2010 Water Quality Monitoring
Mill River
Hamden and New Haven, CT

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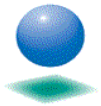
Prepared for

Regional Water Authority

Prepared by



CH2MHILL

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2010 Mill River Water Quality Monitoring

Introduction

This report presents the results of continuing studies by the Regional Water Authority (RWA) to document dissolved oxygen (DO) and salinity concentrations in the Mill River downstream of the Lake Whitney water supply reservoir. The objective of these studies, which began in 1998, is to monitor DO and salinity in the Mill River as they relate to potential impacts from reactivating Lake Whitney as a public water supply. The lake served as a water supply from 1862 until 1991, when its use was temporarily discontinued. The RWA resumed water withdrawals from the reservoir during the summer of 2005, concurrent with completion of the new Lake Whitney Water Treatment Plant (WTP).

As part of a comprehensive environmental assessment of the WTP project, studies of DO and salinity patterns in the lower Mill River were conducted in 1998 and then annually since 2000. DO and salinity were both recognized as important parameters to be considered in developing an environmental management plan for the Lake Whitney water withdrawals (Lake Whitney WTP Environmental Evaluation Team, 1999).

Based on the analysis of data collected from 1998 to 2003, 7.0 milligrams per liter (mg/L) was selected as a reasonable DO target level for the plunge pool in the Mill River immediately below the Lake Whitney Dam (CH2M HILL, 2003). That data indicated that, under most circumstances, this level will result in surface water DO concentration above 5.0 mg/L at the Orange Street Bridge during dry weather conditions. However, DO concentrations slightly below 5.0 mg/L were occasionally observed before water withdrawals from the lake resumed in 2005.

Past monitoring has identified negative effects on Orange Street Bridge DO concentrations during wet weather, believed to be from input of organic matter from urban stormwater runoff and combined sewer overflows (CSOs). To evaluate the effects of lake withdrawals more directly, DO and salinity have been regularly monitored farther upstream, at the footbridge in East Rock Park, since the summer of 2003. At this location, the influence of stormwater runoff, CSOs, and tidal flows are presumed to be lesser factors.

DO and salinity sampling was performed every week between July 2 and September 24, 2010, as part of the continuing monitoring and assessment effort. Because of low DO concentrations encountered during the late summer in previous years, the normal monitoring period of July through August has been extended through the last week of September.

Spells of persistent rainfall of long duration and high intensity were prevalent throughout spring and early summer of 2010 (Figure 1). The precipitation during much of July, August, and September were of much lower intensity. The recorded precipitation from June to September was 14.27 inches at the Lake Whitney rain gauge. The total rainfall amount from June to September was much lower for 2010 compared to 2009, which was 25.8 inches at the Lake Whitney rain gauge. The average precipitation from June to September from 1998 through the year 2010 is 15.1 inches.

Figure 2 presents the rainfall amounts in the 72 hours preceding each sampling event. When analyzing the DO data, it is important to note influences from stormwater runoff. Rainfall accumulation greater than 0.12 inch was considered as a wet-weather measurement event. Rainfall of less than or equal to 0.12 inch was considered a dry-weather event (in the 72 hours preceding each sampling event). Wet-weather measurements were taken on July 16, July 23, August 6, August 13, August 27, September 27, and September 24, with preceding 72-hour rainfall amounts ranging from 0.16 to 1.15 inches. The remaining sampling events had no rainfall (July 2, July 9, July 30, August 20, September 3, and September 10) before measurements.

The WTP was first operational in April 2005 and continued operation through 2010. Due to higher than normal system-wide water storage levels coupled with declining water demand, the RWA switched to a reduced mode of operation beginning in October 2008. In general, the plant has operated only one day a week. In 2010, the average daily withdrawal was 2.83 percent of the maximum daily diversion amount registered with the Connecticut Department of Environmental Protection (Figure 3).

Figure 4 presents estimated Lake Whitney Dam downstream flows to the Mill River from January 2010 to September 2010. Spillway flows ranged from an estimated 27 million gallons per day (MGD) to 1 billion gallons per day (BGD), with an average flow of 114 MGD. Flows are calculated based on the lake level at the spillway and when applicable using metered flows of downstream releases via the artificial waterfall and/or estimates of water released through the blowoff. The Management Plan specifies the initial minimum release as 4.2 MGD when the lake level falls below spillway elevation. Because Lake Whitney water levels remained above spillway elevation for all of 2010, there was no need to conduct downstream releases. Figure 5 presents the estimated flow in the Mill River for each of the sampling dates in 2010. Sampling date flows ranged from 29 MGD on July 2 to 96 MGD on September 17.

The 2010 sampling is the sixth annual DO and salinity monitoring and assessment effort at Mill River since the new WTP has gone on line. This report discusses historical DO data, which was collected to identify possible relationships between flow conditions and DO at the Footbridge and Orange Street stations.

Monitoring Methods

From July 2 to September 24, 2010, the RWA conducted weekly dawn DO and salinity monitoring at and below the Lake Whitney dam (i.e., the spillway, plunge pool, the footbridge, the Orange Street Bridge, and both sides of the tidegates) (Figure 6). The measurements were conducted at dawn to reflect the diurnal oxygen sag that typically occurs in a lake or stream because of overnight respiration and lack of oxygen producing photosynthesis. Table 1 presents a summary of the 2010 Mill River measurements.

As in the previous several years, the weekly data were collected using a Hydrolab Quanta multi-parameter meter that was calibrated before each set of water quality measurements. Measurements were collected at one depth at the spillway and plunge pool. At the footbridge, Orange Street Bridge, and the tidegates, measurements were taken near the surface (0.1- to 0.2-meter depth) and near the bottom to account for the possible presence of distinct water layers caused by salinity intrusion from Long Island Sound. All weekly monitoring data are presented in the Attachment.

TABLE 1
Mill River Monitoring Data Collected in 2010

Frequency/Dates	Locations	Parameters
Weekly – July 2 through September 24 (early morning)	Spillway Plunge Pool Footbridge Orange Street Tidegates (North and South)	Temperature, DO, salinity, pH, estimated flow

Monitoring Results

Salinity

The weekly salinity monitoring data are presented in Figure 7 (surface layer) and Figure 8 (bottom layer). In general, increasing salinity at tidally influenced monitoring stations (footbridge and downstream) occurs during periods of lower freshwater flow from Lake Whitney. The highest salinity measurements at Orange Street were observed on August 13 at both the surface and bottom layers (7.5 ppm and 15 ppm respectively). There was no measurable tidal influx of saline waters at the footbridge station in 2010, with all measurements at this location not significantly different from upstream freshwater monitoring stations.

As expected, compared to upstream locations, salinity levels were elevated at the tide gates, with concentrations ranging from 1.3 to 20 ppt in the bottom waters and from 1.2 to 20 ppt at the surface.

Figure 9 presents surface salinities at Orange Street and the footbridge, with river flow as measured at Lake Whitney Dam (spillway overflow). The salinity at Orange Street increased as the flow gradually decreased in August and September.

Dissolved Oxygen

Weekly surface layer DO measurements from Mill River at the spillway, the plunge pool, the footbridge, Orange Street Bridge, and the tide gates are shown in Figure 10. Bottom layer measurements are shown in Figure 11. Table 2 summarizes all of the 2010 DO concentrations at the spillway, plunge pool, footbridge, Orange Street Bridge, and tidegates, including average, minimum, and maximum DO concentrations. Average DO readings for all weekly monitoring from 2001 to 2010 are presented in Table 3.

TABLE 2
Weekly Dissolved Oxygen Concentrations from July 2, 2010 through September 24, 2010

	Spillway	Plunge Pool	Footbridge Surface	Footbridge Bottom	Orange Street Surface	Orange Street Bottom	North Tidegate Surface	North Tidegate Bottom	South Tidegate Surface	South Tidegate Bottom
7/2/2010	7.59	7.14	**4.78**	**4.61**	7.47	**3.97**	6.32	**4.16**	5.31	5.71
7/9/2010	9.13	6.93	**3.95**	**3.54**	5.62	**3.88**	5.79	**4.16**	5.48	5.40
7/16/2010	7.27	6.96	**4.60**	**4.01**	6.18	**3.61**	5.20	**2.81**	**4.32**	**4.51**
7/23/2010	7.34	6.70	5.27	**4.87**	**4.38**	**4.34**	**4.93**	**4.65**	**4.77**	**4.80**
7/30/2010	7.61	6.94	**3.76**	**3.19**	**4.89**	**2.48**	**4.15**	**4.03**	**4.79**	**4.64**
8/6/2010	6.81	6.49	**4.66**	**4.56**	**3.48**	**3.33**	**4.35**	**4.03**	**4.55**	**3.82**
8/13/2010	7.97	7.02	**3.27**	**2.98**	**3.65**	**1.82**	**4.69**	**4.23**	**4.73**	**4.77**
8/20/2010	8.85	7.03	**3.78**	**3.48**	5.22	**3.59**	5.20	5.07	**4.82**	**4.50**
8/27/2010	7.10	7.50	5.91	5.77	5.27	5.17	5.30	**4.83**	5.74	5.69
9/3/2010	9.18	6.87	**3.66**	**3.36**	**3.72**	**1.87**	**4.73**	**4.44**	**4.44**	**4.24**
9/10/2010	7.20	8.00	**4.60**	**3.80**	5.20	**1.60**	**4.20**	**3.90**	6.20	6.50
9/17/2010	6.78	7.60	7.00	6.90	6.26	5.86	5.57	**4.95**	5.47	**4.78**
9/24/2010	8.36	7.55	5.86	5.83	6.37	5.50	6.30	5.18	6.56	6.65
Average	7.78	7.13	**4.70**	**4.38**	5.21	**3.62**	5.13	**4.34**	5.17	5.08
Min	6.78	6.49	**3.27**	**2.98**	**3.72**	**1.60**	**4.15**	**2.81**	**4.32**	**3.82**
Max	9.18	8.00	7.00	6.90	7.47	5.86	6.32	5.18	6.56	6.65

Notes:

Bold represents DO concentrations less than the Connecticut Department of Environmental Protection water quality standard of 5.0 mg/L.

TABLE 3

Average Mill River Surface Dissolved Oxygen, 2001 – 2010 Weekly Measurements

	2001	2002	2003	2004*	2005	2006	2007	2008	2009	2010
Spillway	8.0	8.0	8.0	8.2	7.6	8.4	7.3	8.8	7.81	7.78
Plunge Pool	7.7	7.9	7.9	4.1	7.5	7.7	7.4	7.6	7.59	7.13
Footbridge	NA	NA	6.5	6.0	5.2	5.5	5.0	5.5	6.40	4.70
Orange Street Bridge	5.9	6.2	6.4	6.8	5.3	6.7	5.9	5.7	6.69	5.21
Tide Gates Upstream	NA	NA	6.2	6.2	5.1	6.1	5.5	5.0	5.78	5.13
Tide Gates (Down-stream)	NA	NA	6.6	6.1	5.6	5.8	5.6	5.1	6.00	5.17

Notes:

- *Flow bypassed around plunge pool July 6 - August 27, 2004 for Lake Drawdown.

NA = No data available

Figure 12 presents the DO concentrations at the plunge pool, Orange Street (surface and bottom), and the footbridge (surface and bottom), along with the flow in the river as measured at the Lake Whitney spillway. Measured DO at the plunge pool typically was 7.0 mg/L or greater on 8 of 13 sampling events, with the remaining 5 measurements ranging from 6.5 to 6.9 mg/L. Percent DO saturation measurements at this location all exceeded 80%. Surface water DO concentrations during the sampling period were frequently below the target of 5 mg/l at the footbridge and to a lesser extent at Orange Street. Bottom DO concentrations were even lower, being at or below the 5 mg/l target at the footbridge and Orange Street during each sampling date until September 17, 2010. After that date the DO values exceeded the 5 mg/L threshold.

Prior to 2010, the historical data showed that, between the beginning of July and end of September, occurrences of surface DO lower than 5.0 mg/L at both the footbridge and Orange Street dropped off substantially when the flow over the spillway was greater than 30 mgd, which corresponds to a lake level of 0.17 feet. The 2010 DO readings were not consistent with the past relationship of flow and DO, as DO concentrations were frequently below 5 mg/l at these locations when spillway flow exceeded 30 MGD.

Conclusions

This report summarizes the information obtained from the sixth year of data collection during operation of the new Lake Whitney WTP. Rainfall in 2010 primarily occurred in prolonged and intense rainfall events in the spring and early summer. Due to the largely de minimis operation of the WTP since October 2008, summer monitoring results from 2010 and 2009 essentially represent baseline conditions. Although there were a number of rainfall events later in the summer, they were of low intensity (Figure 1). While this precipitation pattern minimized the occurrence of low flow events that in prior years have been associated with lower DO values, the resulting flows (Figure 4) may not have been adequate to flush organic matter from the river segment downstream of Lake Whitney. Unlike prior years, low DO concentrations at Orange Street and the footbridge were not closely linked to the magnitude of flow over the dam. Although there are no immediately testable hypotheses that can be offered to explain the low DO concentrations, possible explanations and contributing factors include:

- The lack of "flushing" rainfall events during the summer may have resulted in the accumulation of organic matter in Mill River, particularly the sediments. As this organic matter decayed it can create a higher than normal oxygen demand. This effect is likely to be magnified at the footbridge station due to the wide, shallow river channel, and slower flow velocities at this location, which encouraging settling of organic matter.
- Longer water residence times and high temperatures may have increased primary production in Lake Whitney, resulting in higher than normal phytoplankton densities in the downtream Mill River. The respiration and subsequent death and decay of the phytoplankton can create a net loss of DO, and this effect is likely to be exacerbated by the channel and flow characteristics at the footbridge station discussed above. Photographic evidence of an algal bloom at the footbridge stations in late August 2010 (Figure 13) supports this hypothesis.
- The numerous low intensity rainfall events may have created relatively high repeated organic loads from storm water "first flush" effects (i.e. accumulated organic matter on

streets and in storm sewers washed into the river with the first few tenths of an inch of rain). These first flush events were not followed by larger flows that can dilute the high organic load in the first flush and transport the load further downstream toward the tide gates.

Literature Cited

Lake Whitney WTP Environmental Evaluation Team. 1999. *Lake Whitney Water Treatment Plant Environmental Evaluation, Vol. 1: Environmental Evaluation Team Final Report.* Report prepared for the South Central Connecticut Regional Water Authority, New Haven, CT.

CH2M HILL. 2003. *1998– 2003 Comprehensive Dissolved Oxygen Monitoring in the Lower Mill River, Hamden and New Haven, CT.* Report prepared for the South Central Connecticut Regional Water Authority, New Haven, CT.

Figures

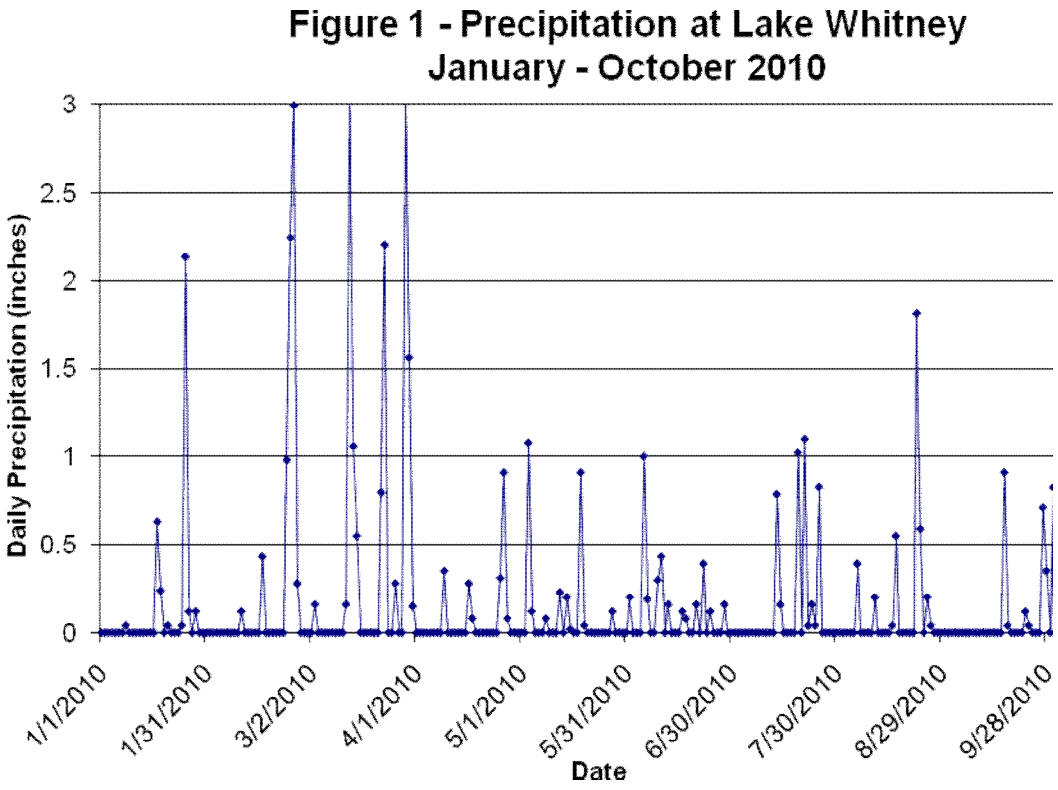
Figure 1 - Precipitation at Lake Whitney
January - October 2010
Daily Precipitation (inches)
3
2.5
2
1.5
1
0.5
0
1/1/2010
1/31/2010
3/2/2010
4/1/2010
5/1/2010
5/31/2010
6/30/2010
7/30/2010
8/29/2010
9/28/2010
Date

Figure 2: 2010 Sampling Event Precipitation (72 hours Prior to each Sampling Event)

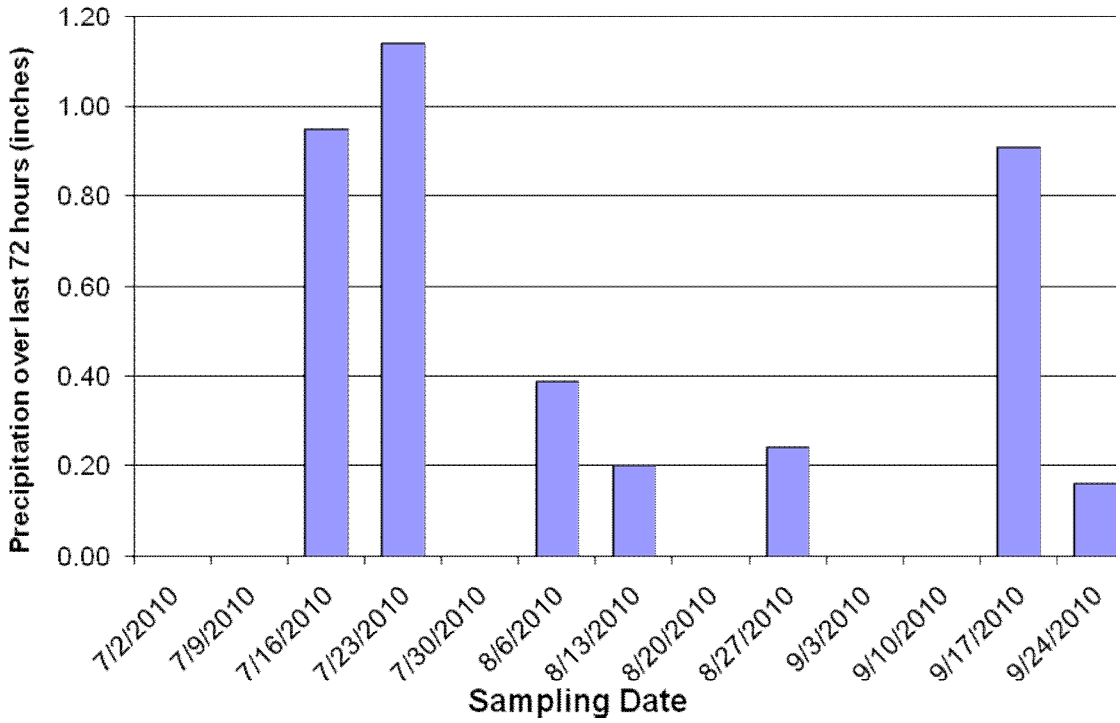

Figure 3 - Lake Whitney Water Treatment Plant Withdrawals

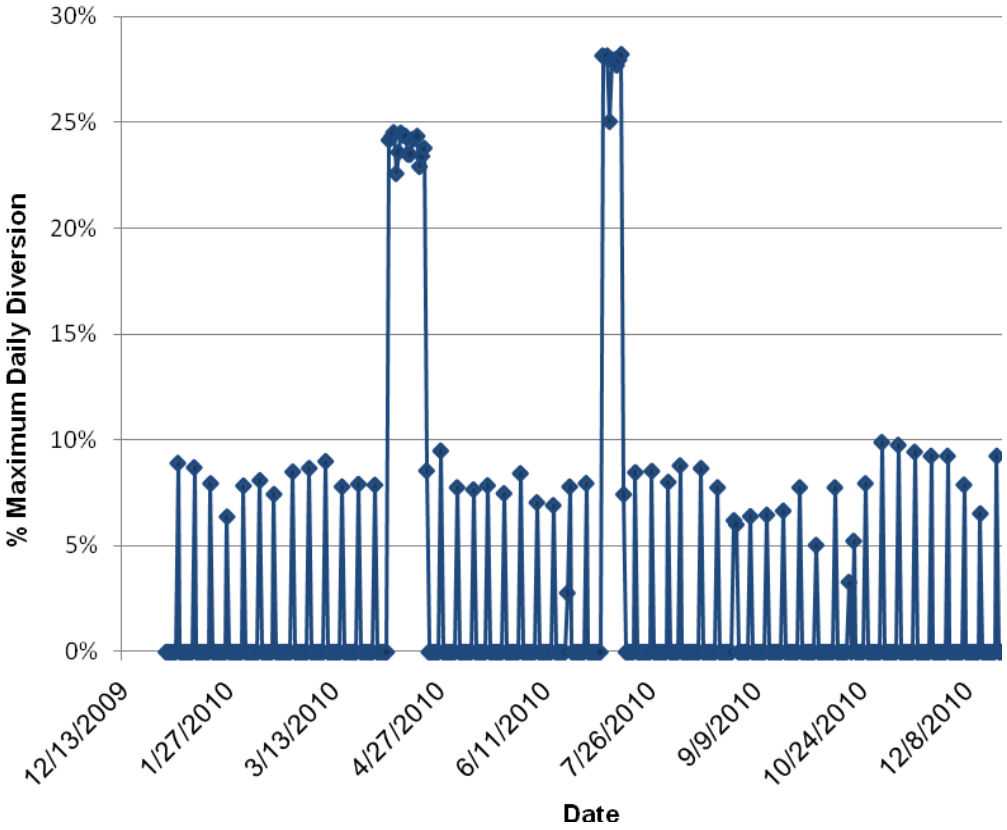

Figure 4: Lake Whitney Overflow January through December 2010

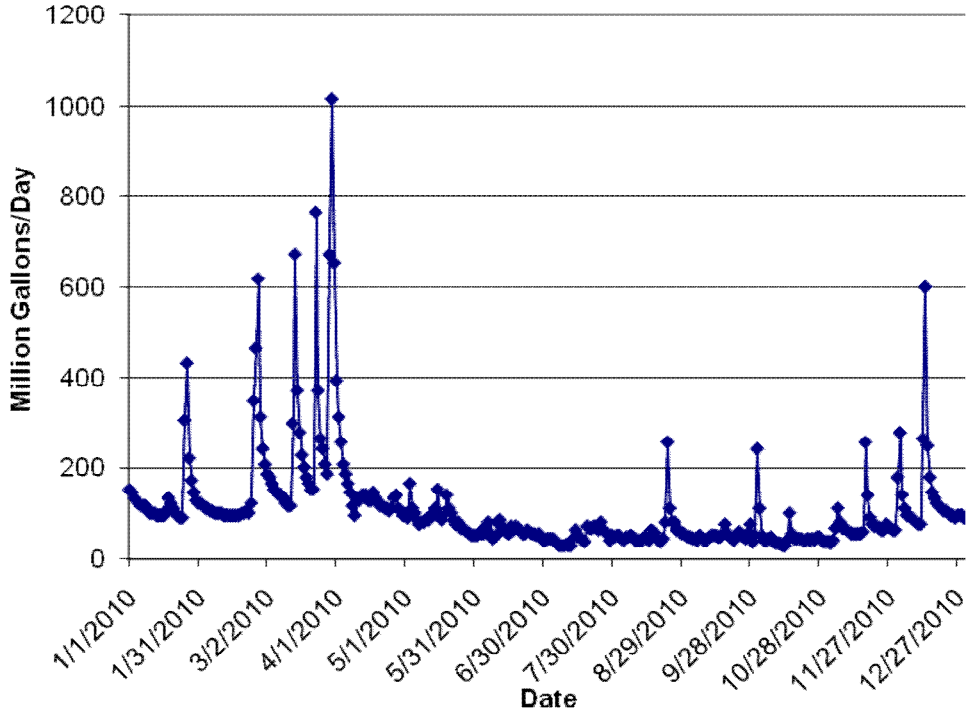

Figure 5: 2010 Mill River Sampling Event Instantaneous Flow

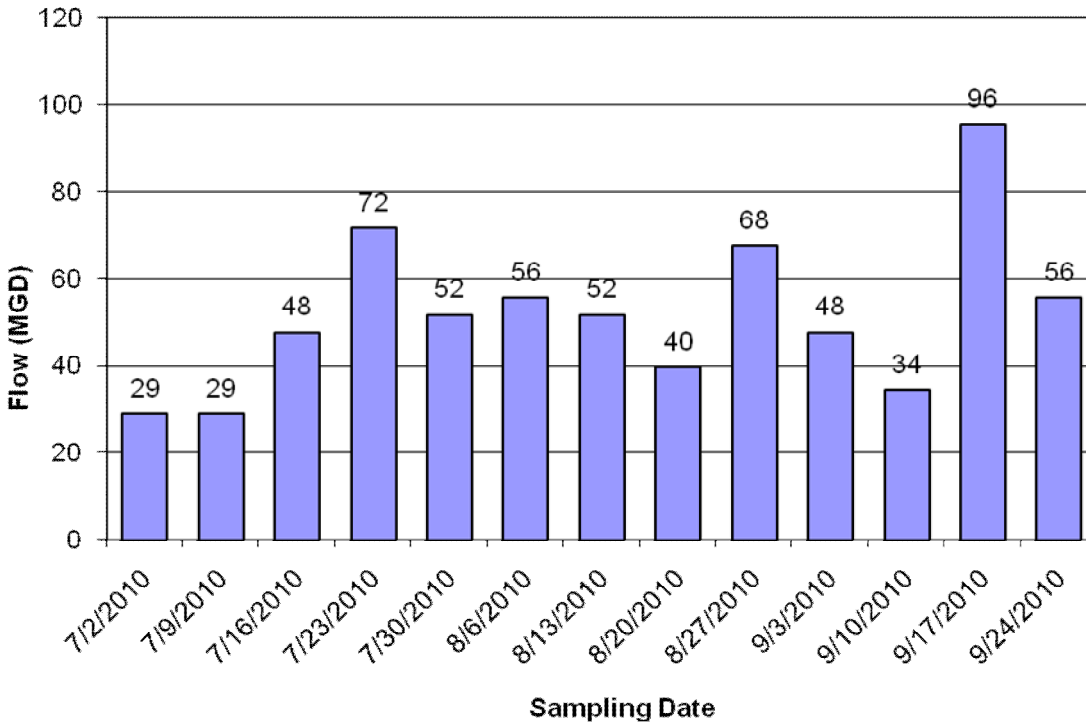

FIGURE 6
Locations Sampled During Mill River Monitoring

Figure 7: 2010 Mill River Surface Salinity

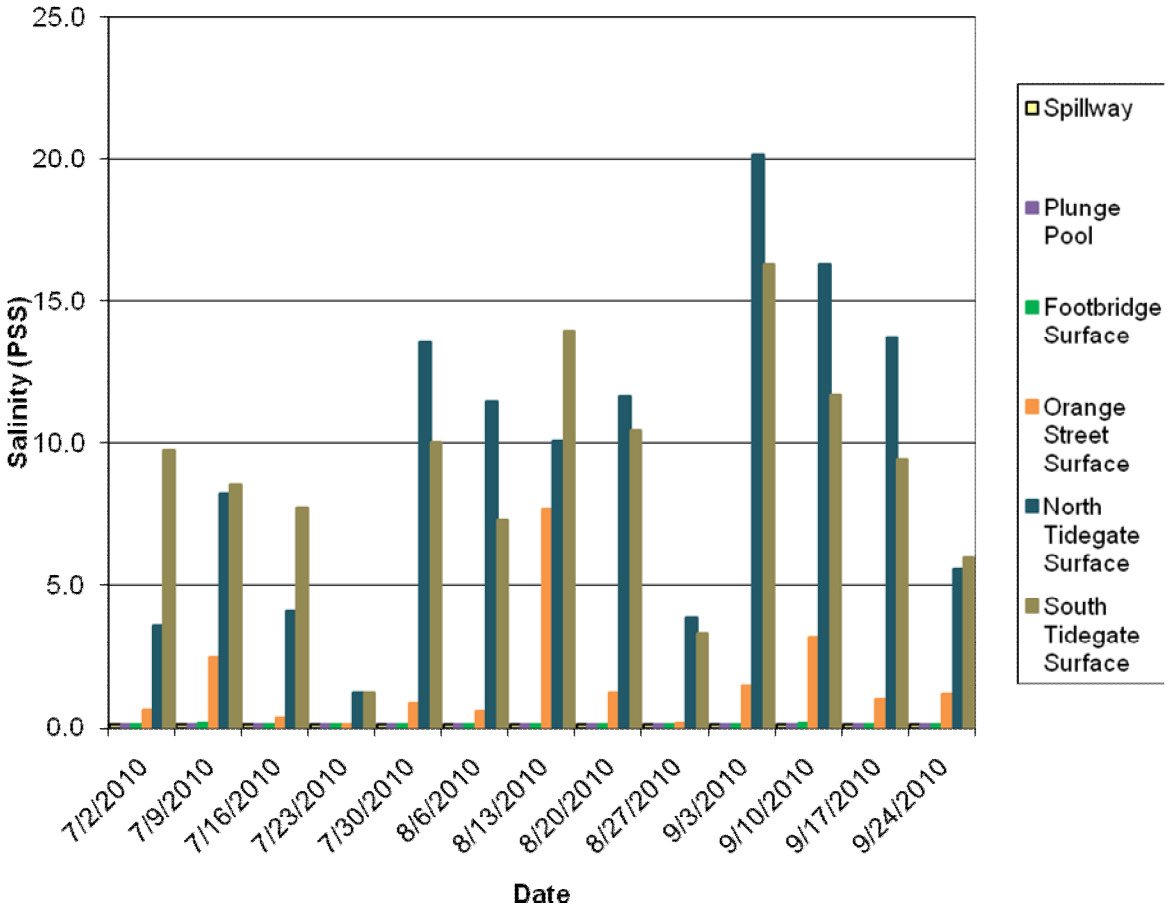

Figure 8: 2010 Mill River Bottom Salinity

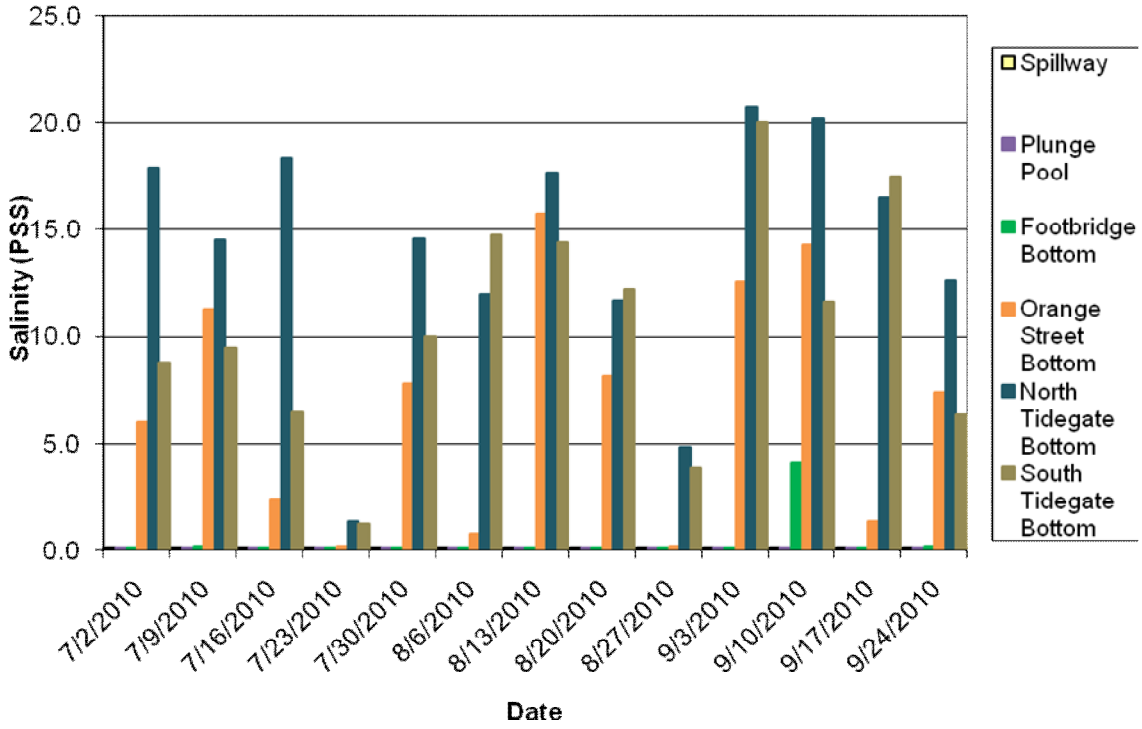

Figure 9: 2010 Mill River Downstream Surface Salinity with Flow

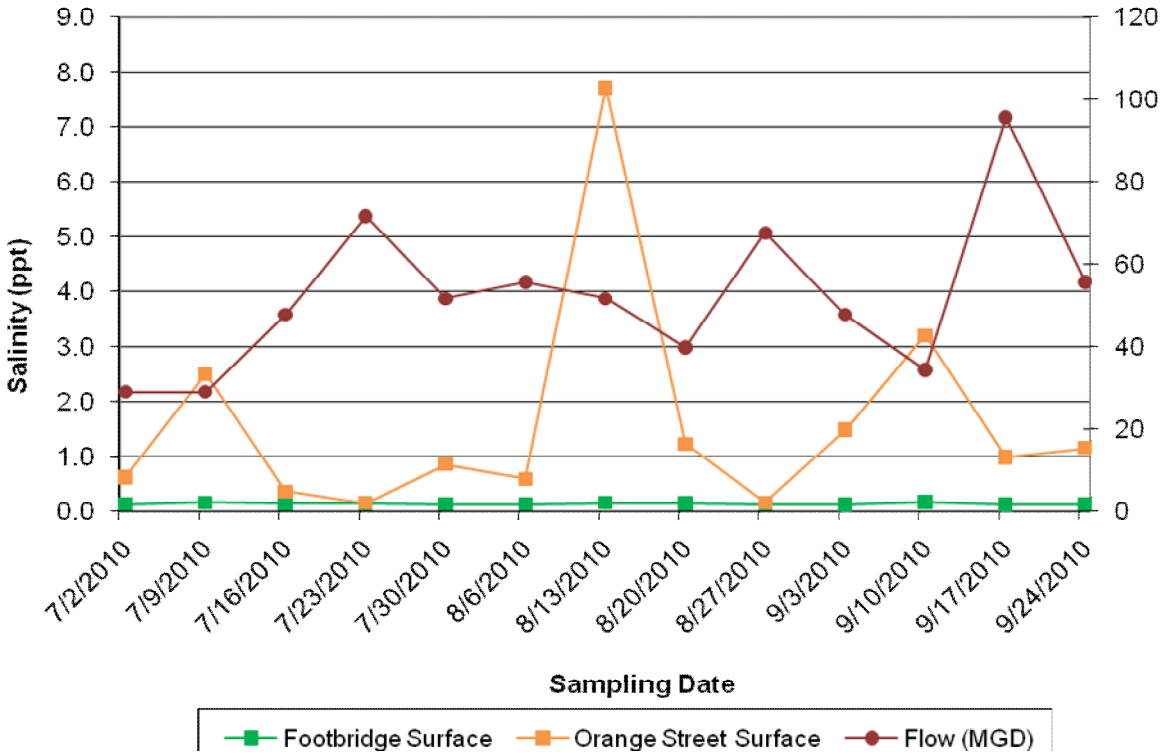

Figure 10: 2010 Mill River Surface Dissolved Oxygen

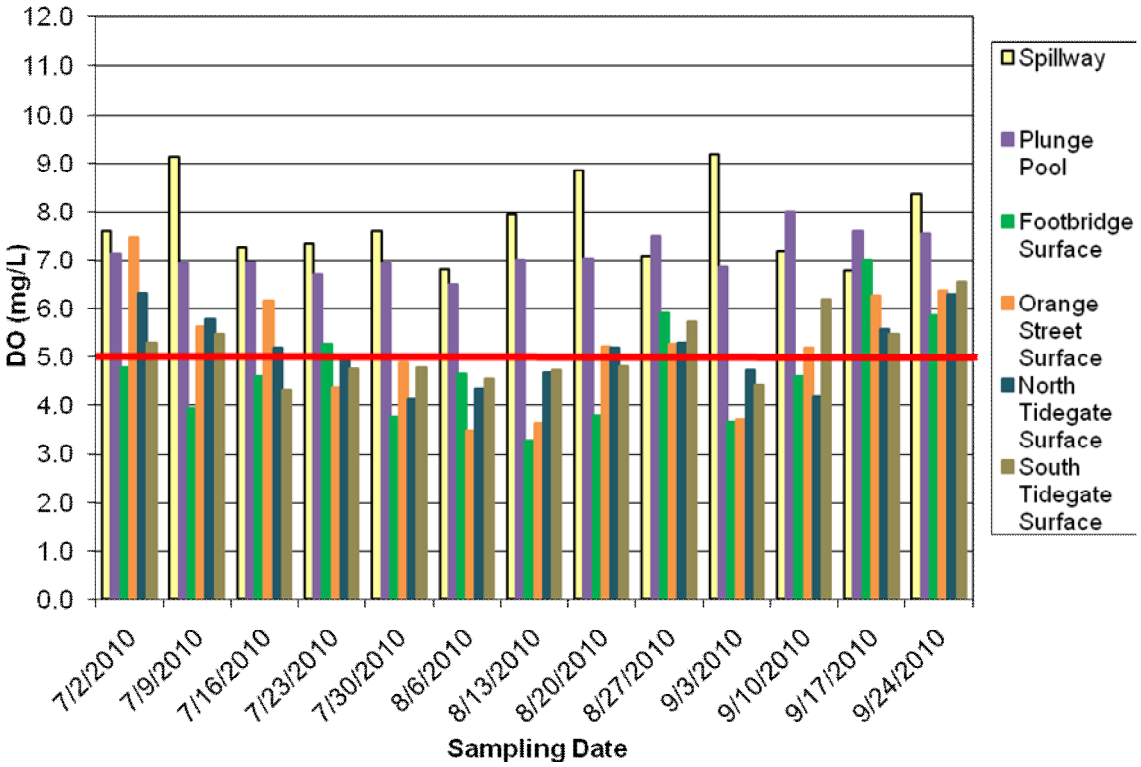

Figure 11: 2010 Mill River Bottom Dissolved Oxygen

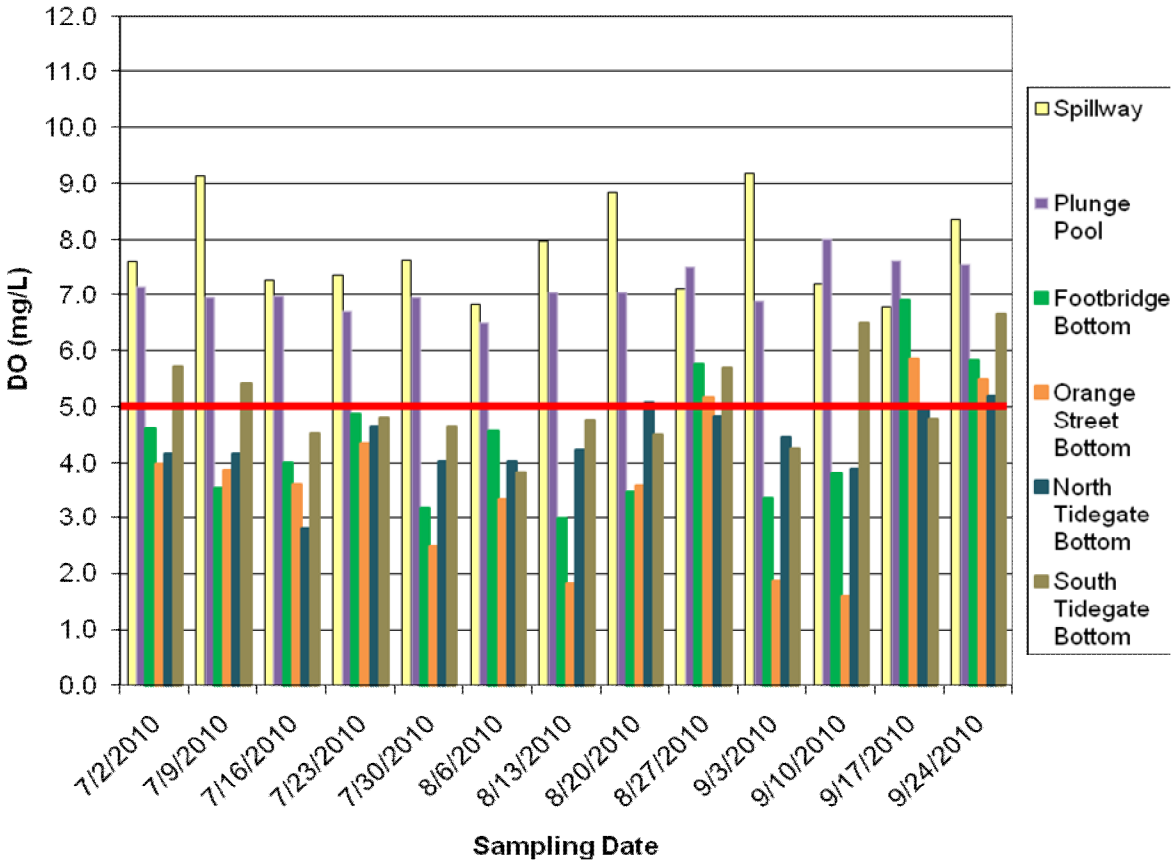

Figure 12: 2010 Mill River Downstream DO With Flow

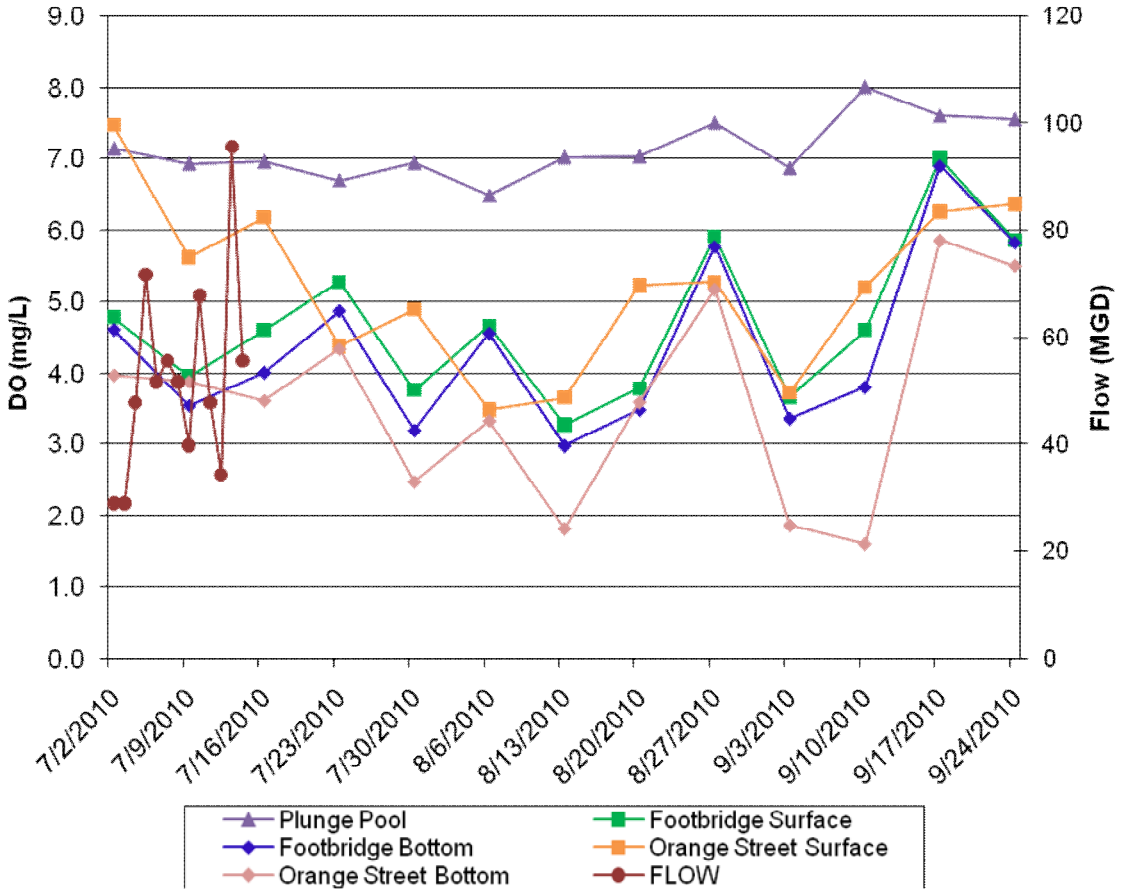

FIGURE 13
Footbridge station algal bloom on August 30, 2010.

Attachment
Weekly Monitoring Data

DATE	Station	Time	Depth (m)	Temp (C)	Salinity (ppt)	DO (mg/l)	DO (%)	pH	Estimate flow (mgd)	Dry or Wet	Tide Stage	Comments
7/2/2010	0	5:50	0.30	24.83	0.14	7.59	91.60	8.46	28.96	Dry	High	
7/2/2010	1	6:00	0.50	23.36	0.14	7.14	83.80	8.48	28.96	Dry	High	
7/2/2010	4	5:35	0.40	22.23	0.14	4.78	55.00	8.08	28.96	Dry	High	
7/2/2010	4	5:40	1.10	22.23	0.14	4.61	52.90	8.07	28.96	Dry	High	
7/2/2010	6	5:20	0.30	21.52	0.63	7.47	85.10	8.20	28.96	Dry	High	flow is slightly south @ Orange St
7/2/2010	6	5:25	0.90	24.08	5.99	3.97	49.10	7.80	28.96	Dry	High	
7/2/2010	7	6:10	0.30	20.74	3.59	6.32	72.30	8.01	28.96	Dry	High	all tide gates are unobstructed
7/2/2010	7	6:15	0.90	21.16	17.93	4.16	52.30	7.76	28.96	Dry	High	
7/2/2010	8	6:20	0.20	20.96	9.75	5.31	63.40	7.88	28.96	Dry	High	
7/2/2010	8	6:25	0.80	20.81	8.78	5.71	67.60	7.94	28.96	Dry	High	
7/9/2010	0	5:10	0.30	28.42	0.14	9.13	117.60	8.33	28.96	Dry	Low	
7/9/2010	1	5:20	0.30	26.97	0.15	6.93	87.00	8.15	28.96	Dry	Low	
7/9/2010	4	5:30	0.20	26.46	0.17	3.95	49.20	7.19	28.96	Dry	Low	
7/9/2010	4	5:35	0.70	26.26	0.16	3.54	43.90	7.13	28.96	Dry	Low	
7/9/2010	6	5:45	0.30	27.74	2.50	5.62	72.70	7.00	28.96	Dry	Low	flow is south @ Orange St
7/9/2010	6	5:50	0.70	27.39	11.30	3.88	52.60	6.60	28.96	Dry	Low	
7/9/2010	7	6:05	0.30	26.78	8.25	5.79	76.30	6.94	28.96	Dry	Low	third tidegate from east is partially blocked open by branch
7/9/2010	7	6:10	0.60	26.71	14.56	4.16	56.80	6.71	28.96	Dry	Low	
7/9/2010	8	6:15	0.20	26.83	8.57	5.48	72.40	6.95	28.96	Dry	Low	
7/9/2010	8	6:20	0.60	26.84	9.49	5.40	71.80	6.94	28.96	Dry	Low	
7/16/2010	0	5:50	0.30	26.73	0.15	7.27	91.00	8.19	47.73	Wet	High	
7/16/2010	1	5:58	0.30	26.25	0.15	6.96	86.20	8.19	47.73	Wet	High	
7/16/2010	4	5:35	0.20	25.46	0.15	4.60	56.10	7.53	47.73	Wet	High	
7/16/2010	4	5:40	1.00	25.38	0.15	4.01	48.90	7.45	47.73	Wet	High	
7/16/2010	6	5:20	0.30	25.76	0.37	6.18	76.00	7.55	47.73	Wet	High	flow is north @ Orange St
7/16/2010	6	5:28	0.80	25.98	2.37	3.61	45.20	7.20	47.73	Wet	High	

DATE	Station	Time	Depth (m)	Temp (C)	Salinity (ppt)	DO (mg/l)	DO (%)	pH	Estimate flow (mgd)	Dry or Wet	Tide Stage	Comments
7/16/2010	7	6:10	0.20	25.20	4.11	5.20	64.90	7.35	47.73	Wet	High	all tidegates are unobstructed
7/16/2010	7	6:15	0.60	24.20	18.34	2.81	37.40	7.01	47.73	Wet	High	
7/16/2010	8	6:25	0.20	24.92	7.76	4.32	54.90	7.23	47.73	Wet	High	
7/16/2010	8	6:28	1.10	24.99	6.47	4.51	56.90	7.28	47.73	Wet	High	
7/23/2010	0	6:05	0.30	27.34	0.15	7.34	92.90	8.38	71.68	Wet	Low	
7/23/2010	1	6:13	0.30	26.73	0.15	6.70	83.80	8.34	71.68	Wet	Low	
7/23/2010	4	5:45	0.20	26.13	0.15	5.27	65.20	7.71	71.68	Wet	Low	
7/23/2010	4	5:55	0.80	26.10	0.15	4.87	60.20	7.72	71.68	Wet	Low	
7/23/2010	6	5:25	0.30	26.14	0.16	4.38	54.10	7.52	71.68	Wet	Low	flow is south @ Orange St
7/23/2010	6	5:35	0.80	26.12	0.16	4.34	53.70	7.54	71.68	Wet	Low	
7/23/2010	7	6:20	0.30	26.59	1.22	4.93	62.00	7.59	71.68	Wet	Low	all tidegates are unobstructed
7/23/2010	7	6:25	0.80	26.63	1.34	4.65	58.50	7.53	71.68	Wet	Low	
7/23/2010	8	6:30	0.20	26.57	1.24	4.77	60.00	7.53	71.68	Wet	Low	
7/23/2010	8	6:40	0.70	26.58	1.24	4.80	60.40	7.53	71.68	Wet	Low	
7/30/2010	0	6:15	0.20	26.25	0.14	7.61	94.20	8.29	51.72	Dry	High	
7/30/2010	1	6:20	0.30	24.80	0.14	6.94	83.70	8.27	51.72	Dry	High	
7/30/2010	4	5:55	0.20	24.30	0.14	3.76	45.00	7.46	51.72	Dry	High	
7/30/2010	4	6:05	0.90	24.30	0.14	3.19	38.20	7.44	51.72	Dry	High	
7/30/2010	6	5:35	0.20	24.81	0.86	4.89	59.40	7.20	51.72	Dry	High	flow is south @ Orange St bridge
7/30/2010	6	5:45	0.70	26.04	7.80	2.48	32.20	6.94	51.72	Dry	High	
7/30/2010	7	6:30	0.20	25.11	13.55	4.15	54.80	7.09	51.72	Dry	High	all tidegates are unobstructed
7/30/2010	7	6:35	0.60	25.11	14.60	4.03	53.50	7.07	51.72	Dry	High	
7/30/2010	8	6:40	0.10	24.97	10.04	4.79	61.70	7.13	51.72	Dry	High	
7/30/2010	8	6:45	0.60	24.95	9.98	4.64	59.80	7.13	51.72	Dry	High	
8/6/2010	0	6:12	0.30	26.64	0.13	6.81	84.90	8.08	55.70	Wet	Low	
8/6/2010	1	6:20	0.20	26.11	0.13	6.49	80.20	8.20	55.70	Wet	Low	
8/6/2010	4	5:55	0.20	25.73	0.14	4.66	57.20	7.48	55.70	Wet	Low	

DATE	Station	Time	Depth (m)	Temp (C)	Salinity (ppt)	DO (mg/l)	DO (%)	pH	Estimate flow (mgd)	Dry or Wet	Tide Stage	Comments
8/6/2010	4	6:00	0.70	25.64	0.14	4.56	55.90	7.46	55.70	Wet	Low	
8/6/2010	6	5:40	0.20	25.96	0.60	3.48	43.10	7.17	55.70	Wet	Low	no flow direction @ Orange St bridge
8/6/2010	6	5:47	0.60	26.03	0.75	3.33	41.30	7.17	55.70	Wet	Low	
8/6/2010	7	6:30	0.20	25.80	11.47	4.35	57.40	7.10	55.70	Wet	Low	all tidegates are unobstructed
8/6/2010	7	6:35	0.60	25.77	11.99	4.03	53.30	7.07	55.70	Wet	Low	
8/6/2010	8	6:40	0.20	25.97	7.30	4.55	58.80	7.14	55.70	Wet	Low	
8/6/2010	8	6:45	0.80	25.63	14.74	3.82	51.30	7.02	55.70	Wet	Low	
8/13/2010	0	6:10	0.20	25.72	0.14	7.97	97.80	8.58	51.72	Wet	High	
8/13/2010	1	6:15	0.20	24.33	0.14	7.02	84.00	8.48	51.72	Wet	High	
8/13/2010	4	5:55	0.20	23.49	0.16	3.27	38.50	7.52	51.72	Wet	High	
8/13/2010	4	6:00	1.00	23.47	0.15	2.98	35.10	7.51	51.72	Wet	High	
8/13/2010	6	5:38	0.20	24.90	7.71	3.65	46.30	7.03	51.72	Wet	High	flow is south @ Orange St
8/13/2010	6	5:45	0.60	25.55	15.74	1.82	24.60	6.86	51.72	Wet	High	
8/13/2010	7	6:25	0.20	24.03	10.10	4.69	59.40	7.16	51.72	Wet	High	all tide gates are unobstructed
8/13/2010	7	6:30	0.90	24.73	17.68	4.23	56.80	7.02	51.72	Wet	High	
8/13/2010	8	6:35	0.20	24.43	13.93	4.73	62.00	7.07	51.72	Wet	High	
8/13/2010	8	6:40	0.70	24.49	14.39	4.77	62.60	7.07	51.72	Wet	High	
8/20/2010	0	6:05	0.30	24.98	0.14	8.85	107.20	8.70	39.75	Dry	Low	
8/20/2010	1	6:10	0.30	23.75	0.14	7.03	83.20	8.56	39.75	Dry	Low	
8/20/2010	4	5:40	0.20	23.22	0.15	3.78	44.30	7.53	39.75	Dry	Low	
8/20/2010	4	5:50	0.70	23.22	0.15	3.48	40.80	7.50	39.75	Dry	Low	
8/20/2010	6	5:25	0.20	24.11	1.23	5.22	62.70	7.24	39.75	Dry	Low	flow is north @ Orange St
8/20/2010	6	5:35	0.70	25.23	8.13	3.59	45.90	6.90	39.75	Dry	Low	
8/20/2010	7	6:25	0.60	24.82	11.71	5.07	65.90	7.11	39.75	Dry	Low	
8/20/2010	8	6:30	0.10	24.66	10.42	4.82	61.90	7.10	39.75	Dry	Low	
8/20/2010	8	6:35	0.70	24.87	12.23	4.50	58.70	7.05	39.75	Dry	Low	
8/27/2010	0	6:15	0.30	22.88	0.14	7.10	82.70	7.82	67.69	Wet	Mid	

DATE	Station	Time	Depth (m)	Temp (C)	Salinity (ppt)	DO (mg/l)	DO (%)	pH	Estimate flow (mgd)	Dry or Wet	Tide Stage	Comments
8/27/2010	1	6:25	0.30	22.06	0.14	7.50	85.80	7.96	67.69	Wet	Mid	
8/27/2010	4	6:00	0.30	21.66	0.14	5.91	67.20	7.52	67.69	Wet	Mid	
8/27/2010	4	6:10	0.80	21.62	0.14	5.77	65.50	7.52	67.69	Wet	Mid	
8/27/2010	6	5:40	0.30	22.41	0.17	5.27	60.80	7.33	67.69	Wet	Mid	flow is south @ Orange St
8/27/2010	6	5:50	0.70	22.44	0.20	5.17	59.80	7.35	67.69	Wet	Mid	
8/27/2010	7	6:40	0.30	22.32	3.87	5.30	62.60	7.25	67.69	Wet	Mid	all tidegates are unobstructed
8/27/2010	7	6:45	7.00	22.40	4.84	4.83	57.50	7.21	67.69	Wet	Mid	
8/27/2010	8	6:50	0.20	22.24	3.32	5.74	67.60	7.27	67.69	Wet	Mid	
8/27/2010	8	6:55	0.40	22.30	3.86	5.69	67.20	7.24	67.69	Wet	Mid	
9/3/2010	0	6:00	0.20	25.43	0.13	9.18	110.40	9.07	47.73	Dry	Mid	
9/3/2010	1	6:12	0.30	24.71	0.13	6.87	82.80	8.96	47.73	Dry	Mid	
9/3/2010	4	5:45	0.20	24.11	0.13	3.66	43.60	8.04	47.73	Dry	Mid	
9/3/2010	4	5:50	0.80	24.09	0.13	3.36	40.00	7.94	47.73	Dry	Mid	
9/3/2010	6	5:25	0.30	25.73	1.49	3.72	46.10	7.38	47.73	Dry	Mid	flow is north @ Orange St
9/3/2010	6	5:35	0.80	25.67	12.57	1.87	24.90	6.86	47.73	Dry	Mid	
9/3/2010	7	6:25	0.20	25.09	20.14	4.73	64.90	7.26	47.73	Dry	Mid	all tidegates are unobstructed
9/3/2010	7	6:30	0.70	25.08	20.76	4.44	61.10	7.22	47.73	Dry	Mid	
9/3/2010	8	6:35	0.30	25.45	16.28	4.44	60.00	7.24	47.73	Dry	Mid	
9/3/2010	8	6:40	1.10	25.15	20.07	4.24	58.20	7.20	47.73	Dry	Mid	
9/10/2010	0	6:10	0.20	22.30	0.13	7.20	82.40	7.70	34.35	Dry	Mid	
9/10/2010	1	6:19	0.10	20.50	0.13	8.00	89.20	7.80	34.35	Dry	Mid	
9/10/2010	4	6:37	0.20	19.00	0.18	4.60	49.90	7.20	34.35	Dry	Mid	
9/10/2010	4	6:39	0.70	21.50	4.10	3.80	44.40	6.90	34.35	Dry	Mid	
9/10/2010	6	6:55	0.20	20.10	3.20	5.20	58.80	7.10	34.35	Dry	Mid	
9/10/2010	6	6:58	0.80	23.40	14.30	1.60	20.60	6.70	34.35	Dry	Mid	
9/10/2010	7	7:12	0.20	22.10	16.30	4.20	53.70	6.90	34.35	Dry	Mid	
9/10/2010	7	7:15	0.60	22.60	20.20	3.90	50.70	6.90	34.35	Dry	Mid	
9/10/2010	8	7:16	0.10	20.70	11.70	6.20	74.30	7.10	34.35	Dry	Mid	

DATE	Station	Time	Depth (m)	Temp (C)	Salinity (ppt)	DO (mg/l)	DO (%)	pH	Estimate flow (mgd)	Dry or Wet	Tide Stage	Comments
9/10/2010	8	7:18	0.30	20.70	11.60	6.50	77.60	7.10	34.35	Dry	Mid	turbulent flow
9/17/2010	0	6:25	0.20	20.26	0.12	6.78	68.40	7.47	95.62	Wet	Mid	
9/17/2010	1	6:35	0.20	20.20	0.12	7.60	83.90	7.69	95.62	Wet	Mid	
9/17/2010	4	6:05	0.20	20.10	0.13	7.00	77.30	7.55	95.62	Wet	Mid	
9/17/2010	4	6:15	0.90	20.11	0.15	6.90	76.10	7.56	95.62	Wet	Mid	
9/17/2010	6	5:45	0.20	20.13	0.99	6.26	69.50	7.16	95.62	Wet	Mid	flow is south @ Orange St
9/17/2010	6	5:55	0.80	20.18	1.35	5.86	65.20	7.13	95.62	Wet	Mid	
9/17/2010	7	6:45	0.20	20.34	13.73	5.57	67.30	7.00	95.62	Wet	Mid	all tidegates are unobstructed
9/17/2010	7	6:50	0.90	20.42	16.51	4.95	60.90	6.95	95.62	Wet	Mid	
9/17/2010	8	6:55	0.20	20.38	9.43	5.47	64.40	7.04	95.62	Wet	Mid	
9/17/2010	8	7:00	1.20	20.44	17.51	4.78	59.20	6.94	95.62	Wet	Mid	
9/24/2010	0	6:20	0.20	20.77	0.13	8.36	93.50	8.24	55.71	Wet	Mid	
9/24/2010	1	6:25	0.20	20.46	0.13	7.55	83.90	8.19	55.71	Wet	Mid	
9/24/2010	4	6:05	0.20	19.59	0.14	5.86	64.00	7.57	55.71	Wet	Mid	
9/24/2010	4	6:13	0.70	19.60	0.16	5.83	63.80	7.54	55.71	Wet	Mid	
9/24/2010	6	5:50	0.20	20.64	1.16	6.37	71.60	7.36	55.71	Wet	Mid	flow is south @ Orange St
9/24/2010	6	5:58	0.60	21.60	7.40	5.50	65.30	6.97	55.71	Wet	Mid	
9/24/2010	7	6:35	0.20	21.00	5.59	6.30	73.40	7.31	55.71	Wet	Mid	all tidegates are unobstructed
9/24/2010	7	6:40	0.60	21.35	12.64	5.18	63.40	7.07	55.71	Wet	Mid	
9/24/2010	8	6:45	0.20	21.03	5.97	6.56	76.50	7.28	55.71	Wet	Mid	
9/24/2010	8	6:50	0.30	21.05	6.34	6.65	77.80	7.27	55.71	Wet	Mid	