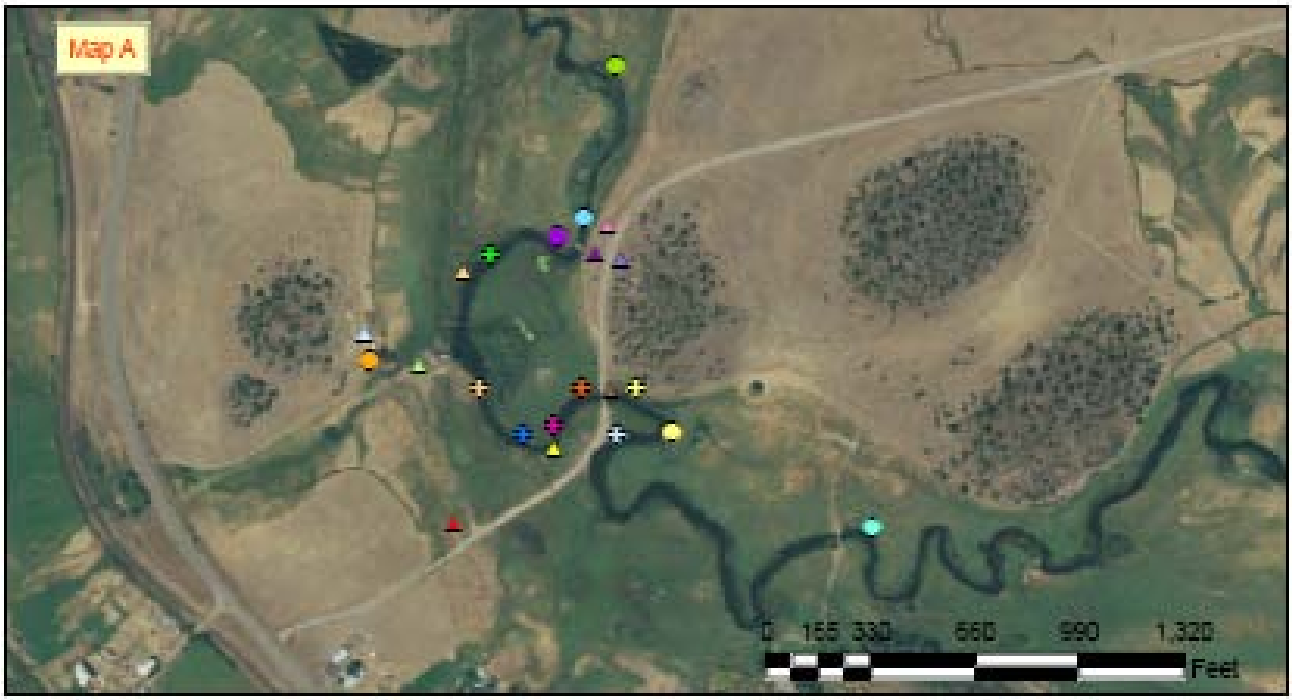
Improved Fish Passage
Digital photographs will be taken in 2009, including during low flows, to document whether any significant change had occurred at the weir structure, assuring a maximum jump height of twelve inches at the boulder weir.

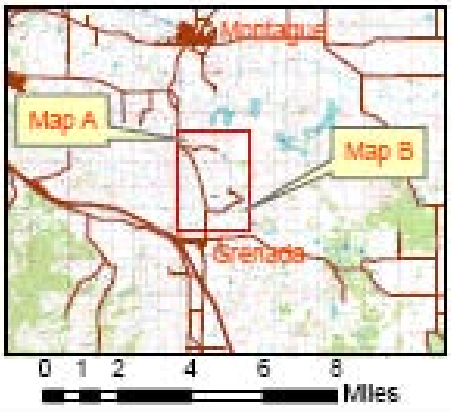
Ditch Maintenance/ Water Usage Fees
The Shasta Valley Resource Conservation District has asked the ranchers to continue to track their labor and herbicide costs for ditch maintenance as well as their water usage fees during 2009.

Summary
Pre-construction monitoring data collected in 2007 and 2008 for the Shasta Water Association project will help provide a baseline with which post-construction monitoring data comparisons can be made. Monitoring by the Shasta Valley Resource Conservation District will continue in order to collect quality data to help determine the effects of the flashboard diversion removal project on the river system and the habitat it provides.

The Shasta River is a unique river system with its spring-fed, low-gradient characteristics and agricultural influences. Much progress has been made in the last decade by various agencies to study and understand its processes. Projects such as the Shasta Water Association Dam Demobilization and Water Quality Enhancement Project not only meet short-term goals to improve water quality, habitat, and passage, but also contribute to the base of knowledge needed for sound resource management.

Figure 1. Shasta Water Association Dam Removal Project Monitoring Locations





Monitoring Locations

- Air Temp
- Site 0 (DO)
- Site 1 (DO, Temp)
- Site 2 (DO, Temp)
- Site 3 (DO, Temp)
- Site 4 (DO, Temp)
- Site 5 (Temp)
- Site 6 (Temp)

Cross Sections

- X-Section A
- X-Section B
- X-Section C
- X-Section D
- X-Section E
- X-Section F
- X-Section G

Photo Points

- Photopoint 1
- Photopoint 3
- Photopoint 6
- Photopoint 8
- Photopoint 9
- Photopoint 11
- Photopoint 12
- Photopoint 14
- Photopoint 16

N
W E
S

Table 1
2008 WATER TEMPERATURE SUMMARY

Site #	Continuous Monitoring Location	Latitude	Longitude	2008 Season		Early 2008 Season Prior to June 20	
				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	NS	NS	23.0	20.49
2	Upstream of Dam	41.687570	-122.530267	NS	NS	25.2	21.73
3	Upstream of Pump and Bridge at Bend	41.685861	-122.528944	25.1	22.81	25.1	21.71
4	Upstream of Small Bridge	41.685028	-122.526667	24.9	22.63	24.9	21.57
5	Off DeSoza Ln. - Dnstrm Property Line	41.657722	-122.500972	25.0	21.66	23.7	
6	Off DeSoza Ln. - Upstrm Property Line	41.654417	-122.503056	25.2	21.55	23.4	20.99

NS *Not Sampled for entire season*
** Sampling Period 3/22/08 - 4/16/08 and 6/11/08 - 6/26/08*

Table 2
2008 DISSOLVED OXYGEN SUMMARY FOR 2008 SEASON AND 2007 DISSOLVED OXYGEN DATA

Site #	Location	Latitude	Longitude	Pre-Construction 2008 Continuous Data Collection			Pre-Construction 2007 Grab Samples	
				2008 Minimum DO ppm	2008 Maximum DO ppm	2008 Average DO ppm	6/12/2007 Pre-Dawn DO ppm	7/9/2007 Pre-Dawn DO ppm
0	500 ft Downstream Dam	41.689110	-122.529528	NS	NS	NS	6.81	6.04
1	50 ft Downstrm SWA Dam *	41.687735	-122.529959	6.584	12.892	9.921	NS	NS
2	Upstream SWA Dam **	41.687570	-122.530267	3.167	33.484	10.794	6.94	5.34
3	Upstrm Pump & Bridge at Bend	41.685861	-122.528944	5.262	34.773	9.406	7.12	5.77
4	Upstream Small Bridge	41.685028	-122.526667	5.296	33.622	9.897	7.14	5.49

** Limited sampling period, removed 6/26/08*
*** Removed 6/20/08*
NS *Not Sampled*

Table 3
2008 DISSOLVED OXYGEN SUMMARY BY MONTH

Site #	Continuous Monitoring Location	April			May			June			July			August			September		
		Month Min	Month Max	Month Avg	Month Min	Month Max	Month Avg	Month Min	Month Max	Month Avg	Month Min	Month Max	Month Avg	Month Min	Month Max	Month Avg	Month Min	Month Max	Month Avg
1	Downstrm Dam Site	8.506	12.892	10.401	INC	INC	INC	6.584	12.837	9.244	NS	NS	NS	NS	NS	NS	NS	NS	NS
2	Upstrm Dam Site	6.038	33.484	11.870	3.167	31.914	10.638	5.639	16.093	9.594	NS	NS	NS	NS	NS	NS	NS	NS	NS
3	Upstrm Pump/Bridge at Bend	6.930	29.194	10.827	5.525	34.773	10.143	5.266	14.683	9.276	5.262	13.125	8.632	5.602	12.547	8.499	6.214	12.358	8.884
4	Upstrm Small Bridge	6.345	33.622	10.906	5.708	27.023	10.457	5.296	17.983	9.418	5.480	20.817	8.959	INC	INC	INC	6.863	14.096	9.355

Lowest value among sites during month
INC *Incomplete record for month*
NS *Not sampled*

Table 4
2008 CONTINUOUS DATA AND GRAB SAMPLE DATA COMPARISON

Sampling Date 4/11/08

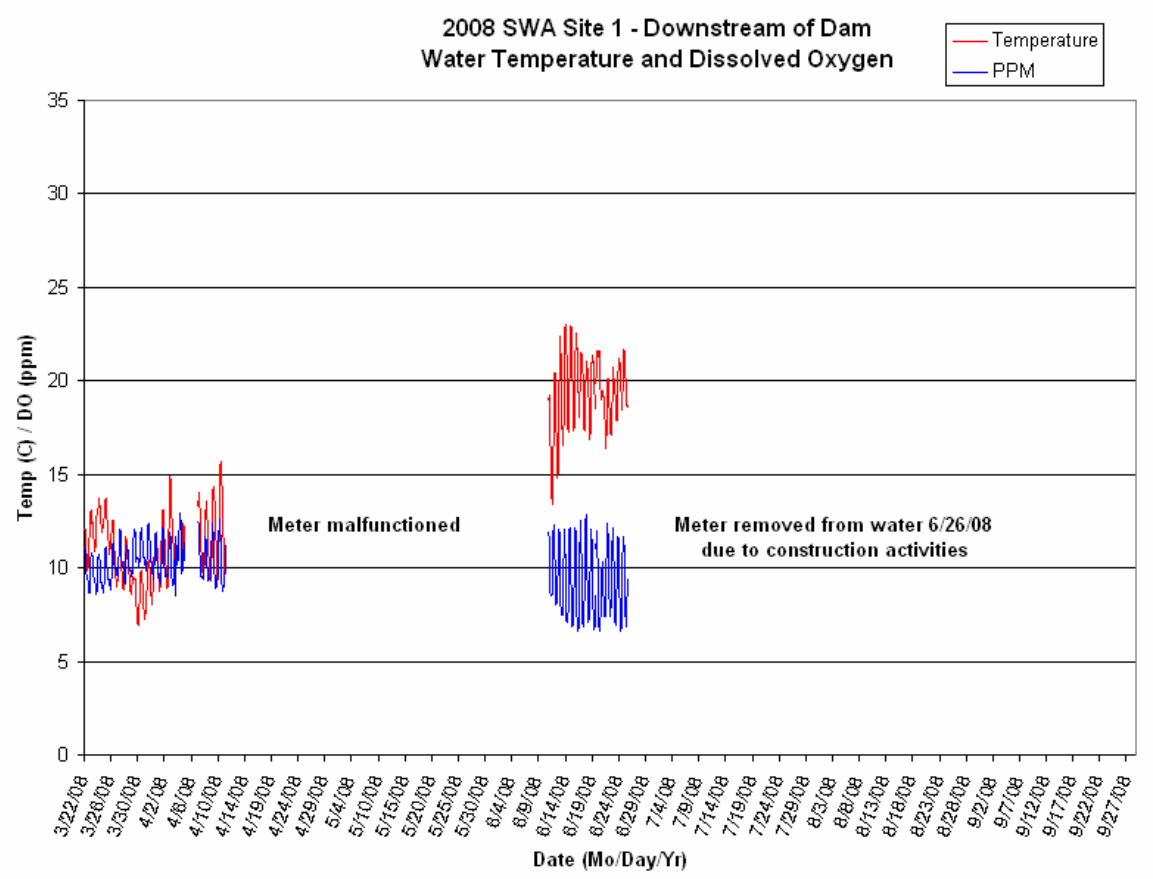
Site #	Location	Continuous Hourly Data			YSI-55 Grab Samples		
		Time	DO ppm	Temp °C	Time	DO ppm	Temp °C
1	50' Downstream SWA Dam	11:30 AM	11.27	10.7	11:25 AM	11.03	10.8
2	Upstream SWA Dam	10:52 AM	27.05	10.4	11:11 AM	10.73	10.8
3	Upstrm Pump/Bridge At Bend	12:07 PM	12.13	11.7	12:24 PM	12.70	12.1
4	Upstream Small Bridge	12:12 PM	12.21	11.8	12:36 PM	11.51	12.3

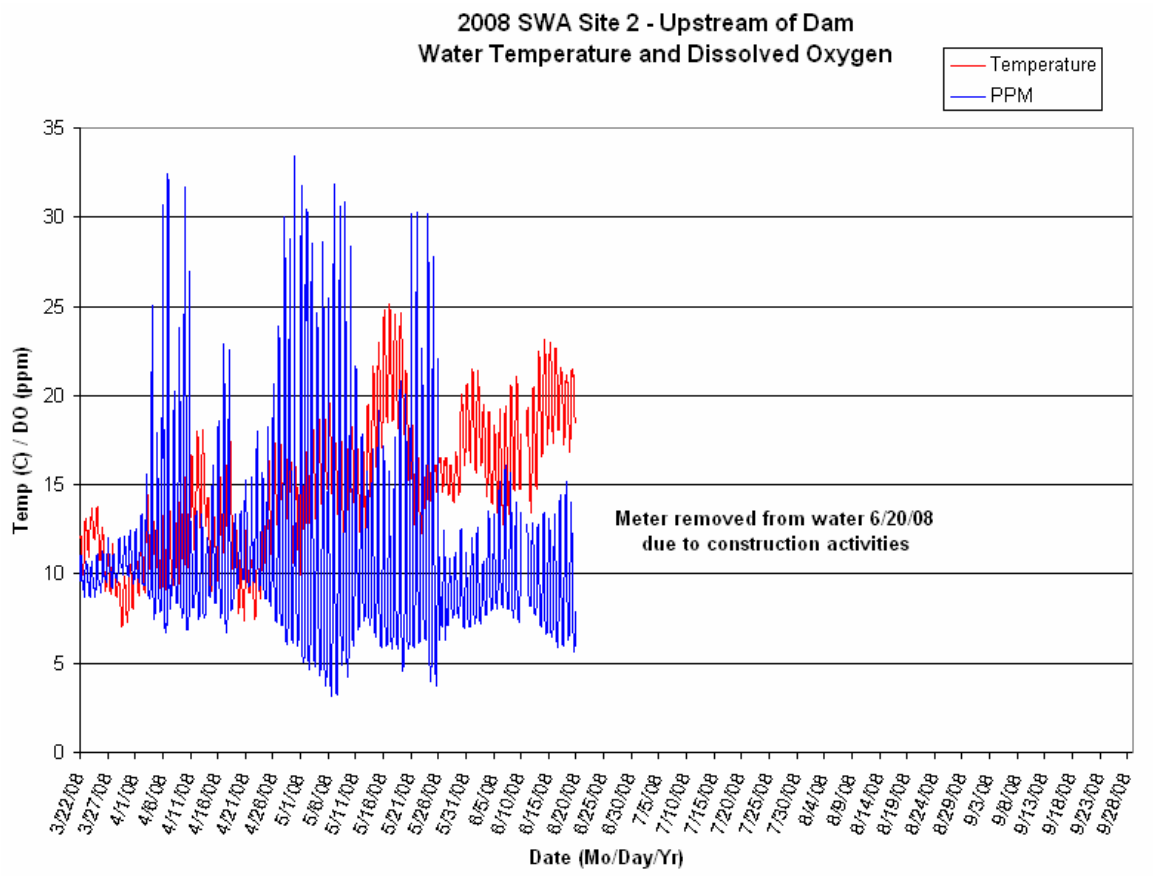
Sampling Date 7/10/08

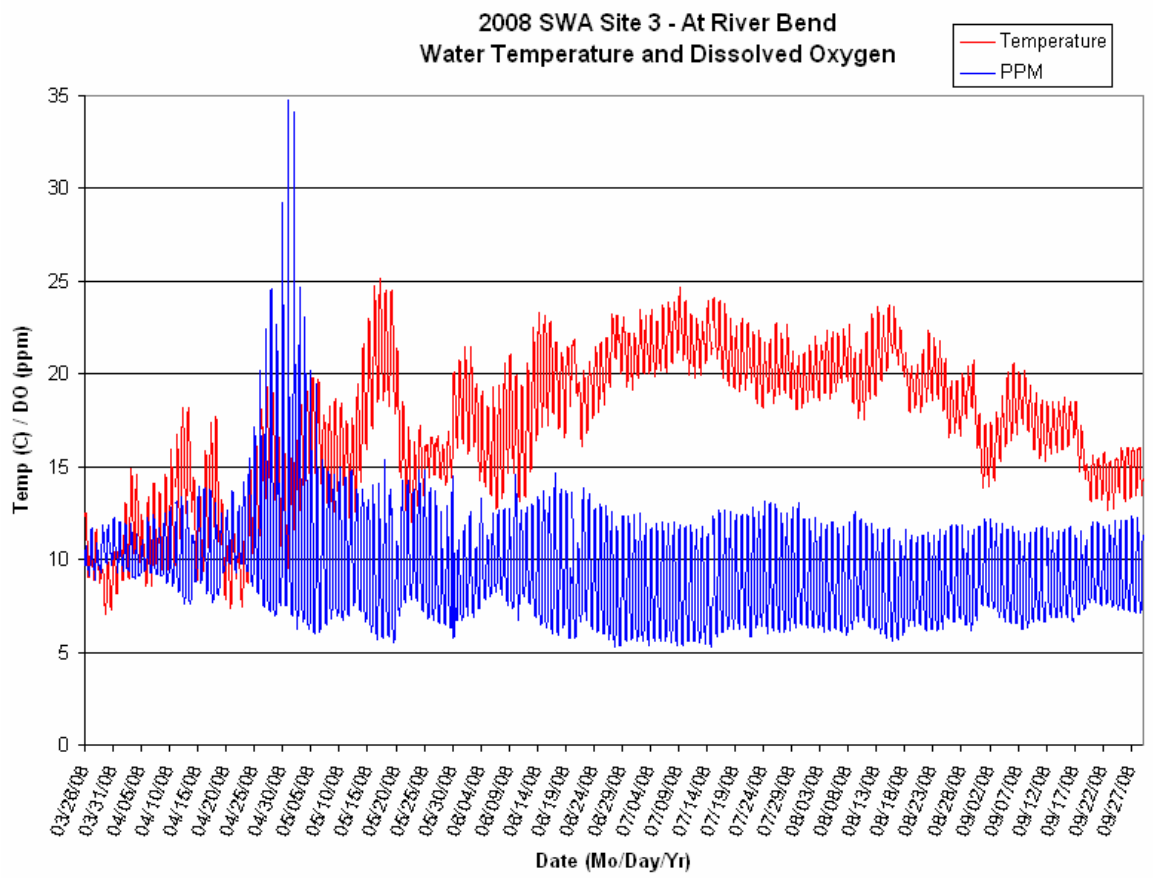
Site #	Location	Continuous Hourly Data			YSI-55 Grab Samples		
		Time	DO ppm	Temp °C	Time	DO ppm	Temp °C
0	500' Downstream SWA Dam	NS	NS	NS	4:16 AM	6.10	22.1
1	50' Downstream SWA Dam	NS - Removed for construction			NS	NS	NS
2	Upstream SWA Dam	NS - Removed for construction			4:24 AM	5.28	22.1
3	Upstrm Pump/Bridge At Bend	5:00 AM	5.36	21.7	4:31 AM	5.51	21.9
4	Upstream Small Bridge	5:00 AM	5.64	21.6	4:39 AM	5.62	21.8

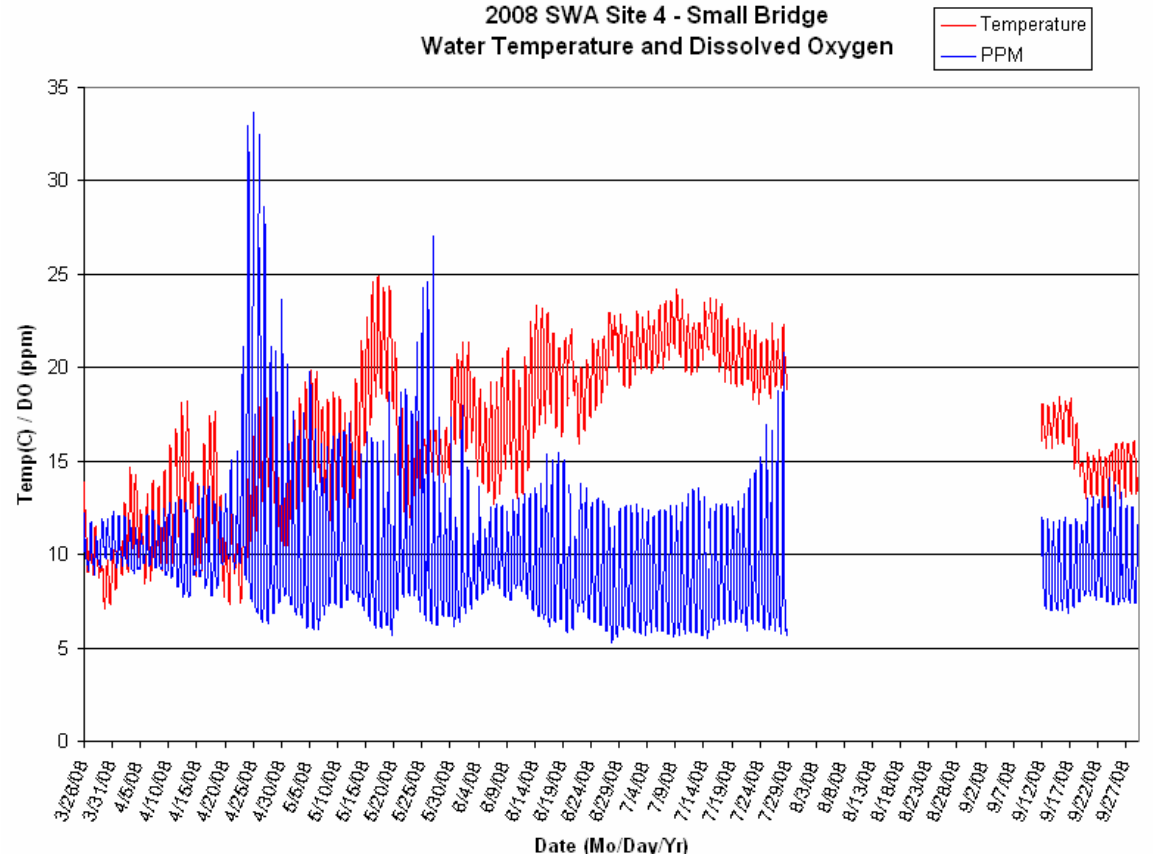
NS *Not Sampled*

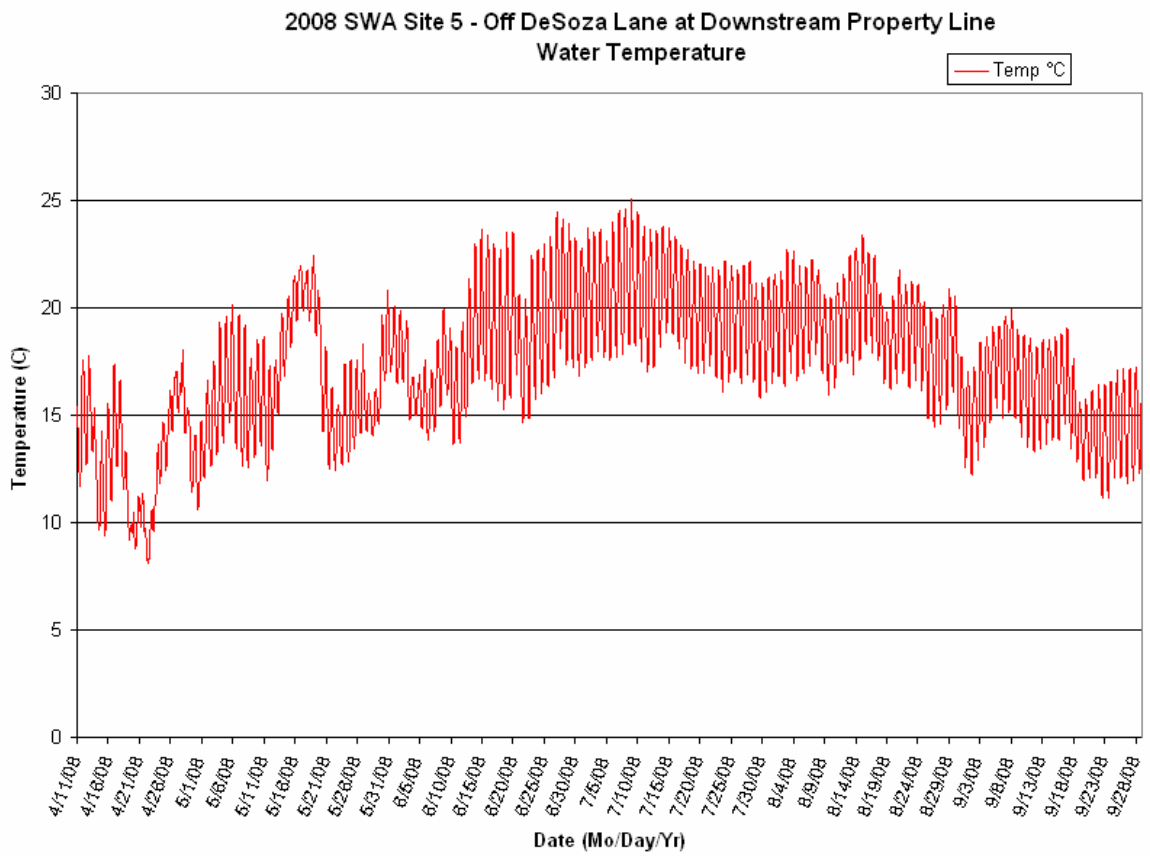
Appendix A. Temperature & Dissolved Oxygen Graphs

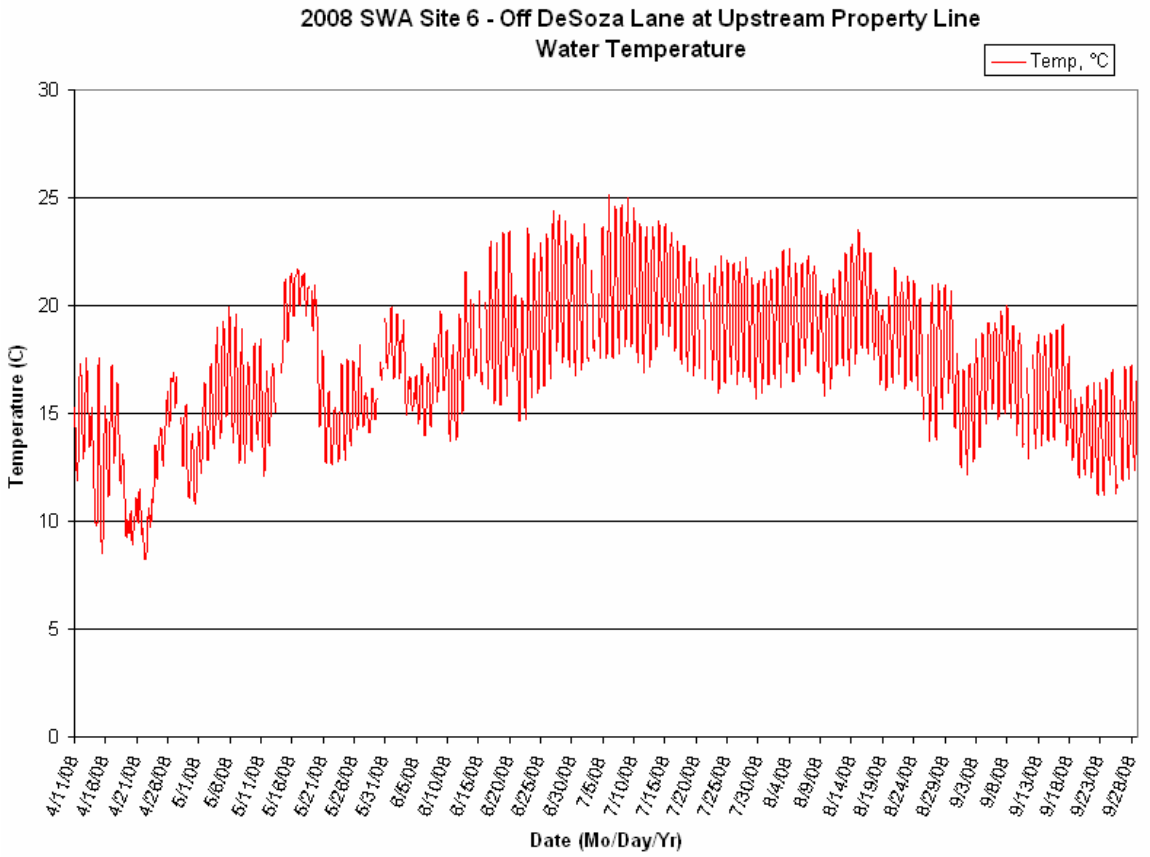


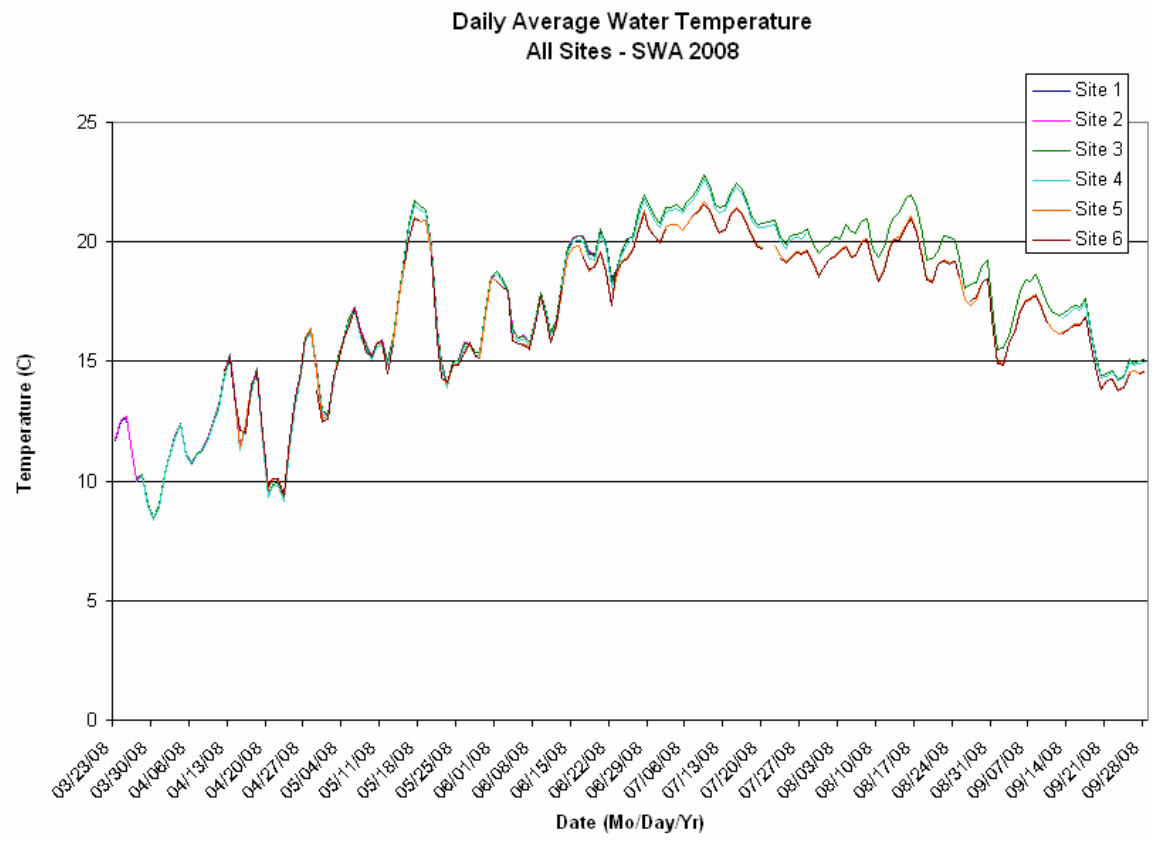


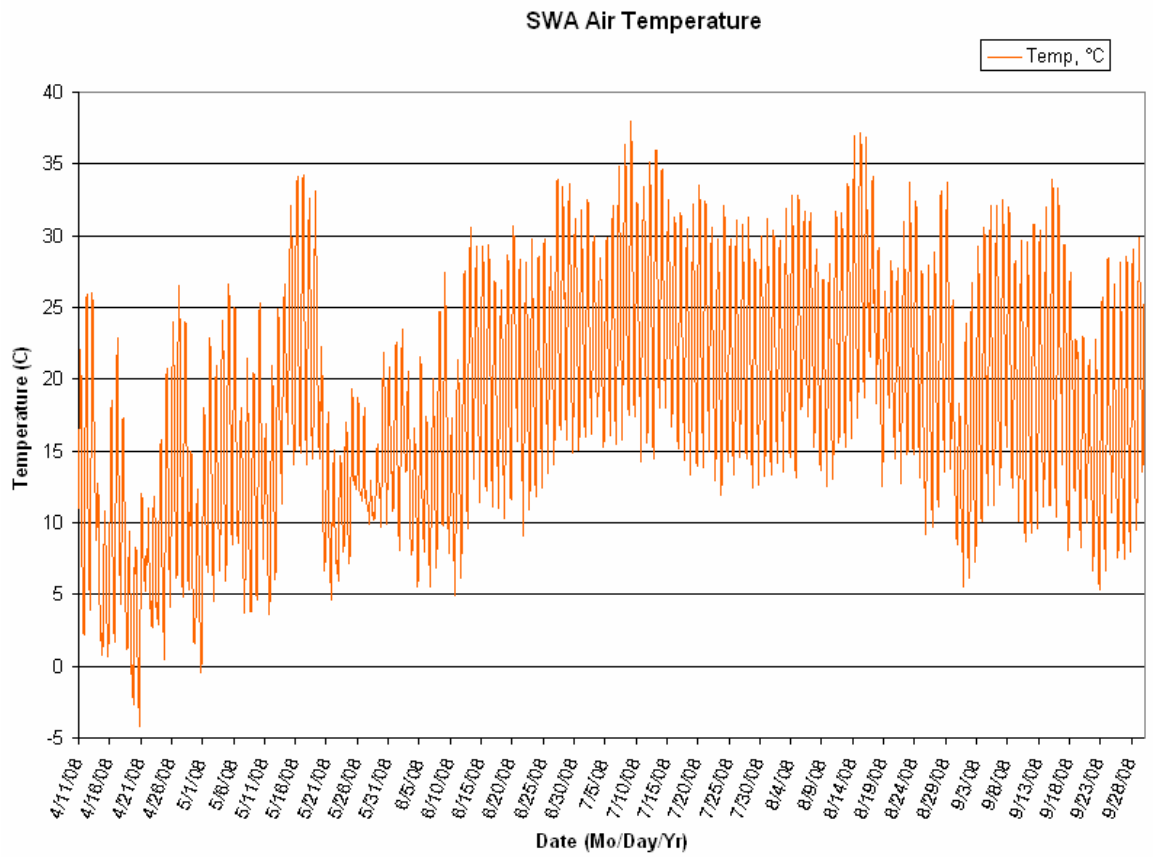

2008 SWA Site 3 - At River Bend
Water Temperature and Dissolved Oxygen
Temperature
PPM
Temp (C) / DO (ppm)
Date (Mo/Day/Yr)

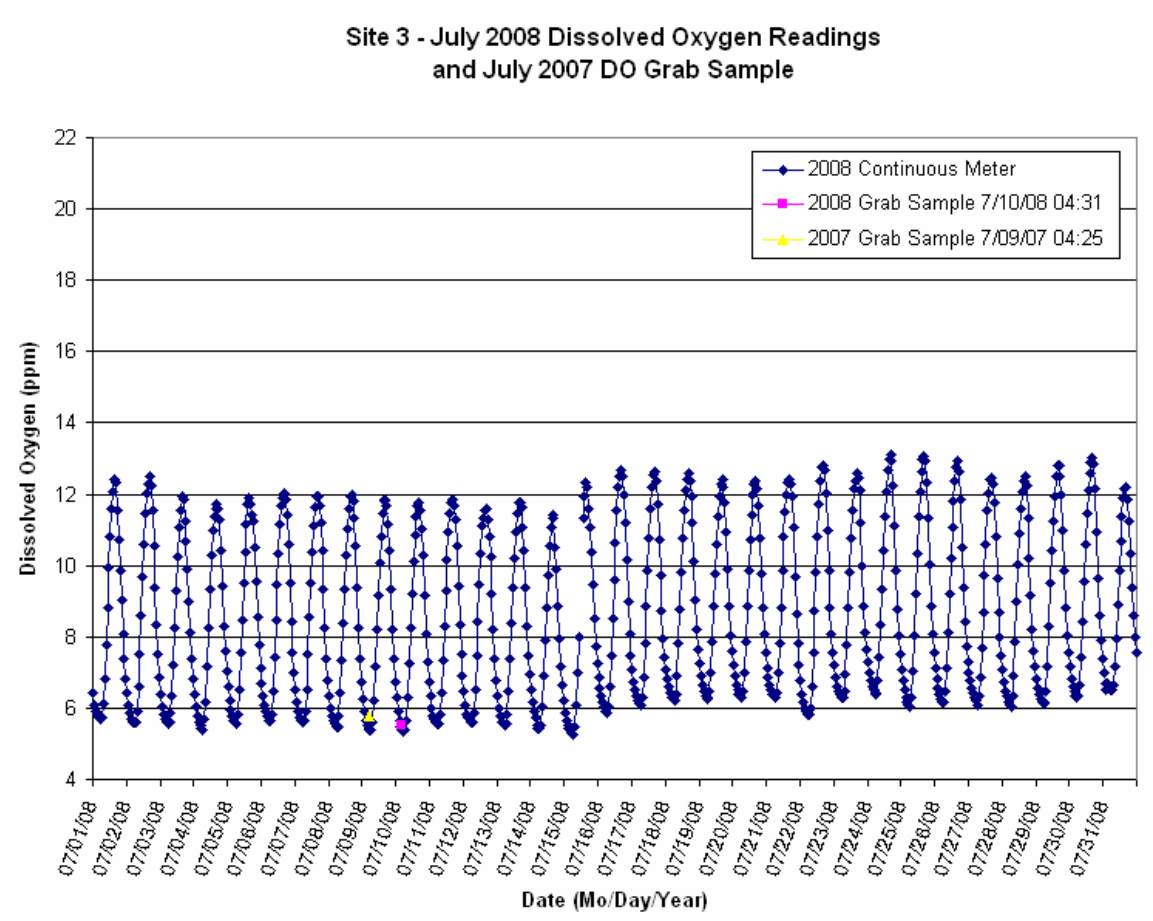

2008 SWA Site 4 - Small Bridge
Water Temperature and Dissolved Oxygen
Temperature
PPM
Temp(C) / DO (ppm)
Date (Mo/Day/Yr)

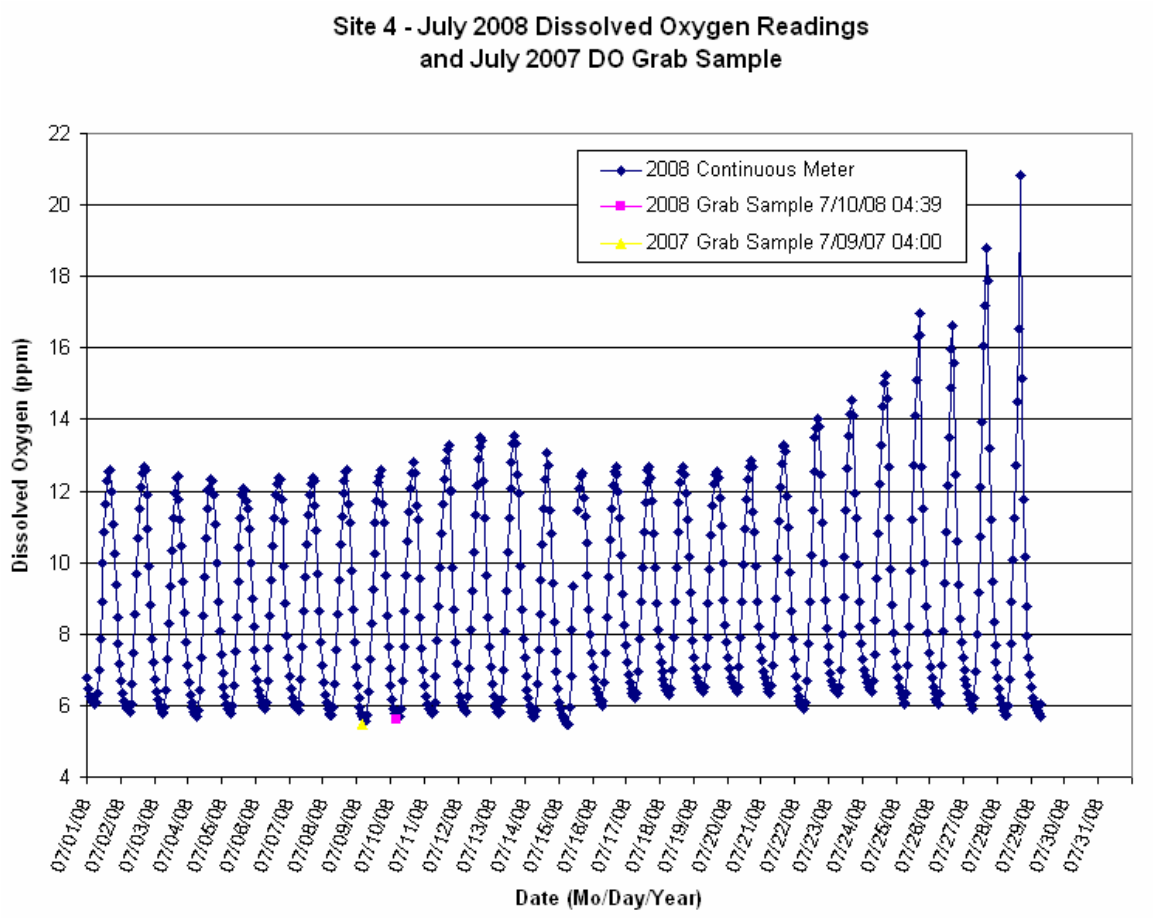

2008 SWA Site 5 - Off DeSoza Lane at Downstream Property Line
Water Temperature
Temp °C
Temperature (C)
Date (Mo/Day/Yr)

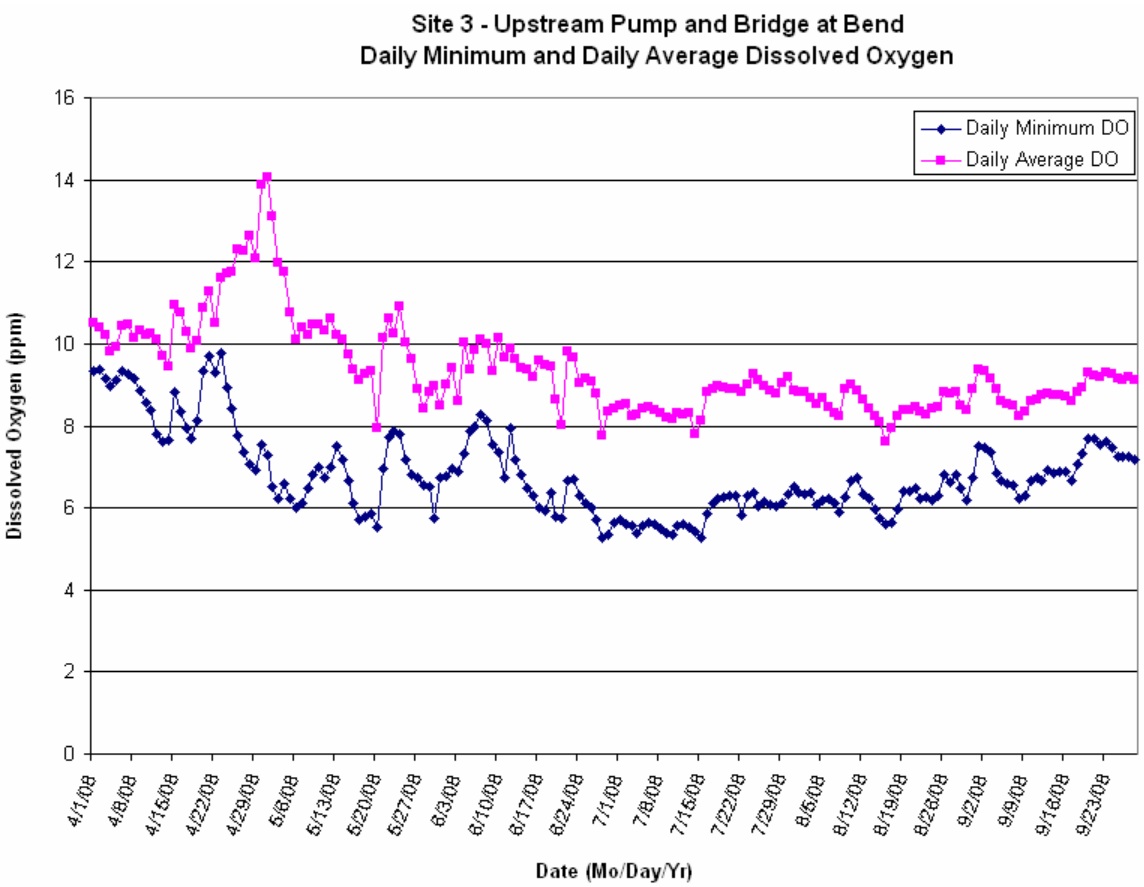

2008 SWA Site 6 - Off DeSoza Lane at Upstream Property Line
Water Temperature
Temp, °C
Temperature (C)
Date (Mo/Day/Yr)

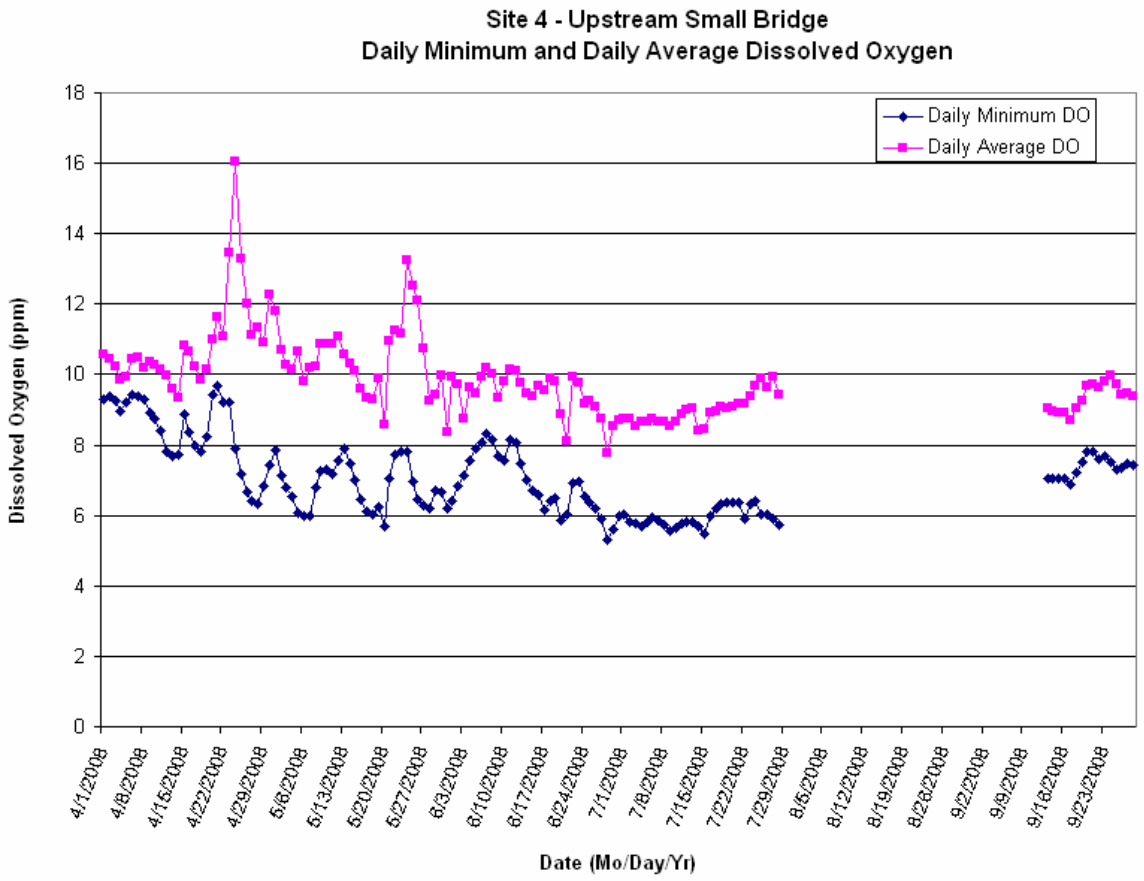

Daily Average Water Temperature
All Sites - SWA 2008
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6
Temperature (C)
25
20
15
10
5
0
03/23/08
03/30/08
04/06/08
04/13/08
04/20/08
04/27/08
05/04/08
05/11/08
05/18/08
05/25/08
06/01/08
06/08/08
06/15/08
06/22/08
06/29/08
07/06/08
07/13/08
07/20/08
07/27/08
08/03/08
08/10/08
08/17/08
08/24/08
08/31/08
09/07/08
09/14/08
09/21/08
09/28/08
Date (Mo/Day/Yr)


SWA Air Temperature
Temp, °C
Temperature (C)
40
35
30
25
20
15
10
5
0
-5
4/11/08
4/16/08
4/21/08
4/26/08
5/1/08
5/6/08
5/11/08
5/16/08
5/21/08
5/26/08
5/31/08
6/5/08
6/10/08
6/15/08
6/20/08
6/25/08
6/30/08
7/5/08
7/10/08
7/15/08
7/20/08
7/25/08
7/30/08
8/4/08
8/9/08
8/14/08
8/19/08
8/24/08
8/29/08
9/3/08
9/8/08
9/13/08
9/18/08
9/23/08
9/28/08
Date (Mo/Day/Yr)

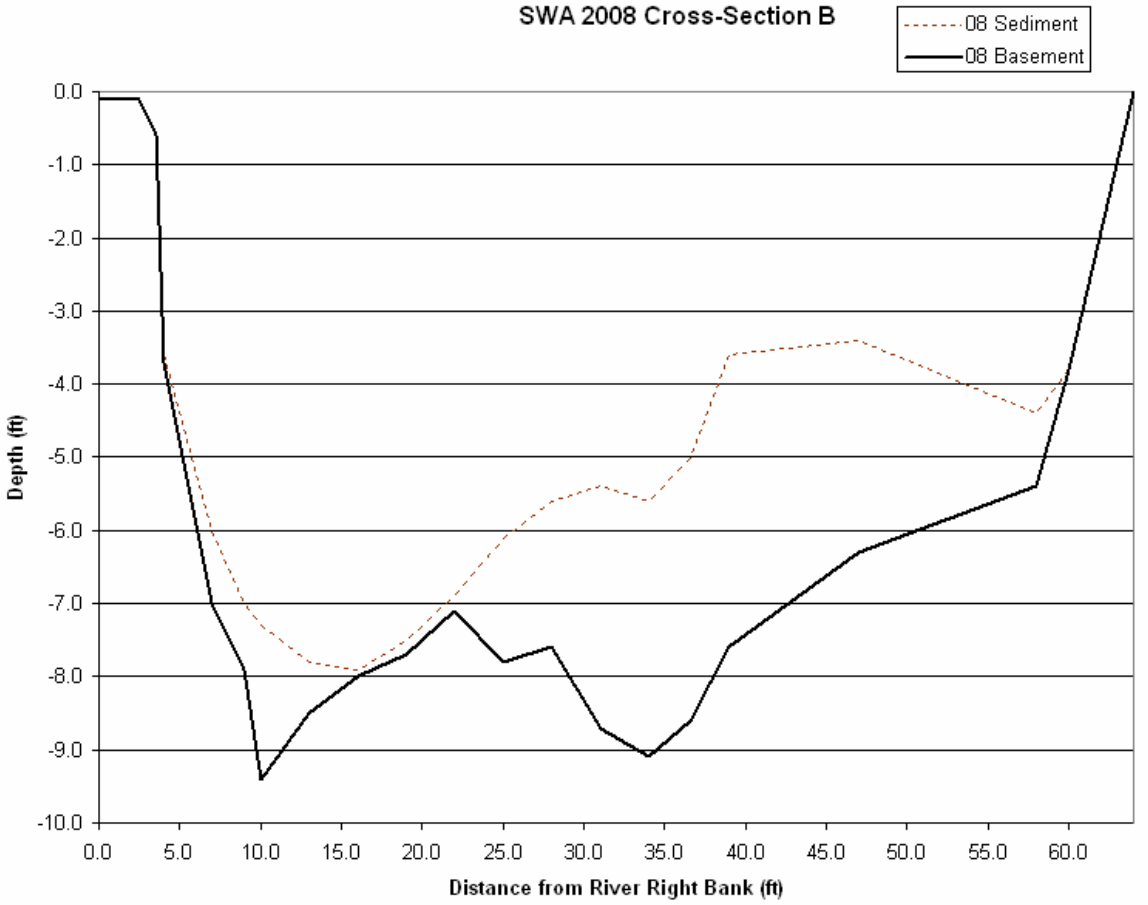

Site 3 - July 2008 Dissolved Oxygen Readings
and July 2007 DO Grab Sample
2008 Continuous Meter
2008 Grab Sample 7/10/08 04:31
2007 Grab Sample 7/09/07 04:25
Dissolved Oxygen (ppm)
Date (Mo/Day/Year)

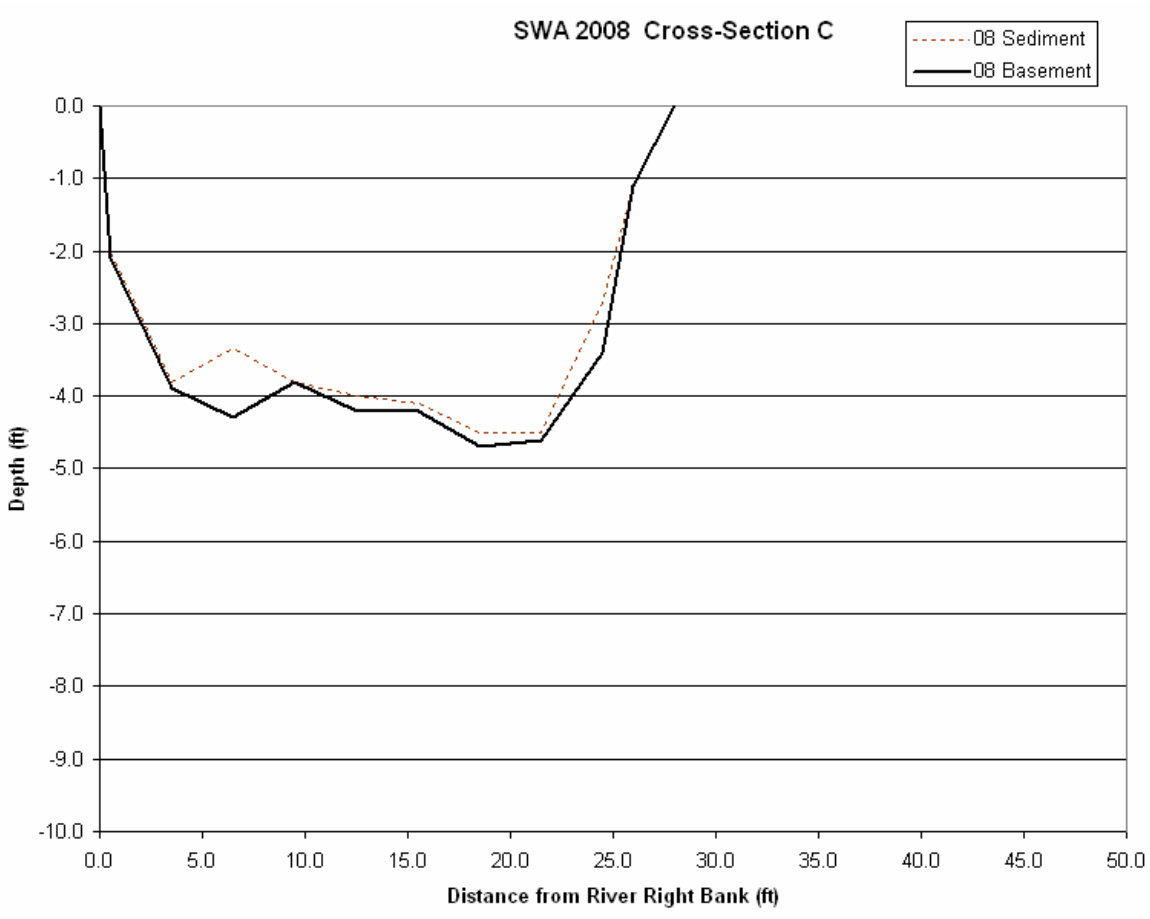

Site 4 - July 2008 Dissolved Oxygen Readings
and July 2007 DO Grab Sample
2008 Continuous Meter
2008 Grab Sample 7/10/08 04:39
2007 Grab Sample 7/09/07 04:00
Dissolved Oxygen (ppm)
Date (Mo/Day/Year)

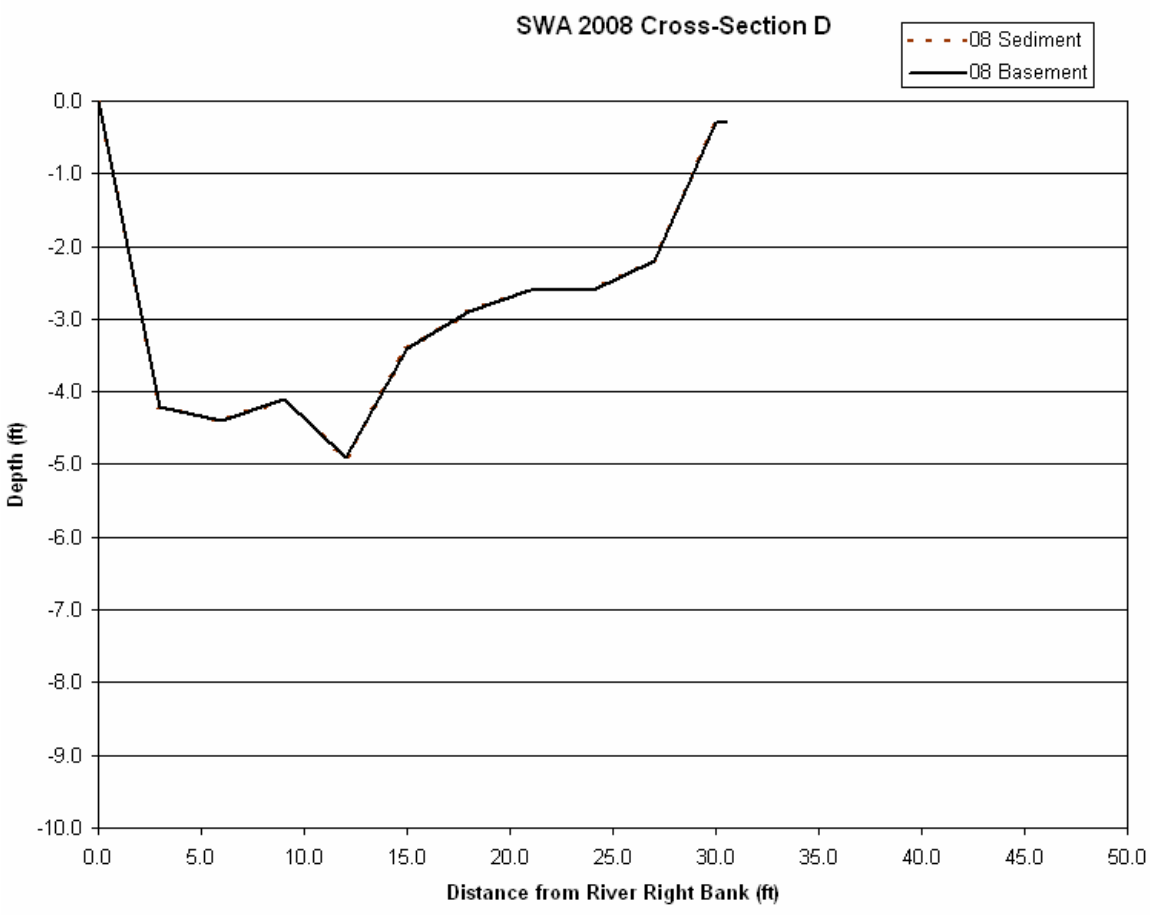

Site 3 - Upstream Pump and Bridge at Bend
Daily Minimum and Daily Average Dissolved Oxygen
Daily Minimum DO
Daily Average DO
Dissolved Oxygen (ppm)
0
2
4
6
8
10
12
14
16
4/1/08
4/8/08
4/15/08
4/22/08
4/29/08
5/6/08
5/13/08
5/20/08
5/27/08
6/3/08
6/10/08
6/17/08
6/24/08
7/1/08
7/8/08
7/15/08
7/22/08
7/29/08
8/5/08
8/12/08
8/19/08
8/26/08
9/2/08
9/9/08
9/16/08
9/23/08
Date (Mo/Day/Yr)

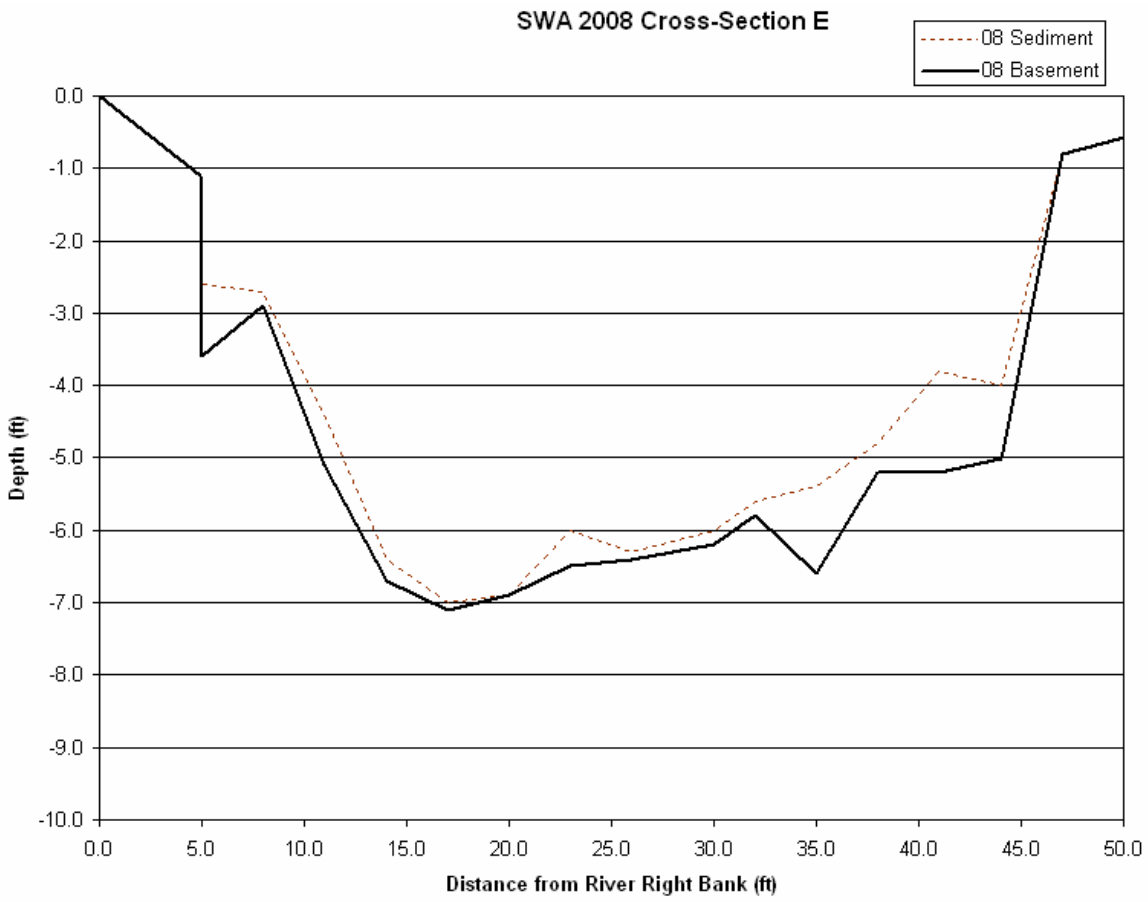

Site 4 - Upstream Small Bridge
Daily Minimum and Daily Average Dissolved Oxygen
Daily Minimum DO
Daily Average DO
Dissolved Oxygen (ppm)
0
2
4
6
8
10
12
14
16
18
4/1/2008
4/8/2008
4/15/2008
4/22/2008
4/29/2008
5/6/2008
5/13/2008
5/20/2008
5/27/2008
6/3/2008
6/10/2008
6/17/2008
6/24/2008
7/1/2008
7/8/2008
7/15/2008
7/22/2008
7/29/2008
8/5/2008
8/12/2008
8/19/2008
8/26/2008
9/2/2008
9/9/2008
9/16/2008
9/23/2008
Date (Mo/Day/Yr)

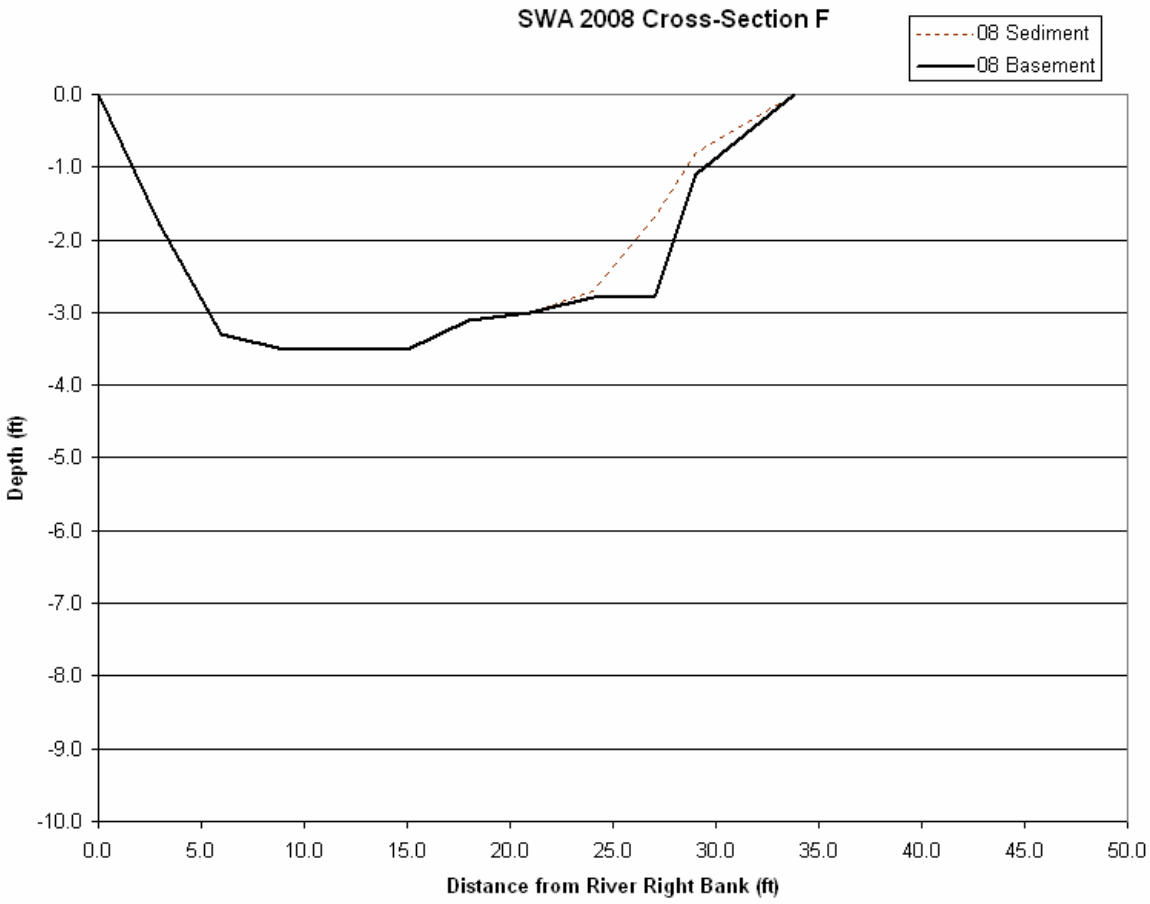
Appendix B. Channel Profiles at Cross-sections

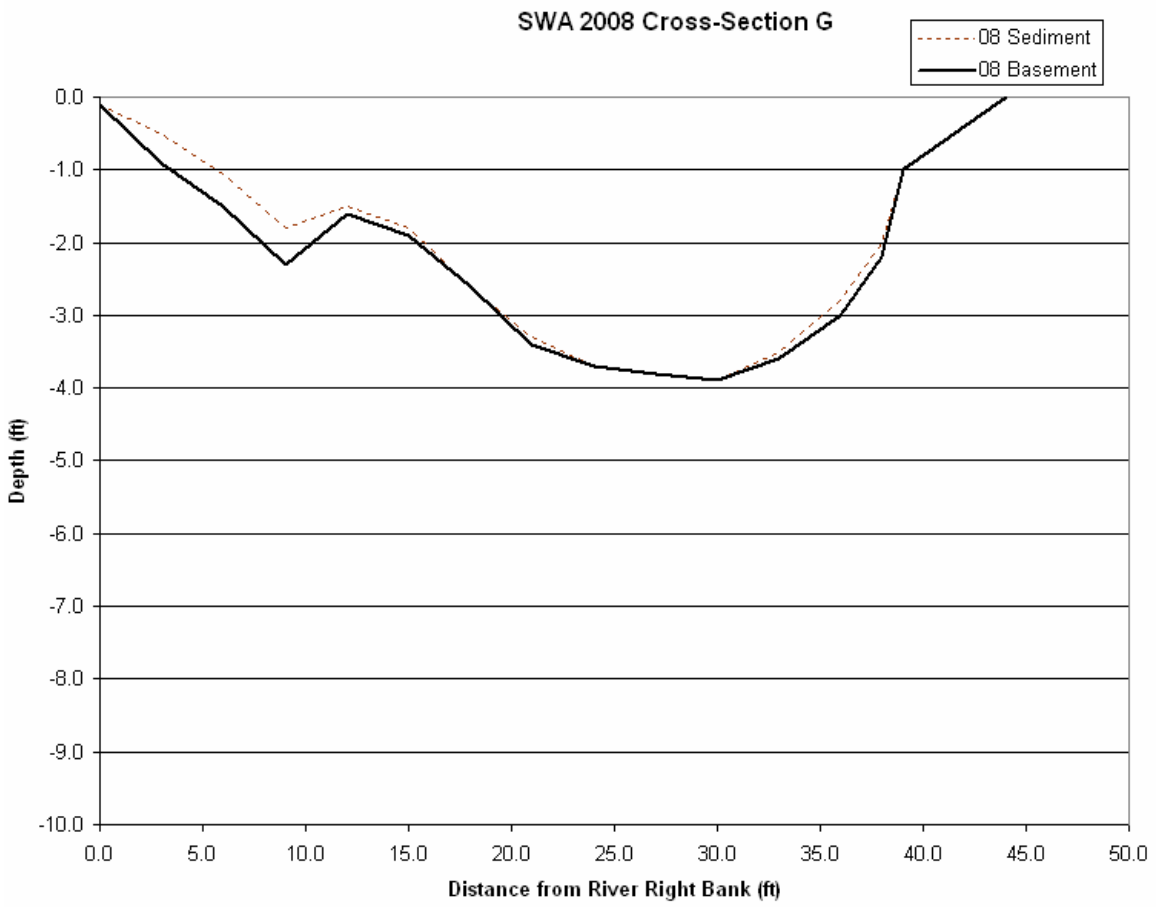



SWA 2008 Cross-Section C
08 Sediment
08 Basement
Depth (ft)
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0
-9.0
-10.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
Distance from River Right Bank (ft)


SWA 2008 Cross-Section D
08 Sediment
08 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
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
Distance from River Right Bank (ft)


SWA 2008 Cross-Section E
08 Sediment
08 Basement
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0
-9.0
-10.0
Depth (ft)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
Distance from River Right Bank (ft)


SWA 2008 Cross-Section F
08 Sediment
08 Basement
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
-8.0
-9.0
-10.0
Depth (ft)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
Distance from River Right Bank (ft)


SWA 2008 Cross-Section G
08 Sediment
08 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
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
Distance from River Right Bank (ft)

Appendix C. Photos of Four Monitoring Locations

Site 1: 50’ Downstream of Dam

Site 2: Upstream of Dam, Looking West

Site 3: Upstream of Pump/ Bridge at Bend

Site 4: Upstream of Small Bridge Looking Downstream