**FINAL**

# 2005 Water Quality Monitoring

# Mill River

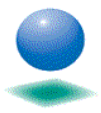
## Hamden and New Haven, CT

**December 2005**

*Prepared for*

**Regional Water Authority**

*Prepared by*



CH2MHILL

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# 2005 Mill River Water Quality Monitoring

## Introduction

This report presents 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 dam. The objective of these studies, which began in 1998, is to assess the potential effects on the river from reactivating Lake Whitney as a public water supply. The lake served as a water supply from 1862 until its use was temporarily discontinued in 1991. The Regional Water Authority 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, prior baseline studies of DO and salinity patterns in the lower Mill River were conducted in 1998 and annually since 2000. Dissolved oxygen and salinity were both recognized as important parameters to be considered in developing an environmental management plan for the Lake Whitney WTP (Lake Whitney WTP Environmental Evaluation Team, 1999). This was further emphasized by a July 25, 2000 Resolution adopted by the RWA's Five-Member Authority Board that included the following obligation:

> "By November 30, 2003, the RWA shall undertake and complete a study of dissolved oxygen concentrations in the downstream Mill River Corridor from the Whitney dam to the Orange Street Bridge, for the purpose of determining the dissolved oxygen concentrations in the spillway plunge pool necessary for maintaining acceptable dissolved oxygen levels downstream."

Based on the analysis of data collected from 1998 to 2003, 7.0 mg/L was selected as a reasonable target DO for the spillway plunge pool in the Mill River during downstream release situations (CH2M HILL, 2003). It is expected that under most circumstances this will result in a surface water DO concentration above 5.0 mg/L at the Orange Street Bridge during dry weather conditions, although surface water DO concentrations slightly below 5.0 mg/L are occasionally observed.

Summer 2005 provided the opportunity to document conditions in the Mill River during a dry summer with sustained low flows. It was by far the driest since monitoring began in 1998, with only 9.3 inches of precipitation recorded from June – September at the Lake Whitney rain gauge. In comparison, the next lowest totals for this period occurred in 1999 and 2001, with 12.0 and 13.4 inches, respectively. No DO or salinity measurements were recorded in 1999 and thus the baseline database is lacking information on river conditions in an extremely dry year. However, given the low WTP withdrawals for most of summer 2005, river conditions until late August likely approximated baseline non-operating conditions for an exceptionally dry summer period.

The WTP became operational in April 2005. Overall water withdrawals were low in 2005 (Figure 1), as much of the spring and summer were devoted to testing of the treatment process at low daily withdrawal rates. From April 20 through September 30, water withdrawals averaged only 18% of the maximum Connecticut Department of Environmental Protection (DEP) registered maximum daily diversion amount. There were three dates in late August/early September when withdrawals rates were increased to about 40 to 90% of the DEP registered daily diversion in order to complete high rate system performance testing.

Summer 2005 provided the opportunity to document river conditions during Management Plan downstream release conditions. Following a long period of dry weather, lake levels were only minimally exceeding spillway elevation by August 28. High rate system performance testing of the WTP began on August 29 and a new artificial waterfall was activated at the 4.2 MGD downstream flow prescribed by the Management Plan. As a result of the increased withdrawals from Lake Whitney for WTP system performance testing and downstream releases through the artificial waterfall, Lake Whitney's water level quickly dropped below spillway elevation. Operation of the artificial waterfall at 4.2 MGD continued until natural flow over the spillway resumed on September 18, 2005.

# Monitoring Methods

From July 1 to September 30, 2005, the RWA conducted at least 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 2). Table 1 below presents a summary of the Mill River monitoring data collected in 2005.

TABLE 1
Mill River Monitoring Data collected in 2005

| Frequency/Dates | Locations | Parameters |
|---|---|---|
| Weekly – July 1 through Sept. 30 (early morning) | Spillway | Temperature, DO, Salinity, specific conductance, pH |
| | Plunge Pool | |
| | Footbridge | |
| | Orange St. | |
| | Tidegates (North and South) | |

The weekly data were collected using a Hydrolab Quanta multi-parameter meter that was calibrated prior to each set of water quality measurements. The weekly monitoring data were collected during the early morning when dissolved oxygen is expected to be at its minimum daily concentration. 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 m depth) and near the bottom to account for the possible presence of distinct water layers due to salinity intrusion from Long Island Sound. All weekly DO monitoring data are presented in Appendix A.

# Monitoring Results

## Weekly Salinity Results

The weekly salinity monitoring data are presented in Figure 3 (surface layer) and Figure 4 (bottom layer). Salinity was elevated at Orange Street in 2005 with 10 of 15 measurements in the surface layer exceeding 1 part per thousand (ppt). There was generally higher saltwater intrusion observed in the bottom layer with 10 of 15 dates exceeding 10 ppt, and the highest measurement of 18.6 ppt recorded on August 26. Greater salinity concentrations usually coincided with dry weather and high tide. As expected, salinity levels were elevated at the tide gates with concentrations ranging up to 24.8 ppt.

Figure 5 presents surface salinities at Orange Street and the footbridge with flow as measured at Lake Whitney dam (spillway overflow or downstream release) and illustrates that salinity increased as the flow gradually decreased from July to late August. The measured salinity was higher than generally reported in previous years; however, periods of higher salinities do occur at the Orange St. Bridge. In 2002, surface water salinities at Orange St. exceeded 6.0 ppt on several dates (CH2M Hill, 2002). The maximum surface salinity recorded at the footbridge in 2005 and all preceding monitoring was 5.8 ppt on August 26, 2005. All other surface salinity measurements at the footbridge station were less than 1.0 ppt.

## Weekly Dissolved Oxygen Results

Weekly surface layer DO measurements from the Mill River at the spillway, the plunge pool, the footbridge, Orange St. Bridge, and the tide gates are shown in Figure 6. Bottom layer measurements are shown in Figure 7. Average 2005 DO and DO ranges at the spillway, plunge pool, footbridge, Orange St. Bridge, and tidegates are summarized in Table 2. Average DO readings for all weekly monitoring from 2001 to 2005 are shown in Table 3. In general, DO concentrations near the bottom of the water column were lower than DO concentrations near the surface at the footbridge and Orange Street monitoring locations.

Figure 8 presents the DO at the plunge pool, Orange St (surface), and the footbridge (surface) along with the flow in the river as measured at the Lake Whitney dam. The DO at the plunge pool always measured 7.0 mg/L or greater except for one measurement on August 26 (6.6 mg/L). The DO measurements at the Orange St. Bridge were 4.8 mg/L or greater from July 1 to August 30. From August 26 to September 30, the surface DO at Orange St was below 5 mg/L on all sampling dates except for August 30 (5.8 mg/L) and September 9 (5.0 mg/L). While this included the approximately three week period of downstream release flows, the lower DO measurements generally coincided with several intense rainfalls events, likely due to organic matter washed into the river with the storm water runoff. This is consistent with findings in previous studies (CH2M HILL, 2003). Surface DO remained below 5.0 mg/L at Orange St. after flow over the spillway resumed on September 18 and through the end of the monitoring period, which ended on September 30.

TABLE 2
Weekly Surface Dissolved Oxygen Average and Range

| | Average (mg/L) | Range (mg/L) |
|---|---|---|
| Spillway | 7.6 | 3.8 - 9.8 |
| Plunge Pool | 7.5 | 6.6 - 8.0 |
| Footbridge (Surface) | 5.2 | 3.4 - 7.3 |
| Footbridge (Bottom) | 4.0 | 2.0 - 6.8 |
| Orange Street (Surface) | 5.3 | 3.8 - 6.7 |
| Orange Street (Bottom) | 3.6 | 1.2 - 6.4 |
| Tide Gate North (Surface) | 5.1 | 3.9 - 6.5 |
| Tide Gate North (Bottom) | 4.4 | 1.8 - 5.9 |
| Tide Gate South (Surface) | 5.5 | 3.9 - 7.2 |
| Tide Gate South (Bottom) | 5.1 | 3.6 - 6.7 |

TABLE 3
2001 – 2005 Weekly Sampling Average Mill River Surface Dissolved Oxygen

| Station | 2001 | 2002 | 2003 | 2004* | 2005 |
|---|---|---|---|---|---|
| Spillway | 8.0 | 8.0 | 8.0 | 8.2 | 7.6 |
| Plunge Pool | 7.7 | 7.9 | 7.9 | 4.1 | 7.5 |
| Footbridge | NA | NA | 6.5 | 6.0 | 5.2 |
| Orange St. Bridge | 5.9 | 6.2 | 6.4 | 6.8 | 5.3 |
| Tide Gates Upstream | NA | NA | 6.2 | 6.2 | 5.1 |
| Tide Gates Downstream | NA | NA | 6.6 | 6.1 | 5.6 |

* Flow bypassed around plunge pool July 6 - August 27, 2004 for lake drawdown

NA = No data available

For 6 out of 13 sampling dates, surface DO at the footbridge station in East Rock Park was less than 5.0 mg/L. DO concentrations generally appeared to be more stressed at the footbridge than at Orange St during the dry period that ensued from about mid-July through the end of August (Figure 9). Surface DO concentrations at the footbridge station were comparable or higher than Orange St. during the month of September 2005, suggesting that DO at the footbridge is less impacted by stormwater runoff factors than the more saline downstream locations. Surface DO measurements less than 5 mg/L at the footbridge were observed on two occasions in prior years (4.8 mg/L on 9/25/2002 and 4.9 mg/L on 8/27/2004), although routine weekly summer monitoring at this station did not commence until July 2003.

All DO measurements in the spillway plunge pool during the downstream release period from August 29 to September 17 exceeded the Management Plan 7.0 mg/L performance standard. The artificial waterfall appeared to be very effective at aerating the downstream flow release with DO increasing by 0.5 mg/L or more over August plunge pool readings when the reservoir was overflowing. Flow and DO at the estuarine stations (footbridge, Orange St., and tide gates) were on a downward trend when water withdrawals were temporarily increased and the downstream release was activated as the lake level dropped below spillway elevation. Plunge pool DO improved during the downstream release period. DO at the footbridge and Orange St. improved initially and were both measured at 5.0 mg/L during the one dry weather sampling date during the release period. However, there were notable declines in DO at these stations in September as this period was also marked by several large rain events. This likely resulted in stormwater-related oxygen demand within the river, similar to that observed in prior studies.

Due to the increasing influence of tidal effects, stormwater runoff, and combined sewer overflows with increasing distance downstream, Orange St. has been established as the downstream limit for the target DO of 5.0 mg/L. However, to provide a broader understanding of downstream water quality, weekly monitoring was also conducted at the Mill River tide gates, including photographing the condition of the tide gates. Dissolved oxygen concentrations at the tide gates are sometimes influenced by turbulence and associated aeration as water flows through the gates. Visual observation and photographs were recorded at the tide gates in 2005. Debris that partially blocked open the tide gates was noted on July 1 and September 16. On both occasions the blockages were no longer evident in the following weeks' monitoring. Average DO in 2005 at the tidegates was lower than seen in previous years monitoring efforts (Table 3).

# Conclusions

This report summarizes the first year of data collection during operation of the new Lake Whitney WTP. 2005 provided the first opportunity to collect data during an exceptionally dry summer and during an actual downstream release scenario using the artificial waterfall. The following conclusions can be drawn from the data collected in 2005:

- At the tidally influenced stations downstream average DO was lower than in prior years (Table 3). The footbridge station was more severely affected during the dry weather period from mid-July through the end of August, while the lowest DO at the Orange St. station generally occurred in response to intense rain events at the end of August and during September. It is unlikely that water withdrawals played a significant role in low DO readings observed during July and August, as water supply withdrawals were very low up to this point.
- The Management Plan downstream release of 4.2 MGD through the artificial waterfall was very effective at meeting and exceeding the plunge pool DO performance standard of 7.0 mg/L when the lake fell below spillway for a three week period. DO was likely enhanced by aeration effects associated with the artificial waterfall. Although DO was 5.0 mg/L at the footbridge and Orange St. during a dry weather sampling event during the downstream release period, monitoring results were confounded by heavy precipitation events that likely caused

stormwater runoff related DO impacts. Future monitoring during downstream release conditions during dry weather will provide further insight on interactions between water withdrawals, downstream releases, and downstream DO.

- Low flows over the spillway resulted in higher salinity concentrations at the footbridge and Orange St than observed in the previous 5 years of monitoring.
- In the past monitoring efforts, low DO concentrations have been associated with stormwater events. This year, exceptionally low flows and tidal influences in July and August also appeared to contribute to lower DO concentrations at the footbridge station. For the vast majority of this period the water treatment plant was operating at low withdrawal rates (Figure 1). Although these water withdrawals incrementally affected downstream flows, the extended dry weather pattern and resulting low inflows to Lake Whitney reservoir are believed to be the major factors affecting the observed downstream conditions in summer 2005.

Future monitoring during operating conditions will provide valuable information for assessing the degree of impact, if any, of future public water supply withdrawals on the environmental quality of the lower Mill River. The data collected will be used to assess the success of the Management Plan measures in mitigating potential water supply withdrawal impacts on river DO. Potential alternatives to supplement downstream DO concentrations include plunge pool aeration, and/or changes in the downstream release schedule. Any changes should be carefully weighed against potential consequences to both upstream and downstream interests.

# 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, (2002). *2002 Water Quality Monitoring, Mill River, Hamden and New Haven, CT.* 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: Lake Whitney Water Treatment Plant Daily Withdrawals**
**April 20 - Sept 30, 2005**

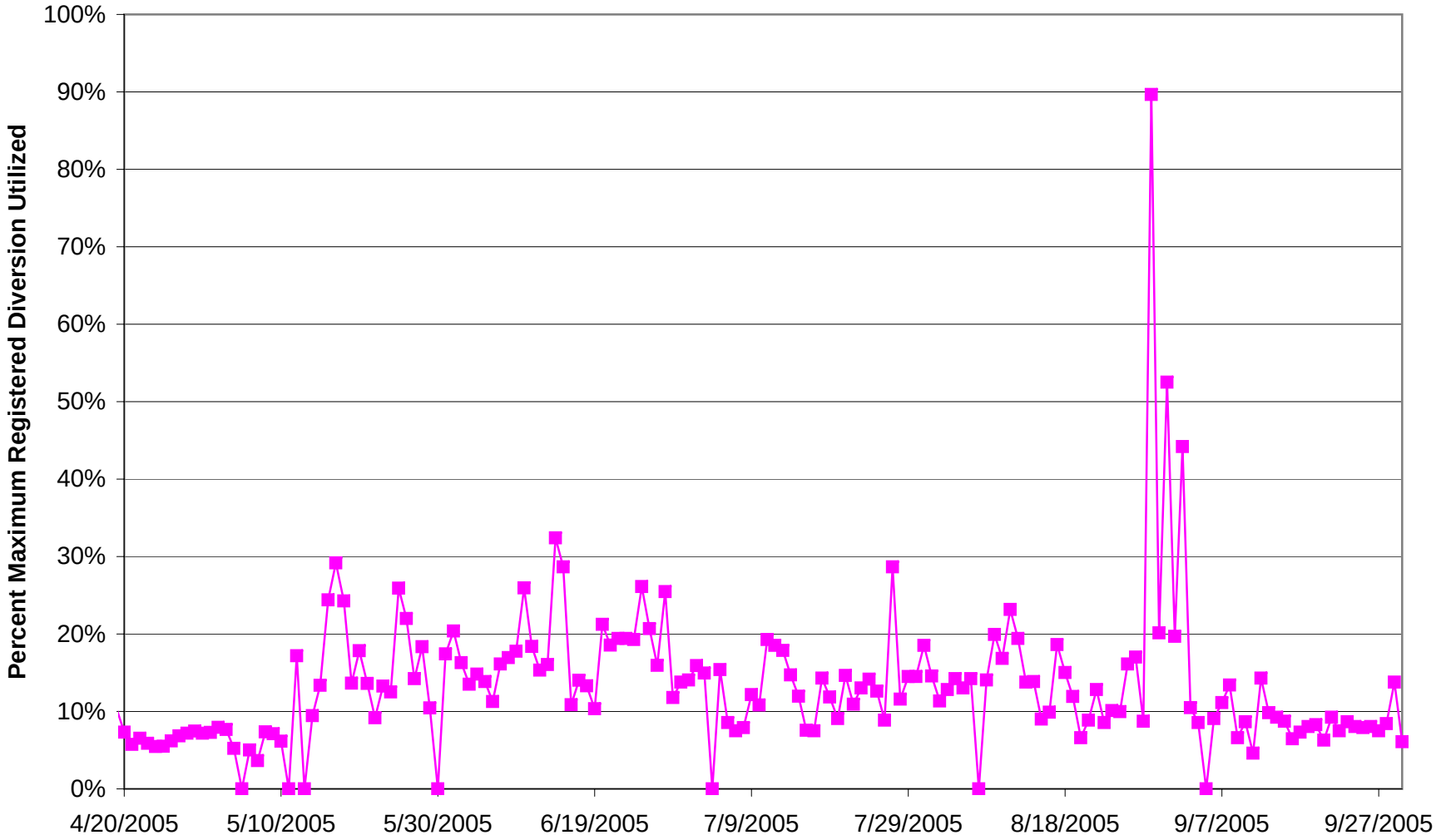
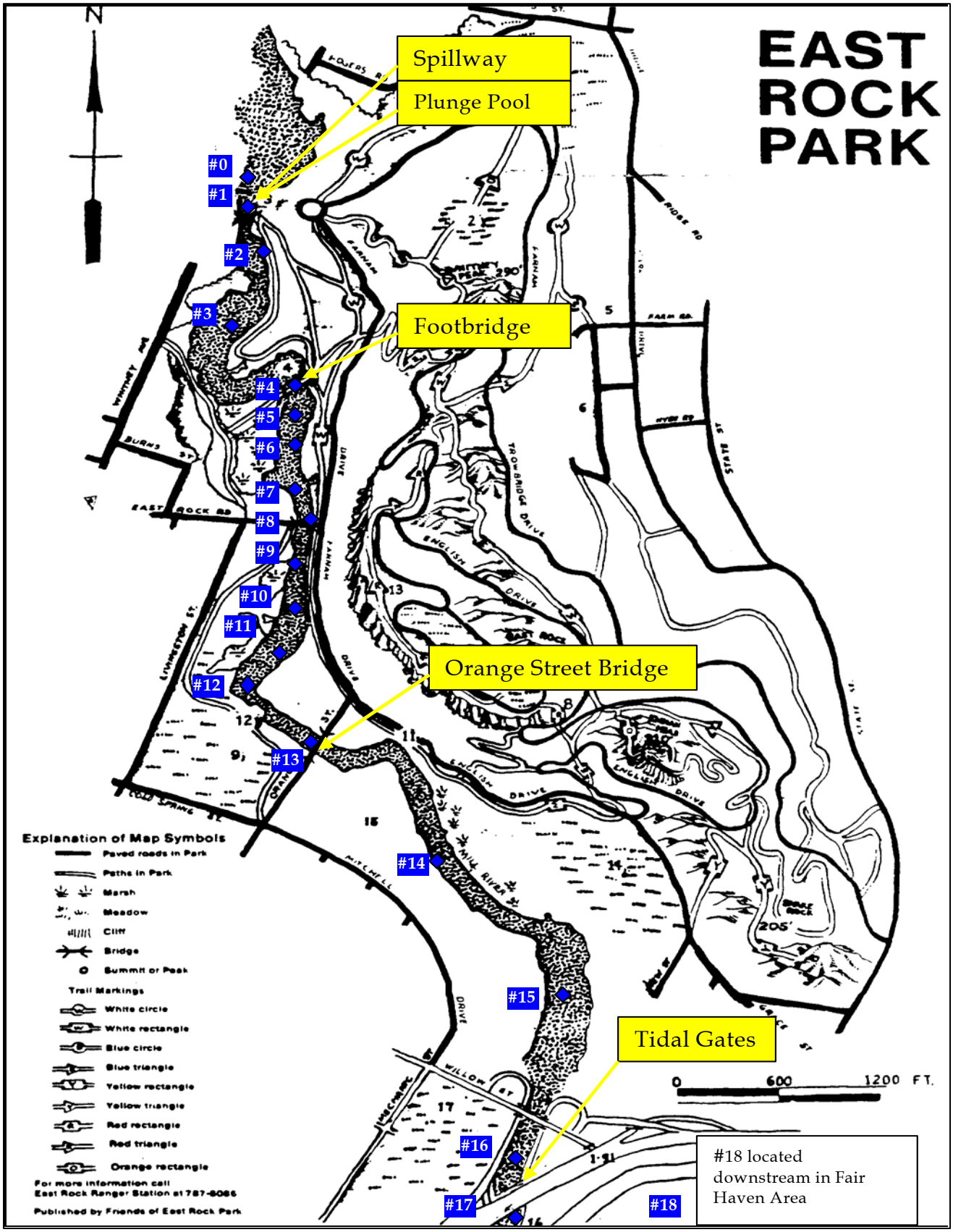
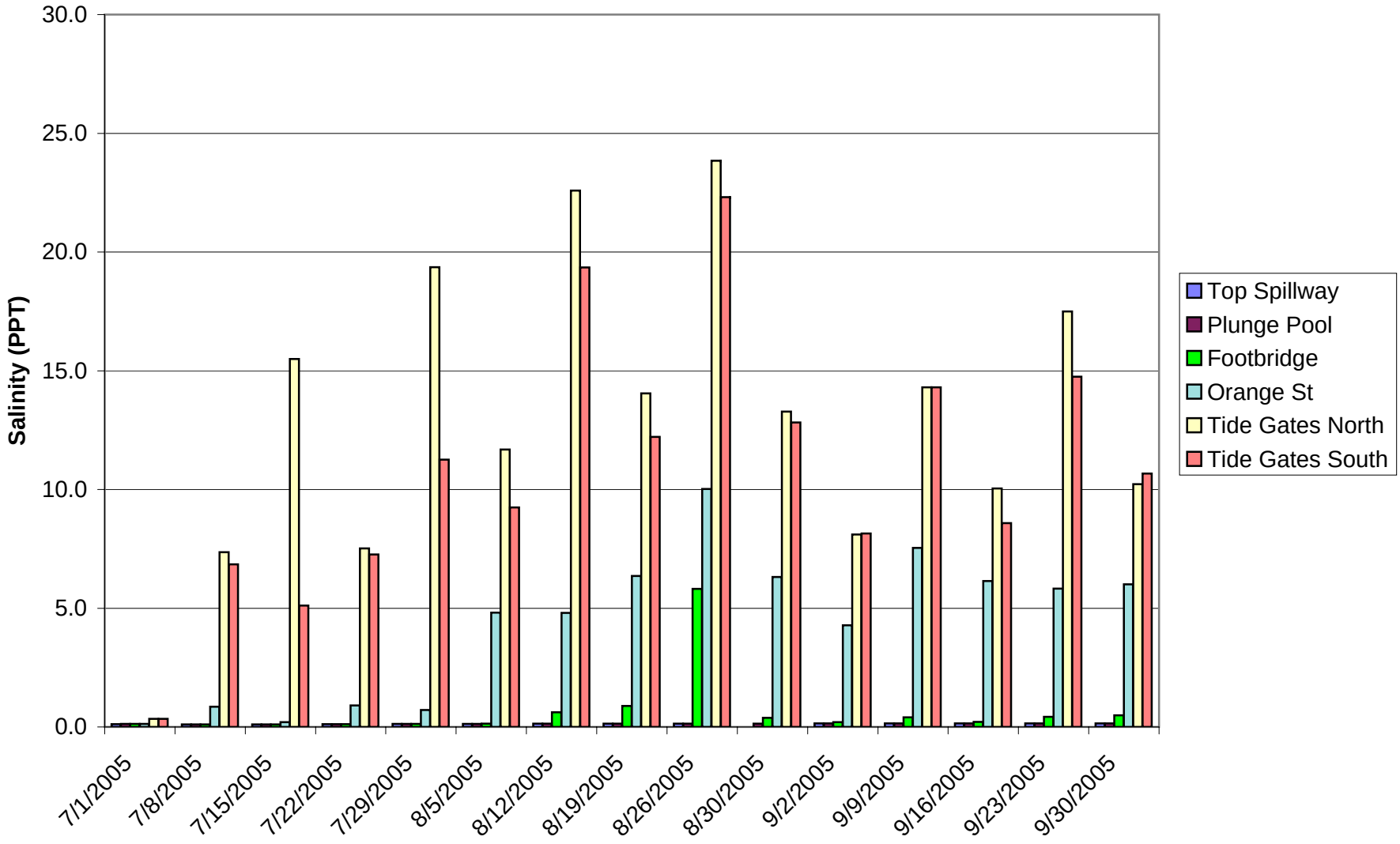


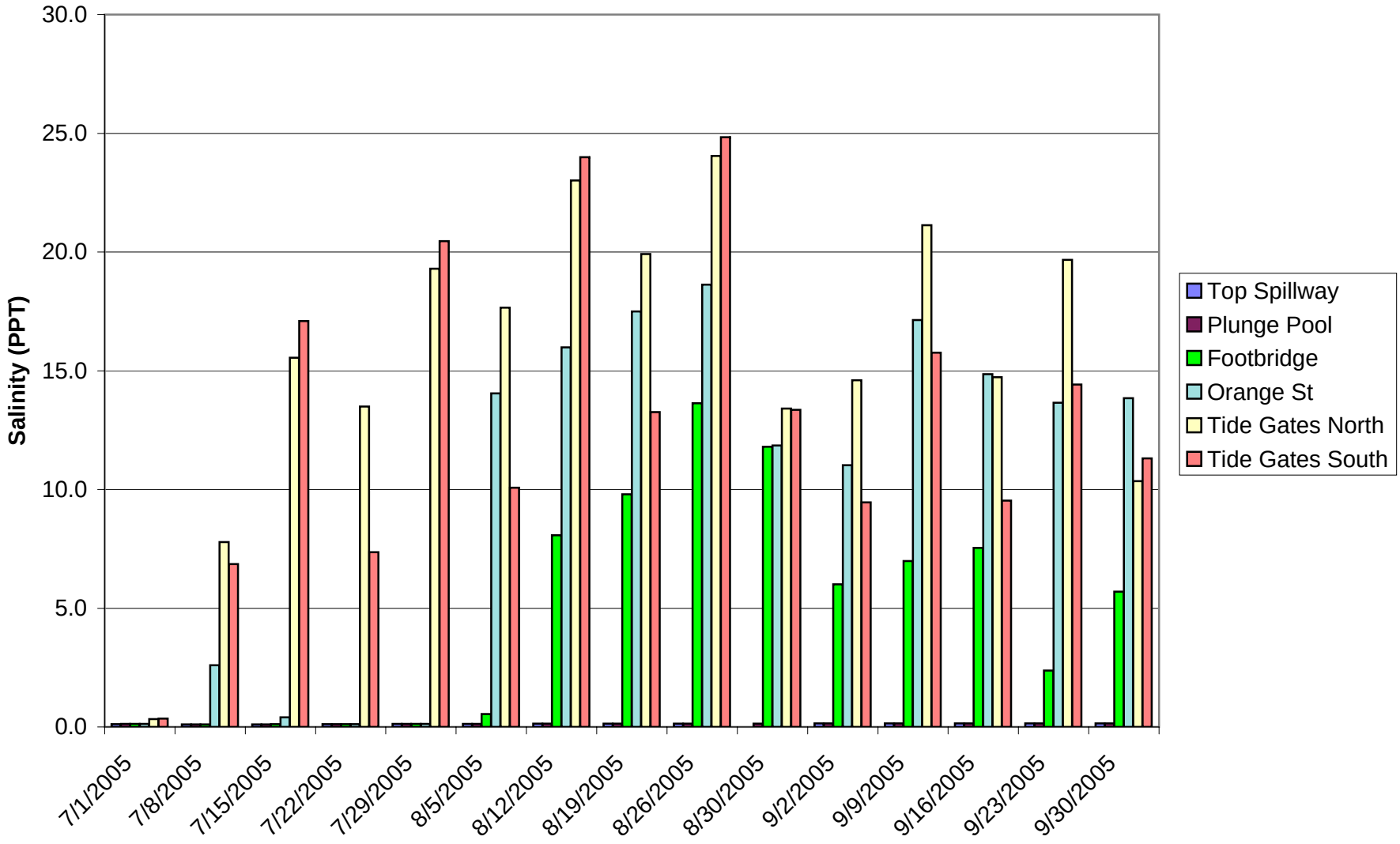
Figure 2 Locations Sampled During Mill River Monitoring



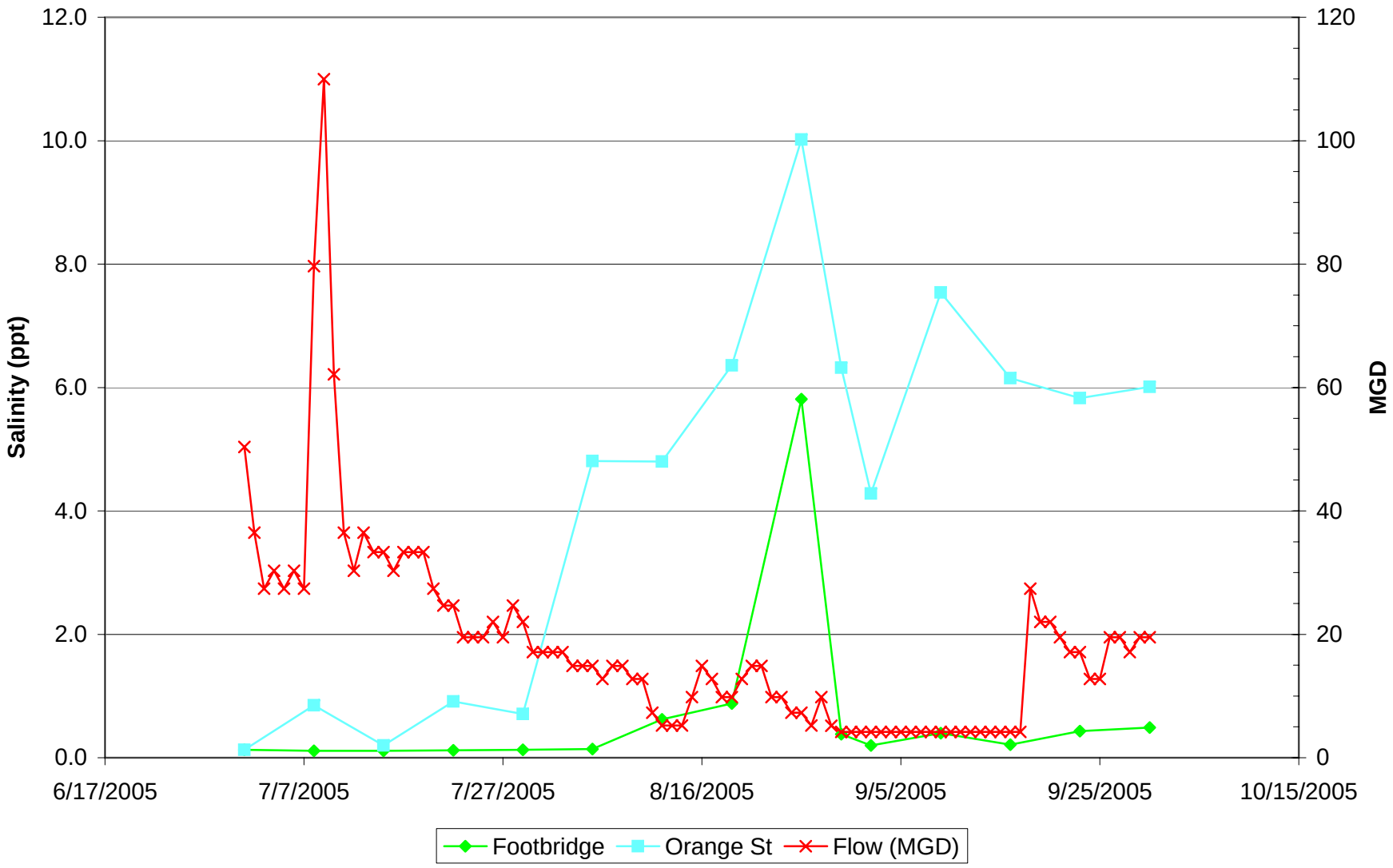
## Figure 3: Summer 2005 Mill River Surface Salinity



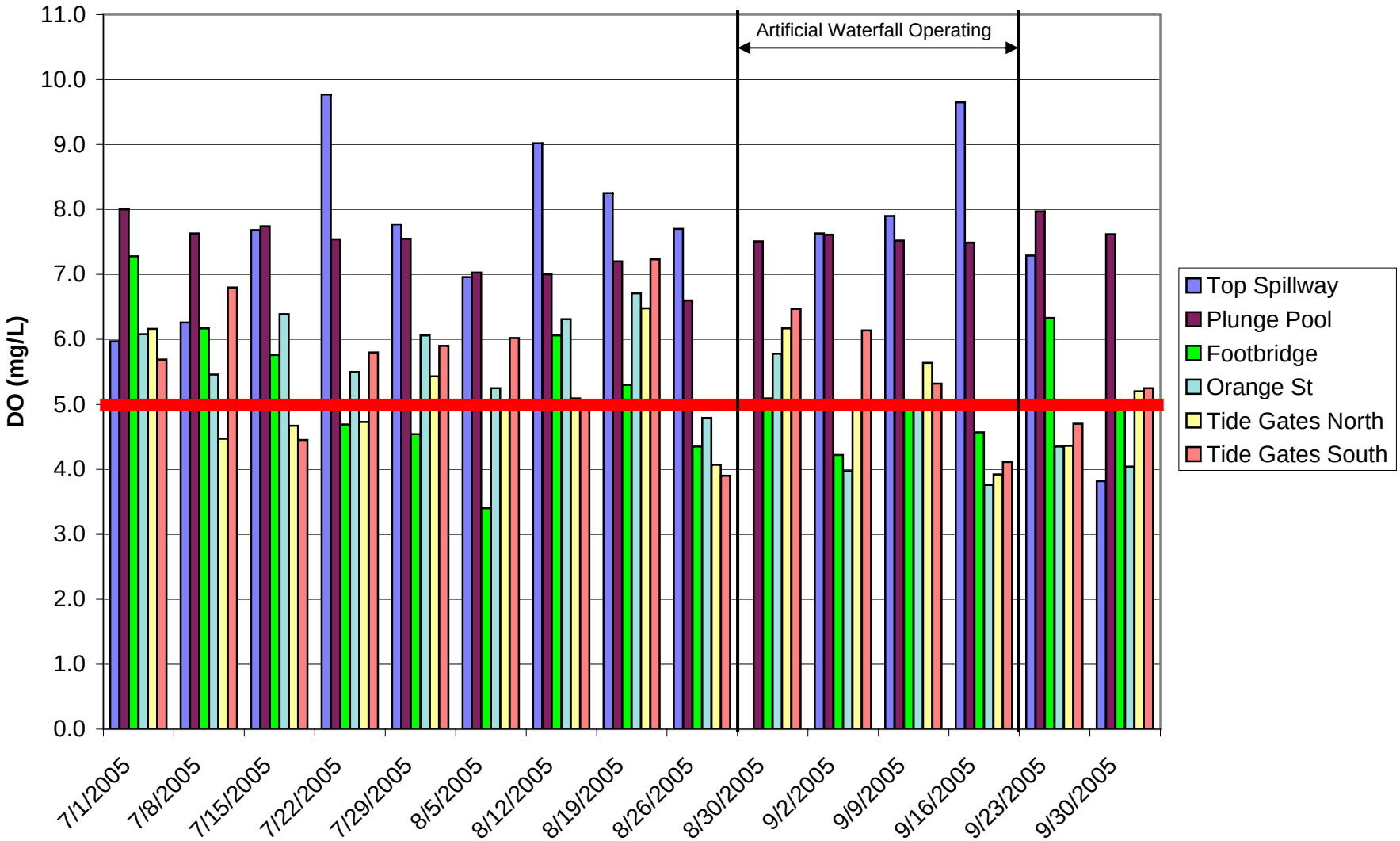
## Figure 4: Summer 2005 Mill River Bottom Salinity



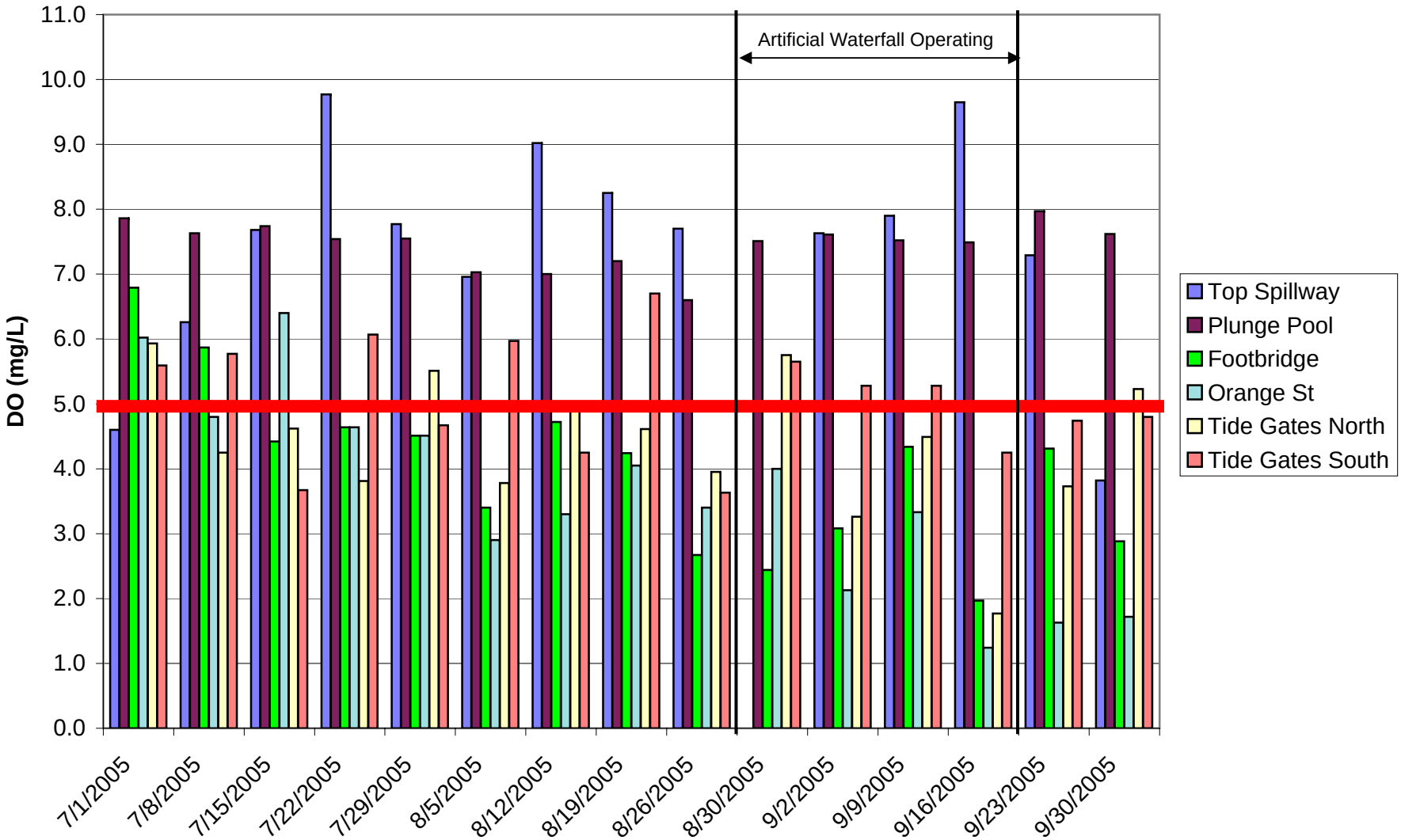
## Figure 5: Mill River Downstream Surface Salinity with Flow



## Figure 6: Summer 2005 Mill River Surface Dissolved Oxygen



## Figure 7: Summer 2005 Mill River Bottom Dissolved Oxygen



## Figure 8: Mill River Downstream Surface DO with Flow

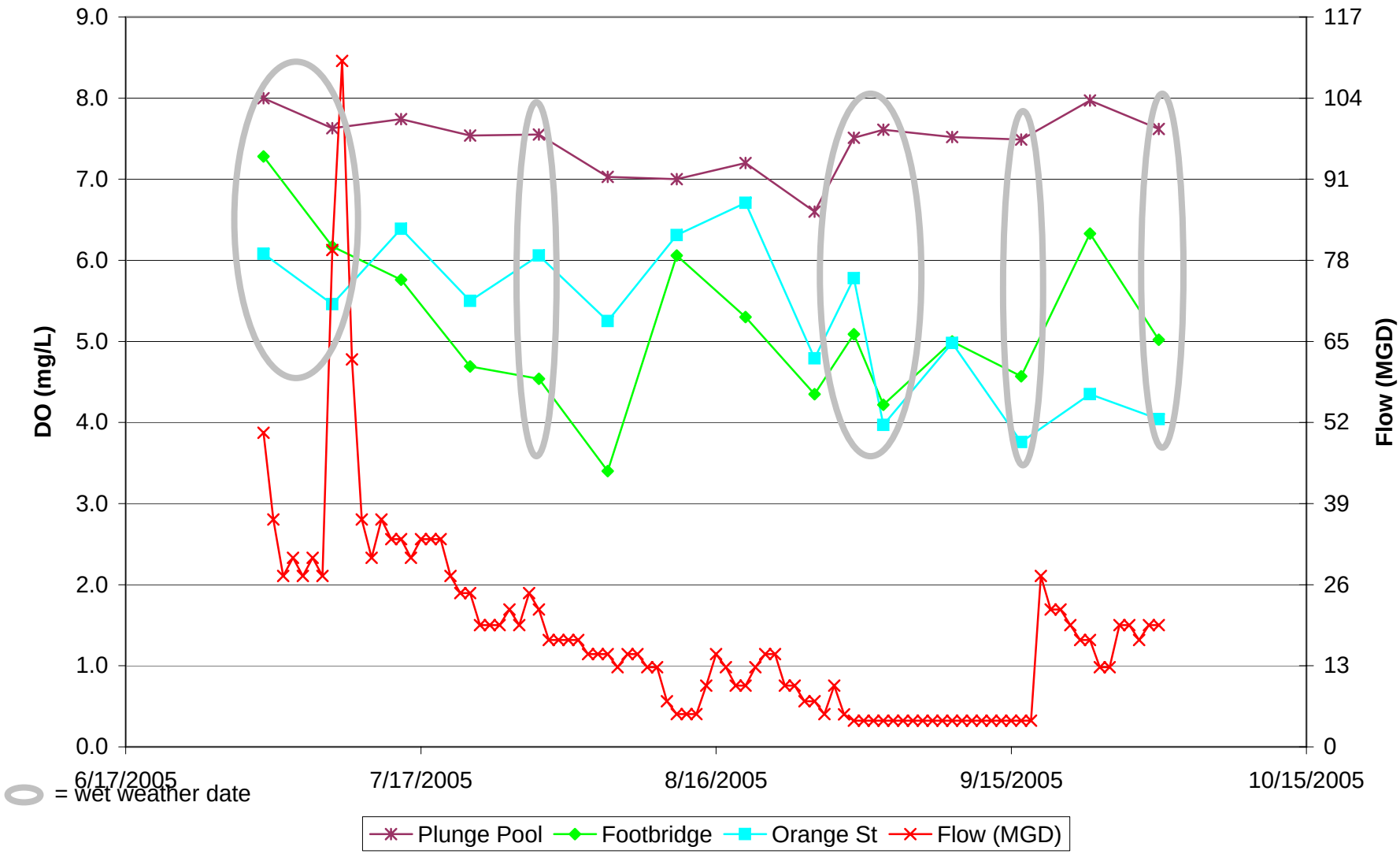
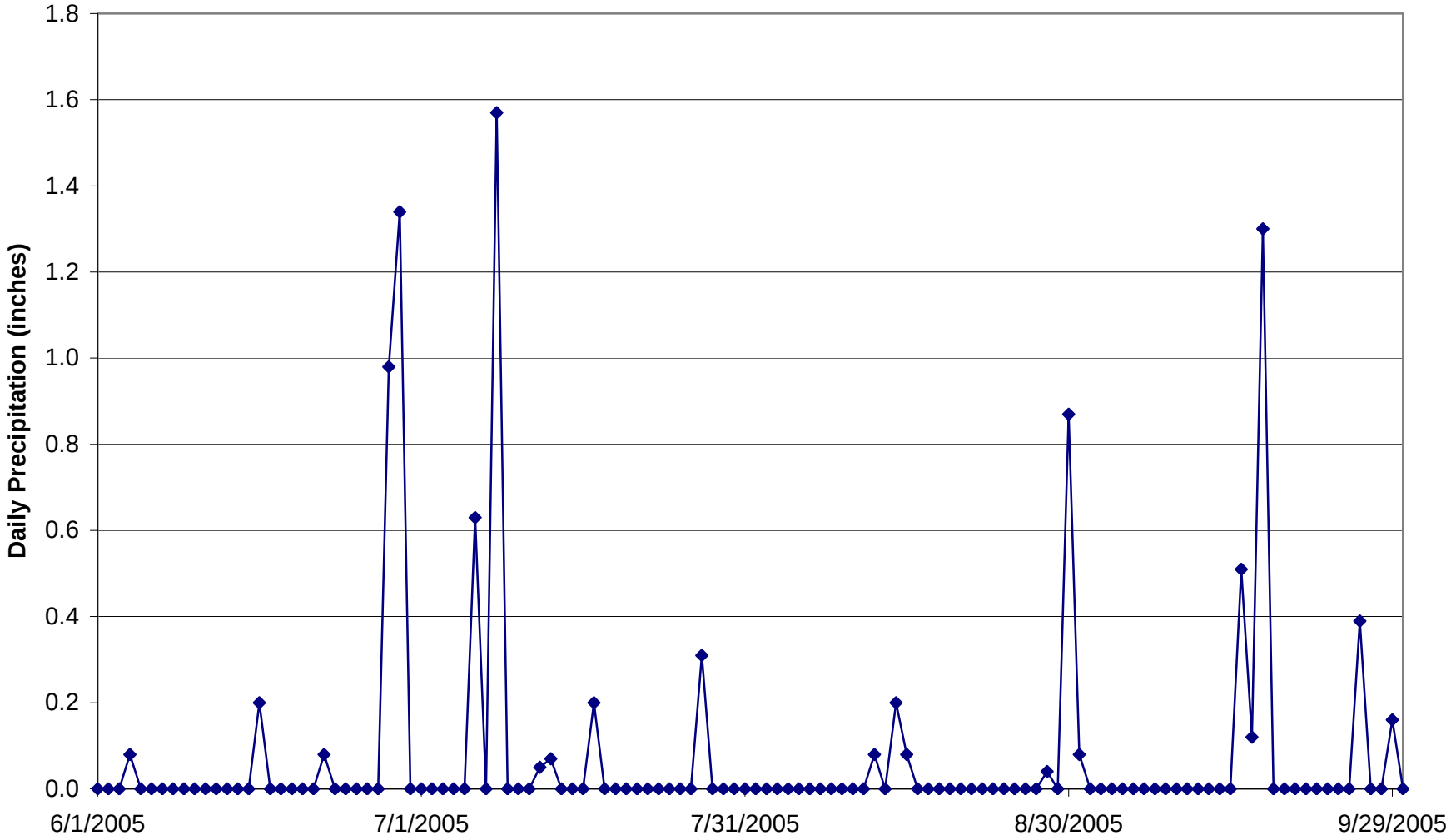


**Figure 9: Precipitation at Lake Whitney**
**June - August 2005**



# Attachment A
# Weekly Monitoring Data

**Mill River**
**2005 DO Monitoring**

| DATE | Station | Time | Depth (m) | Temp (C) | SpC (mS/cm) | Salinity (PSS) | pH | DO (mg/l) | DO% | Tide Stage |
|---|---|---|---|---|---|---|---|---|---|---|
| 7/1/2005 | 0 | 6:00 | 0.10 | 24.13 | 0.255 | 0.12 | 7.21 | 5.97 | 71.20 | Low |
| 7/1/2005 | 0 | 6:08 | 0.70 | 23.61 | 0.241 | 0.12 | 6.99 | 4.60 | 54.30 | Low |
| 7/1/2005 | 1 | 5:40 | 0.20 | 24.35 | 0.265 | 0.13 | 7.57 | 8.00 | 95.7 | Low |
| 7/1/2005 | 1 | 5:55 | 0.60 | 24.34 | 0.265 | 0.13 | 7.60 | 7.86 | 94.0 | Low |
| 7/1/2005 | 4 | 5:30 | 0.20 | 24.04 | 0.263 | 0.13 | 7.25 | 7.28 | 86.6 | Low |
| 7/1/2005 | 4 | 5:38 | 1.00 | 24.06 | 0.263 | 0.13 | 7.32 | 6.79 | 80.8 | Low |
| 7/1/2005 | 6 | 5:20 | 0.20 | 23.71 | 0.27 | 0.13 | 6.61 | 6.08 | 71.9 | Low |
| 7/1/2005 | 6 | 5:25 | 0.90 | 23.71 | 0.273 | 0.13 | 6.73 | 6.02 | 71.2 | Low |
| 7/1/2005 | 7 | 6:15 | 0.20 | 23.76 | 0.689 | 0.34 | 7.29 | 6.16 | 73.1 | Low |
| 7/1/2005 | 7 | 6:19 | 1.10 | 23.75 | 0.681 | 0.33 | 7.28 | 5.93 | 70.3 | Low |
| 7/1/2005 | 8 | 6:22 | 0.20 | 23.76 | 0.704 | 0.34 | 7.29 | 5.69 | 67.5 | Low |
| 7/1/2005 | 8 | 6:30 | 1.20 | 24.68 | 0.72 | 0.35 | 7.25 | 5.59 | 67.4 | Low |
| 7/8/2005 | 0 | 5:58 | 0.40 | 23.70 | 0.229 | 0.11 | 7.17 | 6.26 | 74.0 | Mid |
| 7/8/2005 | 1 | 5:45 | 0.30 | 23.20 | 0.229 | 0.11 | 7.36 | 7.63 | 89.3 | Mid |
| 7/8/2005 | 4 | 5:30 | 0.30 | 22.40 | 0.235 | 0.11 | 6.90 | 6.17 | 71.2 | Mid |
| 7/8/2005 | 4 | 5:35 | 0.90 | 22.40 | 0.235 | 0.11 | 6.87 | 5.87 | 67.7 | Mid |
| 7/8/2005 | 6 | 5:15 | 0.30 | 22.60 | 1.69 | 0.85 | 7.07 | 5.46 | 63.5 | Mid |
| 7/8/2005 | 6 | 5:22 | 0.90 | 22.70 | 4.87 | 2.60 | 7.14 | 4.80 | 56.6 | Mid |
| 7/8/2005 | 7 | 6:10 | 0.20 | 22.30 | 12.87 | 7.36 | 7.25 | 4.47 | 53.9 | Mid |
| 7/8/2005 | 7 | 6:15 | 0.70 | 22.30 | 13.56 | 7.79 | 7.16 | 4.25 | 51.3 | Mid |
| 7/8/2005 | 8 | 6:20 | 0.20 | 22.20 | 12.04 | 6.85 | 7.16 | 6.80 | 81.7 | Mid |
| 7/8/2005 | 8 | 6:28 | 0.60 | 22.20 | 12.05 | 6.86 | 7.13 | 5.77 | 68.7 | Mid |
| 7/15/2005 | 0 | 5:54 | 0.40 | 24.52 | 0.233 | 0.11 | 7.27 | 7.68 | 92.3 | Mid |
| 7/15/2005 | 1 | 5:48 | 0.30 | 24.40 | 0.231 | 0.11 | 7.54 | 7.74 | 92.8 | Mid |
| 7/15/2005 | 4 | 5:34 | 0.20 | 23.91 | 0.237 | 0.11 | 6.95 | 5.76 | 68.4 | Mid |
| 7/15/2005 | 4 | 5:38 | 0.90 | 23.77 | 0.244 | 0.12 | 6.93 | 4.42 | 52.4 | Mid |
| 7/15/2005 | 6 | 5:15 | 0.30 | 25.14 | 0.41 | 0.20 | 6.92 | 6.39 | 77.5 | Mid |
| 7/15/2005 | 6 | 5:24 | 1.00 | 25.29 | 0.807 | 0.40 | 7.13 | 6.40 | 78.2 | Mid |
| 7/15/2005 | 7 | 6:05 | 0.20 | 22.71 | 25.5 | 15.49 | 7.21 | 4.67 | 59.7 | Mid |
| 7/15/2005 | 7 | 6:12 | 0.80 | 22.71 | 25.6 | 15.55 | 7.19 | 4.62 | 59.0 | Mid |
| 7/15/2005 | 8 | 6:15 | 0.20 | 24.16 | 9.16 | 5.11 | 7.20 | 4.45 | 54.9 | Mid |
| 7/15/2005 | 8 | 6:22 | 1.10 | 22.50 | 27.9 | 17.09 | 7.10 | 3.67 | 47.2 | Mid |

**Mill River**
**2005 DO Monitoring**

| DATE | Station | Time | Depth (m) | Temp (C) | SpC (mS/cm) | Salinity (PSS) | pH | DO (mg/l) | DO% | Tide Stage |
|---|---|---|---|---|---|---|---|---|---|---|
| 7/22/2005 | 0 | 5:55 | 0.20 | 27.99 | 0.242 | 0.12 | 8.22 | 9.77 | 125.0 | Low |
| 7/22/2005 | 1 | 5:50 | 0.20 | 26.91 | 0.243 | 0.12 | 8.09 | 7.54 | 94.6 | Low |
| 7/22/2005 | 4 | 5:34 | 0.20 | 25.71 | 0.253 | 0.12 | 7.15 | 4.69 | 57.5 | Low |
| 7/22/2005 | 4 | 5:40 | 0.70 | 25.68 | 0.253 | 0.12 | 7.17 | 4.64 | 56.8 | Low |
| 7/22/2005 | 6 | 5:17 | 0.20 | 26.90 | 1.8 | 0.91 | 7.35 | 5.50 | 69.4 | Low |
| 7/22/2005 | 6 | 5:26 | 0.80 | 26.90 | 9.17 | 5.13 | 7.15 | 3.37 | 43.7 | Low |
| 7/22/2005 | 7 | 6:10 | 0.20 | 25.87 | 13.08 | 7.52 | 7.26 | 4.73 | 61.0 | Low |
| 7/22/2005 | 7 | 6:16 | 0.70 | 25.74 | 22.4 | 13.49 | 7.14 | 3.81 | 50.8 | Low |
| 7/22/2005 | 8 | 6:19 | 0.20 | 25.81 | 12.66 | 7.26 | 7.21 | 5.80 | 74.6 | Low |
| 7/22/2005 | 8 | 6:25 | 0.50 | 25.82 | 12.82 | 7.36 | 7.20 | 6.07 | 78.1 | Low |
| 7/29/2005 | 0 | 6:00 | 0.30 | 26.21 | 0.266 | 0.13 | 7.96 | 7.77 | 96.3 | Mid |
| 7/29/2005 | 1 | 5:50 | 0.20 | 25.16 | 0.267 | 0.13 | 7.85 | 7.55 | 91.6 | Mid |
| 7/29/2005 | 4 | 5:40 | 0.20 | 24.10 | 0.272 | 0.13 | 7.06 | 4.54 | 54.7 | Mid |
| 7/29/2005 | 4 | 5:45 | 0.80 | 24.09 | 0.272 | 0.13 | 7.08 | 4.51 | 53.7 | Mid |
| 7/29/2005 | 6 | 5:15 | 0.30 | 24.44 | 1.423 | 0.71 | 7.48 | 6.06 | 72.9 | Mid |
| 7/29/2005 | 6 | 5:30 | 0.90 | 25.75 | 8.57 | 4.77 | 7.33 | 5.85 | 74.0 | Mid |
| 7/29/2005 | 7 | 6:10 | 0.10 | 24.25 | 31.2 | 19.36 | 7.34 | 5.43 | 73.1 | Mid |
| 7/29/2005 | 7 | 6:15 | 0.80 | 24.26 | 31.1 | 19.30 | 7.30 | 5.51 | 74.1 | Mid |
| 7/29/2005 | 8 | 6:20 | 0.10 | 24.91 | 19 | 11.26 | 7.35 | 5.90 | 76.5 | Mid |
| 7/29/2005 | 8 | 6:28 | 1.10 | 24.22 | 32.8 | 20.46 | 7.18 | 4.67 | 63.0 | Mid |
| 8/5/2005 | 0 | 6:02 | 0.30 | 28.01 | 0.277 | 0.13 | 7.84 | 6.96 | 89.1 | Low |
| 8/5/2005 | 1 | 5:55 | 0.20 | 26.89 | 0.277 | 0.13 | 7.74 | 7.03 | 88.1 | Low |
| 8/5/2005 | 4 | 5:40 | 0.20 | 26.46 | 0.292 | 0.14 | 7.09 | 3.40 | 42.3 | Low |
| 8/5/2005 | 4 | 5:45 | 0.70 | 26.07 | 1.09 | 0.54 | 7.20 | 3.40 | 42.0 | Low |
| 8/5/2005 | 6 | 5:26 | 0.20 | 27.62 | 8.63 | 4.81 | 7.31 | 5.25 | 58.7 | Low |
| 8/5/2005 | 6 | 5:32 | 0.70 | 27.62 | 23.2 | 14.05 | 7.13 | 2.90 | 40.1 | Low |
| 8/5/2005 | 7 | 6:18 | 0.20 | 27.17 | 19.6 | 11.68 | 7.43 | 4.96 | 67.2 | Low |
| 8/5/2005 | 7 | 6:25 | 0.60 | 27.11 | 28.6 | 17.66 | 7.32 | 3.78 | 53.4 | Low |
| 8/5/2005 | 8 | 6:31 | 0.20 | 26.96 | 15.8 | 9.24 | 7.46 | 6.02 | 80.0 | Low |
| 8/5/2005 | 8 | 6:36 | 0.40 | 27.02 | 17.1 | 10.07 | 7.42 | 5.97 | 79.9 | Low |
| 8/12/2005 | 0 | 5:54 | 0.10 | 28.15 | 0.287 | 0.14 | 7.93 | 9.02 | 115.7 | High |
| 8/12/2005 | 1 | 6:02 | 0.10 | 25.87 | 0.29 | 0.14 | 7.83 | 7.00 | 86.2 | High |

**Mill River**
**2005 DO Monitoring**

| DATE | Station | Time | Depth (m) | Temp (C) | SpC (mS/cm) | Salinity (PSS) | pH | DO (mg/l) | DO% | Tide Stage |
|---|---|---|---|---|---|---|---|---|---|---|
| 8/12/2005 | 4 | 6:15 | 0.20 | 25.80 | 1.245 | 0.62 | 7.31 | 6.06 | 74.7 | High |
| 8/12/2005 | 4 | 6:17 | 0.90 | 28.03 | 13.94 | 8.07 | 6.97 | 4.72 | 63.6 | High |
| 8/12/2005 | 6 | 6:30 | 0.10 | 25.75 | 8.62 | 4.80 | 7.30 | 6.31 | 79.8 | High |
| 8/12/2005 | 6 | 6:32 | 0.70 | 27.34 | 26.1 | 15.98 | 6.91 | 3.30 | 45.9 | High |
| 8/12/2005 | 7 | 6:48 | 0.10 | 26.07 | 35.8 | 22.59 | 7.22 | 5.09 | 72.1 | High |
| 8/12/2005 | 7 | 6:50 | 0.90 | 26.09 | 36.4 | 23.01 | 7.21 | 5.02 | 71.3 | High |
| 8/12/2005 | 8 | 6:52 | 0.10 | 26.58 | 31.1 | 19.35 | 7.21 | 5.04 | 70.8 | High |
| 8/12/2005 | 8 | 6:54 | 0.90 | 26.07 | 37.8 | 23.99 | 7.18 | 4.25 | 60.8 | High |
| 8/19/2005 | 0 | 6:05 | 0.10 | 25.47 | 0.3 | 0.14 | 8.12 | 8.25 | 100.8 | Low |
| 8/19/2005 | 1 | 6:00 | 0.30 | 23.20 | 0.3 | 0.14 | 7.77 | 7.20 | 84.3 | Low |
| 8/19/2005 | 4 | 5:50 | 0.10 | 22.79 | 1.75 | 0.88 | 7.22 | 5.30 | 61.9 | Low |
| 8/19/2005 | 4 | 5:54 | 0.70 | 26.35 | 16.7 | 9.80 | 6.88 | 4.24 | 56.0 | Low |
| 8/19/2005 | 6 | 5:30 | 0.10 | 23.54 | 11.22 | 6.36 | 7.24 | 6.71 | 82.3 | Low |
| 8/19/2005 | 6 | 5:41 | 0.80 | 25.90 | 28.4 | 17.50 | 6.96 | 4.05 | 55.5 | Low |
| 8/19/2005 | 7 | 6:15 | 0.20 | 23.92 | 23.3 | 14.05 | 7.30 | 6.48 | 84.0 | Low |
| 8/19/2005 | 7 | 6:25 | 0.70 | 24.70 | 32 | 19.92 | 7.11 | 4.61 | 62.5 | Low |
| 8/19/2005 | 8 | 6:30 | 0.10 | 23.31 | 20.5 | 12.21 | 7.39 | 7.23 | 91.4 | Low |
| 8/19/2005 | 8 | 6:34 | 0.20 | 23.67 | 22.1 | 13.26 | 7.35 | 6.70 | 85.7 | Low |
| 8/26/2005 | 0 | 6:04 | 0.20 | 24.41 | 0.288 | 0.14 | 7.98 | 7.70 | 92.5 | High |
| 8/26/2005 | 1 | 6:08 | 0.20 | 22.03 | 0.293 | 0.14 | 7.69 | 6.60 | 75.6 | High |
| 8/26/2005 | 4 | 6:34 | 0.20 | 23.67 | 10.32 | 5.81 | 7.13 | 4.35 | 53.2 | High |
| 8/26/2005 | 4 | 6:38 | 0.90 | 26.06 | 22.6 | 13.63 | 6.83 | 2.67 | 35.9 | High |
| 8/26/2005 | 6 | 6:48 | 0.10 | 22.73 | 17.1 | 10.02 | 7.08 | 4.79 | 59.2 | High |
| 8/26/2005 | 6 | 6:51 | 0.80 | 24.96 | 30.1 | 18.63 | 6.95 | 3.40 | 46.1 | High |
| 8/26/2005 | 7 | 7:07 | 0.20 | 23.57 | 37.7 | 23.84 | 7.16 | 4.07 | 55.5 | High |
| 8/26/2005 | 7 | 7:08 | 1.00 | 23.63 | 38 | 24.05 | 7.16 | 3.95 | 54.0 | High |
| 8/26/2005 | 8 | 7:10 | 0.20 | 23.75 | 35.5 | 22.31 | 7.13 | 3.90 | 52.9 | High |
| 8/26/2005 | 8 | 7:11 | 0.90 | 23.70 | 39.1 | 24.83 | 7.15 | 3.63 | 50.0 | High |
| 8/30/2005 | 1 | 6:05 | 0.10 | 24.26 | 0.298 | 0.14 | 7.27 | 7.51 | 89.7 | Low |
| 8/30/2005 | 4 | 6:20 | 0.10 | 23.67 | 0.782 | 0.38 | 7.09 | 5.09 | 60.2 | Low |
| 8/30/2005 | 4 | 6:22 | 0.70 | 26.37 | 19.8 | 11.80 | 6.78 | 2.44 | 32.6 | Low |
| 8/30/2005 | 6 | 6:38 | 0.20 | 24.53 | 11.15 | 6.32 | 6.97 | 5.78 | 72.2 | Low |
| 8/30/2005 | 6 | 6:41 | 0.70 | 25.23 | 19.19 | 11.85 | 6.92 | 4.00 | 52.5 | Low |

**Mill River**
**2005 DO Monitoring**

| DATE | Station | Time | Depth (m) | Temp (C) | SpC (mS/cm) | Salinity (PSS) | pH | DO (mg/l) | DO% | Tide Stage |
|---|---|---|---|---|---|---|---|---|---|---|
| 8/30/2005 | 7 | 6:57 | 0.20 | 25.01 | 22.1 | 13.28 | 7.14 | 6.17 | 81.2 | Low |
| 8/30/2005 | 7 | 6:58 | 1.00 | 25.03 | 22.3 | 13.41 | 7.12 | 5.75 | 75.7 | Low |
| 8/30/2005 | 8 | 7:01 | 0.10 | 24.90 | 21.4 | 12.82 | 7.14 | 6.47 | 84.8 | Low |
| 8/30/2005 | 8 | 7:02 | 1.00 | 24.96 | 22.2 | 13.35 | 7.13 | 5.65 | 74.4 | Low |
| 9/2/2005 | 0 | 6:13 | 0.20 | 25.10 | 0.304 | 0.15 | 7.77 | 7.63 | 92.6 | Low |
| 9/2/2005 | 1 | 6:07 | 0.30 | 23.99 | 0.306 | 0.15 | 7.40 | 7.61 | 90.5 | Low |
| 9/2/2005 | 4 | 5:45 | 0.20 | 22.14 | 0.413 | 0.20 | 6.97 | 4.22 | 48.5 | Low |
| 9/2/2005 | 4 | 5:50 | 0.60 | 25.88 | 10.63 | 6.01 | 6.89 | 3.08 | 39.3 | Low |
| 9/2/2005 | 6 | 5:26 | 0.20 | 24.97 | 7.75 | 4.28 | 7.10 | 3.97 | 49.4 | Low |
| 9/2/2005 | 6 | 5:34 | 0.70 | 25.73 | 18.6 | 11.02 | 6.85 | 2.13 | 28.1 | Low |
| 9/2/2005 | 7 | 6:20 | 0.10 | 23.78 | 14.03 | 8.10 | 7.12 | 5.01 | 62.1 | Low |
| 9/2/2005 | 7 | 6:25 | 0.60 | 25.19 | 24.1 | 14.60 | 6.95 | 3.26 | 43.3 | Low |
| 9/2/2005 | 8 | 6:30 | 0.10 | 23.72 | 14.11 | 8.15 | 7.13 | 6.14 | 76.2 | Low |
| 9/2/2005 | 8 | 6:39 | 0.20 | 23.94 | 16.2 | 9.46 | 7.09 | 5.28 | 66.6 | Low |
| 9/9/2005 | 0 | 6:19 | 0.30 | 23.52 | 0.308 | 0.15 | 8.03 | 7.90 | 93.1 | High |
| 9/9/2005 | 1 | 6:10 | 0.20 | 23.06 | 0.312 | 0.15 | 7.82 | 7.52 | 87.8 | High |
| 9/9/2005 | 4 | 5:55 | 0.20 | 22.22 | 0.82 | 0.40 | 7.18 | 5.00 | 57.6 | High |
| 9/9/2005 | 4 | 6:00 | 0.80 | 24.87 | 12.23 | 6.99 | 7.03 | 4.34 | 54.9 | High |
| 9/9/2005 | 6 | 5:35 | 0.20 | 23.80 | 13.13 | 7.54 | 7.16 | 4.98 | 61.9 | High |
| 9/9/2005 | 6 | 5:46 | 0.80 | 24.82 | 27.9 | 17.14 | 6.95 | 3.33 | 44.6 | High |
| 9/9/2005 | 7 | 6:30 | 0.30 | 22.92 | 23.7 | 14.30 | 7.26 | 5.64 | 71.8 | High |
| 9/9/2005 | 7 | 6:35 | 0.70 | 23.40 | 33.8 | 21.13 | 7.13 | 4.49 | 60.1 | High |
| 9/9/2005 | 8 | 6:38 | 0.10 | 22.95 | 23.7 | 14.30 | 7.23 | 5.32 | 67.8 | High |
| 9/9/2005 | 8 | 6:42 | 0.90 | 23.14 | 25.9 | 15.76 | 7.21 | 5.28 | 68.1 | High |
| 9/16/2005 | 0 | 6:20 | 0.20 | 24.55 | 0.307 | 0.15 | 8.44 | 9.65 | 115.9 | Low |
| 9/16/2005 | 1 | 6:10 | 0.10 | 23.25 | 0.316 | 0.15 | 7.64 | 7.49 | 87.8 | Low |
| 9/16/2005 | 4 | 5:55 | 0.10 | 22.66 | 0.441 | 0.21 | 7.01 | 4.57 | 53.0 | Low |
| 9/16/2005 | 4 | 6:05 | 0.50 | 24.99 | 13.13 | 7.54 | 6.86 | 1.97 | 25.0 | Low |
| 9/16/2005 | 6 | 5:35 | 0.20 | 24.70 | 10.87 | 6.15 | 6.99 | 3.76 | 47.1 | Low |
| 9/16/2005 | 6 | 5:45 | 0.70 | 24.74 | 24.5 | 14.86 | 6.83 | 1.24 | 16.4 | Low |
| 9/16/2005 | 7 | 6:30 | 0.10 | 24.52 | 17.1 | 10.04 | 7.10 | 3.92 | 50.0 | Low |
| 9/16/2005 | 7 | 6:35 | 0.50 | 24.71 | 24.3 | 14.73 | 6.94 | 1.77 | 23.3 | Low |
| 9/16/2005 | 8 | 6:40 | 0.10 | 24.45 | 14.8 | 8.58 | 7.08 | 4.11 | 52.0 | Low |
| 9/16/2005 | 8 | 6:50 | 0.40 | 24.52 | 16.3 | 9.53 | 7.07 | 4.25 | 54.2 | Low |

## Mill River
## 2005 DO Monitoring

| DATE | Station | Time | Depth (m) | Temp (C) | SpC (mS/cm) | Salinity (PSS) | pH | DO (mg/l) | DO% | Tide Stage |
|---|---|---|---|---|---|---|---|---|---|---|
| 9/23/2005 | 0 | 6:19 | 0.30 | 22.65 | 0.308 | 0.15 | 7.80 | 7.29 | 84.5 | High |
| 9/23/2005 | 1 | 6:12 | 0.20 | 21.81 | 0.31 | 0.15 | 7.56 | 7.97 | 90.9 | High |
| 9/23/2005 | 4 | 5:55 | 0.10 | 22.01 | 0.874 | 0.43 | 7.34 | 6.33 | 72.7 | High |
| 9/23/2005 | 4 | 6:00 | 0.80 | 22.42 | 4.47 | 2.37 | 7.11 | 4.31 | 50.5 | High |
| 9/23/2005 | 6 | 5:32 | 0.20 | 22.53 | 10.36 | 5.83 | 6.99 | 4.35 | 52.0 | High |
| 9/23/2005 | 6 | 5:46 | 0.80 | 23.52 | 22.7 | 13.65 | 6.80 | 1.63 | 20.9 | High |
| 9/23/2005 | 7 | 6:26 | 0.20 | 22.68 | 28.5 | 17.50 | 7.07 | 4.36 | 56.3 | High |
| 9/23/2005 | 7 | 6:35 | 0.80 | 22.94 | 31.7 | 19.67 | 7.01 | 3.73 | 49.0 | High |
| 9/23/2005 | 8 | 6:44 | 0.20 | 22.39 | 24.4 | 14.75 | 7.09 | 4.70 | 59.4 | High |
| 9/23/2005 | 8 | 6:47 | 0.70 | 22.44 | 23.9 | 14.42 | 7.09 | 4.74 | 60.1 | High |
| 9/30/2005 | 0 | 6:29 | 0.20 | 19.66 | 0.315 | 0.15 | 7.09 | 3.82 | 41.9 | Low |
| 9/30/2005 | 1 | 6:15 | 0.20 | 17.56 | 0.316 | 0.15 | 7.47 | 7.62 | 79.8 | Low |
| 9/30/2005 | 4 | 5:50 | 0.20 | 16.29 | 1.008 | 0.49 | 7.03 | 5.02 | 51.4 | Low |
| 9/30/2005 | 4 | 6:00 | 0.60 | 20.64 | 10.17 | 5.70 | 6.90 | 2.88 | 33.3 | Low |
| 9/30/2005 | 6 | 5:30 | 0.20 | 19.69 | 10.69 | 6.01 | 7.05 | 4.04 | 46.0 | Low |
| 9/30/2005 | 6 | 5:40 | 0.60 | 21.33 | 23.2 | 13.94 | 6.86 | 1.72 | 21.2 | Low |
| 9/30/2005 | 7 | 6:40 | 0.20 | 18.23 | 17.5 | 10.22 | 7.15 | 5.20 | 58.9 | Low |
| 9/30/2005 | 7 | 6:45 | 0.70 | 18.28 | 17.7 | 10.35 | 7.15 | 5.23 | 59.4 | Low |
| 9/30/2005 | 8 | 6:50 | 0.20 | 18.40 | 18.2 | 10.67 | 7.16 | 5.25 | 59.9 | Low |
| 9/30/2005 | 8 | 6:57 | 0.50 | 18.64 | 19.2 | 11.31 | 7.13 | 4.80 | 55.2 | Low |

**Notes:**

Station

| | |
|---|---|
| 0 | Spillway |
| 1 | Plunge Pool |
| 4 | Footbridge |
| 6 | Orange Street Bridge |
| 7 | North of the Tide Gates |
| 8 | South of the Ticde Gates |

Surface and Bottom samples were measured at the Footbridge, Orange St, and the Tidegates