FINAL STUDY REPORT
SEASONAL AND DIURNAL WATER QUALITY IN CONOWINGO POND AND BELOW CONOWINGO DAM
RSP 3.1

CONOWINGO HYDROELECTRIC PROJECT

FERC PROJECT NUMBER 405

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EXECUTIVE SUMMARY

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt Conowingo Hydroelectric Project (Conowingo Project). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014. FERC issued the final study plan determination for the Conowingo Project on February 4, 2010, approving the revised study plan with certain modifications.

The final study plan determination required Exelon to conduct a water quality study with two primary objectives: (1) document water quality within Conowingo Pond under a variety of conditions, and (2) confirm the dissolved oxygen (DO) of turbine discharges under all operational configurations is accurately monitored to ensure state DO water quality standards are being met downstream of the project. Both these objectives were met.

An initial study report (ISR) was filed on March 29, 2011, containing Exelon's 2010 study findings. A meeting was held on August 23 and 24, 2011 with resource agencies and interested members of the public. Formal comments on the ISR including requested study plan modifications were filed with FERC on March 21, 2012 by several resource agencies and interested members of the public. Exelon filed responses to the ISR comments with FERC on April 20, 2012. On May 21, 2012, FERC issued a study plan modification determination order. The order specified what, if any, modifications to the ISR should be made. For this study, FERC's May 21, 2012 order required no modifications to the original study plan. This final study report is being filed with the Final License Application for the Project.

Weekly monitoring of DO, water temperature, surface pH, and turbidity at five historically (1996-1999) established transects in Conowingo Pond and three newly established transects for this study below Conowingo Dam occurred between April and October 2010. Fecal coliform samples were also collected once per month at the midpoint station of each transect. Additionally, discharge "boils" of operating turbines were sampled hourly (0600 hr to 1800 hr) on 20 dates in July and August (preselected by FERC during study scoping).

Water temperature data collected in Conowingo Pond (at Transect 5 approximately 0.5 mi upstream of Conowingo Dam) were compared to data collected at monitoring Station 643, approximately 0.6 mi downstream of Conowingo Dam to confirm the effect of project operations on the temperature of water being released downstream. DO and temperature data collected in the turbine boils and the downstream transects were compared to that measured at the continuous DO monitoring station (Station 643) to confirm that Station 643 is a representative location for determining compliance with the applicable Maryland state DO standards.

Relative to the historic records, flows in the Susquehanna River during the 2010 sampling period were lower in April through September but higher in October. Likewise, incoming water temperatures were higher in April through September and lower in October relative to historical records. The observed pattern of DO and temperature distribution in Conowingo Pond in 2010 was similar to that which has been observed for more than 50 years. Thermal stratification (a decrease in water temperature of 1°C per 1 m increase in depth or 0.55 °F decrease per 1 ft increase in depth) was not observed in Conowingo Pond in 2010. However, summer DO stratification (top to bottom differences in DO) did occur in the lower half of Conowingo Pond in 2010.

Consistent with the findings of earlier studies (Mathur *et al.* 1988; Normandeau Associates 1998-2000), there was no evidence from the DO and temperature data collected in Conowingo Pond in 2010, that the operation of Conowingo Dam had an effect on vertical distribution patterns of DO or water temperature in lower Conowingo Pond. However, meteorological-hydrological events that produced sudden increases of inflows or high wind produced near homogeneous water column conditions at depths greater than 25 ft.

Comparison of water temperature data collected upstream and downstream of Conowingo Dam in 2010 confirmed that the operation of the Project has no measureable effect on the temperature of the water being released downstream. Water temperatures were uniform throughout lower Conowingo Pond and the tailwater area under a variety of unit operating and river flow conditions. Moreover, the temperature of the water measured at Station 643 was also consistently similar (R^2 square ≥ 0.99, to that measured along transects in both the lower head pond and in the tailwater areas, indicating that the location of Station 643 is representative of tailwater temperature conditions.

Comparisons of the water temperature of specific turbine boils to the temperature measured at Station 643 were also made. The water temperature recorded at downstream Station 643 was virtually identical to that of turbine discharge boils.

Aeration capabilities on the smaller Francis generating units (Units 1-7), increase the DO concentration of the water being released from the Project and allow the discharges to meet current state DO standards (5.5 mg/L). DO concentrations measured at the three transects below Conowingo Dam (and Station 643) were at or above the standard on all sampling days in 2010. Comparison of DO concentrations along the downstream transects with the DO measured at Station 643 indicated that Station 643 is representative of DO conditions measured along Transects 6 and 7 most of the time. The greatest difference between DO measured at Station 643 and DO measured at one of the transects was at Transect 8, in late August and mid September, when Station 643 consistently measured DO concentrations 1-2 mg/L lower than the DO measured at Transect 8. This difference seems mostly likely due to natural aeration in the river, as waters move downstream from Station 643.

DO concentrations measured in the turbine boils were mostly above the historical Maryland State standard of 5.0 mg/L. A few hourly DO values of less than 5.5 mg/L were measured in specific turbine boils, on certain sampling days, but all of these measurements were confined to the turbine boils of one of the larger, non-aerating, Kaplan units (Units 8-11) when the head pond was stratified. However, average DO conditions within all the turbine boils were always at or above standards, and were usually similar to the DO conditions measured at Station 643. Additionally, these large turbines are generally used for a few hours only in combination with small Francis turbines when the river flows exceed 10,000cfs.

A detailed comparison of DO concentrations measured in the turbine boils to the DO measured at Station 643 indicated that under most combinations of unit operation, DO concentrations measured at Station 643 are representative of DO conditions in the turbine boils. Exceptions can occur when one or more of the larger Kaplan turbines (Units 8-11) are operating and the head pond is stratified with bottom water DO less than 5.0 mg/L. Under these circumstances, DO measured at Station 643 is, at times, somewhat higher than the average DO concentration measured in the turbine boils. However, when DO was averaged across all the turbine boils during a given sampling day, the DO concentrations in the turbine discharge were shown to be the same as that measured at Station 643 during the same period (33% of the time, 85 of 255 observations), and within + 0.5 mg/l of Station 643 72% of the time (184 of 255 measurements). Moreover a frequency plot of the differences in DO values observed between the turbine boils and Station 643 showed that the distribution was nearly equal between observations when Station 643 under or over recorded the DO measured in the turbine boils. Historically (prior to 2005), the daily DO Maryland State standard was 5.0 mg/L. In addition, the current Maryland State DO standards were also met as stated below.

The current Maryland State DO standard applicable to discharges from Conowingo Dam is as follows:

February 1 through May 31: DO ≥ to 6 mg/L for a 7-day averaging period

June 1 to January 31: DO ≥ 5.5 mg/L for a 30-day averaging period; 4.0 mg/L for a 7-day average; 3.2 mg/L as an instantaneous minimum year round; and for protection of endangered shortnose sturgeon, 4.3 mg/L as an instantaneous minimum at water column temperatures 77°F (25°C).

As measured at Station 643, the discharge from Conowingo Dam met the state DO standards 100% of the time in 2010. Measured DO concentrations in the transects below Conowingo Dam were all greater than 5.5 mg/L.

Although simultaneous discharges from multiple turbines may introduce complexity in downstream flow patterns, hourly DO measurements recorded at Station 643 under multiple turbine operational scenarios adequately reflect DO and temperature conditions in the Conowingo Dam discharges. Consequently, the present monitoring location of Station 643 is considered representative of turbine discharges for the purpose of monitoring compliance with the State of Maryland DO standards.

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LIST OF ABBREVIATIONS

Agencies/Companies

Exelon	Exelon Generating Company, LLC
FERC	Federal Energy Regulatory Commission
MDNR	Maryland Department of Natural Resources
PADEP	Pennsylvania Department of Environmental Protection
PBAPS	Peach Bottom Atomic Power Station
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

Units of Measure

C	Celsius, Centigrade
cfs	cubic feet per second
F	Fahrenheit
ft	foot/feet
h	hour
kcfs	thousand cubic feet per second
L	liter
m	meter
mg	milligram
mi	mile
ml	milliliter
MW	megawatt
NTU	Nephelometric Turbidity Units

Environmental

DO	dissolved oxygen

Miscellaneous

ILP	Integrated Licensing Process
NOI	Notice of Intent
PAD	Pre-application Document
PSP	Proposed Study Plans
RSP	Revised Study Plans

1.0 INTRODUCTION

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt (MW) Conowingo Hydroelectric Project (Project) (Figure 1-1). Exelon is applying for license renewal using the FERC's Integrated Licensing Process (ILP). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014.

Exelon filed its Pre-Application Document (PAD) and Notice of Intent (NOI) with FERC on March 12, 2009. On June 11 and 12, 2009, a site visit and two scoping meetings were held at the Project for resource agencies and interested members of the public. Following these meetings, formal study requests were filed with FERC by several resource agencies. Many of these study requests were included in Exelon's Proposed Study Plan (PSP), which was filed on August 24, 2009. On September 22 and 23, 2009, Exelon held a meeting with resource agencies and interested members of the public to discuss the PSP.

Formal comments on the PSP were filed with FERC on November 22, 2009 by Commission staff and several resource agencies. Exelon filed a Revised Study Plan (RSP) for the Project on December 22, 2009. FERC issued the final study plan determination for the Project on February 4, 2010, approving the RSP with certain modifications.

The final study plan determination required Exelon to conduct a Water Quality Study, which is the subject of this report. The goals and objectives of this study are to: (1) document water quality within Conowingo Pond under a variety of conditions, and (2) confirm the dissolved oxygen (DO) of turbine discharges under all operational configurations is accurately monitored to ensure that the state dissolved oxygen water quality standard is being met downstream of the Project.

An initial study report (ISR) was filed on March 29, 2011, containing Exelon's 2010 study findings. A meeting was held on August 23 and 24, 2011 with resource agencies and interested members of the public. Formal comments on the ISR including requested study plan modifications were filed with FERC on March 21, 2012 by several resource agencies and interested members of the public. Exelon filed responses to the ISR comments with FERC on April 20, 2012. On May 21, 2012, FERC issued a study plan modification determination order. The order specified what, if any, modifications to the ISR should be made. For this study, FERC's May 21, 2012 order required no modifications to the original study plan. This final study report is being filed with the Final License Application for the Project.

2.0 BACKGROUND

2.1 Conowingo Pond

Conowingo Pond, the lower most impoundment on the Susquehanna River (Figure 1-1), was formed in 1928 by the backwater of Conowingo Hydroelectric Dam (river mile 10). The Pond is bounded upstream by Holtwood Dam (river mile 24), which was built in 1914. The Pond has a surface area of about 9,000 acres with a storage capacity of 310,000 acre-ft. It is 14 miles long and averages 1 mile in width. The average depth of the Pond is 20 ft (6.1 m) with a maximum depth of nearly 90 ft (27.4 m) in the lower Pond behind Conowingo Dam; however, some localized deep areas also exist in the upper Pond. Conowingo turbines withdraw water for generation from the deeper portions of Conowingo Pond. The intakes for the Conowingo powerhouse are located at a depth of approximately 40 ft (top of intake).

Water quality of Conowingo Pond and surrounding areas has been characterized for over the past several decades (Whaley 1960; RMC 1985; Mathur *et al*. 1988; Normandeau Associates 1998-2000). Between 1959 and 2007, more than 400,000 DO and temperature measurements were taken over diverse meteorological, hydrological, and Conowingo Station operational conditions. Results of these studies indicated that the patterns of seasonal, spatial, temporal, and diurnal variations in DO and water temperature have essentially remained the same. However, variations in absolute values for these parameters were dependent primarily on prevailing meteorological and hydrological conditions. In general, DO stratification began to develop in the lower Conowingo Pond at river flows of less than 20,000 cfs and decreasing and water temperatures of greater than or equal to 75 °F (23.8 °C) and increasing.

Historical sampling showed that although a vertical DO stratification occurred in deeper waters of lower Conowingo Pond for varying periods in June-September, a classical (Welch 1952) thermal stratification (a decrease of 1° C per 1 m increase in depth or 0.55 ° F decrease in temperature per 1 ft increase in depth) was not observed. It was found that meteorological-hydrological events such as high wind or rain storms would disrupt summer DO stratification in lower Conowingo Pond. DO stratification was not disrupted by station mode of operation (continuous flow, run-of-the-river, or peaking) (RMC 1985; Mathur *et al*. 1988).

The Susquehanna River below Conowingo Dam flows approximately 10 miles before entering Chesapeake Bay (Figure 1-1). The non-tidal portion of the Susquehanna River encompasses approximately 4 miles of river length, from Conowingo Dam downstream to the mouth of Deer Creek (a tributary), which is the approximate natural upstream limit of tidal influence. The Chesapeake Bay stretches about 200 miles from the Susquehanna River in the north to the Atlantic Ocean in the south.

Much of the bay is quite shallow. At the point where the Susquehanna River flows into the bay, the average depth is 30 feet.

2.1.2 Conowingo Project

The Conowingo Project uses limited active storage within Conowingo Pond for generation purposes. Maximum hydraulic capacity of the Conowingo powerhouse is 86,000 cfs. The Conowingo powerhouse is oriented perpendicular to the river (Figure 2-1). The powerhouse contains seven Francis and four Kaplan type turbines which withdraw water for generation from deeper depths from lower Conowingo Pond. The water depth in the area behind the dam is 60 to 90 ft deep, with most areas about 70 ft deep. The top of the Conowingo Station intakes are located at 40 ft and extend to the bottom (Mathur *et al.* 1988). Each Francis turbine has a hydraulic capacity of 5,000 cfs and each Kaplan type turbine has a hydraulic capacity of 10,000 cfs.

The current minimum flow regime below Conowingo Dam was formally established with the signing of a settlement agreement in 1989 between the project owners and several federal and state resource agencies (FERC 1989). The established minimum flow regime below Conowingo Dam is the following:

- March 1 – March 31: 3,500 cfs or natural river flow
- April 1 – April 30: 10,000 cfs or natural river flow, whichever is less
- May 1 – May 31: 7,500 cfs or natural river flow, whichever is less
- June 1 – September 14: 5,000 cfs or natural river flow, whichever is less
- September 15 – November 30: 3,500 cfs or natural river flow, whichever is less
- December 1 – February 28: 3,500 cfs intermittent (maximum six hours off followed by equal amount on)

The downstream discharge must equal these values or the discharge measured at the Susquehanna River at the Marietta, PA United States Geological Survey (USGS gage No. 01576000), whichever is less. The Marietta gage is located approximately 35 miles upstream of Conowingo Dam above the Safe Harbor Dam. Typically, the summer minimum flow requirements are met by releasing flow from either Francis turbine Unit 2 or 5 individually or in combination, as these units have the ability to operate at a lower range of flow then the other Francis units.

The seven Francis turbines (Units 1-7) are equipped with aeration venting systems which were installed between 1988 and 1991 to improve downstream DO conditions. First, a prototype system was installed in Francis Unit 5 in late June 1988, with an intake air injection system and draft tube oxygen augmentation systems available for testing. The installation of the venting system occurred in concurrence with the consulted resource agencies, primarily Maryland Department of Natural Resources (MDNR), and after satisfactory test results and evaluation of a prototype system (C.T. Main 1987; PECO 1989a, 1990). In 1989, a full-scale modified (with more holes/vents than in the initial design) turbine venting system (Figure 2-2) was installed on Francis Units 1 and 3, along with a partial intake air injection system. Each unit was tested with and without the intake air injection system. Comparison of test results revealed that the modified system substantially increased air flow and DO (over ambient levels) in the vented releases (PECO 1990). Based on the test results, the modified venting system (Figure 2-2) was installed in Francis Units 4, 6, and 7, Unit 5 was retrofitted with the same venting system in 1990, and Unit 2 in spring 1991 (PECO 1989a). At that time it was concluded that these installations would allow discharge from the Project to meet Maryland's DO standard under most conditions. The larger Kaplan turbines (Units 8-11) were not equipped with an aeration system because their usage during low summer flow period was anticipated to be infrequent except in the event of a power emergency.

2.1.3 DO Compliance Monitoring

Since the late 1980s, DO and temperature have been measured continuously (1 hour intervals) at Station 643 which is located approximately 0.6 mi downstream of Conowingo Dam near the western shoreline (Figure 2-1). Station 643 was established at this location in consultation with the MDNR, and has served as the monitoring point for compliance with the state DO standards (PECO 1989b). Station 643 is operated from May 1 through October 31 each year, and DO and temperature conditions are recorded hourly.

3.0 METHODS

As specified in the study plan determination, the sampling frequency and locations for DO, water temperature, pH, turbidity, and fecal coliform described below were established to meet the objectives for both Conowingo Pond and downstream of Conowingo Dam. Sampling locations and methods used were in accordance with COMAR 26.08.02 Surface Water Quality Standards for the State of Maryland. The sampling period was between April and October, 2010.

3.1 Transect Water Quality Sampling

To evaluate DO and temperature conditions in the headpond and tailwater areas, weekly monitoring was conducted along five historically (1996-1999) established transects in Conowingo Pond (Figure 3-1 and Table 3-1) and three new transects established for this study downstream of Conowingo Dam (Figure 3-2 and Table 3-1). Station 502 (designated as Station 611 in previous reports, Peach Bottom Atomic Power Station Pre- and Post-operational Reports, 1974-1980) on Transect 5 in Conowingo Pond had been sampled for over four decades. Historic DO and water temperature profiles collected at this station were used to compare to the 2010 findings. Historic daily average inflow water temperatures measured at Holtwood Dam were used to develop temperature duration curves to provide a perspective on 2010 water temperature data.

Vertical profiles (surface to bottom at 5 ft intervals) of DO and water temperature were taken at three to five points on each transect in Conowingo Pond (Figure 3-1). For example, Transect 1 is comprised of Stations 101, 102, and 103; Transect 4 is comprised of Stations 401, 402, 403, and 404. The number of sampling points along each transect was dependent on river width.

Surface pH and turbidity (NTU) values were measured at the mid-point location of each transect. For transects with an even number of sampling points, the deepest of the two middle sampling points was used as the mid-point station.

River flows at Marietta, PA (USGS gage No. 01576000), Conowingo, MD (USGS gage No. 01578310), and Holtwood Dam, PA (data provided by PPL Holtwood), as well as Conowingo generation status and approximate wind speed were recorded during each sampling event. To be consistent with previous water quality studies of Conowingo Pond and downstream areas (*e.g.*, Mathur *et al*. 1988; Normandeau Associates 1998-2000), average daily river flows measured at Holtwood Dam were used in this report for comparison with 2010 data.

Water temperature data collected at Transect 5 in the lower half of Conowingo Pond were compared to hourly water temperatures recorded at Station 643 for corresponding dates and times to assess potential alterations in water temperature in transport through turbines.

Three transects located downstream of Conowingo Dam (Figure 3-2) were sampled on the same dates as those in Conowingo Pond. DO and water temperature measurements were taken at three points along each transect (Figure 3-2). Turbidity, pH and fecal coliform samples were taken from the mid-point station of each transect. DO and water temperature data recorded in this sampling effort were compared with those recorded at the continuous monitoring Station 643. Sampling at both the pond and downstream transects were completed on the same day at approximately the same time each sampling day.

A HACH Surveyor (data logger) and HACH Hydrolab MS5 data sonde with a 30 meter (approximately 100 ft) cable to handle the data electronically was used to measure and record water quality data in both the pond and tailwater areas. This MS5 data sonde was equipped with sensors to measure temperature (±0.1 °C or ±0.2 °F), dissolved oxygen (±0.1 mg/L), pH (±0.2 units), and turbidity (±1% up to 100 NTU and ±3% from 100-400 NTU). The MS5 data sonde along with the Surveyor was used to manually record DO and water temperature vertical profile data. The temperature sensor was set at the factory and all parameter sensors were calibrated per manufacturer's requirements prior to each sampling event. A calibrated YSI Model 57 meter equipped with a DO (±0.1 mg/L)/temperature (±0.5 °C or ±0.9 °F) combination probe and cable (with attached submersible stirrer) was utilized as a back-up. Calibration records for the HACH Hydrolab and YSI meter along with their specifications are provided in Appendix A-1.

Monthly water samples for fecal coliform were collected and delivered the same day to Lancaster Labs, Inc., New Holland, PA, for laboratory analysis using the SM20 9222 D methods (Appendix A-2). The samples were collected in a clear 120 ml round plastic bottle with an added preservative ($Na_2S_2O_3$) (provided by Lancaster Laboratories) and immediately chilled by placing in a cooler with ice as instructed by Lancaster Laboratories personnel (Appendix A-2). The sample bottles were labeled with the site number, date, and time of sample collection. Thirty-five fecal coliform samples were collected in Conowingo Pond during the sampling period, with 21 fecal coliform samples collected downstream of Conowingo Dam during the same sampling period. Weather conditions, approximate wind speed, river flow, and Conowingo generation status were recorded also during each sampling event.

3.1.1 Turbine Boil Discharge Sampling

In accordance with the study plan determination, project discharge turbine boils were sampled on 20 days in July and August 2010. Dates sampled were specified by FERC in the final study plan determination. Sampling occurred on four consecutive days, covering both weekend days (N = 8) and weekdays (N = 12).

- Weekdays in July: 2, 5, 14-16, and 30;
- Weekend days in July: 3-4, 17, and 31;
- Weekdays in August: 2, 13, 16, and 25-27;
- Weekend days in August: 1, 14-15, and 28.

DO and water temperature samples were collected hourly from each operating turbine boil between 0600 and 1800, or for the duration of time that a particular turbine was operating. The DO and water temperature of the turbine boils were measured in grab water samples collected using a bucket and rope. A bucket was lowered from a catwalk on the powerhouse into an operating turbine boil discharge, allowed to fill, then carefully pulled up to the catwalk, (to avoid additional agitation of the sample). The DO and water temperature of the sample was then measured. The process was repeated for any remaining operating turbines. Collection of water samples by bucket is preferred when sampling in highly turbulent waters as it limits the potential for DO probe/cable damage from the turbulent boil discharges.

Turbine boil DO and water temperature were measured using a calibrated YSI model 57 meter equipped with a DO/temp combination probe and cable (with attached submersible stirrer). The instrumentation was calibrated in accordance with manufacturer's specifications prior to each set of hourly measurements. Calibration records for the YSI meter are provided in Appendix A-3. Appendix B-1 provides a listing of individual “boil” hourly measurements of DO and water temperature, along with meteorological data on sampled dates. Appendix B-2 provides river flow and water temperature joint probability occurrences for each month (April-October). Appendix C provides temperature and DO profile plots for Transects 1 through 8. Summarized data are presented in the body of the report text.

DO and temperature conditions measured in the turbine discharge boils were compared with those recorded from the continuous monitoring station (Station 643) to assess the representativeness of the Station 643 location for measuring Conowingo turbine discharge DO and water temperature. When comparing turbine boil conditions with DO and temperature recorded at Station 643, a lag time of up to one hour travel time was allowed for discharge water to reach Station 643.

4.0 RESULTS

4.1 River Flow and Water Temperature Conditions During 2010 Sampling Season

The river flow and water temperature conditions of the Susquehanna River during the 2010 study season were compared to long-term averages (1952-2009) to discern the comparability of conditions during the 2010 study season as compared to average conditions over the past 50+ years. Figure 4-1 shows average daily river flows at Holtwood between April and October of 2010 as compared to the average daily flow at Holtwood for the period 1952-2009. As shown (Figure 4-1), average daily river flows, as measured at Holtwood Dam in 2010, showed a typical seasonal pattern of decrease during the spring and early summer, with the lowest flows recorded in September, 2010. Average daily river flow at Holtwood for the period April thorugh October 2010 ranged from a low of 4,500 cfs (September 14, 2010) to a high of 109,500 cfs (October 3, 2010). Average daily river flows were less than 14,000 cfs in mid-June through September. However, river flows increased precipitously from less than 6,300 cfs in September to 109,500 cfs in early October. As compared to the long-term average flow, river flows were generally lower in 2010 during the period April through September, and higher in October. Flows in 2010 were particularly low during the summer months July-September, as compared to historic averages.

Figure 4-2 provides an average daily flow duration curve for the period April-October, 2010, in comparison to the long-term (1952-2009) average daily flow duration curve for the same months. Individual monthly average daily flow duration curves are provided in Figures 4-3 through 4-9. Again, as shown in these figures, relative to the historical record, the average daily river flows in 2010 were lower for the period April through September, and higher in October.

Figure 4-10 shows average daily water temperature at Holtwood in 2010 as compared to the averge daily water temperature at Holtwood for the period 1956-2009. The seasonal water temperature cycle observed at Holtwood Dam in 2010 was typical of temperate regions, with the lowest temperatures recorded in April and October, and the highest water temperatures occuring during the late summer.

Figure 4-11 provides a 2010 average daily water temperature duration curve for the period April-October, 2010, in comparison to the long-term (1956-2009) average daily temperature duration curve for those same months. Across the study season (April through October) average daily water temperures were higher in 2010 than the historic average. Monthly water temperature duration plots shown in Figures 4-12 through 4-18 demonstrate that water temperatures in 2010 were higher than average in April through June, comparable with the long-term average during the summer months July-September, and lower than the long-term average in October.

Table 4-1 provides a summary of flow and, water temperature conditions during sampling days in 2010, as compared to the long-term averages on those days. Wind information for the 2010 sampling days is also shown. Comparison of flow and water temperature conditions on sampling days to the long-term averages for those days confirms that for most of the sampling season (June through September) river flows were lower and water temperatures were higher than the long-term averages for that period.

Previous studies of Conowingo pond have shown that the probability of strong DO stratification in the lower Pond is high when river flows are less than 20,000 cfs and decreasing, and water temperature is greater than 75 °F (23.9 °C) and increasing (RMC 1985; Mathur *et al.* 1988; Normandeau Associates 1998-2000). An analysis of the joint probability occurrence for each month (April-October) of flows less than 20,000 cfs and water temperatures great than 75 °F (23.9 °C) was performed to provide a perspective on flow and temperature conditions experienced in 2010 relative to those observed historically. The results of this analysis are provided in Appendix B-2.

4.2 Water Quality Conditions in Conowingo Pond in 2010

4.2.1 Conowing Pond Transect Water Temperature

Vertical water temperature profiles for each of the stations sampled on 30 dates in 2010 were developed and are provided in Appendix C. Figure 4-19 provides water temperature profile data for Station 502, the mid-stream station at the lower most transect (approximately 0.5 mile upstream of Conowingo Dam), where water quality data has been collected historically (historic station 611). As shown, a classic thermal stratification (decrease of 1 °C per 1 m increase in depth or 0.55 °F decrease in temperature per 1 ft increase in depth; Welch 1952) was absent at this station on all sampled dates in 2010. A review of temperature profiles for the other sampling stations (Appendix C) reveals that thermal stratification (as defined above) was also absent from all the other transects and sampling stations. There were some small (<4°F or < 2.2 °C) top to bottom temperature differences measured at the sampling locations near the west shore on Transects 2-4 (Stations 201, 301, and 401) in summer months. Surface heating of the water in these locations was limited to the top 15 ft of the water column, and was likely an affect of the Peach Bottom Atomic Power Station (PBAPS) thermal discharge. Compared to Transect 1 (upstream of PBAPS), surface temperatures at locations across the state line and downstream areas were generally less than 2-4 °F (approximately 1-2 °C) than at the deeper depths. This finding is consistent with that observed in previous years (RMC 1985; Normandeau Associates 1998-2000).

In summary, water temperature profiles taken from Conowingo Pond indicated no thermal stratification in the Pond in 2010, even during the summer months when flows were lower than average, and water temperuatres were similar to the historic average for those months. Lack of thermal stratification in Conowingo Pond is consistent with historic conditions observed over the past 30 years.

4.2.2 Conowingo Pond Transect DO

Vertical DO profiles for each of the stations sampled in 2010 were developed and are provided in Appendix C. Figure 4-20 provides top to bottom DO profiles for Station 502, the mid-stream station at the lower most transect (approximately 0.5 mile upstream of Conowingo Dam), where water quality data has been collected historically (Station 611). As shown, at Station 502 differences in top to bottom DO appeared in late May and were consistently evident into July. Through much of August and September, top to bottom differences in DO concentrations had decreased, but during that period DO throughout the water column had dropped below 5.0 mg/L. By early October, DO values had increased significantly and there was little top to bottom diference observed.

Looking at DO conditions along the other transects shows a similar pattern to Transect 4. In adddition, on some sampling dates in July and August, low DO levels (less than 4.0 mg/L) were observed at deeper depths at three locations (Stations 404, 304, and 301).

Overall the DO trends observed in Conowingo Pond in 2010 were similar to those observed in the past. Historically, top to bottom DO differentials have occurred in the lower Conowingo Pond generally in areas with depths greater than or equal to 25 ft (Normandeau Associates 1998-2000).

Previous studies have shown that DO stratification in Conowingo Pond can be destroyed by natural meteorological events that produce high river flows, strong winds, or both (Mathur *et al*. 1988). This phenomenon was also observed in 2010. For example, on July 7, 2010 the lower Pond Transect 5 location (Station 502) was stratified with river flows at 8,000 cfs. By July 13, as flows were increasing, the top to bottom DO difference was significantly reduced, but then began to increase again on July 20 as flows subsided. Stratification was re-established within a week. Overall, both historic data collection and the 2010 sampling results demonstrate that the disruption of DO stratification by a high flow event can result in uniformly low DO conditions throughout the water column.

4.2.3 Conowingo Pond pH, Turbidity, and Fecal Coliform

In addition to DO and temperature, pH and turbidity values were also measured at mid-point stations in Conowingo Pond. Figure 4-21 shows the pH values measured in 2010. The minimum and maximum pH values in Conowingo Pond were 7.0 and 8.9, respectively. Although variations between dates were evident, little difference occurred between locations on a given sampling date. These values are within the range observed in the past (*e.g.*, Pre- and Post-operational Reports for Peach Bottom Atomic Power Station, 1974-1980).

Turbidity values measured at mid-point stations in Conowingo Pond are shown in Figure 4-22. The minimum and maximum turbidity values recorded in Conowingo Pond during the 2010 sampling period were 1.2 and 146.5 NTU units.

Fecal coliform values recorded at each of the Conowingo Pond stations are provided in Table 4-2. Generally, fecal coliform values were low throughout Conowingo Pond during the 2010 sampling season. In the Pond, higher coliform values were recorded at two stations on May 4, and at all stations on October 5, following a period of unusually high river flows. In total, only 5 fecal coliform samples collected from Conowingo Pond in 2010 were greater than 200 per 100 ml.[1] And only one value (May 4 at Station 102) collected during the swimming season (May through September) exceeded 200 per 100 ml.

4.3 Water Quality Downstream of Conowingo Dam

4.3.1 Downstream Transect Temperature and DO

Temporal trends in water temperature measured at the three downstream transects during the 2010 study season are shown in Figure 4-23. As expected, water temperature downstream of the dam increased from April through August and declined thereafter, with the highest temperatures recorded in July and August. This typical seasonal pattern of water temperatures closely mirrored that observed in Conowingo Pond. Figure 4-23 also demonstrates that there was little variation in water temperature between depths observed at any of the downstream transects. This is not surprising given the relatively shallow depths (less than 10 ft or 3.1 m) at each of the transects, making conditions relatively homothermous.

For comparison purposes, the average water temperature measured at Station 643 on the same date and during Transect 6, 7, and 8 sampling period (generally same 4 hours) is also provided in Figure 4-23. This comparison demonstrates a very high degree of similarity between the temperature at Station 643 and that measured along Transects 6, 7 and 8.

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[1] The Pennsylvania Department of Environmental Protection (PADEP, 1999, p.16) fecal coliform standard for bathing (full body contact) is 200 and the U.S. Environmental Protection Agency (USEPA) have the same set of criteria for fecal coliform levels, on the basis of water use. For bathing (full body contact) in recreational freshwater, on the basis of a statistically sufficient number of samples (generally not less than five samples equally spaced over a 30-day period), the geometric mean of the indicated bacterial densities of fecal coliform should not exceed 200 colonies/100 ml during the swimming season (May 1 through September 30) and should not exceed 2,000 colonies/100 ml for the remainder of the year.

DO concentrations measured at the downstream transects along with the DO reference line of historical Maryland State standard of 5.0 mg/L are plotted in Figure 4-24. At Transect 6, DO concentrations were relatively homogenous along the transect and at all depths, for most of the sampling season. On one sampling date, July 31, the recorded DO at the surface of Station 603 was notably higher than the other values, and may have been the result of photosynthetic activity in a shallow pool with little or no flow. DO concentrations along Transects 7 and 8 were also very similar, indicating good mixing and homogenous conditions throughout the tailwater area. For comparison purposes, DO concentrations recorded at Station 643 on the same date and during Transect 6, 7, and 8 sampling period (generally same 4 hours) are also shown in Figure 4-24.

Generally, the DO measured at Station 643 was similar to the DO measured along all three transects, with a few exceptions. At Transect 6, the closest to Station 643, DO values measured at Station 643 were very similar to those measured along the transect from April through June. Starting in July, however, on several days, DO concentrations measured at Station 643 were noticeably higher than those measured along Transect 6. The greatest difference was measured on July 19, when Station 643 DO was approximately 1 mg/L greater than the highest value measured at Transect 6. Later in the summer and into the fall, the DO concentrations measured at Station 643 were again similar to those measured at Transect 6.

In comparison to Transect 7, DO measured at Station 643 was very similar across the entire sampling period. At Transect 8 (the furthest downstream of Station 643) DO concentrations were similar to those measured at Station 643 during the spring and early summer, but by late summer and into the fall, the DO measured at Station 643 was consistently lower than that measured at Transect 8. These results suggest that during the summer months there was additional aeration of the water moving downstream of the powerhouse that was measured at Transect 8 that was not reflected at Station 643. The increased DO at Transect 8 is likely due to natural aeration processes as water traveled downstream to the location of Transect 8, which is tidally influenced.

4.3.2 Turbine Discharge Boil Temperature and DO

Discharge boils of operating turbines were sampled on 20 dates in July and August, 2010 (Table 4-3). A total of 635 hourly DO and water temperature measurements were taken. The turbine discharge boil of each of the 11 Conowingo generating units was sampled on at least two separate days during the study period. The number of combinations of operating turbines available for sampling at any given hour differed between sampling days and even varied between hours within a given sampling day. Some units operated for only one or two hours, while others operated over the entire sampling period (0600 to 1800). During the sampling period, turbine Units 2 and 5 were operated more consistently than other units on these sampling dates, resulting in more hourly measurements of DO and water temperature taken in the discharge boils of these units than the other units. However, when inflows increased, particularly in mid July, the large Kaplan turbine Units 8 to11 were used for a few hours on several days. Turbine boil sampling was conducted at all of the generating units on at least two days during the sampling period.

The number of hours each combination of small and large units operated and sampled is summarized in Figure 4-25. As shown, by far the most sampling occurred during periods of operation when one or two small units, and no large units were operating. Generally, the one or two smaller units operating were Units 2 and 5. As the Licensee typically uses Francis (small) Units 2 and 5 for generation during the lower flow summer months, the sampling emphasis of the operation of one or two of the small units was appropriate for this study.

The hourly water temperature values measured in each of the turbine boils sampled in July and August are plotted in Figure 4-26. In July, turbine discharge temperatures ranged from a low of about 83 °F (28.4 °C) to a high near 90 °F (32.2 °C), with most values measured during the month between 84-86 °F (28.9-30.0 °C). Across turbines, differences in water temperature were small, generally less than 2 °F or approximately 1 °C, and overall, the discharge boils were thermally homogeneous. Differences between hourly temperature measurements within a turbine discharge boil on a given date were also small (up to 2 °F or approximately 1 °C). In early August, turbine boil temperatures were generally higher than in July, but still very homogenous between turbines and over a sampling day. By late August, water temperatures had cooled and during the August 25-28 sampling event water temperatures were notably cooler, in the 80-85 °F (26.7-29.5 °C) range.

Table 4-4 shows the average hourly water temperatures of individual turbine discharge boils on each sampled date. Turbine boil averages were derived by averaging the hourly values taken at each turbine boil on that day. Because not all units operated for the same period of time on each sampling day, the number of hourly values used to create the average varied depending on how many hours each day a given turbine was operated. Also shown is an average of all hourly values taken in all of the turbine boils sampled within a given day (daily average discharge boil water temperature). Because the daily average discharge boil temperature was calculated by averaging all of the hourly values sampled on that day, the daily average turbine boil DO shown is appropriately weighted to reflect the duration of operation of each of the turbines sampled on that day. Finally, for comparison purposes, Table 4-4 shows the average of hourly temperature values taken at Sation 643 during the same day. The hourly Station 643 values used to create the daily average were lagged 1 hour, to account for travel time. For example, for a daily turbine boil sampling period from 0600-1800, Station 643 values between 0700-1900 were used to create the daily average shown in Table 4-4.

Table 4-4 shows that there was little variation in discharge boil temperature observed within a sampled day. In addition, there was no marked difference in the temperature in turbine boils from the smaller Francis turbines (Units 1-7) as compared to the larger Kaplan units (Units 8-11). The daily average temperature for all turbine boils was also very representative of all the units operating in a given day.

Comparing the daily average temperature for all the turbine boils to the daily average temperature measured at Station 643, the values were also very similar. Station 643 consistently measured temperature values within 1 °F (0.5 °C) of the average temperature measured in the turbine boils on any given sampling day. Of 20 days when turbine boils were sampled, on only two was the difference between temperatures measured in the turbine boils more than 1 °F (0.5 °C). On these two occasions, temperature measured at Station 643 was higher (1.1 to 1.2 °F) than that measured in the discharge boils.

Turbine discharge boils were also sampled for DO. The hourly DO values measured in each of the turbine boils sampled in July and August are plotted in Figure 4-27.

Virtually all (622 of 635 or 97.8%) the hourly turbine discharge boil(s) DO values exceeded 5 mg/L. Two consecutive hours of DO less than 5.0 mg/L (4.4-4.8 mg/L) were recorded in the turbine discharge boil of Unit 6 (Figure 4-27 and Appendix B-1). Although the exact causative factors for the occurrence of relatively small number of sporadic low DO values less than 5.0 mg/L (mostly 4.4 to 4.9 mg/L; 8 in large turbine, 5 in Unit 6, and 1 in Unit 4) in discharge boils are unclear at present, two explanations seem likely. First, in some instances low DO values might reflect sampling that occurred during or immediately following turbine start up with insufficient time for stabilization before sampling occurred. This may have occurred as the scheduled sampling was to occur on the hour, and no time was allocated for the discharge to stabilize prior to sampling, in the event a unit came on immediately before or during the scheduled sampling time. In such cases, lower DO water sitting in an idle turbine, particularly a large unit, may have been discharged during initial start up and a sample taken from the boil during or immediately after start up might reflect this lower DO water. Second, in the case of the larger Kaplan units, which do not have aeration capability, lower DO values recorded in these discharge boils may simply be more reflective of the DO concentrations being drawn into the unit from the headpond.

Table 4-5 shows the average of the hourly DO concentrations measured at each of the individual turbine discharge boils on each sampled date. As with temperature, turbine boil DO averages were derived by averaging the hourly values taken at each turbine boil on that day. Because not all units operated for the same period of time on each sampling day, the number of hourly DO values used to create the average varied depending on how many hours each day a given turbine was operated. Also shown is an average of all hourly values taken in all of the turbine boils sampled within a given day (daily average discharge boil DO). For comparison purposes, Table 4-5 shows the average of hourly DO values taken at Sation 643 during the same day. Station 643 values used to create the average were lagged 1 hour, to account for travel time. Thus, for a daily sampling period from 0600-1800, Station 643 DO values between 0700-1900 were used to create the daily average DO shown in Table 4-5.

In general, there was more variability in turbine boil DO averages between turbines, than observed for water temperature. As shown in Table 4-5, on any given sampling day, there might be significant differences in the average DO in each turbine boil. For example, On July 15, turbine boil DO averages ranged from a high of 7.7 mg/L (Unit 2) to a low of 4.8 (Unit 11). On other days, the DO values recorded during a given sampling day were similar for all the operating turbines. Over the course of the sampling season, some general patterns seemed apparent. First, and not surprisingly, among all the turbines the DO averages were generally higher in the discharge boils of the Francis turbines (Units 1 to 7) that have aeration capabilities, than in the discharge boils of the Kaplan turbines (Units 8 to 11) which do not have aeration. Among the smaller Francis units (Units 1-7), the average DO in the discharge boils of Units 2 and 5 was consistently a little higher than the DO measured at Units 1, 3, 4, 6 and 7. The observed differences in DO among Francis turbines may be due to different aeration capabilities and efficiency at the prevailing hydrological-meteorological conditions. However, some of the observed differences between the Francies units in the average DO measured in a given turbine boil on a given day may be due to the fact that on most days Units 2 and 5 operated for many more hours than the other Francis units. Thus, the average DO recorded for that day for Unit 2 and/or Unit 5 is probably averaged across a longer period of time than the average shown for the other units. Among the larger Kaplan turbines (Units 8-11), there were no consistent patterns of differences in DO averages measured in the discharge boils on any given day. In mid-July (July 14-15), the DO average for Unit 11 tended to be lower than the DO average measured on the same day in the discharge boils of Units 8 and 9. This was again observed on August 14. However, Unit 11 was not measured frequently enough to suggest any consistent pattern.

Given the variation in DO concentrations observed in the individual turbine boils, overall, the most representative measure of the DO concentration of water being discharged from the Conowingo powerhouse is an average of the DO concentrations in each of the turbine boils. The average DO concentration for each of the turbine boil sampling days is shown in Table 4-5 (daily average discharge boil DO). Comparing the daily average discharge boil DO concentrations to the Station 643 DO average suggests that Station 643 is fairly representative of DO conditions in the discharge. Table 4-6 shows the differences between average DO values at Station 643 and discharge boil with and without Kaplan turbines operating on FERC selected dates in July-August 2010. The majority of averaged DO values between the discharge boils and Station 643 fall within ±1.0 mg/L. The representativeness of Station 643 for measuring both DO and temperature is discussed more in Sections 4.3.3 and 4.3.4, below.

4.3.3 Continuous Monitoring Station 643

Figure 4-28 is a temporal plot of hourly water temperature recorded at Station 643 from May 1 through October 31, 2010. Temperatures increased from April to a seasonal high (greater than 80 °F or greater than 26.6 °C) in late July through mid August, and, thereafter, declined through October. As shown in Figure 4-29 the pattern of seasonal variation in water temperature observed at Station 643 closely paralleled what was observed at Transect 5 in Conowingo Pond and incoming average daily temperatures at Holtwood (Table 4-1).

Figure 4-30 shows hourly water temperature measurements on selected days in July (14-16) and August (14-16) at Station 643 to assess diurnal variations. Over a given 24 h period, water temperatures were mostly within ± 0.5 °C (or within ± 0.9 °F) from hour to hour and fluctuated approximately 2.0 °C over the course of the day.

Figure 4-31 is a plot of hourly DO concentrations recorded at Station 643 from May 1 through October 31, 2010 along with a reference line of 5.0 mg/L (Maryland State standard prior to 2005) . As shown, virtually all hourly DO values were greater than 6 mg/L, and no DO value less than 5 mg/L was recorded over the study season in 2010.

Figure 4-32 shows diurnal variations in DO on selected dates in July (14-16) and August (14-16). Variations over a given 24-hour period were generally within 1.3 mg/L. However, at times, the diurnal variation in DO may have increased to a certain extent due to mixing of unaerated large unit discharge water with its attendant lower DO than that from the aerated Francis turbines. For example, on July 14 at noon, DO at Station 643 was recorded at 6.9 mg/L with Unit 8 coming online. Prior to noontime, no DO value was less than 7.5 mg/L. A similar situation was observed on August 14 during the daylight hours 1600 and 1800; DO ranged from approximately 7.0 to 8.2 mg/L between 0600 and 1500 hours, but ranged from 5.9 to 6.8 mg/L coincident with operation of large units for short duration (≤ 3 h).

4.3.4 Respresentativeness of Station 643 For DO Monitoring

In 1988, in consultation with Maryland agencies, Station 643 was established at its present location (about 0.6 mi downstream of Conowingo Dam near west shore) to monitor DO. One of the objectives of this study was to determine whether continuous DO measurements recorded at Station 643 are representative of the DO in the water being discharged from the Conowingo Project.

The representativeness of Station 643 as a compliance monitoring location was assessed by calculating differences in DO between discharge boil(s) and those recorded at Station 643 approximately 1 hour later. The one hour difference was use to account for travel time of water from the powerhouse to the monitoring point. The calculated differences in DO between the two locations provide the frequency and magnitude of DO differences between the two locations and a further means to assess the representativeness of the present location of Station 643 for compliance monitoring.

Figure 4-33 shows the frequency (number of hours) of DO differences in intervals of 0.5 mg/L between Station 643 and discharge boils. Negative differences shown on the chart represent observations when DO measured at Station 643 was greater than that measured in a turbine boil. Positive numbers refelect observations when DO measured at Station 643 was less than that measured in the DO boil. As shown, by far the greatest number of observations were for those where there was no observed difference between the turbine boil DO and the Station 643. Moreover, the distribution of values around zero is relatively even between observations where Station 643 over or under recorded the DO measured in the turbine boils. Even more importantly the range of differences in DO measurements is very narrow, with most observations falling within ±0.5 mg/L difference. Statistically, the average difference in DO between Station 643 and the discharge boils was -0.32 mg/L with a relatively low variance (standard error = 0.04).

Based on the discharge boil sampling done in 2010 that covered a range of operating conditions and combinations of unit operation, these results demonstrate that the continuous DO and temperature monitoring conducted Station 643 is very representative of discharges from the Conowingo Project.

4.3.5 Effect of Conowingo Project Operation on Water Temperature and DO

To evaluate the effect of Conowingo Project operation on water temperatures in the Pond as compared to those in the tailwater area, upstream water temperatures were compared to those measured downstream of the dam. Because the bulk of water for power generation is withdrawn from deeper depths (the top of Conowingo intakes are located at 40 ft or 13.1 m) in lower Conowingo Pond, water temperature measurements taken at three stations on Transect 5, located 0.5 mi upstream of the dam, on the same dates and times (as close as possible) were compared with those at Station 643 (Figure 4-34). There was little difference observed between water temperatures measured along Transect 5 and those recorded at Station 643. Previously (Section 4.2) it was shown that there is little thermal stratification in Conowingo Pond; even in the deepest part of the Pond located in the vicinity of Transect 5, just upstream of the powerhouse.

Nonetheless, because the powerhouse intakes are deep (approximately 40 ft to 90 ft or 13.1 to 29.8 m), and the proportion of water withdrawn from specific depths in the Pond is unknown, two separate regression analyses were performed to assess potential alterations in water temperature as it passes through the turbines:

- Correlation between average water temperature at ≥ 40 ft (13.1 m) depth separately at each location (Stations 501, 502, and 503) on Transect 5; and
- Correlation between average water temperature at ≥ 40 ft (13.1 m) depth of all stations grouped together on Transect 5;

The results of the two regression analyses along with the 95% confidence intervals are shown in Figure 4-35. Table 4-7 shows the results of these regression analyses. In all cases, high R^2 values (greater than 99%) and relatively low standard errors of estimates (less than 0.83) were obtained, providing confidence that a linear, predictable relationship exists between Transect 5 water temperatures and those recorded at Station 643. Using these regression results, water temperatures at Station 643 were predicted from Transect 5 water temperatures. Figure 4-36 shows a comparison of predicted and actual water temperature values at Station 643. The actual and observed values are virtually identical indicating little evidence of alterations in temperature of water transported through the turbines.

Additional regression analyses were performed between stations on Transect 6 (Stations 601, 602, and 603) downstream of Conowingo Dam and Station 643. Table 4-8 shows the results of these regression analyses. Stations 601 and 602 exhibited high R^2 values (greater than 99% and relatively low standard errors of estimates (less than 0.84), these two stations are located upstream of 643. A slightly lower R^2 (98.0%) and higher standard error (1.467) was obtained for the regression between Station 603 and Station 643. A likely reason is the location of Station 603 and its shallow depth. Station 603 is located farther east and below the spillway area and because of its shallowness was difficult to easily access it for sampling., The regression between pooled temperature data for stations on Transect 6 also showed a strong relationship ($R^2 > 99\%$) with low variance (standard error of estimate slightly less than 0.730).

Table 4-9 shows the total number of hours each Francis and Kaplan turbine operated at Conowingo in July and August from 2005 through 2010. The 24 hour period was divided between three time periods. Early morning operations consisted of 2400-0759 hour, daytime operations consisted of 0800-1959 hour, and nighttime operations were from 2000-2359 hour. The Kaplan units were operated mainly during the daytime hours and particularily when river flows were greater than 10,000 cfs as measured at Holtwood Station. The large Kaplan turbines are primarily operated in combination with Francis units, rarely alone.

4.4 Compliance With Maryland DO Standards

Historically (prior to 2005), the daily DO standard value of 5.0 mg/L was deemed adequate for meeting both MDNR and PADEP water quality standards. This is the reason why the DO figures in this report have the DO reference line of 5.0 mg/L represented on them. In addition, the current DO standards were also met. The State of Maryland's current DO standards (adopted in 2005) applicable to the discharge at Conowingo Dam are as follows:

- February 1 through May 31, DO ≥ 6 mg/L for a 7-day averaging period; and
- June 1-January 31, DO ≥ 5.5 mg/L as a 30-day average.

As measured by continuous DO measurements recorded at monitoring Station 643 downstream of Conowingo Dam for the period May through October, 2010, the 2005 State of Maryland DO standards were met. As shown in Figure 4-31, virtually all hourly DO values were greater than 6.0 mg/L, and no DO value less than 5.0 mg/L was recorded over the study season in 2010. All DO values were greater than 6 mg/L in May. The 30 day respective averages for June through October were 8.3 mg/L, 7.7 mg/L, 7.2 mg/l, 7.8 mg/L, and 9.5 mg/L. Figure 4-37 shows a comparison of DO values measured at Station 643 with the Maryland State standards in May through October, 2010. As illustrated DO discharges from the Conowingo Project, as measured at Station 643, were well above both the 7-day and 30-day average DO standard throughout the May through October, 2010 period.

The respective minimum and maximum pH values downstream of Conowingo Dam were 6.6 and 8.3. The values are within the established criteria (6.0-9.0 inclusive) of the Pennsylvania and Maryland Water Quality Standards for the duration of the sampling period.

The minimum and maximum turbidity values recorded downstream of Conowingo Dam were 1.1 and 31.9 NTU units. An examination of meteorological records during the sampling period suggests that rain events corresponded with higher turbidity during the sampling period.

The minimum and maximum fecal coliform values recorded in the Conowingo tailrace during the non swimming season were 3 and 290 colonies/100 ml (Table 4-2).

5.0 CONCLUSIONS

The two primary objectives of the study: (1) determine the effects of project operations on water quality (DO and temperature), and (2) confirm the representativeness of the monitoring Station 643 located approximately 0.6 mi downstream of Conowingo Dam, were fulfilled in this study.

In 2010, summer river flows were lower and water temperatures were higher compared to long-term historical averages, providing good, representative conditiosn for assessing both reservoir and tailwater water quality.

When compared to the historical data, the pattern of temperature and DO distribution in Conowingo Pond in 2010 was similar to that which has been observed for over 50 years. A classical temperature stratification, as defined by Welch (1952), (*i.e*., a decrease in water temperature of 1°C per 1 m increase in depth, or 0.55 °F decrease in temperature with 1 ft increase in depth) was not observed in 2010. However, as in the past, summer DO stratification was observed in the deeper layer (depth > 25 ft or 7.6 m) of Conowingo Pond coincident with low river flows (less than 20,000 cfs and decreasing) and high water temperatures (greater than 75 °F or greater than 23.9 °C and increasing).

Operation of Conowingo Dam did not appear to affect DO or water temperature distribution patterns in Conowingo Pond; however, meteorological-hydrological events (*e.g*., sudden increase in inflows, high wind) altered the pattern of DO vertical distribution in the Pond, resulting in mixing of various DO strata until the river flows subsided and DO stratification was reestablished.

Downstream, DO and temperature conditions measured in the transects below the dam were generally homogeneous. Some increases in DO were observed at Transect 8 during the summer as water moved downstream from the powerhouse. These increases were likely due to natural aeration in the shallower river downstream of the dam.

Since the bulk of the water withdrawn for power production comes from the deeper portions of Conowingo Pond, and the Pond does not thermally stratify, the downstream water temperatures were virtually identical to those of the Pond temperature. No obvious changes in temperature of water transported through turbines were observed.

Across turbine discharge boils, water temperatures were all found to be similar. There was considerably more variability measured in the DO concentrations of the turbine boils. For the most part, hourly DO values across similar turbine types on the same sampling days were similar. However, DO cocentrations in the discharge boils of the non-aerating larger Kaplan turbines were lower than the discharges from the

Francis turbines, on some sampling days, particiularly in late July. Although there was some variability in turbine boil DO concentrations, ninety eight percent of all hourly DO values measured in the turbine discharge boils DO in 2010 were greater than 5.5 mg/L in 2010.

Relative to DO values measured at Transects 6, 7, and 8, the average DO measurements recorded at Station 643 on the same dates within the same approximate 4 hour sampling time frame (day time), exhibited similar trends. However, the DO values at Station 643 (though all greater than 6 mg/L), particularly in the mid summer period, were lower than those at Transects 6, 7, and 8 with the difference increasing with downstream distance (Transect 8 is tidally influenced). This would be expected considering the re-aeration provided by river flow between transects.

Although simultaneous discharges from multiple turbines may introduce complexity in downstream flow patterns, hourly DO measurements recorded at Station 643 under multiple turbine operational scenarios adequately reflected the water quality of Conowingo Dam discharges. Most Station 643 DO values were within ±0.5 mg/L of the discharge boils DO. Consequently, the present monitoring location of Station 643 is considered representative of turbine discharges for the purpose of measuring compliance with the Maryland State DO standards. As measured by continuous DO measurements from May 1 through October 31 at monitoring Station 643 downstream of Conowingo Dam, the 2005 State of Maryland DO standards, were met at all times.

Based on these results, the 2010 signficant conclusions of the study can be summarized as follows:

- The operation of the Conowingo Project has no effect on the distribution of temperature and DO conditions in Conowingo Pond;
- Water temperature in the Conowingo Project discharge is similar to pond water temperatures and is unaffected by Project operations;
- DO in the water discharged from the Francis units is significantly enhanced by the aeration capabilities of these units. DO in the water discharged from the Kaplan units tends to be somewhat lower than that discharged from the Francis units, on the same day;
- DO and temperature measured at Station 643 are very similar to the DO and temperature conditions measured in the turbine discharge boils and along the downstream transects. Thus, Station 643, is a good, representative location for monitoring compliance with state standards;

- State DO standards were met or exceeded 100% of the time during the period May 1 through October 31, 2010.

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TABLE 3-1: LOCATIONS OF EIGHT TRANSECTS (5 IN CONOWINGO POND AND 3 DOWNSTREAM OF CONOWINGO DAM) SAMPLED FOR WATER QUALITY PARAMETERS, APRIL-OCTOBER 2010.

Transect Name and Point Numbers	Location Number (Mid-Point Bold)	Average Depth (ft)	Waypoint Locations				
			West Shoreline	Point between mid-point and west shoreline	Mid-Point*	Point between mid-point and east shoreline	East Shoreline
Fishing Creek	101	15.3	39.780718N 76.28041W				
101,102,103	**102**	12.3			**39.785497N 76.273943W**		
	103	7.7					39.790550N 76.269030W
Burkin's Run	201	13.8	39.743799N 76.252617W				
201,202,203,204,205	202	7.8		39.746456N 76.248051W			
	203	14.4			**39.749014N 76.24324W**		
	204	15.5				39.751576N 76.238676W	
	205	4.1					39.755660N 76.235800W
Williams Tunnel	301	23.3	39.733799N 76.242465W				
301,302,303,304	302	10.6		39.734734N 76.237444W			
	303	13.6			**39.735864N 76.232788W**		
	304	27.9					39.736712N 76.228448W
State Line	401	6.8	39.719573N 76.240804W				
401,402,403,404	**402**	20.8			**39.719514N 76.236362W**		
	403	14.7				39.719585N 76.230928W	
	404	40.4					39.719336N 76.22649W
Lower Pond	501	42.8	39.661438N 76.185619W				
501,502,503	**502 (611)**	50.3			**39.665462N 76.182695W**		
	503	43.0					39.668883N 76.179542W
Shure's Landing	601	1 to 10 (3.1)	39.652224N 76.166301W				
601,602,603	**602**	1 to 10 (3.3)			**39.653911N 76.164522W**		
	603	1 to 6 (2.3)					39.655598N 76.162743W
Lee's Ferry	701	1 to 10 (3.5)	39.636949N 76.158944W				
701,702,703	**702**	1 to 10 (5.3)			**39.638928N 76.156808W**		
	703	1 to 10 (3.3)					39.640907N 76.154672W
The Pool	801	2 to 10 (5.3)	39.620898N 76.149753W				
801,802,803	**802**	1 to 10 (4.7)			**39.622122N 76.148105W**		
	803	1 to 10 (6.0)					39.623346N 76.146457W

* - Even number transect mid-point determined by greatest depth of the two points near the middle of the river for a given transect.

TABLE 4-1: INCOMING RIVER FLOWS (2010 AND HISTORICAL DAILY AVERAGES AT HOLTWOOD DAM, PPL) AND METEOROLOGICAL CONDITIONS DURING TRANSECT SAMPLING EVENTS (30) IN CONOWINGO POND AND DOWNSTREAM OF CONOWINGO DAM, APRIL-OCTOBER 2010.

Date sampled	Holtwood		Long Term Averages (1952-2009)		Wind Speed**			
	2010 Flow (cfs)	Water Temp (°F)	River Flow (cfs)	Water Temp (°F)	Range MPH	Gust MPH	Average MPH	Prevailing Direction
6-Apr	63,900	57.8	104,874	47.8	0-11	18	N/A	North
13-Apr	37,700	59.7	76,710	49.6	0-15	45	N/A	North
20-Apr	25,300	58.4	67,071	54.4	0-4	12	N/A	North
27-Apr	26,800	60.6	59,210	57.3	0-7	22	2.3	NNE
4-May	45,400	69.2	30,249	60.3	0-8	19	N/A	North
11-May	26,300	63.2	47,297	62.7	0-7	24	1.7	North
17-May	43,500	66.7	52,366	64.3	0-4	10	N/A	North
24-May	30,300	69.6	43,323	67.3	0-4	9	0.4	North
1-Jun	20,000	77.3	36,394	70.3	0-6	14	2.4	North
8-Jun	15,100	79.1	33,184	72.7	0-6	20	2.3	North
15-Jun	22,400	77.0	24,659	75.8	0-3	8	N/A	North
22-Jun	13,800	81.0	33,290	76.6	0-6	13	N/A	North
29-Jun	9,200	84.9	28,891	78.6	0-3	10	1.3	North
7-Jul	8,000	83.8	18,298	79.7	0-3	8	0.9	North
13-Jul	12,800	N/A*	15,948	81.0	0-5	13	N/A	NNE
20-Jul	8,700	N/A*	14,278	82.1	0-4	12	1.2	North
27-Jul	8,600	N/A*	15,069	82.0	0-4	10	N/A	North
2-Aug	8,600	N/A*	15,300	82.0	0-6	13	N/A	North
10-Aug	5,800	83.9	13,464	81.8	0-4	7	N/A	North
16-Aug	7,700	81.1	12,505	81.0	0-4	16	N/A	NNE
24-Aug	6,600	79.7	11,955	80.2	0-2	6	N/A	North
31-Aug	11,500	79.4	10,655	79.5	0-3	4	N/A	North
7-Sep	6,200	78.7	11,886	78.2	0-7	14	2.8	North
14-Sep	4,500	74.0	12,504	75.7	0-6	17	N/A	North
20-Sep	4,600	71.8	20,707	73.2	0-4	15	N/A	North
28-Sep	5,300	71.7	23,663	70.0	0-9	22	N/A	NNE
5-Oct	68,900	60.7	16,300	66.4	0-2	11	N/A	NE
11-Oct	41,200	61.6	18,156	64.3	0-3	10	0.8	NNE
19-Oct	22,200	56.6	19,826	61.2	0-2	6	N/A	NE
26-Oct	16,300	55.7	24,419	58.2	0-6	15	2.9	North

Holtwood river flow (cfs) and water temperature data supplied by PPL (Long term river flow 1952-2009; water temperature 1956-2009).

* Suspect recorder malfunction

**Wind speed measured at US-1 at Conowingo, MD; data provided by MDDOT through weather underground.com

TABLE 4-2: FECAL COLIFORM SAMPLES COLLECTED FROM CONOWINGO POND AND BELOW CONOWINGO DAM, APRIL-OCTOBER 2010.

				Analytical results per 100 ml							
Sample Collected		Sample Analyzed		Pennsylvania station locations				Maryland station locations			
Date	Time	Date	Time	102	203	303	402	502	602	702	802
6-Apr	10:50-12:00	7-Apr	1920	4	2	5	2	2	5	3	9
4-May	11:09-13:28	5-May	2031	240	99	7	14	<1	<1	<1	<1
1-Jun	09:45-13:04	2-Jun	2055	4	1/70 ml	2/80 ml	2	1	11	4	9
13-Jul	10:10-12:18	14-Jul	1910	1	11	19	22	2	170	85	33
10-Aug	09:57-13:42	11-Aug	1943	1	<1	<10	2	<1	16	6	3
7-Sep	10:42-13:48	8-Sep	1950	<1	<1	2	<1	1	16/81 ml	8/91 ml	4/91 ml
5-Oct	09:55-12:51	6-Oct	2025	250	350	270	210	110	230	290	200

Notes:

1) Analytical Reports produced by Lancaster Laboratories using the SM20 9222 D Method.

2) The Pennsylvania Department of Environmental Protection (PADEP, 1999, p.16) fecal coliform standard for bathing (full body contact) is 200 and the U.S. Environmental Protection Agency (USEPA) have the same set of criteria for fecal coliform levels, on the basis of water use. For bathing (full body contact) in recreational freshwater, on the basis of a statistically sufficient number of samples (generally not less than five samples equally spaced over a 30-day period), the geometric mean of the indicated bacterial densities of fecal coliform should not exceed 200 colonies/100 ml during the swimming season (May 1 through September 30) and should not exceed 2,000 colonies/100 ml for the remainder of the year.

TABLE 4-3: NUMBER OF HOURLY DO AND WATER TEMPERATURE MEASUREMENTS TAKEN IN EACH OPERATING TURBINE DISCHARGE BOIL IN JULY AND AUGUST, 2010.

	Date of Boil Measurements																				Total Number of Measurements
Unit #	**2-Jul**	**3-Jul**	**4-Jul**	**5-Jul**	**14-Jul**	**15-Jul**	**16-Jul**	**17-Jul**	**30-Jul**	**31-Jul**	**1-Aug**	**2-Aug**	**13-Aug**	**14-Aug**	**15-Aug**	**16-Aug**	**25-Aug**	**26-Aug**	**27-Aug**	**28-Aug**	
1					7	10	5	4			4			3			7				40
2	13	13	13	13	13	13	13	12			4	11	13	13	13	13	7	13	11	12	213
3			1		7	10	6	4	2	3	3			3			7	3	3		52
4			1		7		5		2	3				2		6		3	3		32
5	13	13	13	13					13	13	13	13		1	1	6	13				125
6					7		6	12		3				1		6					35
7					13	13	13		2					1		6		3			51
8			1		7	6	6	4			3			2			6	2			37
9					2	6	5	2	2					2			6	2			27
10																			4	8	12
11					3	6								2							11
Total	**26**	**26**	**29**	**26**	**66**	**64**	**59**	**38**	**21**	**22**	**27**	**24**	**13**	**30**	**14**	**37**	**46**	**26**	**21**	**20**	**635**

TABLE 4-4: AVEAGE HOURLY WATER TEMPERATURE (°F) OF OPERATING TURBINE BOILS (0600-1800 HOUR) AT CONOWINGO DAM ON FERC SELECTED DATES IN JULY-AUGUST 2010. FOR COMPARISON, AVERAGE WATER TEMPERATURE VALUES RECORDED 1 HOUR LATER AT STATION 643 DOWNSTREAM OF CONOWINGO DAM (0700-1900 HOUR) FOR THE SAME DATES ARE ALSO GIVEN.

Unit #	Dates																			
	2-Jul	3-Jul	4-Jul	5-Jul	14-Jul	15-Jul	16-Jul	17-Jul	30-Jul	31-Jul	1-Aug	2-Aug	13-Aug	14-Aug	15-Aug	16-Aug	25-Aug	26-Aug	27-Aug	28-Aug
1					86.6	86.2	85.7	85.8			88.1			88.0			84.3			
2	84.8	84.3	84.2	84.7	86.5	86.2	85.8	84.9			88.1	87.7	85.8	88.0	87.2	85.7	84.4	82.1	84.0	83.4
3			84.2		86.4	86.1	85.9	85.6	89.2	89.1	88.2			88.1			84.3	84.0	83.8	
4			84.6		86.3		85.7		89.2	89.2				88.1		85.5		83.9	83.8	
5	84.7	84.4	84.3	84.9					88.4	89.1	88.1	87.7		87.6	87.3	85.6	84.2			
6					86.2		85.7	84.7		89.1				88.0		85.6				
7					86.1	86.0	85.8		89.3					88.0		85.4		83.9		
8			84.2		85.9	86.0	85.9	85.7			88.4			88.1			84.3	83.3		
9					86.4	85.8	85.5	85.7	88.5					88.0			84.4	83.3		
10																			83.6	83.7
11					86.0	86.0								88.1						
Average Boil Water Temp.	84.8	84.4	84.3	84.8	86.3	86.0	85.8	85.4	88.9	89.1	88.2	87.7	85.8	88.0	87.3	85.6	84.3	83.4	83.8	83.6
Station 643	84.2	84.1	84.4	84.7	87.1	87.1	86.6	86.6	88.4	88.7	88.1	87.4	86.6	87.1	86.0	86.3	84.2	84.1	83.7	83.1
Average Conowingo discharge (kcfs)*	5.73	5.61	8.76	6.08	30.96	32.98	24.02	16.06	10.65	10.02	12.74	6.87	5.85	13.28	5.92	17.71	21.37	12.83	9.99	10.11

* - Recorded at Conowingo USGS gage no. 01578310

TABLE 4-5: AVERAGE HOULTY DO (MG/L) OF OPERATING TURBINE BOILS (0600-1800 HOUR) AT CONOWINGO DAM ON FERC SELECTED DATES IN JULY-AUGUST 2010. FOR COMPARISION, AVERAGE DO VALUES AT STATION 643 DOWNSTREAM OF CONOWINGO DAM (0700-1900 HOUR) FOR THE SAME DATES ARE ALSO GIVEN.

	Dates																			
Unit #	**2-Jul**	**3-Jul**	**4-Jul**	**5-Jul**	**14-Jul**	**15-Jul**	**16-Jul**	**17-Jul**	**30-Jul**	**31-Jul**	**1-Aug**	**2-Aug**	**13-Aug**	**14-Aug**	**15-Aug**	**16-Aug**	**25-Aug**	**26-Aug**	**27-Aug**	**28-Aug**
1					7.2	7.3	7.2	7.3			6.7			6.3			7.0			
2	8.5	8.3	8.0	8.1	7.8	7.7	7.9	7.9			7.2	8.2	7.5	7.1	7.5	7.3	7.4	7.8	7.7	8.0
3			7.0		7.2	7.2	7.3	6.8	6.8	6.9	6.3			6.9			6.7	7.2	7.5	
4			7.0		6.9		7.2		6.9	6.8				6.2		6.5		7.0	7.2	
5	8.4	8.2	7.8	7.8					7.3	7.2	7.1	7.8		6.6	7.9	7.2	7.4			
6					6.7		6.7	5.5		6.7				5.7		6.6				
7					7.2	7.0	7.2		6.7					6.6		6.7		6.9		
8			6.0		6.2	5.9	6.2	6.0			5.4			5.1			5.8	6.4		
9					6.0	5.1	5.8	6.3	5.9					5.3			5.6	6.4		
10																			7.5	7.4
11					5.4	4.8								4.3						
Daily Avg. DO (mg/l)	8.5	8.3	7.2	8.0	6.7	6.4	6.9	6.6	6.7	6.9	6.5	8.0	7.5	6.0	7.7	6.9	6.7	7.0	7.5	7.7
Station 643	8.6	8.9	8.0	8.5	7.4	7.6	7.9	8.1	6.9	7.0	6.7	8.0	6.6	7.4	7.7	7.5	7.0	7.5	7.3	7.6
Average Conowingo discharge (kcfs)*	5.73	5.61	8.76	6.08	30.96	32.98	24.02	16.06	10.65	10.02	12.74	6.87	5.85	13.28	5.92	17.71	21.37	12.83	9.99	10.11

* - Recorded at Conowingo USGS gage no. 01578310

TABLE 4-6: DIFFERENCES BETWEEN AVERAGE STATION 643 DO AND AVERAGE DISCHARGE BOIL DO WITH AND WITHOUT KAPLAN TURBINE OPERATION ON FERC SELECTED DATES IN JULY-AUGUST 2010.

		2-Jul	3-Jul	4-Jul	5-Jul	14-Jul	15-Jul	16-Jul	17-Jul	30-Jul	31-Jul	1-Aug	2-Aug	13-Aug	14-Aug	15-Aug	16-Aug	25-Aug	26-Aug	27-Aug	28-Aug	Overall
Kaplan off	Mean 643 DO	8.63	8.90	8.08	8.46	7.87	7.80	8.25	8.37	6.80	6.96	6.82	7.90	6.54	7.56	7.66	7.46	7.41	7.61	7.31	7.16	7.69
	N	12	13	12	13	6	7	7	8	11	13	10	13	13	11	13	13	7	11	7	4	204
	Mean Boil DO	8.42	8.23	7.95	7.94	7.82	7.38	7.85	6.97	7.28	7.04	7.19	7.94	7.51	7.12	7.51	6.94	7.44	7.77	7.67	7.98	7.60
	N	21	26	23	26	12	22	14	16	11	22	12	23	13	13	14	37	10	14	9	4	342
	643 DO minus Boil DO	0.22	0.66	0.12	0.52	0.06	0.42	0.40	1.41	-0.48	-0.08	-0.37	-0.05	-0.96	0.44	0.16	0.53	-0.03	-0.16	-0.36	-0.82	0.10
Kaplan on	Mean 643 DO			7.78		7.18	7.80	7.60	7.71	7.29		6.37			7.20			6.55	7.06	7.38	7.69	7.69
	N			1		7	7	6	4	2		3			2			6	2	4	8	51
	Mean Boil DO			7.00		6.84	6.39	6.88	6.48	6.72		6.45			5.87			6.64	6.83	7.49	7.74	6.72
	N			5		54	42	45	22	10		15			17			36	12	12	16	286
	643 DO minus Boil DO			0.78		0.34	1.41	0.72	1.23	0.57		-0.08			1.33			-0.09	0.22	-0.11	-0.05	0.97

* Several instances occurred with two observations in the same hour at discharge boils, these were averaged. Total number of discharge boil measurements = 635.

TABLE 4-7: REGRESSION STATISTICS FOR RELATIONSHIPS BETWEEN WATER TEMPERATURES AT STATIONS 501-503 IN CONOWINGO POND AND STATION 643 DOWNSTREAM OF CONOWINGO DAM.

Station 501 versus Station 643
$R^2 = 99.5\%$ $S_{y.x} = 0.752$ $N = 25$
Station 502 versus Station 643
$R^2 = 99.4\%$ $S_{y.x} = 0.791$ $N = 25$
Station 503 versus Station 643
$R^2 = 99.4\%$ $S_{y.x} = 0.823$ $N = 25$
Transect 5 (pooled) versus Station 643
$R^2 = 99.5\%$ $S_{y.x} = 0.78$ $N = 25$

TABLE 4.8: REGRESSION STATISTICS FOR RELATIONSHIPS BETWEEN WATER TEMPERATURES AT STATIONS 601-603 (TRANSECT ACROSS STATION 643) AND STATION 643 DOWNSTREAM OF CONOWINGO DAM.

Station 601 versus Station 643	
	R^2 = 99.3% $S_{y.x}$ = 0.840 N = 26
Station 602 versus Station 643	
	R^2 = 99.7% $S_{y.x}$ = 0.522 N = 26
Station 603 versus Station 643	
	R^2 = 98.0% $S_{y.x}$ = 1.467 N = 26
Transect 6 (pooled) versus Station 643	
	R^2 = 99.5% $S_{y.x}$ = 0.729 N = 26

TABLE 4-9: NUMBER OF HOURS EACH FRANCIS (UNITS 1-7) KAPLAN (UNITS 8-11) TURBINE OPERATED AT CONOWINGO HYDROELECTRIC STATION, JULY-AUGUST 2005-2010.

			Unit 1		Unit 2		Unit 3		Unit 4		Unit 5	
			Hours Ran	**% of available hours***	**Hours Ran**	**% of available hours***	**Hours Ran**	**% of available hours***	**Hours Ran**	**% of available hours***	**Hours Ran**	**% of available hours***
2005	July	Day (0800-1959)	174	47	169	45	122	33	191	51	0	0
		Night (2000-2359)	57	46	47	38	16	13	47	38	0	0
		Early Morning (2400-0759)	91	37	86	35	16	6	76	31	0	0
	August	Day (0800-1959)	84	23	323	87	8	2	6	2	0	0
		Night (2000-2359)	28	22	111	89	2	1	5	4	0	0
		Early Morning (2400-0759)	46	18	209	84	0	0	16	6	0	0
2006	July	Day (0800-1959)	363	98	221	60	208	56	311	84	304	88
		Night (2000-2359)	118	95	41	33	51	41	83	67	82	66
		Early Morning (2400-0759)	225	91	47	19	25	10	82	33	91	37
	August	Day (0800-1959)	173	47	41	11	184	49	149	40	302	81
		Night (2000-2359)	52	42	1	1	31	25	23	19	88	71
		Early Morning (2400-0759)	102	41	0	0	0	0	0	0	157	63
2007	July	Day (0800-1959)	34	9	0	0	49	13	32	9	372	100
		Night (2000-2359)	4	3	0	0	4	4	8	7	124	100
		Early Morning (2400-0759)	1	1	0	0	1	1	1	1	248	100
	August	Day (0800-1959)	92	25	1	0	129	35	158	42	365	98
		Night (2000-2359)	12	10	3	2	18	15	15	12	122	98
		Early Morning (2400-0759)	0	0	2	1	0	0	0	0	38	15
2008	July	Day (0800-1959)	62	17	0	0	165	44	145	39	372	100
		Night (2000-2359)	3	2	0	0	15	12	12	10	123	99
		Early Morning (2400-0759)	0	0	0	0	4	2	0	0	248	100
	August	Day (0800-1959)	32	9	0	0	95	25	83	22	367	99
		Night (2000-2359)	2	2	0	0	7	6	7	6	124	100
		Early Morning (2400-0759)	0	0	0	0	0	0	0	0	240	97
2009	July	Day (0800-1959)	136	37	327	88	88	24	213	57	175	47
		Night (2000-2359)	33	27	108	87	26	21	49	40	38	30
		Early Morning (2400-0759)	0	0	204	82	2	1	0	0	42	17
	August	Day (0800-1959)	191	51	292	79	190	51	103	28	236	63
		Night (2000-2359)	49	39	97	78	46	37	29	23	65	52
		Early Morning (2400-0759)	25	10	175	70	2	1	10	4	80	32
2010	July	Day (0800-1959)	55	15	315	85	71	19	44	12	209	56
		Night (2000-2359)	3	2	104	84	6	5	2	2	84	68
		Early Morning (2400-0759)	0	0	205	83	0	0	0	0	141	57
	August	Day (0800-1959)	40	11	293	79	43	12	60	16	134	36
		Night (2000-2359)	5	4	110	89	6	4	8	7	36	29
		Early Morning (2400-0759)	8	3	190	77	0	0	0	0	61	24

TABLE 4.9: CONTINUED.

			Unit 6		Unit 7		Unit 8		Unit 9		Unit 10	
			Hours Ran	% of available hours*	Hours Ran	% of available hours*	Hours Ran	% of available hours*	Hours Ran	% of available hours*	Hours Ran	% of available hours*
2005	July	Day (0800-1959)	111	30	127	34	54	15	66	18	47	13
		Night (2000-2359)	24	19	18	14	1	1	1	1	1	1
		Early Morning (2400-0759)	29	12	16	6	0	0	0	0	0	0
	August	Day (0800-1959)	62	17	46	12	3	1	0	0	6	2
		Night (2000-2359)	25	20	18	14	0	0	0	0	0	0
		Early Morning (2400-0759)	46	18	32	13	0	0	0	0	0	0
2006	July	Day (0800-1959)	0	0	274	74	229	62	233	63	249	67
		Night (2000-2359)	0	0	52	42	49	39	44	36	40	33
		Early Morning (2400-0759)	0	0	64	26	46	18	53	21	57	23
	August	Day (0800-1959)	0	0	100	27	48	13	44	12	61	16
		Night (2000-2359)	0	0	5	4	1	1	1	1	2	2
		Early Morning (2400-0759)	0	0	0	0	0	0	0	0	0	0
2007	July	Day (0800-1959)	0	0	0	0	6	2	0	0	6	2
		Night (2000-2359)	0	0	0	0	1	1	0	0	0	0
		Early Morning (2400-0759)	0	0	0	0	0	0	0	0	0	0
	August	Day (0800-1959)	8	2	0	0	61	16	28	8	22	6
		Night (2000-2359)	2	2	0	0	9	7	3	3	2	2
		Early Morning (2400-0759)	0	0	0	0	0	0	0	0	0	0
2008	July	Day (0800-1959)	50	13	133	36	78	21	30	8	0	0
		Night (2000-2359)	4	3	2	2	1	1	0	0	0	0
		Early Morning (2400-0759)	0	0	2	1	0	0	0	0	0	0
	August	Day (0800-1959)	24	6	31	8	17	5	0	0	5	1
		Night (2000-2359)	7	5	3	2	2	2	0	0	0	0
		Early Morning (2400-0759)	8	3	0	0	0	0	0	0	1	0
2009	July	Day (0800-1959)	160	43	218	59	129	35	74	20	50	13
		Night (2000-2359)	32	26	36	29	29	24	11	9	4	3
		Early Morning (2400-0759)	0	0	0	0	2	1	0	0	0	0
	August	Day (0800-1959)	190	51	238	64	182	49	110	30	131	35
		Night (2000-2359)	50	40	61	49	63	50	32	26	33	26
		Early Morning (2400-0759)	18	7	27	11	18	7	1	0	9	4
2010	July	Day (0800-1959)	130	35	75	20	60	16	38	10	0	0
		Night (2000-2359)	45	36	9	7	1	1	1	1	0	0
		Early Morning (2400-0759)	76	31	20	8	0	0	0	0	0	0
	August	Day (0800-1959)	22	6	26	7	29	8	18	5	11	3
		Night (2000-2359)	3	3	3	3	0	0	0	0	5	4
		Early Morning (2400-0759)	0	0	0	0	0	0	0	0	1	0

TABLE 4.9: CONTINUED.

			Unit 11		Average
			Hours Ran	% of available hours*	Holtwood Flow
2005	July	Day (0800-1959)	43	12	12,490
		Night (2000-2359)	1	1	
		Early Morning (2400-0759)	0	0	
	August	Day (0800-1959)	0	0	4,894
		Night (2000-2359)	0	0	
		Early Morning (2400-0759)	0	0	
2006	July	Day (0800-1959)	261	70	51,713
		Night (2000-2359)	62	50	
		Early Morning (2400-0759)	68	27	
	August	Day (0800-1959)	66	18	14,552
		Night (2000-2359)	2	2	
		Early Morning (2400-0759)	0	0	
2007	July	Day (0800-1959)	0	0	6,594
		Night (2000-2359)	0	0	
		Early Morning (2400-0759)	0	0	
	August	Day (0800-1959)	1	0	9,526
		Night (2000-2359)	0	0	
		Early Morning (2400-0759)	0	0	
2008	July	Day (0800-1959)	0	0	11,219
		Night (2000-2359)	0	0	
		Early Morning (2400-0759)	0	0	
	August	Day (0800-1959)	0	0	7,710
		Night (2000-2359)	0	0	
		Early Morning (2400-0759)	0	0	
2009	July	Day (0800-1959)	51	14	20,342
		Night (2000-2359)	4	3	
		Early Morning (2400-0759)	0	0	
		Day (0800-1959)	123	33	
	August	Night (2000-2359)	29	23	
		Early Morning (2400-0759)	9	4	27,577
2010	July	Day (0800-1959)	12	3	9,448
		Night (2000-2359)	0	0	
		Early Morning (2400-0759)	0	0	
	August	Day (0800-1959)	6	2	8,065
		Night (2000-2359)	0	0	
		Early Morning (2400-0759)	0	0	

FIGURE 1-1: LOCATIONS OF POWER STATIONS IN THE LOWER SUSQUEHANNA RIVER 2010.\

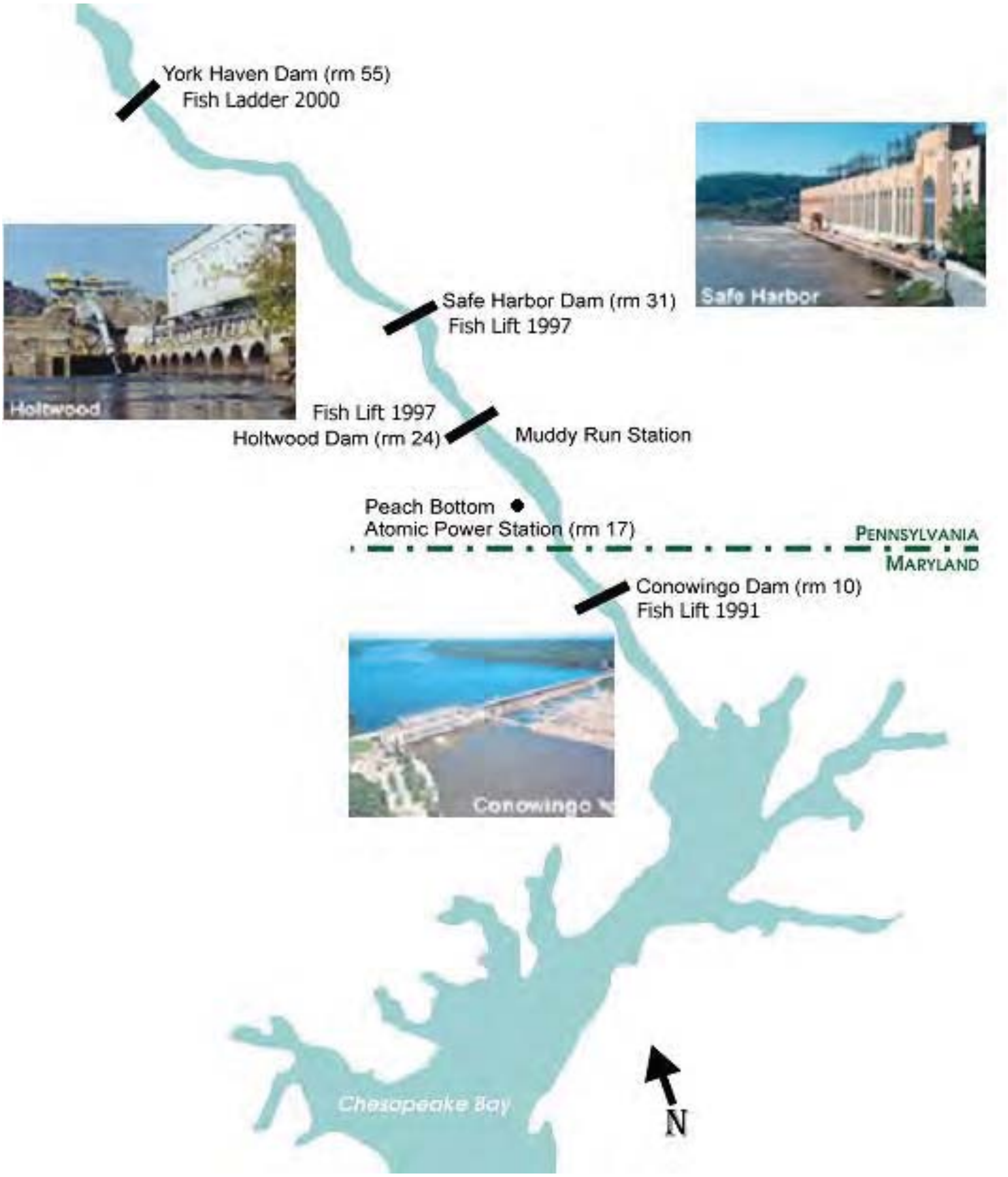


FIGURE 2-1: SCHEMATIC LOCATIONS OF CONOWINGO HYDROELECTRIC STATION FRANCIS TURBINE UNITS (1-7) AND KAPLAN TYPE UNITS (8-11) RELATIVE TO DOWNSTREAM (0.6 MI) WATER QUALITY MONITORING STATION 643.

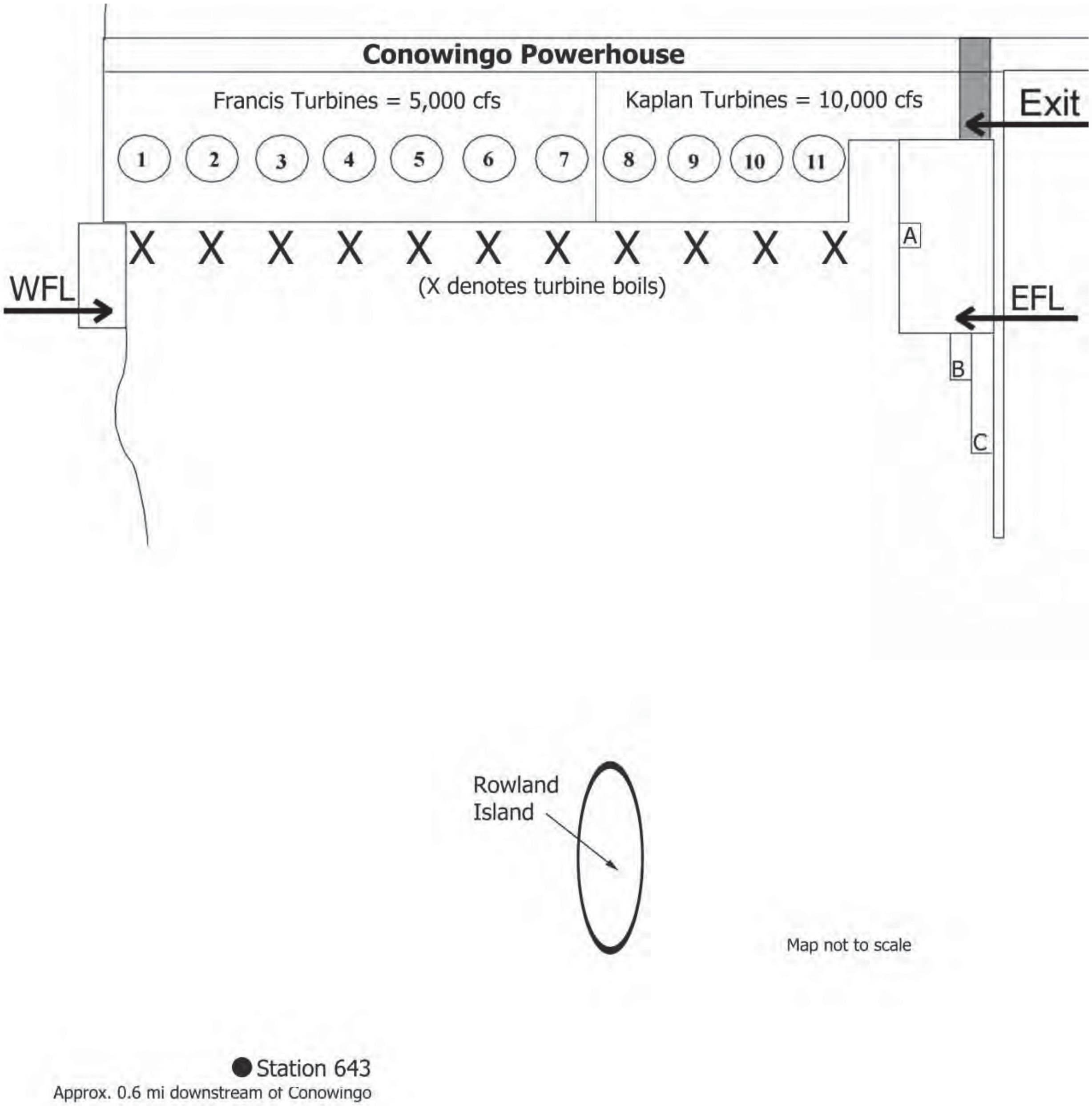
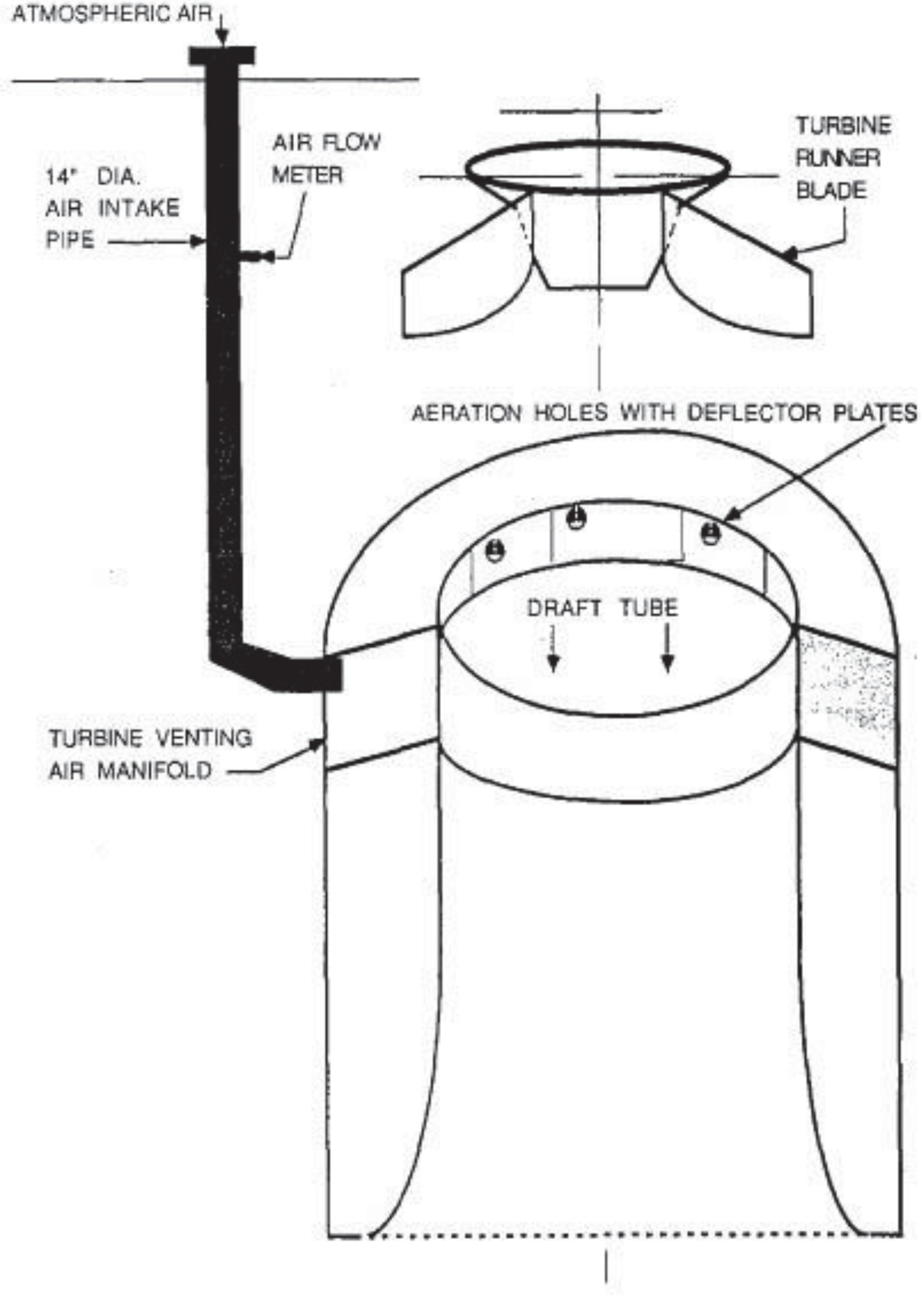
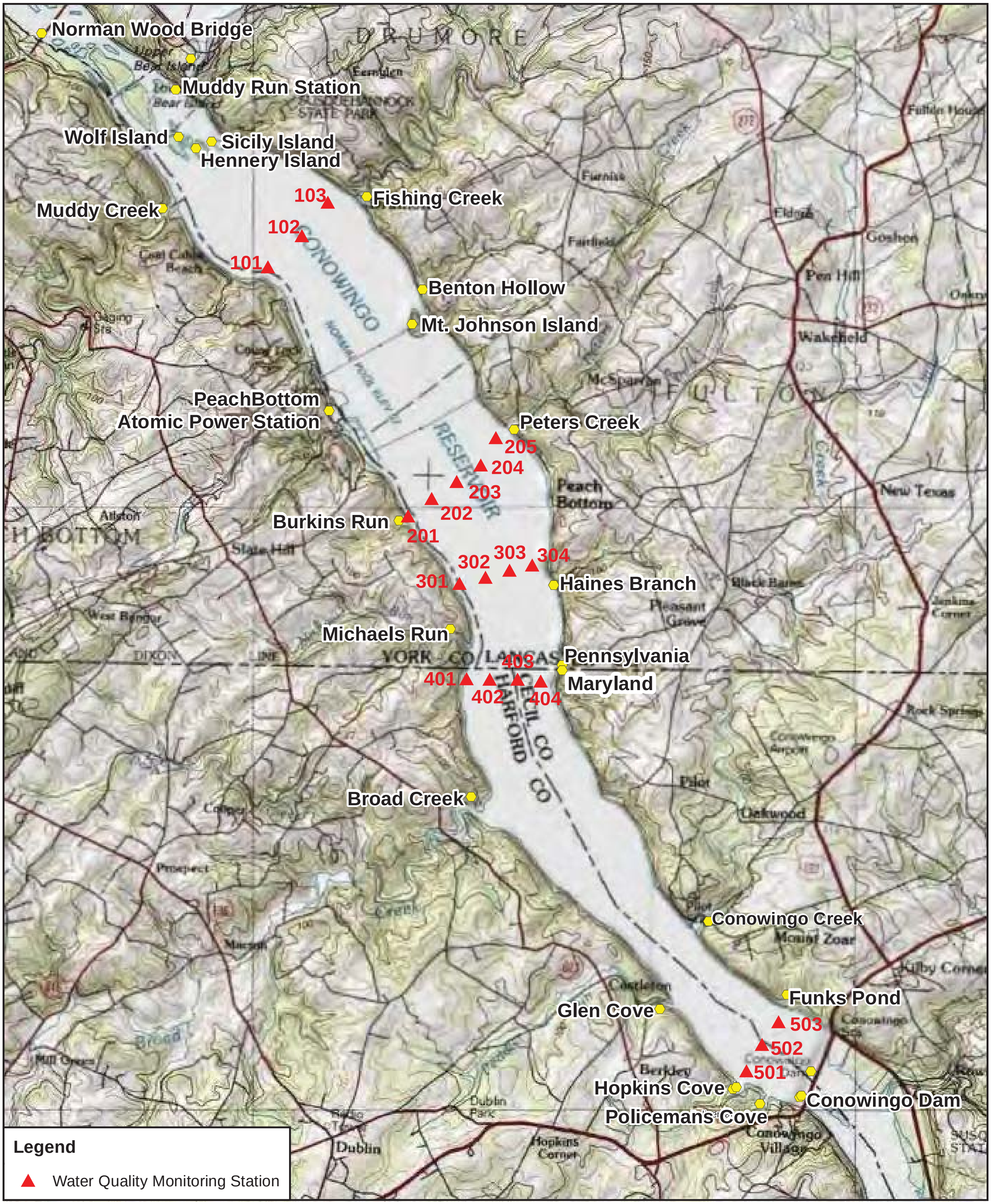


FIGURE 2-2: MODIFIED VENTING SYSTEM INSTALLED IN FRANCIS TURBINES AT CONOWINGO HYDROELECTRIC STATION. REPRODUCED FROM PECO (1990).





EXELON GENERATION COMPANY, LLC

STUDY 3.1
CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405

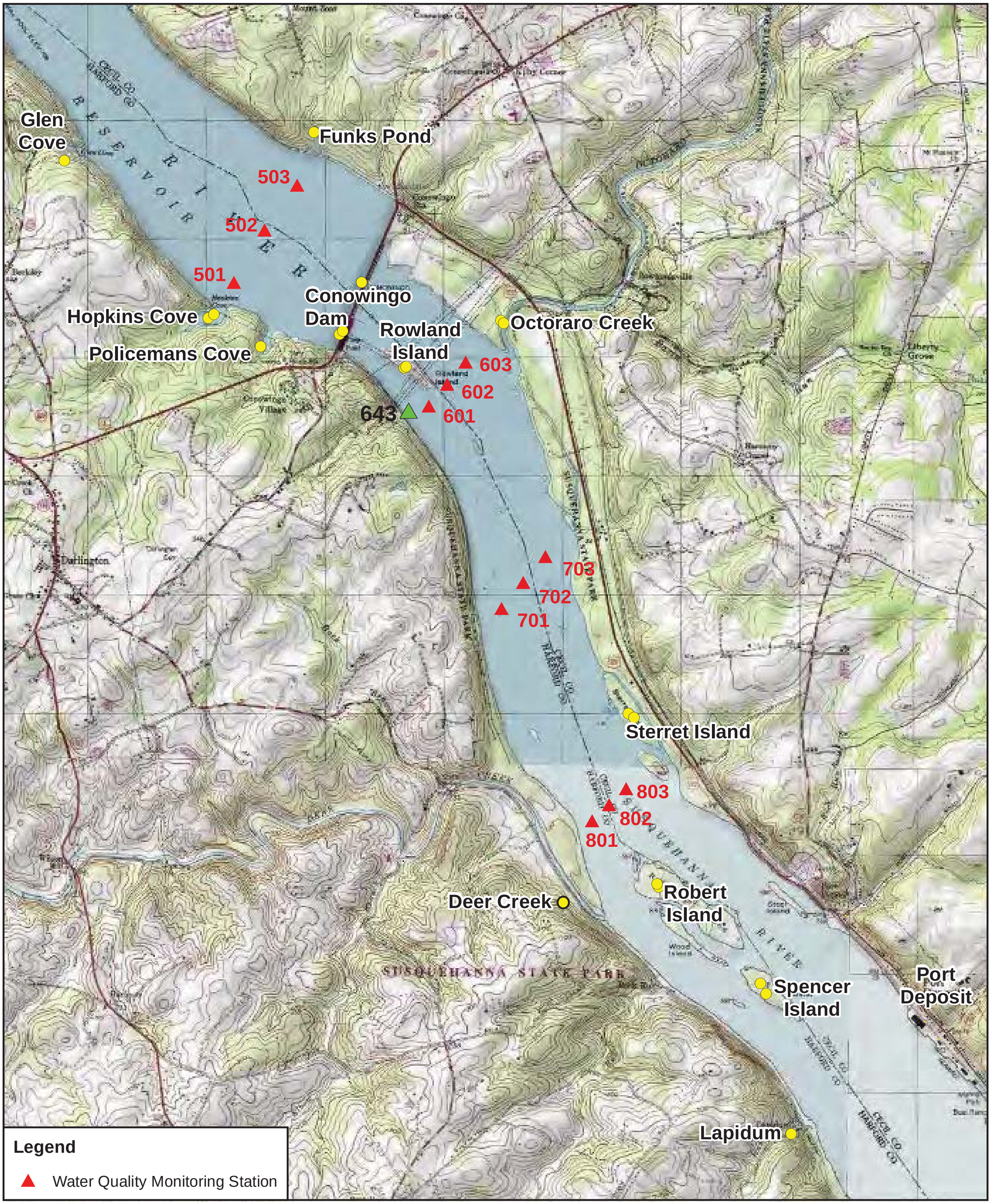
1 inch = 1.5 miles
0 0.75 1.5 3
Miles

N

Exelon.

**Figure 3-1:
Water Quality Sampling Transects
in Conowingo Pond,
April - October 2010**

Path: X:\GISMaps\project_maps\rsp\conowingo\3_01_wq\Figure 3-1_Conowingo_WQ.mxd



EXELON GENERATION COMPANY, LLC

STUDY 3.1
CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405

N

1 inch = 0.7 miles
0 0.35 0.7 1.4 Miles

**Figure 3-2:
Water Quality Sampling Transects
and Station 643 downstream
of Conowingo Dam,
April - October 2010**

Path: X:\GISMaps\project_maps\rsp\conowingo\3_01_wq\Figure 3-2_BelowConowingo_WQ.mxd

FIGURE 4-1: PLOT OF AVERAGE DAILY FLOW IN 2010 (APRIL-OCTOBER) AND LONG-TERM AVERAGE DAILY FLOW (1952-2009) AS MEASURED AT HOLTWOOD DAM, PPL.

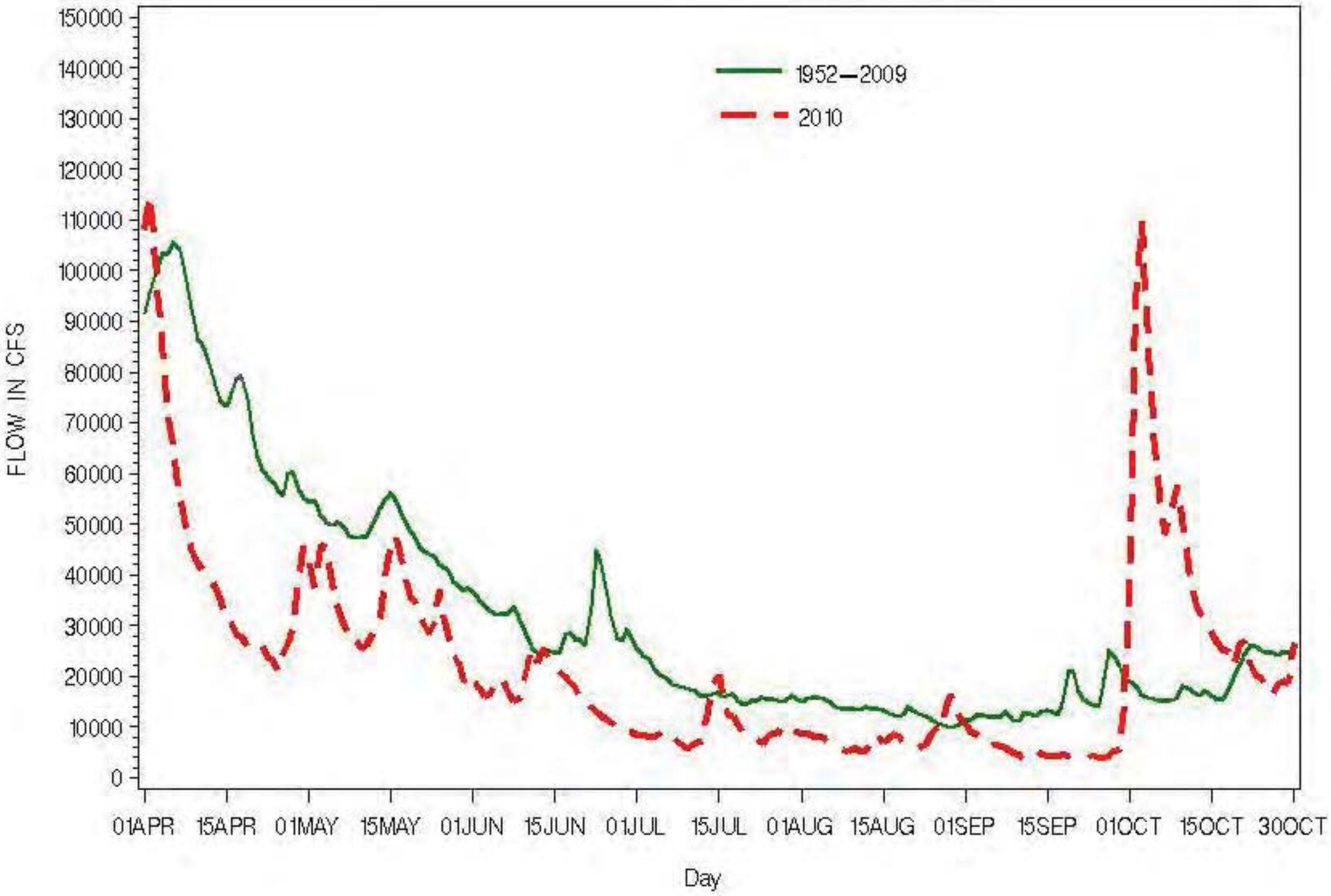


FIGURE 4-2: PROVIDES AN AVERAGE DAILY FLOW DURATION CURVE FOR THE PERIOD APRIL-OCTOBER, 2010, IN COMPARISON TO THE LONG-TERM (1952-2009) AVERAGE DAILY FLOW DURATION CURVE FOR THE SAME MONTHS.

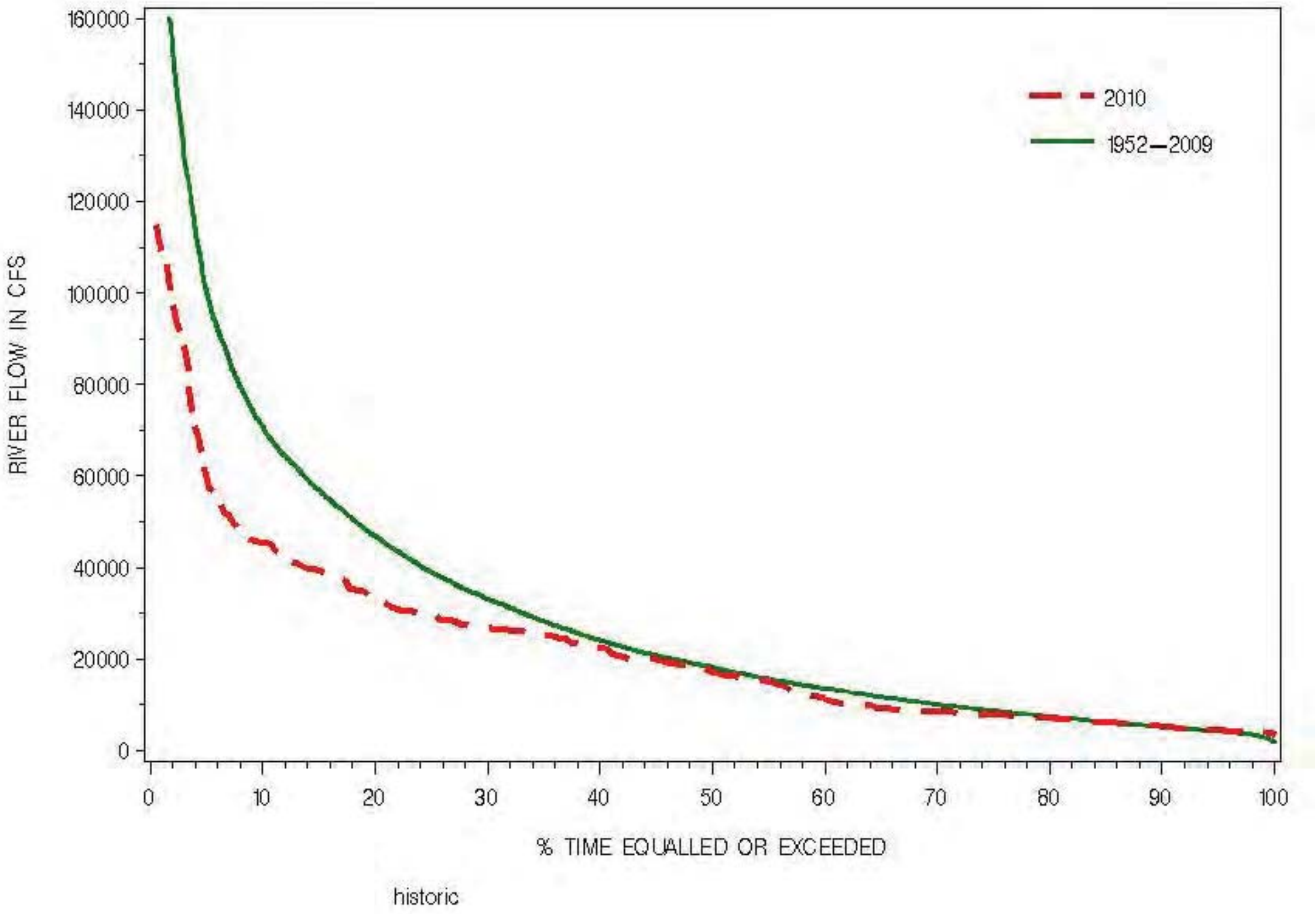


FIGURE 4-3: COMPARISON OF HISTORICAL (1952-2009) DAILY AVERAGE RIVER AND 2010 FLOW DURATION CURVES FOR APRIL.

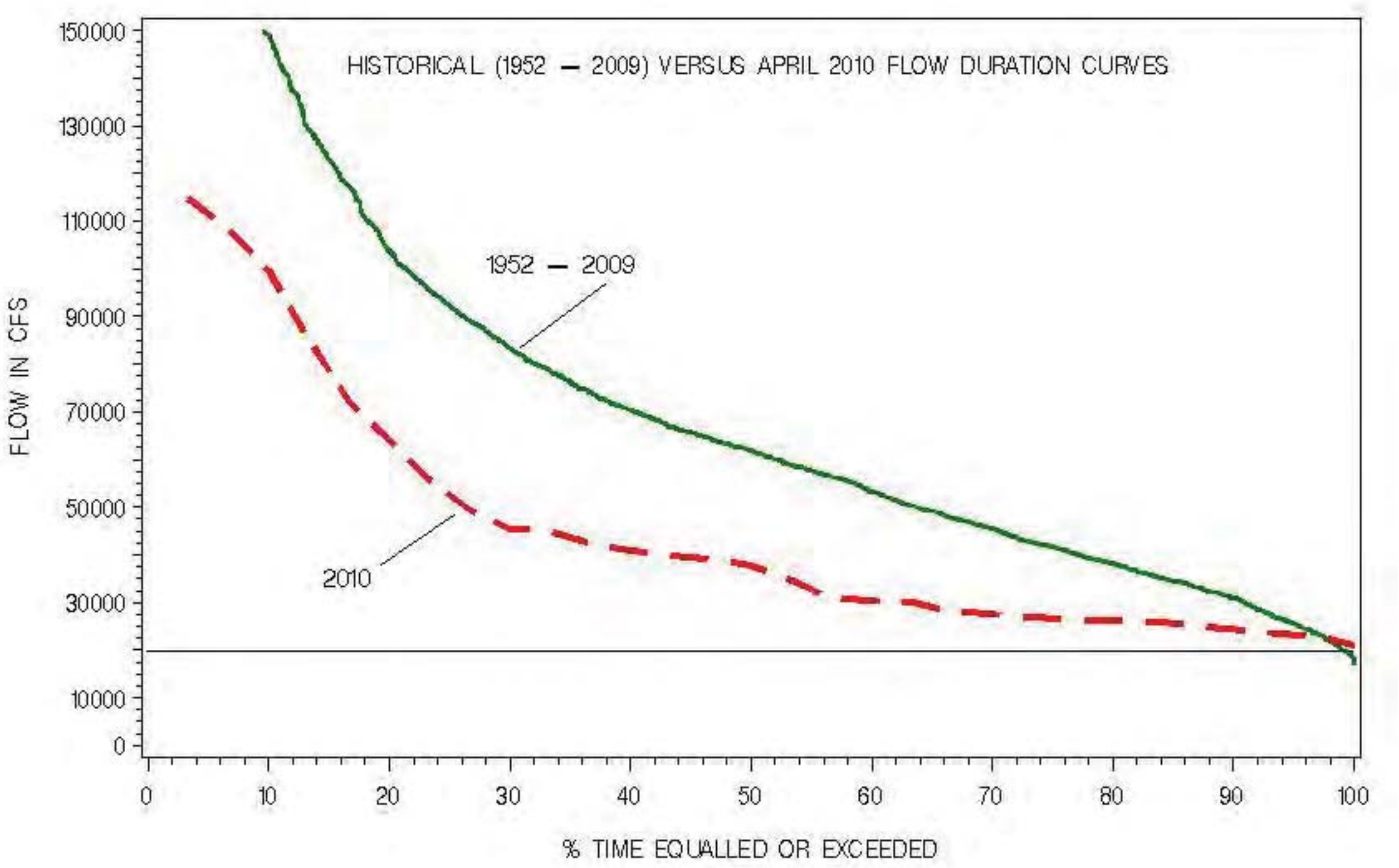


FIGURE 4-4: COMPARISON OF HISTORICAL (1952-2009) DAILY AVERAGE RIVER AND 2010 FLOW DURATION CURVES FOR MAY.

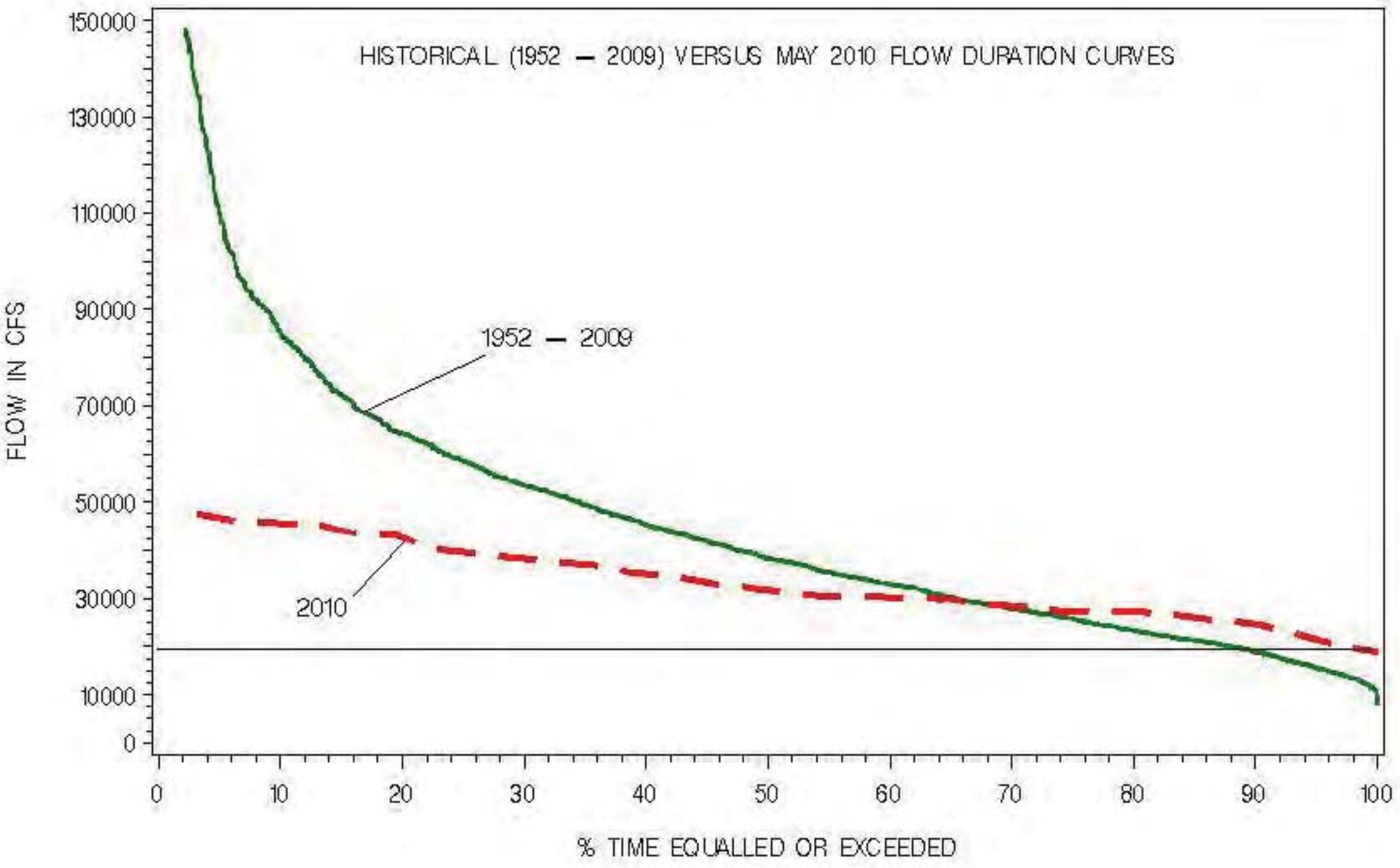


FIGURE 4-5: COMPARISON OF HISTORICAL (1952-2009) DAILY AVERAGE RIVER AND 2010 FLOW DURATION CURVES FOR JUNE.

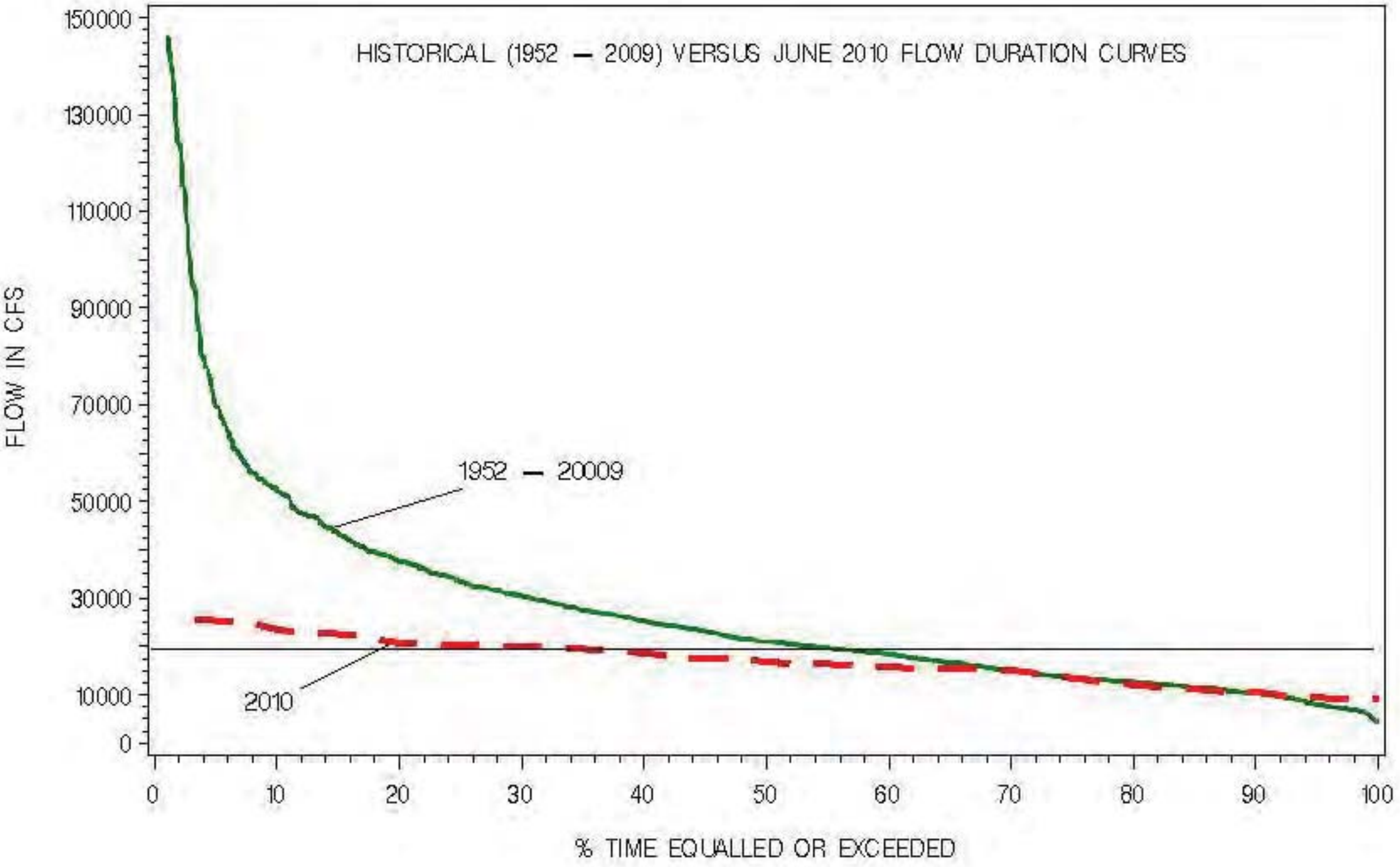


FIGURE 4-6: COMPARISON OF HISTORICAL (1952-2009) DAILY AVERAGE RIVER AND 2010 FLOW DURATION CURVES FOR JULY.

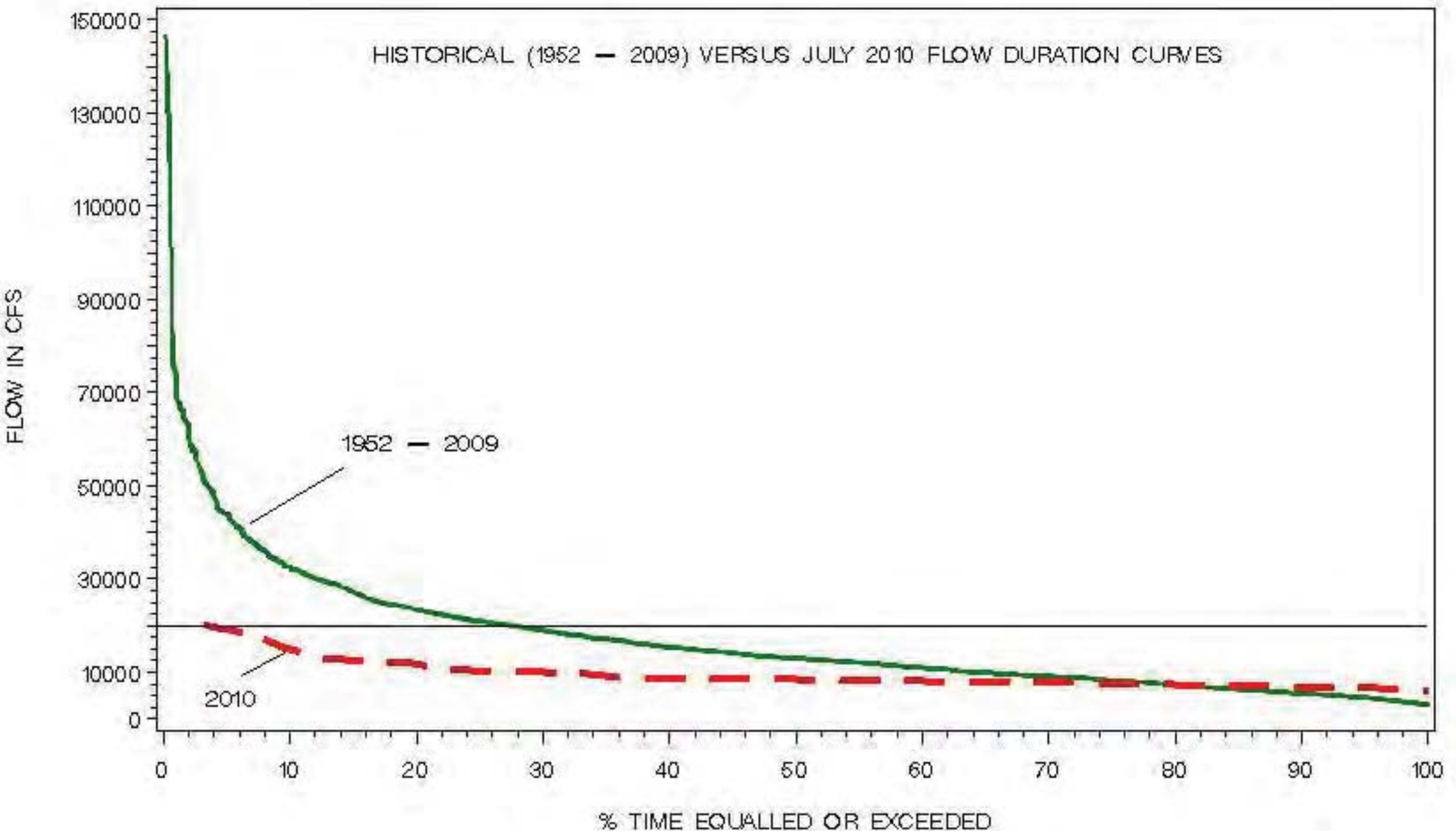


FIGURE 4-7: COMPARISON OF HISTORICAL (1952-2009) DAILY AVERAGE RIVER AND 2010 FLOW DURATION CURVES FOR AUGUST.

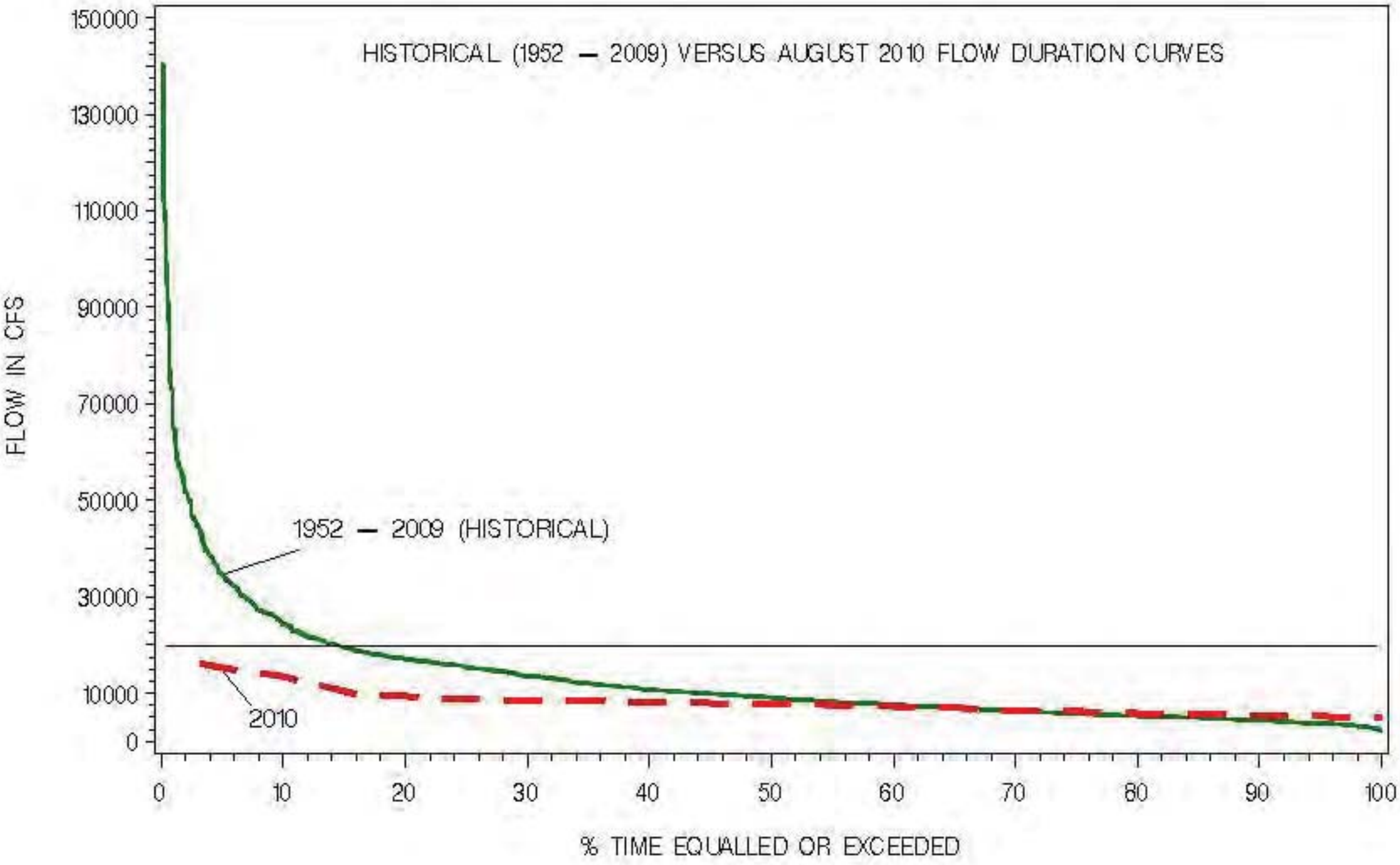


FIGURE 4-8: COMPARISON OF HISTORICAL (1952-2009) DAILY AVERAGE RIVER AND 2010 FLOW DURATION CURVES FOR SEPTEMBER.

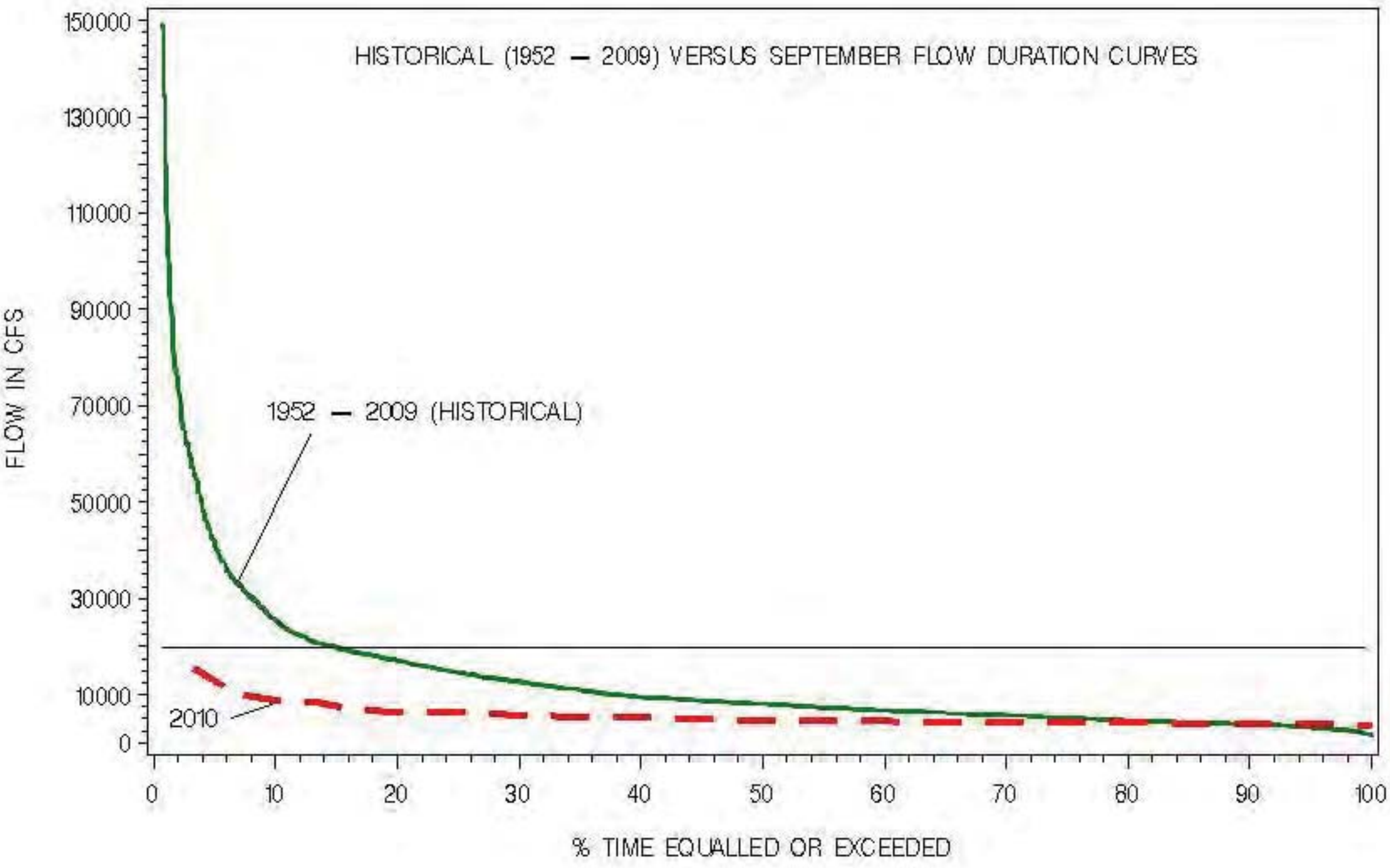


FIGURE 4-9: COMPARISON OF HISTORICAL (1952-2009) DAILY AVERAGE RIVER AND 2010 FLOW DURATION CURVES FOR OCTOBER.

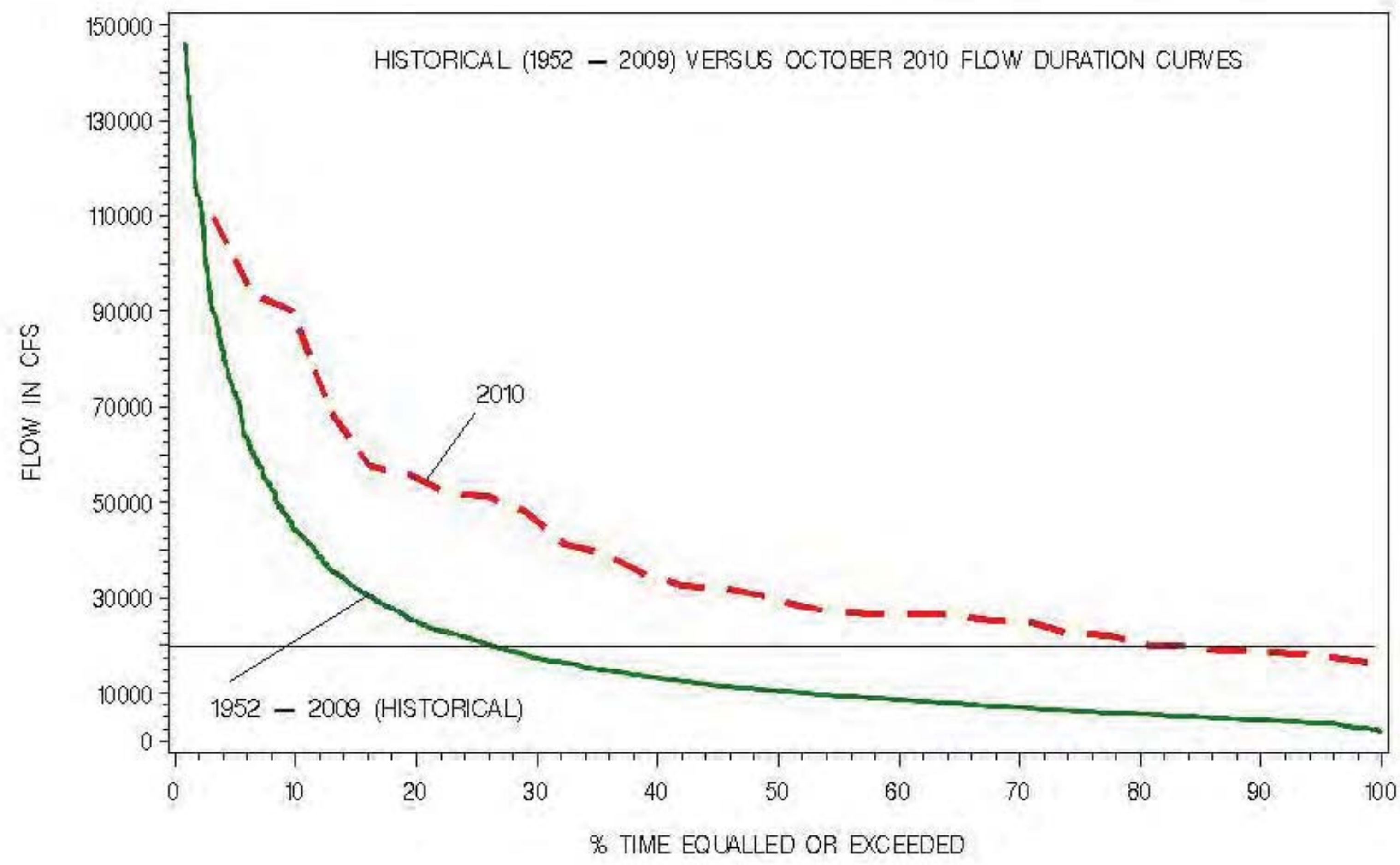


FIGURE 4-10: AVERAGE DAILY WATER TEMPERATURE AT HOLTWOOD IN 2010 AS COMPARED TO THE AVERGE DAILY WATER TEMPERATURE AT HOLTWOOD FOR THE PERIOD 1956-2009.

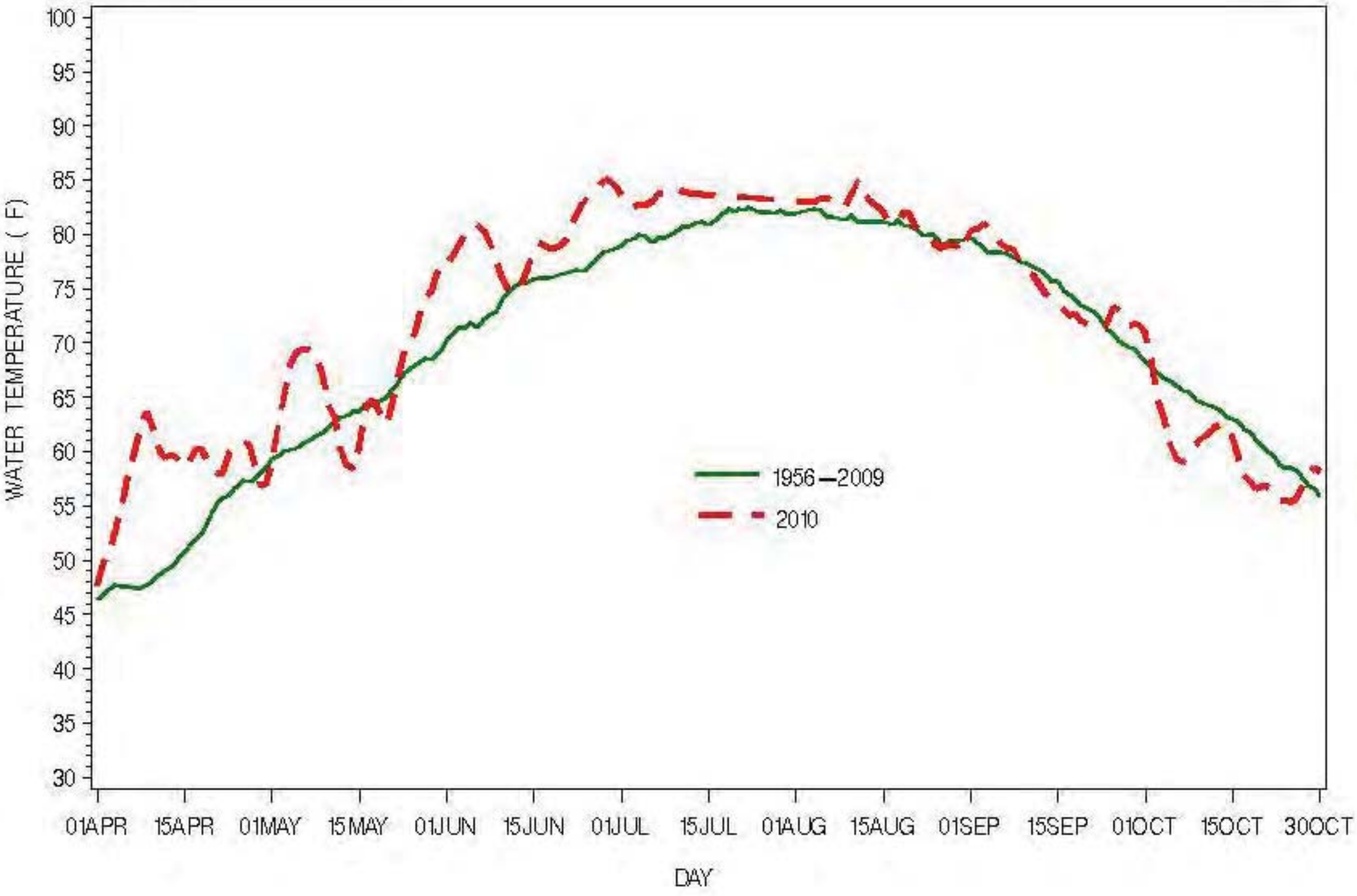


FIGURE 4-11: 2010 AVERAGE DAILY WATER TEMPERATURE DURATION CURVE FOR THE PERIOD APRIL-OCTOBER, 2010, IN COMPARISON TO THE LONG-TERM (1956-2009) AVERAGE DAILY TEMPERATURE DURATION CURVE FOR THOSE SAME MONTHS.

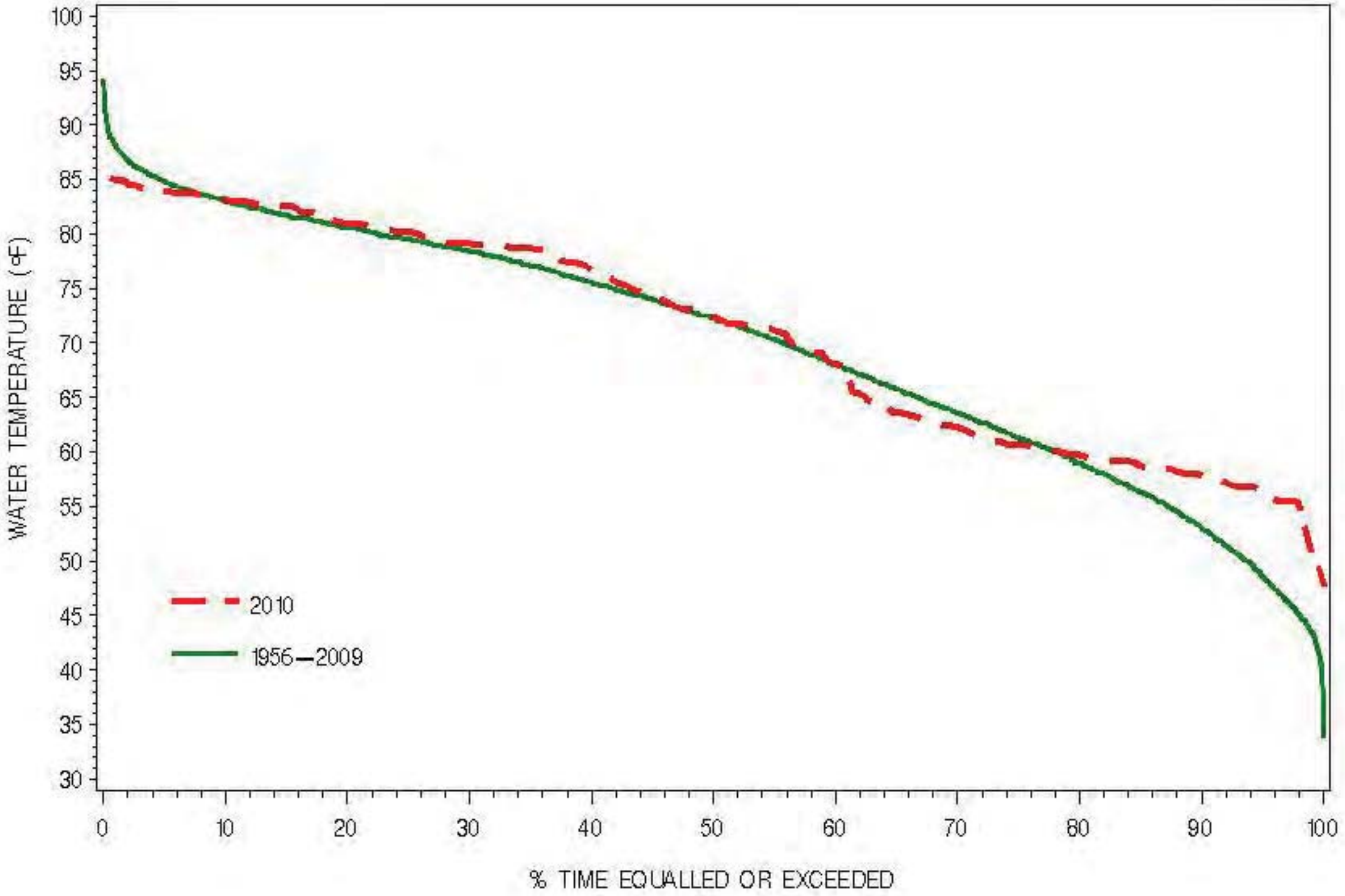


FIGURE 4-12: COMPARISON OF HISTORICAL (1956-2009) AND 2010 DAILY AVERAGE INCOMING WATER TEMPERATURE DURATION CURVES, APRIL.

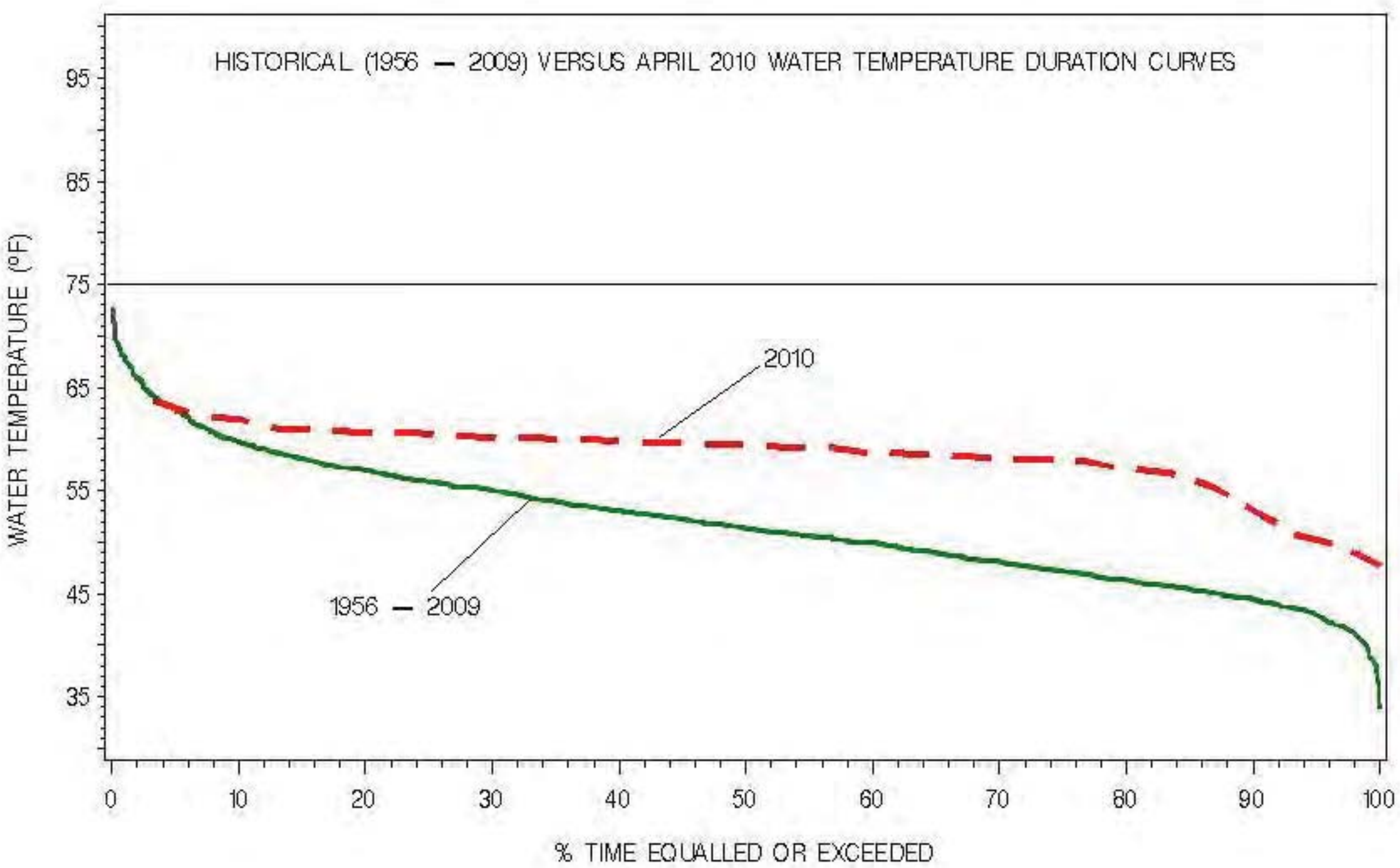


FIGURE 4-13: COMPARISON OF HISTORICAL (1956-2009) AND 2010 DAILY AVERAGE INCOMING WATER TEMPERATURE DURATION CURVES, MAY.

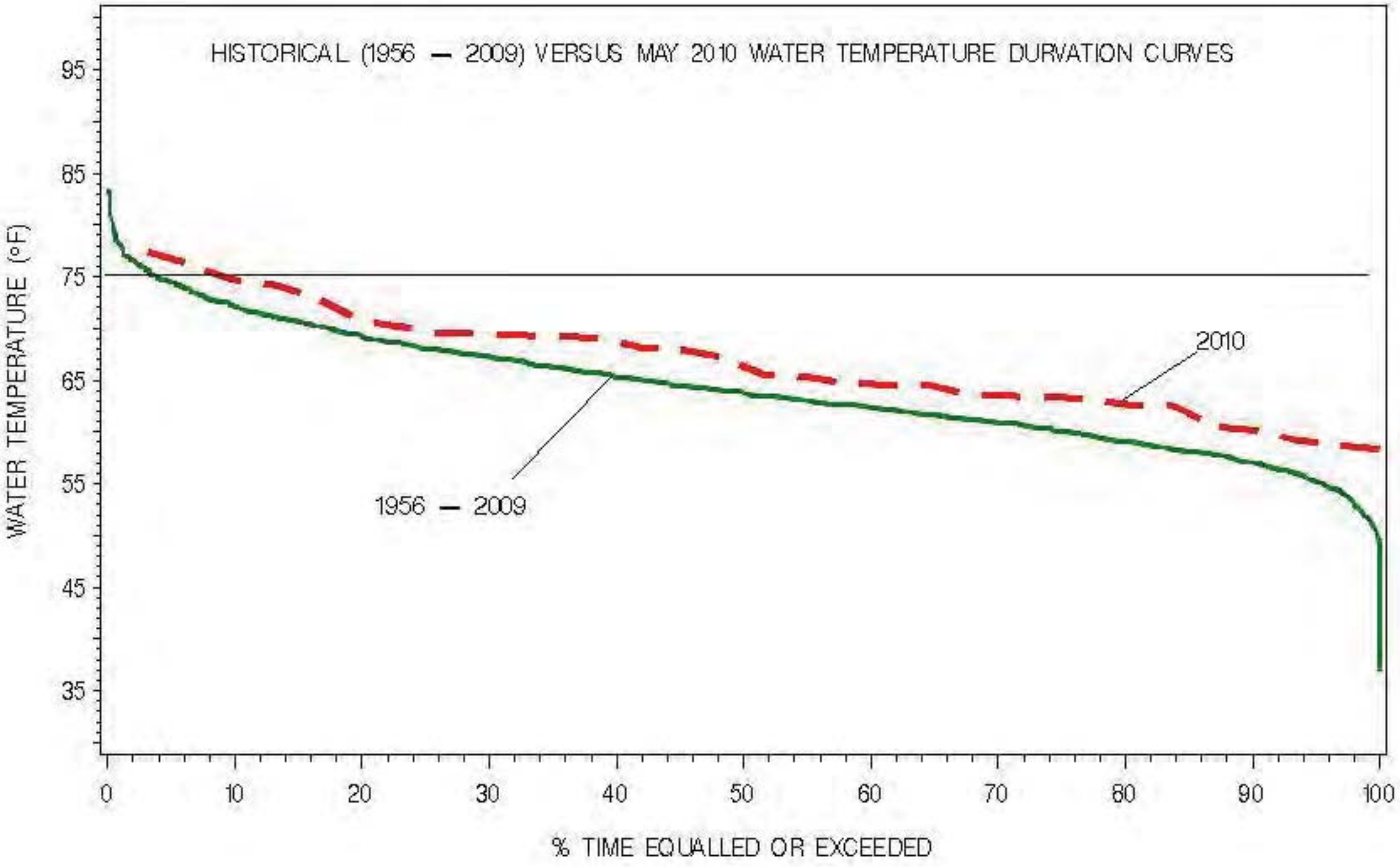


FIGURE 4-14: COMPARISON OF HISTORICAL (1956-2009) AND 2010 DAILY AVERAGE INCOMING WATER TEMPERATURE DURATION CURVES, JUNE.

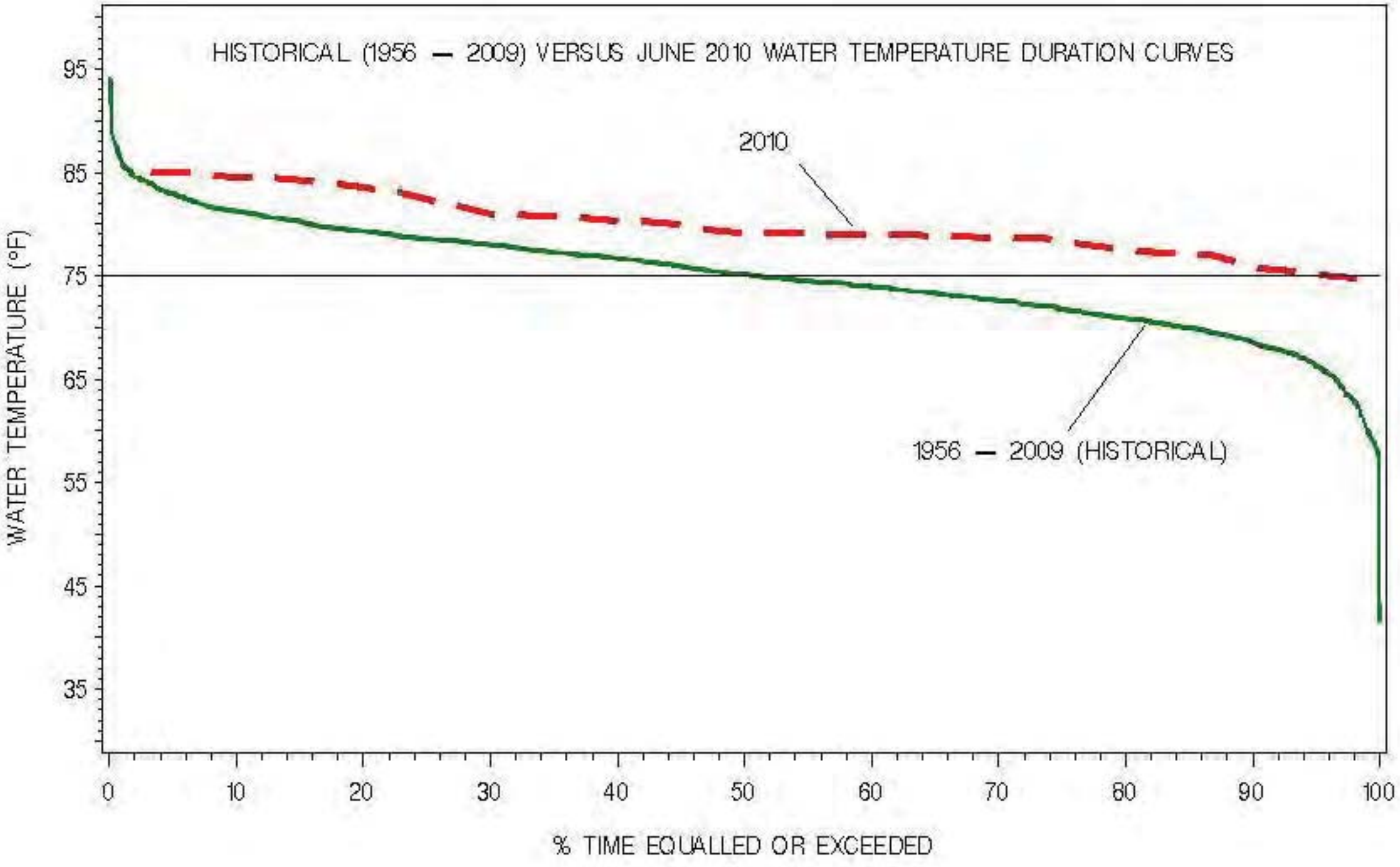


FIGURE 4-15: COMPARISON OF HISTORICAL (1956-2009) AND 2010 DAILY AVERAGE INCOMING WATER TEMPERATURE DURATION CURVES, JULY.

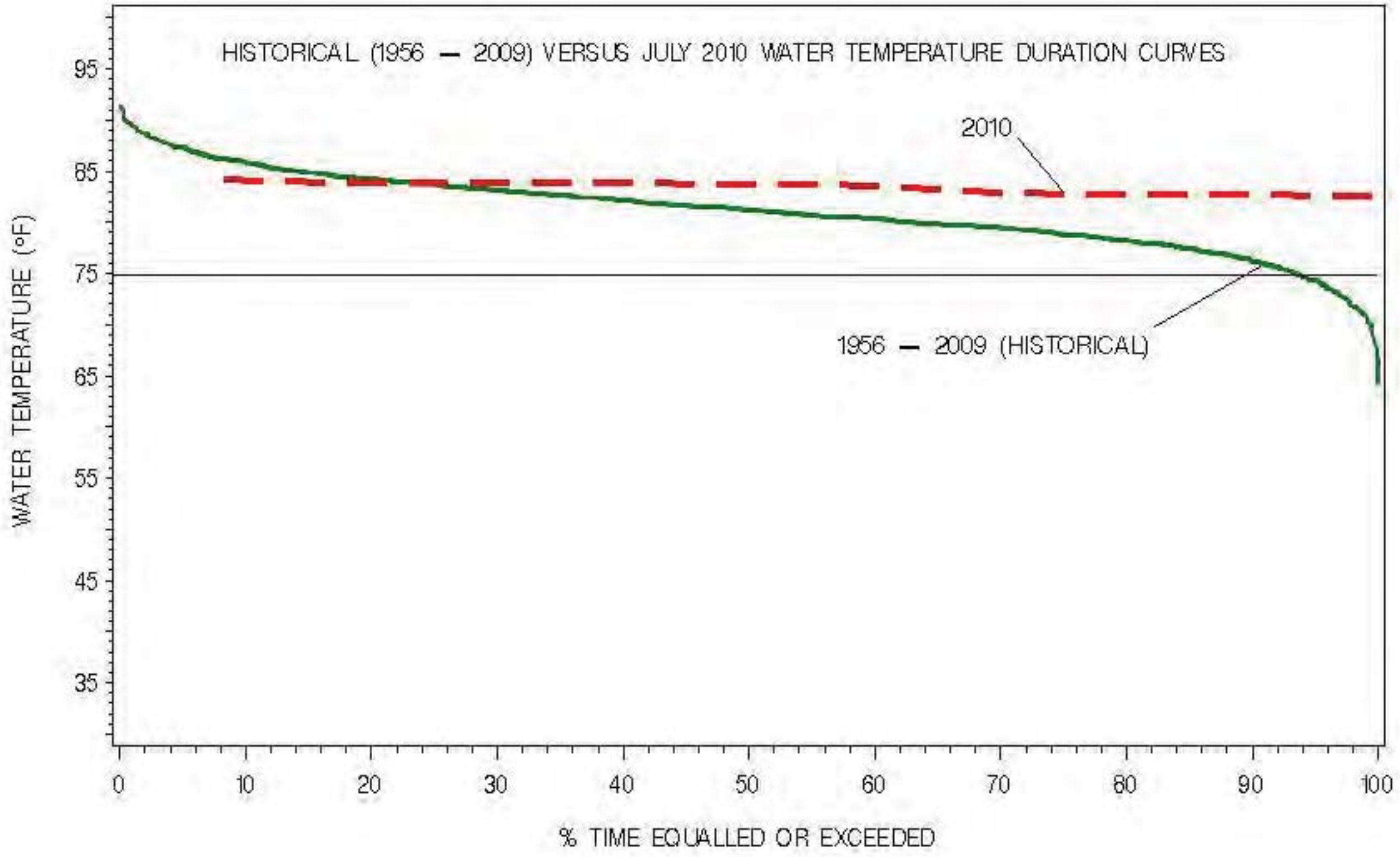


FIGURE 4-16: COMPARISON OF HISTORICAL (1956-2009) AND 2010 DAILY AVERAGE INCOMING WATER TEMPERATURE DURATION CURVES, AUGUST.

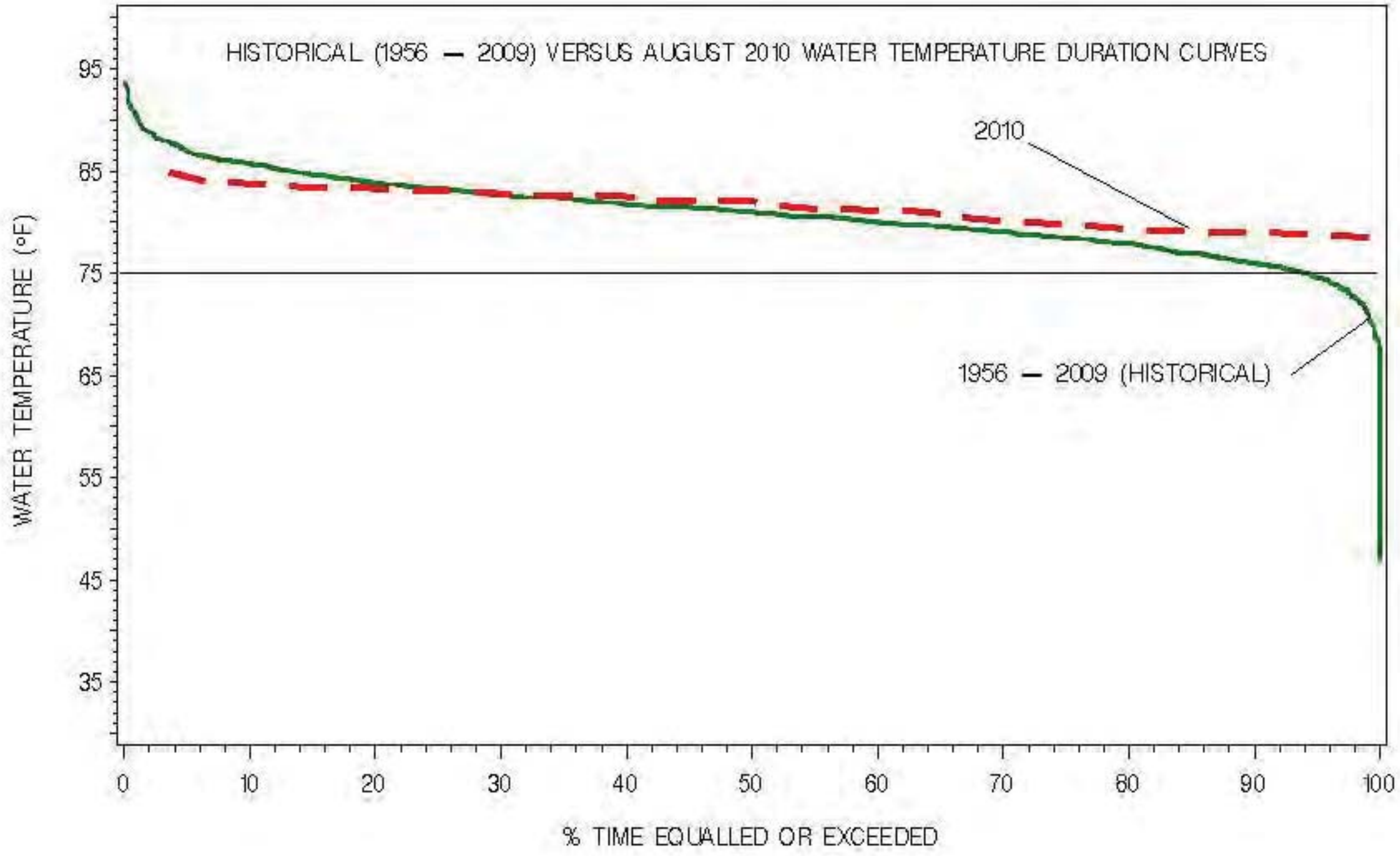


FIGURE 4-17: COMPARISON OF HISTORICAL (1956-2009) AND 2010 DAILY AVERAGE INCOMING WATER TEMPERATURE DURATION CURVES, SEPTEMBER.

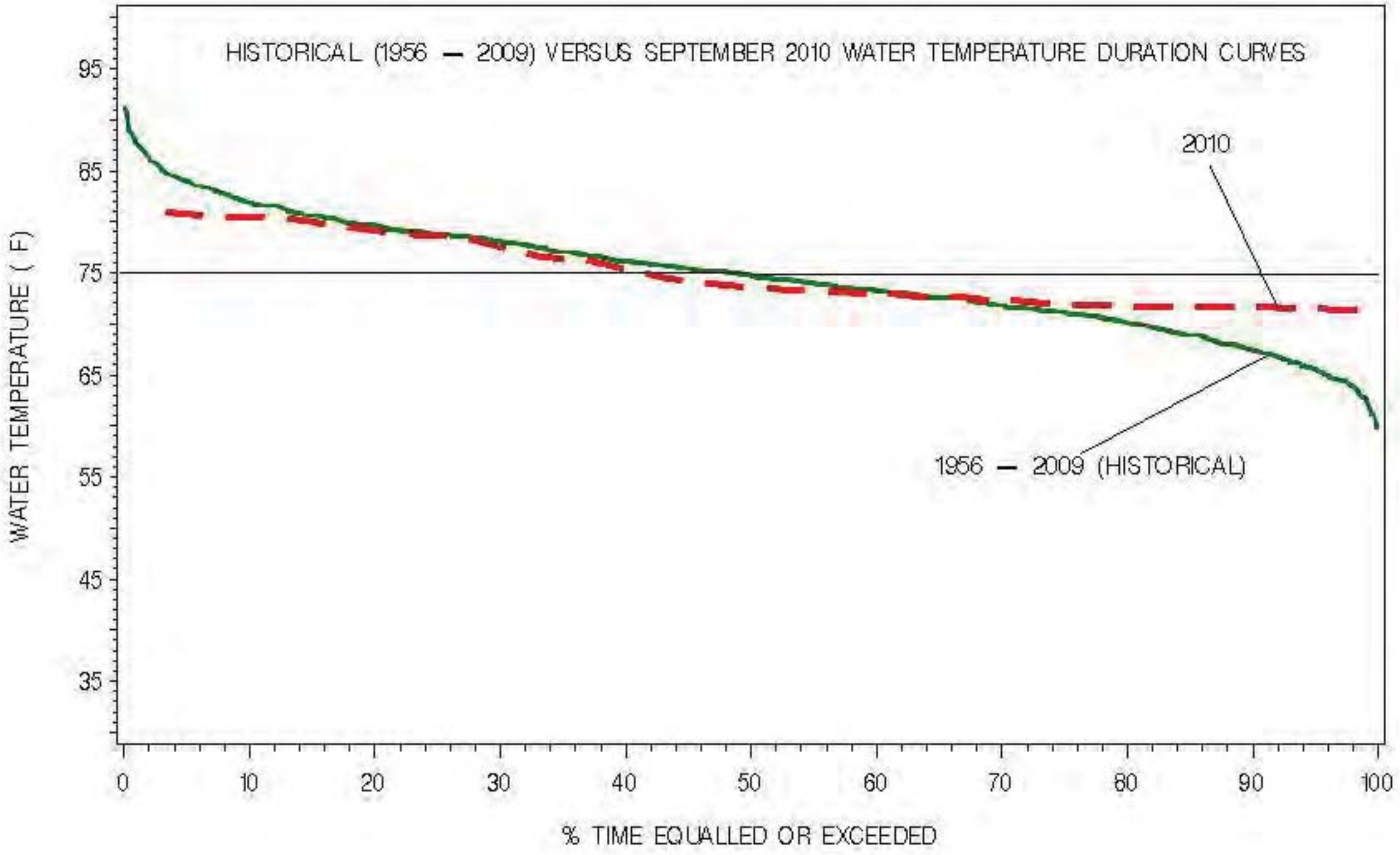


FIGURE 4-18: COMPARISON OF HISTORICAL (1956-2009) AND 2010 DAILY AVERAGE INCOMING WATER TEMPERATURE DURATION CURVES, OCTOBER.

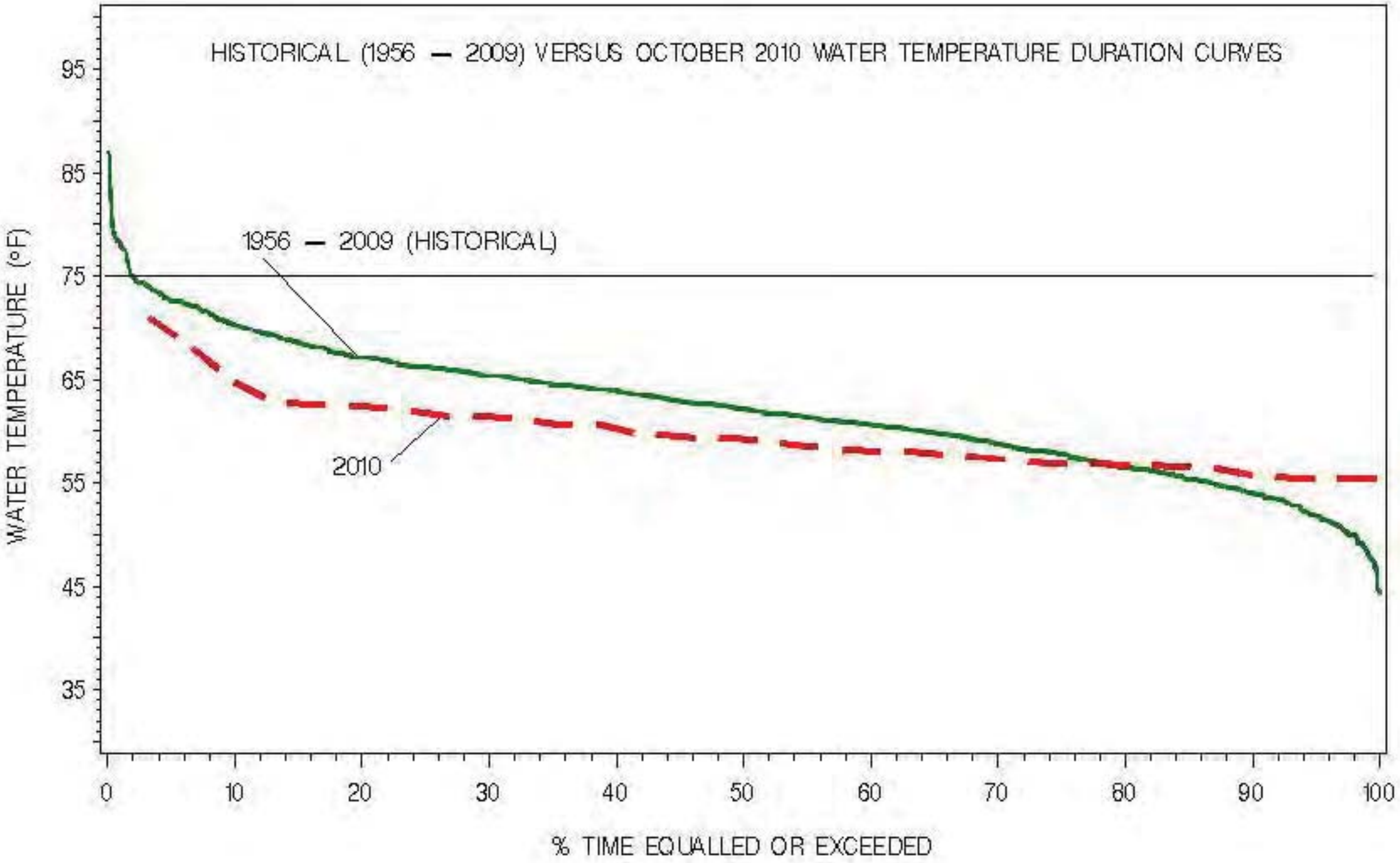


FIGURE 4-19: EXAMPLE OF VERTICAL WATER TEMPERATURE PROFILES AT STATION 502 (MID POINT) IN CONOWINGO POND, APRIL-OCTOBER 2010.

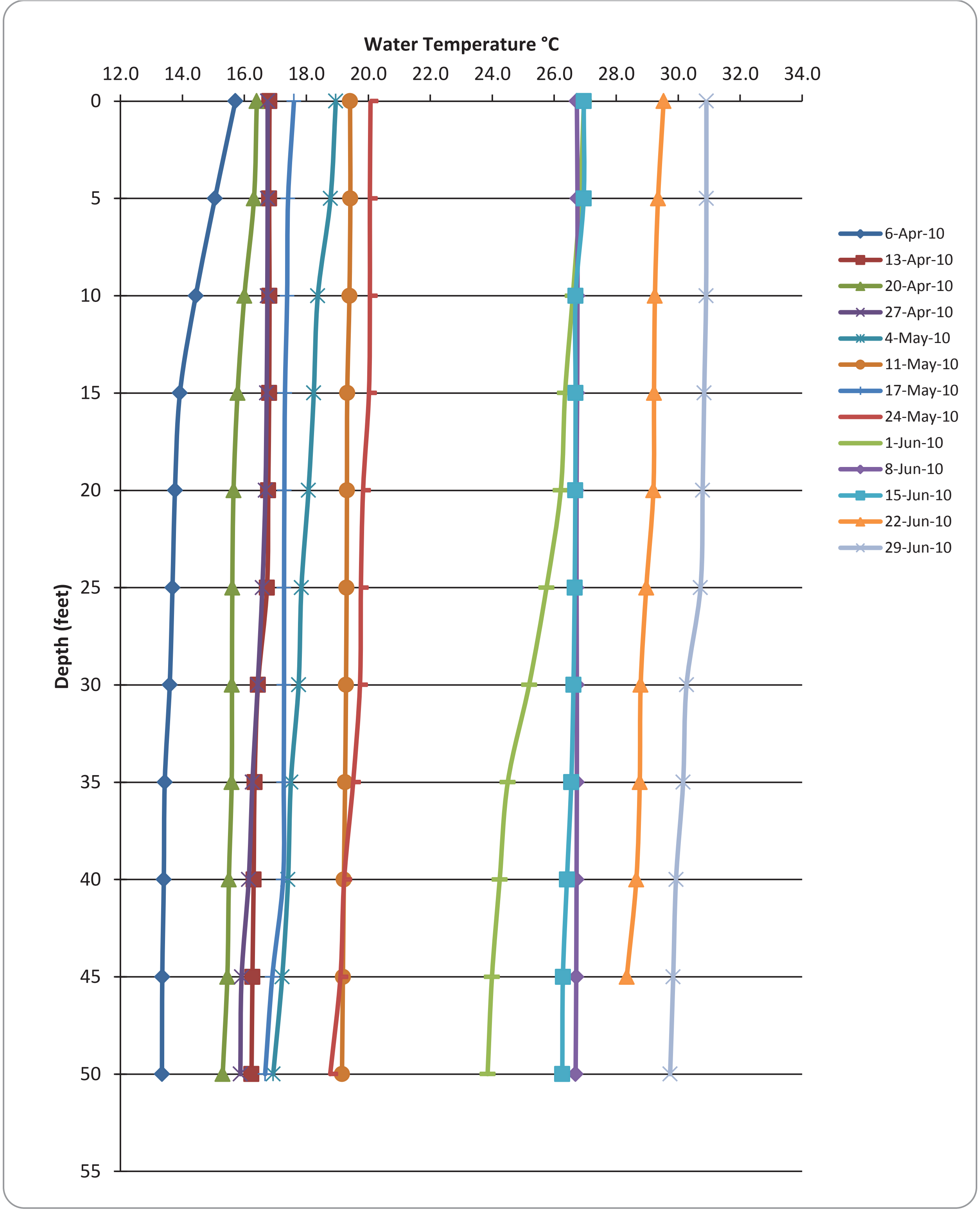


FIGURE 4-19: CONTINUED.

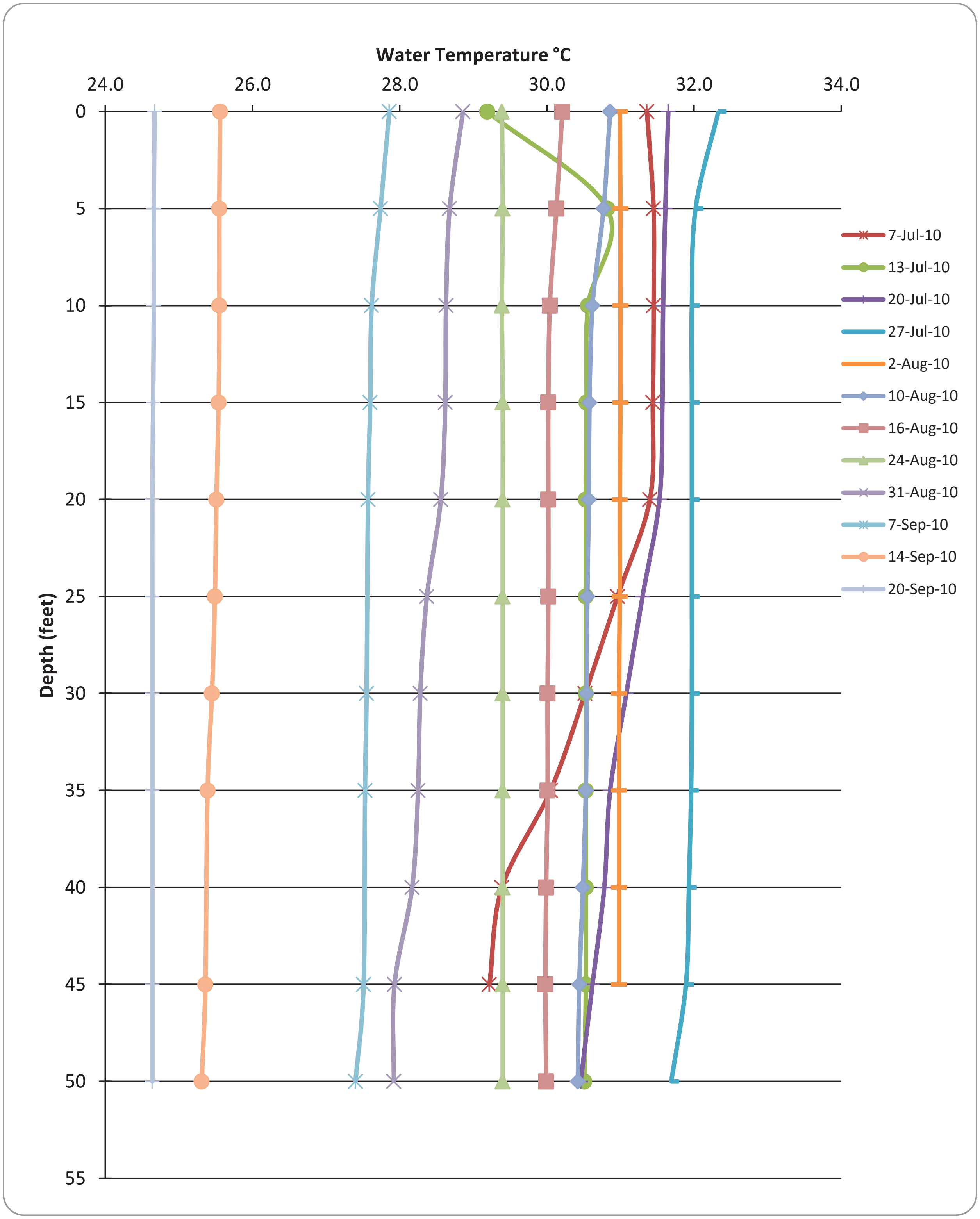


FIGURE 4-19: CONTINUED.

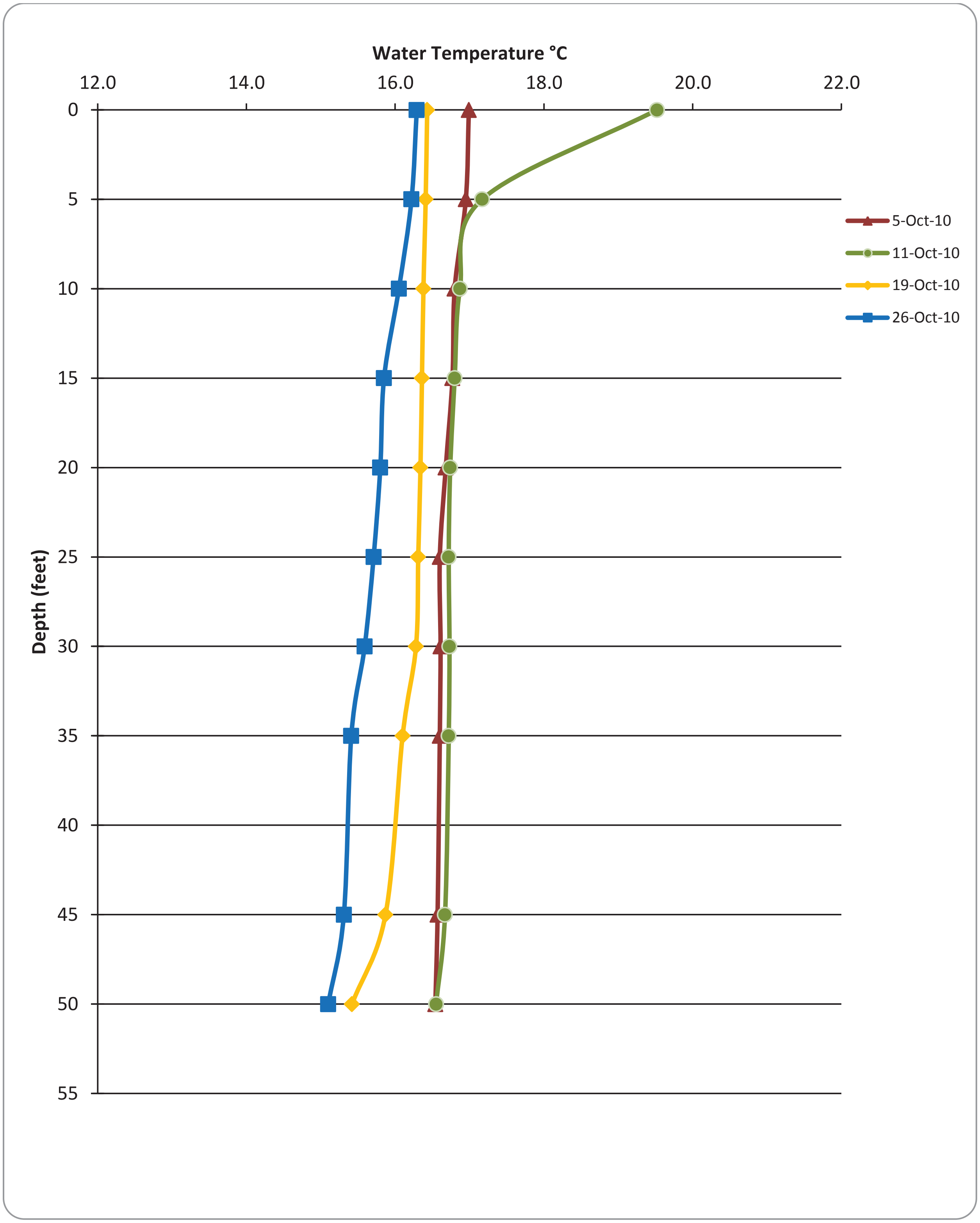


FIGURE 4-20: EXAMPLE OF DO VERTICAL DISTRIBUTION AT STATION 502 (MID POINT) IN CONOWINGO POND, APRIL-OCTOBER 2010.

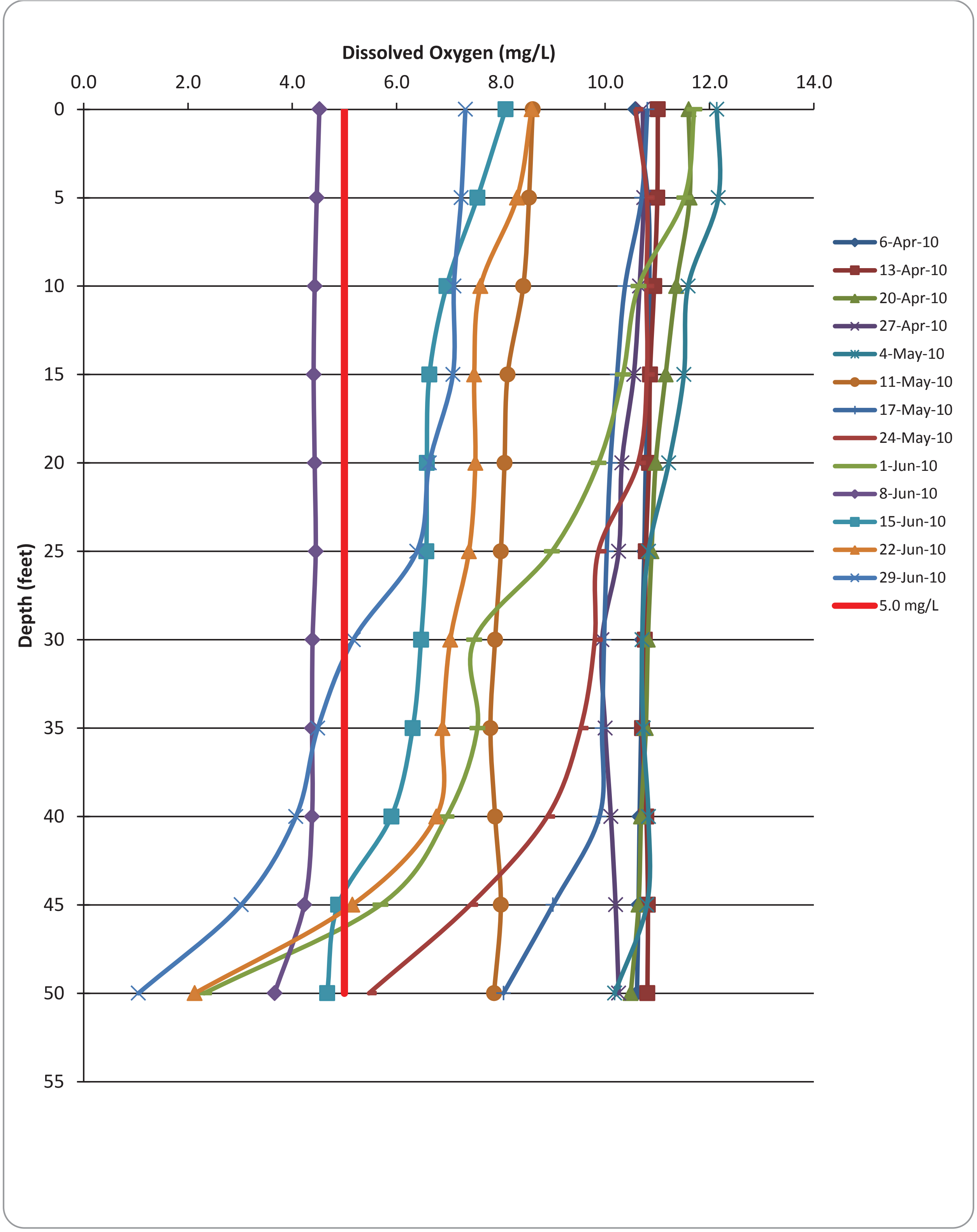


FIGURE 4-20: CONTINUED.

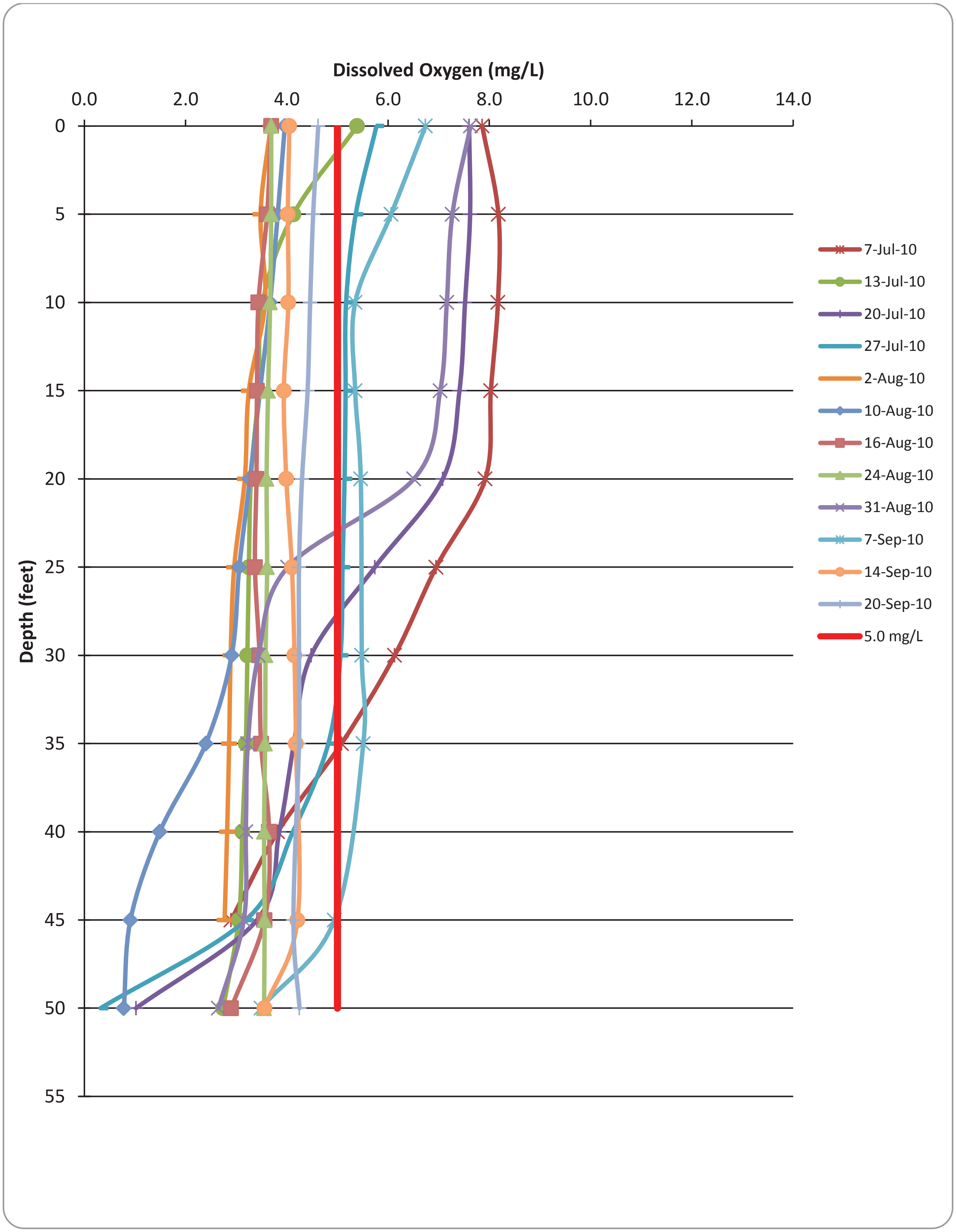


FIGURE 4-20: CONTINUED.

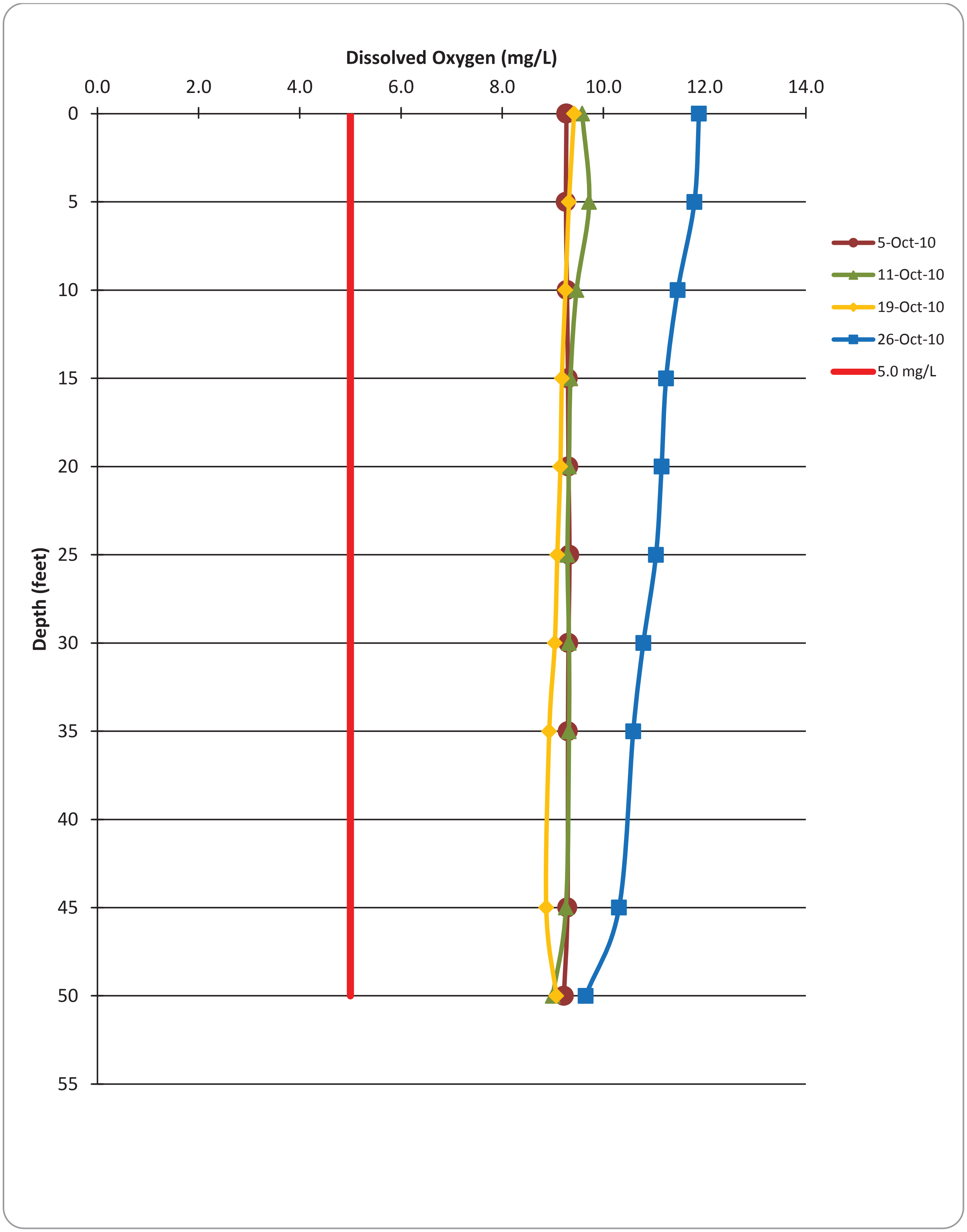


FIGURE 4-21: SEASONAL VARIATIONS IN SURFACE PH AT MID POINTS OF TRANSECTS IN CONOWINGO POND, APRIL-OCTOBER 2010.

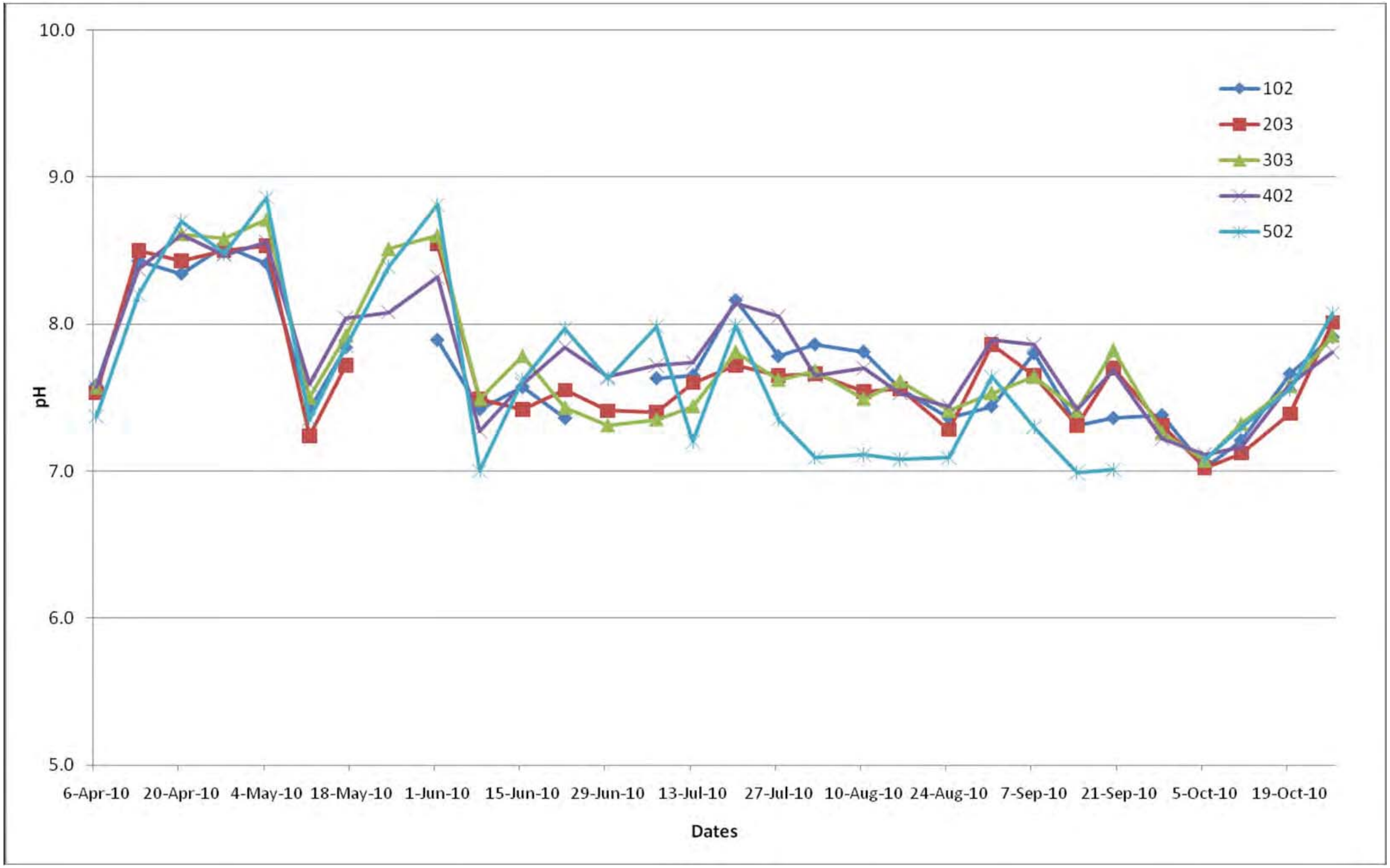


FIGURE 4-22: SEASONAL VARIATIONS IN SURFACE TURBIDITY AT MID POINTS OF TRANSECTS IN CONOWINGO POND, APRIL-OCTOBER 2010.

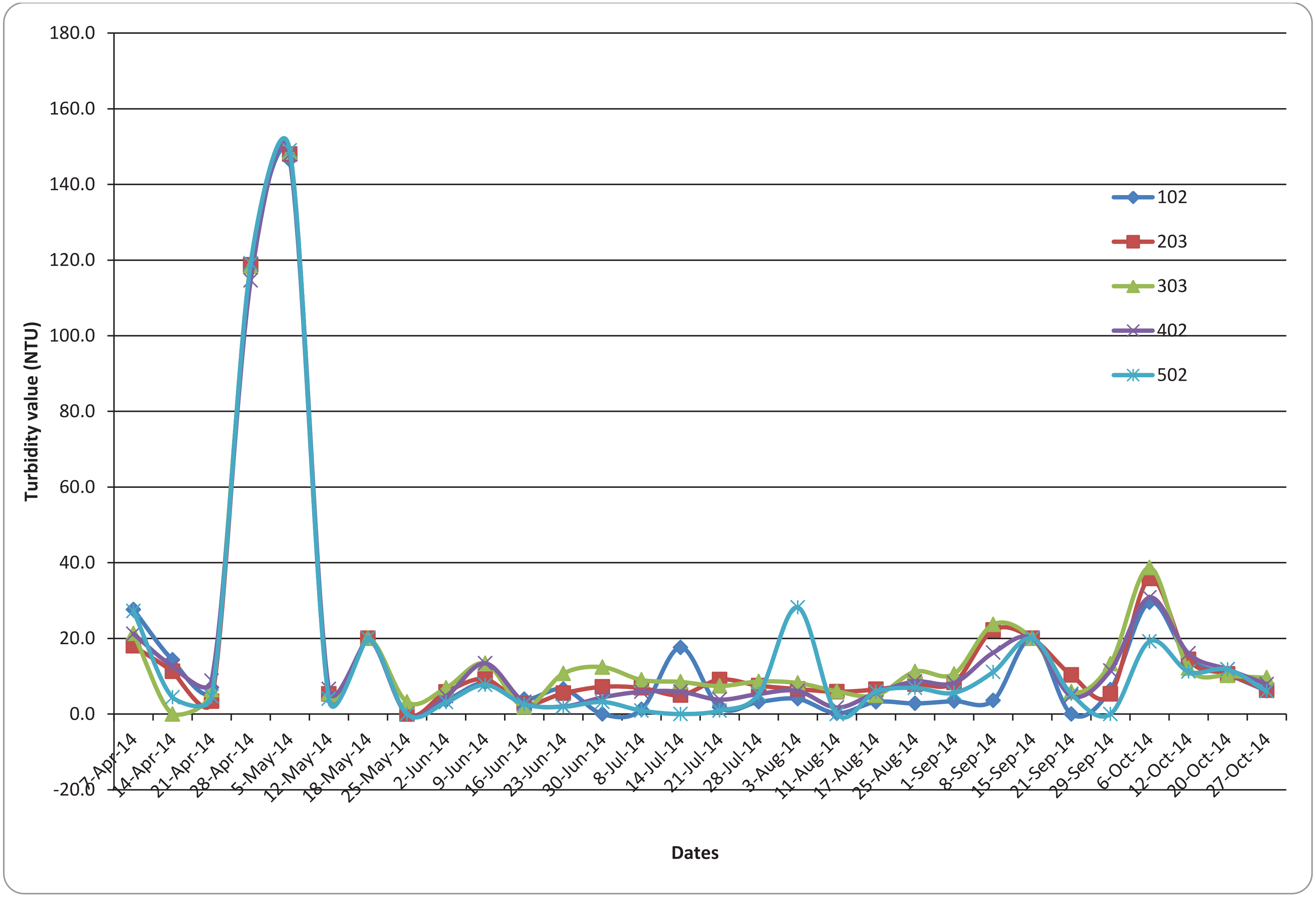


FIGURE 4-23: SEASONAL VARIATIONS IN SURFACE AND BOTTOM WATER TEMPERATURE (°C) AT TRANSECTS 6, 7, AND 8 DOWNSTREAM OF CONOWINGO DAM, APRIL-OCTOBER 2010.

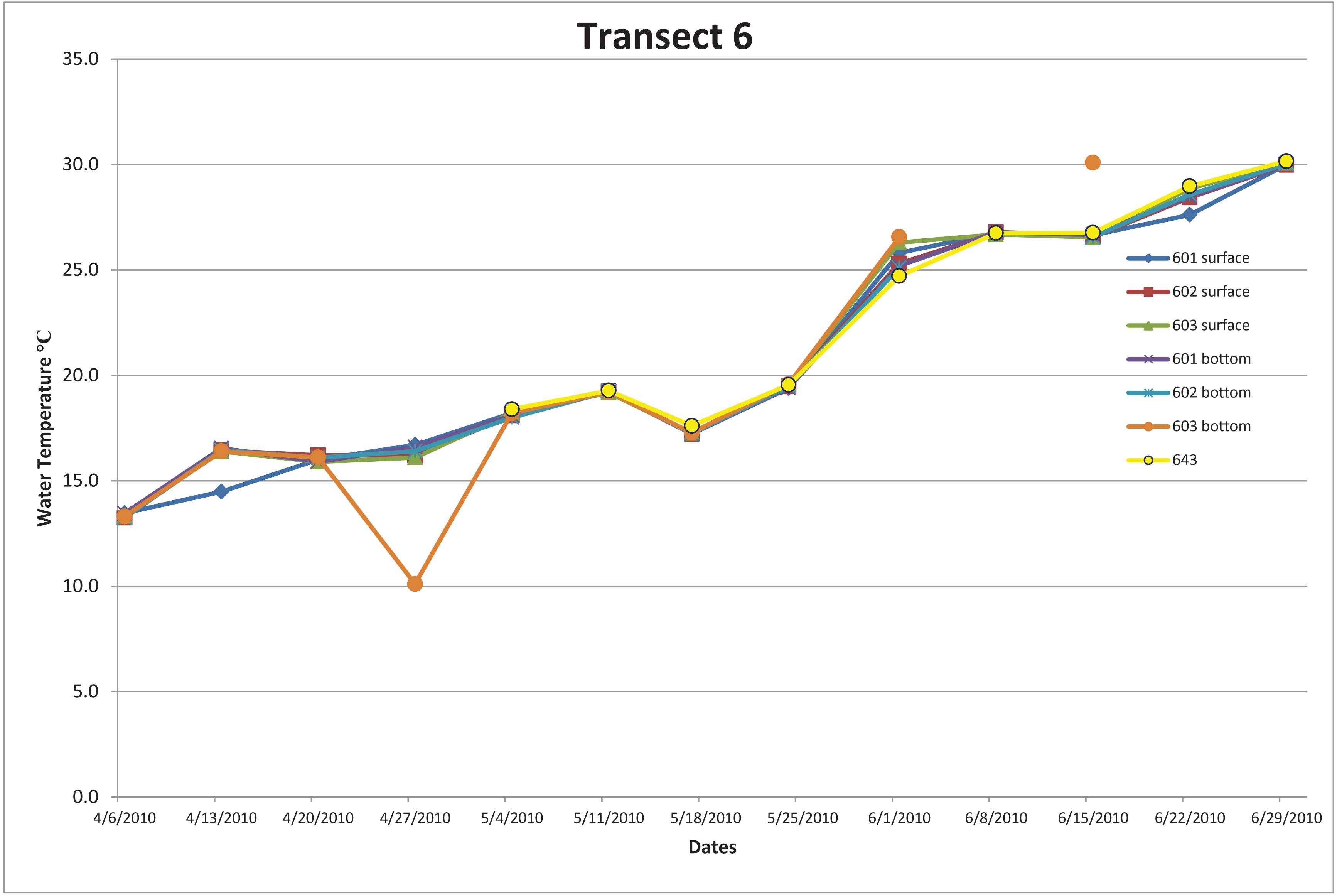


FIGURE 4-23: CONTINUED.

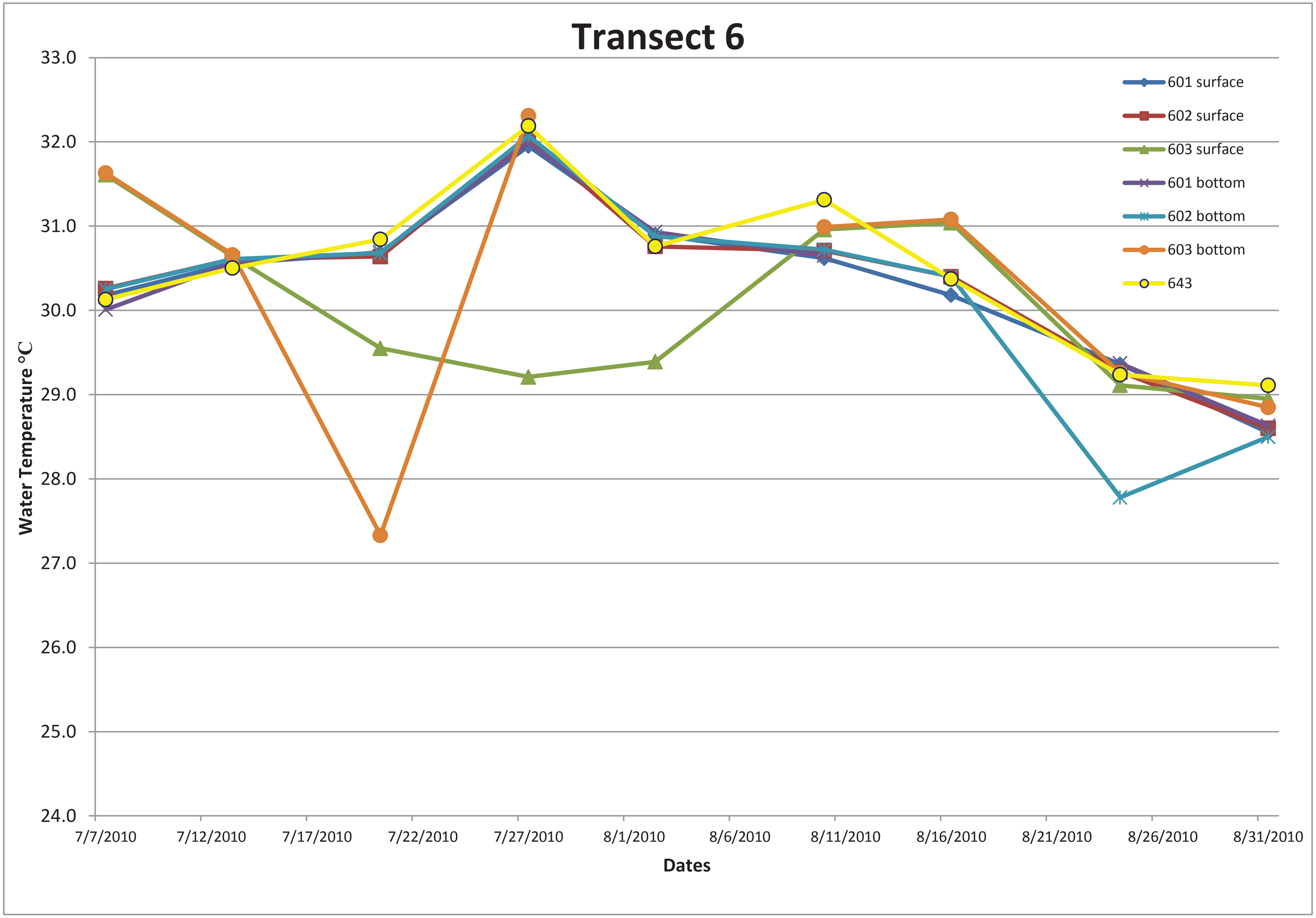


FIGURE 4-23: CONTINUED.

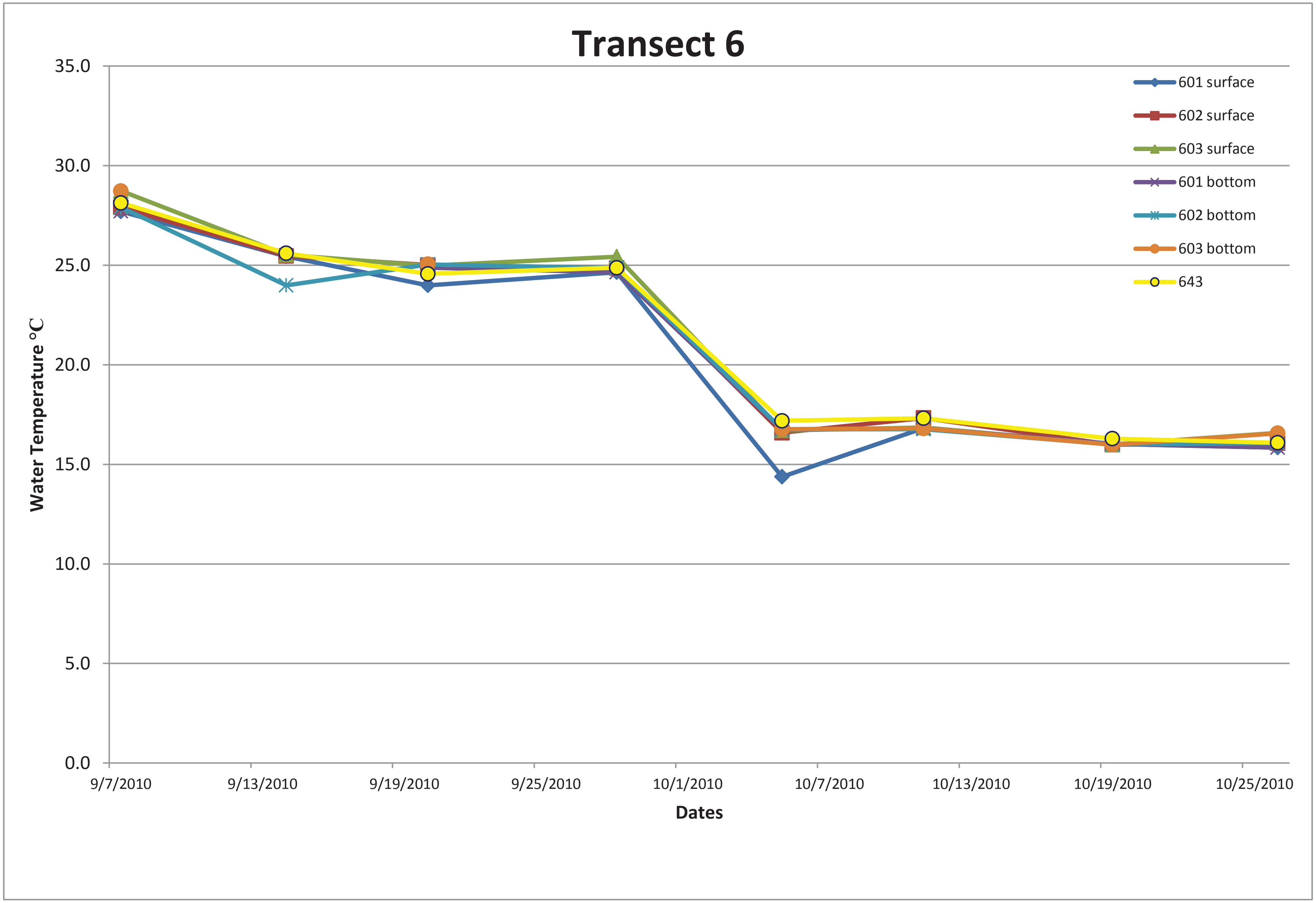


FIGURE 4-23: CONTINUED.

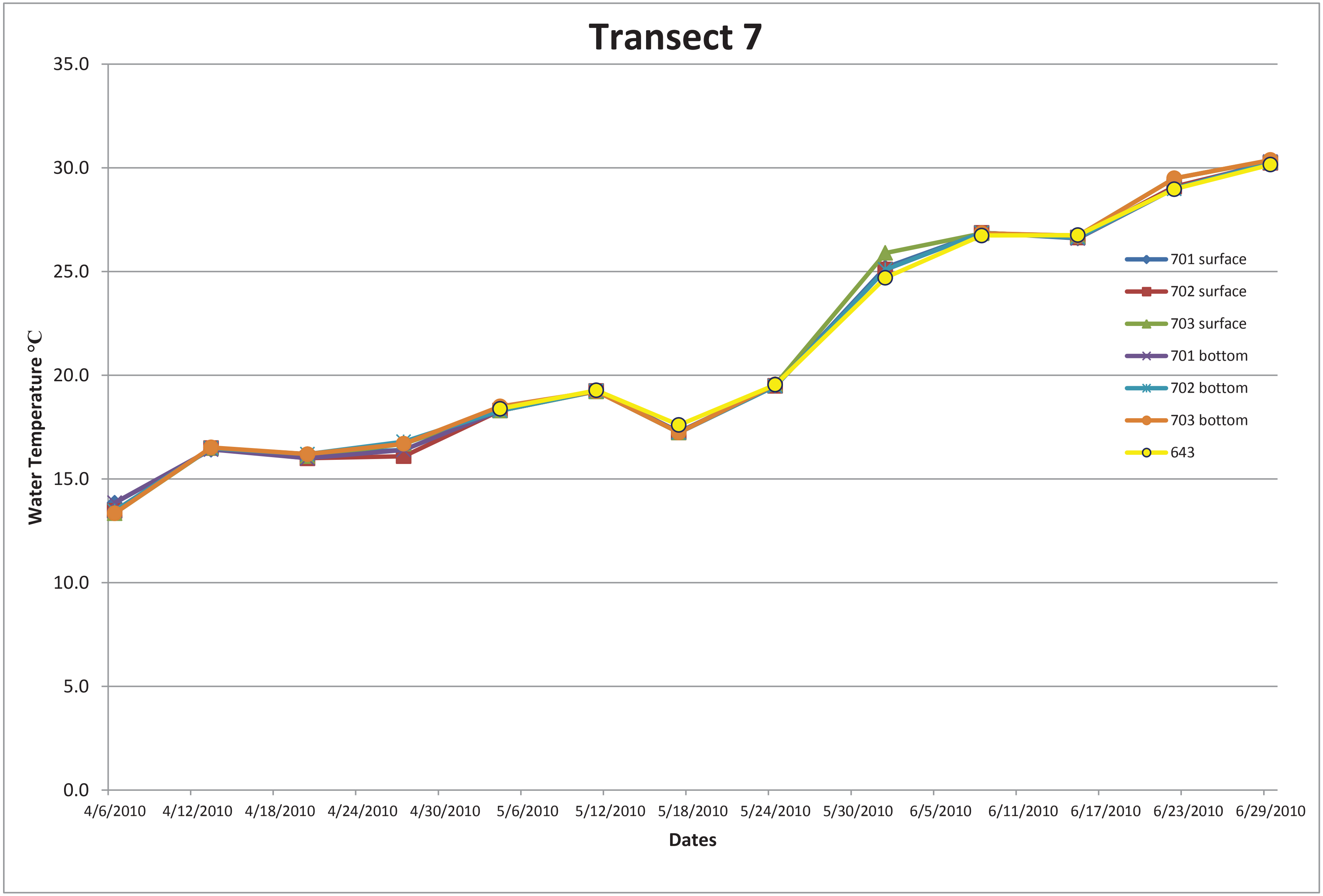


FIGURE 4-23: CONTINUED.

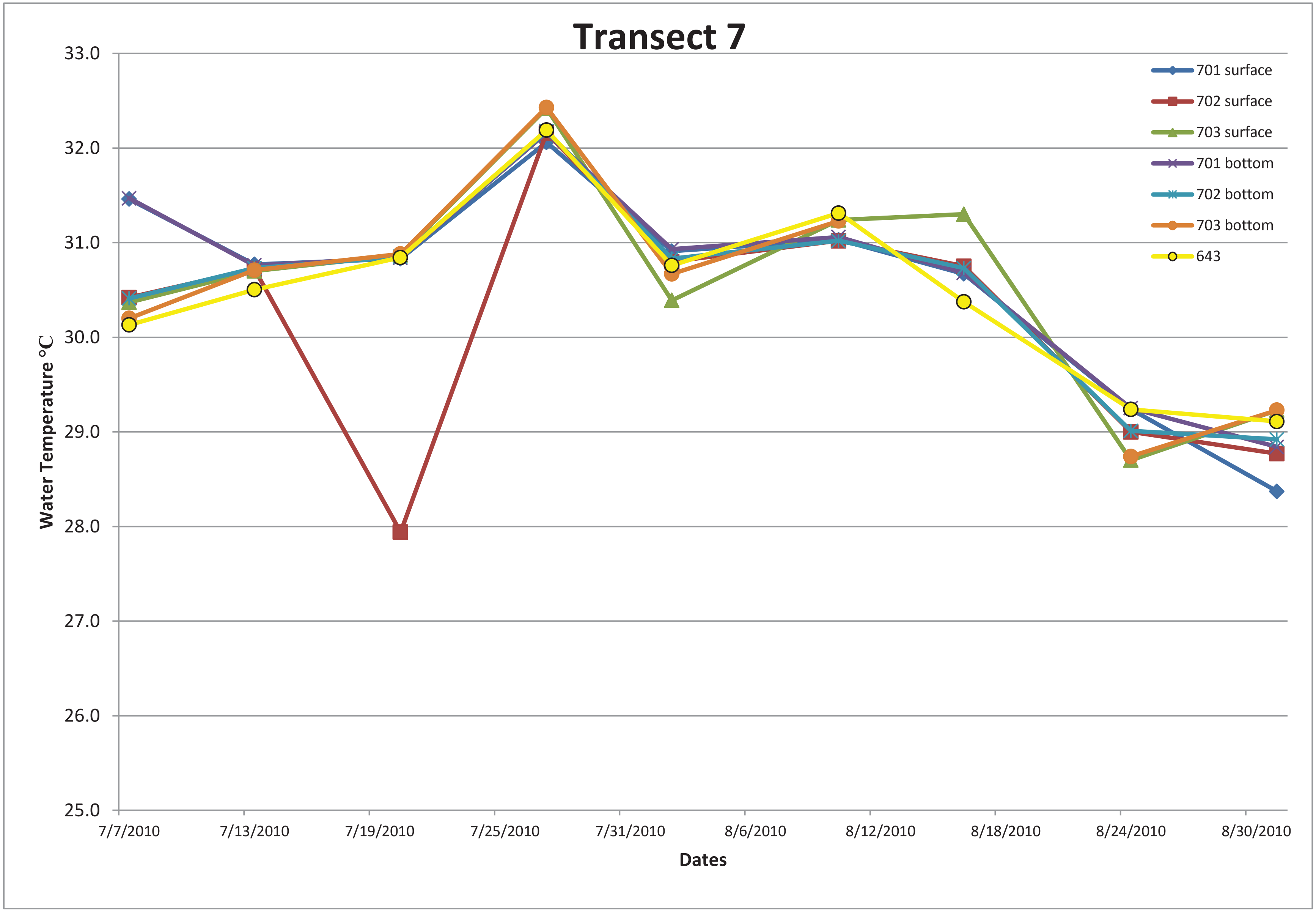


FIGURE 4-23: CONTINUED.

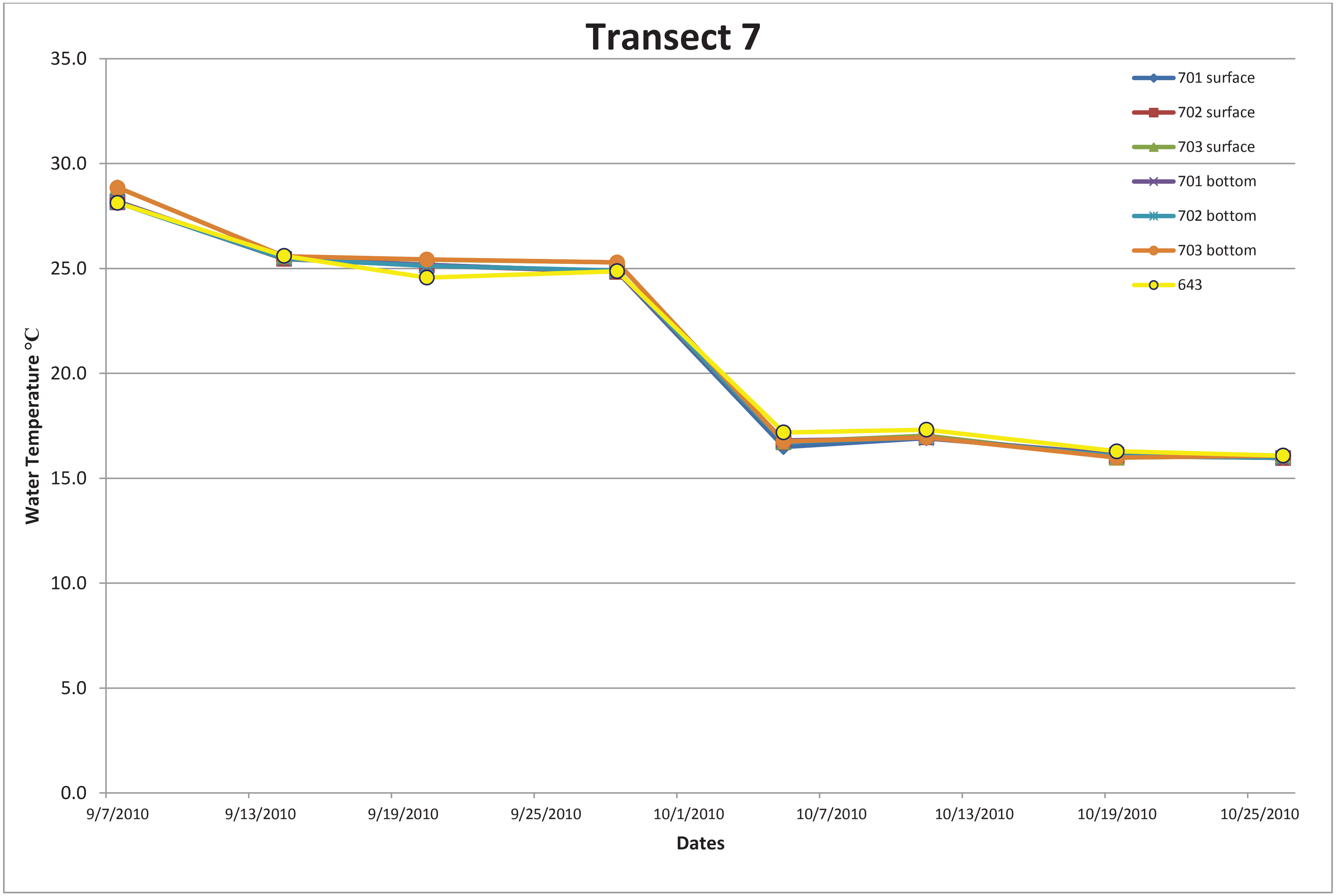


FIGURE 4-23: CONTINUED.

FIGURE 4-23: CONTINUED.

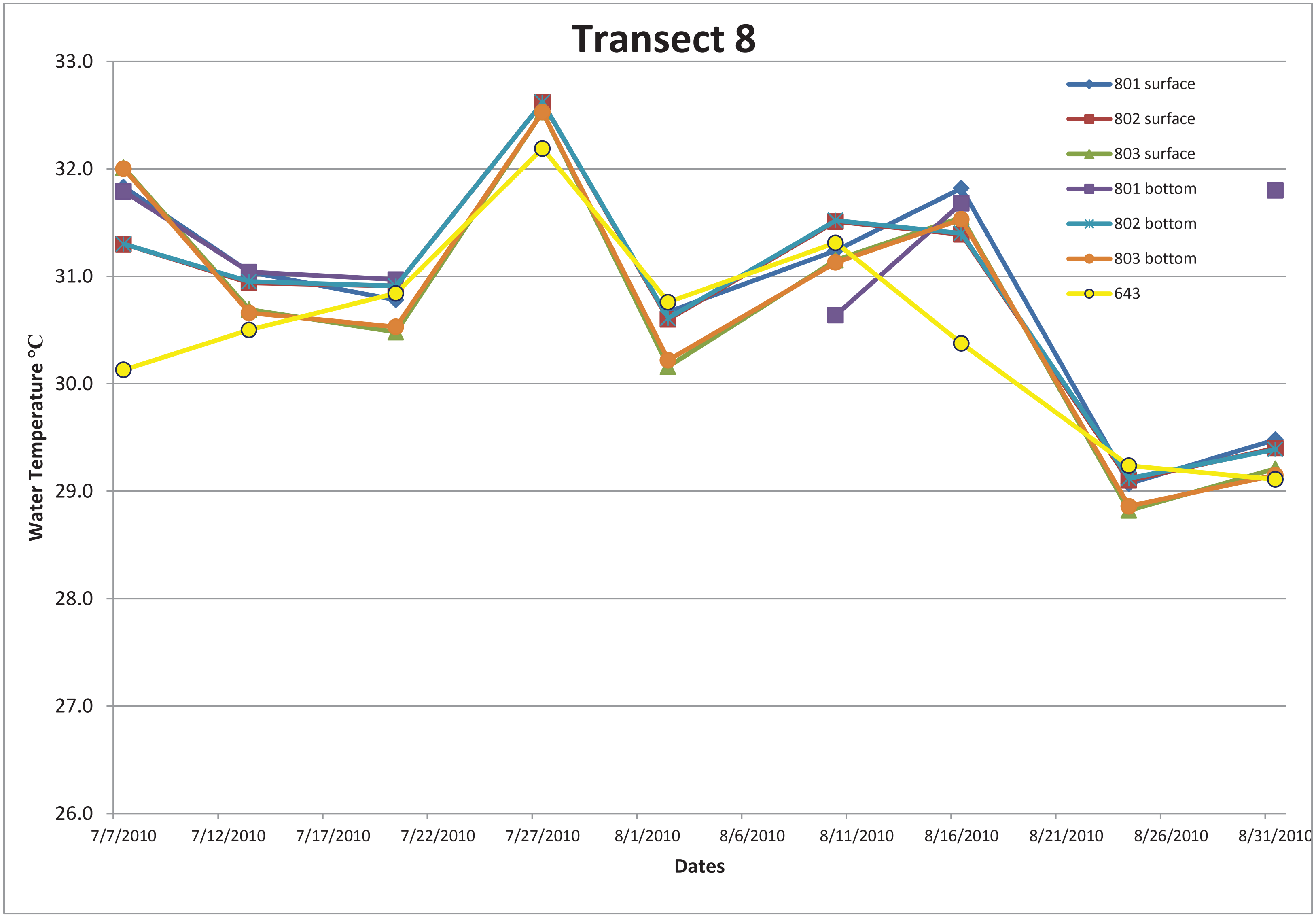


FIGURE 4-23: CONTINUED.

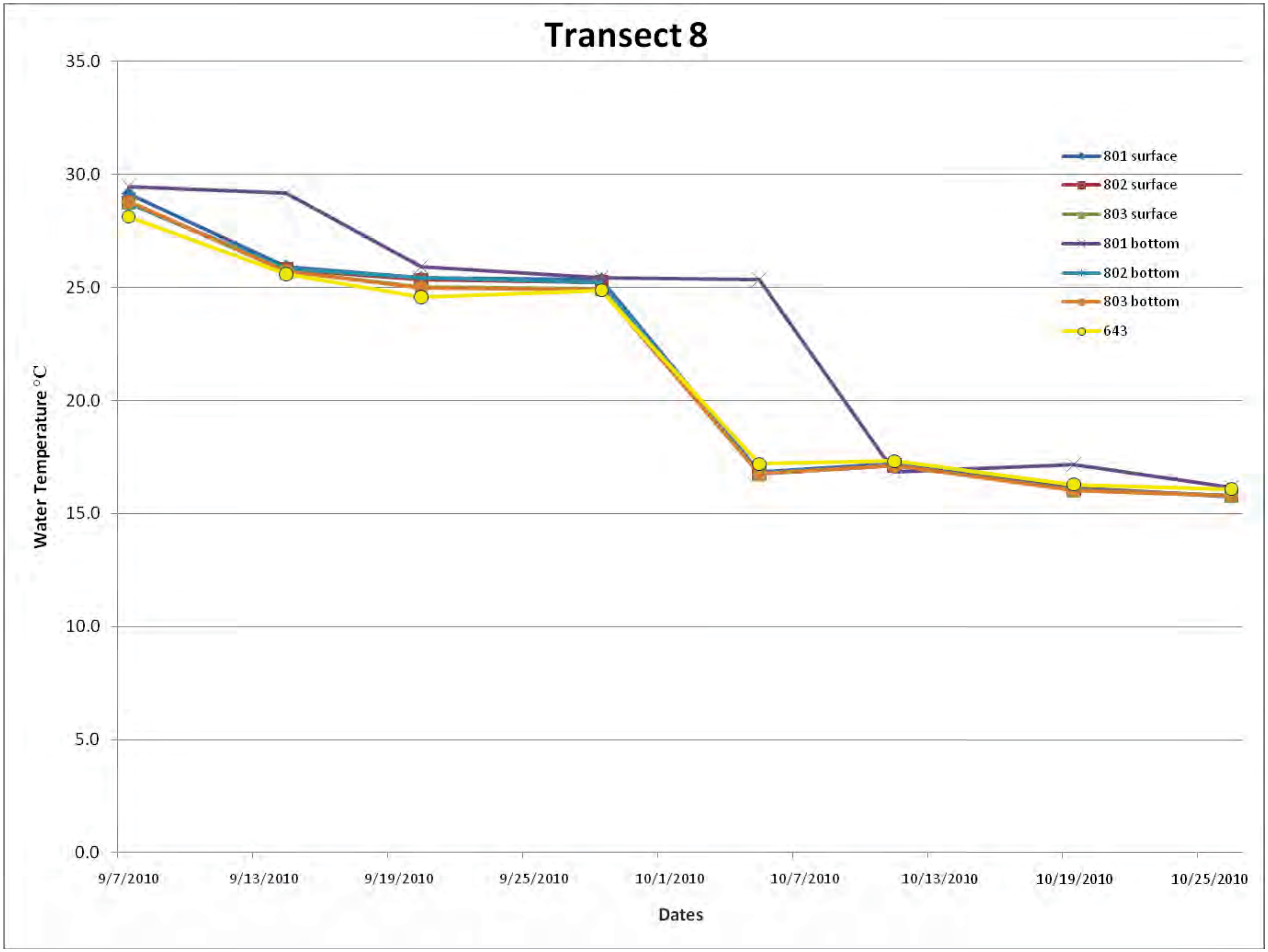


FIGURE 4-24: SURFACE AND BOTTOM DO AT TRANSECTS 6, 7, AND 8 DOWNSTREAM OF CONOWINGO DAM, APRIL-OCTOBER 2010.

FIGURE 4-24: CONTINUED.

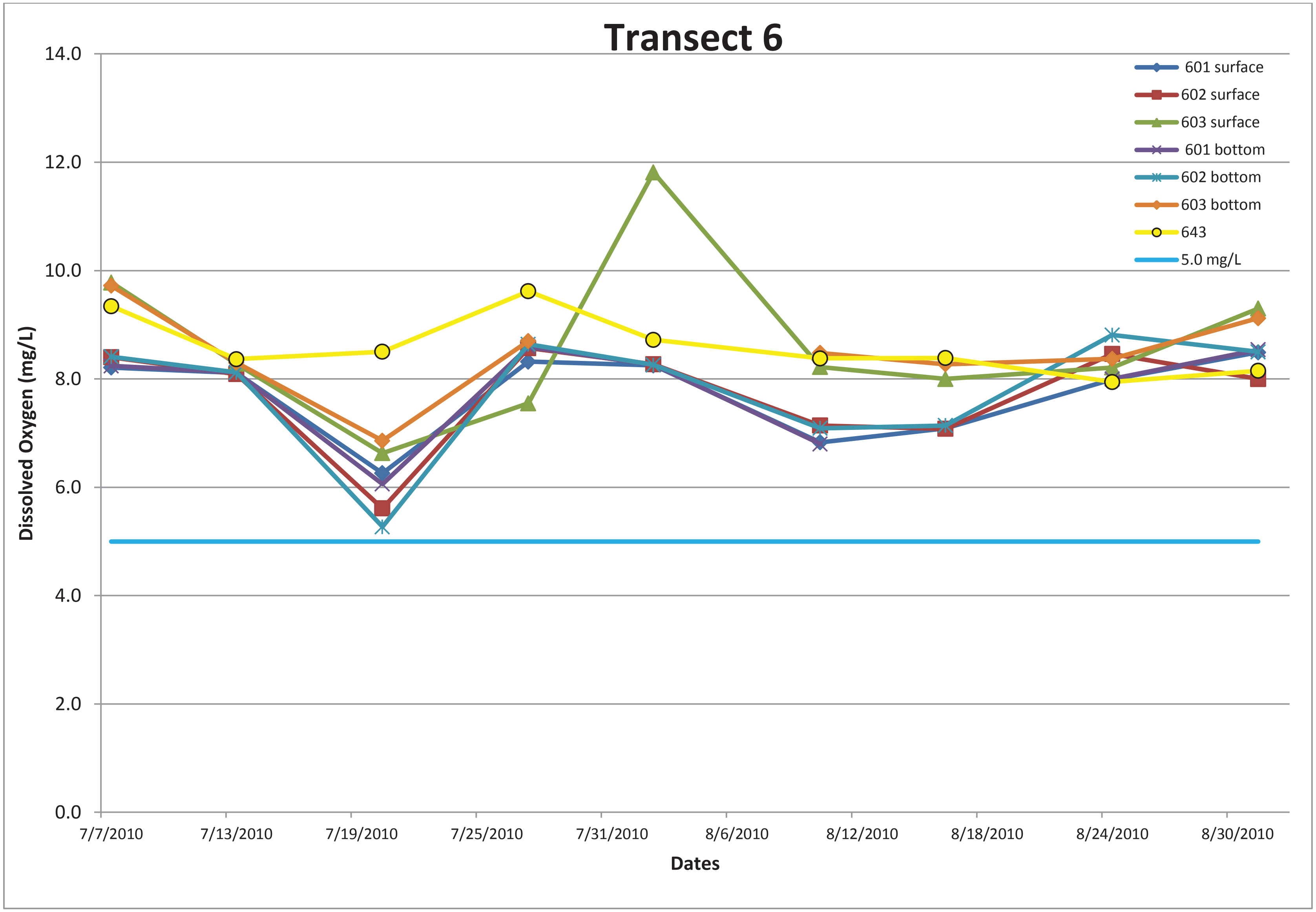


FIGURE 4-24: CONTINUED.

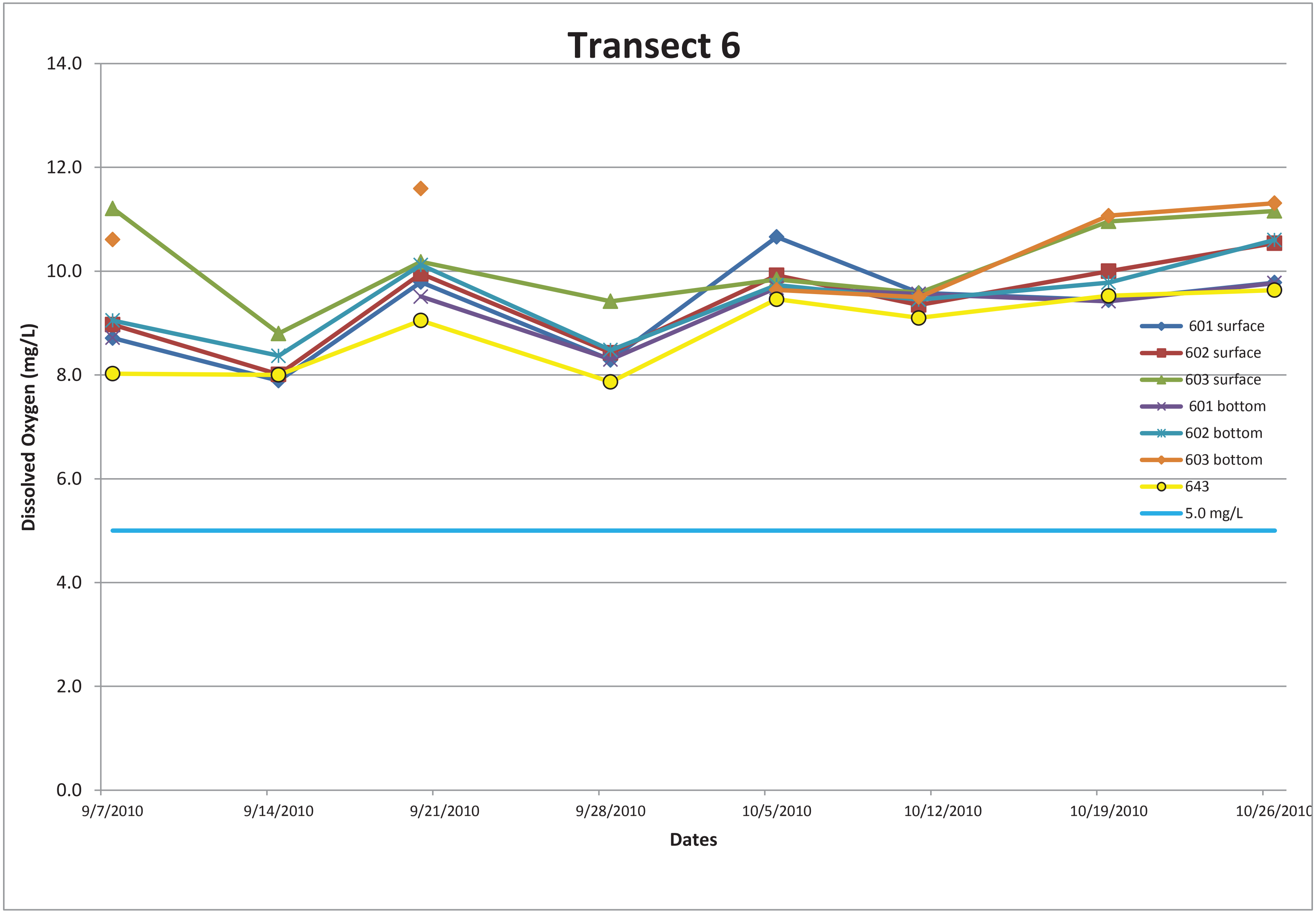


FIGURE 4-24: CONTINUED.

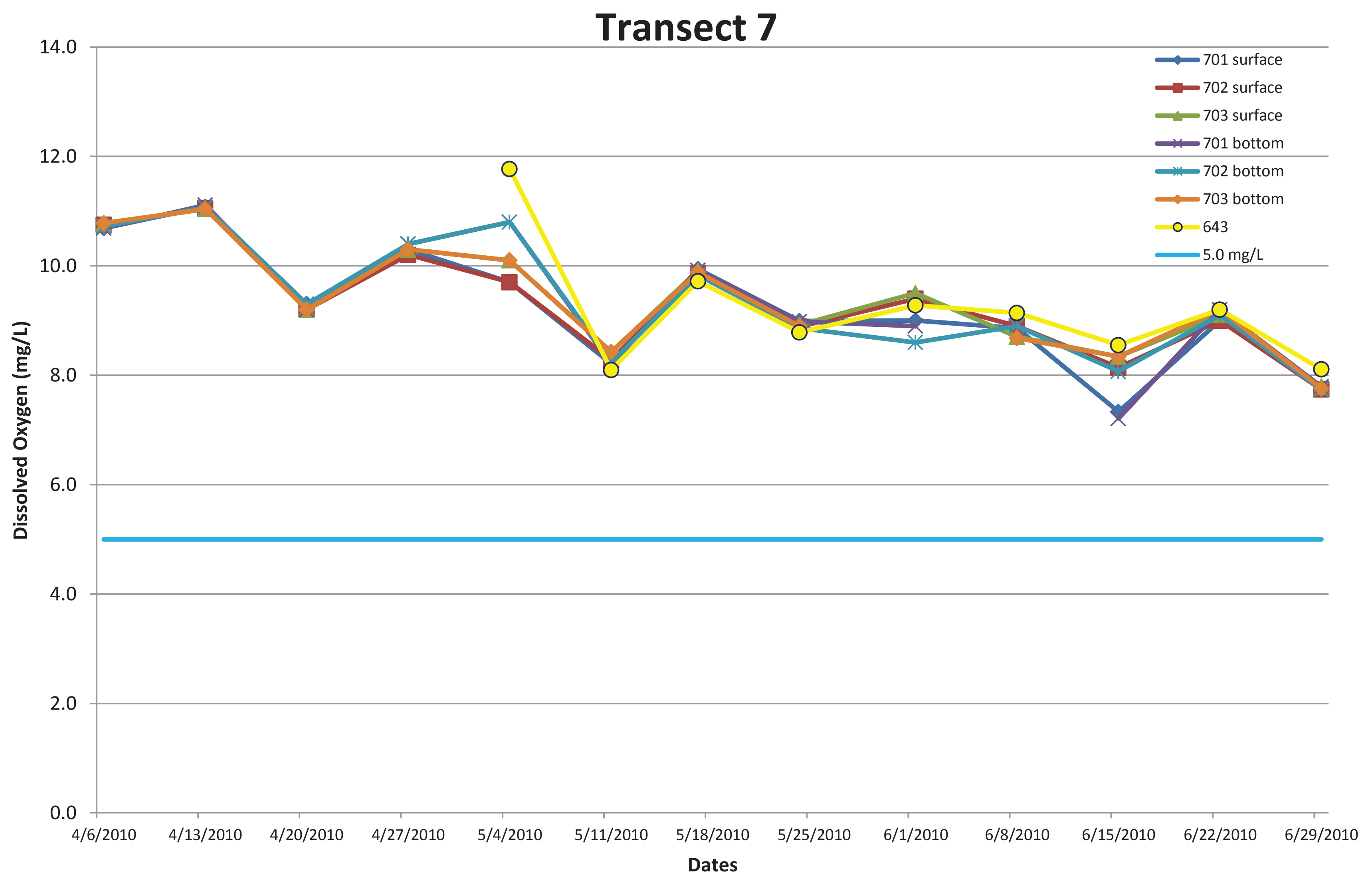


FIGURE 4-24: CONTINUED.

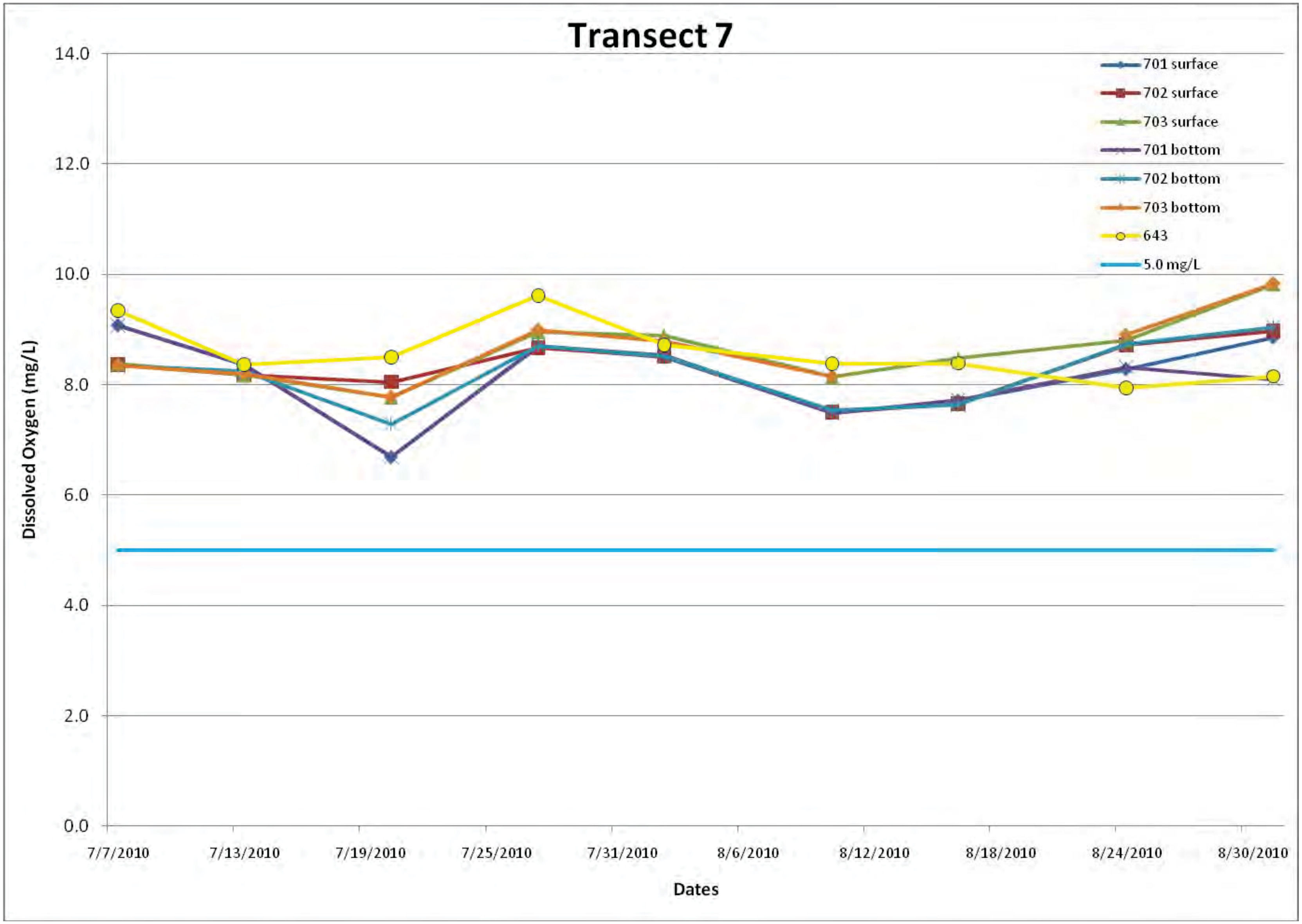


FIGURE 4-24: CONTINUED.

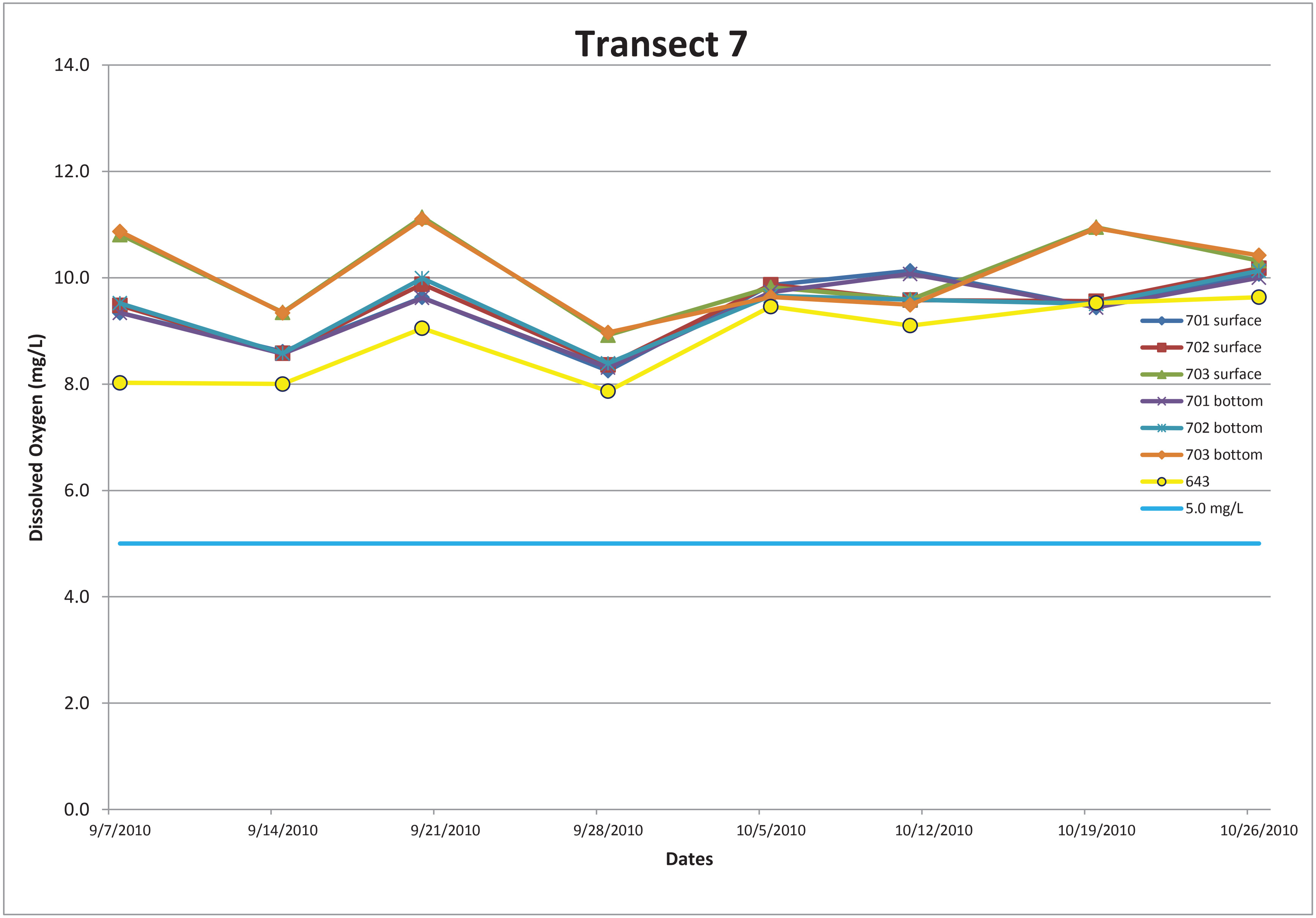


FIGURE 4-24: CONTINUED.

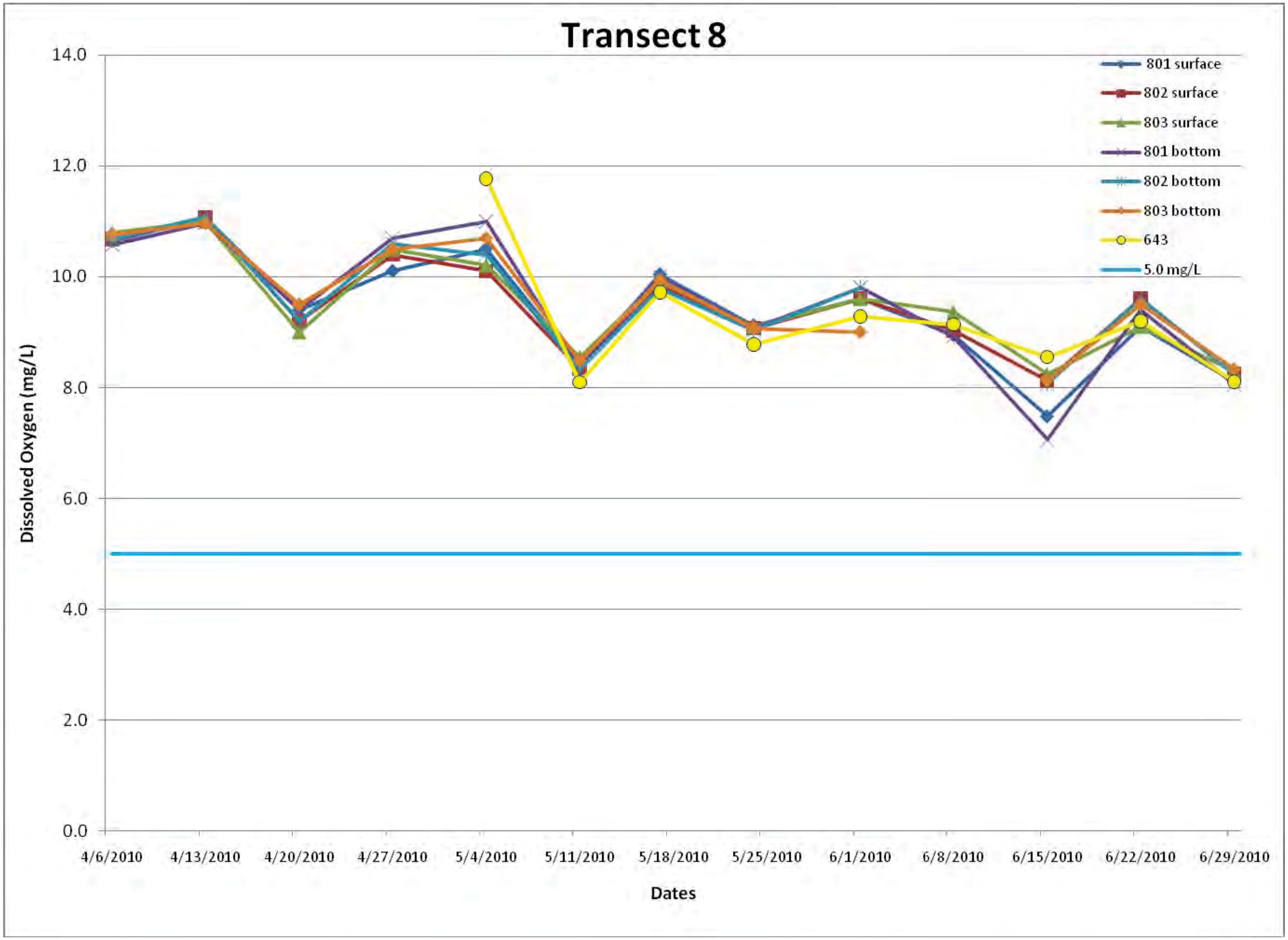


FIGURE 4-24: CONTINUED.

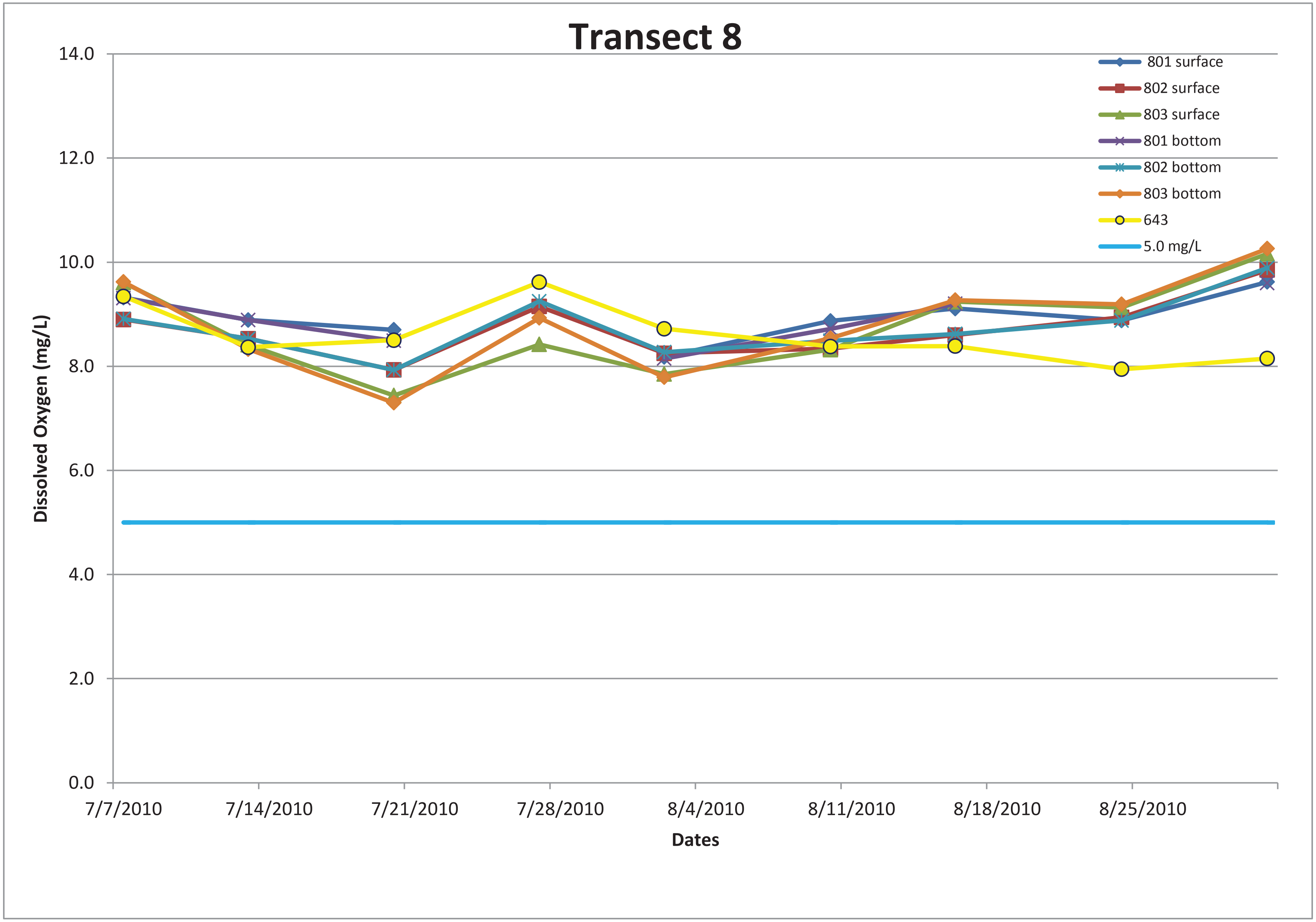


FIGURE 4-24: CONTINUED.

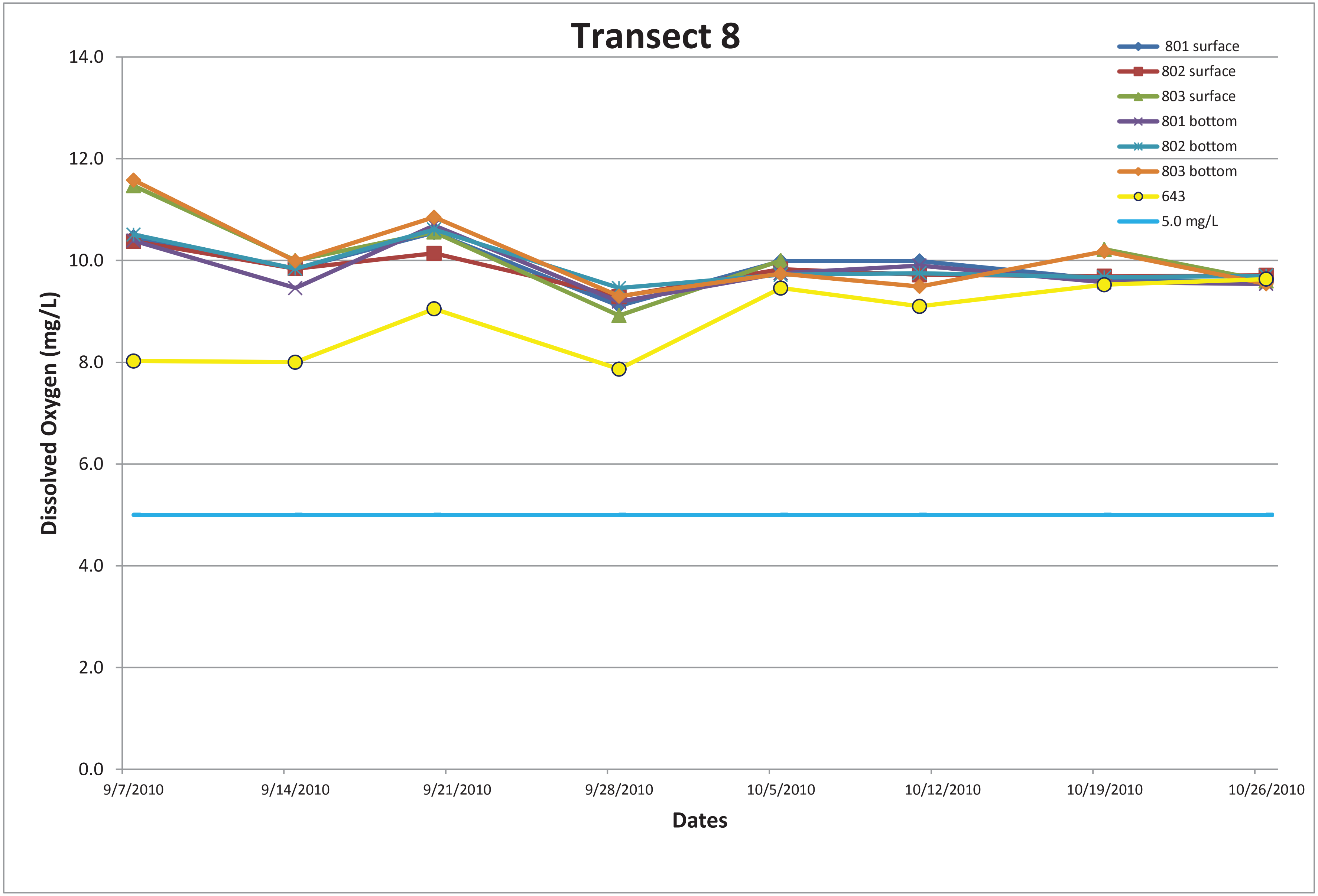
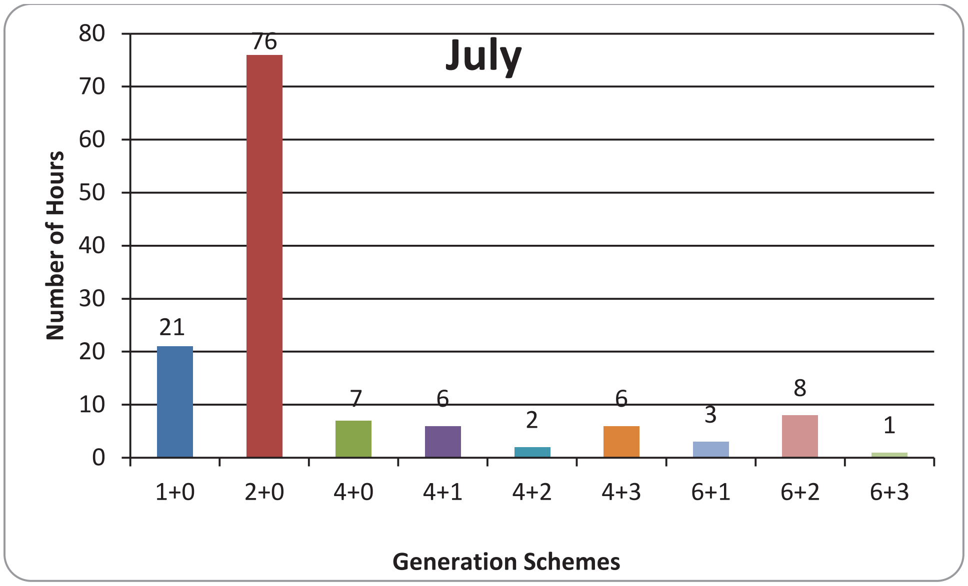
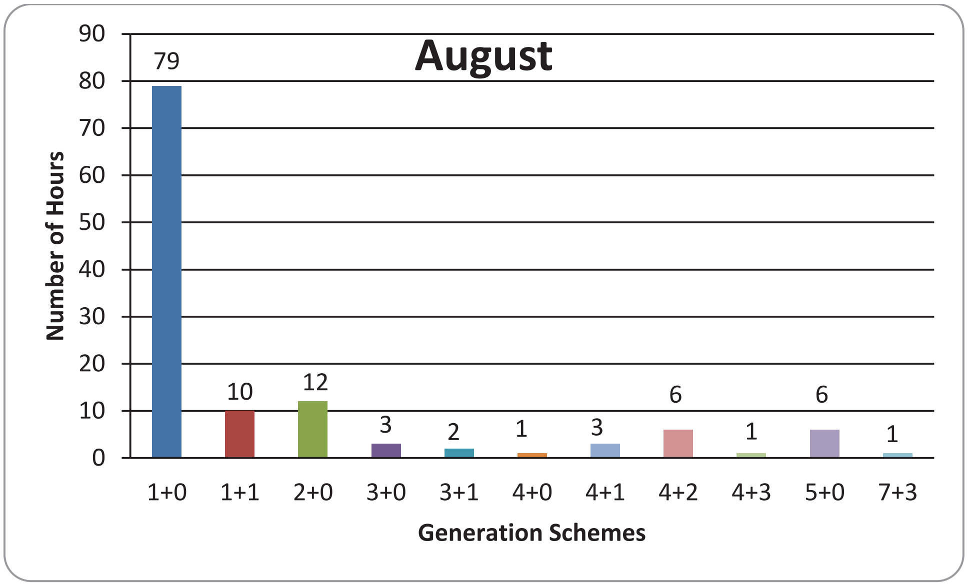


FIGURE 4-25: NUMBER OF HOURLY TURBINE BOIL SAMPLES COLLECTED DURING PERIODS OF VARIOUS COMBINATIONS OF SMALL AND LARGE TURBINES OPERATING AT CONOWINGO IN JULY-AUGUST 2010.





Note: On the x axis lables, the first number indicates the number of small units operating and the second number indicates the number of large units operating. For example the bar labeled 1+0 indicates the number of hours of turbine discharge boil sampling was conducted during the sampling season when one small unit and no large units were operating. As further examples, 1+1 indicates the number of samples taken when one small unit and one large unit were operating, and 7+3 indicates when 7 small units and 3 large units were operating.

FIGURE 4-26: PLOT OF HOURLY TEMPERATURE MEASUREMENTS (°F) OF OPERATING TURBINE DISCHARGE BOILS ON THE FERC SELECTED DATES AT CONOWINGO DAM, JULY-AUGUST 2010.

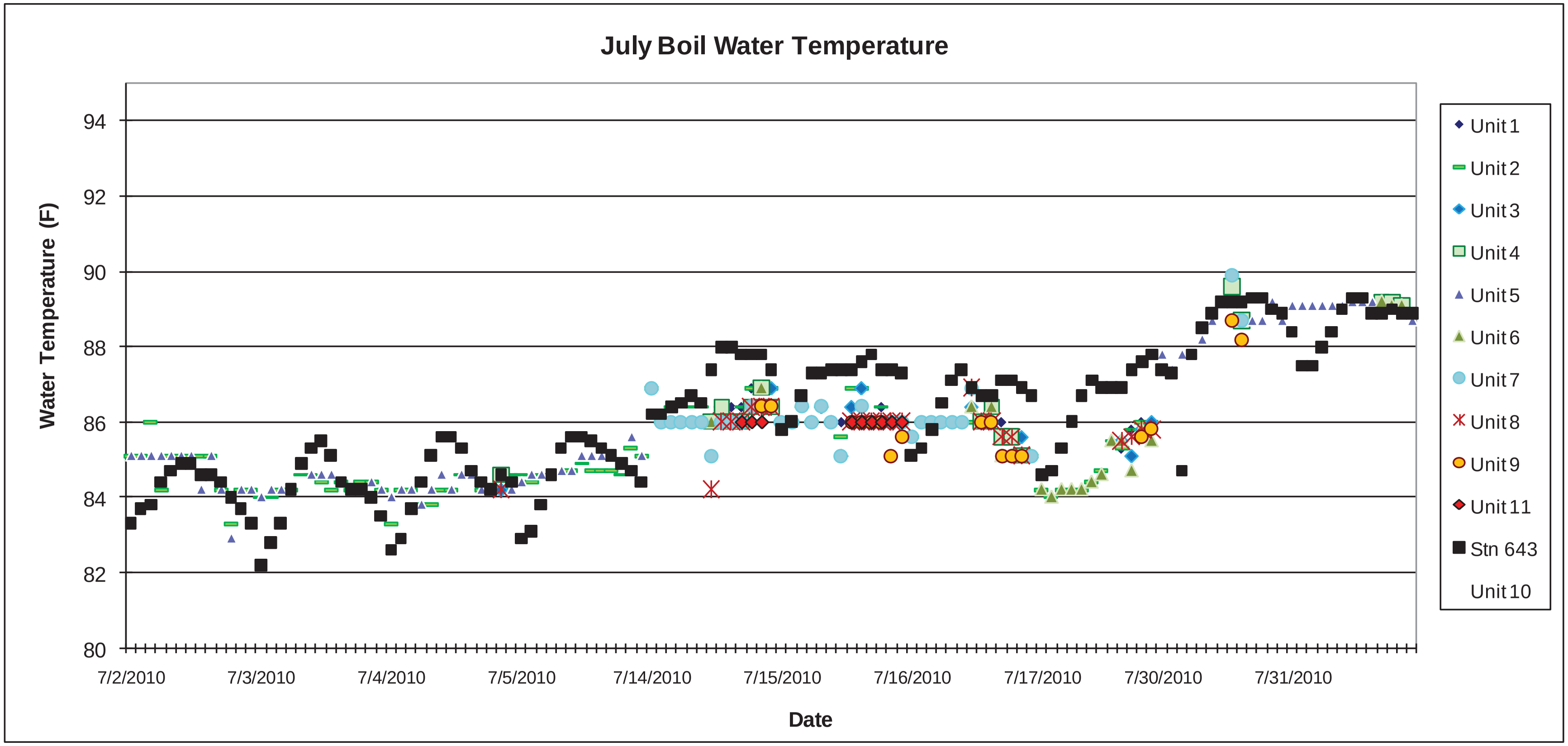


FIGURE 4-26: CONTINUED.

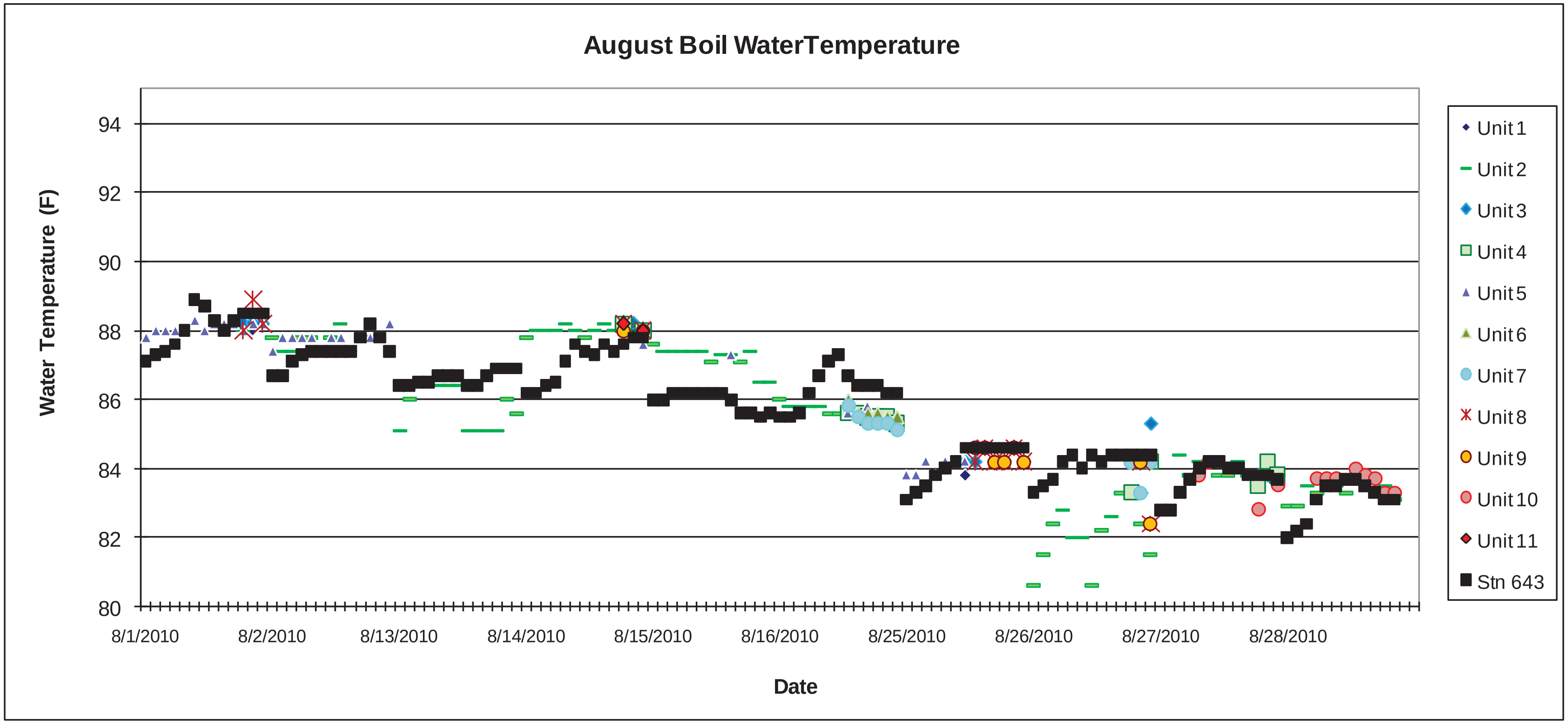


FIGURE 4-27: PLOT OF HOURLY DO MEASUREMENTS (MG/L) OF OPERATING TURBINE DISCHARGE BOILS ON THE FERC SELECTED DATES AT CONOWINGO DAM, JULY-AUGUST 2010.

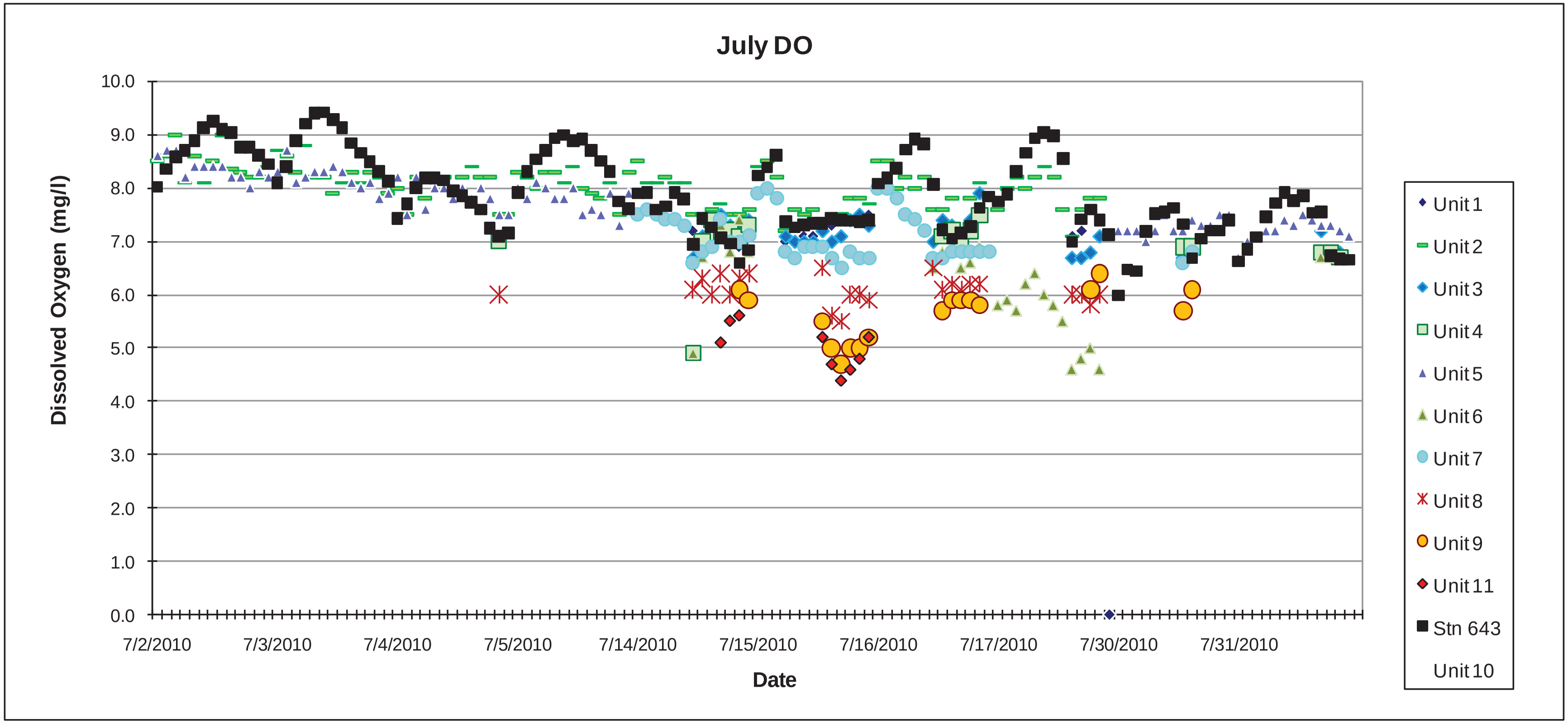


FIGURE 4-27: CONTINUED.

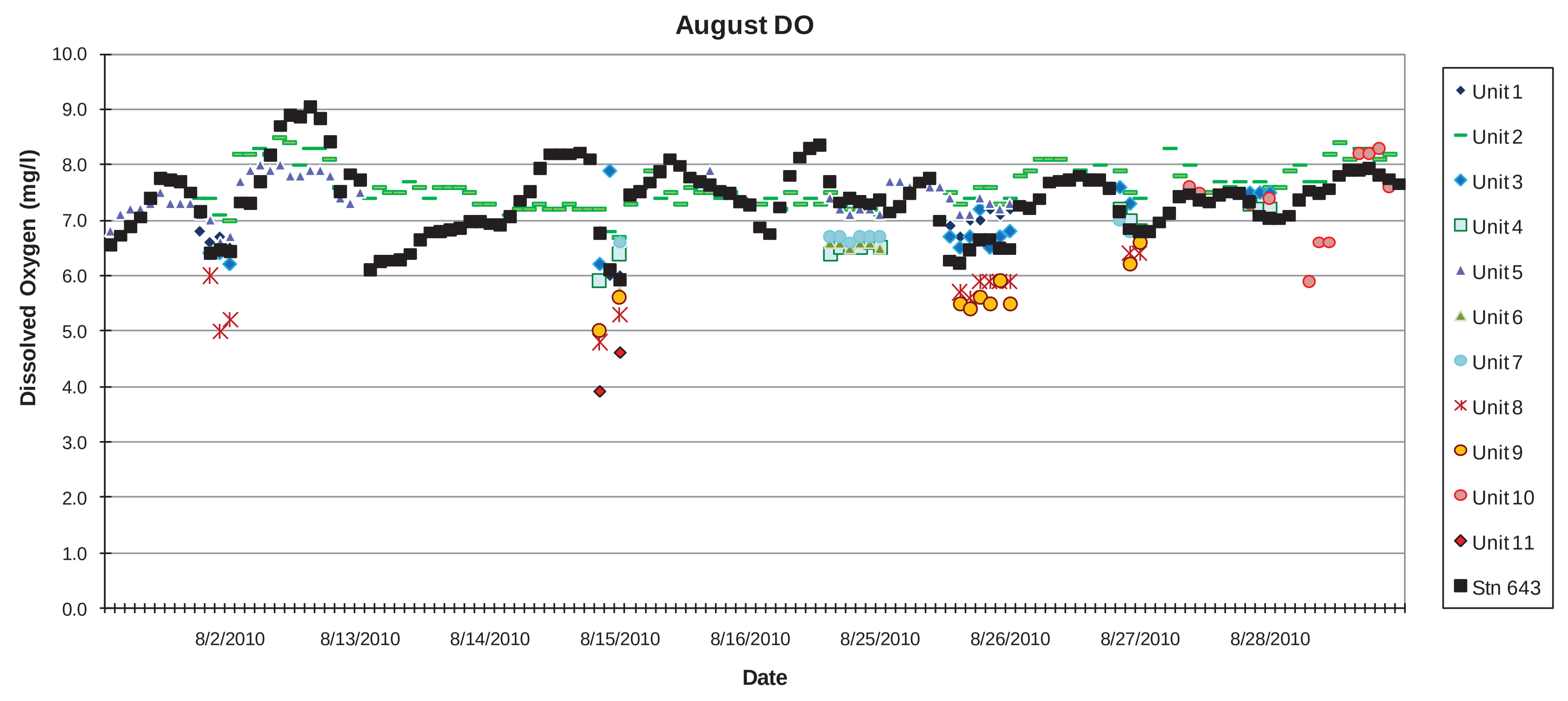


FIGURE 4-28: HOURLY TEMPERATURE MEASUREMENTS AT STATION 643 DOWNSTREAM OF CONOWINGO DAM, MAY-OCTOBER 2010.

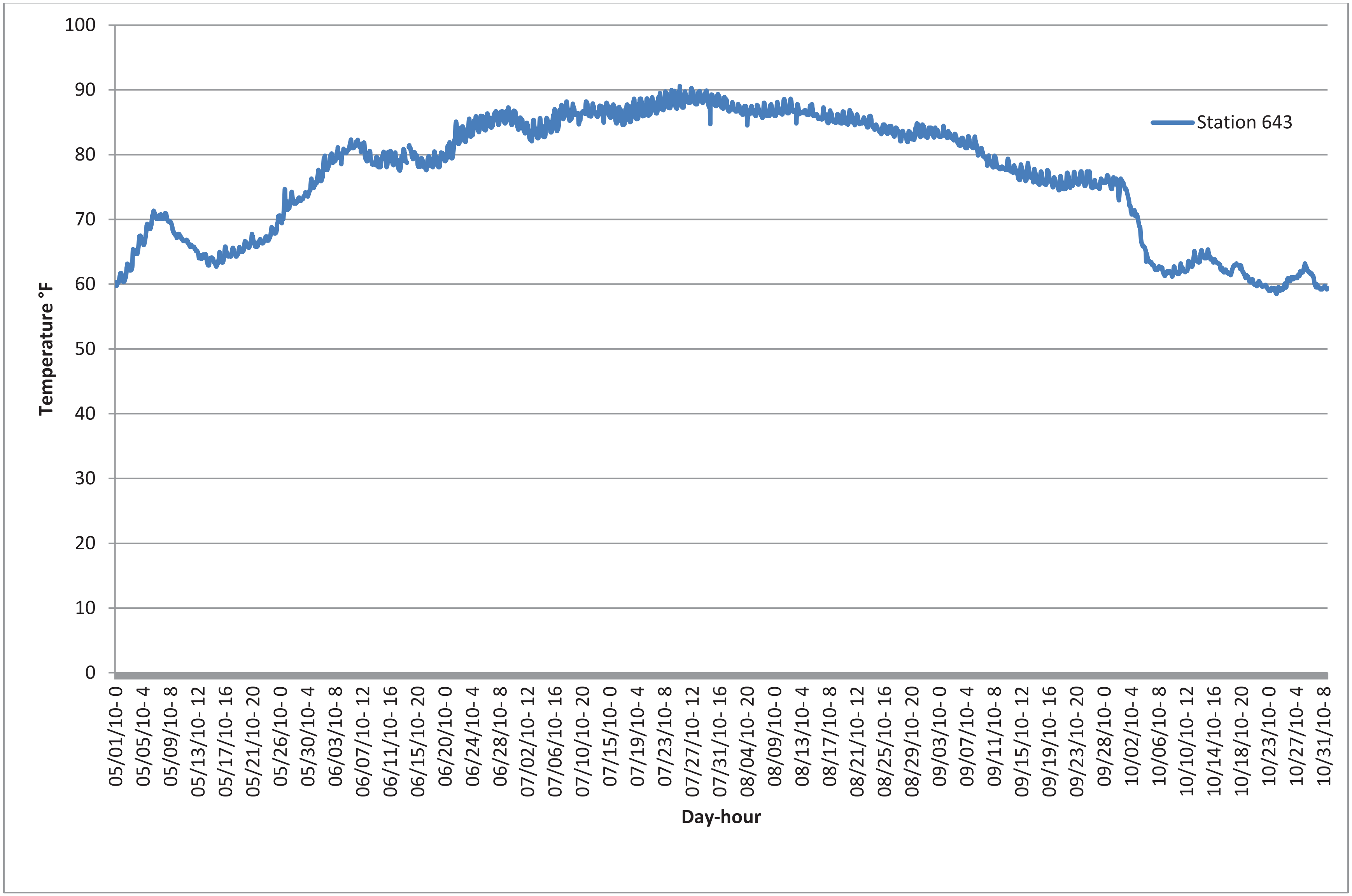
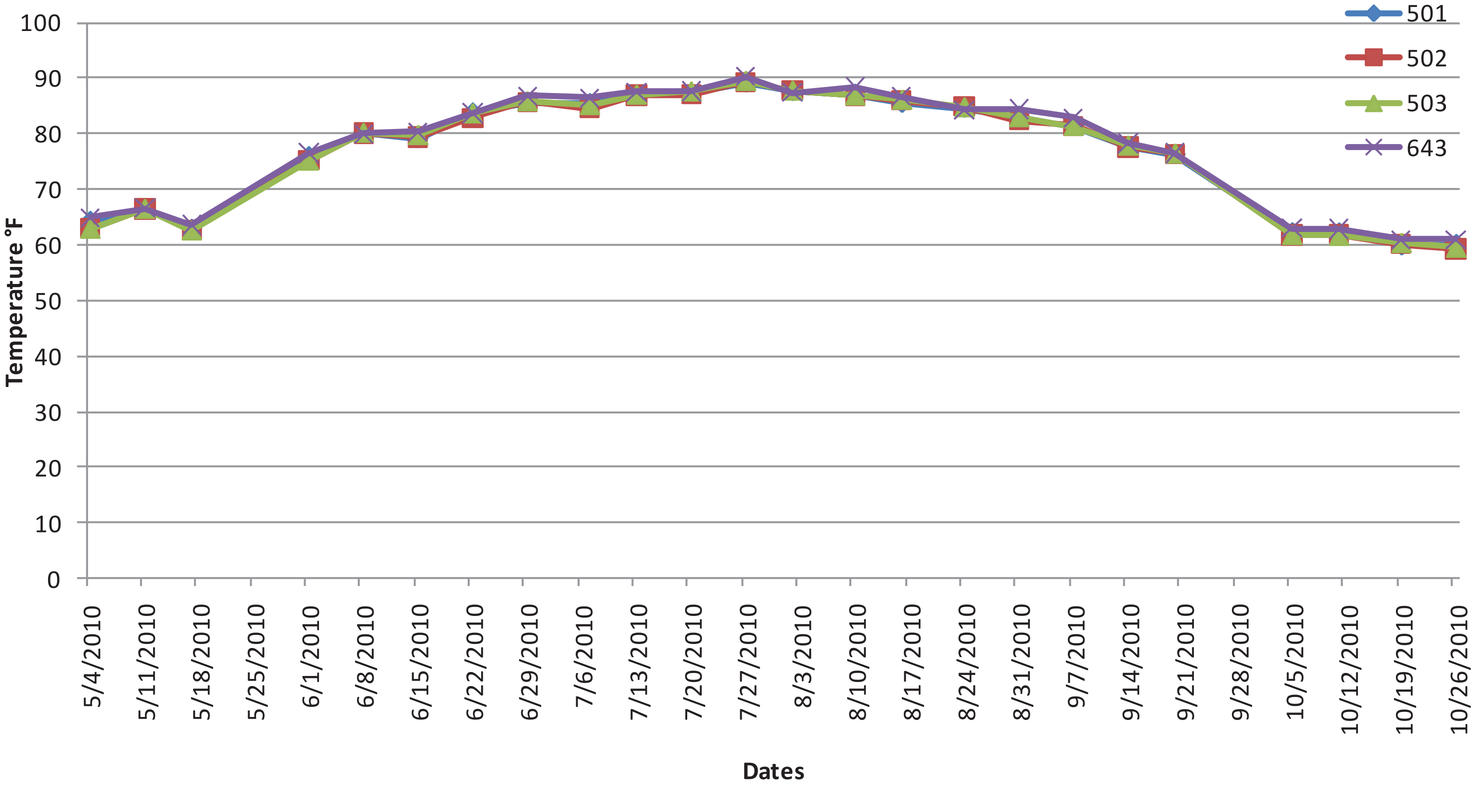


FIGURE 4-29: CONOWINGO POND TRANSECTS 5 AND LOWER RIVER STATION 643 WATER TEMPERATURE.



Temperature measurements occurred within the same hour among all stations

.

FIGURE 4-30: EXAMPLES OF DIURNAL VARIATIONS IN HOURLY WATER TEMPERATURE AT STATION 643 DOWNSTREAM OF CONOWINGO DAM ON JULY 14-16 AND AUGUST 14-16.

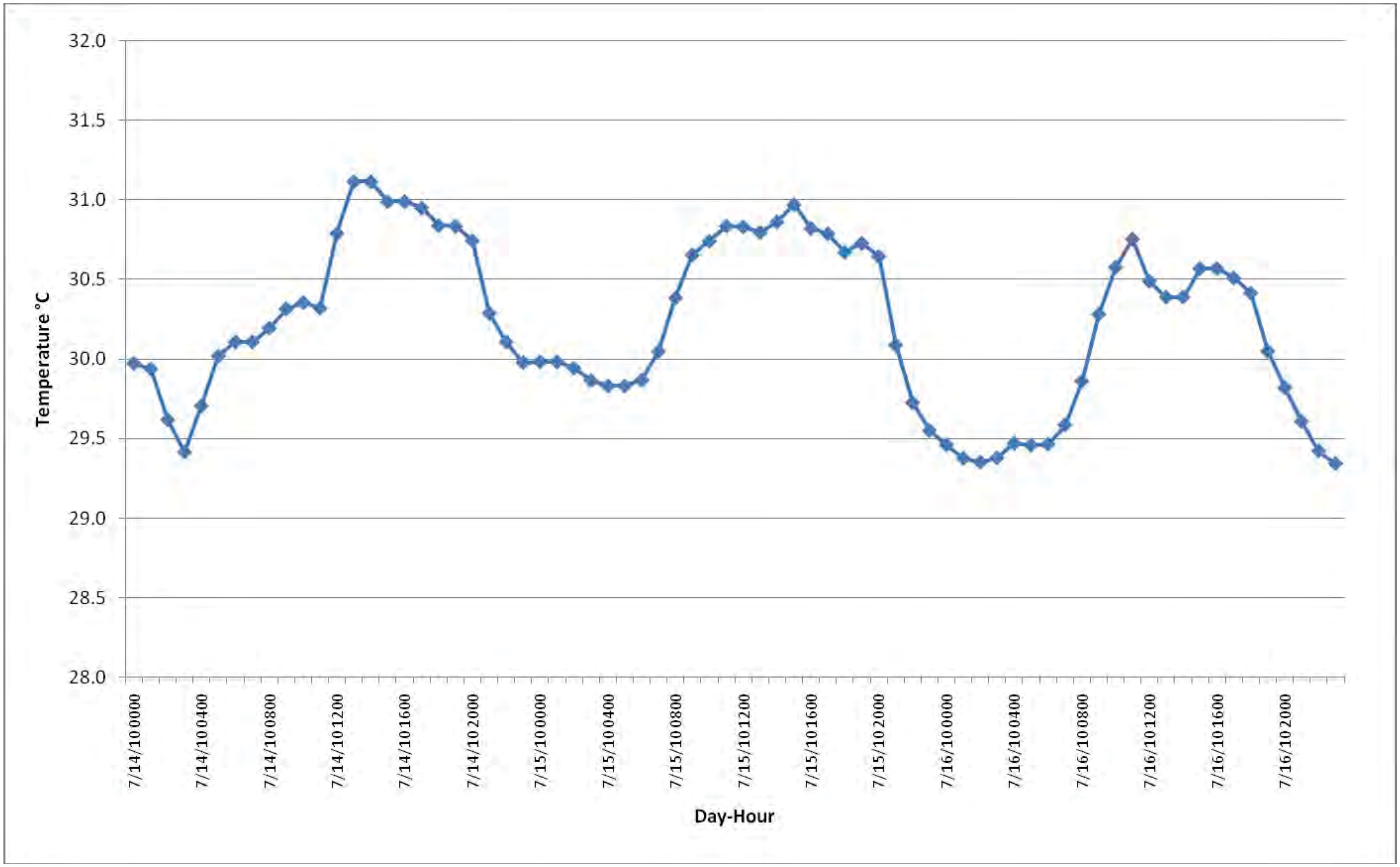


FIGURE 4-30: CONTINUED.

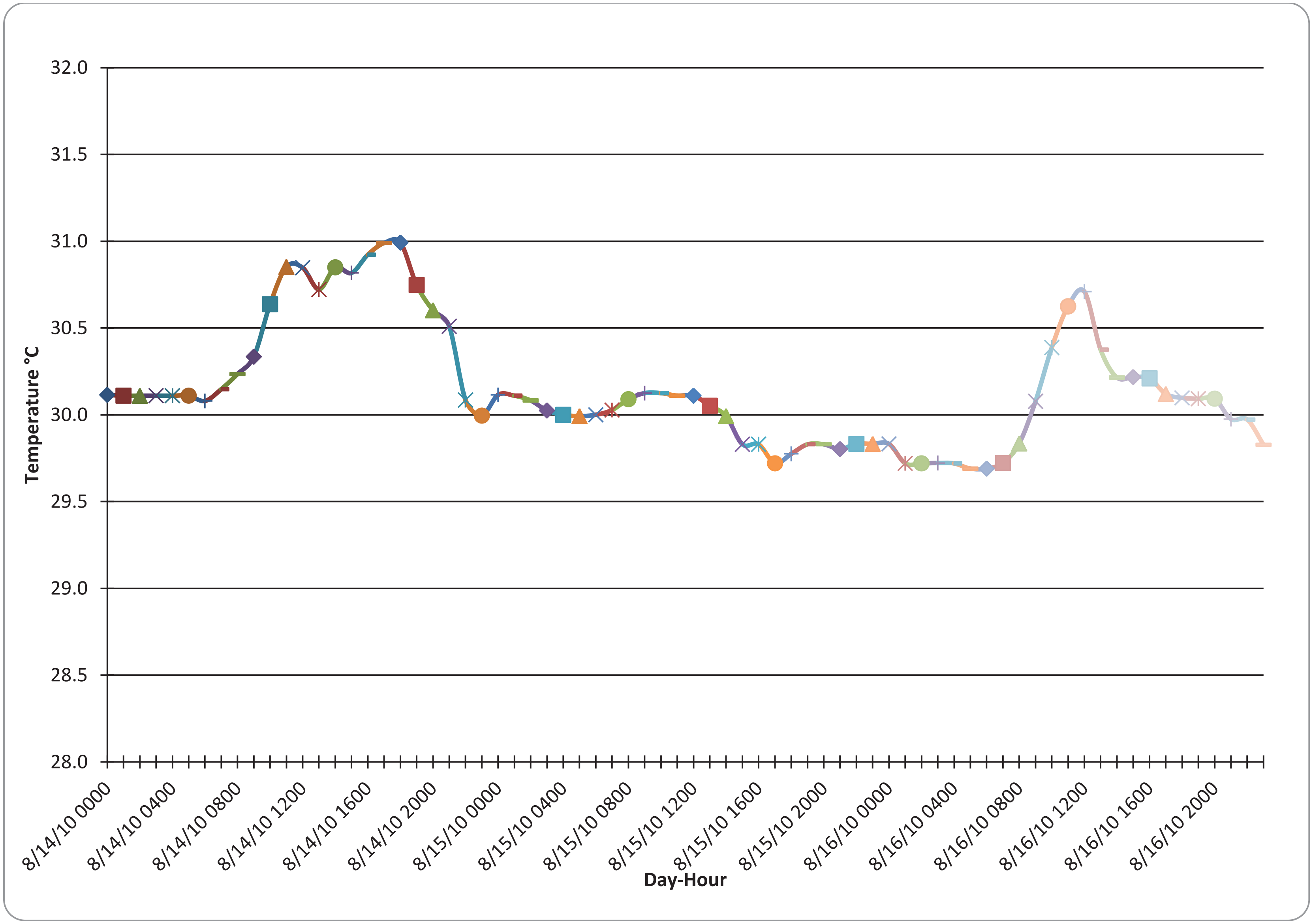


FIGURE 4-31: HOURLY DO MEASUREMENTS AT STATION 643 DOWNSTREAM OF CONOWINGO DAM, MAY 1-OCTOBER 31, 2010.

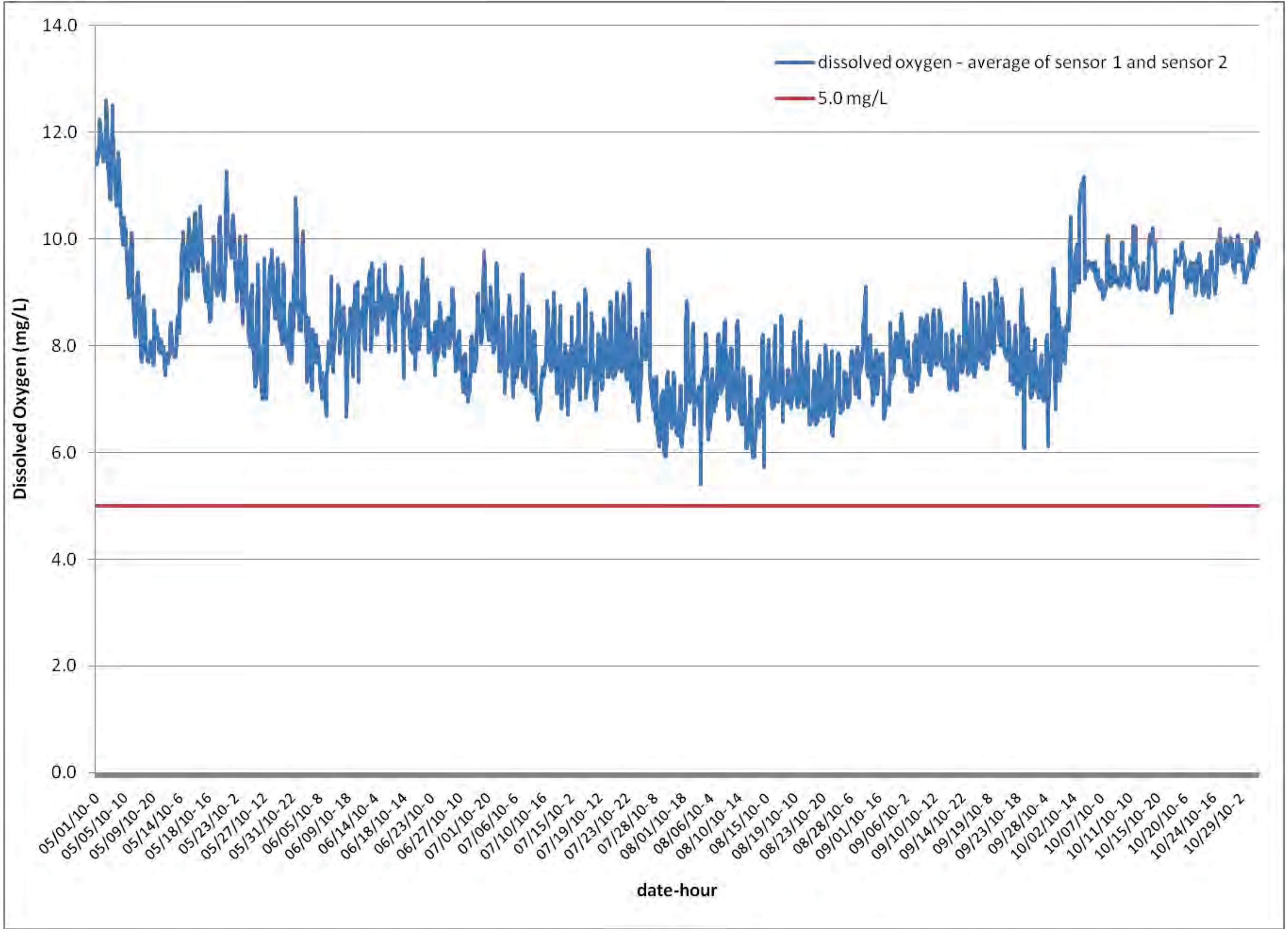


FIGURE 4-32: EXAMPLES OF DIURNAL VARIATIONS IN DO AT STATION 643 ON SELECTED DATES IN JULY AND AUGUST 2010.

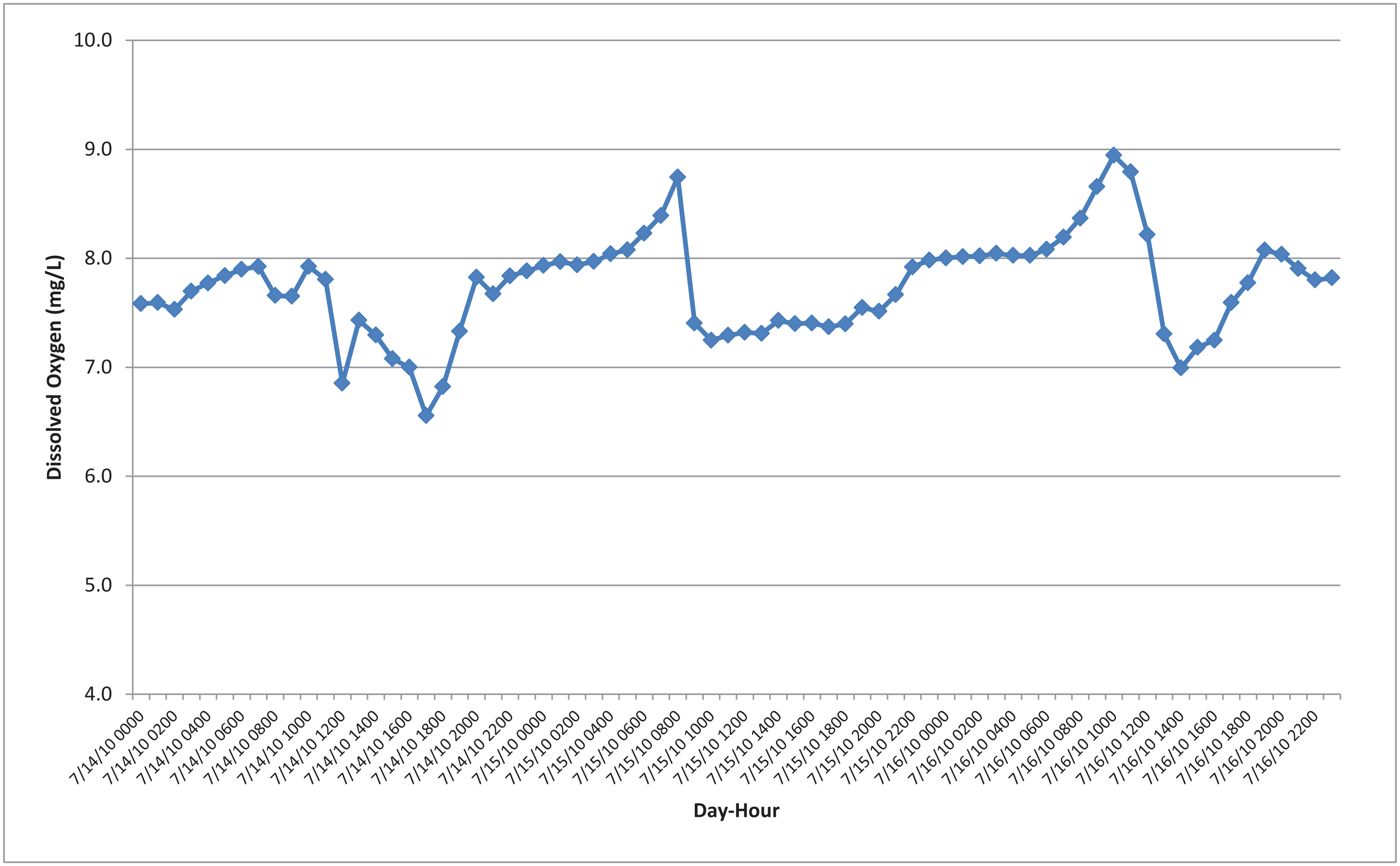


FIGURE 4-32: CONTINUED.

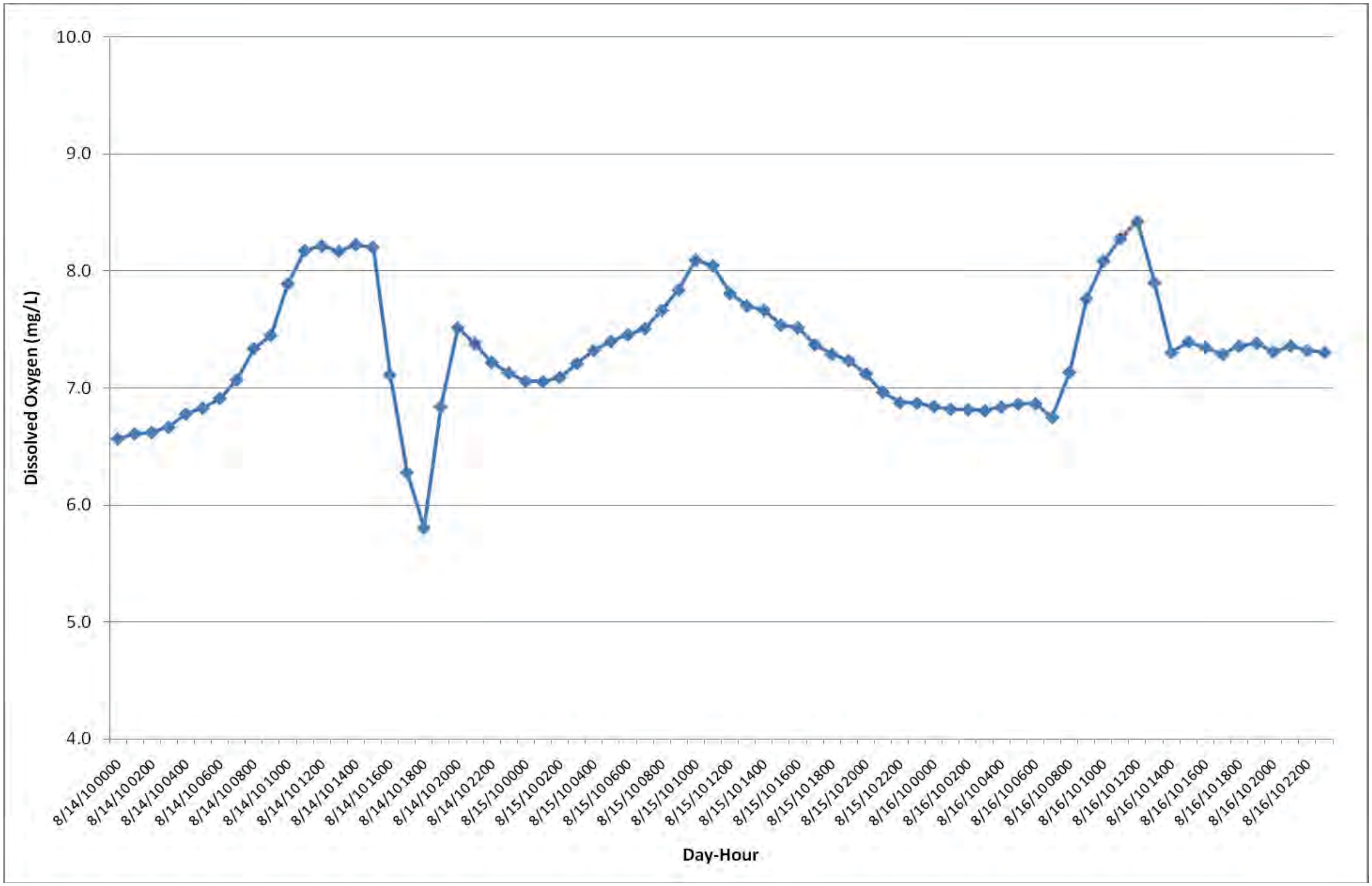


FIGURE 4-33: FREQUENCY DISTRIBUTION OF DIFFERENCES IN AVERAGE HOURLY DO VALUES OF OPERATING TURBINES ON FERC SELECTED SATES AT CONOWINGO DAM AND AVERAGE DO RECORDED 1 HOUR LATER AT STATION 643 DOWNSTREAM OF CONOWINGO DAM, JULY-AUGUST 2010.

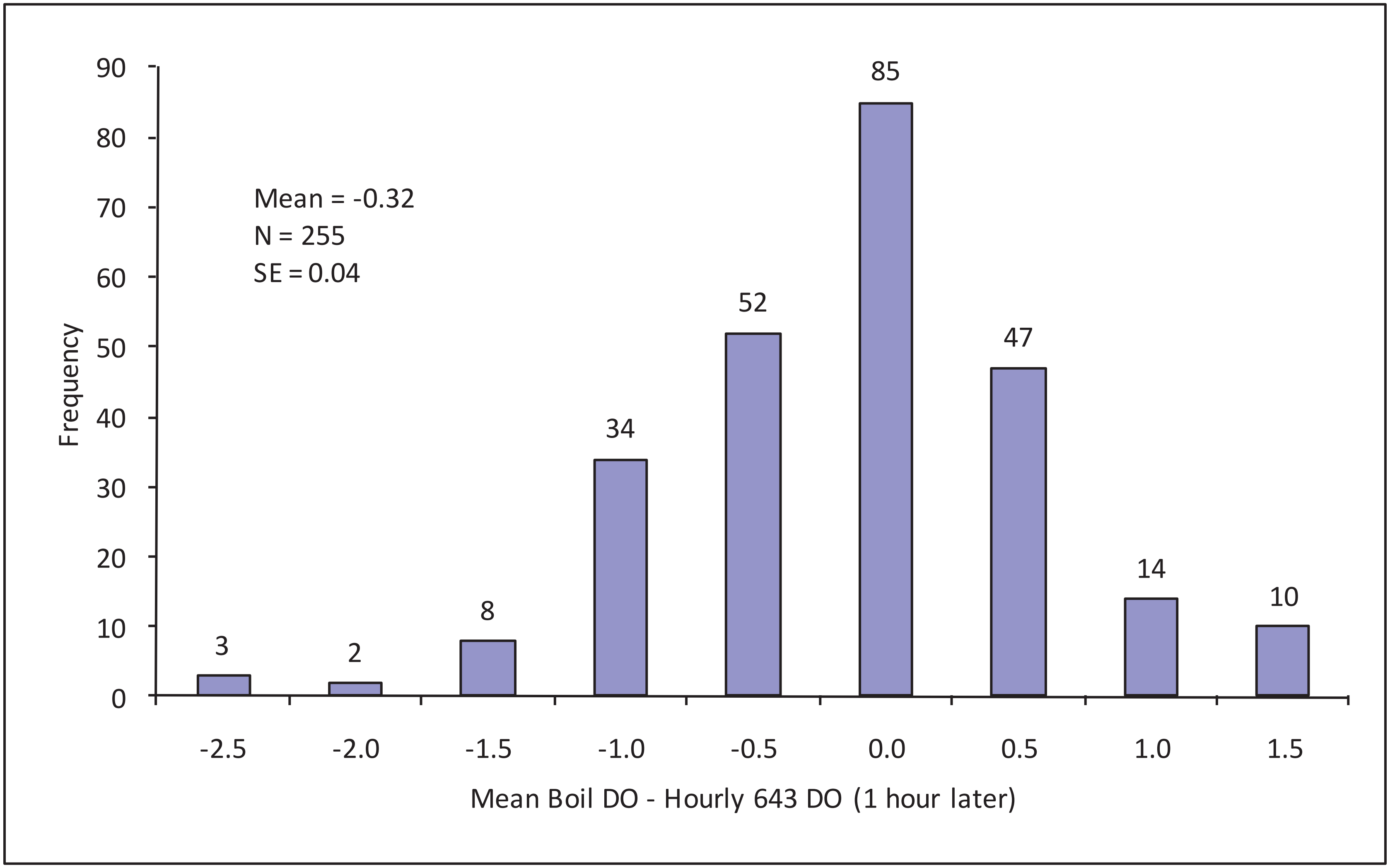
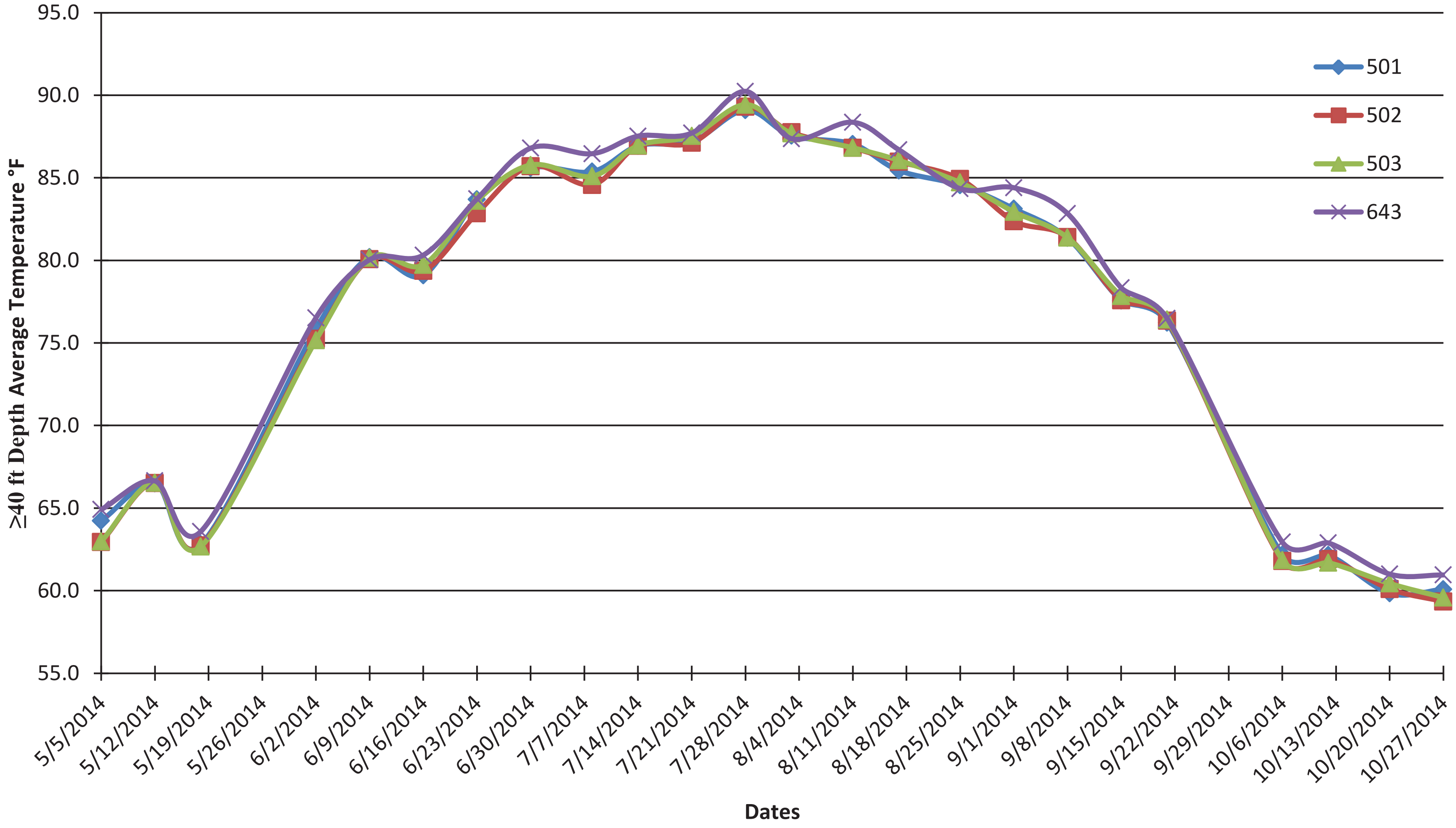


FIGURE 4-34 COMPARISON OF SEASONAL WATER TEMPERATURES (≥40 FT DEPTH) ON TRANSECT 5 IN CONOWINGO POND AT STATIONS 501, 502, AND 503 WITH TEMPERATURES RECORDED AT STATION 643 DOWNSTREAM OF CONOWINGO DAM ON SAME DATES, MAY-OCTOBER 2010.



Temperature measurements occurred within the same hour among all stations

FIGURE 4-35: RELATIONSHIP OF WATER TEMPERATURE AT TRANSECT 5 AND INDIVIDUAL STATIONS ON TRANSECT 5 IN CONOWINGO POND AND POOLED WITH WATER TEMPERATURE AT STATION 643 DOWNSTREAM OF CONOWINGO DAM, MAY-OCTOBER 2010.

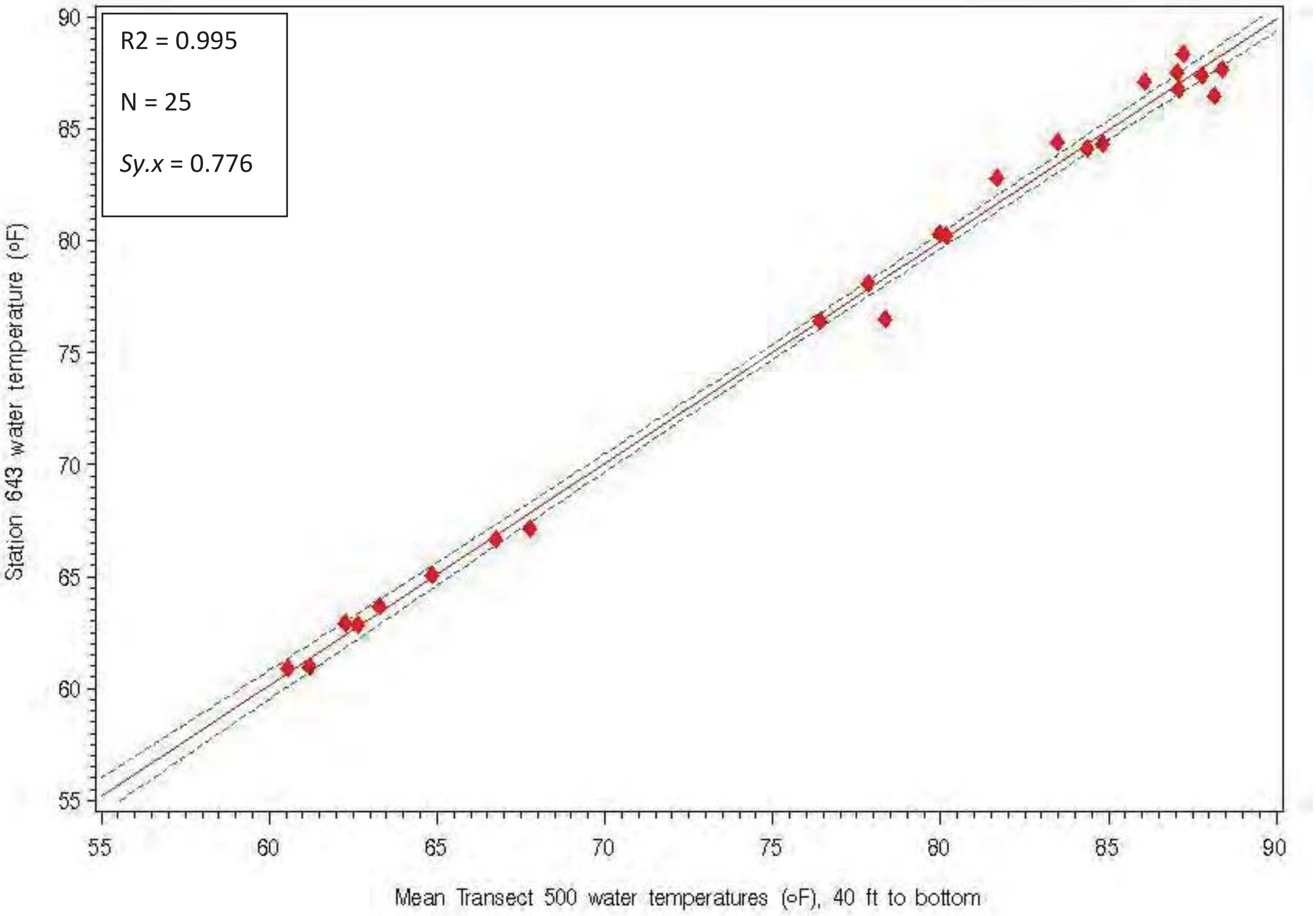


FIGURE 4-35: CONTINUED.

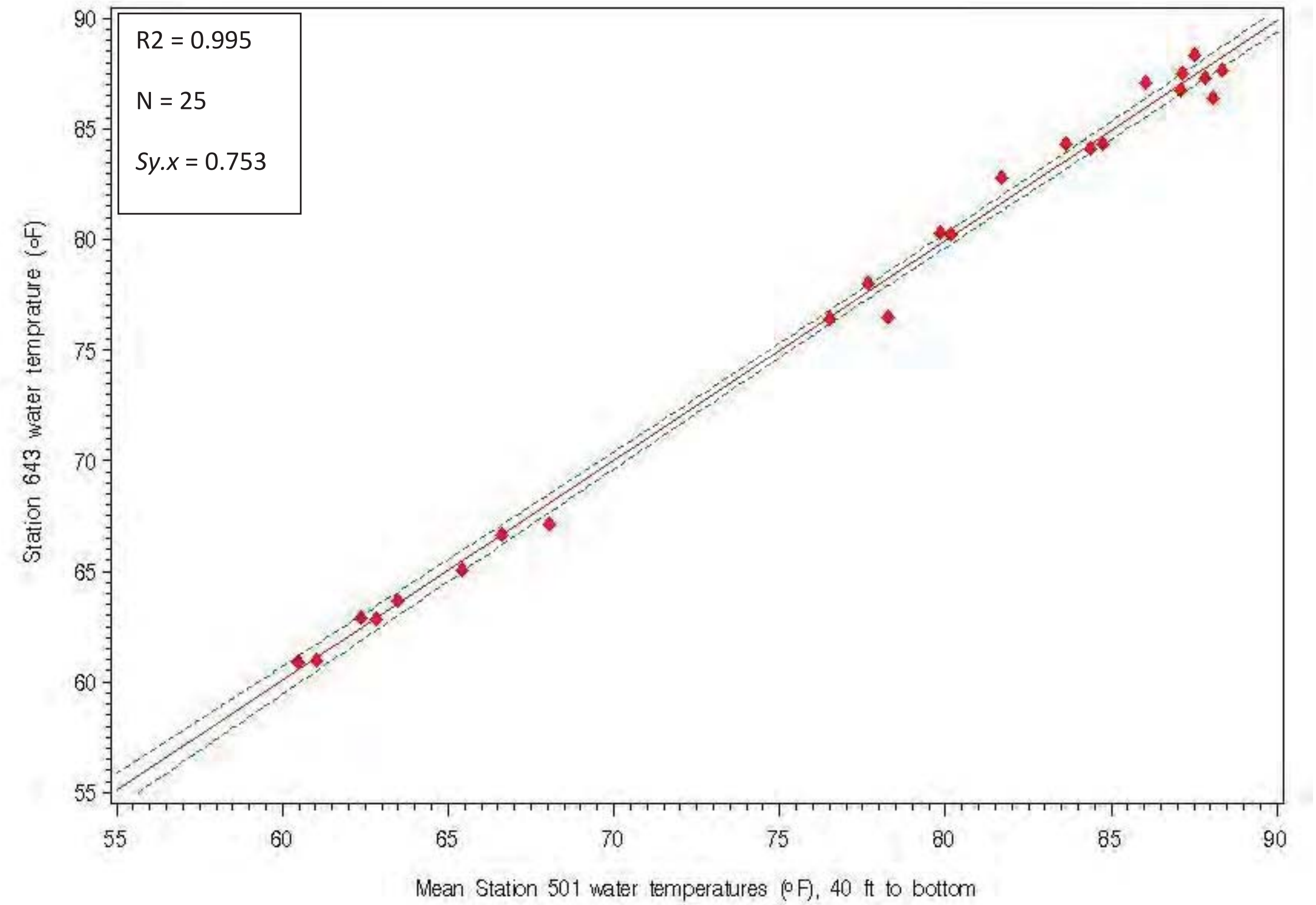


FIGURE 4-35: CONTINUED.

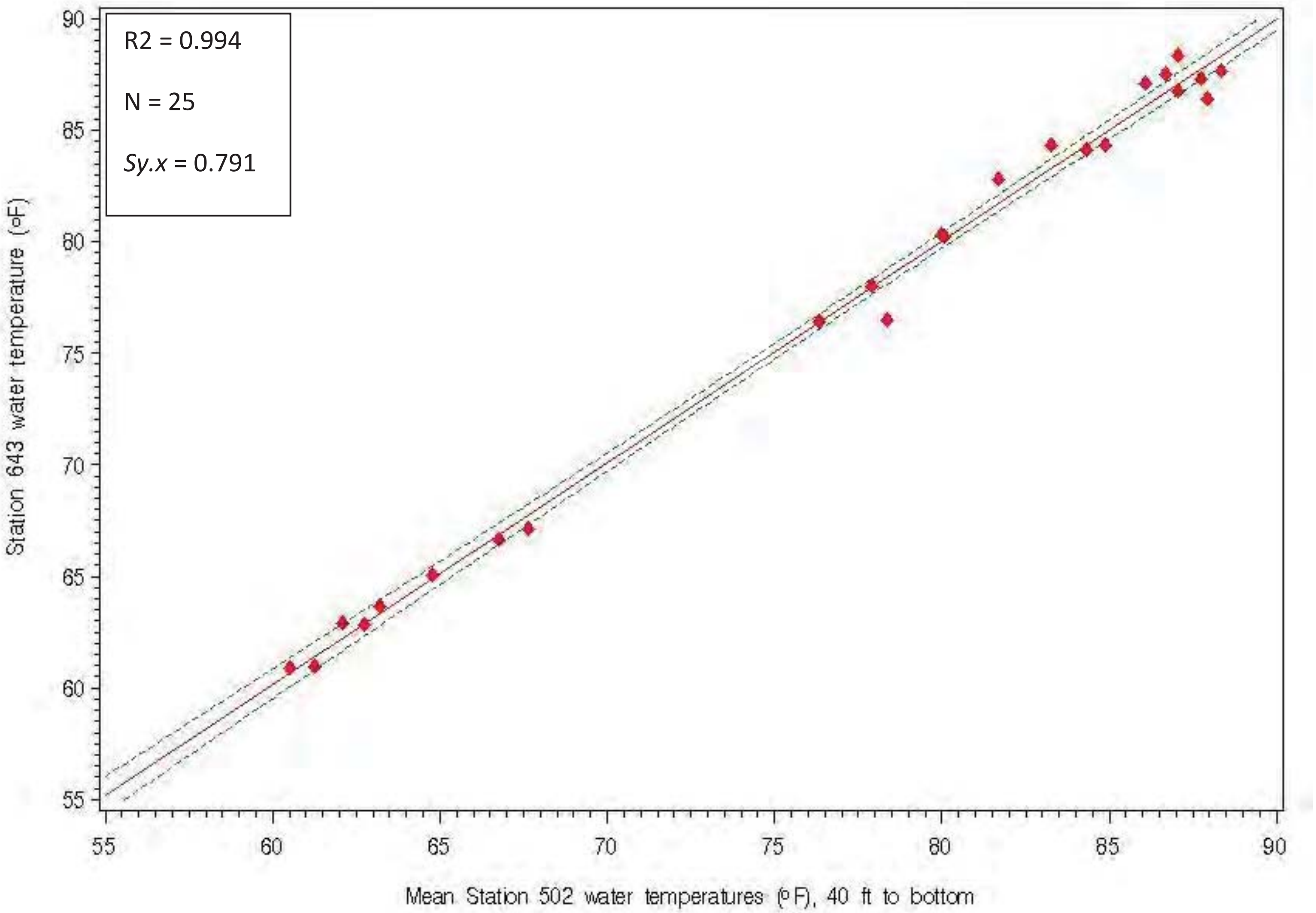


FIGURE 4-35: CONTINUED.

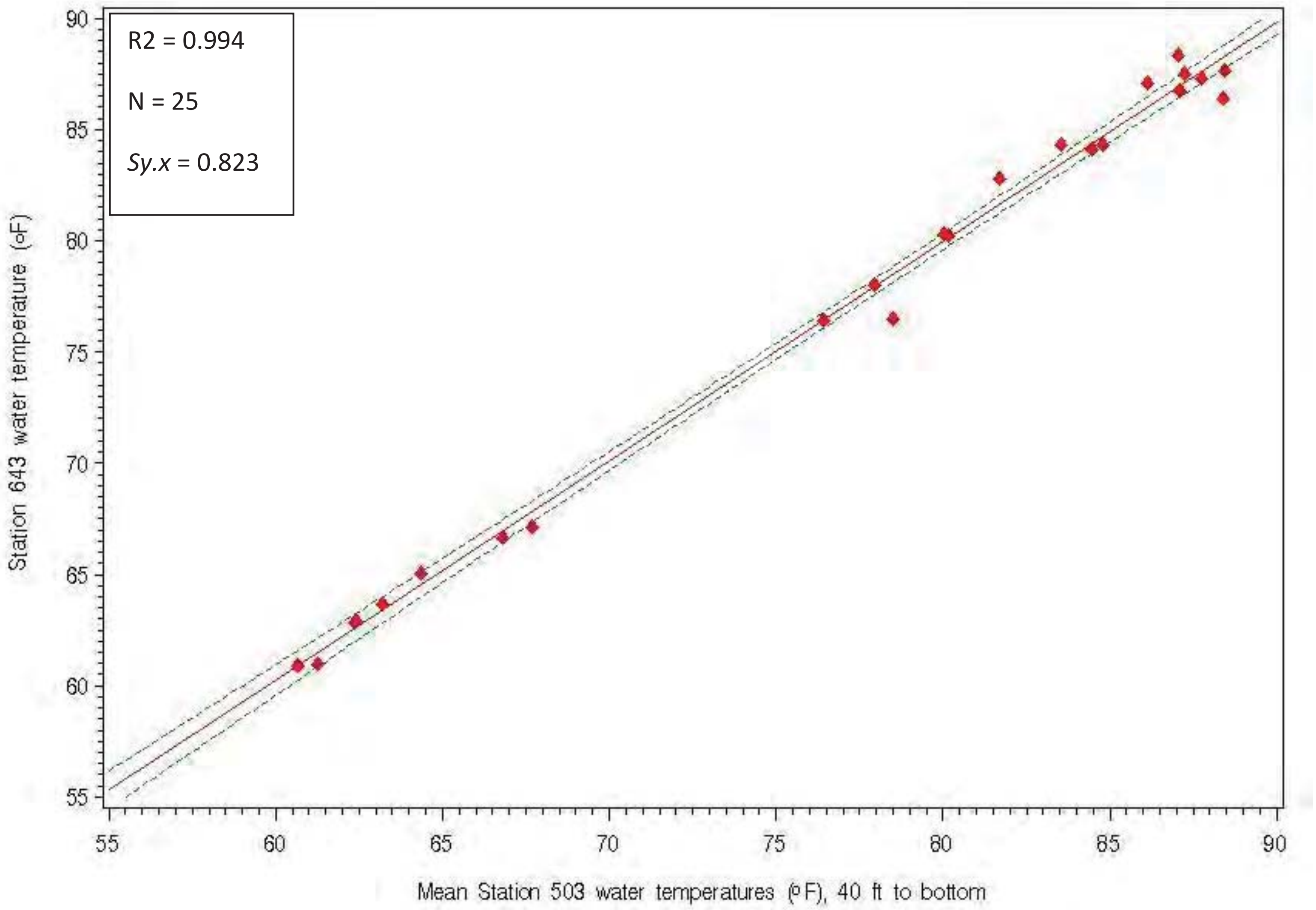
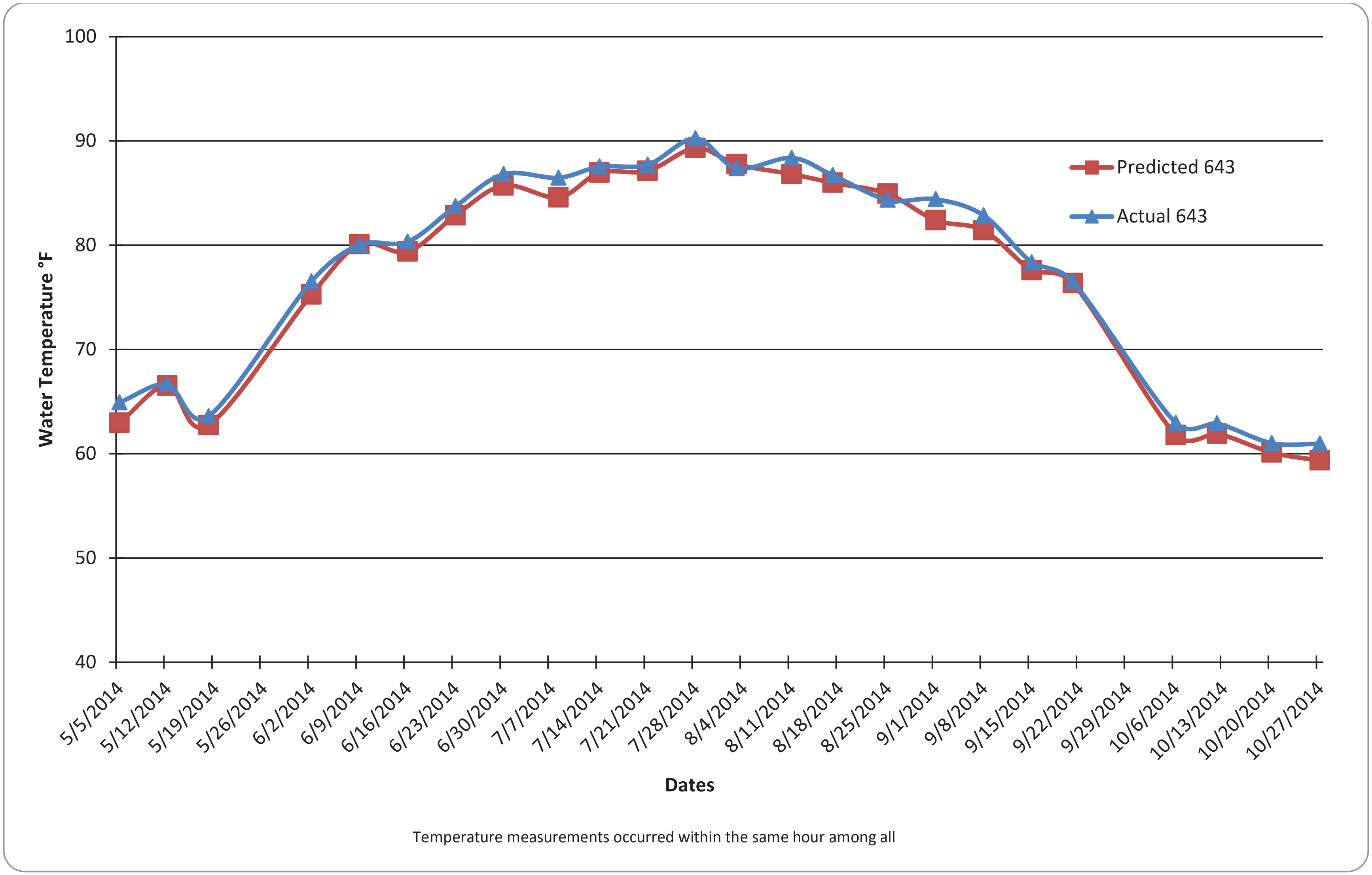
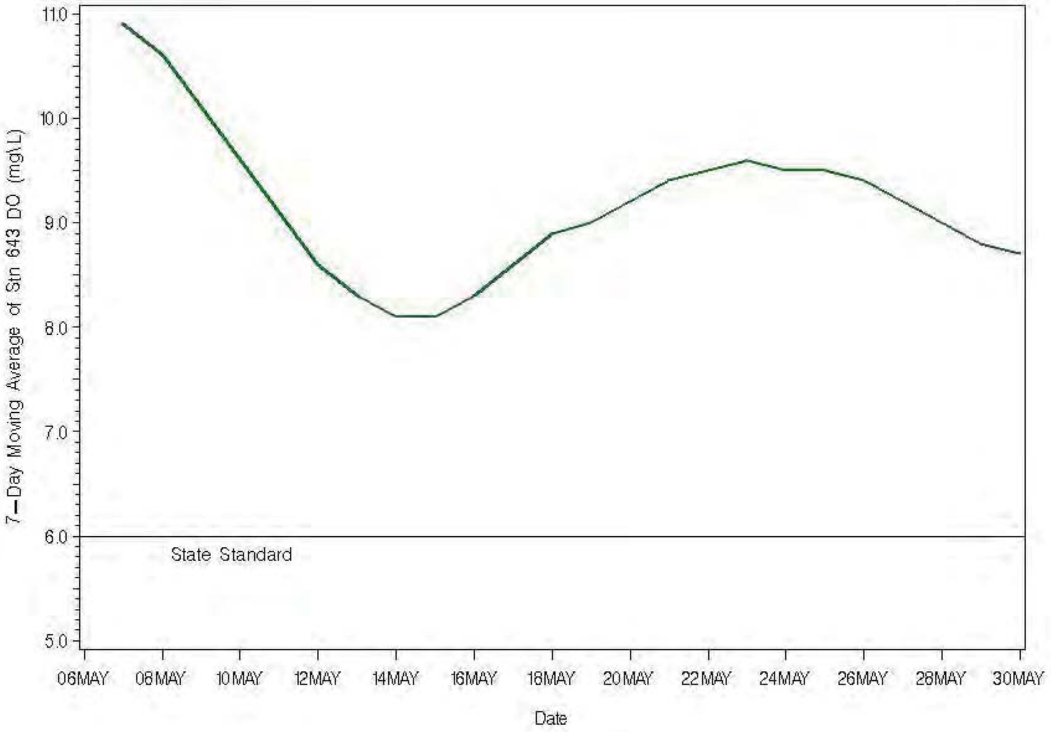


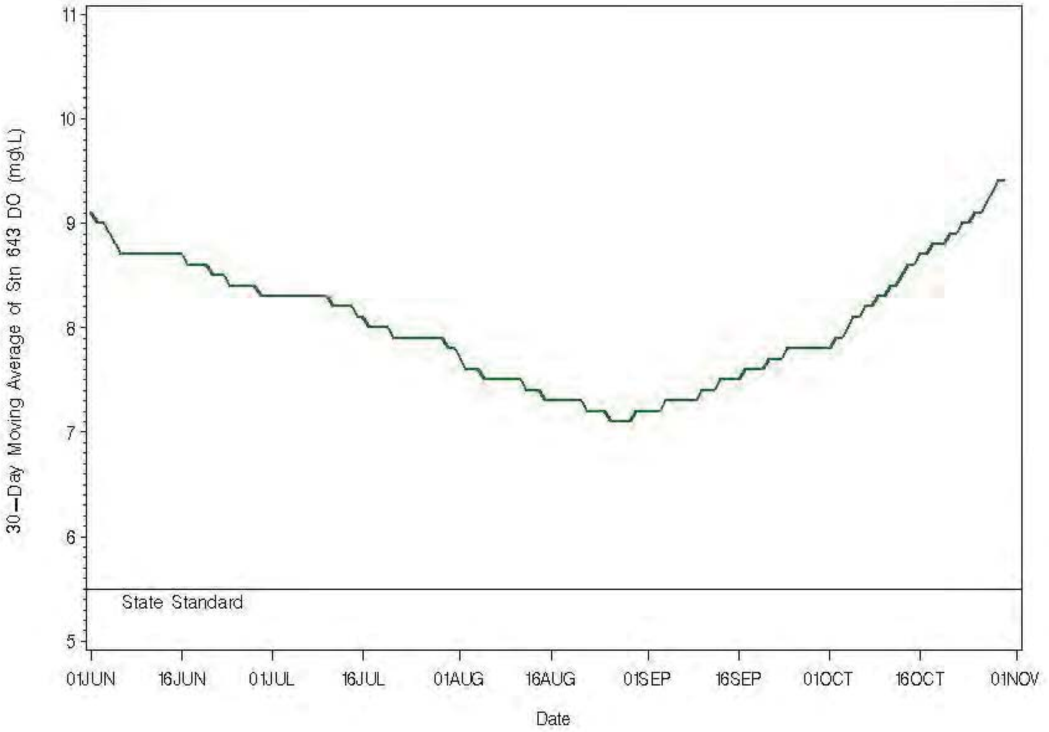
FIGURE 4-36: COMPARISON OF PREDICTED AND OBSERVED WATER TEMPERATURES AT STATION 643. PREDICTIONS MADE FROM WATER TEMPERATURE AT ≥ 40 FT DEPTH STATION 502.



Temperature measurements occurred within the same hour among all

FIGURE 4-37: COMPARISON OF DO (MG/L) VALUES (7-DAY AVERAGE AND 30-DAY AVERAGE) MEASURED AT STATION 643 WITH THE MARYLAND STATE STANDARD IN MAY-OCTOBER 2010.





APPENDIX A-1: CALIBRATION RECORDS FOR PROFILE DATA.

APPENDIX A-1: SPECIFICATIONS OF EQUIPMENT USED IN SAMPLING WATER QUALITY PARAMETERS IN CONOWINGO POND AND DOWNSTREAM OF CONOWINGO DAM, APRIL-OCTOBER 2010, ALONG WITH THE CALIBRATION RECORDS FOR PROFILE DATA.

HACH HYDROLAB UNIT	Outer Diameter	Length	Weight
DS5X Data Sonde	8.9 cm (3.5 in)	58.4 cm (23 in)	3.35 kg (7.4 lbs)
MS5 Data Sonde	4.4 cm (1.75 in)	53.3 cm (21 in)	1.0 kg (2.2 lbs)
Surveyor	Width-109 mm (4.3 in)	270 mm (1.062 in)	Depth-70 mm (2.75 in)
Model/Parameter	**Range**	**Accuracy**	**Resolution**
Hydrolab DS5X / Temperature	-5 to 50 °C	± 0.10 °C	0.01 °C
Hydrolab DS5X / LDO	0 to 30 mg/L	± 0.1 mg/L	0.01 mg/L
Hydrolab DS5X / pH	0 to 14 units	± 0.2 units	0.01 units
Hydrolab DS5X / Specific Conductance	0 to 100 mS/cm	±0.001 mS/cm	0.0001 units
Hydrolab MS5 / Temperature	-5 to 50 °C	± 0.10 °C	0.01 °C
Hydrolab MS5 / LDO	0 to 30 mg/L	± 0.1 mg/L	0.01 mg/L
Hydrolab MS5 / pH	0 to 14 units	± 0.2 units	0.01 units
Hydrolab MS5 / Specific Conductance	0 to 100 mS/cm	±0.001 mS/cm	0.0001 units
Hydrolab MS5 / Self-cleaning Turbidity	0 to 3000 NTU	± 1% up to 100 NTU ± 3% from 100-400	0.1 up to 400 NTU
Hydrolab MS5 / Depth	0 to 100 m	±0.05 m	0.01 m
YSI Model 57 with stirrer / DO	0 to 20 mg/L	± 0.1 mg/L	0.1 mg/L
YSI Model 57 / Temperature	-5 to 45 °C	± 0.50 °C	0.25 °C

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 7/2/10 Calibration Time: 0550
Meter Type: X YSI (meter # PH91-m2) ___ Hach MS5
Calibration Water Temperature 18.5 °C DO Solubility 9.35 ppm
Meter Water Temperature 18.5 °C Meter DO 9.10 ppm
Meter Water Temp. adjusted to 18.5 °C Meter DO adjusted to 9.35 ppm

Calibration Date: 7/2/10 Calibration Time: 0645
Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 18.5 °C DO Solubility 9.35 ppm
Meter Water Temperature 18.5 °C Meter DO 9.35 ppm
Meter Water Temp. adjusted to – °C Meter DO adjusted to – ppm

Calibration Date: 7/2/10 Calibration Time: 0742
Meter Type: X YSI (meter # PH 91-m2) ___ Hach MS5
Calibration Water Temperature 18.5 °C DO Solubility 9.35 ppm
Meter Water Temperature 18.5 °C Meter DO 9.35 ppm
Meter Water Temp. adjusted to – °C Meter DO adjusted to – ppm

Calibration Date: 7/2/10 Calibration Time: 0848
Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 19.5 °C DO Solubility 9.10 ppm
Meter Water Temperature 20.0 °C Meter DO 9.3 ppm
Meter Water Temp. adjusted to 19.5 °C Meter DO adjusted to 9.10 ppm

Calibration Date: 7/2/10 Calibration Time: 0945
Meter Type: X YSI (meter # PH 91-M2) ___ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to – °C Meter DO adjusted to – ppm

Calibration Date: 7/2/10 Calibration Time: 1042
Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to – °C Meter DO adjusted to – ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 7/2/10 Calibration Time: 1155

Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5

Calibration Water Temperature 23.5 °C DO Solubility 8.5 ppm

Meter Water Temperature 23.5 °C Meter DO 8.5 ppm

Meter Water Temp. adjusted to - °C Meter DO adjusted to - ppm

Calibration Date: 7/2/10 Calibration Time: 1253

Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5

Calibration Water Temperature 23.5 °C DO Solubility 8.5 ppm

Meter Water Temperature 23.5 °C Meter DO 8.4 ppm

Meter Water Temp. adjusted to - °C Meter DO adjusted to 8.5 ppm

Calibration Date: 7/2/10 Calibration Time: 1349

Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5

Calibration Water Temperature 23.0 °C DO Solubility 8.5 ppm

Meter Water Temperature 23.0 °C Meter DO 8.5 ppm

Meter Water Temp. adjusted to - °C Meter DO adjusted to - ppm

Calibration Date: 7/2/10 Calibration Time: 1448

Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5

Calibration Water Temperature 23.0 °C DO Solubility 8.5 ppm

Meter Water Temperature 23.0 °C Meter DO 8.5 ppm

Meter Water Temp. adjusted to - °C Meter DO adjusted to - ppm

Calibration Date: 7/2/10 Calibration Time: 1549

Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5

Calibration Water Temperature 23.0 °C DO Solubility 8.5 ppm

Meter Water Temperature 23.0 °C Meter DO 8.5 ppm

Meter Water Temp. adjusted to - °C Meter DO adjusted to - ppm

Calibration Date: 7/2/10 Calibration Time: 1655

Meter Type: ___ YSI (meter # PH91-M2) ___ Hach MS5

Calibration Water Temperature 23.0 °C DO Solubility 8.5 ppm

Meter Water Temperature 23.0 °C Meter DO 8.5 ppm

Meter Water Temp. adjusted to - °C Meter DO adjusted to - ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 07-03-10 Calibration Time: 5:55
Meter Type: X YSI (meter # PH91-M2 ____ Hach MS5
Calibration Water Temperature 17.9 °C DO Solubility 9.5 ppm
Meter Water Temperature 17.9 °C Meter DO 9.4 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 9.5 ok ppm

---

Calibration Date: 07-03-10 Calibration Time: 6:50
Meter Type: ____ YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 17.0 °C DO Solubility 9.7 ppm
Meter Water Temperature 17.0 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 9.7 ok ppm

---

Calibration Date: 07-03-10 Calibration Time: 7:47
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 18.7 °C DO Solubility 9.3 ppm
Meter Water Temperature 18.7 °C Meter DO 9.7 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 9.3 ok ppm

---

Calibration Date: 07-03-10 Calibration Time: 8:48
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.1 ok ppm
Meter Water Temperature 20.0 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to NA ppm

---

Calibration Date: 07-03-10 Calibration Time: 9:49
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 20.8 °C DO Solubility 8.9 ppm
Meter Water Temperature 20.8 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to NA ppm

---

Calibration Date: 07-03-10 Calibration Time: 10:52
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 22.5 °C DO Solubility 8.6 ppm
Meter Water Temperature 22.5 °C Meter DO 8.5 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 8.6 ok ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 07-03-10 Calibration Time: 11:50
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.4 ppm
Meter Water Temperature 24.0 °C Meter DO 8.3 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 8.4 ok ppm

Calibration Date: 07-03-10 Calibration Time: 12:56
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 25.0 °C DO Solubility 8.24 ppm
Meter Water Temperature 25.0 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 8.24 ok ppm

Calibration Date: 07-03-10 Calibration Time: 13:50
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.4 ppm
Meter Water Temperature 24.0 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to N/A ppm

Calibration Date: 07-03-10 Calibration Time: 14:51
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.4 ppm
Meter Water Temperature 240 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to N/A ppm

Calibration Date: 07-03-10 Calibration Time: 15:50
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.4 ppm
Meter Water Temperature 24.0 °C Meter DO 8.3 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 8.4 ok ppm

Calibration Date: 07-03-10 Calibration Time: 16:52
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.4 ppm
Meter Water Temperature 24.0 °C Meter DO 8.5 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 84 ok ppm

Calibration Date: 07-03-10 Calibration Time: 17:51
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temp. 24.0° C DO Solubility 8.4 ppm
Meter Water Temp. 24.0° C Meter DO 8.5 ppm
Meter Water Temp Adjusted To ____ °C Meter DO adjusted to 8.4ppm ok

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Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 07-04-10 Calibration Time: 5:47
Meter Type: ✓ YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 18.5 °C DO Solubility 9.3 ppm
Meter Water Temperature 18.8 °C Meter DO 9.5 ppm
Meter Water Temp. adjusted to 18.5 °C Meter DO adjusted to 9.3 ppm

Calibration Date: 07-04-10 Calibration Time: 0653
Meter Type: ✓ YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 18.5 °C DO Solubility 9.3 ppm
Meter Water Temperature 18.4 °C Meter DO 9.5 ppm
Meter Water Temp. adjusted to 18.5 °C Meter DO adjusted to 9.3 ppm

Calibration Date: 07-04-10 Calibration Time: 0750
Meter Type: ✓ YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 18.5 °C DO Solubility 9.3 ppm
Meter Water Temperature 18.5 °C Meter DO 8.6 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 9.3 ppm

Calibration Date: 07-04-10 Calibration Time: 0846
Meter Type: ✓ YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 19.8 °C DO Solubility 9.2 ppm
Meter Water Temperature 20.0 °C Meter DO 9.5 ppm
Meter Water Temp. adjusted to 19.8 °C Meter DO adjusted to 9.2 ppm

Calibration Date: 07-04-10 Calibration Time: 0952
Meter Type: ✓ YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.5 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.8 ppm

Calibration Date: 07-04-10 Calibration Time: 1050
Meter Type: ✓ YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 23.0 °C DO Solubility 8.5 ppm
Meter Water Temperature 23.0 °C Meter DO 8.5 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

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Calibration Date: 07-04-10 Calibration Time: 1150
Meter Type: ✓ YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.4 ppm
Meter Water Temperature 24.0 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 07-04-10 Calibration Time: 1255
Meter Type: ✓ YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 24.8 °C DO Solubility 8.3 ppm
Meter Water Temperature 24.8 °C Meter DO 8.2 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.3 ppm

Calibration Date: 07-04-10 Calibration Time: 1355
Meter Type: ✓ YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 24.5 °C DO Solubility 8.3 ppm
Meter Water Temperature 24.8 °C Meter DO 8.3 ppm
Meter Water Temp. adjusted to 24.5 °C Meter DO adjusted to N/A ppm

Calibration Date: 07-04-10 Calibration Time: 1450
Meter Type: ✓ YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 25.0 °C DO Solubility 8.2 ppm
Meter Water Temperature 25.0 °C Meter DO 8.2 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 07-04-10 Calibration Time: 1545
Meter Type: ✓ YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 24.5 °C DO Solubility 8.3 ppm
Meter Water Temperature 24.8 °C Meter DO 8.3 ppm
Meter Water Temp. adjusted to 24.5 °C Meter DO adjusted to N/A ppm

Calibration Date: 07-04-10 Calibration Time: 1650
Meter Type: ✓ YSI (meter # DH91-M2) ___ Hach MS5
Calibration Water Temperature 24.5 °C DO Solubility 8.3 ppm
Meter Water Temperature 24.5 °C Meter DO 8.2 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.3 ppm

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Calibration Date: 07-04-10 Calibration Time: 1750
Meter Type: ✓ YSI (meter #PH91-M2) ______ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.4 ppm
Meter Water Temperature 24.0 °C Meter DO 8.5 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.4 ppm

Calibration Date: __________ Calibration Time: __________
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature __________ °C DO Solubility __________ ppm
Meter Water Temperature __________ °C Meter DO __________ ppm
Meter Water Temp. adjusted to __________ °C Meter DO adjusted to ______ ppm

Calibration Date: __________ Calibration Time: __________
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature __________ °C DO Solubility __________ ppm
Meter Water Temperature __________ °C Meter DO __________ ppm
Meter Water Temp. adjusted to __________ °C Meter DO adjusted to ______ ppm

Calibration Date: __________ Calibration Time: __________
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature __________ °C DO Solubility __________ ppm
Meter Water Temperature __________ °C Meter DO __________ ppm
Meter Water Temp. adjusted to __________ °C Meter DO adjusted to ______ ppm

Calibration Date: __________ Calibration Time: __________
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature __________ °C DO Solubility __________ ppm
Meter Water Temperature __________ °C Meter DO __________ ppm
Meter Water Temp. adjusted to __________ °C Meter DO adjusted to ______ ppm

Calibration Date: __________ Calibration Time: __________
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature __________ °C DO Solubility __________ ppm
Meter Water Temperature __________ °C Meter DO __________ ppm
Meter Water Temp. adjusted to __________ °C Meter DO adjusted to ______ ppm

CALIBRATIONS FOR QC@A 07-04-10 KJT

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Calibration Date: 07-04-10 Calibration Time: 0955
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.7 ppm

Calibration Date: 07-04-10 Calibration Time: 1155
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.4 ppm
Meter Water Temperature 24.0 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 07-04-10 Calibration Time: 1349
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 24.5 °C DO Solubility 8.3 ppm
Meter Water Temperature 24.2 °C Meter DO 8.3 ppm
Meter Water Temp. adjusted to 24.5 °C Meter DO adjusted to N/A ppm

Calibration Date: 07-04-10 Calibration Time: 1550
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 24.5 °C DO Solubility 8.3 ppm
Meter Water Temperature 24.5 °C Meter DO 8.3 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 07-04-10 Calibration Time: 1755
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.4 ppm
Meter Water Temperature 24.0 °C Meter DO 8.5 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.4 ppm

Calibration Date: ____________ Calibration Time: ____________
Meter Type: ____ YSI (meter # ________) ____ Hach MS5
Calibration Water Temperature ________ °C DO Solubility ________ ppm
Meter Water Temperature ________ °C Meter DO ________ ppm
Meter Water Temp. adjusted to ________ °C Meter DO adjusted to ____ ppm

- THIS METER SEEMS TO HOLD CALIBRATION RATHER WELL ☺
WORKS WELL + MATCHES SOND'S WHEN WE USE FOR H_2O QUAL. ON C.P. ALSO.

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 1 of 2

Calibration Date: 07-05-10
Calibration Time: 5:54
Meter Type: X YSI (meter # PH91-M2)
_____ Hach MS5
Calibration Water Temperature 18.5 °C
DO Solubility 9.26 ppm
Meter Water Temperature 18.5 °C
Meter DO 10.0 ppm
Meter Water Temp. adjusted to _____ °C
Meter DO adjusted to 9.26 ppm (approx) ok

Calibration Date: _____
Calibration Time: _____
Meter Type: YSI (meter # _____)
_____ Hach MS5
Calibration Water Temperature _____ °C
DO Solubility _____ ppm
Meter Water Temperature °C
Meter DO _____ ppm
Meter Water Temp. adjusted to _____ °C
Meter DO adjusted to _____ ppm

Calibration Date: -()
Calibration Time: _____
Meter Type: X YSI (meter # _____)
_____ Hach MS5
Calibration Water Temperature _____ °C
DO Solubility _____ ppm
Meter Water Temperature _____ °C
Meter DO _____ ppm
Meter Water Temp. adjusted to _____ °C
Meter DO adjusted to _____ ppm

Calibration Date: _____
Calibration Time: _____
Meter Type: _____ YSI (meter # _____)
_____ Hach MS5
Calibration Water Temperature _____ °C
DO Solubility _____ ppm
Meter ater Temperature _____ °C
Meter DO _____ ppm
Meter Water Temp. adjusted to _____ °C
Meter DO adjusted to _____ ppm

Calibration Date: _____
Calibration Time: 9.50
Meter Type: _____ YSI (meter # P)
_____ Hach MS5
Calibration Water Temperature 22 °C
DO Solubility 2 ppm
Meter Water Temperature 22 °C
Meter DO 87 ppm
Meter Water Temp. adjusted to _____ °C
Meter DO adjusted to pm

Calibration Date: 07-05-10
Calibration Time: 10:50
Meter Type: X YSI (meter # PH91-M2)
_____ Hach MS5
Calibration Water Temperature 24.0 °C
DO Solubility 8.4 ppm
Meter Water Temperature 24.0 °C
Meter DO 8.3 ppm
Meter Water Temp. adjusted to _____ °C
Meter DO adjusted to 8.4 ok ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 2 of 2

Calibration Date. 07-05-10 Calibration Time: 11:50
Meter Type X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 25.5 °C DO Solubility 8.09 pm
Meter Water Temperature 25.5 °C Meter DO 8.2 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 8.1 ppm ok

Calibration Date: 07-05-10 Calibration Time: 12:5[illegible]
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 27 °C DO Solubility 7.95 ppm
Meter Water Temperature 27 °C Meter DO 8.0 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

Calibration Date: 07-05-10 Calibration Time: [illegible]
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 27.0 °C DO Solubility 7.95 ppm
Meter Water Temperature 27.0 °C Meter DO 7.5 ppm
Meter Water Temp. adjusted to ______ °C . Meter DO adjusted to 8.0 ppm

Calibration Date: 07-05-10 Calibration Time: 14:51
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 28.0 °C DO Solubility 7.81 ppm
Meter Water Temperature 28.0 °C Meter DO 7.9 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 7.8 ppm ok

Calibration Date: 07-05-10 Calibration Time: [illegible]
Meter Type X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 28.0 °C DO Solubility 7.81 ppm
Meter Water Temperature 28.0 °C Meter DO 7.8 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

Calibration Date: 07-05-10 Calibration Time: 16:51
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 28.0 °C DO Solubility 7.81 ppm
Meter Water Temperature 28.0 °C Meter DO 7.8 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

Calibration Date: 07-05-10 Calibration Time: [illegible]
Meter Type: X YSI (Meter # PH91-M2) ______ Hach MS5
Calibration Water Temp 27.0 °C DO Solubility 7.95 ppm
Meter Water Temp 27.0 °C Meter DO 7.8 ppm
Meter Water Temp adjusted to ______ °C Meter DO adjusted to 8.0 ppm ok

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 7-14-10 Calibration Time: 0553
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.9 ppm
Meter Water Temperature 20.8 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to 21.0 °C Meter DO adjusted to OK ppm

Calibration Date: 07-14-10 Calibration Time: 0653
Meter Type: ___ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm
Meter Water Temperature 21.0 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to 20.5 °C Meter DO adjusted to 9.0 ppm

Calibration Date: 07-14-10 Calibration Time: 0750
Meter Type: ___ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.5 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 7-14-10 Calibration Time: 0850
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.5 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 7-14-10 Calibration Time: 0950
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.5 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 7-14-10 Calibration Time: 1050
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.5 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to 9.0 OK ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 2 of 3

Calibration Date: 7-14-10 Calibration Time: 1150
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.0 ppm
Meter Water Temperature 26.5 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to 20.0 °C Meter DO adjusted to 9.0 ppm

Calibration Date: 7-14-10 Calibration Time: 1250
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 20.0 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 7-14-10 Calibration Time: 1350
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 20.0 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 7-14-10 Calibration Time: 1450
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 20.0 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 7-14-10 Calibration Time: 1550
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 20.0 °C Meter DO 9.2 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to 9.1 ppm

Calibration Date: 7-14-10 Calibration Time: 1650
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 20.0 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to 9.1 ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 3 of 3

Calibration Date: 7-14-10 Calibration Time: 1750
Meter Type: ✓ YSI (meter # 18983) ______ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 20.0 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: __________ Calibration Time: __________
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature __________ °C DO Solubility __________ ppm
Meter Water Temperature __________ °C Meter DO __________ ppm
Meter Water Temp. adjusted to __________ °C Meter DO adjusted to ______ ppm

Calibration Date: __________ Calibration Time: __________
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature __________ °C DO Solubility __________ ppm
Meter Water Temperature __________ °C Meter DO __________ ppm
Meter Water Temp. adjusted to __________ °C Meter DO adjusted to ______ ppm

Calibration Date: __________ Calibration Time: __________
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature __________ °C DO Solubility __________ ppm
Meter Water Temperature __________ °C Meter DO __________ ppm
Meter Water Temp. adjusted to __________ °C Meter DO adjusted to ______ ppm

Calibration Date: __________ Calibration Time: __________
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature __________ °C DO Solubility __________ ppm
Meter Water Temperature __________ °C Meter DO __________ ppm
Meter Water Temp. adjusted to __________ °C Meter DO adjusted to ______ ppm

Calibration Date: __________ Calibration Time: __________
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature __________ °C DO Solubility __________ ppm
Meter Water Temperature __________ °C Meter DO __________ ppm
Meter Water Temp. adjusted to __________ °C Meter DO adjusted to ______ ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 1 of 1

Calibration Date: 7-14-10 Calibration Time: 0554
Meter Type: ✓ YSI (meter # PH91-M)2 ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.9 ppm
Meter Water Temperature 20.8 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to 21.0 °C Meter DO adjusted to 8.9 ppm

Calibration Date: 7-14-10 Calibration Time: 0750
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.5 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 7-14-10 Calibration Time: 0950
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.5 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 7-14-10 Calibration Time: 1150
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 20.5 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to 20.0 °C Meter DO adjusted to 9.1 ppm

Calibration Date: D Calibration Time: 1350
Meter Type: ______ YSI (meter # ______) ______ Hach MS5
Calibration Water Temperature ______ °C DO Solubility 9.1 ppm
Meter Water Temperature ______ °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to OK ppm

Calibration Date: ______ Calibration Time: 1550
Meter Type: ______ YSI (meter # 9) ______ Hach MS5
Calibration Water Temperature ______ °C DO Solubility 9.1 ppm
Meter Water Temperature ______ °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to OK ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 1 of 3

Calibration Date: 7-15-10
Calibration Time: 0550
Meter Type: ✓ YSI (meter # 10983)
______ Hach MS5
Calibration Water Temperature 20.0 °C
DO Solubility 9.1 ppm
Meter Water Temperature 20.0 °C
Meter DO 9.3 ppm
Meter Water Temp. adjusted to OK °C
Meter DO adjusted to 9.1 ok ppm

Calibration Date: 7-15-10
Calibration Time: 0650
Meter Type: ✓ YSI (meter # 10983)
______ Hach MS5
Calibration Water Temperature 20.0 °C
DO Solubility 9.1 ppm
Meter Water Temperature 20.0 °C
Meter DO 9.0 ppm
Meter Water Temp. adjusted to OK °C
Meter DO adjusted to 9.1 ok ppm

Calibration Date: 7-15-10
Calibration Time: 0750
Meter Type: ✓ YSI (meter # 10983)
______ Hach MS5
Calibration Water Temperature 20.5 °C
DO Solubility 9.0 ppm
Meter Water Temperature 20.5 °C
Meter DO 9.1 ppm
Meter Water Temp. adjusted to OK °C
Meter DO adjusted to 9.0 ok ppm

Calibration Date: 7-15-10
Calibration Time: 0850
Meter Type: ✓ YSI (meter # 10983)
______ Hach MS5
Calibration Water Temperature 21.0 °C
DO Solubility 8.9 ppm
Meter Water Temperature 21.0 °C
Meter DO 8.9 ppm
Meter Water Temp. adjusted to OK °C
Meter DO adjusted to OK ppm

Calibration Date: 7-15-10
Calibration Time: 0950
Meter Type: ✓ YSI (meter # 10983)
______ Hach MS5
Calibration Water Temperature 22.0 °C
DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C
Meter DO 8.6 ppm
Meter Water Temp. adjusted to OK °C
Meter DO adjusted to 8.7 ppm

Calibration Date: 7-15-10
Calibration Time: 1050
Meter Type: ✓ YSI (meter # 10983)
______ Hach MS5
Calibration Water Temperature 23.0 °C
DO Solubility 8.56 ppm
Meter Water Temperature 23.5 °C
Meter DO 8.5 ppm
Meter Water Temp. adjusted to 23.0 °C
Meter DO adjusted to 8.56 OK ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 2 of 3

Calibration Date: 7-15-10 Calibration Time: 1150
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.4 ppm
Meter Water Temperature 24.0 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 7-15-10 Calibration Time: 1250
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 24.5 °C DO Solubility 8.3 ppm
Meter Water Temperature 24.0 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to 24.5 °C ok Meter DO adjusted to 8.3 OK ppm

Calibration Date: 7-15-10 Calibration Time: 1350
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 25.0 °C DO Solubility 8.24 ppm
Meter Water Temperature 25.0 °C Meter DO 8.24 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 7-15-10 Calibration Time: 1450
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 25.0 °C DO Solubility 8.24 ppm
Meter Water Temperature 25.2 °C Meter DO 8.1 ppm
Meter Water Temp. adjusted to 25.0 °C OK Meter DO adjusted to 8.24 OK ppm

Calibration Date: 7-15-10 Calibration Time: 1550
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 25.0 °C DO Solubility 8.24 ppm
Meter Water Temperature 25.0 °C Meter DO 8.2 ppm
Meter Water Temp. adjusted to ok °C Meter DO adjusted to 8.24 OK ppm

Calibration Date: 7-15-10 Calibration Time: 1650
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 25.0 °C DO Solubility 8.24 ppm
Meter Water Temperature 25.0 °C Meter DO 8.2 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to 8.24 OK ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 3 of 3

Calibration Date: 7-15-10 Calibration Time: 1750
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.4 ppm
Meter Water Temperature 24.0 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: ____ Calibration Time: ____
Meter Type: ____ YSI (meter # ____) ____ Hach MS5
Calibration Water Temperature ____ °C DO Solubility ____ ppm
Meter Water Temperature ____ °C Meter DO ____ ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to ____ ppm

Calibration Date: ____ Calibration Time: ____
Meter Type: ____ YSI (meter # ____) ____ Hach MS5
Calibration Water Temperature ____ °C DO Solubility ____ ppm
Meter Water Temperature ____ °C Meter DO ____ ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to ____ ppm

Calibration Date: ____ Calibration Time: ____
Meter Type: ____ YSI (meter # ____) ____ Hach MS5
Calibration Water Temperature ____ °C DO Solubility ____ ppm
Meter Water Temperature ____ °C Meter DO ____ ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to ____ ppm

Calibration Date: ____ Calibration Time: ____
Meter Type: ____ YSI (meter # ____) ____ Hach MS5
Calibration Water Temperature ____ °C DO Solubility ____ ppm
Meter Water Temperature ____ °C Meter DO ____ ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to ____ ppm

Calibration Date: ____ Calibration Time: ____
Meter Type: ____ YSI (meter # ____) ____ Hach MS5
Calibration Water Temperature ____ °C DO Solubility ____ ppm
Meter Water Temperature ____ °C Meter DO ____ ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to ____ ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 1 of 1

Calibration Date: 7-15-10 Calibration Time: 0550
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 19.5 °C Meter DO 9.4 ppm
Meter Water Temp. adjusted to 20.0 °C Meter DO adjusted to 9.1 OK ppm

Calibration Date: 7-15-10 Calibration Time: 0750
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.5 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to 9.0 OK ppm

Calibration Date: 7-15-10 Calibration Time: 0950
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 7-15-10 Calibration Time: 1150
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.4 ppm
Meter Water Temperature 24.0 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 7-15-10 Calibration Time: 1350
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 25.0 °C DO Solubility 8.24 ppm
Meter Water Temperature 25.0 °C Meter DO 8.2 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to 8.24 OK ppm

Calibration Date: 7-15-10 Calibration Time: 1550
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 25.0 °C DO Solubility 8.24 ppm
Meter Water Temperature 25.0 °C Meter DO 8.3 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to 8.24 OK ppm

RED & WHITE COOLER

Dissolved Oxygen and Water Temperature Meter Calibration Sheet (QC METER) Page 1 of 1

Calibration Date: 07-16-10 Calibration Time: 0555
Meter Type: ✓ YSI (meter #PH91-M2) ______ Hach MS5
Calibration Water Temperature 18.5 °C DO Solubility 9.3 ppm
Meter Water Temperature 18.5 °C Meter DO 9.5 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 9.3 ppm

Calibration Date: 07-16-10 Calibration Time: 0755
Meter Type: ✓ YSI (meter #PH91-M2) ______ Hach MS5
Calibration Water Temperature 19.5 °C DO Solubility 9.1 ppm
Meter Water Temperature 19.5 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 9.1 ppm

Calibration Date: 07-16-10 Calibration Time: 0955
Meter Type: ✓ YSI (meter #PH91-M2) ______ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.5 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.7 ppm

Calibration Date: 07-16-10 Calibration Time: 1154
Meter Type: ✓ YSI (meter #PH91-M2) ______ Hach MS5
Calibration Water Temperature 24.5 °C DO Solubility 8.3 ppm
Meter Water Temperature 24.5 °C Meter DO 8.3 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 07-16-10 Calibration Time: 1352
Meter Type: ✓ YSI (meter #PH91-M2) ______ Hach MS5
Calibration Water Temperature 25.5 °C DO Solubility 8.1 ppm
Meter Water Temperature 25.5 °C Meter DO 7.9 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.1 ppm

Calibration Date: 07-16-10 Calibration Time: 1551
Meter Type: ✓ YSI (meter #PH91-M2) ______ Hach MS5
Calibration Water Temperature 25.5 °C DO Solubility 8.1 ppm
Meter Water Temperature 26.0 °C Meter DO 8.1 ppm
Meter Water Temp. adjusted to 25.5 °C Meter DO adjusted to N/A ppm

WOODEN BOX

Dissolved Oxygen and Water Temperature Meter Calibration Sheet (USED FOR DATA) Page 1 of 2

Calibration Date: 07-16-10 Calibration Time: 0551
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 18.5 °C DO Solubility 9.3 ppm
Meter Water Temperature 18.2 °C Meter DO 9.3 ppm
Meter Water Temp. adjusted to 18.5 °C Meter DO adjusted to N/A ppm

Calibration Date: 07-16-10 Calibration Time: 0647
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 19.0 °C DO Solubility 9.2 ppm
Meter Water Temperature 19.0 °C Meter DO 9.5 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 9.2 ppm

Calibration Date: 07-16-10 Calibration Time: 0748
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 19.5 °C DO Solubility 9.1 ppm
Meter Water Temperature 19.5 °C Meter DO 9.5 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 9.1 ppm

Calibration Date: 07-16-10 Calibration Time: 0855
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.5 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 07-16-10 Calibration Time: 0955
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 07-16-10 Calibration Time: 1055
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 23.5 °C DO Solubility 8.5 ppm
Meter Water Temperature 23.5 °C Meter DO 8.5 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

* JUST NOTICED ON INSIDE THE METER IS LABELED # 10983 IN 2 PLACES, ON OUTSIDE OF BOX METER IS # 10984 IN 2 PLACES, I USED THE # ON METER, NOT BOX.

WOODEN BOX
(USED FOR DATA)

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 2 of 2

Calibration Date: 07-16-10 Calibration Time: 1154
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 24.5 °C DO Solubility 8.3 ppm
Meter Water Temperature 24.5 °C Meter DO 8.3 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 07-16-10 Calibration Time: 1248
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 25.0 °C DO Solubility 8.2 ppm
Meter Water Temperature 25.2 °C Meter DO 8.2 ppm
Meter Water Temp. adjusted to 25.0 °C Meter DO adjusted to N/A ppm

Calibration Date: 07-16-10 Calibration Time: 1352
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 25.5 °C DO Solubility 8.1 ppm
Meter Water Temperature 25.5 °C Meter DO 8.0 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.1 ppm

Calibration Date: 07-16-10 Calibration Time: 1458
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 25.5 °C DO Solubility 8.1 ppm
Meter Water Temperature 26.0 °C Meter DO 8.1 ppm
Meter Water Temp. adjusted to 25.5 °C Meter DO adjusted to N/A ppm

Calibration Date: 07-16-10 Calibration Time: 1551
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 25.5 °C DO Solubility 8.1 ppm
Meter Water Temperature 25.5 °C Meter DO 8.0 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.1 ppm

Calibration Date: 07-16-10 Calibration Time: 1657
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 26.0 °C DO Solubility 8.0 ppm
Meter Water Temperature 26.0 °C Meter DO 8.0 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 1 of 2

Calibration Date: 07/17/10 Calibration Time: 0655
Meter Type: X YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 19.0 °C DO Solubility 9.26 ppm
Meter Water Temperature 19.0 °C Meter DO 9.4 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 9.5 ppm

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Calibration Date: 07/17/10 Calibration Time: 0850
Meter Type: X YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 21° °C DO Solubility 8.9 ppm
Meter Water Temperature 21° °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

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Calibration Date: 07/17/10 Calibration Time: 1050
Meter Type: X YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 25 °C DO Solubility 8.24 ppm
Meter Water Temperature 25 °C Meter DO 8.1 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 8.25 ok ppm

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Calibration Date: 07/17/10 Calibration Time: 0750
Meter Type: X YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 20 °C DO Solubility 9.07 ppm
Meter Water Temperature 20 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

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Calibration Date: 07/17/10 Calibration Time: 0951
Meter Type: X YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 23° °C DO Solubility 8.56 ppm
Meter Water Temperature 23° °C Meter DO 8.55 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

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Calibration Date: 07/17/10 Calibration Time: 1150
Meter Type: X YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 27 °C DO Solubility 7.95 ppm
Meter Water Temperature 27 °C Meter DO 8.1 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 8.0 ok ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 2 of 2

Calibration Date: 07/17/10 Calibration Time: 13:52
Meter Type: X YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 28 °C DO Solubility 7.81 ppm
Meter Water Temperature 28 °C Meter DO 8.0 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 7.8 ok ppm

Calibration Date: 07/17/10 Calibration Time: 1447
Meter Type: X YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 28 °C DO Solubility 7.81 ppm
Meter Water Temperature 28 °C Meter DO 7.8 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

Calibration Date: 07/17/10 Calibration Time: 1555
Meter Type: X YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 28 °C DO Solubility 7.81 ppm
Meter Water Temperature 28 °C Meter DO 7.7 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 7.8 ok ppm

Calibration Date: 07/17/10 Calibration Time: 1648
Meter Type: X YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 28 °C DO Solubility 7.81 ppm
Meter Water Temperature 28 °C Meter DO 7.9 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 7.8 ok ppm

Calibration Date: 07/17/10 Calibration Time: 17:47
Meter Type: X YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 28 °C DO Solubility 7.81 ppm
Meter Water Temperature 28 °C Meter DO 7.8 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

Calibration Date: 07/17/10 Calibration Time: ______
Meter Type: X YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature ______ °C DO Solubility ______ ppm
Meter Water Temperature ______ °C Meter DO ______ ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to ______ ppm

Calibration Date: 07/17/10 Calibration Time: ______
Meter Type: X YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature ______ °C DO Solubility ______ ppm
Meter Water Temperature ______ °C Meter DO ______ ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to ______ ppm

Q.C. METER- RAW COOLER

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 1 of 1

Calibration Date: 07-30-10 Calibration Time: 0650
Meter Type: ✓ YSI (meter #PH91-M2) ____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.8 °C Meter DO 8.6 ppm
Meter Water Temp. adjusted to 21.5 °C Meter DO adjusted to 8.8 ppm

Calibration Date: 07-30-10 Calibration Time: 0848
Meter Type: ✓ YSI (meter #PH91-M2) ____ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.9 ppm
Meter Water Temperature 21.0 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 07-30-10 Calibration Time: 1054
Meter Type: ✓ YSI (meter #PH91-M2) ____ Hach MS5
Calibration Water Temperature 23.0 °C DO Solubility 8.5 ppm
Meter Water Temperature 23.0 °C Meter DO 8.6 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.5 ppm

Calibration Date: 07-30-10 Calibration Time: 1247
Meter Type: ✓ YSI (meter #PH91-M2) ____ Hach MS5
Calibration Water Temperature 23.5 °C DO Solubility 8.5 ppm
Meter Water Temperature 23.5 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.5 ppm

Calibration Date: 07-30-10 Calibration Time: 1550
Meter Type: ✓ YSI (meter #PH91-M2) ____ Hach MS5
Calibration Water Temperature 23.0 °C DO Solubility 8.5 ppm
Meter Water Temperature 23.0 °C Meter DO 8.6 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.5 ppm

Calibration Date: 07-30-10 Calibration Time: 50
Meter Type: ✓ YSI (meter #PH91-M2) ____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.6 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.8 ppm

WOODEN BOX

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 1 of 2

Calibration Date: 07-30-10 Calibration Time: 0552
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 22.6 °C DO Solubility 8.7 ppm
Meter Water Temperature 21.5 °C Meter DO 8.2 ppm
Meter Water Temp. adjusted to 22.0 °C Meter DO adjusted to 8.7 ppm

Calibration Date: 07-30-10 Calibration Time: 0650
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.8 ppm

Calibration Date: 07-30-10 Calibration Time: 0751
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.5 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 07-30-10 Calibration Time: 0848
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.9 ppm
Meter Water Temperature 20.8 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to 21.0 °C Meter DO adjusted to N/A ppm

Calibration Date: 07-30-10 Calibration Time: 0944
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 21.8 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.8 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 07-30-10 Calibration Time: 1054
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 23.0 °C DO Solubility 8.5 ppm
Meter Water Temperature 23.0 °C Meter DO 8.5 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

W00

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 2 of 2

Calibration Date: 07-30-10 Calibration Time: 1150
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 23.8 °C DO Solubility 8.4 ppm
Meter Water Temperature 23.8 °C Meter DO 8.5 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.4 ppm

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Calibration Date: 07-30-10 Calibration Time: 1247
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 23.5 °C DO Solubility 8.5 ppm
Meter Water Temperature 23.5 °C Meter DO 8.3 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.5 ppm

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Calibration Date: 07-30-10 Calibration Time: 1352
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 23.5 °C DO Solubility 8. ppm
Meter Water Temperature 5 °C Meter DO 8 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to ____ ppm

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Calibration Date: 07-30-10 Calibration Time: 5
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 23.0 °C DO Solubility ____ ppm
Meter Water Temperature 23.0 °C Meter DO ____ ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to ____ ppm

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Calibration Date: 07-30 10 Calibration Time: 6 7
Meter Type: ✓ YSI (meter # 83) ____ Hach MS5
Calibration Water Temperature ____ °C DO Solubility 7 ppm
Meter Water Temperature 0 °C Meter DO 8.3 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to ____ ppm

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Calibration Date: 07-30-10 Calibration Time: 1750
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO ____ ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to ____ ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 1 of 2

Calibration Date: 7/31/10 Calibration Time 6:54
Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.3 ppm
Meter Water Temp. adjusted to ___ °C Meter DO adjusted to 8.9 ok ppm

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Calibration Date: 7/31/10 Calibration Time: 8:50
Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to ___ °C Meter DO adjusted to 8.9 ok ppm

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Calibration Date: 7/31/10 Calibration Time: 10:50
Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 23.0 °C DO Solubility 8.56 (8.5) ppm
Meter Water Temperature 23.0 °C Meter DO 8.6 ppm
Meter Water Temp. adjusted to ___ °C Meter DO adjusted to 8.6 ppm

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Calibration Date: 7/31/10 Calibration Time: 7:48
Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.85 ppm
Meter Water Temp. adjusted to ___ °C Meter DO adjusted to 8.9 ok ppm

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Calibration Date: 7/31/10 Calibration Time: 9:52
Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.72 (8.7) ppm
Meter Water Temperature 22.0 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to ___ °C Meter DO adjusted to 8.7 ok ppm

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Calibration Date: 7/31/10 Calibration Time: 11:51
Meter Type: X YSI (meter # PH91-M2) ___ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.40 ppm
Meter Water Temperature 24.0 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to ___ °C Meter DO adjusted to N/A ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 2 of 2

Calibration Date: 7/31/10 Calibration Time: 12:52
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.40 ppm
Meter Water Temperature 24.0 °C Meter DO 8.3 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 8.4 ok ppm

Calibration Date: 7/31/10 Calibration Time: 13:53
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.40 ppm
Meter Water Temperature 24.0 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

Calibration Date: 7/31/10 Calibration Time: 14:52
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.40 ppm
Meter Water Temperature 24.0 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

Calibration Date: 7/31/10 Calibration Time: 16:54
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.40 ppm
Meter Water Temperature 24.0 °C Meter DO 8.5 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 8.4 ok ppm

Calibration Date: 7/31/10 Calibration Time: 17:52
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 24.0 °C DO Solubility 8.40 ppm
Meter Water Temperature 24.0 °C Meter DO ______ ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to ______ ppm

Calibration Date: ______ Calibration Time: ______
Meter Type: ______ YSI (meter # ______) ______ Hach MS5
Calibration Water Temperature ______ °C DO Solubility ______ ppm
Meter Water Temperature ______ °C Meter DO ______ ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to ______ ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 8/1/10 Calibration Time: 6:53
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.4 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 8.9 ok ppm

Calibration Date: 8/1/10 Calibration Time: 7:53
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.07 (9.1) ppm
I don't know how it went down but it did!
Meter Water Temperature 20.0 °C Meter DO 8.95 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 9.1 ok ppm

Calibration Date: 8/1/10 Calibration Time: 8:52
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.07 (9.1) ppm
Meter Water Temperature 20.0 °C Meter DO 9.15 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 9.1 ok ppm

Calibration Date: 8/1/10 Calibration Time: 9:52
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.07 (9.1) ppm
Meter Water Temperature 20.0 °C Meter DO ____ ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to ____ ppm

Calibration Date: 8/1/10 Calibration Time: 10:54
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9 ppm
Meter Water Temperature ____ °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 9.1 ppm

Calibration Date: 8/1/10 Calibration Time: 11:
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature ____ °C DO Solubility ____ ppm
Meter Water Temperature ____ °C Meter DO ____ ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to ____ ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 2 of 2

Calibration Date: 8/1/10 Calibration Time: 12:57
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.72 (8.7) ppm
Meter Water Temperature 22.0 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

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Calibration Date: 8/1/10 Calibration Time: 13:52
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 23.0 °C DO Solubility 8.56 (8.55) ppm
Meter Water Temperature 23.0 °C Meter DO 8.5 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 8.55 ok ppm

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Calibration Date: 8/1/10 Calibration Time: 14:52
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 23.0 °C DO Solubility 8.56 (8.55) ppm
Meter Water Temperature 23.0 °C Meter DO 8.55 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

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Calibration Date: 8/1/10 Calibration Time: 16:53
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 23.0 °C DO Solubility 8.56 (8.55) ppm
Meter Water Temperature 23.0 °C Meter DO 8.5 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

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Calibration Date: 8/1/10 Calibration Time: 17:50
Meter Type: X YSI (meter # PH91 M2) ______ Hach MS5
Calibration Water Temperature 3 °C DO Solubility 8 ppm
Meter Water Temperature 30 °C Meter DO 8.6 ppm
put ' between 8.5 & 8.6
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 8.55 ppm

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Calibration Date: ______ Calibration Time: ______
Meter Type: ______ YSI (meter # ______) ______ Hach MS5
Calibration Water Temperature ______ °C DO Solubility ______ ppm
Meter Water Temperature ______ °C Meter DO ______ ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to ______ ppm

R+W COOLER (QC)

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 08-02-10 Calibration Time: 0552
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 08-02-10 Calibration Time: 0748
Meter Type: ✓ YSI (meter # PH91-M2 ______ Hach MS5
Calibration Water Temperature 21.8 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.8 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.8 ppm

Calibration Date: 08-02-10 Calibration Time: 0942
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.6 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.7 ppm

Calibration Date: 08-02-10 Calibration Time: 1151
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.7 ppm

Calibration Date: 08-02-10 Calibration Time: 1355
Meter Type: ✓ YSI (meter # P M) ______ Hach MS5
Calibration Water Temperature 2 °C DO Solubility 8.7 ppm
Meter Water Temperature ______ °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to °C Meter DO adjusted to N/A ppm

Calibration Date: 08-02-10 Calibration Time: 1448
Meter Type: ✓ YSI (meter # PH91-M8) ______ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.7 ppm

✓ PH91-M2 1659

21.5 8.8
21.2 8.7
21.5 8.8

WOODEN BOX

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 08-02-10 Calibration Time: 0552
Meter Type: ✓ YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO ______ ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to ______ ppm

Calibration Date: 08-02-10 Calibration Time: 0653
Meter Type: ✓ YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 87 ppm
Meter Water Temperature 22.0 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 08-02-10 Calibration Time: 0748
Meter Type: ✓ YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 21.8 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.9 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 08-02-10 Calibration Time: 0854
Meter Type: ✓ YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 08-02-10 Calibration Time: 0942
Meter Type: ✓ YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8. ppm
Meter Water Temperature 22.0 °C Meter DO 8.6 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.7 ppm

Calibration Date: 08-2-10 Calibration Time: 1058
Meter Type: ✓ YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

WOODEN BOX

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 2 of 2

Calibration Date: 08-02-10 Calibration Time: 1151
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 08-02-10 Calibration Time: 1258
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 08-02 Calibration Time: ____
Meter Type: ✓ YSI (meter # ____) ____ Hach MS5
Calibration Water Temperature ____ °C DO Solubility ____ ppm
Meter Water Temperature 2 °C Meter DO 8 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 7 ppm

Calibration Date: 08-02-10 Calibration Time: 1448
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 08-02-10 Calibration Time: 1553
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.6 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.8 ppm

Calibration Date: 08-02-10 Calibration Time: 1659
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

08-02-10
✓ YSI

1755
8.8
8.7
8.8

Dissolved Oxygen and Water Temperature Meter Calibration Sheet 8-13-10 Page 1 of 2 SJC/dab

Calibration Date: 8-13-10 Calibration Time: 6:52
Meter Type: YSI YSI (meter # 10983) ______ Hach MS5
Calibration Water Temperature 20.8 °C DO Solubility 8.9 ppm
Meter Water Temperature 20.8 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 8-13-10 Calibration Time: 7:54
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature 20.8 °C DO Solubility 8.9 ppm
Meter Water Temperature 20.8 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 8-13-10 Calibration Time: 8:54
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature 20.8 °C DO Solubility 8.9 ppm
Meter Water Temperature 20.8 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to 8.9 ppm

Calibration Date: 8-13-10 Calibration Time: 9:54
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature 20.9 °C DO Solubility 8.9 ppm
Meter Water Temperature 20.9 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to 8.9 ppm

Calibration Date: 8-13-10 Calibration Time: 10:53
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.9 ppm
Meter Water Temperature 21.1 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 8-13-10 Calibration Time: 11:53
Meter Type: ______ YSI (meter #__________) ______ Hach MS5
Calibration Water Temperature 21.2 °C DO Solubility 8.9 ppm
Meter Water Temperature 21.2 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to 8.9 ppm

STC/ELCB

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 8-13-10 Calibration Time: 1250 hrs
Meter Type: YSI YSI (meter # 10983) _____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 8/13/10 Calibration Time: 1350 hrs
Meter Type: YSI YSI (meter # 10983) _____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 8/13/10 Calibration Time: 1453 hrs
Meter Type: YSI YSI (meter # 10983) _____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 8/13/10 Calibration Time: 1550 hrs
Meter Type: ✓ YSI (meter # 10983) _____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 8/13/10 Calibration Time: 1648 hrs
Meter Type: ✓ YSI (meter # 10983) _____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 8/13/10 Calibration Time: 1745
Meter Type: ✓ YSI (meter # 10983) _____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

OWL

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 8/14/10 Calibration Time: 6:54
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.72 (8.7) ppm
Meter Water Temperature 22.0 °C Meter DO 8.2 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 8.7 ok ppm

Calibration Date: 8/14/10 Calibration Time: 8:52
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to N/A ppm

Calibration Date: 8/14/10 Calibration Time: 10:50
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.72 (8.7) ppm
Meter Water Temperature 22.0 °C Meter DO 8.1 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 8.7 ok ppm

Calibration Date: 8/14/10 Calibration Time: 7:57
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 8.9 ok ppm

I turned the AC up so that is probubly th cause of th 1° temp drop. (22 to 21°C)

Calibration Date: 8/14/10 Calibration Time: 9:52
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO ____ ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to ____ ppm

Calibration Date: 8/14/10 Calibration Time: 11:52
Meter Type: X YSI (meter # PH91-M2) ____ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.72 (8.7) ppm
Meter Water Temperature 22.0 °C Meter DO 8.6 ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to 8.7 ok ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 8/ 10
Calibration Time: 12:52
Meter Type: X YSI (meter # PH91-M2)
_____ Hach MS5
Calibration Water Temperature 22.0 °C
DO Solubility 8.72 (8.7) ppm
Meter Water Temperature 22.0 °C
Meter DO 8.6 ppm
Meter Water Temp. adjusted to _____ °C
Meter DO adjusted to 8.7 ok ppm

Calibration Date: 8/14/10
Calibration Time: 13:55
Meter Type: X YSI (meter # PH91-M2)
_____ Hach MS5
Calibration Water Temperature 23.0 °C
DO Solubility 8.56 (8.5) ppm
Meter Water Temperature 23.0 °C
Meter DO _____ ppm
Meter Water Temp. adjusted to _____ °C
Meter DO adjusted to _____ ppm

Calibration Date: 8/14/10
Calibration Time: 14:54
Meter Type: X YSI (meter # PH91-M2)
_____ Hach MS5
Calibration Water Temperature 23.0 °C
DO Solubility 8.56 (8.5) ppm
Meter Water Temperature 23.0 °C
Meter DO 8.5 ppm
Meter Water Temp. adjusted to _____ °C
Meter DO adjusted to N/A ppm

Calibration Date: 8/14/10
Calibration Time: 15:53
Meter Type: X YSI (meter # PH91-M2)
_____ Hach MS5
Calibration Water Temperature 23.0 °C
DO Solubility 8.56 (8.5) ppm
Meter Water Temperature 23.0 °C
Meter DO 8.5 ppm
Meter Water Temp. adjusted to _____ °C
Meter DO adjusted to N/A ppm

Calibration Date: 8/14/10
Calibration Time: 17:50
Meter Type: X YSI (meter # PH91-M2)
_____ Hach MS5
Calibration Water Temperature 23.0 °C
DO Solubility 8.56 (8.5) ppm
Meter Water Temperature 23.0 °C
Meter DO 8.5 ppm
Meter Water Temp. adjusted to _____ °C
Meter DO adjusted to N/A ppm

Calibration Date: _____
Calibration Time: _____
Meter Type: _____ YSI (meter # _____)
_____ Hach MS5
Calibration Water Temperature _____ °C
DO Solubility _____ ppm
Meter Water Temperature _____ °C
Meter DO _____ ppm
Meter Water Temp. adjusted to _____ °C
Meter DO adjusted to _____ ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 8/15/10 Calibration Time: 6:
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.72 (8.7) ppm
Meter Water Temperature 22.0 °C Meter DO 8.1 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 8.7 ok ppm

Calibration Date: 8/15/10 Calibration Time: 7:55
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO ______ ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to ______ ppm

Calibration Date: 8/15/10 Calibration Time: 8:53
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

Calibration Date: 8/15/10 Calibration Time: 9:50
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

Calibration Date: 8/15/10 Calibration Time: 10:55
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO ______ ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to ______ ppm

Calibration Date: 8/15/10 Calibration Time: 11:54
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.07 (9.1) ppm
Meter Water Temperature 20.0 °C Meter DO ______ ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to ______ ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: ____________ Calibration Time: ____________
Meter Type: X YSI (meter #____________) ______ Hach MS5
Calibration Water Temperature ____________ °C DO Solubility ____________ ppm
Meter Water Temperature ____________ °C Meter DO ____________ ppm
Meter Water Temp. adjusted to °C Meter DO adjusted to ______ ppm

Calibration Date: ____________ Calibration Time: ____________
Meter Type: ______ YSI (meter #____________) ______ Hach MS5
Calibration Water Temperature 2 °C DO Solubility ____________ ppm
Meter Water Temperature ____________ °C Meter DO ____________ ppm
Meter Water Temp. adjusted to ____________ °C Meter DO adjusted to ______ ppm

Calibration Date: 8/15/10 Calibration Time: 17:50
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.9 ou ppm
Meter Water Temp. adjusted to ____________ °C Meter DO adjusted to N/A ppm

Calibration Date: 0 Calibration Time: ____________
Meter Type: ______ YSI (meter #____________) ______ Hach MS5
Calibration Water Temperature ____________ °C DO Solubility ____________ ppm
Meter Water Temperature ____________ °C Meter DO ____________ ppm
Meter Water Temp. adjusted to ____________ °C Meter DO adjusted to ______ ppm

Calibration Date: ____________ Calibration Time: ____________
Meter Type: ______ YSI (meter #____________) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to ____________ °C Meter DO adjusted to N/A ppm

Calibration Date: ____________ Calibration Time: ____________
Meter Type: ______ YSI (meter #____________) ______ Hach MS5
Calibration Water Temperature ____________ °C DO Solubility ____________ ppm
Meter Water Temperature ____________ °C Meter DO ____________ ppm
Meter Water Temp. adjusted to ____________ °C Meter DO adjusted to ______ ppm

EK

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 8-16-10 Calibration Time: 0550
Meter Type: YSI YSI (meter # PH-91-M2 ______ Hach MS5
Calibration Water Temperature 22.5 °C DO Solubility 8.65 ppm
Meter Water Temperature 22.45 °C Meter DO 8.70 ppm
Meter Water Temp. adjusted to 22.5 °C Meter DO adjusted to 8.65 ppm

Calibration Date: 8-16-10 Calibration Time: 0650
Meter Type: YSI YSI (meter # PH91M2) ______ Hach MS5
Calibration Water Temperature 22.5 °C DO Solubility 8.65 ppm
Meter Water Temperature 22.5 °C Meter DO 8.6 ppm
Meter Water Temp. adjusted to 22.5 °C Meter DO adjusted to 8.65 ppm

Calibration Date: 8-16-10 Calibration Time: 0750
Meter Type: YSI YSI (meter # PH91 M2) ______ Hach MS5
Calibration Water Temperature 22.5 °C DO Solubility 8.65 ppm
Meter Water Temperature 22.5 °C Meter DO 8.70 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to 8.65 ppm

Calibration Date: 8-16-10 Calibration Time: 0850
Meter Type: YSI YSI (meter # PH91M2) ______ Hach MS5
Calibration Water Temperature 22.9 °C DO Solubility 8.6 ppm
Meter Water Temperature 22.9 °C Meter DO 8.6 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 8-16-10 Calibration Time: 0950
Meter Type: YSI YSI (meter # PH91M2) ______ Hach MS5
Calibration Water Temperature 23.0 °C DO Solubility 8.56 ppm
Meter Water Temperature 23.2 °C Meter DO 8.56 ppm
Meter Water Temp. adjusted to 23.0 °C Meter DO adjusted to OK ppm

Calibration Date: 8-16-10 Calibration Time: 1050
Meter Type: YSI YSI (meter # PH-91M2) ______ Hach MS5
Calibration Water Temperature 25.0 °C DO Solubility 8.24 ppm
Meter Water Temperature 25.1 °C Meter DO 8.30 ppm
Meter Water Temp. adjusted to 25.0 °C Meter DO adjusted to 8.24 ppm

EK

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

Page 2 of 3

Calibration Date: 8-16-10 Calibration Time: 1150
Meter Type: YSI YSI (meter #PH91 M2) ______ Hach MS5
Calibration Water Temperature 25.5 °C DO Solubility 8.2 ppm
Meter Water Temperature 25.5 °C Meter DO 8.2 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 8-16-10 Calibration Time: 1250
Meter Type: YSI YSI (meter #PH91M2) ______ Hach MS5
Calibration Water Temperature 26.0 °C DO Solubility 8.1 ppm
Meter Water Temperature 26.0 °C Meter DO 8.1 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 8-16-10 Calibration Time: 1350
Meter Type: YSI YSI (meter #PH91 M2) ______ Hach MS5
Calibration Water Temperature 26.2 °C DO Solubility 8.05 ppm
Meter Water Temperature 26.2 °C Meter DO 8.1 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to 8.05 ppm

Calibration Date: 8-16-10 Calibration Time: 1450
Meter Type: YSI YSI (meter #PH91M2) ______ Hach MS5
Calibration Water Temperature 26.3 °C DO Solubility 8.05 ppm
Meter Water Temperature 26.3 °C Meter DO 8.10 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to 8.05 ppm

Calibration Date: 8-16-10 Calibration Time: 1550
Meter Type: YSI YSI (meter #PH91M2) ______ Hach MS5
Calibration Water Temperature 26.0 °C DO Solubility 8.1 ppm
Meter Water Temperature 26.0 °C Meter DO 8.1 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: 8-16-10 Calibration Time: 1650
Meter Type: YSI YSI (meter #PH 91 M2) ______ Hach MS5
Calibration Water Temperature 26.0 °C DO Solubility 8.1 ppm
Meter Water Temperature 26.0 °C Meter DO 8.2 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 8.1 ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 8-16-10 Calibration Time: 1750
Meter Type: YSI YSI (meter # PH91M2) ___ Hach MS5
Calibration Water Temperature 25.2 °C DO Solubility 8.2 ppm
Meter Water Temperature 25.2 °C Meter DO 8.2 ppm
Meter Water Temp. adjusted to OK °C Meter DO adjusted to OK ppm

Calibration Date: ___ Calibration Time: ___
Meter Type: ___ YSI (meter # ___) ___ Hach MS5
Calibration Water Temperature ___ °C DO Solubility ___ ppm
Meter Water Temperature ___ °C Meter DO ___ ppm
Meter Water Temp. adjusted to ___ °C Meter DO adjusted to ___ ppm

Calibration Date: ___ Calibration Time: ___
Meter Type: ___ YSI (meter # ___) ___ Hach MS5
Calibration Water Temperature ___ °C DO Solubility ___ ppm
Meter Water Temperature ___ °C Meter DO ___ ppm
Meter Water Temp. adjusted to ___ °C Meter DO adjusted to ___ ppm

Calibration Date: ___ Calibration Time: ___
Meter Type: ___ YSI (meter # ___) ___ Hach MS5
Calibration Water Temperature ___ °C DO Solubility ___ ppm
Meter Water Temperature ___ °C Meter DO ___ ppm
Meter Water Temp. adjusted to ___ °C Meter DO adjusted to ___ ppm

Calibration Date: ___ Calibration Time: ___
Meter Type: ___ YSI (meter # ___) ___ Hach MS5
Calibration Water Temperature ___ °C DO Solubility ___ ppm
Meter Water Temperature ___ °C Meter DO ___ ppm
Meter Water Temp. adjusted to ___ °C Meter DO adjusted to ___ ppm

Calibration Date: ___ Calibration Time: ___
Meter Type: ___ YSI (meter # ___) ___ Hach MS5
Calibration Water Temperature ___ °C DO Solubility ___ ppm
Meter Water Temperature ___ °C Meter DO ___ ppm
Meter Water Temp. adjusted to ___ °C Meter DO adjusted to ___ ppm

RED + WHT COOLER

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 08-25-10 Calibration Time: 0615
Meter Type: ✓ YSI (meter #PH91-M2) ______ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.0 ppm
Meter Water Temperature 19.8 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to 20.0 °C Meter DO adjusted to 9.0 ppm

Calibration Date: 08-25-10 Calibration Time: 0750
Meter Type: ✓ YSI (meter #PH91-M2) ______ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.0 ppm
Meter Water Temperature 19.9 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to 20.0 °C Meter DO adjusted to 9.0 ppm

Calibration Date: 08-25-10 Calibration Time: 0955
Meter Type: ✓ YSI (meter #PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.9 ppm
Meter Water Temperature 21.0 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 08-25-10 Calibration Time: 1150
Meter Type: ✓ YSI (meter #PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.8 ppm

Calibration Date: 08-25-10 Calibration Time: 1345
Meter Type: ✓ YSI (meter #PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 08-25-10 Calibration Time: 1550
Meter Type: ✓ YSI (meter #PH91-M2) ______ Hach MS5
Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.5 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 9.0 ppm

1750 HRS 20 9.0
8.9
N A

WOODEN BOX

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 08-25-10 Calibration Time: 0615
Meter Type: ✓ YSI (meter # 10983) Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.0 ppm
Meter Water Temperature 19.8 °C Meter DO 9.2 ppm
Meter Water Temp. adjusted to 20.0 °C Meter DO adjusted to 9.0 ppm

Calibration Date: 08-25-10 Calibration Time: 0651
Meter Type: ✓ YSI (meter # 10983) Hach MS5
Calibration Water Temperature 20.1 °C DO Solubility 9.1 ppm
Meter Water Temperature 20.0 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to 20.1 °C Meter DO adjusted to N/A ppm

Calibration Date: 08-25-10 Calibration Time: 0750
Meter Type: ✓ YSI (meter # 10983) Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.0 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 08-25-10 Calibration Time: 0851
Meter Type: ✓ YSI (meter # 10983) Hach MS5
Calibration Water Temperature 20.2 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.4 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to 20.2 °C Meter DO adjusted to 9.0 ppm

Calibration Date: 08-25-10 Calibration Time: 0955
Meter Type: ✓ YSI (meter # 10983) Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 89 ppm
Meter Water Temperature 20.8 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to 21.0 °C Meter DO adjusted to N/A ppm

Calibration Date: 08-25-10 Calibration Time: 1047
Meter Type: ✓ YSI (meter # 10983) Hach MS5
Calibration Water Temperature 21.6 °C DO Solubility 8.9 ppm
Meter Water Temperature 21.0 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.9 ppm

WOODEN BOX

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 08-25-10 Calibration Time: 1150
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to N/A ppm

Calibration Date: 08-25-10 Calibration Time: 1249
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.8 ppm

Calibration Date: 08-25-10 Calibration Time: 1345
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 21.5 °C DO Solubility 8.8 ppm
Meter Water Temperature 21.5 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.8 ppm

Calibration Date: 08-25-10 Calibration Time: 1449
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.9 ppm
Meter Water Temperature 21.2 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to 21.0 °C Meter DO adjusted to 8.9 ppm

Calibration Date: 08-25-10 Calibration Time: 1550
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.5 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 9.0 ppm

Calibration Date: 08-25-10 Calibration Time: 1644
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.0 ppm
Meter Water Temperature 19.8 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to 20.0 °C Meter DO adjusted to 9.0 ppm

1750 HRS
20.0°C 9.0
20.2°C 9.0
20.0°C N/A

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 8/26/10 Calibration Time: 0555
Meter Type: X YSI (meter # PH91-m2) ____ Hach MS5
Calibration Water Temperature 19.9 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.1 °C Meter DO 9.8 ppm
Meter Water Temp. adjusted to 19.9 °C Meter DO adjusted to 9.0 ppm

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Calibration Date: 8/26/10 Calibration Time: 0645
Meter Type: X YSI (meter # PH91-m2) ____ Hach MS5
Calibration Water Temperature 19.9 °C DO Solubility 9.07 ppm
Meter Water Temperature 19.9 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to — °C Meter DO adjusted to 9.0 ppm

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Calibration Date: 8/26/10 Calibration Time: 0751
Meter Type: X YSI (meter # PH91-m2) ____ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.07 ppm
Meter Water Temperature 20.0 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to — °C Meter DO adjusted to 9.0 ppm

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Calibration Date: 8/26/10 Calibration Time: 0848
Meter Type: X YSI (meter # ____) ____ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 20.0 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to — °C Meter DO adjusted to — ppm

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Calibration Date: 8/26/10 Calibration Time: 0947
Meter Type: X YSI (meter # ____) ____ Hach MS5
Calibration Water Temperature 20.8 °C DO Solubility 8.9 ppm
Meter Water Temperature — °C Meter DO — ppm
Meter Water Temp. adjusted to — °C Meter DO adjusted to ____ ppm

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Calibration Date: 8/26/10 Calibration Time: 1648
Meter Type: X YSI (meter # ____) ____ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 21.0 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to — °C Meter DO adjusted to — ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 8/26/10 Calibration Time: 1140
Meter Type: X YSI (meter #) ___ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 21.0 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to — °C Meter DO adjusted to — ppm

Calibration Date: 8/26/10 Calibration Time: 1237
Meter Type: ___ YSI (meter #) ___ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 21.0 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to — °C Meter DO adjusted to → ppm

Calibration Date: 8/26/10 Calibration Time: 1348
Meter Type: X YSI (meter #) ___ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 21.0 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to — °C Meter DO adjusted to 9.1 ppm

Calibration Date: 8/26/10 Calibration Time: 1448
Meter Type: X YSI (meter #) ___ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 210 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to — °C Meter DO adjusted to — ppm

Calibration Date: 8/26 Calibration Time: 1545
Meter Type: X YSI (meter #) ___ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 20.0 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to — °C Meter DO adjusted to — ppm

Calibration Date: 8/26 Calibration Time: 1640
Meter Type: X YSI (meter #) ___ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.1 ppm
Meter Water Temperature 20.0 °C Meter DO 9.1 ppm
Meter Water Temp. adjusted to — °C Meter DO adjusted to — ppm

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Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 8/27/10 Calibration Time: 0810
Meter Type: X YSI (meter # 1098.3) ___ Hach MS5
Calibration Water Temperature 19.0 °C DO Solubility 9.3 ppm
Meter Water Temperature 19.5 °C Meter DO 8.6 ppm
Meter Water Temp. adjusted to 19.0 °C Meter DO adjusted to 9.26 ppm

Calibration Date: 8/27/10 Calibration Time: 0840
Meter Type: / YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 19.5 °C DO Solubility 9.1 ppm
Meter Water Temperature 19.5 °C Meter DO 9.8 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 9.5 ppm

Calibration Date: 08-27-10 Calibration Time: 0951
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 22.6 °C DO Solubility 8.7 ppm
Meter Water Temperature 22.0 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.7 ppm

Calibration Date: 8-27-10 Calibration Time: 1055
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm
Meter Water Temperature 21.8 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to 22.0 °C Meter DO adjusted to 8.7 ppm

Calibration Date: 8-27-10 Calibration Time: 1148
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.9 ppm
Meter Water Temperature 21.5 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to 21.0 °C Meter DO adjusted to 8.9 ppm

Calibration Date: 08-27-10 Calibration Time: 1253
Meter Type: ✓ YSI (meter # 10983) ___ Hach MS5
Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm
Meter Water Temperature 20.8 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to 20.5 °C Meter DO adjusted to 9.0 ppm

WOODEN BOX

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 08-27-10 Calibration Time: 1350
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.0 ppm
Meter Water Temperature 19.8 °C Meter DO 8.9 ppm
Meter Water Temp. adjusted to 20.0 °C Meter DO adjusted to 9.0 ppm

Calibration Date: 08-27-10 Calibration Time: 1448
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 19.0 °C DO Solubility 9.2 ppm
Meter Water Temperature 19.2 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to 19.0 °C Meter DO adjusted to 9.2 ppm

Calibration Date: 08-27-10 Calibration Time: 1552
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 19.0 °C DO Solubility 9.2 ppm
Meter Water Temperature 19.0 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 9.2 ppm

Calibration Date: 08-27-10 Calibration Time: 1641
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 18.8 °C DO Solubility 9.3 ppm
Meter Water Temperature 18.5 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to 18.8 °C Meter DO adjusted to 9.3 ppm

Calibration Date: 08-27-10 Calibration Time: 1743
Meter Type: ✓ YSI (meter # 10983) ____ Hach MS5
Calibration Water Temperature 19.0 °C DO Solubility 9.2 ppm
Meter Water Temperature 19.0 °C Meter DO 9.0 ppm
Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 9.2 ppm

Calibration Date: ____ Calibration Time: ____
Meter Type: ____ YSI (meter # ____) ____ Hach MS5
Calibration Water Temperature ____ °C DO Solubility ____ ppm
Meter Water Temperature ____ °C Meter DO ____ ppm
Meter Water Temp. adjusted to ____ °C Meter DO adjusted to ____ ppm

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Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 8/27/10 Calibration Time: 0840
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5

Calibration Water Temperature 19.5 °C DO Solubility 9.1 ppm

Meter Water Temperature 19.5 °C Meter DO 8.5 ppm

Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 9.1 ppm

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Calibration Date: 8-27-10 Calibration Time: 1055
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5

Calibration Water Temperature 22.0 °C DO Solubility 8.7 ppm

Meter Water Temperature 22.0 °C Meter DO 8.3 ppm

Meter Water Temp. adjusted to N/A °C Meter DO adjusted to 8.7 ppm

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Calibration Date: 8·27-10 Calibration Time: 1253
Meter Type: ✓ YSI (meter # PH92-M2) ______ Hach MS5

Calibration Water Temperature 20.5 °C DO Solubility 9.0 ppm

Meter Water Temperature 20.2 °C Meter DO 8.8 ppm

Meter Water Temp. adjusted to 20.5 °C Meter DO adjusted to 9.0 ppm

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Calibration Date: 08·27-10 Calibration Time: 1448
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5

Calibration Water Temperature 19.0 °C DO Solubility 9.2 ppm

Meter Water Temperature 19.2 °C Meter DO 9.5 ppm

Meter Water Temp. adjusted to 19.0 °C Meter DO adjusted to 9.2 ppm

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Calibration Date: 08-27- 0 Calibration Time: 1641
Meter Type: ✓ YSI (meter # P ______) ______ Hach MS5

Calibration Water Temperature 18.8 °C DO Solubility ______ ppm

Meter Water Temperature 18.5 °C Meter DO ______ ppm

Meter Water Temp. adjusted to 18.8 °C Meter DO adjusted to ______ ppm

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Calibration Date: ______ Calibration Time: ______
Meter Type: ______ YSI (meter # ______) ______ Hach MS5

Calibration Water Temperature ______ °C DO Solubility ______ ppm

Meter Water Temperature ______ °C Meter DO ______ ppm

Meter Water Temp. adjusted to ______ °C Meter DO adjusted to ______ ppm

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Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 8/28/10 Calibration Time: 6:55
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 18.0 °C DO Solubility 9.45 (9.5) ppm
Meter Water Temperature 18.0 °C Meter DO 9.6 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 9.5 ok ppm

Calibration Date: 8/28/10 Calibration Time: 7:54
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 19.0 °C DO Solubility 9.26 (9.3) ppm
Meter Water Temperature 19.0 °C Meter DO 9.4 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 9.3 ok ppm

Calibration Date: 8/28/10 Calibration Time: 8:54
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.07 (9.1) ppm
Meter Water Temperature 20.0 °C Meter DO 9.2 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 9.1 ok ppm

Calibration Date: 8/28/10 Calibration Time: 9:54
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 8.9 ok ppm

Calibration Date: 8/28/10 Calibration Time: 10:
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.8 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 8.9 ok ppm

Calibration Date: 8/28/10 Calibration Time: 11:51
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.9 ppm
Meter Water Temperature 21.0 °C Meter DO 8.9 ok ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

Dissolved Oxygen and Water Temperature Meter Calibration Sheet

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Calibration Date: 8/28/10 Calibration Time: 12:53
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.9 ok ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

Calibration Date: 8/28/10 Calibration Time: 15:56
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.9 ok ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to ______ ppm

Calibration Date: 8/28/10 Calibration Time: 17:54
Meter Type: ✓ YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.07 (9.1) ppm
Meter Water Temperature 20.0 °C Meter DO 9.1 ok ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to N/A ppm

Calibration Date: 8/28/10 Calibration Time: 14:54
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 21.0 °C DO Solubility 8.90 ppm
Meter Water Temperature 21.0 °C Meter DO 8.7 ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to 8.9 ok ppm

Calibration Date: 8/28/10 Calibration Time: 16:55
Meter Type: X YSI (meter # PH91-M2) ______ Hach MS5
Calibration Water Temperature 20.0 °C DO Solubility 9.07 (9.1) ppm
Meter Water Temperature 20.0 °C Meter DO ______ ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to ______ ppm

Calibration Date: ______ Calibration Time: ______
Meter Type: ______ YSI (meter # ______) ______ Hach MS5
Calibration Water Temperature ______ °C DO Solubility ______ ppm
Meter Water Temperature ______ °C Meter DO ______ ppm
Meter Water Temp. adjusted to ______ °C Meter DO adjusted to ______ ppm

APPENDIX A-2: FECAL COLIFORM SAMPLING AND ANALYSIS PROCEDURES.

Lancaster Laboratories

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Analysis #0199, 11028
Revision 08
Supersedes Date: 06/23/08
Effective Date: JUL 2 8 2010
Page 1 of 23

Modification
Fecal Coliform by Membrane Filtration

Approvals:

Prepared by: ______________________ Date: 7/9/10
Microbiologist

Approved by: ______________________ Date: 7-13-10
Environmental Microbiology Management

Approved by: ______________________ Date: 07/14/10
Quality Assurance

Revision Log:

Revision: 08	Effective Date: This Version	
Section	**Justification**	**Changes**
Document Number (Header)	Combine Documents	Added analysis 11028
Revision Log	Formatting requirement per LOM-SOP-LAB-201	Removed revision logs up to the previous version
Cross Reference	Reflect applicable documents	Replaced OMC-PM-045 with OMC-MCV-002 and added OMC-PS-012
Basic Principles	To reflect current practices	Removed sentence pertaining to normal volume filtered and minor wording changes
Interferences	Clarification To reflect requirements	Removed ">50ppm" Chlorine residual not required for QC samples
Safety Precautions and Waste Handling	Formatting requirement per LOM-SOP-LAB-201	Added required verbiage
Personnel Training and Qualifications	Formatting requirement per LOM-SOP-LAB-201	Added required verbiage
Sample Collection, Preservation, and Handling	Added applicable analysis Clarification on analysis hold time	Added analysis 11028 for non-NPDES permit samples Incorporated PA # 1 (dated 08/18/08) – Changed 2nd paragraph
Apparatus and Equipment	To reflect current practices Addition Clarification	Removed 10- and 1-mL pipettes Added disposable pipettes to sterile pipette tips Removed glass funnels, UV sterilizer, and sterile filters, renumbered section accordingly
Calibration	Formatting requirement per LOM-SOP-LAB-201	Added as new, added reference to OMC-PS-012
Procedure	To reflect current practices	Added direction for testing chlorine positive samples
Procedure A.	Clarification	Added requirement for use of calibrated micropipettors
Procedure A.1.b.	To reflect current practices	Added that it is acceptable to use the client designation if the sample number has not yet been generated
Procedure A.6.	To reflect current requirements	Added use of continuous flow of sterile water for rinsing
Procedure A.10.	To reflect current practices	Added new recording time step, renumbered section accordingly
Procedure A.16. (Previously A.15.)	Clarification on temperature excursions	Incorporated PA #3 (dated 02/18/09) – Added text regarding temperature excursion
Procedure A.17. (Previously A.16.)	To reflect current requirements Clarification To reflect current requirements	Added use of magnifying lens Added rounding requirements Added requirement of recording total counts and TNTC result if there are >200 total CFU
Procedure B.	Clarification	Added table illustrating possible dilution scheme and noted the acceptable use of direct filtration
Procedure B.1.	Correction	Incorporated PA #2 (dated 12/03/08) – Updated to include effluents

Revision: 08	Effective Date: This version	
Procedure B.2.	Correction Information moved	Incorporated PA #2 (dated 12/03/08) – Updated to remove effluents Deleted information regarding dilution scheme, added to note at beginning of section
Procedure B.3.	Clarification	Added units to sample weights
Procedure B.4.	Clarification Clarification	Added reference to Attachment I Added units to sample weights
Procedure C.	To reflect current practices	Deleted section, glass funnels no longer in use
Data Entry 1.	To reflect current practices	Added review of collection information during data entry stage
Data Entry 4.	To reflect current requirements	Added new entry information for plates with >200 total CFU
Quality Assurance/ Quality Control	To reflect current practices	Changed volume of *E. coli* from 1.0 mL to 0.5 mL

Revision: 07	Effective Date: 06/23/08	
Section	Justification	Changes
Cross Reference	To reflect documents currently applicable	Removed Analysis #0302 and #2378; added OMC-PM-045
Scope	Information moved to appropriate section Duplication of information found in Sample Handling section	Moved LOQ information to Calculations section and wastewater effluent sample information to Sample Handling section Removed statement of 24 hour completion if verification not needed
Definitions	For informational purposes	Addition of influent, effluent, NPDES, bathing beach and monitoring well definitions
Personnel Training and Qualifications	Clarification No longer applicable	Removed sections pertaining to aseptic technique and pipette aid use; added general statement about aseptic technique and pipette aid use, about training and what training records should contain, and about data entry; minor wording changes Removed reference to Analysis #0302
Interferences	No longer applicable	Removed reference to Analysis #2378; minor wording changes
Safety Precautions and Waste Handling	UV lamps being removed from testing	Removed section about testing UV lamps
Sample Handling	Information moved to appropriate section	Added wastewater effluent sample information
Apparatus and Equipment	NELAC requirement Testing material change	Added requirement for use of calibrated pipettes Added sterile pipette tips and presterilized disposable filter units
Reagents and Standards	Clarification	Added *E. coli* and *S. marcescens*; minor wording changes
Procedure	Clarification Applicable information	Rearranged section; removed reference to UV lamps; totally reconstructed testing steps; added use of purchased presterilized disposable filter units; made minor wording changes Added reference to use of client parameters

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Revision: 07	Effective Date: 06/23/08	
Procedure B.	Provide direction for balance calibration	Added reference to OMC-PM-045
Calculations	Informational purposes	Added example for calculation
Data Entry	Incorporation of PA #1 (dated 03/28/08)	Entire section rewritten
Quality Assurance/ Quality Control	New testing step	Step 3. - added negative control information
	Direction for lot comparison testing	Step 4. - added procedure reference for lot comparison testing
	Applicable information	Step 5. – added to provide monthly duplicate counts information
		Step 6. - added testing steps for monthly verification
	Testing material change	Removed section for checking sterility of each funnel

Reference:

1. *Standard Methods for the Examination of Water and Wastewater*, Section 9222D, Current Edition.
2. "Direct Membrane Filter (MF) Method," *Microbiological Methods for Monitoring the Environment - Water and Wastes*, 1978, p. 124. Environmental Protection Agency (EPA).
3. Draft Method 1680: *Fecal Coliform in Biosolids by Multiple-Tube Fermentation and Membrane Filter Procedures*, July, 1998. Environmental Protection Agency (EPA).
4. *Environmental Quality Policy Manual*, Lancaster Laboratories, Current Version.
5. *Chemical Hygiene Plan,* Lancaster Laboratories, current version.

Cross Reference:

Document	Document Title
Analysis #0416	Modification DPD Free Chlorine Residual In Water (Presence/Absence)
Analysis #6477, 6479, 8161	Total Coliform and E. coli Analysis Potable Water (Presence/Absence), 6477 Swimming Pool Samples, 6479 Potable Water (Quantitative), 8161
OMC-MCV-002	Laboratory Balances
OMC-PS-012	Mechanical Pipettes
SOP-PM-001	Preparation Manual
SOP-PM-041	Quality Control/Quality Assurance Procedure for Environmental Microbiology

Scope:

This method is performed at Lancaster Laboratories by Environmental Microbiology. Membrane filtration is the most commonly used method to detect and enumerate fecal coliforms present in effluents, influents, bathing beaches, and monitoring wells. This method is also used for sludge samples for compliance to Federal 503 Regulations and for biosolid enumeration.

Basic Principles:

Some samples may have the potential to have high bacteria counts. In this case, a dilution series is filtered for the sample. The filter is then placed on a growth media and incubated. After incubation, colonies exhibiting typical growth for fecal coliform are counted.

Reference Modifications:

Standard Methods reference 9222D is a modification of the standard membrane filtration method for total coliform, 9222B. It involves using a different growth medium and incubation temperature to isolate fecal coliform organisms. Lancaster Laboratories is adhering to the published modifications. Biosolid samples are tested after a special set of preparation steps that involve blending a larger sample volume than is routinely used.

Definitions:

1. CFU - Colony-forming units. Colonies may arise from pairs, chains, clusters or single cells. All of these are included in the term colony-forming unit

2. Influent – Wastewater sample that goes into the processing system. Contamination is common for influent samples

3. Effluent – Wastewater sample that is discharged from the processing system. This is processed water and should be clean

4. NPDES – National Pollutant Discharge Elimination System

5. Bathing Beach – Any area of a stream, lake, ocean, impoundment, or hot spring that is used for recreation

6. Monitoring Well – A sampling well used for collecting ground water samples at a site

7. DOC – Demonstration of Capability

Interferences:

High levels of settleable solids or turbidity may interfere with the filtration process and/or counting of membrane filters. The presence of high levels of heterotrophic bacteria may also interfere with counting the membrane filters. Analysis 8161 may be substituted, depending upon the client requirements. Another alternative may be to dilute the sample or filter multiple sub-samples. Example, instead of filtering a 100-mL sample, two 50-mL or four 25-mL sub-samples would be filtered and the counts combined.

High levels of free chlorine that exceed the quenching capacity of the sodium thiosulfate present in the Lancaster Laboratories 024-sample container will invalidate the sample. This is examined with Analysis #0416. Analysis #0416 is not applicable to quality control samples.

Safety Precautions and Waste Handling:

All laboratory waste is accumulated, managed, and disposed of in accordance with all federal, state, and local laws and regulations. See *Chemical Hygiene Plan* for general information regarding employee safety, waste management, and pollution prevention.

1. Follow general safety precautions, good laboratory practices, and use aseptic technique.

2. Wear safety glasses and appropriate protective clothing.

3. Use a bulb or similar pipetting aid for all pipetting.

4. Sterilize all biological waste including disposable equipment and inoculated media before disposal.

5. The blender container must be covered with a plastic container or beaker during the blending step. This will contain broken glass if the container shatters.

Personnel Training and Qualifications:

All personnel performing this procedure must have documentation of reading, understanding and agreeing to follow the current version of this SOP and a documented Demonstration of Capability.

Training in this procedure will be conducted by a qualified trainer as designated by management. Training may be performed by any or all of the following items: review of the procedure by the trainee, observation by the trainee of the procedure being performed, direct observation of the trainee by the trainer during performance of the procedure.

The trainee may also have additional basic training as core TRNs performed upon initial starting in the test area. Basic skills such as aseptic technique, use of the pipette aid, and dilution preparation will be reviewed as part of the training in how they pertain specifically to the analysis.

The analyst training records should document, at a minimum, the following items:

1. Reading and understanding of this SOP

2. Performance of analysis - The analyst must demonstrate he/she can perform a membrane filtration analysis by performing at least three positive/negative control sets. Documentation of this work will be maintained in the analyst's training record.

3. Counting plates

4. Data Entry

5. Colony verification

Sample Collection, Preservation, and Handling:

Generally samples are analyzed within 24 hours of collection in order to minimize changes that may occur in bacteria populations (non-NPDES permit samples – analysis 11028). This is particularly critical with water samples. This hold time applies if verification of fecal coliforms that were detected is not required.

Wastewater Effluent Samples for NPDES Permit Requirements (Analysis 0199) - The sample hold-time is generally 24 hours. Samples for NPDES compliance must be shipped to the lab within 6 hours and tested within 8 hours of collection in order to meet the requirements. If a client requests that a sample be run beyond this time limit, a comment stating that the holding time for the analysis was exceeded must appear on the report (comment #0677).

Water samples are collected in sterile containers, and if the sample has been chlorinated, sodium thiosulfate addition is required to quench the action of the chlorine. The 024 container supplied by the laboratory contains sodium thiosulfate.

Solid samples may be submitted in Whirl-pak™ bags, new or chemically-clean glass containers.

A minimum of 125 mL water or 50 grams of solid sample is required, depending on the type of sample and expected reporting limit. Most solid samples are reported on a dry-weight basis, so additional sample for moisture is required. Samples must be cool (<10°C) and are held refrigerated at 1°-5°C if not processed immediately

Apparatus and Equipment:

1. Water bath, 44.5° ± 0.2°C or equivalent
2. Stereoscope, 10-15x, with light source (fluorescent source optional) or equivalent

3. Calibrated micropipettors or equivalent
4. Sterile pipette tips or disposable pipets
5. Presterilized 0.45-µm disposable filter funnel units or equivalent
6. Filter manifold or equivalent
7. Smooth-tipped forceps
8. Presterilized Petri dishes with pads, 47-mm, or equivalent
9. Sterile inoculation equipment
10. Laboratory balance
11. Bact-incinerator
12. Blender
13. Sterile blender blades

Reagents and Standards:

Refer to the number in parenthesis for directions of preparation, shelf life and storage conditions in SOP-PM-001 (where applicable).

1. mFC broth in pre-packaged sterile 2-mL vials or equivalent (Media #397)
2. Purchased sterile phosphate buffered dilution water or equivalent (Media #097)
3. Sterile rinse water (Media #104) or equivalent

4. LST (single strength, Media #398) or equivalent
5. Purchased sterile EC broth or equivalent (Media #401)
6. *Escherichia coli* (ATCC #8739) or equivalent
7. *Serratia marcescens* (ATCC #43862) or equivalent

Calibration:

All micropipettors must be calibrated per OMC-PS-012.

Procedure:

Turn on the bact-incinerator at least 10 minutes before it is needed.

Disinfect the bench with germicide and sterilize the forceps to be used for testing.

Check the printed sample label against the client label, if one is present. The information should be identical. If there is a difference, confirm the change with Sample Administration.

Analysis #0416 must be performed on all liquid samples and the results recorded in the appropriate data record book. If a sample is chlorine positive (any shade of pink), that sample is not acceptable for testing, unless otherwise directed by the client. Another appropriately collected container or sample must be chlorine checked, then analyzed.

Before beginning the analysis, check for client parameters. If a client parameter is not available, follow guidelines for sample in appropriate section of this procedure.

Turn on the vacuum source prior to starting testing.

A. Preparation and Filtration

NOTE: Calibrated micropipettors must be used to perform any preparation or filtration step. If a micropipettor is not available, disposable pipets may be used, but must have been checked per NELAC requirements.

1. Set out and label the appropriate number of petri dishes.
    a. Use one plate for each dilution or amount of sample tested.
    b. Label the plate with at least the last four digits of the sample number and the dilution or amount of sample being tested. If the sample number has not been assigned, the client designation may be used.
2. Dispense the mFC broth into each dish (approximately 2 mL). Pour off excess.
3. Place filter funnel unit onto manifold.
4. Mix water sample by shaking thoroughly.
5. Filter the appropriate dilution or amount of sample by dispensing into a filter funnel unit and opening the vacuum to the port of the manifold. If a client parameter is not available, check the sample description and follow the appropriate dilution scheme from Procedure section B.

   If 10 mL or less is to be filtered, add approximately 10 mL of sterile dilution water or rinse water to the filter unit prior to adding the sample. This aids in uniform dispersion over the entire filtering surface.
6. Rinse insides of filter unit three times with, or with a continuous flow of, sterile rinse water. Filter each rinse as above.

7. Place the tip of the forceps into the bact-incinerator for a few seconds. Allow the forceps to cool before transferring the filter.

8. Aseptically transfer filter to the appropriate petri dish with a rolling motion to avoid air pockets.

9. Close the vacuum to the port of the manifold

10. Record the time that the last dilution of the sample was filtered.

11. Repeat Procedure steps A.3. through A.10. for each dilution or amount of sample to be tested.

12. Perform a negative control for each batch following Procedure steps A.3. through A.9. using an uninoculated bottle of dilution water.

13. Turn off vacuum source after testing is complete.

14. Invert sample plates and place into a watertight WHIRL-PAK™ bag.

15. Submerge the bag in the 44.5°C water bath and incubate for 24 ± 2 hours. Document the temperature and the start time of the incubation in the databook.

    Sample plates **must be** incubated **within 30 minutes** of filtration.

16. At the end of the incubation period, document the temperature, date and time that the plates are removed from the water bath. If a temperature excursion occurred during incubation, the client must be notified to assess the potential impact on the test result. If the data will be reported, a note will be added to the report describing the excursion.

17. Count plates within ½ hour of removal from incubation using magnification (i.e. a 10-15x lens).

    a. The standard counting range is 20 to 60 fecal coliform colonies per filter. For counts below 10 CFU, round to the whole number. For counts between 10 and 99 CFU, record whole number. For counts greater than 100 CFU, round to 2 significant figures.

    b. Fecal coliform colonies are a shade of blue on this media.

    c. Record the total number of colonies observed on each plate. If the total number of colonies (coliform and non-coliform) exceeds 200 per plate, record the number as TNTC. See Data Entry for specific instruction on reporting.

B. Dilution Schemes

NOTE: Check for a client parameter sheet. If a parameter sheet is not available, follow the appropriate dilution scheme if the source of the sample can be determined by the sample description.

Volumes can be directly filtered or diluted as below by filtering 10mL from each dilution bottle:

Sample	Volume added to 99mL Sterile Dilution Water (mL)	Volume of Original Sample Filtered (mL)
Direct	11	1.0mL (A)
A	11	0.1mL (B)

1. Effluents, bathing beaches and other potentially low-count samples

   100 mL and 10 mL are filtered for these samples.

2. Influents and other samples with suspected high fecal counts

   10 mL of the original sample and 10 mL of a 1:10 dilution (A) are filtered for these samples.

3. Solid samples (e.g. soils)

   a. Weigh 11 g. of sample into a sterile WHIRL-PAK™ bag. Perform weighing on a calibrated balance per OMC-MCV-002. Record the weight in the data notebook.

   b. Add one bottle of sterile dilution water to weighed sample.

      (1) Mix sample by shaking thoroughly.

      (2) Filter 5 mL of the sample mixture. This is a 1:2 dilution (0.5 g).

      (3) Filter 1 mL of the sample mixture. This is a 1:10 dilution (0.1 g).

      (4) Filter 0.1 mL of the sample mixture. This is a 1:100 dilution (0.01g).

   c. Transfer 1 mL of the sample mixture to a bottle of sterile dilution water labeled “A”.

      (1) Mix sample by shaking thoroughly.

      (2) Filter 1 mL from dilution bottle “A”. This is a 1:1,000 dilution (0.001 g).

      (3) Filter 0.1 mL from dilution bottle “A”. This is a 1:10,000 dilution (0.0001 g).

d. Transfer 1 mL from dilution bottle "A" to a bottle of sterile dilution water labeled "B".

   (1) Mix sample by shaking thoroughly.

   (2) Filter 1 mL from dilution bottle "B". This is a 1:100,000 dilution (0.00001 g).

4. Biosolid samples for compliance to EPA 503 regulations (Class B). See Attachment I for dilution scheme flowchart.

   a. Weigh 30 grams of sample into a sterile blending jar. Add sterile dilution water to a total weight of 300 grams. Perform weighing on a calibrated balance per OMC-MCV-002. Record the weight in the data notebook.

   b. Blend for 2 minutes. Cover jar with a plastic container during blending.

   c. Transfer 11 mL of sample mixture to a bottle of sterile dilution water labeled "A".

      (1) Mix sample by shaking thoroughly.

      (2) Filter 1 mL from dilution bottle "A". This is a 1:100 dilution (0.01g).

   d. Transfer 1 mL from dilution bottle "A" to a bottle of sterile dilution water labeled "B".

      (1) Mix sample by shaking thoroughly.

      (2) Filter 10 mL from dilution bottle "B". This is a 1:1,000 dilution (0.001 g).

(3) Filter 1 mL from dilution bottle “B”. This is a 1:10,000 dilution (0.0001 g).

e. Transfer 1 mL from dilution bottle “B” to a bottle of sterile dilution water labeled “C”.

(1) Mix sample by shaking thoroughly.

(2) Filter 10 mL from dilution bottle “C”. This is a 1:100,000 dilution (0.00001 g).

Calculations:

The following formula is used for a liquid sample:

$$\frac{\text{MF colonies counted (or verified)}}{\text{mL of sample}} \times 100 = \text{CFU per 100 mL}$$

For a solid sample this formula is used:

$$\frac{\text{MF colonies counted (orverified)}}{\text{grams of sample}} = \text{CFU/gram}$$

The computer calculates the result in a dry weight basis using the following formula:

$$D = 100 - \text{moisture} / 100 \qquad \text{Dry weight value} = \text{As received value} / D$$

If no filter has a fecal coliform count in the 20-60 CFU range, total the fecal coliform counts on all filters and divide by the sum of all the volumes. For water samples multiply this number by 100.

Example:

A 10-mL and 1-mL filtration was performed for a sample. A count of 12 CFU was obtained on the 10-mL plate and 1 CFU on the 1-mL plate. The reported value would be (12 + 1) / (10 + 1) = 1.18; 1.18 (100) = 118. This would be rounded to two significant figures and reported as est. 120 CFU/100mL.

The limit of quantitation (LOQ) is 1 CFU/100 mL if a 100-mL volume is filtered, 10 CFU/100 mL if a 10-mL volume is filtered, and 2 CFU/gram if 5 mL of a 1:10 dilution is used as the initial dilution for a solid sample. The reporting range for fecal coliforms in bathing beach samples is from 1 to 600 CFU/100 mL. The reporting range of effluents is normally from 10 to 6000 CFU/100 mL. The reporting range for fecal coliforms in sludge samples is from 2 to 6,000,000 CFU/gram, as received. The reporting range for biosolids is from 100 to 6,000,000 CFU/gram, as received. Sludges and biosolids samples are usually reported on a dry weight basis.

Data Entry:

1. Enter data into the computer under the appropriate analysis and sample numbers. Check that the appropriate collection information is entered, including a collection date and time for the sample. Follow up with the Client Service Representative if any information is missing.

2. Enter the appropriate dilution in the dilution field.

3. Enter the result for each dilution that was plated. The program will automatically use the results that were entered for each dilution to calculate the final result. The final result will be reported from the dilution that had results in the countable range (20-60 CFU). If there are no results in the countable range the computer will determine the result based on the following logic:

   If there are no results within the countable range and there is one dilution with an estimated count, the estimated count should be used for the result, and the LOQ should be set to the value appropriate for that dilution.

If there are no results within the countable range and there are 2 or more dilutions with an estimated count, the result should be determined as follows:

The sum of the estimated counts is divided by the sum of the dilutions, and that value is multiplied by 100. The LOQ is 1.

A result can be designated TNTC (too numerous to count) by entering –2. If a dilution is TNTC but there is another dilution with a count, enter –2 for the TNTC dilution and the rest of the dilution counts should be processed as noted in 1-3 above.

If a result is TNTC and there are no dilutions with counts, the calculation should do the following:

If the TNTC is for the direct dilution (DF 100), the Final Result should be set to –2 and the LOQ should be 1 (the value appropriate for that dilution). If the TNTC is not for the direct dilution, or if more than one dilution is marked TNTC and the last dilution entered is not the direct dilution - then the upper limit should be set (so that the analysis can report as >UL).

4. Report TNTC counts due to bacterial interference if there are no plates within the countable range.

    a. If no typical colonies are observed, add comment 1104.

    b. If any typical colonies are observed, add comment 1235.

Statistical Information/Method Performance:

This method gives 93% accuracy in the differentiation between coliforms from warm-blooded animals and those from other sources. 95% confidence limits are assumed.

Quality Assurance/Quality Control:

1. The temperature in the water bath is monitored twice daily with at least 4 hours between checks if samples are in the water bath or on normal business days.

2. A negative control consisting of an uninoculated bottle of dilution water must be analyzed with each testing batch. If the negative control exhibits growth, samples in the batch that have growth must be evaluated to determine if the growth present is likely to be representative of the original sample or was introduced during testing. An investigation must be performed to document the justification as to whether the sample results are valid or invalid.

3. An *E. coli* positive organism and *S. marcescens* negative organism control are performed on each batch of media as a QC release. These controls may also be run with a testing batch per management discretion. An appropriate dilution of the positive organism should be used to obtain a countable range of 20-60 CFU. Typically, 0.5 mL of a 10^{-7} dilution of *E. coli* and 10 mL of a 10^{-3} dilution of *S. marcescens* are used for this testing.

4. Each new lot of mFC media, presterilized membrane filter units, and membrane filters are compared to a previous lot for satisfactory performance. See SOP-PM-041 for testing instruction.

5. Refer to SOP-PM-041 for applicable quality assurance/quality control requirements, including duplicate counts and DOC statements.

6. At least one fecal coliform sample per month is verified for quality assurance purposes. The following procedure steps can be followed or the verification can be performed by another approved method such as API 20E.

    a. A client sample with at least ten typical (blue) and two (maximum 5) atypical colony-types should be used for the monthly fecal verification.

b. Testing parameters

- (1) Typical colonies
  - (a) Set up ten EC broth tubes and ten 1x LST tubes.
  - (b) One colony will be used for one set of EC and 1x LST tubes.
  - (c) Pick the colony to the EC tube first, and then using the sample loop inoculate the 1x LST tube.
- (2) Atypical colonies
  - (a) Set up two EC broth tubes and two 1x LST tubes.
  - (b) One colony will be used for one set of EC and 1x LST tubes.
  - (c) Pick the colony to the EC tube first, and then using the sample loop inoculate the 1x LST tube.
- (3) Incubation of Tubes
  - (a) EC broth
    - (i) Incubate for 24 hours at 44.5° ± 0.2°C.
    - (ii) Check for gas fermentation at the end of 24 hours.
    - (iii) Record results in the appropriate databook.

(b) 1x LST

(i) Incubate for 48 hours at 35° ± 0.5°C.

(ii) Check for gas fermentation.

(iii) Record results in the appropriate databook.

c. Tubes positive for 1x LST, but negative for EC

(a) Transfer from the 1x LST to a second EC tube.

(b) Incubate for 24 hours at 44.5° ± 0.2°C.

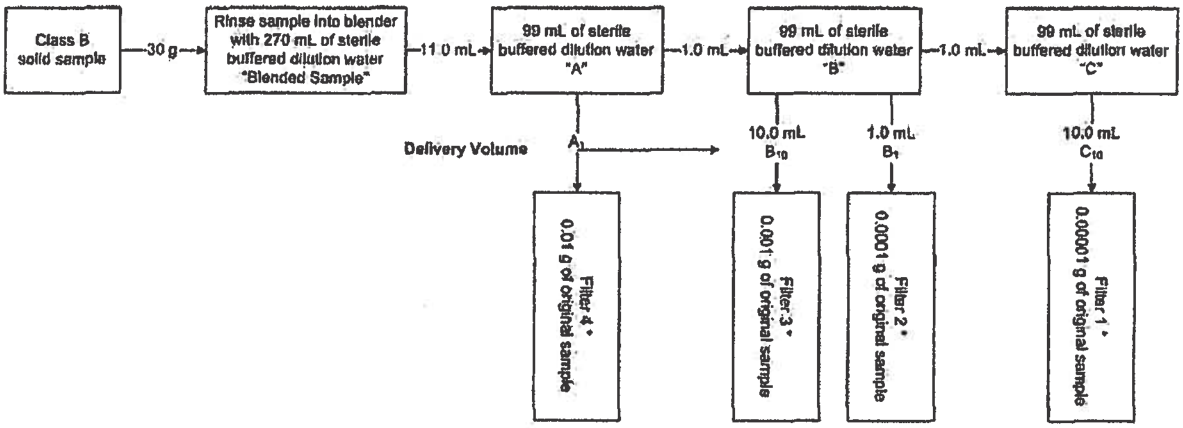
(c) Check for gas fermentation.

(d) Record results in the appropriate databook.

d. If there are positive reactions for the atypical colonies, contact the Group Leader for further instruction.

Attachment I

DILUTION AND FILTRATION SCHEME FOR CLASS B: SOLID (MEMBRANE FILTER)



* Samples should be filtered in order of highest dilution (least sample volume) first to avoid carry-over contamination. Filtration should take place in the following order: filter 1, 2, 3, and 4.

APPENDIX A-3: OPERATING TURBINE BOIL CALIBRATION SHEETS.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Cono Pond **Investigator :** RAB/JCA

DATE 0 4 0 6 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0820 (prevailing, 24 hr) *

CAL Temp 23.0 °C **CAL DO** 8.56 (mg/l)
Meter Temp 21.0 °C OK Meter DO 8.8 (mg/l) OK
Meter adj. to 23.0 °C Meter adj to 8.56 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time 0810 Meter reading @ 7.00 su 7.00 @ 4.01 su ______ or @ 10.00 su 10.00 OK

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: conductivity 500uS/cm ok 1412uS/cm OK

Turbidity calibrated at factory. good for ~1 month

DO Calibration* ** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO SAT%
Cal Temp ______ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2
Cal DO ☐☐☐ **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2
pH Calibration *** @ 7.00 7.00 OK @ 4.01 ______ @ 10.00 10.00 OK (Record OK for buffer(s) used)
Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 20.0 °C **Wind Conditions** (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock, e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Lower River **Investigator :** SWA / KJT

DATE 0 4 0 6 1 0 (m m d d y y)

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0820 (prevailing, 24 hr) *

CAL Temp 23.0 °C
Meter Temp 18.0 °C
Meter adj. to 23.0 °C

CAL DO 8.56 (mg/l)
Meter DO 9.2 (mg/l)
Meter adj to 8.56 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time 0810 Meter reading @ 7.00 su 7.00 @ 4.01 su ____ or @ 10.00 su 10.00 OK

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ____ °C **
DO ____ mg/l **
pH ____ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ____ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ____ **1** = None required; **2** = Sensors cleaned; **3** = pH electrolyte replaced; **4** = Batteries replaced; **5** = Other (____)

5 MONITOR CALIBRATION:

2-pt conductivity calibiated OK

Turbidity 'alibrated at actory-good for 1 month.

DO Calibration* ** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO SAT%

Cal Temp ____ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO ☐☐☐ **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 7.00 OK @ 4.01 ____ @ 10.00 10.00 (Record OK for buffer(s) used) OK

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time 0820 (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ____ °C **
DO ____ mg/l **
pH ____ su **

7 Air Temperature 19.8 °C **Wind Conditions** (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ____

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Conowingo Pond CP-84 CP2a files **Investigator :** JCA/Chuck Barnes

DATE 0 4 1 3 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 4
1=Clear 2=P. Cloudy 3=Overcast
4=Lt Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0845
(prevailing, 24 hr) *

CAL Temp	21.0 °C	**CAL DO**	8.8 (mg/l)
Meter Temp	20.5 °C OK	Meter DO	8.6 (mg/l) OK
Meter adj. to	21.0 °C	Meter adj to	8.8 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

	DO / pH Meter	**MS5 Monitor**
Temp	☐☐☐ °C	______ °C **
DO	☐☐☐ mg/l	______ mg/l **
pH	☐☐☐☐ su	______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: Conductivity 500µS/cm-OK 1412uS/cm-OK

100% SAT method OK

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other 100% SAT
Cal Temp ______ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2
Cal DO ☐☐☐ **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2
pH Calibration *** @ 7.00 7.00 OK @ 4.01 ______ @ 10.00 10.00 OK (Record OK for buffer(s) used)

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

	DO / pH Meter	**MS5 Monitor**
Temp	☐☐☐ °C	______ °C **
DO	☐☐☐ mg/l	______ mg/l **
pH	☐☐☐☐ su	______ su **

7 Air Temperature 10.0 °C

Wind Conditions (Circle one): Calm [✓ Light] Moderate Gusty Strong
Other Sampling Notes: ______

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* Use 24 hour clock, e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Lower River **Investigator :** SWA / KJT

DATE 0 4 1 3 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 4
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0845
(prevailing, 24 hr) *

CAL Temp	21.0	°C	**CAL DO**	8.8	(mg/l)
Meter Temp	20.0	°C ok	Meter DO	8.9	(mg/l) ok
Meter adj. to	21.0	°C	Meter adj to	8.8	(mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	DO / pH Meter			MS5 Monitor		
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐	°C	Temp	______	°C **
	DO	☐☐☐	mg/l	DO	______	mg/l **
	pH	☐☐☐☐	su	pH	______	su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ (Lab or Onsite) **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: conductivity- 500mS/cm OK 1412mS/cm -OK

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other 100% SAT.

100% SAT **Cal Temp** ______ (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

METHOD **Cal DO** ☐☐☐ (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

OK **pH Calibration ***** @ 7.00 7.00 ok @ 4.01 ______ @ 10.00 10.00 (Record OK for buffer(s) used) OK

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	DO / pH Meter			MS5 Monitor		
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐	°C	Temp	______	°C **
	DO	☐☐☐	mg/l	DO	______	mg/l **
	pH	☐☐☐☐	su	pH	______	su **

7 Air Temperature 10.0 °C

Wind Conditions (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock, e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONO. POND

Investigator : SWA/CAB

DATE 5 4 2 0 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 2
1=Clear 2=P. Cloudy 3=Overcast
4=Lt Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8)

Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0830 (prevailing, 24 hr) *

CAL Temp 21.0 °C

Meter Temp 20.5 °C

Meter adj. to 21.0 °C

CAL DO 8.9 (mg/l)

Meter DO 9.1 (mg/l)

Meter adj to 8.9 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

CALIBRATED 4-19-10 CALIBRATION GOOD FOR 1 MONTH BUT WILL DO WEEKLY

5 MONITOR CALIBRATION:

CALIBRATED FOR MR RES. PROFILE ON 4-19-10

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp ______ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO ☐☐☐ **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ______ @ 4.01 ______ @ 10.00 ______ (Record OK for buffer(s) used)

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 15.5 °C

Wind Conditions (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: NO DEAD FISH OBSERVED ON POND

---

* Use 24 hour clock, e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Conowingo Lower River Investigator: JCA

DATE 0 4 2 0 1 0 (m m d d y y)

PURPOSE 3

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1

1=Clear 2=P. Cloudy 3=Overcast
4=Lt Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: YES or NO (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0830 (prevailing, 24 hr) *

CAL Temp	20.1 °C	**CAL DO**	7.10 (mg/l)
Meter Temp	20.1 °C	Meter DO	7.10 (mg/l)
Meter adj. to	– °C	Meter adj to	– (mg/l)

ph pen

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time 815 Meter reading @ 7.00 su 700 @ 4.01 su 4 or @ 10.00 su 1000

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	DO / pH Meter		MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐ °C	Temp	____ °C **
	DO	☐☐☐ mg/l	DO	____ mg/l **
	pH	☐☐☐☐ su	pH	____ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ________ (Lab or Onsite) Time of Download: ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: _____ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (________________)

5 MONITOR CALIBRATION:

*

DO Calibration*** Method Used: ☐ 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other ________

Cal Temp ________ (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO ☐☐☐ (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 _____ @ 4.01 _____ @ 10.00 _____ (Record OK for buffer(s) used)

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	DO / pH Meter		MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐ °C	Temp	____ °C **
	DO	☐☐☐ mg/l	DO	____ mg/l **
	pH	☐☐☐☐ su	pH	____ su **

7 Air Temperature _____ °C Wind Conditions (Circle one): [✓ Calm] [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ________________________________

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr

** Record values later from downloaded data at the corresponding time of portable meter measurements.

*** May be done in Lab or Field just prior to deployment, experience to dictate location.

* Sonde/Surveyor not working used ph pen, cond. pen turbidity meter
YSI BDX YSI Hand held

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONO POND **Investigator :** SWA/CAB

DATE 0 4 2 7 1 0 (m m d d y y)

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 2
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

meter 10983

Time 0746 (prevailing, 24 hr) *

CAL Temp 21.0 °C **CAL DO** 8.9 (mg/l)
Meter Temp 22.2 °C OK Meter DO 8.5 (mg/l) OK
Meter adj. to 21.0 °C Meter adj to 8.9 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced
4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: CONDUCTIVITY - 714µS/cm - OK 1413µS/cm - OK

TURBIDITY CAL
1.0 - OK
20.0 - OK

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp ______ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO ☐☐☐ **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

TIME 0805 hr

pH Calibration *** @ 7.00 7.00 OK @ 4.01 ______ @ 10.00 10.00 OK (Record **OK** for buffer(s) used)

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 17.5 °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty [✓ Strong]

Other Sampling Notes: ______

---

* Use 24 hour clock, e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: LOWER RIVER CONO-WO **Investigator :** JLA / KT

DATE 0 4 2 7 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 2
1=Clear 2=P. Cloudy 3=Overcast
4=Lt Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

meter
10984

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0755 (prevailing, 24 hr) *
CAL Temp 21.0 °C **CAL DO** 8.9 (mg/l)
Meter Temp 20.8 °C O/C Meter DO 8.0 (mg/l) O/C
Meter adj. to 21.0 °C Meter adj to 8.9 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time 1157 (prevailing, 24 hr) *

DO / pH Meter Hand
Temp 16.8 °C
DO 10.1 mg/l
pH 8.7 su

MS5 Monitor Box
Temp 16.8 °C **
DO 10.1 mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: conductivity - 714us/cm-OK 1413us/cm-OK

Turbidity cal
1.0 - OK
20.0 - OK

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT
Cal Temp ______ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2
Cal DO ☐☐☐ **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2
pH Calibration *** @ 7.00 7.00 OK @ 4.01 ______ @ 10.00 10.00 OK (Record OK for buffer(s) used)

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 21.1 °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: 70°s

* Use 24 hour clock, e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONOWINGO POND **Investigator :** SWA/CAB

DATE 0 5 0 4 1 0 (m m d d y y) **PURPOSE** 2 **Weather Code** 1

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast 4=Lt Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0802 (prevailing, 24 hr) *

CAL Temp 26.0 °C **CAL DO** 8.1 (mg/l)
Meter Temp 25.5 °C Meter DO 8.2 (mg/l)
Meter adj. to 26.0 °C Meter adj to 8.1 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ **Meter reading @ 7.00 su** ______ **@ 4.01 su** ______ **or @ 10.00 su** ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ **1** = None required; **2** = Sensors cleaned; **3** = pH electrolyte replaced; **4** = Batteries replaced; **5** = Other (______)

5 MONITOR CALIBRATION: Conductivity 74 µS/cm - OK 1413 µS/cm - OK

TURBIDITY
1 - OK
24 - OK

DO Calibration* Method Used:** 3 **1** = Aerated Water; **2** = River Water (bucket) vs YSI; **3** = Other LDO 100% SAT
Cal Temp ______ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2
Cal DO ☐☐☐ **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2
pH Calibration *** @ 7.00 7.0 OK @ 4.01 ______ @ 10.00 10.0 OK (Record **OK** for buffer(s) used)

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 24.0 °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Lower River Conowingo **Investigator:** JCA / KJT

DATE 05|09|10 (m m d d y y)

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8)
Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0815 (prevailing, 24 hr) *

Redline ok

CAL Temp 26.0 °C
Meter Temp 25.5 °C
Meter adj. to 26.0 °C

CAL DO 7.6 (mg/l)
Meter DO 7.5 (mg/l) OK ✓
Meter adj to 7.6 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

Last

	DO / pH Meter		**MS5 Monitor**	
Temp	18.7	°C	______	°C **
DO	10.5	mg/l	______	mg/l **
pH	8.4	su	______	su **

pH pen
conducting pen 718
test 720 in pen
OK ✓

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ (Lab or Onsite) **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

Turbidity cal
1.0 - OK
20 0 - OK

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO-100% SAT
Cal Temp ______ (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2
Cal DO ☐☐☐ (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2
pH Calibration *** @ 7.00 700 ok @ 4.01 ______ @ 10.00 1000 ok (Record OK for buffer(s) used)

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

	DO / pH Meter		**MS5 Monitor**	
Temp	☐☐☐	°C	______	°C **
DO	☐☐☐	mg/l	______	mg/l **
pH	☐☐☐☐	su	______	su **

7 Air Temperature 21.9 °C

Wind Conditions (Circle one): Calm [✓ Light] Moderate Gusty Strong
Other Sampling Notes: Sunny

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: U River Cono Pond CP-6 **Investigator :** JCA / CAB

DATE 0 5 1 1 1 0 (m m d d y y)

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 3
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 7:51 (prevailing, 24 hr) *
Meter #10983

CAL Temp 19 °C
Meter Temp 19 °C
Meter adj. to N/A °C

CAL DO 9.26 (mg/l)
Meter DO 9.2 (mg/l)
Meter adj to ↑ .06 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

759.7 BP

DO Calibration* ** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LWO 100% SAT

Cal Temp 65.3F 18.5 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO ☐☐☐ (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 OK @ 4.01 ______ @ 10.00 OK (Record OK for buffer(s) used)

Conductivity Calibration*** @ 74µS/cm OK @ 718µS/cm OK @ 1413µS/cm ______

Turbidity Calibration*** @ ~~0~~ .3 NTU OK @ 10 NTU ______ @ 20 NTU OK

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 11 °C

Wind Conditions (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: 51.8°C

---

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: LOWER RIVER

Investigator : SWA / KJT

DATE 05 11 10 (m m d d y y)

PURPOSE 2

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 3

1=Clear 2=P. Cloudy 3=Overcast 4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8)

Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0755 (prevailing, 24 hr) *

10984

CAL Temp 19.0 °C
Meter Temp 18.8 °C
Meter adj. to (19.0 9.2 °C OK

CAL DO 9.26 (mg/l)
Meter DO 9.8 (mg/l)
Meter adj to 9.26 (mg/l) OK

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

	DO / pH Meter		**MS5 Monitor**	
Temp		°C		°C **
DO		mg/l		mg/l **
pH		su		su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ **1** = None required; **2** = Sensors cleaned; **3** = pH electrolyte replaced; **4** = Batteries replaced; **5** = Other (______)

5 MONITOR CALIBRATION:

BP = 759.7

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 65.2 °F (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 9.35 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 7.00 ok @ 4.01 ______ @ 10.00 10.00 ok (Record OK for buffer(s) used)

Conductivity Calibration*** @ 74µS/cm 74 OK @ 718µS/cm 718 OK @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU 0.3 OK @ 10 NTU ______ @ 20 NTU 20. OK

~~**Time that the monitor was redeployed in the Tailrace** ☐☐☐☐ (prevailing, 24 hr)~~ *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

	DO / pH Meter		**MS5 Monitor**	
Temp		°C		°C **
DO		mg/l		mg/l **
pH		su		su **

7 Air Temperature 11 °C

Wind Conditions (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr

** Record values later from downloaded data at the corresponding time of portable meter measurements.

*** May be done in Lab or Field just prior to deployment, experience to dictate location.

Normandeau Associates, Inc

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Cono Pond CP7 **Investigator :** JCA / CAB

DATE 0 5 1 2 1 0
m m d d y y

PURPOSE 2

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 3 & 4
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

meter # 10983

Time 0757 (prevailing, 24 hr) *

CAL Temp	21.0	°C	**CAL DO**	8.9	(mg/l)
Meter Temp	20.5	°C	Meter DO	8.8	(mg/l)
Meter adj. to	21.0	°C OK	Meter adj to	8.9	(mg/l) OK

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time		DO / pH Meter			MS5 Monitor	
1 3 4 5 (prevailing, 24 hr) *	Temp	17.9	°C	Temp	18	°C **
	DO	10.9	mg/l	DO	10.9	mg/l **
	pH		su	pH	7.6	su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

BP 765

DO Calibration* Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 21.5 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.88 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 OK @ 4.01 ______ @ 10.00 OK (Record OK for buffer(s) used)

Conductivity Calibration*** @ 74µS/cm OK @ 718µS/cm OK @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU ✓ .3 @ 10 NTU ______ @ 20 NTU ✓

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time		DO / pH Meter			MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp		°C	Temp		°C **
	DO		mg/l	DO		mg/l **
	pH		su	pH		su **

7 Air Temperature 14.5 °C **Wind Conditions** (Circle one): [✓ Calm] Light Moderate Gusty Strong

Other Sampling Notes: Rainy, Cloudy

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

Normandeau Associates, Inc

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: LOWER RIVER **Investigator :** SWA/KJT

DATE 0 5 1 7 1 0
m m d d y y

PURPOSE 2

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 3
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Meter
10984

Time 0759 (prevailing, 24 hr) *

CAL Temp 21.0 **°C** **CAL DO** 8.9 **(mg/l)**
Meter Temp 21.2 °C Meter DO 9.0 (mg/l)
Meter adj. to 21.0 °C OK Meter adj to 8.9 (mg/l) OK

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ **1** = None required; **2** = Sensors cleaned; **3** = pH electrolyte replaced; **4** = Batteries replaced; **5** = Other (______)

5 MONITOR CALIBRATION:

BP=765.

DO Calibration*** **Method Used:** 3 **1** = Aerated Water; **2** = River Water (bucket) vs YSI; **3** = Other 100% LDO SAT

Cal Temp 70.8 F (21.5) **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8 8 8 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 OK @ 4.01 ______ @ 10.00 OK (Record OK for buffer(s) used)

Conductivity Calibration*** @ ~~74~~ 0µS/cm OK @ 718µS/cm OK @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU OK @ 10 NTU ______ @ 20 NTU OK

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

7 Air Temperature 20.4 °C **Wind Conditions** (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CP-8 **Investigator :** JCA / check

DATE 0 5 2 4 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code – →1-4
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Meter # 10983

Time 0755 (prevailing, 24 hr) *

CAL Temp 24.0 °C **CAL DO** 8.4 **(mg/l)**
Meter Temp 23.8 °C Meter DO 8.2 (mg/l) OK
Meter adj. to 24.0 °C Meter adj to 8.4 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**	
1 5 1 5 (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **	used YSI Box
	DO ☐☐☐ mg/l	DO ______ mg/l **	temp-20.4
	pH ☐☐☐☐ su	pH ______ su **	D.O.-9.6

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ **1** = None required; **2** = Sensors cleaned; **3** = pH electrolyte replaced; **4** = Batteries replaced; **5** = Other (______)

5 MONITOR CALIBRATION:

DO Calibration*** **Method Used:** 3 **1** = Aerated Water; **2** = River Water (bucket) vs YSI; **3** = Other LDO 100% SAT

Cal Temp 74.9 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8 3 4 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ok ✓ @ 4.01 ______ @ 10.00 OK ✓ (Record OK for buffer(s) used)

Conductivity Calibration*** @ ~~74~~ 0 µS/cm ✓ OK @ 718µS/cm ✓ ok @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU ok @ 10 NTU ______ @ 20 NTU OK

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

7 Air Temperature ______ °C

Wind Conditions (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr

** Record values later from downloaded data at the corresponding time of portable meter measurements.

*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: LOWER RIVER **Investigator :** SWA / KJT

DATE 0 5 2 4 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1-4
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ____ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

meter #10984

Time 0800 (prevailing, 24 hr) *

CAL Temp 24.0 °C **CAL DO** 8.4 (mg/l)

Meter Temp 23.2 °C ok Meter DO 8.6 (mg/l) ok

Meter adj. to 24.0 °C Meter adj to 8.4 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ______ (prevailing, 24 hr) *

DO / pH Meter
Temp ______ °C
DO ______ mg/l
pH ______ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ______ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ______ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

DO Calibration* ** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other 100% LDO

Cal Temp 75.1 F (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.35 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓ ok @ 4.01 ______ @ 10.00 ✓ ok (Record OK for buffer(s) used)

Conductivity Calibration*** @ ~~74~~ 2µS/cm ✓ OK @ 718µS/cm OK ✓ @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU OK ✓ @ 10 NTU ______ @ 20 NTU ok ✓

Time that the monitor was redeployed in the Tailrace ______ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ______ (prevailing, 24 hr) *

DO / pH Meter
Temp ______ °C
DO ______ mg/l
pH ______ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 20.4 °C

Wind Conditions (Circle one): Calm [✓ Light Moderate] Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr

** Record values later from downloaded data at the corresponding time of portable meter measurements.

*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Cono Pond **Investigator :** CAB/SWA

DATE 0 6 0 1 1 0 (m m d d y y)

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 2
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8)

Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Meter 10983

Time 0808 (prevailing, 24 hr) *

CAL Temp 26.0 °C
Meter Temp 26.2 °C
Meter adj. to 26.0 °C

CAL DO 8.1 (mg/l)
Meter DO 8.0 (mg/l) OK
Meter adj to 8.1 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

BP= 744.9

DO Calibration* Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDo 100% SAT

Cal Temp 758' (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO . 8 2 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓OK @ 4.01 / @ 10.00 ✓OK (Record OK for buffer(s) used)

Conductivity Calibration*** @074µS/cm ✓OK @ 718µS/cm ✓OK @ 1413µS/cm /

Turbidity Calibration*** @ 0 NTU ✓OK @ 10 NTU ______ @ 20 NTU 0 ✓OK

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature ______ °C

Wind Conditions (Circle one): Calm Light Moderate Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: LOWER RIVER **Investigator :** JCA / KJT

DATE 0 6 0 1 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1 5 late last eve
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Meter 10984

Time 0811 (prevailing, 24 hr) *

CAL Temp 26.0 °C **CAL DO** 8.1 (mg/l)
Meter Temp 26.0 °C Meter DO 8.0 (mg/l) OK
Meter adj. to OK °C Meter adj to 8.1 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

BP=744.9

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 76.4 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

LDO
Cal DO 7 4 4.9 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

LDO mg/ 7.54

pH Calibration *** @ 7.00 ✓ok @ ~~4.01~~ ~~______~~ @ 10.00 ✓ok (Record OK for buffer(s) used)
Conductivity Calibration*** @ 0 ~~74~~ μS/cm ✓ok @ 718μS/cm ✓ok @ 1413μS/cm ______
Turbidity Calibration*** @ ~~0~~ .3 NTU ✓ok @ 10 NTU ______ @ 20 NTU ______

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 70's °C **Wind Conditions** (Circle one): Calm [✓ Light] Moderate Gusty Strong

22.8

Other Sampling Notes: After heavy Rain previous Night

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Cono Pond **Investigator :** SWA/

DATE 0 6 0 8 1 0
m m d d y y

PURPOSE 2
- **1** = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
- **2** = Performance check (complete Sections 1, 2, 3 & 7)
- **3** = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0746 (prevailing, 24 hr) *

meter #10983

CAL Temp 24.0 °C
Meter Temp 24.0 °C
Meter adj. to OK °C

CAL DO 8.4 (mg/l)
Meter DO 8.3 (mg/l)
Meter adj to 8.4 (mg/l) OK

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

BP=750.8

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 74.8 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.4 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 OK @ 4.01 ______ @ 10.00 OK (Record OK for buffer(s) used)

Conductivity Calibration*** @ 74µS/cm OK @ 718µS/cm OK @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU OK @ 10 NTU ______ @ 20 NTU OK

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 199 °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr

** Record values later from downloaded data at the corresponding time of portable meter measurements

*** May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Lower River **Investigator :** JLA / CAB

DATE 0 6 0 8 1 0
m m d d y y

PURPOSE - → 2 3 5
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one) 2

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0807 (prevailing, 24 hr) *
meter #10984
CAL Temp 23.5 °C
Meter Temp 23.5 °C
Meter adj. to OK °C
CAL DO 8.4 (mg/l)
Meter DO 8.5 (mg/l) OK
Meter adj to 8.4 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL [✓ "CAL END POINT"] OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp 9.0 °C	Temp 8.9 °C ** ✓
	DO 27.0 mg/l	DO 26.9 mg/l ** ✓
	pH ☐☐☐☐ su	pH 7.1 su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

BP = 750.8

DO Calibration* ** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 25 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO ☐☐☐ **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓ ok @ 4.01 ______ @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration* ** @ ~~74~~ 0 µS/cm ✓ @ 718µS/cm ✓ @ 1413µS/cm ✓

Turbidity Calibration* ** @ 0 NTU ✓ @ 10 NTU ______ @ 20 NTU ✓

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

7 Air Temperature 23.8 °C **Wind Conditions** (Circle one): Calm Light Moderate [✓ Gusty] Strong

Other Sampling Notes: Sonde Still beeping after turned off

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONO POND **Investigator :** SWA/KJT

DATE 0 6 1 5 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 2/3/4
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0745
(prevailing, 24 hr) *
meter # 10983

CAL Temp 25.5 °C
Meter Temp 25.5 °C ok
Meter adj. to ok °C

CAL DO 8.15 (mg/l)
Meter DO 8.2 (mg/l) ok
Meter adj to 8.15 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: 0750 hr BP= 748.6

DO Calibration* Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 76.1 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.14 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration * ** @ 7.00 OK @ 4.01 ______ @ 10.00 OK (Record OK for buffer(s) used)

Conductivity Calibration* ** @ ~~24~~ 0µS/cm OK @ 718µS/cm OK @ 1413µS/cm ______

Turbidity Calibration* ** @ 0 NTU OK @ 10 NTU ______ @ 20 NTU OK

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 24.0 °C **Wind Conditions** (Circle one): Calm Light Moderate Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: LR 6/15/10 **Investigator :** JCA / CAB

DATE 0 6 1 5 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 2/3/4
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0749 (prevailing, 24 hr) *
Meter #10984

CAL Temp 25.5 °C
Meter Temp 25.5 °C
Meter adj. to OK °C

CAL DO 8.15 **(mg/l)**
Meter DO 8.3 (mg/l)
Meter adj to 8.15 (mg/l) OK

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

✓ END

Time
1 3 4 0 (prevailing, 24 hr) *

DO / pH Meter
Temp 2 6 . 9 °C
DO 8 . 5 mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp 26.7 °C **
DO 8.1 mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

BP = 748.6

DO Calibration* Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 26.1 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8 1 4 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration * ** @ 7.00 ✓ @ 4.01 ✓ @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration* ** @ 74µS/cm ______ @ 718µS/cm ✓ @ 1413µS/cm ______

Turbidity Calibration* ** @ 0 NTU OK @ 10 NTU ______ @ 20 NTU ✓

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time
☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 70.5 °C/ 23.3°F **Wind Conditions** (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: Light Rain

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Cono Pond **Investigator :** SWA / KJT

DATE 0 6 2 2 1 0 (m m d d y y) **PURPOSE** 2 **Weather Code** 2

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0748 (prevailing, 24 hr) *
meter # 10983

CAL Temp 26.0 °C **CAL DO** 8.1 **(mg/l)**
Meter Temp 26.0 °C Meter DO 8.0 (mg/l) OK
Meter adj. to OK °C Meter adj to 8.1 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ____ Meter reading @ 7.00 su ____ @ 4.01 su ____ or @ 10.00 su ____

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	DO / pH Meter	MS5 Monitor
____ (prevailing, 24 hr) *	Temp ____ °C	Temp ____ °C **
	DO ____ mg/l	DO ____ mg/l **
	pH ____ su	pH ____ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ____ (prevailing, 24 hr) *
Data Download Location: ____ **(Lab or Onsite)** **Time of Download:** ____ (24 hr) *
Applicable Maintenance Performed: ____ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (____)

5 MONITOR CALIBRATION: 0800 hr BP 751.75

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 28.3 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.06 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 OK @ 4.01 ____ @ 10.00 OK (Record OK for buffer(s) used)

Conductivity Calibration*** @ 74µS/cm OK @ 718µS/cm OK @ 1413µS/cm ____

Turbidity Calibration*** @ 0 NTU OK @ 10 NTU ____ @ 20 NTU OK

Time that the monitor was redeployed in the Tailrace ____ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	DO / pH Meter	MS5 Monitor
____ (prevailing, 24 hr) *	Temp ____ °C	Temp ____ °C **
	DO ____ mg/l	DO ____ mg/l **
	pH ____ su	pH ____ su **

7 Air Temperature ____ °C

Wind Conditions (Circle one): [✓ Calm] [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ____

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: LOWER RIVER 62210 **Investigator :** JCA / CAD

DATE 0 6 2 2 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0752
(prevailing, 24 hr) *
meter #10984

CAL Temp 26.0 °C
Meter Temp 25.8 °C ok
Meter adj. to 26.0 °C

CAL DO 8.1 (mg/l)
Meter DO 7.8 (mg/l) OK
Meter adj to 8.1 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	DO / pH Meter	MS5 Monitor
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

BP=751.75

DO Calibration* ** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 27.0° (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO ☐☐☐ (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ok✓ @ 4.01 ______ @ 10.00 ✓ok (Record OK for buffer(s) used)

Conductivity Calibration* ** @ 0 74µS/cm OK✓ @ 718µS/cm ✓OK @ 1413µS/cm ______

Turbidity Calibration* ** @ 0 NTU ✓ok 0.3 @ 10 NTU ______ @ 20 NTU ok✓

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	DO / pH Meter	MS5 Monitor
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp 78.2 °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

7 Air Temperature ______ °C

Wind Conditions (Circle one): Calm Light Moderate Gusty Strong

Other Sampling Notes: Calibrated deep in At DO

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr

** Record values later from downloaded data at the corresponding time of portable meter measurements.

*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONOWINGO POND **Investigator :** KJT, CMB

DATE 0 6 2 9 1 0 (m m d d y y) **PURPOSE** 1 CALIBRATE + COLLECT DATA **Weather Code** 1

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

? → No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: YES or [✓ NO] (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

WAS STILL PRETTY GOOD FROM YESTERDAY →

Time	0745 (prevailing, 24 hr) *	**CAL Temp**	25.5 °C	**CAL DO**	8.15 (mg/l)
		Meter Temp	25- °C	Meter DO	8.15 (mg/l)
		Meter adj. to	25.5 °C	Meter adj to	N/A (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

N/A **Time** ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	DO / pH Meter		MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐ °C	Temp	______ °C **
	DO	☐☐☐ mg/l	DO	______ mg/l **
	pH	☐☐☐☐ su	pH	______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

BP = 743.65

DO Calibration* ** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 25.5 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.25 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration * ** @ 7.00 7.00 @ 4.01 N/A @ 10.00 10.00 (Record OK for buffer(s) used)

Conductivity Calibration* ** @ 74µS/cm N/A @ 718µS/cm 718.0 @ 1413µS/cm N/A

Turbidity Calibration* ** @ 0 NTU .03 NTU @ 10 NTU N/A @ 20 NTU 20 NTU

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

1009.2 mb = 743.65 mm Hg

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	DO / pH Meter		MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐ °C	Temp	______ °C **
	DO	☐☐☐ mg/l	DO	______ mg/l **
	pH	☐☐☐☐ su	pH	______ su **

7 Air Temperature 32.0 °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr

** Record values later from downloaded data at the corresponding time of portable meter measurements.

*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: L2 6/29/10 **Investigator :** JCx /CO13

DATE 0 6 2 9 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time ______ (prevailing, 24 hr) *

CAL Temp 25.2 °C **CAL DO** 8.4 (mg/l)
Meter Temp 25.2 °C Meter DO 8.4 (mg/l)
Meter adj. to 0 °C Meter adj to 0 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp 25.2 °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

BP= 743.65

DO Calibration* Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp ______ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO ☐☐☐ **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓ @ 4.01 ______ @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration*** @ 74µS/cm ✓ @ 718µS/cm ✓ @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU ✓ @ 10 NTU ______ @ 20 NTU ✓

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

7 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm Light Moderate Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

Normandeau Associates, Inc

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Conowingo Pond **Investigator :** JLA MDM

DATE 07 07 10 (m m d d y y) **PURPOSE** 2 **Weather Code** 1 &6

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 705 am (prevailing, 24 hr) *

CAL Temp 23.4 °C **CAL DO** 8.56 (mg/l)
Meter Temp 23.6 °C Meter DO 7.9 (mg/l) OK ✓
Meter adj. to 23.4 °C Meter adj to 8.56 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: BP 749.58

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100%SAT

Cal Temp 77.5°c (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8 1 5 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓ @ 4.01 ______ @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration*** @ ~~7~~04µS/cm ✓ @ 718µS/cm ✓ @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU ✓ @ 10 NTU ______ @ 20 NTU ✓

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 29.8 °C 91 Wind Conditions (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: LR - Below Conowingo Dam **Investigator :** SWA/KJT

DATE 0 7 0 7 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 1105 (prevailing, 24 hr) *

meter # 10983

CAL Temp 29.0 °C **CAL DO** 7.67 (mg/l)

Meter Temp 29.5 °C Meter DO 7.5 (mg/l) OK

Meter adj. to 29.0 °C Meter adj to 7.67 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	DO / pH Meter	MS5 Monitor
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

BP 749.58

cal. 0800 hr

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 24.7 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.26 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓ @ 4.01 ______ @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration*** @ 8 ~~74~~µS/cm ✓ @ 718µS/cm ✓ @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU ✓ @ 10 NTU ______ @ 20 NTU ✓

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	DO / pH Meter	MS5 Monitor
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

7 Air Temperature 37.5 °C **Wind Conditions** (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONO POND **Investigator :** JCA / Chad

DATE 07 13 10
m m d d y y

PURPOSE 2

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1/2
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0754 (prevailing, 24 hr) *
meter #15436

CAL Temp 25.5 °C **CAL DO** 8.15 (mg/l)
Meter Temp 25.8 °C OK Meter DO 8.3 (mg/l) OK
Meter adj. to 25.5 °C Meter adj to 8.15 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ (Lab or Onsite) **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ **1** = None required; **2** = Sensors cleaned; **3** = pH electrolyte replaced; **4** = Batteries replaced; **5** = Other (______)

5 MONITOR CALIBRATION:

BP 746.3

DO Calibration* Method Used:** 3 **1** = Aerated Water; **2** = River Water (bucket) vs YSI; **3** = Other LDO 100% SAT

Cal Temp 78.2 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.50 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓ @ 4.01 ______ @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration*** @ ~~74~~0μS/cm ✓ @ 718μS/cm ✓ @ 1413μS/cm ______

Turbidity Calibration*** @ 0 NTU ✓ @ 10 NTU ______ @ 20 NTU ✓

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm Light Moderate Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: L.S.R. **Investigator :** SWA, KJT

DATE 0 7 1 3 1 0 (m m d d y y) **PURPOSE** 2 **Weather Code** 4 +3

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0920 (prevailing, 24 hr) *
meter #10983

CAL Temp 21.0 °C **CAL DO** 8.9 **(mg/l)**
Meter Temp 21.2 °C OK Meter DO 9.4 (mg/l) OK
Meter adj. to 21.0 °C Meter adj to 8.9 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ (Lab or Onsite) **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ **1** = None required; **2** = Sensors cleaned; **3** = pH electrolyte replaced; **4** = Batteries replaced; **5** = Other (______)

5 MONITOR CALIBRATION: @0820 hr BP 746.3

DO Calibration*** **Method Used:** 3 **1** = Aerated Water; **2** = River Water (bucket) vs YSI; **3** = Other L.D.O. SAT

Cal Temp 78.1 ~~(°C)~~ F >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 7 9 8 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 7.0 @ 4.01 N/A @ 10.00 10.0 (Record OK for buffer(s) used)

Conductivity Calibration*** @ 74µS/cm N/A @ 718µS/cm 718 @ 1413µS/cm N/A

Turbidity Calibration*** @ 0 NTU .03 @ 10 NTU N/A @ 20 NTU 20.0

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm Light Moderate Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONO POND **Investigator :** SWA/CAB

DATE 0 7 2 0 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0744 (prevailing, 24 hr) *
meter #10984
CAL Temp 27.5 °C
Meter Temp 27.2 °C ok
Meter adj. to 27.5 °C
CAL DO 7.9 (mg/l)
Meter DO 8.1 (mg/l) OK
Meter adj to 7.9 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: 0750 hr BP 747.03

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT
Cal Temp 79.0°F (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2
Cal DO 7.94 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2
pH Calibration *** @ 7.00 ✓OK @ 4.01 ______ @ 10.00 ✓OK (Record OK for buffer(s) used)
Conductivity Calibration*** @ 740µS/cm ✓OK @ 718µS/cm ✓OK @ 1413µS/cm ______
Turbidity Calibration*** @ 0 NTU ✓ok @ 10 NTU ______ @ 20 NTU ✓ok

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature ______ °C

Wind Conditions (Circle one): [✓ Calm] Light Moderate Gusty Strong
Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONOWINGO - L.S.R. **Investigator:** JCA, KJT

DATE 07 20 10 (m m d d y y) **PURPOSE** 2 **Weather Code** 1

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: YES or [✓ NO] (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0825 (prevailing, 24 hr) *

CAL Temp	27.0 °C	**CAL DO**	7.9 (mg/l)
Meter Temp	27.0 °C	Meter DO	8.1 (mg/l)
Meter adj. to	N/A °C	Meter adj to	7.9 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	DO / pH Meter		MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐ °C	Temp	______ °C **
	DO	☐☐☐ mg/l	DO	______ mg/l **
	pH	☐☐☐☐ su	pH	______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

BP 747.03

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 79.0°F 27.0 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 7.94 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 7.00 @ 4.01 ______ @ 10.00 10.01 (Record OK for buffer(s) used)

Conductivity Calibration*** @ 74µS/cm – @ 718µS/cm – @ 1413µS/cm –

Turbidity Calibration*** @ 0 NTU .03 @ 10 NTU ______ @ 20 NTU 20.0

Time that the monitor was redeployed in the Tailrace N/A (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	DO / pH Meter		MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐ °C	Temp	______ °C **
	DO	☐☐☐ mg/l	DO	______ mg/l **
	pH	☐☐☐☐ su	pH	______ su **

7 Air Temperature ______ °C **Wind Conditions** (Circle one): [✓ Calm] Light Moderate Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr

** Record values later from downloaded data at the corresponding time of portable meter measurements.

*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONO POND **Investigator :** SWA/MDM

DATE 0 7 2 7 1 0
m m d d y y

PURPOSE 2

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 2

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or [✓ **NO**] (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0745 (prevailing, 24 hr) *

meter #10984

CAL Temp 25.0 °C
Meter Temp 25.5 °C OK
Meter adj. to 25.0 °C

CAL DO 8.24 (mg/l)
Meter DO 8.1 (mg/l) OK
Meter adj to 8.24 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: BP 751.98

@ 0800 hr **DO Calibration*** ** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 77.7 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.09 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 OK ✓ @ 4.01 ______ @ 10.00 ✓ OK (Record OK for buffer(s) used)

Conductivity Calibration* ** @ ~~74~~ 0 µS/cm ✓ OK @ 718µS/cm ✓ OK @ 1413µS/cm ______

Turbidity Calibration* ** @ 0 NTU ✓ OK @ 10 NTU ______ @ 20 NTU ✓ OK

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 26.9 °C

Wind Conditions (Circle one): [✓ Calm] Light Moderate Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr

** Record values later from downloaded data at the corresponding time of portable meter measurements.

*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: LR 7/27/10 **Investigator :** JCO / COD

DATE 0 7 2 7 1 0 (m m d d y y) **PURPOSE** 7 **Weather Code** 1

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time ________ (prevailing, 24 hr) *

CAL Temp 24.1 °C **CAL DO** 8.4 (mg/l)
Meter Temp 24.1 °C Meter DO 8.4 (mg/l)
Meter adj. to — °C Meter adj to — (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ________ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (__________)

5 MONITOR CALIBRATION:

BP= 751.98

DO Calibration* Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other 100% SAT

Cal Temp 76.0 (°~~C~~F) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 7 8 0 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓ @ 4.01 ______ @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 [illegible]µS/cm ______ @ 718µS/cm ✓ @ 1413µS/cm ✓

Turbidity Calibration*** @ 0 NTU ✓ @ 10 NTU ______ @ 20 NTU —

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 85 ~~°C~~ F **Wind Conditions** (Circle one): [✓ Calm Light] Moderate Gusty Strong

Other Sampling Notes: ____________

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONO POND **Investigator :** SC/A/ACS

DATE 0 8 0 2 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 3
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0800 (prevailing, 24 hr) *
meter# 10984

CAL Temp 25.5 **°C** **CAL DO** 8.15 **(mg/l)**
Meter Temp 25.8 °C Meter DO 8.25 (mg/l) OK
Meter adj. to 25.5 °C JK Meter adj to 8.15 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	DO / pH Meter		MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐	°C	Temp ______	°C **
	DO ☐☐☐	mg/l	DO ______	mg/l **
	pH ☐☐☐☐	su	pH ______	su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ **1** = None required; **2** = Sensors cleaned; **3** = pH electrolyte replaced; **4** = Batteries replaced; **5** = Other (______)

5 MONITOR CALIBRATION: BP 752.1

@0830 **DO Calibration***** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 78.5°F **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.02 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓ @ 4.01 ______ @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration*** @ ~~74~~0µS/cm ✓ @ 718µS/cm ✓ @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU ✓ @ 10 NTU ______ @ 20 NTU ✓

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	DO / pH Meter		MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐	°C	Temp ______	°C **
	DO ☐☐☐	mg/l	DO ______	mg/l **
	pH ☐☐☐☐	su	pH ______	su **

7 Air Temperature 26.0°C

Wind Conditions (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: LR 8/2/10 **Investigator :** JCA / EK

DATE 0 8 0 2 1 0
m m d d y y

PURPOSE ~~1~~ 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 3
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0850 (prevailing, 24 hr) *
meter #15436

CAL Temp 26 °C
Meter Temp 26 °C
Meter adj. to — °C

CAL DO 8.06 (mg/l)
Meter DO 5.4 (mg/l)
Meter adj to 8.06 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: @0800 BP 752.1

DO Calibration* Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 78.5F (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO ☐☐☐ (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓ @ 4.01 ______ @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration*** @074µS/cm ✓ @ 718µS/cm ✓ @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU ✓ @ 10 NTU ______ @ 20 NTU ✓

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Cono Pond **Investigator :** SWA/MDM

DATE 0 8 1 0 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0740 (prevailing, 24 hr) *
meter #10584

CAL Temp 25.8 °C
Meter Temp 25.2 °C O/K
Meter adj. to 25.8 °C

CAL DO 8.1 (mg/l)
Meter DO 7.5 (mg/l) OK
Meter adj to 8.1 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time		DO / pH Meter		MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐ °C	Temp	______ °C **	
	DO	☐☐☐ mg/l	DO	______ mg/l **	
	pH	☐☐☐☐ su	pH	______ su **	

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced;
4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: BP 746.9

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 78.8 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 7.91 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ______ @ 4.01 ______ @ 10.00 ______ (Record OK for buffer(s) used)

Conductivity Calibration*** @ ~~[illegible]~~ 0µS/cm ✓ OK @ 718µS/cm ✓ OK @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU ✓ OK @ 10 NTU ______ @ 20 NTU ✓ OK

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time		DO / pH Meter		MS5 Monitor
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐ °C	Temp	______ °C **
	DO	☐☐☐ mg/l	DO	______ mg/l **
	pH	☐☐☐☐ su	pH	______ su **

7 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm Light Moderate Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: L.S.R. Below Cono Dam **Investigator :** KJT, JCA

✓ **DATE** 0 8 1 0 1 0 (m m d d y y) **PURPOSE** 2 **Weather Code** 1

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

✓ No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: YES or [✓ NO] (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

✓

Time 0821 (prevailing, 24 hr) *

CAL Temp 25.5 °C **CAL DO** 8.1 (mg/l)

Meter Temp 25.8 °C Meter DO 8.6 (mg/l)

Meter adj. to 25.5 °C Meter adj to 8.1 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

N/A

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

N/A

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

N/A

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ (Lab or Onsite) **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

✓

BP=746.9

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 25.5 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8 0 0 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 7.00 @ 4.01 N/A @ 10.00 10.0 (Record OK for buffer(s) used)

Conductivity Calibration*** @ 74µS/cm N/A @ 718µS/cm 718 @ 1413µS/cm N/A

Turbidity Calibration*** @ 0 NTU 0.00 @ 10 NTU 10.0 @ 20 NTU N/A

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

N/A

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm Light Moderate Gusty Strong

N/A

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr

** Record values later from downloaded data at the corresponding time of portable meter measurements.

*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONO POND **Investigator :** SWA / ACS

DATE 0 8 1 6 1 0 (m m d d y y) **PURPOSE** 2 **Weather Code** 3

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0735 (prevailing, 24 hr) *

Meter # 15436

CAL Temp 25.5 °C **CAL DO** 8.15 (mg/l)
Meter Temp 25.0 °C Meter DO 8.20 (mg/l)
Meter adj. to 25.5 °C Meter adj to 8.15 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ (Lab or Onsite) **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: BP 747.4

DO Calibration* Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 78.9°F (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.02 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓OK @ 4.01 ______ @ 10.00 ✓OK (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm ✓OK @ 718µS/cm ✓OK @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU ✓OK @ 10 NTU ✓OK @ 20 NTU ______

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: L.S.R. BELOW CONO **Investigator :** KJT, MDM

✓ **DATE** 0 8 1 6 1 0 (m m d d y y) **PURPOSE** 2 **Weather Code** 3

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

✓

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

✓

Time 1029 (prevailing, 24 hr) *

CAL Temp 24.0 °C **CAL DO** 8.4 **(mg/l)**
Meter Temp 24.2 °C Meter DO 8.6 (mg/l)
Meter adj. to 24.0 °C Meter adj to 8.4 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

N/A

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

N/A

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

BP=747.4

✓

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 25.6 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 7 9 6 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 6.97→7.00 @ 4.01 N/A @ 10.00 10.03→10 (Record OK for buffer(s) used)

Conductivity Calibration*** @ 7~~4~~0µS/cm N/A @ 718µS/cm 708→718 @ 1413µS/cm N/A

Turbidity Calibration*** @ 0 NTU 0.0 @ 10 NTU 8.2→10.0 @ 20 NTU N/A

Time that the monitor was redeployed in the Tailrace N A (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

N/A

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature 28.4 °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: OUTSIDE

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr

** Record values later from downloaded data at the corresponding time of portable meter measurements.

*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONO POND **Investigator :** SWA/ACS

DATE 0 8 2 4 1 0 (m m d d y y) **PURPOSE** 2 **Weather Code** 3

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0630 (prevailing, 24 hr) *
CAL Temp 26.5 °C **CAL DO** 8.0 **(mg/l)**
Meter Temp 26.5 °C Meter DO 7.9 (mg/l) OK
meter #15436
Meter adj. to OK °C Meter adj to 8.0 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: BP 748.6

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 79.9 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 7.91 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓OK @ 4.01 ______ @ 10.00 ✓OK (Record OK for buffer(s) used)

Conductivity Calibration*** @ ~~84~~ 0µS/cm ✓OK @ 718µS/cm ✓OK @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU ✓OK @ 10 NTU ______ @ 20 NTU ✓OK

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Lower River **Investigator :** KJT/GAB

✓ **DATE** 0 8 2 4 1 0 (m m d d y y) **PURPOSE** 2 **Weather Code** 3

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast 4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

✓ **Time** 0820 (prevailing, 24 hr) *

CAL Temp 26.8 °C **CAL DO** 7.95 **(mg/l)**

Meter Temp 26.8 °C Meter DO 7.9 (mg/l)

Meter adj. to N/A °C Meter adj to N/A (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

✓ **Time** ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter

Temp ☐☐☐ °C

DO ☐☐☐ mg/l

pH ☐☐☐☐ su

MS5 Monitor

Temp ______ °C **

DO ______ mg/l **

pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

✓ **Time retrieved (taken out of service)** ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: BP = 748.6

✓ **DO Calibration***** 26.4 **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp ~~99.9~~ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 7.96 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 Ok @ 4.01 ______ @ 10.00 OK (Record OK for buffer(s) used)

Conductivity Calibration*** @ 74µS/cm ______ @ 718µS/cm OK @ 1413µS/cm ______ OAS OK

Turbidity Calibration*** @ 0 NTU OK (.03) @ 10 NTU ______ @ 20 NTU OK

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

✓ **Time** ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter

Temp ☐☐☐ °C

DO ☐☐☐ mg/l

pH ☐☐☐☐ su

MS5 Monitor

Temp ______ °C **

DO ______ mg/l **

pH ______ su **

7 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr

** Record values later from downloaded data at the corresponding time of portable meter measurements.

*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONO POND **Investigator :** SWA/MDM

DATE 0 8 3 1 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0750 (prevailing, 24 hr) *
meter #15436

CAL Temp 25.5 °C
Meter Temp 26.0 °C OK
Meter adj. to 25.5 °C

CAL DO 8.1 (mg/l)
Meter DO 8.0 (mg/l) OK
Meter adj to 8.1 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: BP 754.23

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT

Cal Temp 79.2 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 7.97 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓ @ 4.01 ______ @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration*** @ ~~84~~ 0µS/cm ✓ @ 718µS/cm ✓ @ 1413µS/cm ______

Turbidity Calibration*** @ 0 NTU ✓ @ 10 NTU ______ @ 20 NTU ✓

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

7 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: LOWER RIVER **Investigator :** ACS / KJT

DATE 0 8 3 1 1 2 (m m d d y y) **PURPOSE** 2 **Weather Code** 1

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0830 (prevailing, 24 hr) *
meter # 10984

CAL Temp 26.0 °C **CAL DO** 8.0 **(mg/l)**
Meter Temp 25.9 °C Meter DO 8.1 (mg/l)
Meter adj. to 26.0 °C Meter adj to 8.0 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ____ (prevailing, 24 hr) *

	DO / pH Meter		**MS5 Monitor**	
Temp		°C		°C **
DO		mg/l		mg/l **
pH		su		su **

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ____ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ____ (24 hr) *
Applicable Maintenance Performed: ______ **1** = None required; **2** = Sensors cleaned; **3** = pH electrolyte replaced; **4** = Batteries replaced; **5** = Other (______)

5 MONITOR CALIBRATION: BP 754.23

DO Calibration* ** **Method Used:** 3 **1** = Aerated Water; **2** = River Water (bucket) vs YSI; **3** = Other LDO 100% SAT

Cal Temp 78.6 **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8 0 4 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓OK. @ 4.01 N/A @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration* ** @ ~~74~~ 0 µS/cm ✓OK @ 718µS/cm ✓OK @ 1413µS/cm N/A

Turbidity Calibration* ** @ 0 NTU ✓OK @ 10 NTU N/A @ 20 NTU ✓OK

Time that the monitor was redeployed in the Tailrace NA ____ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ____ (prevailing, 24 hr) *

	DO / pH Meter		**MS5 Monitor**	
Temp		°C		°C **
DO		mg/l		mg/l **
pH		su		su **

7 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ______

---

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Cono Bnd **Investigator :** ACS, MDM

DATE 0 9 0 7 1 0
m m d d y y

PURPOSE 1
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0800 (prevailing, 24 hr) *
Meter # 15436

CAL Temp 25.0 °C
Meter Temp 24.0 °C
Meter adj. to 8.24 °C

CAL DO 8.24 (mg/l)
Meter DO 8.0 (mg/l)
Meter adj to 8.24 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 MONITOR CALIBRATION:

Barometric pressure = 753.25

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT
4 = Other ______

Cal Temp 26.9 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 7 5 4 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓ @ 4.01 ______ @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm ✓ @ 718 µS/cm ✓ @ 1413 µS/cm ______

Turbidity Calibration*** @ <1 NTU ✓ @ 10 NTU ______ @ 20 NTU ✓

4 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

5 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

6 Air Temperature 27.2 °C

Wind Conditions (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: L.S.R. H_2O QUAL **Investigator :** KJT, CAB

DATE 0 9 0 7 1 0 (m m d d y y)

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0820 (prevailing, 24 hr) *
Meter # 57
CAL Temp 25.0 °C
Meter Temp 25.0 °C
Meter adj. to N/A °C
CAL DO 8.2 (mg/l)
Meter DO 8.0 (mg/l)
Meter adj to 8.2 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 MONITOR CALIBRATION:

Barometric pressure = 753.25

DO Calibration* **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT
4 = Other ______

Cal Temp 76.6 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.01 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 OK. @ 4.01 N/A @ 10.00 O.K. (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm O.K. @ 718 µS/cm O.K. @ 1413 µS/cm N/A

Turbidity Calibration*** @ <1 NTU O.K. @ 10 NTU N/A @ 20 NTU O.K.

4 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

N/A

Time
☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

5 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

N/A

Time
☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

6 Air Temperature ______ °C

Wind Conditions (Circle one): [✓ Calm] Light Moderate Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Conowingo Pond **Investigator :** CAB, ACS

DATE 0 9 1 4 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 2
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0810 (prevailing, 24 hr) *

Meter # 1

CAL Temp 24.2 °C
Meter Temp 24.5 °C
Meter adj. to 24.2 °C

CAL DO 8.4 (mg/l)
Meter DO 8.2 (mg/l)
Meter adj to 8.4 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 MONITOR CALIBRATION:

Barometric pressure = 746.425

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT
4 = Other ______

Cal Temp 77 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8 1 8 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ok @ 4.01 OK @ 10.00 ______ (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm OK @ 718 µS/cm OK @ 1413 µS/cm ______

Turbidity Calibration*** @ <1 NTU OK @ 10 NTU ______ @ 20 NTU OK

4 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter		**MS5 Monitor**	
Temp	°C	Temp	°C **
DO	mg/l	DO	mg/l **
pH	su	pH	su **

5 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter		**MS5 Monitor**	
Temp	°C	Temp	°C **
DO	mg/l	DO	mg/l **
pH	su	pH	su **

6 Air Temperature 25.0 °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes:

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

MUDDY RUN STATION
DS5X LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: MRPSP STA004-Cylinder or STA005-TR Deck **Investigator :** KJT, MDM

DATE 0 9 1 4 1 0
m m d d y y

PURPOSE 1
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)
4 = Download only (complete sections 1,2,3,4,& 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

✓

1 PROJECT FLOW / RELEASE CONDITIONS:

Reservoir Elevation —

No. of MR Units Operating 0 (0 to 8)

Flow from Holtwood Evident: YES or [✓ NO] (circle one)

✓

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time	0820 (prevailing, 24 hr) *	CAL Temp	24.2 °C	CAL DO	8.35 (mg/l)
		Meter Temp	24.5 °C	Meter DO	8.5 (mg/l)
Meter #	57	Meter adj. to	24.2 °C	Meter adj to	8.4 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

N/A

Time	DO / pH Meter		DS5X Monitor		MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐ °C	Temp	______ °C **	Temp	______ °C
	DO	☐☐☐ mg/l	DO	______ mg/l **	DO	______ mg/l
	pH	☐☐☐☐ su	pH	______ su **	pH	______ su
			Cond	______ µS/cm**	Cond	______ µS/cm

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

N/A

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ (Lab or Onsite) Time of Download: ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

Barometric pressure = 746.4

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT
4 = Other ______

Cal Temp 24.4 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.01 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 OK @ 4.01 N/A @ 10.00 OK. (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm OK @ 718 µS/cm OK @ 1413 µS/cm N/A

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) * TURBIDITY ✓ O.K.

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

N/A

Time	DO / pH Meter		DS5X Monitor		MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐ °C	Temp	______ °C **	Temp	______ °C
	DO	☐☐☐ mg/l	DO	______ mg/l **	DO	______ mg/l
	pH	☐☐☐☐ su	pH	______ su **	pH	______ su
			Cond	______ µS/cm**	Cond	______ µS/cm

7 Air Temperature 20.3 °C

Wind Conditions (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONO POND **Investigator :** SWA/

DATE 0 9 2 0 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0740 (prevailing, 24 hr) *
CAL Temp 25.0 °C **CAL DO** 8.24 **(mg/l)**
Meter Temp 25.0 °C Meter DO 8.3 (mg/l) OK
Meter # ______ Meter adj. to OK °C Meter adj to 8.24 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 MONITOR CALIBRATION:

Barometric pressure = 749.88

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT
4 = Other ______

Cal Temp 76.0°F **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8 2 2 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓OK @ 4.01 ______ @ 10.00 ✓OK (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm ✓OK @ 718 µS/cm ✓OK @ 1413 µS/cm N/A

Turbidity Calibration*** @ <1 NTU ✓OK @ 10 NTU N/A @ 20 NTU ✓OK

4 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

5 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter
Temp ☐☐☐ °C
DO ☐☐☐ mg/l
pH ☐☐☐☐ su

MS5 Monitor
Temp ______ °C **
DO ______ mg/l **
pH ______ su **

6 Air Temperature 20.0 °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: ______

---

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: L River Wa Q **Investigator :** KJT / JCA

DATE 09 20 10 (m m d d y y) **PURPOSE** 2 **Weather Code** 1

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast 4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0820 (prevailing, 24 hr) *

CAL Temp 24.9 °C **CAL DO** 8.4 (mg/l)
Meter Temp 24.6 °C Meter DO 8.6 (mg/l)
Meter adj. to 24.9 °C Meter adj to 8.4 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

N/A **Time** ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

Redline adjusted up

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *
Data Download Location: ______ **(Lab or Onsite)** **Time of Download:** ☐☐☐☐ (24 hr) *
Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION: BP 749.88

DO Calibration* Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = Other LDO 100% SAT
Cal Temp 76.2/24.5 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2
Cal DO 8.2 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2
pH Calibration *** @ 7.00 ✓ @ 4.01 N/A @ 10.00 ✓ (Record OK for buffer(s) used)
Conductivity Calibration*** @ ~~74~~0µS/cm N/A @ 718µS/cm ✓ @ 1413µS/cm N/A
Turbidity Calibration*** @ 0 NTU ✓ @ 10 NTU N/A @ 20 NTU ✓

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

7 Air Temperature 20.0 °C **Wind Conditions** (Circle one): Calm Light Moderate [✓ Gusty] Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONO POND **Investigator :** SWA/ACS

DATE 0 9 2 8 1 0 (m m d d y y) **PURPOSE** 2 **Weather Code** 3 4+5

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0750 (prevailing, 24 hr) * **CAL Temp** 24.5 °C **CAL DO** 8.3 (mg/l)

Meter Temp 24.5 °C Meter DO 8.4 (mg/l) OK

Meter # 10983 Meter adj. to OK °C Meter adj to 8.3 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 MONITOR CALIBRATION:

Barometric pressure = 739.9

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT
4 = Other ______

Cal Temp 76.0°F ______ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8.10 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓OK @ 4.01 ______ @ 10.00 ✓OK (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm ✓OK @ 718 µS/cm ✓OK @ 1413 µS/cm ______

Turbidity Calibration*** @ <1 NTU ✓OK @ 10 NTU ______ @ 20 NTU ✓OK

4 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter		**MS5 Monitor**	
Temp	☐☐☐ °C	Temp	______ °C **
DO	☐☐☐ mg/l	DO	______ mg/l **
pH	☐☐☐☐ su	pH	______ su **

5 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time ☐☐☐☐ (prevailing, 24 hr) *

DO / pH Meter		**MS5 Monitor**	
Temp	☐☐☐ °C	Temp	______ °C **
DO	☐☐☐ mg/l	DO	______ mg/l **
pH	☐☐☐☐ su	pH	______ su **

6 Air Temperature 22.8 °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Lower River **Investigator :** JCA, CAB

DATE 0 9 2 8 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 3
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0845 (prevailing, 24 hr) *
CAL Temp 24.0 °C **CAL DO** 8.40 (mg/l)
Meter Temp 24.0 °C Meter DO 8.50 (mg/l)
Meter # 1 Meter adj. to – °C Meter adj to 8.40 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 MONITOR CALIBRATION:

Barometric pressure = 739.9

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT
4 = Other ______

Cal Temp 74.9 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8 1 8 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 X @ 4.01 ______ @ 10.00 X (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm X @ 718 µS/cm X @ 1413 µS/cm ______

Turbidity Calibration*** @ <1 NTU X @ 10 NTU ______ @ 20 NTU X

4 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

5 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

6 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Cono Pond **Investigator :** SWA/ACS

DATE 1 0 0 5 1 0 (m m d d y y) **PURPOSE** 2 **Weather Code** 3/4

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time	0750	**CAL Temp**	20.0 °C	**CAL DO**	9.07 (mg/l)
(prevailing, 24 hr) *		Meter Temp	20.0 °C	Meter DO	9.0 (mg/l) OK
Meter #	10983	Meter adj. to	OK °C	Meter adj to	9.07 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 MONITOR CALIBRATION:

Barometric pressure = 749.95

DO Calibration* Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT
4 = Other ______

Cal Temp 20 0 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 9.1 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration * ** @ 7.00 √OK @ 4.01 ______ @ 10.00 √OK (Record OK for buffer(s) used)

Conductivity Calibration* ** @ 0 µS/cm √OK @ 718 µS/cm √OK @ 1413 µS/cm ______

Turbidity Calibration* ** @ <1 NTU √OK @ 10 NTU ______ @ 20 NTU √OK

4 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	DO / pH Meter	MS5 Monitor
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

5 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	DO / pH Meter	MS5 Monitor
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

6 Air Temperature 17.0 °C

Wind Conditions (Circle one): Calm Light [✓ Moderate] Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: LR 10/5/10 **Investigator :** JCa / EK

DATE 1 0 0 5 1 0 (m m d d y y) **PURPOSE** 2 **Weather Code** 3/4

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 8:30 (prevailing, 24 hr) * **CAL Temp** 20° °C **CAL DO** 9.07 **(mg/l)**
Meter Temp 20° °C Meter DO 9.0 (mg/l)
Meter # #1 Meter adj. to — °C Meter adj to 9.07 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 MONITOR CALIBRATION:

Barometric pressure = 749.95

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT
4 = Other ______

Cal Temp ______ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO ☐☐☐ **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 X @ 4.01 ______ @ 10.00 X (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm X @ 718 µS/cm X @ 1413 µS/cm ______

Turbidity Calibration*** @ <1 NTU X @ 10 NTU ______ @ 20 NTU X

4 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

5 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

6 Air Temperature ______ °C

Wind Conditions (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: Light Rain, misty

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONO POND **Investigator :** SWA/RDK

DATE 1 0 1 1 1 0 (m m d d y y)

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 1
1=Clear 2=P. Cloudy 3=Overcast 4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time	0730 (prevailing, 24 hr) *	**CAL Temp**	23.0 °C	**CAL DO**	8.56 (mg/l)
		Meter Temp	23.2 °C OK	Meter DO	8.3 (mg/l) OK
Meter #	10983	Meter adj. to	23.0 °C	Meter adj to	8.56 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 MONITOR CALIBRATION: #2 Barometric pressure = 744.2

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT 4 = Other ______

Cal Temp 72.2°F ______ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8 5 0 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓OK @ 4.01 ______ @ 10.00 ✓OK (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm ✓OK @ 718 µS/cm ✓OK @ 1413 µS/cm ______

Turbidity Calibration*** @ <1 NTU ✓OK @ 10 NTU ______ @ 20 NTU ✓OK

4 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	DO / pH Meter		MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐ °C	Temp	______ °C **
	DO	☐☐☐ mg/l	DO	______ mg/l **
	pH	☐☐☐☐ su	pH	______ su **

5 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	DO / pH Meter		MS5 Monitor	
☐☐☐☐ (prevailing, 24 hr) *	Temp	☐☐☐ °C	Temp	______ °C **
	DO	☐☐☐ mg/l	DO	______ mg/l **
	pH	☐☐☐☐ su	pH	______ su **

6 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

MUDDY RUN STATION

MS5 ~~DS5X~~ LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: MRPSP STA004-Cylinder or STA005-TR Deck **Investigator :** JCa/EK

DATE 1 0 1 1 1 0 (m m d d y y) **PURPOSE** 2 **Weather Code** 1

1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)
4 = Download only (complete sections 1,2,3,4,& 7)

1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

Reservoir Elevation ______

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: YES or NO (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time ______ (prevailing, 24 hr) *	CAL Temp 23 °C	CAL DO 8.56 (mg/l)
	Meter Temp 23 °C	Meter DO 8.56 (mg/l)
Meter # ______	Meter adj. to — °C	Meter adj to — (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	DO / pH Meter	DS5X Monitor	MS5 Monitor
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **	Temp ______ °C
	DO ☐☐☐ mg/l	DO ______ mg/l **	DO ______ mg/l
	pH ☐☐☐☐ su	pH ______ su **	pH ______ su
		Cond ______ µS/cm**	Cond ______ µS/cm

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: ______ (Lab or Onsite) **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: ______ 1 = None required; 2 = Sensors cleaned; 3 = pH electrolyte replaced; 4 = Batteries replaced; 5 = Other (______)

5 MONITOR CALIBRATION:

Barometric pressure = 744.2

DO Calibration* Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT 4 = Other ______

Cal Temp 23 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO — (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓ @ 4.01 ______ @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm ✓ @ 718 µS/cm ✓ @ 1413 µS/cm ______

Turbidity <1 - OK
20.6 - OK

Time that the monitor was redeployed in the Tailrace ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	DO / pH Meter	DS5X Monitor	MS5 Monitor
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **	Temp ______ °C
	DO ☐☐☐ mg/l	DO ______ mg/l **	DO ______ mg/l
	pH ☐☐☐☐ su	pH ______ su **	pH ______ su
		Cond ______ µS/cm**	Cond ______ µS/cm

7 Air Temperature ______ °C

Wind Conditions (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ______

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: CONOWINGO POND **Investigator :** SWA/LNT

DATE 1 0 1 9 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 4
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0745 (prevailing, 24 hr) *
CAL Temp 20.5 °C
CAL DO 9.0 (mg/l)
Meter Temp 20.5 °C
Meter DO 8.5 (mg/l)
Meter # 10983
Meter adj. to OK °C
Meter adj to 9.0 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 MONITOR CALIBRATION:

Barometric pressure = 746.95

DO Calibration* Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT
4 = Other ______

Cal Temp 68.6 ______ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8 9 0 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓OK @ 4.01 ______ @ 10.00 ✓OK (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm ✓OK @ 718 µS/cm ✓OK @ 1413 µS/cm ______

Turbidity Calibration*** @ <1 NTU ✓OK @ 10 NTU ______ @ 20 NTU ✓OK

4 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	DO / pH Meter	MS5 Monitor
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

5 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	DO / pH Meter	MS5 Monitor
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

6 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm Light Moderate Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Lower River **Investigator :** EK, ACS

DATE 1 0 1 9 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code ☐
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: **YES** or **NO** (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time	0831	**CAL Temp**	20.5 °C	**CAL DO**	8.9 (mg/l)
(prevailing, 24 hr) *		Meter Temp	20.5 °C	Meter DO	8.6 (mg/l)
Meter #	57	Meter adj. to	°C	Meter adj to	8.9 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 MONITOR CALIBRATION: 0825 hr **Barometric pressure =** 746.95

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT
4 = Other ______

Cal Temp 68.1 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8 9 2 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓OK @ 4.01 ______ @ 10.00 ✓OK (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm ✓OK @ 718 µS/cm ✓OK @ 1413 µS/cm ______

Turbidity Calibration*** @ <1 NTU ✓OK @ 10 NTU ______ @ 20 NTU ✓OK

4 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

5 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

6 Air Temperature ______ °C **Wind Conditions** (Circle one): Calm Light Moderate Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: Conowingo Pond **Investigator :** ACS AMH

DATE 1 0 2 6 1 0
m m d d y y

PURPOSE 3
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 3
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: [✓ YES] or NO (circle one)

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0815 (prevailing, 24 hr) *
Meter # 57

CAL Temp 22.0 °C
Meter Temp 22.0 °C
Meter adj. to 22.0 °C

CAL DO 8.72 (mg/l)
Meter DO 8.50 (mg/l)
Meter adj to 8.72 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)
Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

3 MONITOR CALIBRATION:

Barometric pressure = 745.375

DO Calibration* Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT
4 = Other ______

Cal Temp ______ **(°C)** >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 1 0 0 **(mg/l)** >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 ✓ @ 4.01 ______ @ 10.00 ✓ (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm ✓ @ 718 µS/cm ✓ @ 1413 µS/cm ______

Turbidity Calibration*** @ <1 NTU ✓ @ 10 NTU ______ @ 20 NTU ✓

4 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

5 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	**DO / pH Meter**	**MS5 Monitor**
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

6 Air Temperature 17.4 °C

Wind Conditions (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: ______

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

ENCLOSURE 1

CONOWINGO & MUDDY RUN STATIONS
MS5 LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: L.S.R. BELOW CONOWINGO **Investigator :** KJT, MDM

DATE 1 0 2 6 1 0
m m d d y y

PURPOSE 2
1 = Calibrate & deploy monitor (complete Sec 1, 2, 5, 6, & 7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code 3
1=Clear 2=P. Cloudy 3=Overcast
4=Lt.Rain 5= H. Rain 6=Fog/Haze

✓

1 PROJECT FLOW / RELEASE CONDITIONS:

No. of MR Units Operating ☐ (0 to 8) Flow from Holtwood Evident: [✓ YES] or NO (circle one)

✓

2 YSI DO METER CALIBRATION: Calibrate the YSI meter with the DO probe in air saturated (aerated) water.

Time 0835 (prevailing, 24 hr) *
Meter # 10984

CAL Temp 22.0 °C
Meter Temp 21.8 °C
Meter adj. to 22.0 °C

CAL DO 8.7 (mg/l)
Meter DO 10.4 (mg/l)
Meter adj to 8.7 (mg/l)

pH METER CALIBRATION: Use a one or two buffer system (7.00 and 4.01 or 10.00 su)

Time ______ Meter reading @ 7.00 su ______ @ 4.01 su ______ or @ 10.00 su ______

✓

3 MONITOR CALIBRATION:

Barometric pressure = 745.3

DO Calibration*** **Method Used:** 3 1 = Aerated Water; 2 = River Water (bucket) vs YSI; 3 = LDO 100% SAT 4 = Other ______

Cal Temp 22.8 (°C) >> °C from hand thermometer; YSI; or Sonde thermistor for Method 1 or 2

Cal DO 8 4 0 (mg/l) >> DO value (from solubility table) for Method 1, or the YSI DO value for Method 2

pH Calibration *** @ 7.00 O.K.! @ 4.01 N/A @ 10.00 O.K.! (Record OK for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm O.K.! @ 718 µS/cm O.K.✓ @ 1413 µS/cm N/A

Turbidity Calibration*** @ <1 NTU O.K.! @ 10 NTU N/A @ 20 NTU O.K.✓

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4 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

N/A

Time	DO / pH Meter	MS5 Monitor
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

5 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

N/A

Time	DO / pH Meter	MS5 Monitor
☐☐☐☐ (prevailing, 24 hr) *	Temp ☐☐☐ °C	Temp ______ °C **
	DO ☐☐☐ mg/l	DO ______ mg/l **
	pH ☐☐☐☐ su	pH ______ su **

6 Air Temperature 17.2 °C

Wind Conditions (Circle one): Calm [✓ Light] Moderate Gusty Strong

Other Sampling Notes: LITTLE UNSURE OF D.O. ON YSI. MAY NEED TO CHANGE MEMBRANE.

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* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr
** Record values later from downloaded data at the corresponding time of portable meter measurements.
*** May be done in Lab or Field just prior to deployment, experience to dictate location.

APPENDIX B-1: LISTING OF HOURLY OPERATING TURBINE BOIL MEASUREMENTS.

Appendix B

Boil Measurements

Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	7/2/10	NW	3	2	2	6	4	1	8.5	25.5	29.5
21342031	9	7/2/10	NW	3	2	5	6	9	1	8.6	25.5	29.5
21342031	9	7/2/10	NW	3	2	2	6	57	1	8.6	25.5	29.5
21342031	9	7/2/10	NW	3	2	5	7	2	1	8.7	25.5	29.5
21342031	9	7/2/10	NW	3	2	2	7	59	1	9.0	25.5	30.0
21342031	9	7/2/10	NW	3	2	5	8	3	1	8.7	25.5	29.5
21342031	9	7/2/10	NW	3	2	2	9	2	1	8.1	25.5	29.0
21342031	9	7/2/10	NW	3	2	5	9	6	1	8.2	25.5	29.5
21342031	9	7/2/10	NW	3	2	2	10	3	1	8.6	25.5	29.5
21342031	9	7/2/10	NW	3	2	5	10	8	1	8.4	25.5	29.5
21342031	9	7/2/10	NW	3	2	2	10	55	1	8.1	25.5	29.5
21342031	9	7/2/10	NW	3	2	5	10	58	1	8.4	25.5	29.5
21342031	9	7/2/10	NW	3	2	2	11	58	1	8.5	25.5	29.5
21342031	9	7/2/10	NW	3	2	5	12	2	1	8.4	25.5	29.5
21342031	9	7/2/10	NW	3	2	2	12	56	1	9.0	25.5	29.5
21342031	9	7/2/10	NW	3	2	5	13	1	1	8.4	25.5	29.0
21342031	9	7/2/10	NW	3	2	2	14	0	1	8.4	25.5	29.5
21342031	9	7/2/10	NW	3	2	5	14	4	1	8.2	25.5	29.5
21342031	9	7/2/10	NW	3	2	2	14	57	1	8.3	25.5	29.0
21342031	9	7/2/10	NW	3	2	5	15	0	1	8.2	25.5	29.0
21342031	9	7/2/10	NW	3	2	2	15	57	1	8.2	25.5	28.5
21342031	9	7/2/10	NW	3	2	5	16	2	1	8.0	25.5	28.3
21342031	9	7/2/10	NW	3	2	2	16	57	1	8.2	25.5	29.0
21342031	9	7/2/10	NW	3	2	5	17	3	1	8.4	25.5	29.0
21342031	9	7/2/10	NW	3	2	2	17	47	1	8.4	25.5	29.0
21342031	9	7/2/10	NW	3	2	5	17	53	1	8.2	25.5	29.0
21342031	9	7/3/10	NE	1	1	2	6	2	1	8.7	13.8	28.9
21342031	9	7/3/10	NE	1	1	5	6	5	1	8.3	13.8	28.9
21342031	9	7/3/10	NE	1	1	2	7	0	1	8.6	13.8	28.9
21342031	9	7/3/10	NE	1	1	5	7	3	1	8.7	13.8	29.0
21342031	9	7/3/10	NE	1	1	2	8	1	1	8.3	13.8	29.0
21342031	9	7/3/10	NE	1	1	5	8	5	1	8.1	13.8	29.0
21342031	9	7/3/10	NE	1	1	2	9	4	1	8.8	13.8	29.0
21342031	9	7/3/10	NE	1	1	5	9	7	1	8.2	13.8	29.0
21342031	9	7/3/10	NE	1	1	2	10	0	1	8.2	13.8	29.2
21342031	9	7/3/10	NE	1	1	5	10	4	1	8.3	13.8	29.4
21342031	9	7/3/10	NE	1	1	2	11	0	1	8.2	13.8	29.2
21342031	9	7/3/10	NE	1	1	5	11	4	1	8.3	13.8	29.2

21342031	9	7/3/10	NE	1	1	2	12	1	1	7.9	13.8	29.1

Appendix B

Continued.

Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	7/3/10	NE	1	1	5	12	6	1	8.4	13.8	29.2
21342031	9	7/3/10	NE	1	1	2	13	3	1	8.1	31.0	29.0
21342031	9	7/3/10	NE	1	1	5	13	8	1	8.3	31.0	29.2
21342031	9	7/3/10	NE	1	1	2	14	0	1	8.3	31.0	29.1
21342031	9	7/3/10	NE	1	1	5	14	3	1	8.1	31.0	29.1
21342031	9	7/3/10	NE	1	1	2	15	0	1	8.1	31.0	29.0
21342031	9	7/3/10	NE	1	1	5	15	3	1	8.0	31.0	29.0
21342031	9	7/3/10	NE	1	1	2	16	0	1	8.3	31.0	29.1
21342031	9	7/3/10	NE	1	1	5	16	4	1	8.1	31.0	29.0
21342031	9	7/3/10	NE	1	1	2	17	0	1	8.2	31.0	29.1
21342031	9	7/3/10	NE	1	1	5	17	4	1	7.8	31.0	29.1
21342031	9	7/3/10	NE	1	1	2	18	0	1	7.9	31.0	29.0
21342031	9	7/3/10	NE	1	1	5	18	3	1	7.9	31.0	29.0
21342031	9	7/4/10	N	1	1	2	6	2	1	8.0	17.8	28.5
21342031	9	7/4/10	N	1	1	5	6	8	1	8.2	17.8	28.9
21342031	9	7/4/10	N	1	1	2	7	0	1	7.5	17.8	29.0
21342031	9	7/4/10	N	1	1	5	7	5	1	7.5	17.8	29.0
21342031	9	7/4/10	N	1	1	2	7	57	1	8.2	17.8	29.0
21342031	9	7/4/10	N	1	1	5	8	3	1	8.2	17.8	29.0
21342031	9	7/4/10	N	1	1	2	8	57	1	7.8	17.8	28.8
21342031	9	7/4/10	N	1	1	5	9	2	1	7.6	17.8	28.8
21342031	9	7/4/10	N	1	1	2	10	0	1	8.2	17.8	28.8
21342031	9	7/4/10	N	1	1	5	10	5	1	8.0	17.8	29.0
21342031	9	7/4/10	N	1	1	2	11	3	1	8.2	17.8	29.0
21342031	9	7/4/10	N	1	1	5	11	7	1	8.0	17.8	29.2
21342031	9	7/4/10	N	1	1	2	12	1	1	8.0	17.8	29.0
21342031	9	7/4/10	N	1	1	5	12	6	1	7.8	17.8	29.0
21342031	9	7/4/10	N	1	1	2	13	2	1	8.2	17.8	29.2
21342031	9	7/4/10	N	1	1	5	13	7	1	8.0	17.8	29.2
21342031	9	7/4/10	N	1	1	2	14	0	1	8.4	17.8	29.2
21342031	9	7/4/10	N	1	1	5	14	6	1	7.8	17.8	29.2
21342031	9	7/4/10	N	1	1	2	15	4	1	8.2	17.8	29.0
21342031	9	7/4/10	N	1	1	5	15	7	1	8.0	17.8	29.0
21342031	9	7/4/10	N	1	1	2	16	3	1	8.2	17.8	29.0
21342031	9	7/4/10	N	1	1	5	16	9	1	7.8	17.8	29.0
21342031	9	7/4/10	N	1	1	2	17	0	1	7.5	17.8	29.0
21342031	9	7/4/10	N	1	1	3	17	3	1	7.0	17.8	29.0

Appendix B

Continued.

Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	7/4/10	N	1	1	4	17	7	1	7.0	17.8	29.2
21342031	9	7/4/10	N	1	1	5	17	11	1	7.5	17.8	29.2
21342031	9	7/4/10	N	1	1	8	17	16	1	6.0	17.8	29.0
21342031	9	7/4/10	N	1	1	2	18	2	1	7.5	17.8	29.2
21342031	9	7/4/10	N	1	1	5	18	10	1	7.5	17.8	29.0
21342031	9	7/5/10	N	1	1	2	6	2	1	8.3	20.0	29.2
21342031	9	7/5/10	N	1	1	5	6	5	1	8.0	20.0	29.1
21342031	9	7/5/10	N	1	1	2	7	2	1	8.2	20.0	29.1
21342031	9	7/5/10	N	1	1	5	7	7	1	7.8	20.0	29.2
21342031	9	7/5/10	N	1	1	2	8	0	1	8.0	20.0	29.2
21342031	9	7/5/10	N	1	1	5	8	3	1	8.1	20.0	29.2
21342031	9	7/5/10	N	1	1	2	9	1	1	8.3	20.0	29.2
21342031	9	7/5/10	N	1	1	5	9	4	1	8.0	20.0	29.2
21342031	9	7/5/10	N	1	1	2	10	0	1	8.3	20.0	29.2
21342031	9	7/5/10	N	1	1	5	10	4	1	7.8	20.0	29.3
21342031	9	7/5/10	N	1	1	2	11	0	1	8.1	20.0	29.3
21342031	9	7/5/10	N	1	1	5	11	3	1	7.8	20.0	29.3
21342031	9	7/5/10	N	1	1	2	12	1	1	8.4	20.0	29.4
21342031	9	7/5/10	N	1	1	5	12	5	1	8.0	20.0	29.5
21342031	9	7/5/10	N	1	2	2	13	4	1	8.0	36.8	29.3
21342031	9	7/5/10	N	1	2	5	13	7	1	7.5	36.8	29.5
21342031	9	7/5/10	N	1	2	2	14	2	1	7.9	36.8	29.3
21342031	9	7/5/10	N	1	2	5	14	5	1	7.6	36.8	29.5
21342031	9	7/5/10	N	1	2	2	15	0	1	7.8	36.8	29.3
21342031	9	7/5/10	N	1	2	5	15	4	1	7.5	36.8	29.5
21342031	9	7/5/10	N	1	2	2	16	1	1	8.1	36.8	29.2
21342031	9	7/5/10	N	1	2	5	16	5	1	7.9	36.8	29.4
21342031	9	7/5/10	N	1	2	2	17	0	1	7.5	36.8	29.6
21342031	9	7/5/10	N	1	2	5	17	4	1	7.3	36.8	29.8
21342031	9	7/5/10	N	1	2	2	18	0	1	8.3	36.8	29.5
21342031	9	7/5/10	N	1	2	5	18	3	1	7.9	36.8	29.5
21342031	9	7/14/10		1	3	2	6	0	1	8.5	22.0	30.5
21342031	9	7/14/10		1	3	7	6	5	1	7.5	22.0	30.5
21342031	9	7/14/10		1	3	7	7	0	1	7.6	22.0	30.0
21342031	9	7/14/10		1	3	2	7	6	1	8.1	22.0	30.0
21342031	9	7/14/10		1	3	7	8	0	1	7.5	22.0	30.0
21342031	9	7/14/10		1	3	2	8	6	1	8.1	22.0	30.2
21342031	9	7/14/10		1	3	7	9	0	1	7.4	22.0	30.0

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Continued.

Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	7/14/10		1	3	2	9	5	1	8.2	22.0	30.2
21342031	9	7/14/10		1	3	7	10	0	1	7.4	22.0	30.0
21342031	9	7/14/10		1	3	2	10	5	1	8.1	22.0	30.2
21342031	9	7/14/10		1	4	7	11	0	1	7.3	22.5	30.0
21342031	9	7/14/10		1	4	2	11	5	1	8.1	22.5	30.2
21342031	9	7/14/10		1	4	8	12	0	1	6.1	22.5	29.0
21342031	9	7/14/10		1	4	7	12	5	1	6.6	22.5	29.5
21342031	9	7/14/10		1	4	6	12	10	1	4.9	22.5	30.0
21342031	9	7/14/10		1	4	4	12	14	1	4.9	22.5	30.0
21342031	9	7/14/10		1	4	3	12	16	1	6.7	22.5	30.0
21342031	9	7/14/10		1	4	2	12	20	1	7.5	22.5	30.0
21342031	9	7/14/10		1	4	1	12	25	1	7.2	22.5	30.0
21342031	9	7/14/10		1	4	8	13	0	1	6.3	22.5	30.0
21342031	9	7/14/10		1	4	7	13	2	1	6.8	22.5	30.0
21342031	9	7/14/10		1	4	6	13	3	1	6.7	22.5	30.0
21342031	9	7/14/10		1	4	4	13	6	1	7.0	22.5	30.2
21342031	9	7/14/10		1	4	3	13	9	1	7.1	22.5	30.2
21342031	9	7/14/10		1	4	2	13	11	1	7.5	22.5	30.2
21342031	9	7/14/10		1	4	1	13	13	1	7.4	22.5	30.2
21342031	9	7/14/10		1	3	8	14	0	1	6.0	22.5	30.0
21342031	9	7/14/10		1	3	7	14	2	1	6.9	22.5	30.0
21342031	9	7/14/10		1	3	6	14	5	1	7.3	22.5	30.0
21342031	9	7/14/10		1	3	4	14	7	1	7.4	22.5	30.0
21342031	9	7/14/10		1	3	3	14	9	1	7.4	22.5	30.0
21342031	9	7/14/10		1	3	2	14	12	1	7.6	22.5	30.0
21342031	9	7/14/10		1	3	1	14	16	1	7.3	22.5	30.2
21342031	9	7/14/10		1	3	11	15	0	1	5.1	22.5	30.0
21342031	9	7/14/10		1	3	8	15	5	1	6.4	22.5	30.0
21342031	9	7/14/10		1	3	7	15	9	1	7.4	22.5	30.0
21342031	9	7/14/10		1	3	6	15	13	1	7.3	22.5	30.0
21342031	9	7/14/10		1	3	4	15	17	1	7.1	22.5	30.0
21342031	9	7/14/10		1	3	3	15	19	1	7.5	22.5	30.0
21342031	9	7/14/10		1	3	2	15	22	1	7.7	22.5	30.2
21342031	9	7/14/10		1	3	1	15	25	1	7.2	22.5	30.2
21342031	9	7/14/10		1	3	11	16	0	1	5.5	22.5	30.0
21342031	9	7/14/10		1	3	8	16	5	1	6.0	22.5	30.2
21342031	9	7/14/10		1	3	7	16	9	1	7.0	22.5	30.2
21342031	9	7/14/10		1	4	6	16	11	1	6.8	25.0	30.2

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Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	7/14/10		1	4	4	16	14	1	7.2	25.0	30.2
21342031	9	7/14/10		1	4	3	16	16	1	7.3	25.0	30.2
21342031	9	7/14/10		1	4	2	16	18	1	7.5	25.0	30.5
21342031	9	7/14/10		1	4	1	16	20	1	7.0	25.0	30.5
21342031	9	7/14/10		1	4	11	17	0	1	5.6	25.0	30.0
21342031	9	7/14/10		1	4	9	17	5	1	6.1	25.0	30.2
21342031	9	7/14/10		1	4	8	17	8	1	6.3	25.0	30.2
21342031	9	7/14/10		1	4	7	17	12	1	7.0	25.0	30.2
21342031	9	7/14/10		1	4	6	17	14	1	7.4	25.0	30.5
21342031	9	7/14/10		1	4	4	17	17	1	7.1	25.0	30.5
21342031	9	7/14/10		1	4	3	17	19	1	7.2	25.0	30.5
21342031	9	7/14/10		1	4	2	17	21	1	7.5	25.0	30.5
21342031	9	7/14/10		1	4	1	17	25	1	6.9	25.0	30.5
21342031	9	7/14/10		1	4	9	18	0	1	5.9	25.0	30.2
21342031	9	7/14/10		1	4	8	18	4	1	6.4	25.0	30.2
21342031	9	7/14/10		1	4	7	18	7	1	7.1	25.0	30.2
21342031	9	7/14/10		1	4	6	18	9	1	6.8	25.0	30.2
21342031	9	7/14/10		1	2	4	18	11	1	7.3	26.0	30.2
21342031	9	7/14/10		1	2	3	18	14	1	7.4	26.0	30.5
21342031	9	7/14/10		1	2	2	18	16	1	7.6	26.0	30.5
21342031	9	7/14/10		1	2	1	18	18	1	7.1	26.0	30.5
21342031	9	7/15/10	N	1	2	7	6	0	1	7.9	21.2	30.0
21342031	9	7/15/10	N	1	2	2	6	6	1	8.4	21.2	30.0
21342031	9	7/15/10	N	1	2	7	7	0	1	8.0	21.2	30.0
21342031	9	7/15/10	N	1	2	2	7	5	1	8.5	21.2	30.0
21342031	9	7/15/10	N	1	2	7	8	0	1	7.8	21.2	30.2
21342031	9	7/15/10	N	1	2	2	8	5	1	8.2	21.2	30.2
21342031	9	7/15/10	N	1	2	7	9	0	1	6.8	21.2	30.0
21342031	9	7/15/10	N	1	2	3	9	3	1	7.1	21.2	30.0
21342031	9	7/15/10	N	1	2	2	9	6	1	7.2	21.2	30.0
21342031	9	7/15/10	N	1	2	1	9	8	1	7.0	21.2	30.0
21342031	9	7/15/10	N	1	2	7	10	0	1	6.7	21.2	30.2
21342031	9	7/15/10	N	1	2	3	10	4	1	7.0	21.2	30.2
21342031	9	7/15/10	N	1	2	2	10	7	1	7.6	21.2	30.2
21342031	9	7/15/10	N	1	2	1	10	10	1	7.0	21.2	30.2
21342031	9	7/15/10	N	1	2	7	11	0	1	6.9	30.0	30.0
21342031	9	7/15/10	N	1	2	3	11	5	1	7.0	30.0	30.0
21342031	9	7/15/10	N	1	2	2	11	8	1	7.5	30.0	30.0

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Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	7/15/10	N	1	2	1	11	10	1	7.1	30.0	30.0
21342031	9	7/15/10	N	1	2	7	12	0	1	6.9	30.0	29.5
21342031	9	7/15/10	N	1	2	3	12	4	1	7.0	30.0	29.5
21342031	9	7/15/10	N	1	2	2	12	6	1	7.6	30.0	29.8
21342031	9	7/15/10	N	1	2	1	12	8	1	7.1	30.0	30.0
21342031	9	7/15/10	N	1	2	11	13	0	1	5.2	30.0	30.0
21342031	9	7/15/10	N	1	2	9	13	3	1	5.5	30.0	30.0
21342031	9	7/15/10	N	1	2	8	13	6	1	6.5	30.0	30.0
21342031	9	7/15/10	N	1	2	7	13	9	1	6.9	30.0	30.0
21342031	9	7/15/10	N	1	2	3	13	12	1	7.2	30.0	30.2
21342031	9	7/15/10	N	1	2	2	13	15	1	7.4	30.0	30.5
21342031	9	7/15/10	N	1	2	1	13	18	1	7.2	30.0	30.2
21342031	9	7/15/10	N	1	2	11	14	0	1	4.7	30.0	30.0
21342031	9	7/15/10	N	1	2	9	14	4	1	5.0	30.0	30.0
21342031	9	7/15/10	N	1	2	8	14	8	1	5.6	34.0	30.0
21342031	9	7/15/10	N	1	2	7	14	11	1	6.7	34.0	30.2
21342031	9	7/15/10	N	1	2	3	14	14	1	7.0	34.0	30.5
21342031	9	7/15/10	N	1	2	2	14	17	1	7.4	34.0	30.5
21342031	9	7/15/10	N	1	2	1	14	19	1	7.3	34.0	30.5
21342031	9	7/15/10	N	1	2	11	15	1	1	4.4	34.0	30.0
21342031	9	7/15/10	N	1	2	9	15	5	1	4.7	34.0	30.0
21342031	9	7/15/10	N	1	2	8	15	8	1	5.5	34.0	30.0
21342031	9	7/15/10	N	1	2	7	15	11	1	6.5	34.0	30.0
21342031	9	7/15/10	N	1	2	3	15	15	1	7.1	34.0	30.0
21342031	9	7/15/10	N	1	2	2	15	17	1	7.5	34.0	30.0
21342031	9	7/15/10	N	1	2	1	15	19	1	7.4	34.0	30.0
21342031	9	7/15/10	N	1	2	11	16	0	1	4.6	34.0	30.0
21342031	9	7/15/10	N	1	2	9	16	5	1	5.0	34.0	30.0
21342031	9	7/15/10	N	1	2	8	16	8	1	6.0	34.0	30.0
21342031	9	7/15/10	N	1	2	7	16	11	1	6.8	34.0	30.0
21342031	9	7/15/10	N	1	2	3	16	14	1	7.4	34.0	30.0
21342031	9	7/15/10	N	1	2	2	16	16	1	7.8	34.0	30.2
21342031	9	7/15/10	N	1	2	1	16	19	1	7.4	34.0	30.2
21342031	9	7/15/10	N	1	2	11	17	0	1	4.8	34.0	30.0
21342031	9	7/15/10	N	1	2	9	17	3	1	5.0	34.0	29.5
21342031	9	7/15/10	N	1	2	8	17	5	1	6.0	34.0	30.0
21342031	9	7/15/10	N	1	2	7	17	7	1	6.7	34.0	30.0
21342031	9	7/15/10	N	1	2	3	17	11	1	7.5	34.0	30.0

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Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	7/15/10	N	1	2	2	17	13	1	7.8	34.0	30.0
21342031	9	7/15/10	N	1	2	1	17	16	1	7.5	34.0	30.0
21342031	9	7/15/10	N	1	2	11	18	0	1	5.2	34.0	30.0
21342031	9	7/15/10	N	1	2	9	18	4	1	5.2	34.0	29.8
21342031	9	7/15/10	N	1	2	8	18	7	1	5.9	34.0	30.0
21342031	9	7/15/10	N	1	2	7	18	9	1	6.7	34.0	30.0
21342031	9	7/15/10	N	1	2	3	18	12	1	7.3	34.0	30.0
21342031	9	7/15/10	N	1	2	2	18	14	1	7.7	34.0	30.0
21342031	9	7/15/10	N	1	2	1	18	15	1	7.5	34.0	30.0
21342031	9	7/16/10	N	1	1	2	6	1	1	8.5	31.0	29.8
21342031	9	7/16/10	N	1	1	7	6	9	1	8.0	31.0	29.8
21342031	9	7/16/10	N	1	1	2	7	2	1	8.5	31.0	30.0
21342031	9	7/16/10	N	1	1	7	7	10	1	8.0	31.0	30.0
21342031	9	7/16/10	N	1	1	2	8	9	1	8.0	31.0	30.0
21342031	9	7/16/10	N	1	1	7	8	16	1	7.8	31.0	30.0
21342031	9	7/16/10	N	1	1	2	9	1	1	8.2	31.0	30.0
21342031	9	7/16/10	N	1	1	7	9	6	1	7.5	31.0	30.0
21342031	9	7/16/10	N	1	1	2	10	5	1	8.0	31.0	30.0
21342031	9	7/16/10	N	1	1	7	10	9	1	7.4	31.0	30.0
21342031	9	7/16/10	N	1	1	2	11	3	1	8.2	34.5	30.0
21342031	9	7/16/10	N	1	1	7	11	7	1	7.2	34.5	30.0
21342031	9	7/16/10	N	1	1	2	12	6	1	7.6	34.5	30.0
21342031	9	7/16/10	N	1	1	3	12	9	1	7.0	34.5	30.2
21342031	9	7/16/10	N	1	1	6	12	14	1	6.5	34.5	30.2
21342031	9	7/16/10	N	1	1	7	12	19	1	6.7	34.5	30.5
21342031	9	7/16/10	N	1	1	8	12	22	1	6.5	34.5	30.5
21342031	9	7/16/10	N	1	1	1	13	11	1	7.2	34.5	30.0
21342031	9	7/16/10	N	1	1	2	13	7	1	7.6	34.5	30.0
21342031	9	7/16/10	N	1	1	3	13	13	1	7.4	34.5	30.0
21342031	9	7/16/10	N	1	1	4	13	15	1	7.1	30.5	30.0
21342031	9	7/16/10	N	1	1	6	13	18	1	6.8	30.5	30.0
21342031	9	7/16/10	N	1	1	7	13	21	1	6.7	30.5	30.0
21342031	9	7/16/10	N	1	1	8	13	23	1	6.1	30.5	30.0
21342031	9	7/16/10	N	1	1	9	13	27	1	5.7	30.5	30.0
21342031	9	7/16/10	N	1	1	1	14	1	1	7.2	30.5	30.0
21342031	9	7/16/10	N	1	1	2	14	6	1	7.8	30.5	30.0
21342031	9	7/16/10	N	1	1	3	14	11	1	7.3	30.5	30.0
21342031	9	7/16/10	N	1	1	4	14	14	1	7.2	30.5	30.2

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Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	7/16/10	N	1	1	6	14	19	1	6.8	30.5	30.2
21342031	9	7/16/10	N	1	1	7	14	22	1	6.8	31.0	30.0
21342031	9	7/16/10	N	1	1	8	14	26	1	6.2	31.0	30.0
21342031	9	7/16/10	N	1	1	9	14	30	1	5.9	31.0	30.0
21342031	9	7/16/10	N	1	1	1	15	6	1	7.0	31.0	30.0
21342031	9	7/16/10	N	1	1	2	15	9	1	7.2	31.0	29.8
21342031	9	7/16/10	N	1	1	3	15	12	1	7.0	31.0	29.8
21342031	9	7/16/10	N	1	1	4	15	15	1	7.0	31.0	29.8
21342031	9	7/16/10	N	1	1	6	15	18	1	6.5	31.0	29.5
21342031	9	7/16/10	N	1	1	7	15	20	1	6.8	31.0	29.5
21342031	9	7/16/10	N	1	1	8	15	23	1	6.1	31.0	29.8
21342031	9	7/16/10	N	1	1	9	15	26	1	5.9	32.5	29.5
21342031	9	7/16/10	N	1	1	1	16	1	1	7.2	32.5	29.8
21342031	9	7/16/10	N	1	1	2	16	4	1	7.8	32.5	29.8
21342031	9	7/16/10	N	1	1	3	16	8	1	7.4	32.5	29.8
21342031	9	7/16/10	N	1	1	4	16	11	1	7.2	32.5	29.8
21342031	9	7/16/10	N	1	1	6	16	16	1	6.6	32.5	29.5
21342031	9	7/16/10	N	1	1	7	16	20	1	6.8	32.5	29.5
21342031	9	7/16/10	N	1	1	8	16	23	1	6.2	32.5	29.8
21342031	9	7/16/10	N	1	1	9	16	26	1	5.9	32.5	29.5
21342031	9	7/16/10	N	1	1	1	17	9	1	7.6	32.5	29.5
21342031	9	7/16/10	N	1	1	2	17	14	1	8.1	32.5	29.5
21342031	9	7/16/10	N	1	1	3	17	19	1	7.9	32.5	29.8
21342031	9	7/16/10	N	1	1	4	17	22	1	7.5	32.5	29.5
21342031	9	7/16/10	N	1	1	6	17	26	1	6.9	32.5	29.5
21342031	9	7/16/10	N	1	1	7	17	30	1	6.8	32.5	29.5
21342031	9	7/16/10	N	1	1	8	17	33	1	6.2	32.5	29.5
21342031	9	7/16/10	N	1	1	9	17	37	1	5.8	32.5	29.5
21342031	9	7/16/10	N	1	1	2	18	6	1	7.8	32.5	29.5
21342031	9	7/16/10	N	1	1	7	18	11	1	6.8	32.5	29.5
21342031	9	7/17/10	N	1	1	2	6	4	1	7.6	23.0	29.0
21342031	9	7/17/10	N	1	1	6	6	8	1	5.8	23.0	29.0
21342031	9	7/17/10	N	1	1	2	7	1	1	8.0	23.0	28.9
21342031	9	7/17/10	N	1	1	6	7	5	1	5.9	23.0	28.9
21342031	9	7/17/10	N	1	1	2	8	0	1	8.2	23.0	29.0
21342031	9	7/17/10	N	1	1	6	8	4	1	5.7	23.0	29.0
21342031	9	7/17/10	N	1	1	2	9	0	1	8.0	23.0	29.0
21342031	9	7/17/10	N	1	1	6	9	3	1	6.2	23.0	29.0

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Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	7/17/10	N	1	1	2	10	0	1	8.2	23.0	29.0
21342031	9	7/17/10	N	1	1	6	10	4	1	6.4	23.0	29.0
21342031	9	7/17/10	N	1	1	2	11	1	1	8.4	23.0	29.1
21342031	9	7/17/10	N	1	1	6	11	5	1	6.0	23.0	29.1
21342031	9	7/17/10	N	1	1	2	12	0	1	8.2	23.0	29.3
21342031	9	7/17/10	N	1	1	6	12	5	1	5.8	23.0	29.2
21342031	9	7/17/10	NE	2	2	2	13	3	1	7.6	23.0	29.7
21342031	9	7/17/10	NE	2	2	6	13	7	1	5.5	23.0	29.7
21342031	9	7/17/10	NE	2	2	1	14	2	1	7.1	23.0	29.6
21342031	9	7/17/10	NE	2	2	2	14	6	1	7.1	23.0	29.6
21342031	9	7/17/10	NE	2	2	3	14	10	1	6.7	23.0	29.7
21342031	9	7/17/10	NE	2	2	6	14	15	1	4.6	23.0	29.7
21342031	9	7/17/10	NE	2	2	8	14	20	1	6.0	23.0	29.7
21342031	9	7/17/10	NE	2	2	1	15	0	1	7.2	23.0	29.9
21342031	9	7/17/10	NE	2	2	2	15	4	1	7.6	23.0	29.9
21342031	9	7/17/10	NE	2	2	3	15	8	1	6.7	23.0	29.5
21342031	9	7/17/10	NE	2	2	6	15	13	1	4.8	23.0	29.3
21342031	9	7/17/10	NE	2	2	8	15	18	1	6.0	23.0	29.8
21342031	9	7/17/10	NE	2	2	1	16	1	1	7.6	23.0	30.0
21342031	9	7/17/10	NE	2	2	2	16	4	1	7.8	23.0	30.0
21342031	9	7/17/10	NE	2	2	3	16	8	1	6.8	23.0	29.9
21342031	9	7/17/10	NE	2	2	6	16	13	1	5.0	23.0	29.9
21342031	9	7/17/10	NE	2	2	8	16	18	1	5.8	23.0	29.9
21342031	9	7/17/10	NE	2	2	9	16	21	1	6.1	23.0	29.8
21342031	9	7/17/10	NE	2	2	1	17	0	1	7.4	23.0	30.0
21342031	9	7/17/10	NE	2	2	2	17	3	1	7.8	23.0	30.0
21342031	9	7/17/10	NE	2	2	3	17	7	1	7.1	23.0	30.0
21342031	9	7/17/10	NE	2	2	6	17	11	1	4.9	23.0	29.7
21342031	9	7/17/10	NE	2	2	8	17	16	1	6.0	23.0	29.9
21342031	9	7/17/10	NE	2	2	9	17	19	1	6.4	23.0	29.9
21342031	9	7/30/10	N	1	1	5	6	0	1	7.2	18.8	31.0
21342031	9	7/30/10	N	1	1	5	7	0	1	7.2	18.8	30.8
21342031	9	7/30/10	N	1	1	5	8	0	1	7.2	18.8	31.0
21342031	9	7/30/10	N	1	1	5	9	0	1	7.0	18.8	31.0
21342031	9	7/30/10	N	1	1	5	10	0	1	7.2	18.8	31.2
21342031	9	7/30/10	N	1	1	5	11	4	1	7.5	18.8	31.5
21342031	9	7/30/10	N	1	1	5	12	1	1	7.2	18.8	31.8
21342031	9	7/30/10	N	1	1	5	13	1	1	7.2	18.8	31.5

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Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	7/30/10	N	1	1	9	13	6	1	5.7	18.8	31.5
21342031	9	7/30/10	N	1	1	7	13	10	1	6.6	18.8	32.0
21342031	9	7/30/10	N	2	1	4	13	15	1	6.9	27.5	32.0
21342031	9	7/30/10	N	2	1	3	13	19	1	6.7	27.5	32.0
21342031	9	7/30/10	N	2	1	3	14	1	1	6.9	27.5	31.5
21342031	9	7/30/10	N	2	1	4	14	5	1	6.9	27.5	31.5
21342031	9	7/30/10	N	2	1	5	14	12	1	7.4	27.5	31.5
21342031	9	7/30/10	N	2	1	7	14	16	1	6.8	27.5	31.5
21342031	9	7/30/10	N	2	1	9	14	19	1	6.1	27.5	31.2
21342031	9	7/30/10	N	2	1	5	15	4	1	7.3	27.5	31.5
21342031	9	7/30/10	N	2	1	5	16	1	1	7.3	27.5	31.5
21342031	9	7/30/10	N	2	1	5	17	6	1	7.5	27.5	31.8
21342031	9	7/30/10	N	2	1	5	18	4	1	7.5	27.5	31.5
21342031	9	7/31/10		1	2	5	6	0	1	6.7		31.7
21342031	9	7/31/10		1	2	5	7	0	1	7.0		31.7
21342031	9	7/31/10		1	2	5	8	0	1	7.1		31.7
21342031	9	7/31/10		1	2	5	9	0	1	7.2		31.7
21342031	9	7/31/10		1	2	5	10	0	1	7.2		31.7
21342031	9	7/31/10		1	2	5	11	1	1	7.4		31.7
21342031	9	7/31/10		1	2	5	12	1	1	7.3		31.8
21342031	9	7/31/10		1	2	5	13	2	1	7.5		31.8
21342031	9	7/31/10		1	2	5	14	0	1	7.4		31.8
21342031	9	7/31/10	NE	2	2	3	15	2	1	7.2		31.7
21342031	9	7/31/10	NE	2	2	4	15	6	1	6.8		31.8
21342031	9	7/31/10	NE	2	2	5	15	9	1	7.3		31.8
21342031	9	7/31/10	NE	2	2	6	15	13	1	6.7		31.8
21342031	9	7/31/10	NE	2	2	3	16	0	1	6.8		31.7
21342031	9	7/31/10	NE	2	2	4	16	3	1	6.8		31.8
21342031	9	7/31/10	NE	2	2	5	16	7	1	7.3		31.7
21342031	9	7/31/10	NE	2	2	6	16	10	1	6.7		31.7
21342031	9	7/31/10	NE	2	2	3	17	0	1	6.8		31.7
21342031	9	7/31/10	NE	2	2	4	17	3	1	6.7		31.7
21342031	9	7/31/10	NE	2	2	5	17	7	1	7.2		31.6
21342031	9	7/31/10	NE	2	2	6	17	10	1	6.7		31.7
21342031	9	7/31/10	NE	2	2	5	18	7	1	7.1		31.5
21342031	9	8/1/10	NE	1	3	5	6	1	1	6.8	21.0	31.0
21342031	9	8/1/10	NE	1	3	5	7	0	1	7.1	21.0	31.1
21342031	9	8/1/10	NE	1	3	5	8	0	1	7.2	21.0	31.1

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Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	8/1/10	NE	1	3	5	9	1	1	7.2	21.0	31.1
21342031	9	8/1/10	NE	1	3	5	10	0	1	7.3	21.0	31.1
21342031	9	8/1/10	NE	1	3	5	11	0	1	7.5	21.0	31.3
21342031	9	8/1/10	NE	1	3	5	12	2	1	7.3	21.0	31.1
21342031	9	8/1/10	NE	1	3	5	13	5	1	7.3	21.0	31.2
21342031	9	8/1/10	NE	1	3	5	14	0	1	7.3	21.0	31.2
21342031	9	8/1/10	NE	1	3	1	15	2	1	6.8	21.0	
21342031	9	8/1/10	NE	1	3	2	15	6	1	7.4	21.0	
21342031	9	8/1/10	E	2	2	5	15	10	1	7.1	28.5	31.2
21342031	9	8/1/10	E	2	2	1	16	4	1	6.6	28.5	31.1
21342031	9	8/1/10	E	2	2	2	16	7	1	7.4	28.5	31.1
21342031	9	8/1/10	E	2	2	3	16	11	1	6.4	28.5	31.2
21342031	9	8/1/10	E	2	2	5	16	15	1	7.0	28.5	31.1
21342031	9	8/1/10	E	2	2	8	16	22	1	6.0	28.5	31.1
21342031	9	8/1/10	E	2	2	1	17	0	1	6.7	28.5	31.1
21342031	9	8/1/10	E	2	2	2	17	3	1	7.1	28.5	31.2
21342031	9	8/1/10	E	2	2	3	17	6	1	6.4	28.5	31.2
21342031	9	8/1/10	E	2	2	5	17	10	1	6.6	28.5	31.2
21342031	9	8/1/10	E	2	2	8	17	15	1	5.0	28.5	31.6
21342031	9	8/1/10	E	2	2	1	18	0	1	6.5	28.5	31.2
21342031	9	8/1/10	E	2	2	2	18	4	1	7.0	28.5	31.2
21342031	9	8/1/10	E	2	2	3	18	7	1	6.2	28.5	31.2
21342031	9	8/1/10	E	2	2	5	18	11	1	6.7	28.5	31.2
21342031	9	8/1/10	E	2	2	8	18	16	1	5.2	28.5	31.2
21342031	9	8/2/10	N	1	1	2	6	5	1	8.2	23.5	31.0
21342031	9	8/2/10	N	1	1	5	6	11	1	7.7	23.5	30.8
21342031	9	8/2/10	N	1	1	2	7	1	1	8.2	23.5	30.8
21342031	9	8/2/10	N	1	1	5	7	6	1	7.9	23.5	31.0
21342031	9	8/2/10	N	1	1	2	8	4	1	8.3	23.5	30.8
21342031	9	8/2/10	N	1	1	5	8	10	1	8.0	23.5	31.0
21342031	9	8/2/10	N	1	1	2	9	0	1	8.2	23.5	31.0
21342031	9	8/2/10	N	1	1	5	9	3	1	7.9	23.5	31.0
21342031	9	8/2/10	N	1	1	2	9	53	1	8.5	23.5	31.0
21342031	9	8/2/10	N	1	1	5	10	0	1	8.0	23.5	31.0
21342031	9	8/2/10	N	1	1	2	11	4	1	8.4	24.0	30.8
21342031	9	8/2/10	N	1	1	5	11	10	1	7.8	24.0	30.8
21342031	9	8/2/10	N	1	1	2	12	1	1	8.0	24.0	31.0
21342031	9	8/2/10	N	1	1	5	12	8	1	7.8	24.0	31.0

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Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	8/2/10	N	1	1	2	13	0	1	8.3	24.0	31.2
21342031	9	8/2/10	N	1	1	5	13	4	1	7.9	24.0	31.0
21342031	9	8/2/10	N	1	1	2	14	2	1	8.3	24.0	30.8
21342031	9	8/2/10	N	1	1	5	14	7	1	7.9	24.0	30.8
21342031	9	8/2/10	N	1	1	2	15	4	1	8.1	24.0	31.0
21342031	9	8/2/10	N	1	1	5	15	9	1	7.8	24.0	31.0
21342031	9	8/2/10	N	1	1	2	16	18	1	7.6	24.0	31.0
21342031	9	8/2/10	N	1	1	5	16	21	1	7.4	24.0	31.0
21342031	9	8/2/10	N	1	1	5	17	10	1	7.3	24.0	31.0
21342031	9	8/2/10	N	1	1	5	18	0	1	7.5	24.0	31.2
21342031	9	8/13/10	E	1	4	2	6	0	1	7.4	22.0	29.5
21342031	9	8/13/10	E	1	4	2	7	0	1	7.6	22.0	30.0
21342031	9	8/13/10	E	1	4	2	8	0	1	7.5	22.0	30.2
21342031	9	8/13/10	E	1	4	2	9	0	1	7.5	22.0	30.2
21342031	9	8/13/10	E	1	4	2	10	0	1	7.7	22.0	30.2
21342031	9	8/13/10	E	1	4	2	11	0	1	7.6	22.0	30.2
21342031	9	8/13/10	E	1	4	2	12	0	1	7.4	22.0	30.2
21342031	9	8/13/10	E	1	4	2	13	0	1	7.6	22.0	29.5
21342031	9	8/13/10	E	1	4	2	14	2	1	7.6	22.0	29.5
21342031	9	8/13/10	E	1	4	2	15	2	1	7.6	22.0	29.5
21342031	9	8/13/10	E	1	3	2	16	0	1	7.5	22.5	29.5
21342031	9	8/13/10	E	1	3	2	17	0	1	7.3	22.5	30.0
21342031	9	8/13/10	E	1	3	2	18	0	1	7.3	22.5	29.8
21342031	9	8/14/10	E	1	2	2	6	5	1	6.9	18.9	31.0
21342031	9	8/14/10	E	1	2	2	7	1	1	7.1	18.9	31.1
21342031	9	8/14/10	E	1	2	2	8	3	1	7.2	18.9	31.1
21342031	9	8/14/10	E	1	2	2	9	0	1	7.2	18.9	31.1
21342031	9	8/14/10	E	1	2	2	10	0	1	7.3	18.9	31.2
21342031	9	8/14/10	E	1	2	2	11	0	1	7.2	18.9	31.1
21342031	9	8/14/10	E	1	2	2	12	2	1	7.2	18.9	31.0
21342031	9	8/14/10	E	1	2	2	13	0	1	7.3	18.9	31.1
21342031	9	8/14/10	E	1	2	2	14	2	1	7.2	18.9	31.2
21342031	9	8/14/10	E	1	2	2	15	1	1	7.2	18.9	31.1
21342031	9	8/14/10	E	1	2	1	16	5	1	6.8	25.0	31.2
21342031	9	8/14/10	E	1	2	2	16	7	1	7.2	25.0	31.2
21342031	9	8/14/10	E	1	2	3	16	8	1	6.2	25.0	31.2
21342031	9	8/14/10	E	1	2	4	16	12	1	5.9	25.0	31.2
21342031	9	8/14/10	E	1	2	8	16	17	1	4.8	25.0	31.2

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Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	8/14/10	E	1	2	9	16	19	1	5.0	25.0	31.1
21342031	9	8/14/10	E	1	2	11	16	22	1	3.9	25.0	31.2
21342031	9	8/14/10	E	1	2	1	17	2	1	6.0	25.0	31.1
21342031	9	8/14/10	E	1	2	2	17	5	1	6.8	25.0	31.2
21342031	9	8/14/10	E	1	2	3	17	8	1	7.9	25.0	31.2
21342031	9	8/14/10	E	2	2	1	18	3	1	6.0	25.0	31.0
21342031	9	8/14/10	E	2	2	2	18	6	1	6.7	25.0	31.0
21342031	9	8/14/10	E	2	2	3	18	9	1	6.5	25.0	31.1
21342031	9	8/14/10	E	2	2	4	18	12	1	6.4	25.0	31.1
21342031	9	8/14/10	E	2	2	5	18	16	1	6.6	25.0	30.9
21342031	9	8/14/10	E	2	2	6	18	19	1	5.7	25.0	31.1
21342031	9	8/14/10	E	2	2	7	18	22	1	6.6	25.0	31.1
21342031	9	8/14/10	E	2	2	8	18	26	1	5.3	25.0	31.1
21342031	9	8/14/10	E	2	2	9	18	29	1	5.6	25.0	31.1
21342031	9	8/14/10	E	2	2	11	18	32	1	4.6	25.0	31.1
21342031	9	8/15/10	S	1	3	2	6	5	1	7.3	22.0	30.9
21342031	9	8/15/10	S	1	3	2	7	1	1	7.6	22.0	30.8
21342031	9	8/15/10	S	1	3	2	8	2	1	7.9	22.0	30.8
21342031	9	8/15/10	S	1	3	2	9	0	1	7.4	22.0	30.8
21342031	9	8/15/10	S	1	3	2	10	0	1	7.5	22.0	30.8
21342031	9	8/15/10	S	1	3	2	11	3	1	7.3	22.0	30.8
21342031	9	8/15/10	S	1	3	2	12	1	1	7.6	22.0	30.6
21342031	9	8/15/10	S	1	3	2	13	2	1	7.5	22.0	30.7
21342031	9	8/15/10	S	1	3	2	14	2	1	7.5	22.0	30.7
21342031	9	8/15/10	S	1	3	5	14	5	1	7.9	22.0	30.7
21342031	9	8/15/10	S	1	3	2	15	1	1	7.4	22.0	30.6
21342031	9	8/15/10	S	2	4	2	16	1	1	7.5	23.0	30.8
21342031	9	8/15/10	S	2	4	2	17	2	1	7.4	23.0	30.3
21342031	9	8/15/10	S	2	4	2	18	1	1	7.3	23.0	30.3
21342031	9	8/16/10	SE	1	2	2	6	0	1	7.3	22.0	30.0
21342031	9	8/16/10	SE	1	2	2	7	0	1	7.4	22.0	29.9
21342031	9	8/16/10	SE	1	2	2	8	0	1	7.2	22.0	29.9
21342031	9	8/16/10	SE	1	2	2	9	0	1	7.5	22.0	29.9
21342031	9	8/16/10	SE	1	2	2	10	0	1	7.3	22.0	29.9
21342031	9	8/16/10	SE	1	2	2	11	0	1	7.4	22.0	29.8
21342031	9	8/16/10	SE	1	2	2	12	0	1	7.3	22.0	29.8
21342031	9	8/16/10	SE	1	2	2	13	0	1	7.5	22.0	29.8
21342031	9	8/16/10	SE	1	2	4	13	5	1	6.4	22.0	29.8

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Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	8/16/10	SE	1	2	5	13	8	1	7.4	22.0	29.8
21342031	9	8/16/10	SE	1	2	6	13	11	1	6.6	22.0	30.0
21342031	9	8/16/10	SE	1	2	7	13	14	1	6.7	22.0	29.9
21342031	9	8/16/10	SE	1	2	2	14	0	1	7.3	22.0	29.8
21342031	9	8/16/10	SE	1	2	4	14	4	1	6.5	22.0	29.8
21342031	9	8/16/10	SE	1	2	5	14	7	1	7.2	22.0	29.8
21342031	9	8/16/10	SE	1	2	6	14	10	1	6.6	22.0	29.8
21342031	9	8/16/10	SE	1	2	7	14	13	1	6.7	22.0	29.7
21342031	9	8/16/10	SE	1	2	2	15	0	1	7.2	22.0	29.8
21342031	9	8/16/10	SE	1	2	4	15	3	1	6.5	22.0	29.7
21342031	9	8/16/10	SE	1	2	5	15	6	1	7.1	22.0	29.9
21342031	9	8/16/10	SE	1	2	6	15	9	1	6.5	31.5	29.8
21342031	9	8/16/10	SE	1	2	7	15	12	1	6.6	31.5	29.6
21342031	9	8/16/10	SE	1	2	2	16	0	1	7.2	31.5	29.8
21342031	9	8/16/10	SE	1	2	4	16	3	1	6.5	31.5	29.7
21342031	9	8/16/10	SE	1	2	5	16	6	1	7.2	31.5	29.7
21342031	9	8/16/10	SE	1	2	6	16	9	1	6.6	31.5	29.8
21342031	9	8/16/10	SE	1	2	7	16	12	1	6.7	31.5	29.6
21342031	9	8/16/10	SE	1	2	2	17	0	1	7.2	31.5	29.7
21342031	9	8/16/10	SE	1	2	4	17	3	1	6.6	31.5	29.7
21342031	9	8/16/10	SE	1	2	5	17	6	1	7.2	31.5	29.7
21342031	9	8/16/10	SE	1	2	6	17	9	1	6.6	31.5	29.7
21342031	9	8/16/10	SE	1	2	7	17	12	1	6.7	31.5	29.6
21342031	9	8/16/10	SE	1	2	2	18	0	1	7.1	31.5	29.6
21342031	9	8/16/10	SE	1	2	4	18	3	1	6.5	31.5	29.6
21342031	9	8/16/10	SE	1	2	5	18	6	1	7.1	31.5	29.7
21342031	9	8/16/10	SE	1	2	6	18	8	1	6.5	31.5	29.7
21342031	9	8/16/10	SE	1	2	7	18	10	1	6.7	31.5	29.5
21342031	9	8/25/10	N	1	3	5	6	20	1	7.7	19.8	28.8
21342031	9	8/25/10	N	1	3	5	7	21	1	7.7	19.8	28.8
21342031	9	8/25/10	N	1	3	5	8	1	1	7.6	19.8	29.0
21342031	9	8/25/10	N	1	3	5	9	1	1	7.7	19.8	28.8
21342031	9	8/25/10	N	1	3	5	10	1	1	7.6	19.8	29.0
21342031	9	8/25/10	N	1	3	5	11	1	1	7.6	19.8	29.0
21342031	9	8/25/10	N	1	3	1	12	3	1	6.9	19.8	28.8
21342031	9	8/25/10	N	1	3	2	12	6	1	7.5	19.8	29.0
21342031	9	8/25/10	N	1	3	3	12	10	1	6.7	19.8	29.0
21342031	9	8/25/10	N	1	3	5	12	17	1	7.4	19.8	29.0

Appendix B

Continued.

Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	8/25/10	N	1	2	1	13	3	1	6.7		29.0
21342031	9	8/25/10	N	1	2	2	13	7	1	7.3		29.2
21342031	9	8/25/10	N	1	2	3	13	10	1	6.5		29.0
21342031	9	8/25/10	N	1	2	5	13	14	1	7.1		29.2
21342031	9	8/25/10	N	1	2	8	13	19	1	5.7		29.0
21342031	9	8/25/10	N	1	2	9	13	22	1	5.5		29.2
21342031	9	8/25/10	N	1	2	1	14	1	1	7.0		29.2
21342031	9	8/25/10	N	1	2	2	14	6	1	7.4		29.2
21342031	9	8/25/10	N	1	2	3	14	10	1	6.7		29.2
21342031	9	8/25/10	N	1	2	5	14	14	1	7.1		29.2
21342031	9	8/25/10	N	1	2	8	14	20	1	5.6		29.2
21342031	9	8/25/10	N	1	2	9	14	25	1	5.4		29.2
21342031	9	8/25/10	N	1	2	1	15	4	1	7.0		29.0
21342031	9	8/25/10	N	1	2	2	15	7	1	7.6		29.0
21342031	9	8/25/10	N	1	2	3	15	11	1	7.2		29.0
21342031	9	8/25/10	N	1	2	5	15	13	1	7.4		29.0
21342031	9	8/25/10	N	1	2	8	15	18	1	5.9		29.0
21342031	9	8/25/10	N	1	2	9	15	21	1	5.6		29.0
21342031	9	8/25/10	N	1	2	1	16	2	1	7.2		29.0
21342031	9	8/25/10	N	1	2	2	16	7	1	7.6		29.0
21342031	9	8/25/10	N	1	2	3	16	10	1	6.5	23.0	29.0
21342031	9	8/25/10	N	1	2	5	16	15	1	7.3	23.0	29.0
21342031	9	8/25/10	N	1	2	8	16	20	1	5.9	23.0	29.0
21342031	9	8/25/10	N	1	2	9	16	24	1	5.5	23.0	29.0
21342031	9	8/25/10	N	1	2	1	17	1	1	7.1	23.0	29.2
21342031	9	8/25/10	N	1	2	2	17	5	1	7.3	23.0	29.2
21342031	9	8/25/10	N	1	2	3	17	8	1	6.7	23.0	29.2
21342031	9	8/25/10	N	1	2	5	17	10	1	7.2	23.0	29.2
21342031	9	8/25/10	N	1	2	8	17	14	1	5.9	23.0	29.2
21342031	9	8/25/10	N	1	2	9	17	19	1	5.9	23.0	29.2
21342031	9	8/25/10	N	1	2	1	18	1	1	7.2		29.0
21342031	9	8/25/10	N	1	2	2	18	5	1	7.4		29.0
21342031	9	8/25/10	N	1	2	3	18	11	1	6.8		29.0
21342031	9	8/25/10	N	1	2	5	18	17	1	7.3		29.0
21342031	9	8/25/10	N	1	2	8	18	25	1	5.9		29.0
21342031	9	8/25/10	N	1	2	9	18	28	1	5.5		29.0
21342031	9	8/26/10	NW	2	2	2	6	0	1	7.8	26.0	27.0
21342031	9	8/26/10	NW	2	2	2	7	0	1	7.9	26.0	27.5

Appendix B

Continued.

Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	8/26/10	NW	2	2	2	8	0	1	8.1	26.0	28.0
21342031	9	8/26/10	NW	2	2	2	9	0	1	8.1	26.0	28.2
21342031	9	8/26/10	NW	2	2	2	10	0	1	8.1	26.0	27.8
21342031	9	8/26/10	NW	2	2	2	11	1	1	7.8	26.0	27.8
21342031	9	8/26/10	NW	2	2	2	12	1	1	7.9	26.0	27.0
21342031	9	8/26/10	NW	2	2	2	13	1	1	7.8	26.0	27.9
21342031	9	8/26/10	NW	2	2	2	14	0	1	8.0	26.0	28.1
21342031	9	8/26/10	NW	2	2	2	15	1	1	7.6	26.0	28.5
21342031	9	8/26/10	NW	2	2	2	16	0	1	7.9	26.0	28.5
21342031	9	8/26/10	NW	2	2	3	16	5	1	7.6	26.0	28.5
21342031	9	8/26/10	NW	2	2	4	16	9	1	7.2	26.0	28.5
21342031	9	8/26/10	NW	2	2	7	16	12	1	7.0	26.0	29.0
21342031	9	8/26/10	NW	2	2	2	17	2	1	7.5	26.0	28.0
21342031	9	8/26/10	NW	2	2	3	17	5	1	7.3	26.0	28.5
21342031	9	8/26/10	NW	2	2	4	17	7	1	7.0	26.0	29.0
21342031	9	8/26/10	NW	2	2	7	17	13	1	6.8	26.0	28.5
21342031	9	8/26/10	NW	2	2	8	17	18	1	6.4	26.0	29.0
21342031	9	8/26/10	NW	2	2	9	17	21	1	6.2	26.0	29.0
21342031	9	8/26/10	NW	2	2	2	18	2	1	7.4	26.0	27.5
21342031	9	8/26/10	NW	2	2	3	18	5	1	6.8	26.0	28.5
21342031	9	8/26/10	NW	2	2	4	18	7	1	6.8	26.0	29.0
21342031	9	8/26/10	NW	2	2	7	18	12	1	6.8	26.0	29.0
21342031	9	8/26/10	NW	2	2	8	18	15	1	6.4	26.0	28.0
21342031	9	8/26/10	NW	2	2	9	18	19	1	6.6	26.0	28.0
21342031	9	8/27/10	NW	1	1	2	8	32	1	8.3		29.1
21342031	9	8/27/10	NW	1	1	2	9	6	1	7.8		28.8
21342031	9	8/27/10	NW	1	1	2	10	0	1	8.0		29.0
21342031	9	8/27/10	NW	1	1	10	10	6	1	7.6		28.8
21342031	9	8/27/10	NW	1	1	2	11	3	1	7.5		29.0
21342031	9	8/27/10	NW	1	1	10	11	12	1	7.5		29.0
21342031	9	8/27/10	NW	1	1	2	12	3	1	7.5		28.8
21342031	9	8/27/10	NW	1	1	2	13	1	1	7.7		28.8
21342031	9	8/27/10	NW	1	1	2	14	0	1	7.6		29.0
21342031	9	8/27/10	NW	1	1	2	15	1	1	7.7		28.8
21342031	9	8/27/10	NW	1	1	2	16	4	1	7.5		28.8
21342031	9	8/27/10	NW	1	1	3	16	8	1	7.5		28.8
21342031	9	8/27/10	NW	1	1	4	16	12	1	7.3		28.6
21342031	9	8/27/10	NW	1	1	10	16	18	1	7.3		28.2

Appendix B

Continued.

Client	Program	Date	Wind Direction	Wind Speed	Weather	Unit	Hour	Minute	Depth	DO	Air Temperature °C	Water Temperature °C
21342031	9	8/27/10	NW	1	1	2	17	2	1	7.7		28.8
21342031	9	8/27/10	NW	1	1	3	17	5	1	7.5		28.8
21342031	9	8/27/10	NW	1	1	4	17	10	1	7.2		29.0
21342031	9	8/27/10	NW	1	1	2	18	0	1	7.6		28.8
21342031	9	8/27/10	NW	1	1	3	18	3	1	7.5		28.8
21342031	9	8/27/10	NW	1	1	4	18	7	1	7.2		28.8
21342031	9	8/27/10	NW	1	1	10	18	12	1	7.4		28.6
21342031	9	8/28/10	S	1	2	2	6	5	1	7.6	15.0	28.3
21342031	9	8/28/10	S	1	2	2	7	3	1	7.9	15.0	28.3
21342031	9	8/28/10	S	1	2	2	8	2	1	8.0	15.0	28.6
21342031	9	8/28/10	S	1	2	2	9	1	1	7.7	15.0	28.5
21342031	9	8/28/10	S	1	2	10	9	6	1	5.9	15.0	28.7
21342031	9	8/28/10	S	1	2	2	10	1	1	7.7	15.0	28.6
21342031	9	8/28/10	S	1	2	10	10	5	1	6.6	15.0	28.7
21342031	9	8/28/10	S	1	2	2	11	0	1	8.2	15.0	28.6
21342031	9	8/28/10	S	1	2	10	11	6	1	6.6	15.0	28.7
21342031	9	8/28/10	S	1	2	2	12	0	1	8.4	15.0	28.5
21342031	9	8/28/10	S	1	2	2	13	0	1	8.1	15.0	28.8
21342031	9	8/28/10	S	1	2	10	13	5	1	7.9	15.0	28.9
21342031	9	8/28/10	S	1	1	2	14	1	1	8.3	28.5	28.7
21342031	9	8/28/10	S	1	1	10	14	6	1	8.2	28.5	28.8
21342031	9	8/28/10	S	1	1	2	15	1	1	8.3	28.5	28.5
21342031	9	8/28/10	S	1	1	10	15	7	1	8.2	28.5	28.7
21342031	9	8/28/10	S	1	1	2	16	3	1	8.1	28.5	28.6
21342031	9	8/28/10	S	1	1	10	16	9	1	8.3	28.5	28.5
21342031	9	8/28/10	S	1	1	2	17	0	1	8.2	28.5	28.4
21342031	9	8/28/10	S	1	1	10	17	5	1	7.6	28.5	28.5

Joint occurrence of daily Holtwood river flows and temperatures April, 1956 - 2009 (historic) and 2010.

	1956-2009 (Historic)																			
	32-35		36-40		41-45		46-50		51-55		56-60		61-65		66-70		71-75		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
15,000-19,999							2	0.12	4	0.25	5	0.31	3	0.19	1	0.06			15	0.93
20,000-24,999							2	0.12	15	0.93	26	1.6	13	0.8	4	0.25	1	0.06	61	3.76
25,000-29,999							5	0.31	22	1.36	29	1.79	13	0.8	10	0.62	1	0.06	80	4.94
30,000-34,999					3	0.19	13	0.8	35	2.16	25	1.54	14	0.86	6	0.37	1	0.06	97	5.98
35,000-39,999			1	0.06	6	0.37	14	0.86	28	1.73	35	2.16	20	1.23	5	0.31			109	6.72
40,000-44,999					8	0.49	21	1.3	32	1.97	37	2.28	11	0.68	1	0.06			110	6.79
45,000-49,999			1	0.06	8	0.49	22	1.36	41	2.53	26	1.6	8	0.49	1	0.06			107	6.6
50,000 PLUS	2	0.12	19	1.17	202	12.5	393	24.2	289	17.8	116	7.16	15	0.93	6	0.37			1042	64.3
TOTAL	**2**	**0.12**	**21**	**1.3**	**227**	**14**	**472**	**29.1**	**466**	**28.8**	**299**	**18.5**	**97**	**5.98**	**34**	**2.1**	**3**	**0.19**	**1621**	**100**

	2010																			
	32-35		36-40		41-45		46-50		51-55		56-60		61-65		66-70		71-75		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
20,000-24,999											1	3.33	3	10					4	13.3
25,000-29,999											6	20	1	3.33					7	23.3
30,000-34,999											4	13.3							4	13.3
35,000-39,999											3	10							3	10
40,000-44,999											1	3.33	1	3.33					2	6.67
45,000-49,999											1	3.33	2	6.67					3	10
50,000 PLUS							2	6.67	3	10	2	6.67							7	23.3
TOTAL							**2**	**6.67**	**3**	**10**	**18**	**60**	**7**	**23.3**					**30**	**100**

Joint occurrence of daily Holtwood river flows and temperatures May, 1956 - 2009 (historic) and 2010.

	1956-2009 (Historic)																			
	36-40		46-50		51-55		56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
7,500-9,999							1	0.06											1	0.06
10,000-14,999									3	0.18	24	1.44	14	0.84	14	0.84	2	0.12	57	3.43
15,000-19,999									16	0.96	54	3.25	36	2.16	28	1.68	2	0.12	136	8.17
20,000-24,999					1	0.06	11	0.66	59	3.55	69	4.15	51	3.06	4	0.24			195	11.72
25,000-29,999					8	0.48	27	1.62	57	3.43	62	3.73	30	1.8	2	0.12			186	11.18
30,000-34,999	1	0.06			4	0.24	29	1.74	63	3.79	50	3	23	1.38					170	10.22
35,000-39,999					4	0.24	20	1.2	61	3.67	37	2.22	15	0.9	1	0.06			138	8.29
40,000-44,999					7	0.42	24	1.44	66	3.97	20	1.2	9	0.54					126	7.57
45,000-49,999					1	0.06	31	1.86	40	2.4	18	1.08	10	0.6					100	6.01
50,000 PLUS			5	0.3	64	3.85	220	13.22	189	11.36	59	3.55	16	0.96	2	0.12			555	33.35
TOTAL	**1**	**0.06**	**5**	**0.3**	**89**	**5.35**	**363**	**21.81**	**554**	**33.29**	**393**	**23.62**	**204**	**12.26**	**51**	**3.06**	**4**	**0.24**	**1664**	**100**

	2010																			
	36-40		46-50		51-55		56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
15,000-19,999															1	3.23			1	3.23
20,000-24,999													2	6.45	1	3.23			3	9.68
25,000-29,999							1	3.23	3	9.68	3	9.68	1	3.23					8	25.81
30,000-34,999							1	3.23	2	6.45	3	9.68	1	3.23					7	22.58
35,000-39,999							1	3.23	2	6.45	2	6.45							5	16.13
40,000-44,999							1	3.23	2	6.45									3	9.68
45,000-49,999							1	3.23	2	6.45	1	3.23							4	12.9
TOTAL							**5**	**16.13**	**11**	**35.48**	**9**	**29.03**	**4**	**12.9**	**2**	**6.45**			**31**	**100**

Joint occurrence of daily Holtwood river flows and temperatures June, 1956 - 2009 (historic) and 2010.

	1956 - 2009 (Historic)															
	41-45		**56-60**		**61-65**		**66-70**		**71-75**		**76-80**		**>80**		**TOTAL**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
2,500-4,999									1	0.06	4	0.25	1	0.06	6	0.37
5,000-7,499									6	0.37	38	2.37	17	1.06	61	3.81
7,500-9,999							1	0.06	7	0.44	31	1.94	41	2.56	80	5
10,000-14,999							19	1.19	76	4.75	149	9.31	92	5.75	336	20.99
15,000-19,999					1	0.06	18	1.12	102	6.37	115	7.18	26	1.62	262	16.36
20,000-24,999			1	0.06	1	0.06	27	1.69	95	5.93	68	4.25	21	1.31	213	13.3
25,000-29,999			1	0.06	4	0.25	28	1.75	71	4.43	40	2.5	9	0.56	153	9.56
30,000-34,999					3	0.19	25	1.56	54	3.37	31	1.94	9	0.56	122	7.62
35,000-39,999					1	0.06	24	1.5	42	2.62	23	1.44	1	0.06	91	5.68
40,000-44,999	1	0.06			1	0.06	16	1	23	1.44	15	0.94	1	0.06	57	3.56
45,000-49,999					2	0.12	16	1	18	1.12	6	0.37			42	2.62
50,000 PLUS	1	0.06	15	0.94	33	2.06	46	2.87	68	4.25	14	0.87	1	0.06	178	11.12
TOTAL	**2**	**0.12**	**17**	**1.06**	**46**	**2.87**	**220**	**13.74**	**563**	**35.17**	**534**	**33.35**	**219**	**13.68**	**1601**	**100**

	2010															
	41-45		**56-60**		**61-65**		**66-70**		**71-75**		**76-80**		**>80**		**TOTAL**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
7,500-9,999													3	10	3	10
10,000-14,999													6	20	6	20
15,000-19,999											10	33.33	2	6.67	12	40
20,000-24,999									1	3.33	6	20			7	23.33
25,000-29,999									2	6.67					2	6.67
TOTAL									**3**	**10**	**16**	**53.33**	**11**	**36.67**	**30**	**100**

Joint occurrence of daily Holtwood river flows and temperatures July, 1956 - 2009 (historic) and 2010.

	1956 - 2009 (historic)											
	61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%
2,500-5,499							2	0.12	120	7.34	122	7.47
5,500-7,499							33	2.02	187	11.44	220	13.46
7,500-9,999					4	0.24	36	2.2	189	11.57	229	14.01
10,000-14,999					9	0.55	126	7.71	234	14.32	369	22.58
15,000-19,999					8	0.49	107	6.55	116	7.1	231	14.14
20,000-24,999					14	0.86	97	5.94	56	3.43	167	10.22
25,000-29,999					12	0.73	45	2.75	26	1.59	83	5.08
30,000-34,999					8	0.49	44	2.69	12	0.73	64	3.92
35,000-39,999					8	0.49	22	1.35	8	0.49	38	2.33
40,000-44,999					11	0.67	20	1.22	2	0.12	33	2.02
45,000-49,999			1	0.06	4	0.24	9	0.55	1	0.06	15	0.92
50,000 PLUS	1	0.06	12	0.73	34	2.08	14	0.86	2	0.12	63	3.86
TOTAL	**1**	**0.06**	**13**	**0.8**	**112**	**6.85**	**555**	**33.97**	**953**	**58.32**	**1634**	**100**

	2010											
	61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%
5,500-7,499									6	50	6	50
7,500-9,999									6	50	6	50
TOTAL									**12**	**100**	**12**	**100**

Joint occurrence of daily Holtwood river flows and temperatures August, 1956 - 2009 (historic) and 2010.

	1956 - 2009 (historic)											
	46-50		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%
0-2,499									3	0.18	3	0.18
2,500-5,499					1	0.06	36	2.17	224	13.48	261	15.7
5,500-7,499					12	0.72	87	5.23	261	15.7	360	21.66
7,500-9,999			2	0.12	10	0.6	81	4.87	168	10.11	261	15.7
10,000-14,999			2	0.12	21	1.26	126	7.58	160	9.63	309	18.59
15,000-19,999			2	0.12	21	1.26	125	7.52	67	4.03	215	12.94
20,000-24,999	1	0.06			10	0.6	42	2.53	27	1.62	80	4.81
25,000-29,999					8	0.48	37	2.23	8	0.48	53	3.19
30,000-34,999					10	0.6	21	1.26	4	0.24	35	2.11
35,000-39,999					6	0.36	14	0.84	2	0.12	22	1.32
40,000-44,999					5	0.3	5	0.3	1	0.06	11	0.66
45,000-49,999					2	0.12	6	0.36	2	0.12	10	0.6
50,000 PLUS			7	0.42	9	0.54	25	1.5	1	0.06	42	2.53
TOTAL	**1**	**0.06**	**13**	**0.78**	**115**	**6.92**	**605**	**36.4**	**928**	**55.84**	**1662**	**100**

	2010											
	46-50		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%
5,000-7,499							3	10.71	11	39.29	14	50
7,500-9,999							3	10.71	7	25	10	35.71
10,000-14,999							3	10.71			3	10.71
15,000-19,999							1	3.57			1	3.57
TOTAL							**10**	**35.71**	**18**	**64.29**	**28**	**100**

Joint occurrence of daily Holtwood river flows and temperatures September, 1956 - 2009 (historic) and 2010.

	1956 - 2009 (Historic)													
	56-60		**61-65**		**66-70**		**71-75**		**76-80**		**>80**		**TOTAL**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
0-2,499									6	0.4	19	1.25	25	1.65
2,500-5,499					11	0.73	95	6.26	137	9.03	76	5.01	319	21.03
5,500-7,499			3	0.2	42	2.77	91	6	133	8.77	55	3.63	324	21.36
7,500-9,999			5	0.33	23	1.52	108	7.12	64	4.22	48	3.16	248	16.35
10,000-14,999			2	0.13	31	2.04	102	6.72	56	3.69	21	1.38	212	13.97
15,000-19,999			18	1.19	47	3.1	66	4.35	11	0.73	9	0.59	151	9.95
20,000-24,999			14	0.92	21	1.38	24	1.58	15	0.99	2	0.13	76	5.01
25,000-29,999			7	0.46	15	0.99	6	0.4	5	0.33			33	2.18
30,000-34,999			3	0.2	15	0.99	7	0.46	5	0.33			30	1.98
35,000-39,999			4	0.26	6	0.4	4	0.26					14	0.92
40,000-44,999			2	0.13	3	0.2	5	0.33	1	0.07	1	0.07	12	0.79
45,000-49,999					6	0.4	1	0.07			1	0.07	8	0.53
50,000 PLUS	5	0.33	14	0.92	31	2.04	9	0.59	2	0.13	4	0.26	65	4.28
TOTAL	**5**	**0.33**	**72**	**4.75**	**251**	**16.55**	**518**	**34.15**	**435**	**28.68**	**236**	**15.56**	**1517**	**100**

	2010													
	56-60		**61-65**		**66-70**		**71-75**		**76-80**		**>80**		**TOTAL**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
2,500-5,499							15	50	3	10			18	60
5,500-7,499							3	10	5	16.67			8	26.67
7,500-9,999									1	3.33	1	3.33	2	6.67
10,000-14,999									1	3.33			1	3.33
15,000-19,999							1	3.33					1	3.33
TOTAL							**19**	**63.33**	**10**	**33.33**	**1**	**3.33**	**30**	**100**

Joint occurrence of daily Holtwood river flows and temperatures October, 1956 - 2009 (historic) and 2010.

	1956-2009 (Historic) and 2010																			
	41-45		46-50		51-55		56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
0-2,499											7	0.44	5	0.31					12	0.75
2,500-4,999					5	0.31	27	1.68	43	2.68	70	4.36	48	2.99	9	0.56	4	0.25	206	12.83
5,000-7,499					22	1.37	58	3.61	104	6.48	61	3.8	12	0.75	7	0.44	1	0.06	265	16.5
7,500-9,999					10	0.62	40	2.49	93	5.79	69	4.3	20	1.25	2	0.12			234	14.57
10,000-14,999					28	1.74	75	4.67	122	7.6	48	2.99	15	0.93	1	0.06			289	18
15,000-19,999			4	0.25	16	1	59	3.67	44	2.74	19	1.18	8	0.5	1	0.06			151	9.4
20,000-24,999			1	0.06	21	1.31	38	2.37	33	2.05	12	0.75	3	0.19					108	6.72
25,000-29,999			2	0.12	18	1.12	10	0.62	21	1.31	4	0.25	5	0.31	1	0.06			61	3.8
30,000-34,999					15	0.93	14	0.87	13	0.81	6	0.37	2	0.12					50	3.11
35,000-39,999			1	0.06	9	0.56	8	0.5	7	0.44	6	0.37	2	0.12					33	2.05
40,000-44,999			1	0.06	11	0.68	13	0.81	1	0.06	3	0.19	1	0.06					30	1.87
45,000-49,999			3	0.19	6	0.37	9	0.56	3	0.19	2	0.12							23	1.43
50,000 PLUS	4	0.25	31	1.93	45	2.8	38	2.37	17	1.06	4	0.25	5	0.31					144	8.97
TOTAL	**4**	**0.25**	**43**	**2.68**	**206**	**12.83**	**389**	**24.22**	**501**	**31.2**	**311**	**19.36**	**126**	**7.85**	**21**	**1.31**	**5**	**0.31**	**1606**	**100**

	2010																			
	41-45		46-50		51-55		56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
15,000-19,999					2	6.45	4	12.9											6	19.35
20,000-24,999					1	3.23	3	9.68											4	12.9
25,000-29,999							5	16.13	1	3.23									6	19.35
30,000-34,999							1	3.23	2	6.45									3	9.68
35,000-39,999									1	3.23			1	3.23					2	6.45
40,000-44,999									1	3.23									1	3.23
45,000-49,999							1	3.23											1	3.23
50,000 PLUS							2	6.45	5	16.13	1	3.23							8	25.81
TOTAL					**3**	**9.68**	**16**	**51.61**	**10**	**32.26**	**1**	**3.23**	**1**	**3.23**					**31**	**100**

Joint occurrence of daily Holtwood river flows and temperatures April, 1956 - 2010.

	32-35		36-40		41-45		46-50		51-55		56-60		61-65		66-70		71-75		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
15,000-19,999							2	0.12	4	0.24	5	0.3	3	0.18	1	0.06			15	0.91
20,000-24,999							2	0.12	15	0.91	27	1.64	16	0.97	4	0.24	1	0.06	65	3.94
25,000-29,999							5	0.3	22	1.33	35	2.12	14	0.85	10	0.61	1	0.06	87	5.27
30,000-34,999					3	0.18	13	0.79	35	2.12	29	1.76	14	0.85	6	0.36	1	0.06	101	6.12
35,000-39,999			1	0.06	6	0.36	14	0.85	28	1.7	38	2.3	20	1.21	5	0.3			112	6.78
40,000-44,999					8	0.48	21	1.27	32	1.94	38	2.3	12	0.73	1	0.06			112	6.78
45,000-49,999			1	0.06	8	0.48	22	1.33	41	2.48	27	1.64	10	0.61	1	0.06			110	6.66
50,000 PLUS	2	0.12	19	1.15	202	12.24	395	23.92	292	17.69	118	7.15	15	0.91	6	0.36			1049	63.54
TOTAL	2	0.12	21	1.27	227	13.75	474	28.71	469	28.41	317	19.2	104	6.3	34	2.06	3	0.18	1651	100

Joint occurrence of daily Holtwood river flows and temperatures May, 1956 - 2010.

	36-40		46-50		51-55		56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
7,500-9,999							1	0.06											1	0.06
10,000-14,999									3	0.18	24	1.42	14	0.83	14	0.83	2	0.12	57	3.36
15,000-19,999									16	0.94	54	3.19	36	2.12	29	1.71	2	0.12	137	8.08
20,000-24,999					1	0.06	11	0.65	59	3.48	69	4.07	53	3.13	5	0.29			198	11.68
25,000-29,999					8	0.47	28	1.65	60	3.54	65	3.83	31	1.83	2	0.12			194	11.45
30,000-34,999	1	0.06			4	0.24	30	1.77	65	3.83	53	3.13	24	1.42					177	10.44
35,000-39,999					4	0.24	21	1.24	63	3.72	39	2.3	15	0.88	1	0.06			143	8.44
40,000-44,999					7	0.41	25	1.47	68	4.01	20	1.18	9	0.53					129	7.61
45,000-49,999					1	0.06	32	1.89	42	2.48	19	1.12	10	0.59					104	6.14
50,000 PLUS			5	0.29	64	3.78	220	12.98	189	11.15	59	3.48	16	0.94	2	0.12			555	32.74
TOTAL	1	0.06	5	0.29	89	5.25	368	21.71	565	33.33	402	23.72	208	12.27	53	3.13	4	0.24	1695	100

Joint occurrence of daily Holtwood river flows and temperatures June, 1956 - 2010.

	41-45		56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%			N	%
2,500-4,999									1	0.06	4	0.25	1	0.06	6	0.37
5,000-7,499									6	0.37	38	2.33	17	1.04	61	3.74
7,500-9,999							1	0.06	7	0.43	31	1.9	44	2.7	83	5.09
10,000-14,999							19	1.16	76	4.66	149	9.14	98	6.01	342	20.97
15,000-19,999					1	0.06	18	1.1	102	6.25	125	7.66	28	1.72	274	16.8
20,000-24,999			1	0.06	1	0.06	27	1.66	96	5.89	74	4.54	21	1.29	220	13.49
25,000-29,999			1	0.06	4	0.25	28	1.72	73	4.48	40	2.45	9	0.55	155	9.5
30,000-34,999					3	0.18	25	1.53	54	3.31	31	1.9	9	0.55	122	7.48
35,000-39,999					1	0.06	24	1.47	42	2.58	23	1.41	1	0.06	91	5.58
40,000-44,999	1	0.06			1	0.06	16	0.98	23	1.41	15	0.92	1	0.06	57	3.49
45,000-49,999					2	0.12	16	0.98	18	1.1	6	0.37			42	2.58
50,000 PLUS	1	0.06	15	0.92	33	2.02	46	2.82	68	4.17	14	0.86	1	0.06	178	10.91
TOTAL	2	0.12	17	1.04	46	2.82	220	13.49	566	34.7	550	33.72	230	14.1	1631	100

Joint occurrence of daily Holtwood river flows and temperatures July, 1956 - 2010.

	61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%			N	%
2,500-4,999							2	0.12	120	7.29	122	7.41
5,000-7,499							33	2	193	11.73	226	13.73
7,500-9,999					4	0.24	36	2.19	195	11.85	235	14.28
10,000-14,999					9	0.55	126	7.65	234	14.22	369	22.42
15,000-19,999					8	0.49	107	6.5	116	7.05	231	14.03
20,000-24,999					14	0.85	97	5.89	56	3.4	167	10.15
25,000-29,999					12	0.73	45	2.73	26	1.58	83	5.04
30,000-34,999					8	0.49	44	2.67	12	0.73	64	3.89
35,000-39,999					8	0.49	22	1.34	8	0.49	38	2.31
40,000-44,999					11	0.67	20	1.22	2	0.12	33	2
45,000-49,999			1	0.06	4	0.24	9	0.55	1	0.06	15	0.91
50,000 PLUS	1	0.06	12	0.73	34	2.07	14	0.85	2	0.12	63	3.83
TOTAL	1	0.06	13	0.79	112	6.8	555	33.72	965	58.63	1646	100

Joint occurrence of daily Holtwood river flows and temperatures August, 1956 - 2010.

	46-50		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%
0-2,499									3	0.18	3	0.18
2,500-4,999					1	0.06	36	2.13	224	13.25	261	15.44
5,000-7,499					12	0.71	90	5.33	272	16.09	374	22.13
7,500-9,999			2	0.12	10	0.59	84	4.97	175	10.36	271	16.04
10,000-14,999			2	0.12	21	1.24	129	7.63	160	9.47	312	18.46
15,000-19,999			2	0.12	21	1.24	126	7.46	67	3.96	216	12.78
20,000-24,999	1	0.06			10	0.59	42	2.49	27	1.6	80	4.73
25,000-29,999					8	0.47	37	2.19	8	0.47	53	3.14
30,000-34,999					10	0.59	21	1.24	4	0.24	35	2.07
35,000-39,999					6	0.36	14	0.83	2	0.12	22	1.3
40,000-44,999					5	0.3	5	0.3	1	0.06	11	0.65
45,000-49,999					2	0.12	6	0.36	2	0.12	10	0.59
50,000 PLUS			7	0.41	9	0.53	25	1.48	1	0.06	42	2.49
TOTAL	1	0.06	13	0.77	115	6.8	615	36.39	946	55.98	1690	100

Joint occurrence of daily Holtwood river flows and temperatures September, 1956 - 2010.

	56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
0-2,499									6	0.39	19	1.23	25	1.62
2,500-4,999					11	0.71	110	7.11	140	9.05	76	4.91	337	21.78
5,000-7,499			3	0.19	42	2.71	94	6.08	138	8.92	55	3.56	332	21.46
7,500-9,999			5	0.32	23	1.49	108	6.98	65	4.2	49	3.17	250	16.16
10,000-14,999			2	0.13	31	2	102	6.59	57	3.68	21	1.36	213	13.77
15,000-19,999			18	1.16	47	3.04	67	4.33	11	0.71	9	0.58	152	9.83
20,000-24,999			14	0.9	21	1.36	24	1.55	15	0.97	2	0.13	76	4.91
25,000-29,999			7	0.45	15	0.97	6	0.39	5	0.32			33	2.13
30,000-34,999			3	0.19	15	0.97	7	0.45	5	0.32			30	1.94
35,000-39,999			4	0.26	6	0.39	4	0.26					14	0.9
40,000-44,999			2	0.13	3	0.19	5	0.32	1	0.06	1	0.06	12	0.78
45,000-49,999					6	0.39	1	0.06			1	0.06	8	0.52
50,000 PLUS	5	0.32	14	0.9	31	2	9	0.58	2	0.13	4	0.26	65	4.2
TOTAL	5	0.32	72	4.65	251	16.22	537	34.71	445	28.77	237	15.32	1547	100

Joint occurrence of daily Holtwood river flows and temperatures October, 1956 - 2010.

	41-45		46-50		51-55		56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
0-2,499											7	0.43	5	0.31					12	0.73
2,500-4,999					5	0.31	27	1.65	43	2.63	70	4.28	48	2.93	9	0.55	4	0.24	206	12.58
5,000-7,499					22	1.34	58	3.54	104	6.35	61	3.73	12	0.73	7	0.43	1	0.06	265	16.19
7,500-9,999					10	0.61	40	2.44	93	5.68	69	4.22	20	1.22	2	0.12			234	14.29
10,000-14,999					28	1.71	75	4.58	122	7.45	48	2.93	15	0.92	1	0.06			289	17.65
15,000-19,999			4	0.24	18	1.1	63	3.85	44	2.69	19	1.16	8	0.49	1	0.06			157	9.59
20,000-24,999			1	0.06	22	1.34	41	2.5	33	2.02	12	0.73	3	0.18					112	6.84
25,000-29,999			2	0.12	18	1.1	15	0.92	22	1.34	4	0.24	5	0.31	1	0.06			67	4.09
30,000-34,999					15	0.92	15	0.92	15	0.92	6	0.37	2	0.12					53	3.24
35,000-39,999			1	0.06	9	0.55	8	0.49	8	0.49	6	0.37	3	0.18					35	2.14
40,000-44,999			1	0.06	11	0.67	13	0.79	2	0.12	3	0.18	1	0.06					31	1.89
45,000-49,999			3	0.18	6	0.37	10	0.61	3	0.18	2	0.12							24	1.47
50,000 PLUS	4	0.24	31	1.89	45	2.75	40	2.44	22	1.34	5	0.31	5	0.31					152	9.29
TOTAL	4	0.24	43	2.63	209	12.77	405	24.74	511	31.22	312	19.06	127	7.76	21	1.28	5	0.31	1637	100

SAH=monthly_jnt_occur_56-2010_flow_interval_v3/Oct 56-2010-2/8/2011

Joint occurrence of daily Holtwood river flows and temperatures November, 1956 - 2009.

	32-35		36-40		41-45		46-50		51-55		56-60		61-65		66-70		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
0-2,499													1	0.06	2	0.13	3	0.19
2,500-4,999			1	0.06			11	0.7	17	1.08	14	0.89	4	0.25	1	0.06	48	3.05
5,000-7,499					6	0.38	25	1.59	57	3.63	31	1.97	11	0.7	4	0.25	134	8.52
7,500-9,999					6	0.38	18	1.15	35	2.23	19	1.21	10	0.64			88	5.6
10,000-14,999			16	1.02	21	1.34	52	3.31	82	5.22	13	0.83	8	0.51			192	12.21
15,000-19,999			14	0.89	24	1.53	46	2.93	47	2.99	9	0.57	4	0.25			144	9.16
20,000-24,999	5	0.32	19	1.21	33	2.1	48	3.05	31	1.97	14	0.89	4	0.25			154	9.8
25,000-29,999			33	2.1	34	2.16	55	3.5	28	1.78	9	0.57	2	0.13			161	10.24
30,000-34,999			25	1.59	32	2.04	39	2.48	33	2.1	2	0.13					131	8.33
35,000-39,999			15	0.95	36	2.29	26	1.65	18	1.15	6	0.38	2	0.13			103	6.55
40,000-44,999			9	0.57	39	2.48	24	1.53	8	0.51	1	0.06					81	5.15
45,000-49,999			3	0.19	20	1.27	17	1.08	6	0.38	1	0.06					47	2.99
50,000 PLUS			32	2.04	112	7.12	89	5.66	39	2.48	13	0.83	1	0.06			286	18.19
TOTAL	5	0.32	167	10.62	363	23.09	450	28.63	401	25.51	132	8.4	47	2.99	7	0.45	1572	100

APPENDIX B-2: RIVER FLOW AND WATER TEMPERATURE JOINT PROBABILITY OCCURRENCES FOR EACH MONTH (APRIL-OCTOBER).

	1956-2009 (Historic)																			
	32-35		36-40		41-45		46-50		51-55		56-60		61-65		66-70		71-75		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
15,000-19,999							2	0.12	4	0.25	5	0.31	3	0.19	1	0.06			15	0.93
20,000-24,999							2	0.12	15	0.93	26	1.6	13	0.8	4	0.25	1	0.06	61	3.76
25,000-29,999							5	0.31	22	1.36	29	1.79	13	0.8	10	0.62	1	0.06	80	4.94
30,000-34,999					3	0.19	13	0.8	35	2.16	25	1.54	14	0.86	6	0.37	1	0.06	97	5.98
35,000-39,999			1	0.06	6	0.37	14	0.86	28	1.73	35	2.16	20	1.23	5	0.31			109	6.72
40,000-44,999					8	0.49	21	1.3	32	1.97	37	2.28	11	0.68	1	0.06			110	6.79
45,000-49,999			1	0.06	8	0.49	22	1.36	41	2.53	26	1.6	8	0.49	1	0.06			107	6.6
50,000 PLUS	2	0.12	19	1.17	202	12.46	393	24.24	289	17.83	116	7.16	15	0.93	6	0.37			1042	64.28
TOTAL	**2**	**0.12**	**21**	**1.3**	**227**	**14**	**472**	**29.1**	**466**	**28.8**	**299**	**18.5**	**97**	**5.98**	**34**	**2.1**	**3**	**0.19**	**1621**	**100**

	2010																			
	32-35		36-40		41-45		46-50		51-55		56-60		61-65		66-70		71-75		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
20,000-24,999											1	3.33	3	10					4	13.33
25,000-29,999											6	20	1	3.33					7	23.33
30,000-34,999											4	13.33							4	13.33
35,000-39,999											3	10							3	10
40,000-44,999											1	3.33	1	3.33					2	6.67
45,000-49,999											1	3.33	2	6.67					3	10
50,000 PLUS							2	6.67	3	10	2	6.67							7	23.33
TOTAL							**2**	**6.67**	**3**	**10**	**18**	**60**	**7**	**23.3**					**30**	**100**

APPENDIX B-2: JOINT OCCURRENCE OF DAILY HOLTWOOD RIVER FLOWS AND TEMPERATURES MAY, 1956-2009 (HISTORIC) AND 2010.

	1956-2009 (Historic)																			
	36-40		46-50		51-55		56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
7,500-9,999							1	0.06											1	0.06
10,000-14,999									3	0.18	24	1.44	14	0.84	14	0.84	2	0.12	57	3.43
15,000-19,999									16	0.96	54	3.25	36	2.16	28	1.68	2	0.12	136	8.17
20,000-24,999					1	0.06	11	0.66	59	3.55	69	4.15	51	3.06	4	0.24			195	11.72
25,000-29,999					8	0.48	27	1.62	57	3.43	62	3.73	30	1.8	2	0.12			186	11.18
30,000-34,999	1	0.06			4	0.24	29	1.74	63	3.79	50	3	23	1.38					170	10.22
35,000-39,999					4	0.24	20	1.2	61	3.67	37	2.22	15	0.9	1	0.06			138	8.29
40,000-44,999					7	0.42	24	1.44	66	3.97	20	1.2	9	0.54					126	7.57
45,000-49,999					1	0.06	31	1.86	40	2.4	18	1.08	10	0.6					100	6.01
50,000 PLUS			5	0.3	64	3.85	220	13.22	189	11.36	59	3.55	16	0.96	2	0.12			555	33.35
TOTAL	**1**	**0.06**	**5**	**0.3**	**89**	**5.35**	**363**	**21.8**	**554**	**33.3**	**393**	**23.6**	**204**	**12.3**	**51**	**3.06**	**4**	**0.24**	**1664**	**100**

	2010																			
	36-40		46-50		51-55		56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
15,000-19,999															1	3.23			1	3.23
20,000-24,999													2	6.45	1	3.23			3	9.68
25,000-29,999							1	3.23	3	9.68	3	9.68	1	3.23					8	25.81
30,000-34,999							1	3.23	2	6.45	3	9.68	1	3.23					7	22.58
35,000-39,999							1	3.23	2	6.45	2	6.45							5	16.13
40,000-44,999							1	3.23	2	6.45									3	9.68
45,000-49,999							1	3.23	2	6.45	1	3.23							4	12.9
TOTAL							**5**	**16.1**	**11**	**35.5**	**9**	**29**	**4**	**12.9**	**2**	**6.45**			**31**	**100**

APPENDIX B-2: JOINT OCCURRENCE OF DAILY HOLTWOOD RIVER FLOWS AND TEMPERATURES JUNE, 1956-2009 (HISTORIC) AND 2010.

	1956 - 2009 (Historic)															
	41-45		**56-60**		**61-65**		**66-70**		**71-75**		**76-80**		**>80**		**TOTAL**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
2,500-4,999									1	0.06	4	0.25	1	0.06	6	0.37
5,000-7,499									6	0.37	38	2.37	17	1.06	61	3.81
7,500-9,999							1	0.06	7	0.44	31	1.94	41	2.56	80	5
10,000-14,999							19	1.19	76	4.75	149	9.31	92	5.75	336	20.99
15,000-19,999					1	0.06	18	1.12	102	6.37	115	7.18	26	1.62	262	16.36
20,000-24,999			1	0.06	1	0.06	27	1.69	95	5.93	68	4.25	21	1.31	213	13.3
25,000-29,999			1	0.06	4	0.25	28	1.75	71	4.43	40	2.5	9	0.56	153	9.56
30,000-34,999					3	0.19	25	1.56	54	3.37	31	1.94	9	0.56	122	7.62
35,000-39,999					1	0.06	24	1.5	42	2.62	23	1.44	1	0.06	91	5.68
40,000-44,999	1	0.06			1	0.06	16	1	23	1.44	15	0.94	1	0.06	57	3.56
45,000-49,999					2	0.12	16	1	18	1.12	6	0.37			42	2.62
50,000 PLUS	1	0.06	15	0.94	33	2.06	46	2.87	68	4.25	14	0.87	1	0.06	178	11.12
TOTAL	**2**	**0.12**	**17**	**1.06**	**46**	**2.87**	**220**	**13.7**	**563**	**35.2**	**534**	**33.4**	**219**	**13.7**	**1601**	**100**

	2010															
	41-45		**56-60**		**61-65**		**66-70**		**71-75**		**76-80**		**>80**		**TOTAL**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
7,500-9,999													3	10	3	10
10,000-14,999													6	20	6	20
15,000-19,999											10	33.33	2	6.67	12	40
20,000-24,999									1	3.33	6	20			7	23.33
25,000-29,999									2	6.67					2	6.67
TOTAL									**3**	**10**	**16**	**53.3**	**11**	**36.7**	**30**	**100**

APPENDIX B-2: JOINT OCCURRENCE OF DAILY HOLTWOOD RIVER FLOWS AND TEMPERATURES JULY, 1956-2009 (HISTORIC) AND 2010.

	1956 - 2009 (Historic)											
	61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%
2,500-5,499							2	0.12	120	7.34	122	7.47
5,500-7,499							33	2.02	187	11.44	220	13.46
7,500-9,999					4	0.24	36	2.2	189	11.57	229	14.01
10,000-14,999					9	0.55	126	7.71	234	14.32	369	22.58
15,000-19,999					8	0.49	107	6.55	116	7.1	231	14.14
20,000-24,999					14	0.86	97	5.94	56	3.43	167	10.22
25,000-29,999					12	0.73	45	2.75	26	1.59	83	5.08
30,000-34,999					8	0.49	44	2.69	12	0.73	64	3.92
35,000-39,999					8	0.49	22	1.35	8	0.49	38	2.33
40,000-44,999					11	0.67	20	1.22	2	0.12	33	2.02
45,000-49,999			1	0.06	4	0.24	9	0.55	1	0.06	15	0.92
50,000 PLUS	1	0.06	12	0.73	34	2.08	14	0.86	2	0.12	63	3.86
TOTAL	**1**	**0.06**	**13**	**0.8**	**112**	**6.85**	**555**	**33.97**	**953**	**58.32**	**1634**	**100**

	2010											
	61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%
5,500-7,499									6	50	6	50
7,500-9,999									6	50	6	50
TOTAL									**12**	**100**	**12**	**100**

APPENDIX B-2: JOINT OCCURRENCE OF DAILY HOLTWOOD RIVER FLOWS AND TEMPERATURES AUGUST, 1956-2009 (HISTORIC) AND 2010.

	1956 - 2009 (Historic)											
	46-50		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%
0-2,499									3	0.18	3	0.18
2,500-5,499					1	0.06	36	2.17	224	13.48	261	15.7
5,500-7,499					12	0.72	87	5.23	261	15.7	360	21.66
7,500-9,999			2	0.12	10	0.6	81	4.87	168	10.11	261	15.7
10,000-14,999			2	0.12	21	1.26	126	7.58	160	9.63	309	18.59
15,000-19,999			2	0.12	21	1.26	125	7.52	67	4.03	215	12.94
20,000-24,999	1	0.06			10	0.6	42	2.53	27	1.62	80	4.81
25,000-29,999					8	0.48	37	2.23	8	0.48	53	3.19
30,000-34,999					10	0.6	21	1.26	4	0.24	35	2.11
35,000-39,999					6	0.36	14	0.84	2	0.12	22	1.32
40,000-44,999					5	0.3	5	0.3	1	0.06	11	0.66
45,000-49,999					2	0.12	6	0.36	2	0.12	10	0.6
50,000 PLUS			7	0.42	9	0.54	25	1.5	1	0.06	42	2.53
TOTAL	**1**	**0.06**	**13**	**0.78**	**115**	**6.92**	**605**	**36.4**	**928**	**55.84**	**1662**	**100**

	2010											
	46-50		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%
5,000-7,499							3	10.71	11	39.29	14	50
7,500-9,999							3	10.71	7	25	10	35.71
10,000-14,999							3	10.71			3	10.71
15,000-19,999							1	3.57			1	3.57
TOTAL							**10**	**35.71**	**18**	**64.29**	**28**	**100**

APPENDIX B-2: JOINT OCCURRENCE OF DAILY HOLTWOOD RIVER FLOWS AND TEMPERATURES SEPTEMBER, 1956-2009 (HISTORIC) AND 2010.

	1956 - 2009 (Historic)													
	56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
0-2,499									6	0.4	19	1.25	25	1.65
2,500-5,499					11	0.73	95	6.26	137	9.03	76	5.01	319	21.03
5,500-7,499			3	0.2	42	2.77	91	6	133	8.77	55	3.63	324	21.36
7,500-9,999			5	0.33	23	1.52	108	7.12	64	4.22	48	3.16	248	16.35
10,000-14,999			2	0.13	31	2.04	102	6.72	56	3.69	21	1.38	212	13.97
15,000-19,999			18	1.19	47	3.1	66	4.35	11	0.73	9	0.59	151	9.95
20,000-24,999			14	0.92	21	1.38	24	1.58	15	0.99	2	0.13	76	5.01
25,000-29,999			7	0.46	15	0.99	6	0.4	5	0.33			33	2.18
30,000-34,999			3	0.2	15	0.99	7	0.46	5	0.33			30	1.98
35,000-39,999			4	0.26	6	0.4	4	0.26					14	0.92
40,000-44,999			2	0.13	3	0.2	5	0.33	1	0.07	1	0.07	12	0.79
45,000-49,999					6	0.4	1	0.07			1	0.07	8	0.53
50,000 PLUS	5	0.33	14	0.92	31	2.04	9	0.59	2	0.13	4	0.26	65	4.28
TOTAL	**5**	**0.33**	**72**	**4.75**	**251**	**16.6**	**518**	**34.2**	**435**	**28.7**	**236**	**15.6**	**1517**	**100**

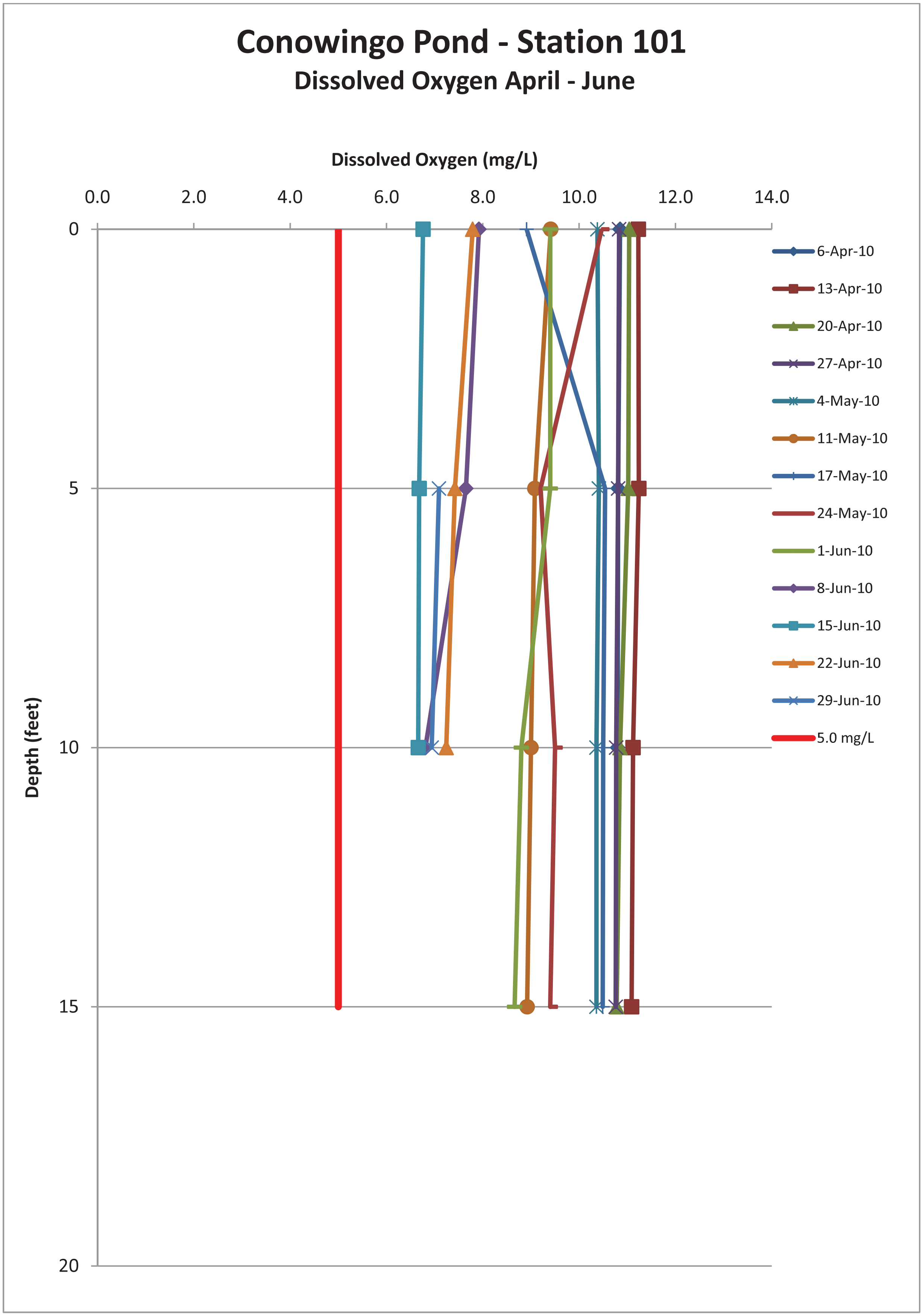
	2010													
	56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
2,500-5,499							15	50	3	10			18	60
5,500-7,499							3	10	5	16.67			8	26.67
7,500-9,999									1	3.33	1	3.33	2	6.67
10,000-14,999									1	3.33			1	3.33
15,000-19,999							1	3.33					1	3.33
TOTAL							**19**	**63.3**	**10**	**33.3**	**1**	**3.33**	**30**	**100**

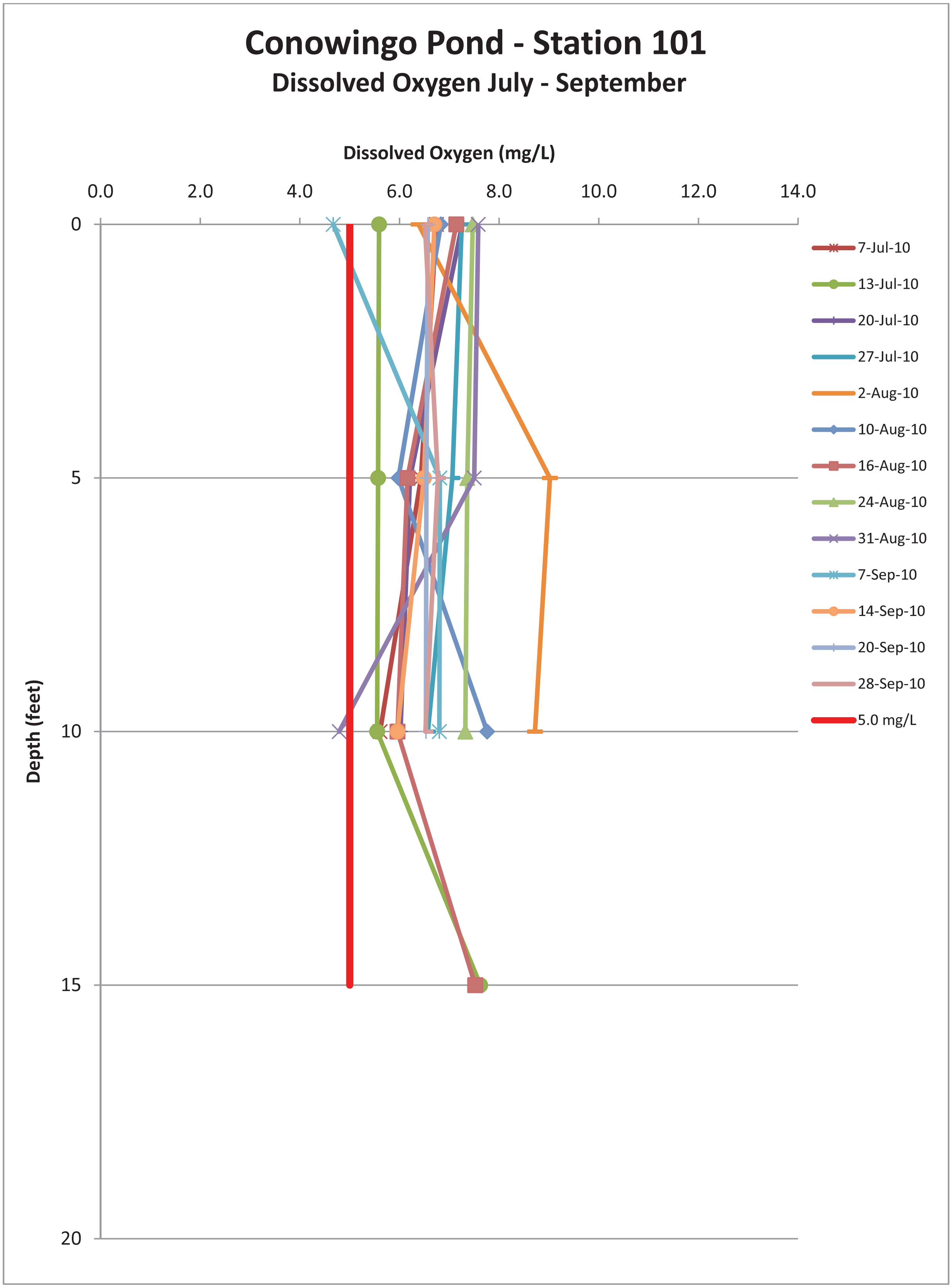
APPENDIX B-2: JOINT OCCURRENCE OF DAILY HOLTWOOD RIVER FLOWS AND TEMPERATURES OCTOBER, 1956-2009 (HISTORIC) AND 2010.

	1956-2009 (Historic) and 2010																			
	41-45		46-50		51-55		56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
0-2,499											7	0.44	5	0.31					12	0.75
2,500-4,999					5	0.31	27	1.68	43	2.68	70	4.36	48	2.99	9	0.56	4	0.25	206	12.83
5,000-7,499					22	1.37	58	3.61	104	6.48	61	3.8	12	0.75	7	0.44	1	0.06	265	16.5
7,500-9,999					10	0.62	40	2.49	93	5.79	69	4.3	20	1.25	2	0.12			234	14.57
10,000-14,999					28	1.74	75	4.67	122	7.6	48	2.99	15	0.93	1	0.06			289	18
15,000-19,999			4	0.25	16	1	59	3.67	44	2.74	19	1.18	8	0.5	1	0.06			151	9.4
20,000-24,999			1	0.06	21	1.31	38	2.37	33	2.05	12	0.75	3	0.19					108	6.72
25,000-29,999			2	0.12	18	1.12	10	0.62	21	1.31	4	0.25	5	0.31	1	0.06			61	3.8
30,000-34,999					15	0.93	14	0.87	13	0.81	6	0.37	2	0.12					50	3.11
35,000-39,999			1	0.06	9	0.56	8	0.5	7	0.44	6	0.37	2	0.12					33	2.05
40,000-44,999			1	0.06	11	0.68	13	0.81	1	0.06	3	0.19	1	0.06					30	1.87
45,000-49,999			3	0.19	6	0.37	9	0.56	3	0.19	2	0.12							23	1.43
50,000 PLUS	4	0.25	31	1.93	45	2.8	38	2.37	17	1.06	4	0.25	5	0.31					144	8.97
TOTAL	**4**	**0.25**	**43**	**2.68**	**206**	**12.8**	**389**	**24.2**	**501**	**31.2**	**311**	**19.4**	**126**	**7.85**	**21**	**1.31**	**5**	**0.31**	**1606**	**100**

	2010																			
	41-45		46-50		51-55		56-60		61-65		66-70		71-75		76-80		>80		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
15,000-19,999					2	6.45	4	12.9											6	19.35
20,000-24,999					1	3.23	3	9.68											4	12.9
25,000-29,999							5	16.13	1	3.23									6	19.35
30,000-34,999							1	3.23	2	6.45									3	9.68
35,000-39,999									1	3.23			1	3.23					2	6.45
40,000-44,999									1	3.23									1	3.23
45,000-49,999							1	3.23											1	3.23
50,000 PLUS							2	6.45	5	16.13	1	3.23							8	25.81
TOTAL					**3**	**9.68**	**16**	**51.6**	**10**	**32.3**	**1**	**3.23**	**1**	**3.23**					**31**	**100**

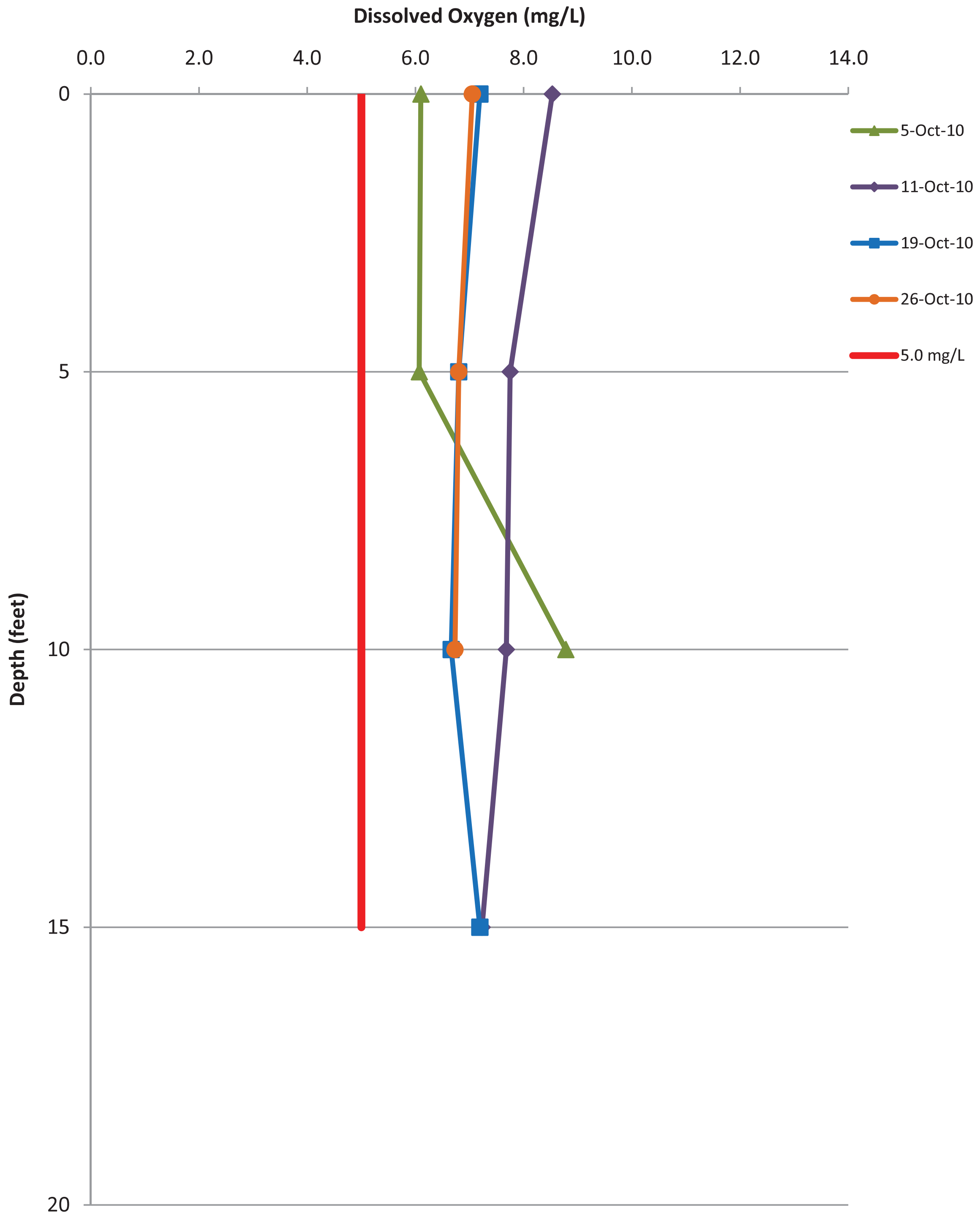
APPENDIX C: CONOWINGO POND DO AND WATER TEMPERATURE PROFILE PLOTS (ALL 8 TRANSECTS)


Conowingo Pond - Station 101
Dissolved Oxygen April - June
Dissolved Oxygen (mg/L)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
Depth (feet)
0
5
10
15
20
6-Apr-10
13-Apr-10
20-Apr-10
27-Apr-10
4-May-10
11-May-10
17-May-10
24-May-10
1-Jun-10
8-Jun-10
15-Jun-10
22-Jun-10
29-Jun-10
5.0 mg/L


Conowingo Pond - Station 101
Dissolved Oxygen July - September
Dissolved Oxygen (mg/L)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
Depth (feet)
0
5
10
15
20
7-Jul-10
13-Jul-10
20-Jul-10
27-Jul-10
2-Aug-10
10-Aug-10
16-Aug-10
24-Aug-10
31-Aug-10
7-Sep-10
14-Sep-10
20-Sep-10
28-Sep-10
5.0 mg/L

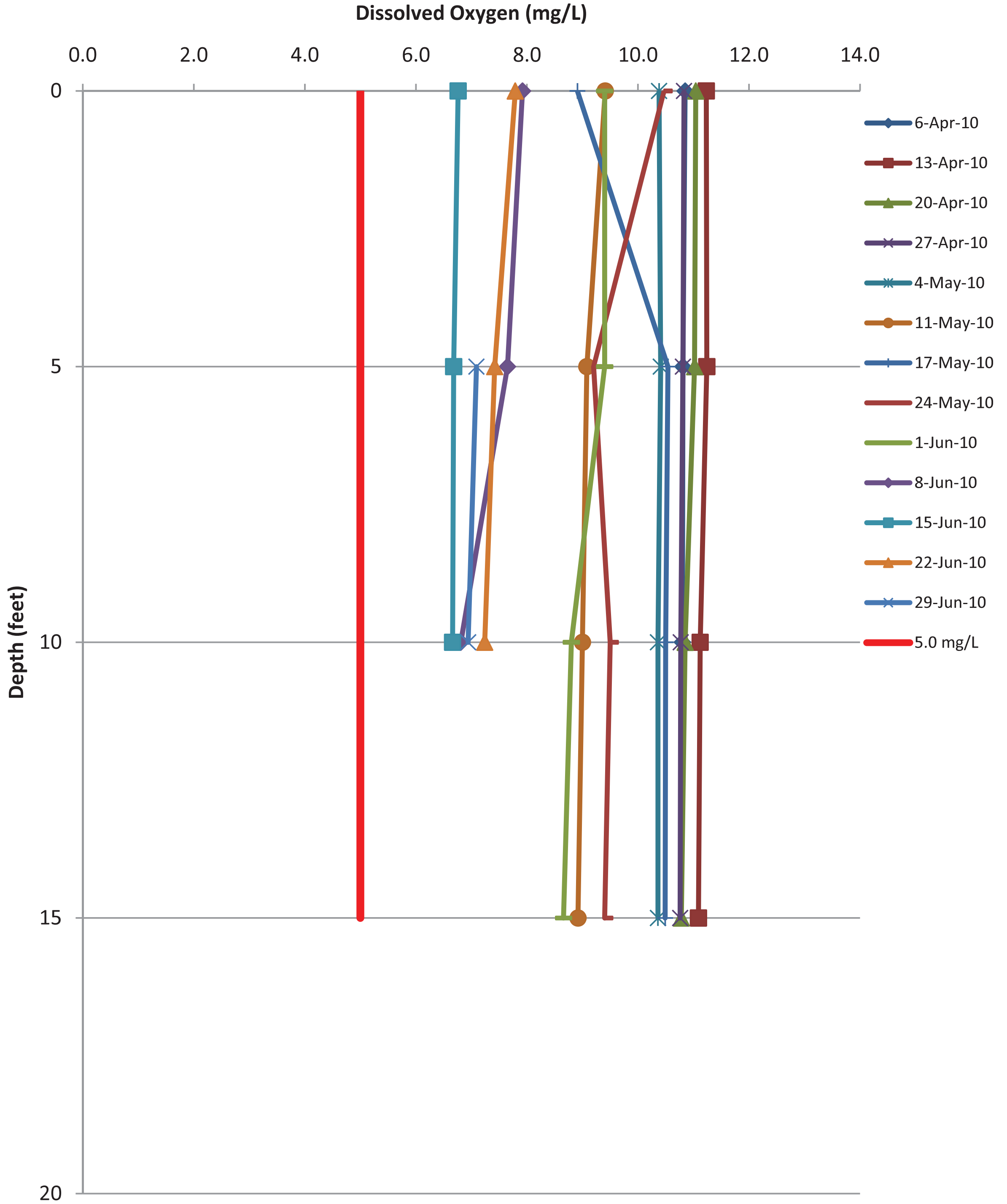
Conowingo Pond - Station101

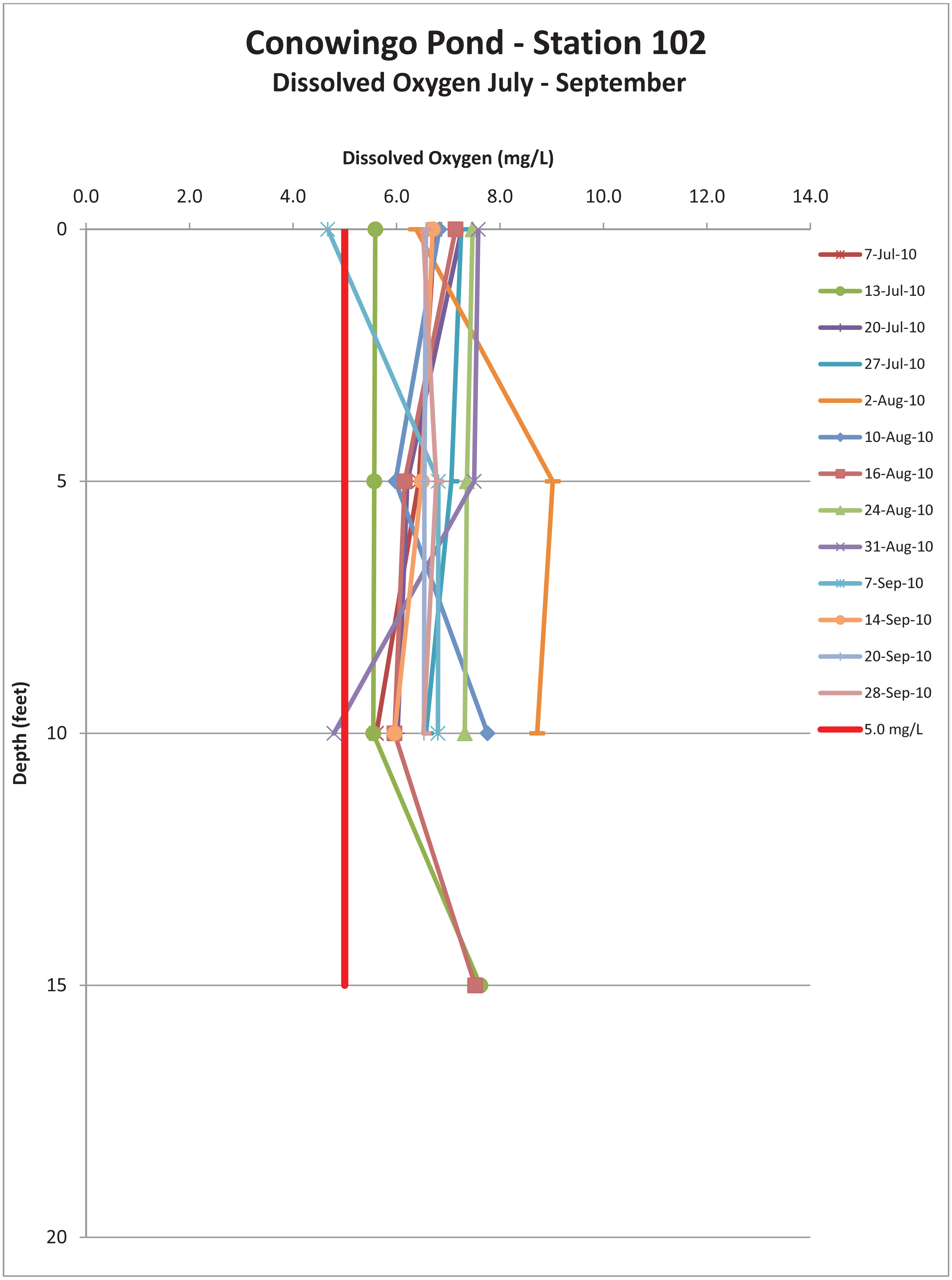
Dissolved Oxygen October

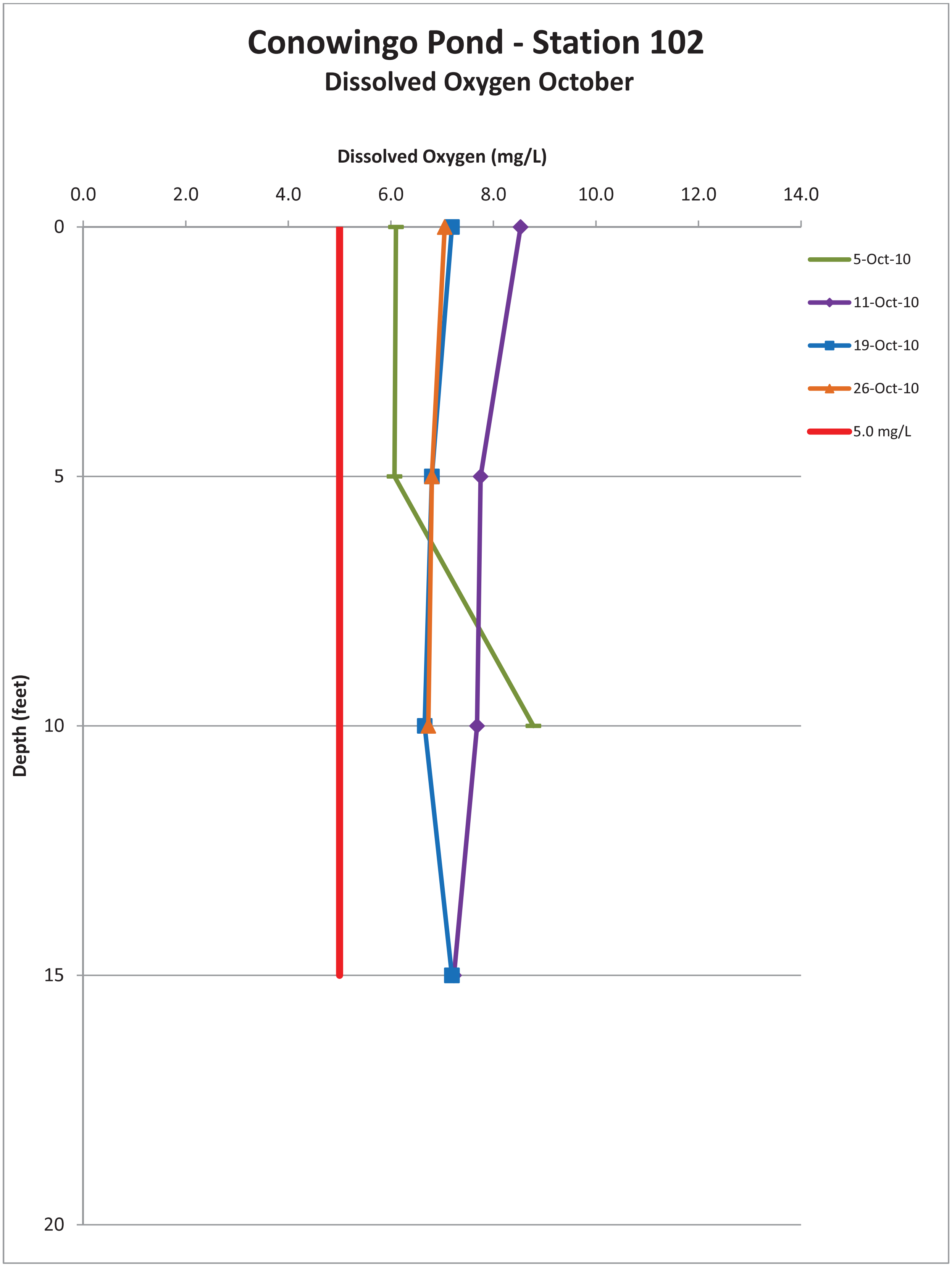


Conowingo Pond - Station 102

Dissolved Oxygen April - June




Conowingo Pond - Station 102
Dissolved Oxygen July - September
Dissolved Oxygen (mg/L)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
Depth (feet)
0
5
10
15
20
7-Jul-10
13-Jul-10
20-Jul-10
27-Jul-10
2-Aug-10
10-Aug-10
16-Aug-10
24-Aug-10
31-Aug-10
7-Sep-10
14-Sep-10
20-Sep-10
28-Sep-10
5.0 mg/L


Conowingo Pond - Station 102
Dissolved Oxygen October
Dissolved Oxygen (mg/L)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
Depth (feet)
0
5
10
15
20
5-Oct-10
11-Oct-10
19-Oct-10
26-Oct-10
5.0 mg/L

FINAL STUDY REPORT
BIOLOGICAL AND ENGINEERING STUDIES OF AMERICAN EEL
RSP 3.3

CONOWINGO HYDROELECTRIC PROJECT

FERC PROJECT NUMBER 405

Prepared for:

Exelon.

Prepared by:

Gomez and Sullivan Engineers, P.C.

August 2012

EXECUTIVE SUMMARY

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt (MW) Conowingo Hydroelectric Project (Project). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014. FERC issued the final study plan determination for the Conowingo Project on February 4, 2010, approving the revised study plan with certain modifications.

The final study plan determination required Exelon to conduct Biological and Engineering Studies of American Eel, which is the subject of this report. The objectives of this study are as follows: (1) summarize available scientific and commercial information regarding the American eel; (2) identify suspected factors affecting American eel abundance; (3) describe the spatial distribution and size characteristics of American eels in the Conowingo tailrace; (4) examine the engineering feasibility and costs of upstream and downstream passage options, including consideration of potential fallback of eels after exiting an upstream passage device; (5) examine the potential impact of upstream and downstream passage of American eels on the Susquehanna River; (6) assess the cumulative impacts to the biodiversity of the Susquehanna River ecosystem of upstream and downstream passage of American eel; and (7) if deemed beneficial to American eel abundance, identify potential locations for an upstream passage facility.

The 2010 and 2011 results for Objective 3, listed above, were presented separately in reports titled Conowingo RSP 3.3 Eel Sampling below Conowingo Dam (Normandeau and Gomez and Sullivan 2012a, b). The other six objectives and the results of a workshop on downstream passage that was held on October 25 and 26, 2011 are addressed in this report. These reports address all aspects of the final study plan.

The American eel is a catadromous fish species whose range extends from Greenland and Iceland south to Venezuela. All American eels migrate to the Sargasso Sea to spawn. The Sargasso Sea is located in the south central portion of the North Atlantic Ocean, approximately 1,400 km east of Florida. During the maturation phase, the species utilizes a combination of freshwater, estuarine, and coastal ocean waters over a period of 4 to 24+ years coast-wide and 6 to 16 years specifically in the Chesapeake Bay region (DOI 2007). The species is panmictic and, as such, is composed of a well mixed single breeding population where the juveniles do not necessarily return to natal streams (Wirth and Bernatchez 2003). Eels' eggs and larvae (leptocephali) are dispersed across their entire range by ocean currents. Once the leptocephali reach the continental shelf, they metamorphose into glass eels. The glass eels actively migrate toward land and develop pigmentation in brackish or freshwater and are termed elvers. When elvers reach approximately age 2, they are termed yellow eels, which is their primary growth stage. Sexual differentiation occurs during the yellow eel phase. As the eels sexually mature they take on a silver pigmentation (silver eels) and begin their journey back to the Sargasso Sea to spawn.

Due to their migratory behavior, eels provide an ecologic link between the marine and freshwater environments. For example, American eels serve as hosts to the larval stage (known as glochidia) of freshwater mussels, allowing for the dispersion of mussels to upstream areas. As predators of fish and invertebrates primarily, eels also tie up and remove nutrients from their prey in growth and production. Some of this freshwater/estuarine accumulated biomass is returned to the Sargasso Sea when the eels spawn and die.

In February 2007, the US Department of Interior (DOI) issued its finding on a petition to list the American eel as threatened or endangered (DOI 2007). Based on trends of glass eel abundance indices, the DOI found that the overall eel population is stable. In its findings, the DOI also stated that indices of yellow eel abundance were good indicators of local or regional conditions. Yellow eel abundance in the Chesapeake Bay, one of the largest American eel fisheries in the United States, experienced a significant decline (50 percent) over the period 1994 to 2004 (DOI 2007)[1].

At a local level, there are no abundance indices available for the Susquehanna River. The Maryland Biological Stream Survey has compiled eel data in several Chesapeake Bay tributaries, including Deer and Octoraro Creeks, which are tributaries to the Susquehanna with confluences downstream of Conowingo Dam. An analysis of these data (EPRI 2011) indicates that the densities in Deer Creek (0.292-0.357 eels/m^2) and Octoraro Creek (0.347 eels/m^2) were in the middle to lower end of the density estimate range for all Chesapeake Bay tributaries analyzed (total range 0.253-0.975 eels/m^2).

There are a variety of factors that have been postulated as affecting American eel abundance. These factors include a) changes in ocean currents and the corresponding change in the dispersal of leptocephali; b) commercial fishing; c) increased predation due to increased densities downstream of barriers; d) increased parasitic vulnerability, particularly to the non-indigenous nematode *Anguillicola crassus*; e) loss of freshwater habitat; f) contamination and g) turbine mortality.

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[1] On September 28, 2011, DOI issued its 90-day finding on a petition to list American eel filed in 2010 from the Council for Endangered Species Act Reliability. In the finding, DOI found that a 12-month status review was warranted, with the review currently ongoing.

The interaction and synergistic effects of these factors is poorly understood. However, the fact that American eel is a species generalist and will use fresh and estuarine waters, as well as the marine environment, as growth and maturation habitat helps mitigate these potential effects (Jessop et al. 2002, Lamson et al. 2006). Some American eels enter freshwater, while others complete their entire life-cycle in the marine or estuarine environment without ever entering fresh water (DOI 2007).

To better understand how American eel use the area in the immediate vicinity of the Conowingo tailrace, the United States Fish and Wildlife Service (USFWS) initiated a study in 2005. Eels have been sampled by the USFWS with ramps using Enkamat® substrate and pots near Conowingo's West Fish Lift (WFL) from 2005 to the present. In 2010, Exelon initiated eel sampling with ramps and pots in the spillway region of the project. For the 2010 Exelon sampling, one sampling ramp was placed adjacent to the dividing wall between the tailrace and East Fish Lift (EFL spillway ramp 2010) while the other ramp was placed on the east abutment end of the spillway at Spillbay 50 (spillbay 50 ramp 2010), both ramps used Enkamat® substrate. For the 2011 Exelon sampling, the ramps were placed in similar areas with the exception that tandem ramps were installed at each location with Enkamat® and AkwaDrain™ substrate fished side-by-side to compare efficacy. Eel pots were fished adjacent to the ramps for both 2010 and 2011. Both gear types are similar in design and deployment to those used by the USFWS. The results of the USFWS and Exelon sampling are presented on Table ES-1. The Enkamat® substrate used on the ramps is reportedly size-selective for eels less than 260 mm (Solomon and Beach 2004b), and neither the ramps nor the pots captured eels between 188 and 256 mm.

Table ES-1: Summary of eels collected at Conowingo Dam 2005 – 2010

Year/Source	Eels Caught with Ramps	Eel Length Range (mm)	Eels Caught with Pots	Length Range of Eels Caught in Pots (mm)
2005/USFWS WFL	42	-	78	93-733 (range given for all eels caught)
2006/USFWS WFL	19	-	208	83-735 (range given for all eels caught)
2007/USFWS WFL	3,837	76-169	51	256-734
2008/USFWS WFL	44,006 (824 on east side)	90-176	38 (25 recaptures)	321-770
2009/USFWS WFL	17,437	92-162	116 (49 recaptures)	318-655
2010/USFWS WFL	24,000	95-195	25 (9 recaptures)	335-696
2010/EXELON/EFL SPILLBAY RAMP 2010	8	103-148	1	525
2010/EXELON/SPILLBAY 50 RAMP 2010	158	92-154	91	115-650

Year/Source	Eels Caught with Ramps	Eel Length Range (mm)	Eels Caught with Pots	Length Range of Eels Caught in Pots (mm)
2011/EXELON/EFL SPILLWAY RAMPS 2011	405/156*	88-182	59	300-689
2011/EXELON/SPILLBAY 50 RAMPS/2011	133/406*	87-188	0	NA
2011/USFWS WFL	85,000	84-225	224 (55 recaptures)	333-659

*: Numbers displayed for eels caught on Enkamat®/AkwaDrain™ substrate.

Exelon conducted night reconnaissance surveys of the spillway plunge pool in 2011 to determine eel congregation areas relative to the ramp entrances. During these surveys, young eels (i.e., elvers and small yellow eels) were only observed in abundance below crest gate #30. Located immediately downstream of crest gate #30 is a plateau of concrete or macadam. Young eels were observed at this location during all three nighttime surveys. Young eels were also observed, (although not in abundance) near seeps, or areas where water trickled over the spillway sill and when water cascaded down bedrocks near these seeps. In these areas where these eels were observed, predatory fish such as channel catfish and striped bass were also observed.

A preliminary review of upstream eel passage facilities on several river systems provided background and information on the potential options for upstream eel passage at Conowingo Dam. At the St. Lawrence-FDR Power Project, with a comparable civil works configuration and operating head to Conowingo Dam, a state-of-the-art eel passage facility was constructed in 2006. It is anticipated that a permanent (fixed) eel passage facility at the Conowingo Project would include similar technologies incorporated in the St. Lawrence-FDR facility. These major features include a ramp with substrate that eels can climb to a holding area. From the holding area, eels would either pass upstream via a pipe containing a continuous flow that eels would swim through to a safe release point upstream of the Project in Conowingo Pond or be transported to selected water bodies above Conowingo Dam.

Based on data collected during studies from 2005 – 2010, eel passage facilities were evaluated at the east and west bank of Conowingo Dam. The west bank of the tailrace near the WFL presents challenges to direct passage because the powerhouse is also on the west side of the dam. In addition to passing eels over the dam, consideration was given to an exit location that will allow continued upstream movement. If the eels exit too close to the powerhouse, downstream currents could cause them to pass back through the turbines.

For this study, conceptual layouts and cost opinions were developed for five potential upstream eel passage alternatives. The alternatives ranged from eel passage facilities of limited length with a trap-and-transport program to full-length eel passage facilities that provide the opportunity for full volitional passage to Conowingo Pond. Table ES-2 presents a summary of the conceptual opinions of probable cost for the alternatives evaluated.

Table ES-2: Summary of Upstream Eel Passage Alternatives

Alternative	Brief Description	Capital Costs (2011 Dollars)	Annual Operations Costs, If Applicable (2011 Dollars)
West Bank - Trap and Transport	Limited length eel ramp with collection facility in existing parking lot.	$639,000	$585,000
West Bank - Volitional Passage near West Fish Lift	Full eel ramp with resting pools from tailrace to pond elevation, sited near West Fish Lift superstructure.	$1,695,000	$200,000 per year (assumed personnel cost)
West Bank - Volitional Passage near Administration Building	Full eel ramp with resting pools from tailrace to pond elevation, portion buried beneath parking lot daylighting near Administration Building.	$2,230,000	$200,000 per year (assumed personnel cost)
East Bank - Trap and Transport	Limited length eel ramp with collection facility in existing access area, below non-overflow section of dam.	$622,000	$585,000
East Bank - Volitional Passage	Full eel ramp with resting pools from tailrace below spillbay 50 to pond, cored through top of dam.	$1,125,000	$200,000 per year (assumed personnel cost)

In evaluating the impacts of eel passage, an assessment has to consider the expected overall upstream passage efficiency and the expected downstream passage survival. Information available from the eel passage facility on the 82-ft high Moses-Saunders Power dam on the St. Lawrence River was used to estimate expected upstream passage efficiencies at three dams on the lower Susquehanna (Conowingo, Holtwood, and Safe Harbor). The Moses-Saunders Power Dam has an estimated overall upstream passage efficiency (defined as the proportion of tagged eels released in the tailrace that later ascend the passage facility/ladder) of 33 to 39 percent. For the smaller dam at York Haven, overall upstream passage efficiency was estimated to be 36 to 45 percent based on information provided by a researcher with eel-passage experience at smaller dams (D. Desrochers, personal communication).

As would be expected with any volitional passage, a portion of the migrating eels will become residents in the impoundments through which they pass, so that the cumulative passage efficiency from the Conowingo tailrace to the York Haven (1.3 to 2.5 percent) impoundment was estimated as the product of the four dams' upstream passage efficiencies. In contrast to volitional passage, the comparable upstream passage efficiency of the trap-and-transport approach from Conowingo Dam to upstream of York Haven would be expected to be between 36 and 43 percent. With an expected very low mortality associated with transport, the overall efficiency of transported fish upstream of York Haven (or any reasonable distance of transport) would remain constant between 36 and 43 percent.

Upon maturity, eels transported or volitionally passed upstream on the Susquehanna River would have to migrate downstream and pass through one or more dam's turbines and/or through spillage if it is occurring. Survival estimates for downstream turbine passage is a function of turbine type. Based on the proportion of the types of turbines (*i.e.*, Francis or Kaplan) at each of the lower Susquehanna hydroelectric projects, the Electric Power Research Institute (EPRI) reported estimated silver eel survival at the York Haven, Safe Harbor, Holtwood and Conowingo Dams (EPRI 2011). These estimates were used to estimate cumulative downstream passage efficiencies from each of the four reservoirs.

In October 2011, a workshop was held with the relicensing stakeholders and eel experts to discuss options for the downstream passage of adult eels at hydroelectric projects generally and the Conowingo Project specifically. After discussing a variety of turbine passage, behavioral/guidance, structural, as well as trap and transport options, the group consensus was that trap and transport was the most practical alternative for the lower Susquehanna River. The specifics of the program have not been worked out as of the date of the submission of this report. For costing purposes, Exelon has assumed the program will start in small tributaries (~50 feet wide) upstream of York Haven Dam that have been stocked by the USFWS. The capital and operations costs for a single eel trapping weir of this nature are estimated to be $169,500 and $266,000/yr, respectively. Exelon anticipates that the cost of a trap and transport program would be shared among the licensees of the four dams the eels would be required to pass.

In order to determine the potential number of silver eels available for outmigration to the Sargasso Sea as well as the potential abundance of eels distributed via passage to upstream areas, a simple eel passage survival model was constructed for various passage scenarios. These models include: a.) low-end estimates of upstream passage efficiency and downstream survival for volitional passage; b) high-end estimates of upstream passage efficiency and downstream survival for volitional passage; c.) trap and transport efficiency to upstream of York Haven with low-end downstream survival for volitional passage; d.) trap and transport efficiency to upstream of York Haven with high-end downstream survival for volitional passage; and e) trap and transport efficiency to upstream of York Haven with trap and transport to both upstream of York Haven and downstream of Conowingo (a series of sensitivity analyses).

From a resource-management perspective, the model showed that the choice of methods for achieving upstream and downstream passage of American eel depends on the resource goals of an overall program. If the sole resource management objective is to provide the most silver eels leaving the Susquehanna River for the journey to the Sargasso Sea, the model shows that volitional upstream and downstream passage is likely to provide the most silver eels downstream of Conowingo Dam (90.0 percent of eels below Conowingo Dam) than options involving trap-and transportation (81.3 – 87.5 percent of eels below Conowingo). Complete volitional passage has such a high return rate of fish to the Sargasso Sea primarily because a large percentage (67%) of the eels remain below Conowingo Dam and never migrate upstream.

If the sole resource management objective is to maximize eel abundance upstream of York Haven Dam, the model shows that this goal would be accomplished with an option involving a trap-and transport program. Any trap-and-transport option program would deliver 36 to 43 percent of the eels below Conowingo upstream of York Haven while volitional passage at the four dams would only deliver 1.3 to 25 percent of these eels above York Haven.

If an upstream and downstream eel-passage program sought to balance these two resource objectives, the model predicts that an upstream and downstream trap-and-transport program would be the best approach. If capture efficiencies for the downstream trap-and-transport program are high (approximately 75% or more), this program would also provide more silver eels leaving the river than the volitional approach. Inter-annual variability of glass eels returning to the Susquehanna River, however, makes predictions of long-term benefits of any potential program uncertain.

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LIST OF ACRONYMS

Agencies

ASMFC	Atlantic States Marine Fish Commission
DOI	United States Department of Interior
EPRI	Electric Power Research Institute
FERC	Federal Energy Regulatory Commission
ICES	International Council for the Exploration of the Sea
NOAA	National Oceanic and Atmospheric Administration
NYPA	New York Power Authority
SRAFRC	Susquehanna River Anadromous Fish Restoration Cooperative
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VIMS	Virginia Institute of Marine Science

Units of Measure

cfs	cubic feet per second
F	Fahrenheit
fps	feet per second
ft	feet
h	hour
hp	horsepower
in	inch
L	liter
min	minute
mm	millimeter
MW	megawatt
rpm	revolutions per minute

Environmental

PIT	Passive Integrated Transponder

Miscellaneous

CFR	Code of Federal Regulations
EFL	East Fish Lift
ILP	Integrated Licensing Process
MBSS	Maryland Biological Stream Survey
NOI	Notice of Intent
PAD	Pre-Application Document
PSP	Proposed Study Plan
RSP	Revised Study Plan
WFL	West Fish Lift

1.0 INTRODUCTION

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt (MW) Conowingo Hydroelectric Project (Project). Exelon is applying for a new license using the FERC's Integrated Licensing Process (ILP). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014.

As required by the ILP, Exelon filed its Pre-Application Document (PAD) and Notice of Intent (NOI) with FERC on March 12, 2009. On June 11 and 12, 2009, a site visit and two scoping meetings were held at the Project for resource agencies and interested members of the public. Following these meetings, formal study requests were filed with FERC by several resource agencies. Many of these study requests were included in Exelon's Proposed Study Plan (PSP), which was filed on August 24, 2009. On September 22 and 23, 2009, Exelon held a meeting with resource agencies and interested members of the public to discuss the PSP.

Formal comments on the PSP were filed with FERC on November 22, 2009 by Commission staff and several resource agencies. Exelon filed a Revised Study Plan (RSP) for the Project on December 22, 2009. FERC issued the final study plan determination for the Project on February 4, 2010, approving the RSP with certain modifications.

The objectives of this study, which is part of the RSP, are as follows: (1) summarize available scientific and commercial information regarding the American eel; (2) identify suspected factors affecting the American eel abundance; (3) describe the spatial distribution and size characteristics of American eels in the Conowingo tailrace; (4) examine the engineering feasibility and costs of upstream and downstream passage options, including consideration of potential fallback of eels after exiting an upstream passage device; (5) examine the potential impact of upstream and downstream passage of American eels on the Susquehanna River; (6) assess the cumulative impacts to the biodiversity of the Susquehanna River ecosystem of upstream and downstream passage of American eel; and (7) if deemed beneficial to American eel abundance, identify potential locations for an upstream passage facility.

The 2010 and 2011 results for Objective 3, listed above, were presented separately in reports titled Conowingo RSP 3.3 Eel Sampling below Conowingo Dam (Normandeau and Gomez and Sullivan 2012a, b). The other six objectives and the results of a workshop on downstream passage that was held on October 25 and 26, 2011 are addressed in this report. These reports address all aspects of the final study plan.

2.0 BACKGROUND

2.1 Project Description

2.1.1 Conowingo Pond

The impoundment, known as Conowingo Pond and formed by Conowingo Dam, extends approximately 14 miles upstream from Conowingo Dam to the lower end of the Holtwood Project tailrace. The Conowingo Pond is typically fluctuated between elevations 105.2[2] feet (ft) and 109.2 ft, though the FERC license permits pond elevations between 101.2 ft and 110.2 ft. Conowingo Pond has a surface area of approximately 8,500 acres and a total impoundment volume of approximately 310,000 acre-ft.

2.1.2 Conowingo Dam and Spillway

The Conowingo Dam (Figure 2.1.1-1) is a concrete gravity dam with a maximum height of approximately 94 ft and a total length of 4,648 ft. The dam consists of four distinct sections from east to west: a 1,190-foot long non-overflow gravity section with an elevation of 115.7 ft; an ogee shaped spillway (the major portion, which is 2,250 ft long with a crest elevation of 86.7 ft and the minor portion, which is 135 ft long with a crest elevation of 98.7 ft); an intake-powerhouse section, which is 950 feet long; and a 100-foot-long abutment section. The powerhouse and spillway sections of the dam are separated by a dividing wall extending 300 feet downstream of the powerhouse. The dam also supports U.S. Highway Route No. 1.

Flow over the ogee spillway sections is controlled by 50 stony-type crest gates with crest elevations of 86.7 ft and two regulating gates with crest elevations of 98.7 ft. Each crest gate is 22.5 ft high by 38 ft wide and has a discharge capacity of 16,000 cfs at a reservoir elevation of 109.2 ft. The two regulating gates are 10 ft high by 38 ft wide and have a discharge capacity of 4,000 cfs per gate at a reservoir elevation of 109.2 ft. All gates are designed such that they must be locked in a fully open or fully closed position, with no partial openings.

2.1.3 Conowingo Powerhouse

The Conowingo Powerhouse contains eleven turbine/generating units. The turbines are comprised of seven Francis-type single runner hydraulic turbines (unit numbers 1 through 7) operating at 81.8 revolutions per minute (rpm) and four Kaplan-type turbines (unit numbers 8 through 11) operating at 120 rpm. Under a rated head of 89 ft, units 1, 3, 4, 6 and 7 have a rated output of 6,749 cfs, and units 2 and 5 have a rated output of 6,320 cfs. Units numbers 8 through 11 are mixed flow Kaplan turbines that operate

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[2] Elevations in this document refer to the National Geodetic Vertical Datum of 1929 (NGVD 1929). NGVD 1929 elevations are 0.7 feet higher than Conowingo Datum, such that elevation 104.5 ft Conowingo Datum equals 105.2 ft NGVD 1929.

at 120 rpm. Under a rated head of 89 ft, unit 8 has a rated output of 9,352 cfs and units 9-11 have a rated output of 9,727 cfs. The Conowingo Project also includes two small Francis house turbines that operate at 360 rpm with a rated output of 247 cfs under a design head of 89 ft. The house units provide station service and "black-start" capability. Under normal conditions only one house unit is operated for station service. Flow to the house units is minimal (247 cfs per unit) compared to the generating units (6,320 to 9,727 cfs, maximum hydraulic capacity of 86,000 cfs). Water for the generating turbines is taken from the mid to lower levels of the pond. The ceiling of the turbine intake bays is 40 ft below the water surface at normal full pond (elevation 109.2 ft) and extends down to 98 ft below normal full pond. Thus, the intake opening extends from elevation 69.2 ft down to elevation 11.2 ft. Each large unit is screened by bar racks with a clear spacing of 5.375 inches, while the house units are screened by bar racks with a clear spacing of 2 inches. Table 2.1.3-1 depicts the turbine characteristics at Conowingo Dam.

2.1.4 Tailrace

The makeup of Conowingo Dam's tailrace varies laterally along the dam (Figure 2.1.1-1). The west section, downstream of the powerhouse, consists of a deep bedrock channel with depths up to 21 ft at full generation (86,000 cfs), with a generally rectangular cross-section shape. The center and east sections, downstream of the spillway, consist of a bedrock outcrop-dominated landscape with various interconnected shallow pools and channels.

The Conowingo tailrace experiences a wide fluctuation of tailwater elevations. The tailwater elevation versus flow relationship is shown in Figure 2.1.4-1. Normal operating tailwater, with all units generating, is nominally El. 21.5 ft. Tailwater elevations can range from El. 12.0 ft (~0 cfs) during temporary winter turbine shutdowns to greater than El. 25.0 ft (~175,000 cfs) during minor flooding events.

2.1.5 Fish Passage Facilities

Exelon currently operates two fish lifts at Conowingo Dam. The West Fish Lift (WFL), which passes approximately 350 cfs, is adjacent to the 100 ft long right abutment and is currently operated under a settlement agreement with the United States Fish and Wildlife Service (USFWS) for American shad egg production and other research purposes. The newer East Fish Lift (EFL) is located at the dividing wall between the powerhouse and spillway sections and is used primarily to pass American shad and other migratory fishes during the April to June migration season. The flow through the EFL can vary from 300 to 900 cfs depending on the gate setting.

2.1.6 Seasonal Flow Requirements

The current minimum flow regime below Conowingo Dam was formally established with a settlement agreement in 1989 between the Project owners and several federal and state resource agencies. The established minimum flow regime below Conowingo Dam is the following:

March 1 – March 31	3,500 cfs or natural river flow
April 1 – April 30	10,000 cfs or natural river flow, whichever is less
May 1 – May 31	7,500 cfs or natural river flow, whichever is less
June 1 – September 14	5,000 cfs or natural river flow, whichever is less
September 15 – November 30	3,500 cfs or natural river flow, whichever is less
December 1 – February 28	3,500 cfs intermittent (maximum six hours off followed by equal amount on)

The natural river flow is the discharge measured at the Susquehanna River at the Marietta United States Geological Survey (USGS) gage (No. 01576000). The Marietta USGS gage is located approximately 35 miles upstream of Conowingo Dam above the Safe Harbor Dam.

TABLE 2.1.3-1: TURBINE CHARACTERISTICS OF THE CONOWINGO HYDROELECTRIC FACILITY.

Unit Nos.	1,3,4,6,7	2,5	8	9-11	House Units (2)
Turbine Type	Francis	Francis	Kaplan (Mixed Flow)	Kaplan (Mixed Flow)	Francis
Trash rack spacing (in)	5 3/8	5 3/8	5 3/8	5 3/8	2
No. blades (buckets)	13	13	6	6	13
Rated head (ft)	89	89	86	86	89
Intake Elevation (ft)	11.2 to 69.2	11.2 to 69.2	11.2 to 69.2	11.2 to 69.2	11.2 to 69.2
Approximate rated flow (cfs)	6,749	6,320	9,352	9,727	247
Operating Speed (rpm)	81.8	81.8	120	120	360
Runner diameter (in)	203	203	225	225	43.5
Blade tip speed (ft/s)	72.5	72.5	117.8	117.8	68.3
No. wicket gates	24	24	24	24	16
Pad Height (in) [Clear distance between top & bottom of wicket gate]	72.1	72.1	108.5	108.5	15.5
Wicket gate spacing (in)	13.75	13.75	22.16	22.16	3.72

FIGURE 2.1.1-1: CONOWINGO HYDROELECTRIC PROJECT

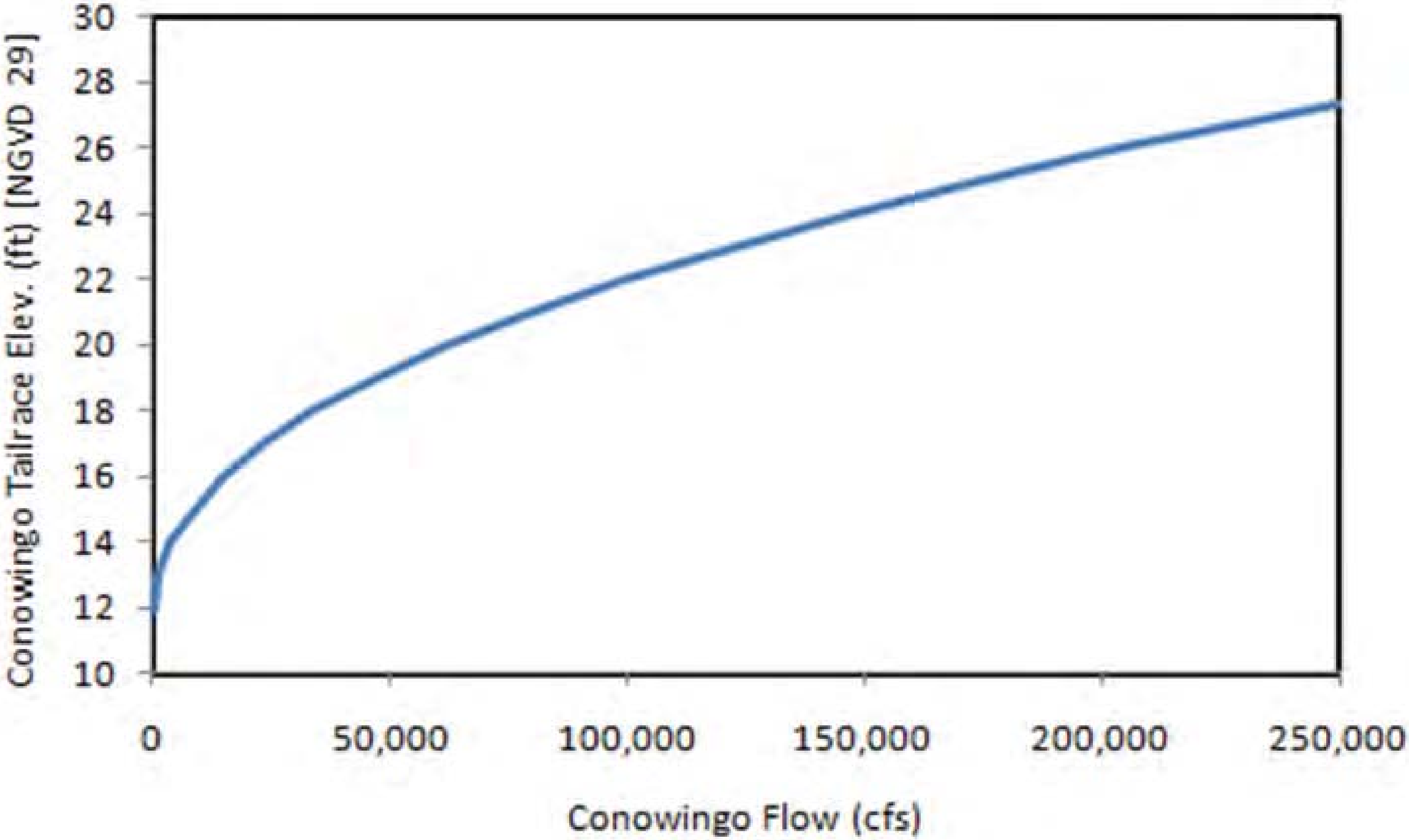

FIGURE 2.1.4-1: TAILWATER RATING CURVE BELOW CONOWINGO DAM

3.0 EXISTING DATA ON AMERICAN EEL

The information presented in this section of the report summarizes the life cycle and distribution of American eel, its ecological role, as well as the current population status and factors affecting abundance.

3.1 Life Cycle and Distribution

The American eel is a catadromous fish species with a broad geographic range that extends from Greenland south to the northeast coast of South America and includes the eastern coast of North America. It is a facultative catadromous species[3] that spends its life in freshwater, estuaries, or saltwater and then migrates to spawn in the Sargasso Sea, which is located in the south-central portion of the North Atlantic Ocean (Bonhommeau et al. 2009).

The American eel population is panmictic, referring to a well-mixed, single breeding population where the juveniles do not necessarily return to streams from which the parent eels came (Wirth and Bernatchez 2003). This single breeding population is the result of random mating of all individuals from the entire range in the spawning region of the Sargasso Sea and the dispersal of larvae via the Gulf Stream, North Atlantic Ocean, Caribbean Sea and coastal waters as influenced by the North Atlantic Oscillation[4]. The significance of panmixis is, unlike anadromous species such as American shad, there is no river-specific stock of American eel. Thus, specific systems' eel populations are dependent on the overall population's reproductive success and dispersal.

Life stages of the American eel include: egg, leptocephali (larval stage), glass eel, yellow eel, and silver eel. Spawning is thought to occur in late winter with a peak in the February to March timeframe (McCleave 2008). Following spawning, hatching begins in February and may continue until April (McCleave et al. 1987). The eggs hatch into leptocephali, which disperse and are transported by ocean currents from the Sargasso Sea toward coastal areas. Leptocephali have a limited ability to swim and are carried on the currents for several months to up to a year. The leptocephali metamorphose into miniature, transparent glass eels as they approach the continental shelf and begin active migration toward land. Glass

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[3] As opposed to obligative catadromy, where species instinctively migrate to freshwater for required biological development.

[4] The North Atlantic Oscillation is the climatic fluctuation of the difference of air pressure at sea level between the Icelandic low and Azores high that through east-west oscillation movements controls the strength and direction of the westerly winds and storm tracks across the North Atlantic Ocean.

eels are typically found along the coastal United States from February through May in the south-central portion of the North American range and into June and July in the northern extent of their North American range (Sullivan et al. 2006).

At approximately 100 mm, the glass eels develop pigmentation as they move into brackish or freshwater and are termed elvers (ASMFC 2000). Some American eels enter freshwater, while others complete their life cycle in the marine or estuarine environment (Jessop et al. 2002; Morrison et al. 2003; Lamson et al. 2006). Recent investigations using otolith microchemistry report three groups: saltwater residents, freshwater residents and inter-habitat migrants (Jessop et al 2002; Lamson et al. 2006). DOI (2007) stated that it has been suggested that brackish (or estuarine) waters produce eels that grow faster, mature earlier and emigrate as silver eels sooner than eels in fresh water.

Upstream migration of the elvers into fresh or estuarine waters occurs over a range of time from May through October, depending in part on latitude. The yellow eel stage generally begins when eels reach age 2 and this is considered the primary growth stage (DOI 2007). Yellow eels typically have a dark brown or black dorsal surface that transition to a pale yellow or olive-brown ventral surface. Eels are primarily benthic, utilizing rock, sand, mud and aquatic vegetation. They are largely nocturnal and feed mostly on invertebrates and smaller fishes. In as few as 4 and as many as 24 or more years with the mean outmigration age increasing with increasing latitude (6 to 16 years for Chesapeake Bay eels), yellow eels transform to sexually mature, adult silver eels, and begin a migration toward oceanic spawning grounds in the Sargasso Sea (DOI 2007). At the onset of and continuing throughout this migration, the eels undergo a number of physical changes. Some of the physical changes are substantially enlarged eyes, atrophy of the stomach and a change to a dark dorsal and silvery ventral color.

3.2 Population Status

In February 2007, the United States Department of Interior (DOI) issued its finding on a petition to list the American eel as threatened or endangered (DOI 2007). As part of that finding, the DOI conducted a comprehensive population status review. This type of status review typically consists of an assessment of the range-wide population size and structure. However, no range-wide estimate of abundance exists for American eel. Such an estimate is hampered by the panmictic nature of the species, the species' large and diverse geographic range, and growth rates and sex ratios that are environmentally dependent (DOI 2007). Absent range-wide estimates of abundance, the DOI elected to evaluate site-specific information on eels in the context of its significance to the entire population.

In evaluating site-specific information, the DOI analyzed four indices each for glass and yellow eels. The DOI evaluated glass eel indices from two sites in the US that have long-term data sets (North Carolina and New Jersey) as well as two sites in Nova Scotia. None of these indices showed a declining trend in glass eel production over a 13 to 15 year period beginning in 1989 (DOI 2007). Based on this trend, the DOI concluded the following:

> *"…of the available index data for the different American eel life history stages, we have determined that glass eel indices best represent the species status range-wide. Although we do not have glass eel indices from the entire range, the random nature of the leptocephali dispersal allows us to consider these data representative of the reproductive success of the species. As described above, there is no evidence of a sustained downward trend of these glass eel indices; therefore, we conclude that the American eel is not undergoing a sustained downward trend at a population level."*

Relative to yellow eel abundance, the DOI found the following:

> *"…indices from freshwater and tidal sites distributed from the mid-Atlantic region north to Canada and the St. Lawrence River indicated a statistically significant trend in yellow eel abundance at three sites. Two of these indices, Lake Ontario and the Chesapeake Bay index, had strong and statistically significant declining trends over the recent 1994 to 2004 time period, with 10-year declines in the order of 50% in the Chesapeake Bay…"*

The ongoing Chesapeake Bay surveys as referenced in DOI 2007 (ASMFC 2006) are conducted by the Virginia Institute of Marine Science (VIMS). Figure 3.2-1 is a replica of a graph in a summary report submitted by VIMS reporting the Chesapeake Bay eel index. It shows a highly variable index with a general trend of declining abundance of juvenile eels throughout the Bay (random stratified catch) and tributaries (river only catch) beginning approximately in 1988 and continuing through 2007.

A petition to list American eel as a threatened species under the Endangered Species Act was filed with the USFWS by the Council for Endangered Species Reliability (CESR) on April 30, 2010. CESR commented that the basis for this petition was new information as well as information not considered in the FWS 2007 determination that listing was not warranted.

The USFWS conducted a 90-day review of the CESR petition that was published in the Federal Register on September 29, 2011 (FR Vol. 46, No. 189, Pages 60431-60444). The USFWS, in summary, stated:

> *We find that the information provided in the petition, as well as other new information in our files, presents substantial scientific or commercial information indicating that the petitioned action may be warranted by a causal link between oceanic changes (increasing sea surface temperature with a corresponding shift in spawning location, decrease in food availability, or shift in leptocephali transport by currents, tied to global warming) and decreasing glass eel recruitment. We will further explore any current o future population level impacts that may result from climate change in our new 12-month status review. However, we find that the information provided in the petition, as well as baseline and other new information in our files, does not present substantial scientific or commercial information indicating that the petitioned action may be warranted due to hydropower impacts, contaminants, electro-magnetic fields, acoustic disturbance, or the harvest of seaweed for biofuel. Information in our files and in the petition does not present new information to change the Service's previous conclusion in the 2007 12-month finding that hydropower and contaminants are not significant threats to the American eel population.*

3.3 Ecological Role

Generally, little quantitative information has been published about the ecological role of American eel. Due to their migratory behavior, eels provide an ecologic link between the marine and freshwater environments. This link manifests itself in the predator-prey relationships of the species, as well as in its ability to act as a host for a variety of parasitic organisms.

Elvers and small yellow eels are prey species for larger aquatic predators such as largemouth bass and striped bass as well as avian species such as gulls, cormorants and bald eagles. The species also exhibits cannibalistic behavior, with larger yellow eels preying on incoming glass eels and elvers (Facey and Van Den Avyle 1987).

As predators, eels have a diverse diet that depends on their life stage and available food. Generally, eels are bottom feeders, and the diversity of their diet increases with size. Elvers feed on aquatic insects, cladocerans, amphipods and fish parts (Facey and Van Den Avyle 1987). As the elvers continue to grow into yellow eels, their diet can expand to include crustaceans, frogs and fishes (Facey and Van Den Avyle 1987, MacGregor et al. 2010). Large yellow eels compete directly with other piscivores such as bass, northern pike and walleye that feed on similar prey. However, it should be noted that Canadian angler surveys on the Bay of Quinte and the St. Lawrence River including Lake St. Francis revealed very little impact on sport fisheries (presumably for the above species) when eel populations declined (MacGregor et al. 2010).

As predators, eels utilize nutrients and energy stores from their prey in growth and production. Some of this freshwater/estuarine accumulated biomass and energy stores are released into the Sargasso Sea once the fish die and decompose, post spawning.

In addition to being nutrient exporters via consumed biomass, eels serve as importation vehicles for several parasitic organisms. Parasites of American eel include a variety of protozoans, trematodes, nematodes, cestodes and copepods (Facey and Van Den Avyle 1987). American eels also serve as a host species for the larval stage (known as glochidia) of freshwater mussels. Freshwater mussels filter and remove bacteria, algae, and fine particles from large quantities of water, playing an important role in water quality.

Mussel species depend on their hosts for dispersal, which completes a mussel's life cycle. Minkkinen and Park (2008) report that American eels may have a unique role as a host species for the mussel eastern elliptio (*Elliptio complanata*) and cite work conducted by the United States Geological Survey (USGS) Northern Appalachian Research Laboratory that found higher abundances of eastern elliptio on the nearby Delaware River than on the Susquehanna River. The Minkkinen and Park (2008) report suggests that low recruitment of eastern elliptio on the Susquehanna River could be attributed to the lack of eel passage at the four dams on the lower Susquehanna.

Over its range (Georgia to the St. Lawrence River and west to Lake Superior and Hudson Bay), eastern elliptio use several fish species as hosts, including white perch, yellow perch, American eel, alewife, blueback herring, three-spine stickleback, banded killifish, white sucker, pumpkinseed sunfish, redbreast sunfish, black crappie, largemouth bass, smallmouth bass, brook trout, lake trout and mottled sculpin (Wiles 1975, Watters 1994, Lellis et al. 2001, Kneeland and Rhymer 2008 as cited in Nedeau 2008).

Attempts to obtain and review the documentation of the original USGS research establishing the American eel-eastern elliptio link were made. On March 12, 2012, Exelon received information from USGS in response to a FOIA request regarding mussels in the Susquehanna River. The cover letter indicated that the package contained information on eastern elliptio in New Jersey, New York along with manuscripts, emails and abstracts of posters and oral presentations. Two abstracts included with this information are of relevance to the Susquehanna River. The abstracts of interest are titled: Host Identification for *Elliptio complanta* (Bivalvia: Unionidae) from the upper Susquehanna River Basin, Pennsylvania and Assessing the Importance of American Eel (*Anguilla rostrata*) to Freshwater Mussel Populations in the Susquehanna River.

The first abstract[5] described a laboratory experiment where multiple fish species were exposed to infestation by freshly-released glochidia of eastern elliptio. The results of the experiment showed metamorphosed individuals on American eel, brook trout, lake trout and mottled sculpin. Juvenile mussels were recovered from 18 to 48 days. No metamorphosed individuals were observed on American toad tadpoles, Atlantic sturgeon, blacknose dace, bluntnose minnow, central stoneroller, common shiner, cutlips minnow, fallfish, longnose dace, margined madtom, red-spotted newt, river chub, rock bass, shield darter, smallmouth bass, spottail shiner, tessellated darter or white sucker.

The second abstract[6] linked the low number of eastern elliptio in the Susquehanna River to the lack of upstream eel passage at hydropower dams. The abstract suggests that large populations of eastern elliptio in neighboring rivers and streams results from their their larger eel populations compared to low elliptio and eel numbers in the Susquehanna River. The abstract indicates that host fish studies showed that American eels were likely the primary host for eastern elliptio prior to dam construction. The study used qualitative and quantitative surveys above and below the Conowingo Dam to compare eastern elliptio recruitment. The results presented showed that population estimates in high density areas in the Susquehanna River were much lower than high density areas in the Delaware River. Other results presented showed that the eastern elliptio below Conowingo Dam are smaller than those at the six sites sampled above the dam. The conclusion presented in the abstract is that this indicates limited recruitment, presumably above the dam.

The remaining information supplied is various email correspondence concerning eastern elliptio. The correspondence identifies American eel and lake trout as the best hosts for eastern elliptio and mottled and slimy sculpin as minor hosts. The correspondence also identifies many other unsuccessful host species not listed in the abstract above. The correspondence mentions the incongruity of these results to results of other published studies as well as the common knowledge about eastern elliptio.

Unfortunately, the information presented in the FOIA concerning the relationship between American eel and eastern elliptio was limited, with very little supporting data or technical reports.

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[5] Host Identification for *Elliptio Complanata* (Vivalvia: Unionidate) from the upper Susquehanna River Basin, Pennsylvania . W.A. Lellis, E.S. Gray, J.C. Cole, B.S. White and J.S. Hotter. U.S. Geological Survey, Northern Appalachian Research Laboratory.

[6] Assessing the Importance of American Eel (*Anguilla Rostrata*) to Freshweater Mussels Populations in the Susquehanna River. Julie Devers, Jeffrey Cole, Barbara St. John White, Steve Minkkinen (Maryland Fishery Resource Office, USFWS), and William Lellis (Northern Appalachian Research Laboratory, USGS)..

3.4 Factors Affecting Abundance

There are a variety of factors that have been postulated as affecting the abundance of American eel. These factors include ocean conditions, commercial fisheries, predation, parasites, freshwater habitat loss, contaminants, and turbine mortality. The potential effect of each of these factors is described below. A complete discussion of each of these factors is beyond the scope of this report. The discussion presented below is meant to summarize these factors with the purpose of giving general context for American eel abundance in the Susquehanna drainage basin.

3.4.1 Ocean Conditions

Evidence indicates that changes to the North Atlantic Oscillation have been affecting the dispersal of juvenile eels in the Atlantic. Analyses have shown a negative correlation between Sargasso Sea surface temperatures and European eel abundance with a 12-year lag and that the North Atlantic Oscillation index and inflow of North Atlantic water into the North Sea were also negatively correlated with an 11-year lag (Durif et al. 2010). It is apparently not the first time this has happened, as Wirth and Bernatchez (2003) found that American and European eels have undergone several population contractions with the most recent in the Wisconsinan glaciation and that eels are sensitive to the strength and position of the Gulf Stream. Bonhommeau et al. (2009) indicated that changes in oceanic productivity related to climate change may have influenced the decline of European, American and Japanese eel populations and that shifts in the marine temperature regime in the late 1970s were followed by shifts in glass eel recruitment of the same three species. Friedland et al. (2007) also found a strong negative correlation between the North Atlantic Oscillation and long term variations in catches of European glass eels lagged by one year. They also indicated that the relationships between several ocean parameters and the Den Oever recruitment index (a long term (1940 to present) fishery independent glass eel recruitment index in the Netherlands) suggest that changing oceanic conditions may be contributing to declining recruitment of European and probably American eels.

3.4.2 Commercial Fisheries

American eels have supported local and coastal fisheries prior to and since European occupation of North America. Historical records of commercial eel harvest in the Susquehanna River are sparse, but indicate a fairly substantial fishery in the late-1800s and early-1900s. SRAFRC (2010) estimated that the approximate annual catch ranged from 44,002 to 147,222 pounds with an average of 88,339 pounds of eels caught in the Susquehanna River from 1909 to 1912 and up to 197,000 pounds in 1920.

Maryland showed eel landings of over 300,000 pounds in 2007 and along with New Jersey and Delaware comprised 73 percent of total commercial landings in the United States (ASMFC 2009). Indications are that nearly all commercial eel landings in the United States are from saline waters (ICES 2009). Commercial landings in Chesapeake Bay were 369,890 pounds in 2008, and the preliminary number for 2009 is 306,563 pounds (SRAFRC 2010).

The Chesapeake Bay commercial fishery is the main fishery for American eel in the United States (50 percent of yellow eel landings) with an exploitation rate (percentage of mortality associated with harvest) of silver eels estimated at less than 25 percent (DOI 2007). American eel are vulnerable to commercial harvest because it takes place before the species has had an opportunity to spawn (glass eels, elvers, yellow and silver eels all harvested). The fact that all continental life stages are subject to harvest in some portion of the species' range means that multiple year classes can be negatively affected in any given harvest year and the same year class can be negatively affected in multiple years.

The DOI found that commercial harvest affects the American eel only at a local or regional level as opposed to a population level (DOI 2007). Modeling by Weeder and Uphoff (2003) as cited in DOI (2007) found that commercial harvest has depleted the abundance of eels in the Chesapeake Bay.

3.4.3 Predation

Predation impacts American eel as eels are fed upon by piscivorous fish and by mammals throughout their life history, and in high-density situations it is apparent that there can be a significant degree of cannibalism as well (DOI 2007). Also, juveniles and adults are likely a seasonal food item for finfish, birds and mammals such as mink; however, the degree of dependence on the various eel life stages by these predators is unknown (ASMFC 2000). It can be assumed that there may be increased predation in high density situations as well; however, there is only anecdotal evidence to suggest increased predation by predators such as striped bass. As a result, the predation impact on eels below dams has not been quantified.

3.4.4 Parasites

American eels are vulnerable to parasites. One parasite in particular, the non-indigenous nematode *Anguillicola crassus*, which becomes sexually mature in the swim bladder of the eel, may impair the capacity of the eel to undertake migration to the Sargasso Sea (Palstra et al. 2007). As of 1997, 10 to 29 percent of American eels in the Chesapeake Bay were infected by *A. crassus*. In 2000, greater than 60 percent of American eels in the freshwater portions of the Hudson River were infected (DOI 2007) and the parasite was documented, with relatively high infection rates, in eels throughout New England (Aieta and Oliveira 2009).

A. crassus have the potential to significantly affect silver eels on their migration to the spawning grounds in the Sargasso Sea by consuming the eel's energy reserves. These parasites may also impair the eel's swimming capacity and adversely affect buoyancy regulation needed during the ocean migration to the Sargasso Sea (as cited in EPRI 2011). It appears that infection rates and severity of infection of *A. crassus* are higher in freshwater than in estuarine water (as cited in EPRI 2011).

3.4.5 Freshwater Habitat Loss

Freshwater habitat includes both lacustrine (lake/pond) and riverine areas. Some studies have shown that the greater the amount of lacustrine habitat within a watershed, the more the sex ratio favors females (DOI 2007). Riverine habitat utilized within the range of American eel exhibits a high variability in terms of water depth, temperature and flow. Researchers have found that the amount of habitat rather than the specific type of habitat within a river determines how many eels a river can support (DOI 2007).

Dams, particularly large dams with a nearly vertical downstream face such as Conowingo Dam, represent a barrier to the upstream migration of American eel. Although, dams reportedly reduce the available freshwater habitat over the species' entire range by approximately 25 percent, DOI (2007) concluded that "*the loss of this habitat does not threaten the species' long-term persistence*". The presence of the four dams on the lower Susquehanna River impedes access to the watershed above the dams although young eels have passed Conowingo Dam in past years via the EFL. Few eels have been recorded in the EFL since the 1990's.

The fate of eels that are unsuccessful in passing Conowingo Dam is unknown, but Drinkwater and Frank (1994) as cited in Craig (2000) suggested that catadromous species, unlike anadromous species, are more likely to move to another river if their path is blocked by a dam. Additionally, the species will use freshwater, estuarine and marine habitat to grow and mature. However, overcrowding below barrier dams may increase the likelihood that eels will become male, increase competition, increase predation, and reduce food availability (which negatively affects growth rates). One study found that densities are highest below barriers, while age, growth (in length) and the average number of females increased above barriers (ICES 2009).

Notwithstanding these general conclusions regarding the effects of barriers, an analysis by EPRI (2011) found no indication that eels recruited to the upper Chesapeake Bay are habitat limited. As illustrated in Table 3.4.5-1 from the EPRI report, EPRI analyzed data from 25 Maryland Biological Stream Survey (MBSS) sites and found that eel densities in Susquehanna River tributaries downstream of Conowingo

Dam are similar to or lower than densities elsewhere in the Chesapeake Bay watershed. Lower densities in the tributaries below Conowingo Dam suggest that these habitats may not be fully utilized.

3.4.6 Contaminants

Eels are a relatively long-lived fish species that are exposed to a wide variety of environmental contaminants through direct exposure and through ingestion of contaminated prey. The DOI (2007) assessment of American eel included a comprehensive review of potential contaminant effects. They found that yellow and silver eel tissue contained several contaminants including polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), pesticides and heavy metals (DOI 2007). They found that the contaminant concentrations were at levels that have affected other fish species, and further noted that some eels were surviving with contaminant loads at or above concentrations that would kill other fish. In summary, they found that there was a potential for contaminants to impact eels, particularly during younger life-stages.

Geeraerts and Belpaire (2009) conducted a more recent comprehensive review of contaminant effects on European eel. Given the similarity in the biology of American eel and European eel and the likelihood that American eels face similar contaminant exposure, their findings are relevant to American eel. Geeraerts and Belpaire (2009) concluded that:

> *"Eels are more vulnerable than other fish as they accumulate contaminants to a much higher degree than other species. In many fish species in Western Europe, pollution has been reported to hamper normal reproduction and larval development (endocrine disruption). Considering the high levels of contamination in eels for many areas, endocrine disruption in mature silver eels can be expected, jeopardizing normal reproduction (Belpaire 2008). Many contaminants are widespread and measured concentrations are at a level which more than likely is causing ecotoxicological effects in eel."*

3.4.7 Turbine Mortality

During outmigration through river systems with hydroelectric dams, some eels become entrained and enter hydroelectric turbines, which can result in injury or death, depending on dam size, turbine type, load, and specific opening conditions. The degree of injury and mortality increases with larger eels, suggesting that mortality rates of large female eels may be higher than mortality rates of smaller males.

Cumulative turbine mortality, which refers to the estimated combined turbine mortality within a watershed, is thought to cause significant reductions in a watershed's reproductive contribution to the eel population. This is true even when survival rates of eel passage are relatively high through each successive turbine or dam project on the river system. Downstream adult migrants would have to pass over or through some or all of the four hydroelectric dams on the Susquehanna River. A report prepared by EPRI (2011) determined the cumulative survival of eels passing downstream through the four Lower Susquehanna River's dams, based on the number and type of turbines at each dam. Eels passing only one, two, or three of the dams would have higher cumulative survival.

While the impact of turbines on the American eel might result in a decrease in local or regional abundance, it is unlikely that impacts will have a noticeable direct effect on recruitment of eels to the Susquehanna River basin. Given the panmictic nature of the species, recruitment is not directly related to the number of adults leaving a specific system in a given year. Furthermore, turbines principally affect migrants from freshwater, leaving the portion of the population that inhabits estuarine and marine waters unaffected. As a consequence, any loss of migrating adults resulting from turbine mortality would be buffered by the spawning input from eels residing in unaffected freshwater habitats and the estuarine or marine habitats throughout its wide range.

The 2007 DOI assessment in their 12-month finding on a petition to list the American eel as threatened or endangered generally agreed with this assessment and concluded:

> *"…that turbines are responsible for decreases in abundance at a local or regional scale, but turbine mortality is not a significant threat to the American eel at a population level."*

TABLE 3.4.5-1: AMERICAN EEL ABUNDANCE IN 25 MARYLAND BIOLOGICAL STREAM SURVEY SITES. SOURCE MBSS DATABASE AS CITED IN EPRI 2011.

Rank	Site ID	Basin	Avg. Width (m)	Number	Density (no./m^2)
1	STMA-113-R-2000	Lower Potomac River	2.38	174	0.975
2	LANG-204-R-2002	Chester River	3.18	189	0.792
3	LOCR-114-R-2002	Chester River	1.10	60	0.727
4	NEWP-116-R-2001	Ocean Coastal	3.47	177	0.680
5	SASS-104-R-2001	Elk River	2.70	84	0.415
6	STMA-104-R-2000	Lower Potomac River	2.58	75	0.388
7	AA-N-160-215-97	West Chesapeake Bay	4.80	128	0.356
8	CHIN-119-R-2001	Ocean Coastal	1.33	35	0.351
9	DEER-414-R-2001	Susquehanna River	21.38	557	0.347
10	OCTO-107-R-2004	Susquehanna River	0.73	19	0.347
11	LOGU-202-R-2002	Gunpowder River	3.03	78	0.343
12	BOHE-105-R-2003	Elk River	2.48	62	0.333
13	CH-S-044-303-95	Lower Potomac River	6.08	149	0.327
14	TRAN-219-R-2004	Nanticoke/Wicomico Rivers	6.70	162	0.322
15	LOGU-109-R-2002	Gunpowder River	1.45	35	0.322
16	DO-S-003-202-95	Nanticoke/Wicomico Rivers	3.13	72	0.307
17	QA-N-033-321-95	Chester River	4.43	100	0.301
18	WI-S-023-112-95	Nanticoke/Wicomico Rivers	1.98	44	0.296
19	DEER-408-R-2001	Susquehanna River	25.58	560	0.292
20	STMA-119-R-2003	Lower Potomac River	0.98	21	0.286
21	TA-N-042-104-95	Chester River	1.68	36	0.286
22	WYER-206-R-2003	Chester River	5.00	105	0.280
23	BA-P-203-215-96	Gunpowder River	3.85	79	0.274
24	WI-S-057-309-97	Pocomoke River	4.68	93	0.265
25	LANG-109-R-2002	Chester River	2.42	46	0.253

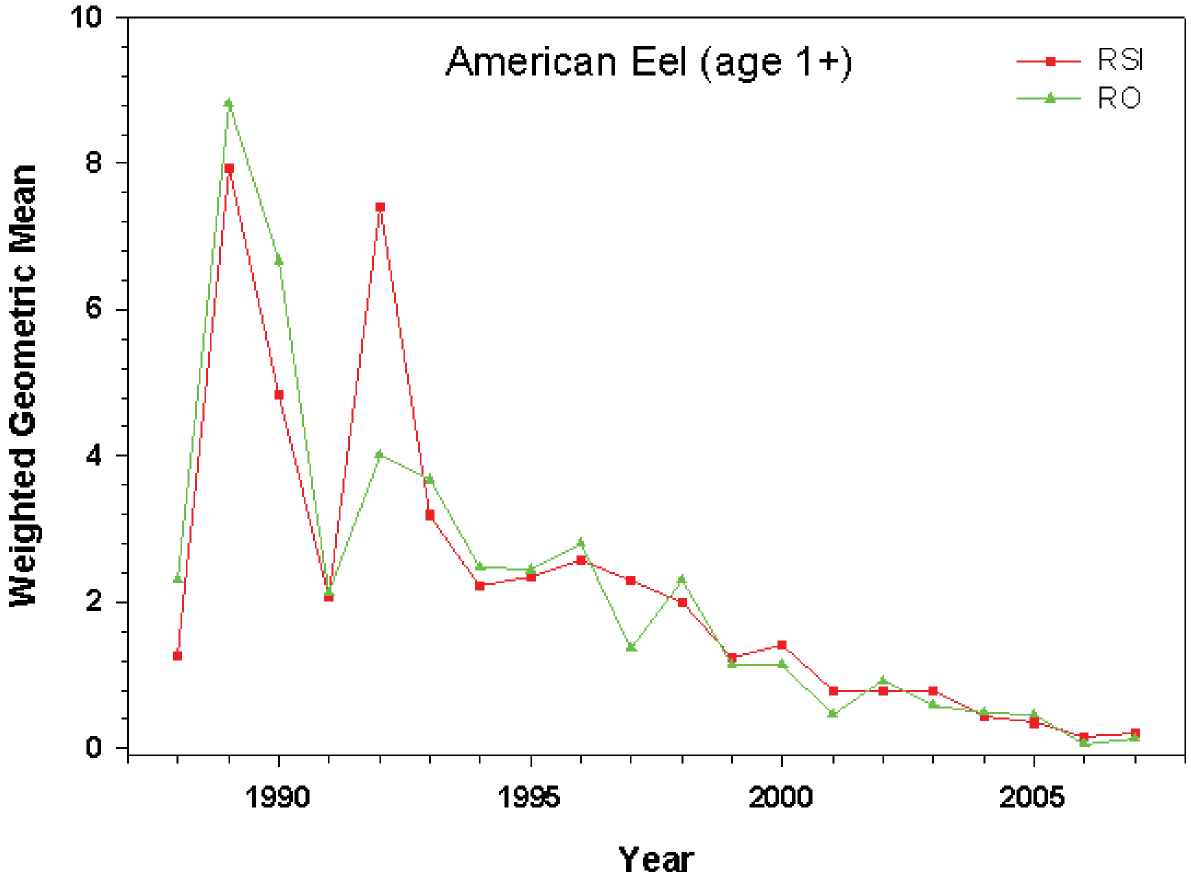


FIGURE 3.2-1: AMERICAN EEL RANDOM STRATIFIED (RSI) AND RIVERS ONLY (RO) FIXED TRANSECT INDICES USING THE WEIGHTED GEOMETRIC MEAN CATCH OF EELS PER TRAWL IN TRIBUTARIES TO THE CHESAPEAKE BAY AS PUBLISHED IN FABRIZIO AND MONTAINE (2007).

4.0 UPSTREAM EEL STUDIES

Conowingo Study 3.3 Biological and Engineering Studies of the American Eel at Conowingo Project – 2010 Eel Sampling below Conowingo Dam (Normandeau and Gomez and Sullivan 2012a, b)was developed to investigate the locations where eels congregate below Conowingo Dam with the goal of determining an appropriate location for more permanent upstream eel passage facilities.

The USFWS initiated eel studies on upstream migrant eels at the Conowingo Dam in 2005 and they continue to the present. Eels have been sampled with ramp traps and pots near the West Fish Lift (WFL). Elvers collected in the traps have been transported upstream beginning in 2007. Additionally, Exelon sponsored sampling at other locations below the Conowingo Dam in 2010, with a second sampling season in 2011.

As described below, captured eels generally fell into two size groups: 76 – 195 mm and 256 – 770 mm. Aging studies of 77 eels in 2011 showed both juvenile eels (age 1 and 2) and small yellow eels (age 3 – 5) in the smaller size range. Rather than differentiating eels in this range into the two life stages, eels in this range are described in this report as young eels. The larger size range generally corresponded to yellow eels older than age 5, and these eels are subsequently referred to in this section as yellow eels.

4.1 Results of USFWS Studies in the Conowingo Tailrace

The first two years of sampling in 2005 and 2006 collected relatively few young eels as only 42 and 19 were captured, respectively. There were 78 and 2,008 eels caught in pots for 2005 and 2006, respectively. The lengths of all eels caught in 2005 ranged from 93 to 733 mm and those caught in 2006 ranged from 83 to 735 mm. Sampling was conducted from May 18th through August 10th in 2005 and from May 10 to June 26 in 2006. In 2007, sampling occurred from May 30 through August 8 and 3,837 young eels were captured in the ramp trap. Peaks in young eel abundance occurred at the end of June and July. Lengths of young eels ranged from 76 to 169 mm. Fifty one yellow eels were collected in pots and they ranged in size from 256 to 734 mm. In 2008, substantially more young eels, 43,059, were captured than in previous years. Sampling occurred from May 13 through August 4 2008. Approximately 17,500 of the collected young eels were released into Conestoga Creek (upstream of Holtwood Dam) in Pennsylvania. Lengths of young eels ranged from 90 to 176 mm. The lengths of 38 yellow eels collected in pots ranged from 321 to 770 mm. Of the yellow eels captured, 13 were new captures and 25 were recaptures. In 2009, the number of young eels caught in the May 29 through September 2 sampling decreased to 17,437. A total of 15,316 were stocked in Conowingo Creek, PA (above Conowingo Dam). Lengths of young eels collected in the ramp trap ranged from 92 to 162 mm while the lengths of the 116 yellow eels captured in the pots ranged from 318 to 655 mm. Of the yellow eels captured, 68 were new captures and 49 were recaptures. In the May 31 through August 2, 2010 sampling, the USFWS collected 24,000 young eels with approximately 17,500 transported to Buffalo and Conowingo Creeks in Pennsylvania. The young eels ranged in size from 95 to 195 mm in length. Eel pots collected 25 yellow and silver eels ranging in size from 335 to 696 mm with 11 new captures, 9 recaptures and 5 that were not scanned for tags.

4.2 Results of 2010 Exelon Eel Studies

Conowingo Study 3.3 Biological and Engineering Studies of the American Eel at Conowingo Project – 2010 Eel Sampling below Conowingo Dam (Normandeau and Gomez and Sullivan 2012a) provides the results of an eel ramp and eel pot sampling study conducted from June 15, 2010 through September 30, 2010 to assess potential locations for upstream eel passage facilities at Conowingo Dam. One sampling ramp was placed adjacent to the dividing wall between the tailrace and EFL (EFL spillbay ramp 2010) while the other ramp was placed on the east abutment end of the spillway at Spillbay 50 (spillbay 50 ramp 2010). Figure 4.2-1 illustrates the locations of the ramps. Eel pots were fished adjacent to the ramps. Both gear types were similar in design and deployment as those used by the USFWS in their comparable study programs.

The ramps were fastened to the spillway lip and located at or near spillway drainage or overflow. The EFL spillway ramp entrance was located at a constant discharge from a spillway lip drain. The spillbay 50 2010 ramp extended toward several small spillway overflows in case these were attracting upstream migrants.

There was difference in the number of young eels caught between the two locations. The spillbay 50 ramp 2010 caught 158 young eels, while the EFL spillway ramp only captured 8 individuals. The opposite pattern was seen for the eel pots as the EFL spillbay 2010 pots caught 91 yellow eels, while the spillbay 50 2010 pots yielded only a single yellow eel.

Lengths of young eels collected at the EFL spillbay ramp were 103 to 148 mm, while those collected from the spillbay 50 ramp ranged from 92 to 154 mm. A few yellow eels were also taken at the ramps; their lengths ranged from 301 to 640 mm. The young eels were age 1 or 2, while the ages of the yellow eels were mainly 7, 8 or 9. Eels of ages 4 through 6 were not represented in the catch from either gear, which may be due to gear selectivity. The Enkamat® substrate used on the ramps is reportedly size-selective for eels less than 260 mm (Solomon and Beach 2004b), and neither the ramps nor the pots captured eels between 154 and 260 mm. The length range of eels collected in the spillbay 50 pots ranged from 115 to 650 mm and the lone yellow eel collected in the EFL spillbay pots measured 525 mm. Since neither Enkamat® nor two sizes of pots caught eels in the 155-300 mm size range, attempts were made during the 2011 field sampling season to capture the age classes not represented in the 2010 study.

The inception of the Exelon 2010 study lagged the start of the USFWS study, due to high flows delaying installation of the Exelon ramps. The Exelon traps had to be set in relatively exposed positions below the spillway and were subject to effects of high water, while the USFWS ramp sat higher on the bank and thus was not as exposed to high water conditions. The beginning portion of the upstream migration of eels may have been missed in the Exelon study, however, the majority of the eels collected at the USFWS ramp trap occurred in June and July and far fewer were collected in May, thus suggesting that little was missed. In addition to the initial delay in the Exelon 2010 upstream eel study, remnants of a tropical storm caused high river flows that resulted in the study ending in late September, slightly ahead of the planned mid-October end date.

4.3 Results of 2011 Exelon Eel Studies

Conowingo Study 3.3 Biological and Engineering Studies of the American Eel at Conowingo Project – 2011 Eel Sampling below Conowingo Dam (Normandeau and Gomez and Sullivan 2012b)provides the results of year two of an eel ramp and eel pot study below Conowingo Dam. Year two was conducted from June 23, 2011 to September 5, 2011 and was a continuation of the assessment of potential upstream eel passage locations at Conowingo Dam. In 2011, two ramps per site, each with different substrates (Figure 4.3-1) were deployed. In addition to the Enkamat® substrate utilized in 2010, a second substrate called AkwaDrain™ was placed in a separate ramp adjacent to the Enkamat® ramp.

The EFL spillway ramps 2011 were constructed and placed parallel to the wing wall near the EFL on June 23, 2011 (Figures 4.3-2 and 4.3-3), with additional water cascading down from the top of the wing wall to create disturbance and additional flow for attraction purposes. The EFL spillway ramps 2011 operated for nearly two weeks prior to the installation of the spillbay 50 ramps 2011.

The spillbay 50 sampling location used in 2010 was structurally damaged by heavy spring rainfall. Therefore, on July 1, 2011, the ramps (Figure 4.3-4) were deployed at a location adjacent to the location used in 2010. The spillbay 50 ramps 2011 were constructed on scaffolding located near the mouth of a small intermittent stream entering the Susquehanna River near the base of the dam (Figure 4.3-5). This provided natural water flow patterns that may have attracted eels to the ramp. Eel pots were fished adjacent to both sets of ramps as in the 2010 sampling.

A total of 1,159 eels were collected. Of these, 1,100 were young eels collected from the ramps. The spillbay 50 ramps 2011 collected 539 young eels, with 133 harvested in the Enkamat® substrate and 406 captured from the AkwaDrain™ substrate. The EFL spillway ramps 2011 collected 561 young eels, with 405 harvested in the Enkamat® substrate and 156 collected in the AkwaDrain™ substrate. Lengths of these eels ranged from 87 to 188 mm total length (TL), with an average size of 124.9 mm. Yellow eels harvested from the eel pots totaled 59; all yellow eels were collected from the EFL spillway pots 2011. The length range of eels collected in pots ranged from 300 to 689 mm TL, with an average length of 515.4 mm.

Hourly water temperatures were recorded throughout the study period. Water temperatures typically rose and fell three to four degrees Fahrenheit (°F) every day. The water temperature in the Conowingo spillway ranged from a low of 73.7° F on September 3 to a high of 90.8° F on July 24. A comparison of water temperatures to catch at the ramps revealed no apparent relationship.

The study period encompassed three new moon periods and two full moon periods. A possible, but weak and limited relationship between the number of eels collected and moon periods was observed during part of the study period.

In 2011, 77 eels were preserved for otolith ageing. A total of 73 of the 77 otoliths preserved were aged successfully. The majority of eels were split at age 1 or 2, and 3 to 5 years of age. A large gap in age at years 6 to 8 is apparent due to a lack of specimens in the 189 to 299 mm size range. Larger eels were aged as 9 to 17, plus one at age 19.

Nighttime surveys along the base of the spillway portion of the dam were conducted to document areas of eel congregation in the spillway. During these surveys, eels were only observed in abundance below crest gate #30. Located immediately downstream of crest gate #30 is a plateau of concrete or macadam. Young eels were observed at this location during all three nighttime surveys. Young eels were also observed, (although not in abundance) near seeps, or areas where water trickled over the spillway sill, and when water cascaded down bedrocks associated near these seeps. In these areas where young eels were observed, predatory fish such as channel catfish, and striped bass also were observed.

Although the 2011 study period was bookended by heavy rains that attributed to a late start and early finish, the overall catch of young eels was substantially higher in 2011 (1,159), than in 2010 (258) . Once the study was underway, the ramps sampled eels for 74 days as compared to 106 days in 2010. Collection of young eels and yellow eels was consistent throughout the entire study period with a few exceptions. The spillbay 50 2011 facility collected 239 young eels from a single ramp on July 11, 2011.

Predation from both land-based animals and birds was not directly observed but may have occurred at the east side. On several collection days, raccoon tracks were present in the muddy areas near the ramps. This same area exhibited an abundance of avian fecal matter and feathers littered on and around the ramp platform. The 2011 catch of young eels was much higher than the total collected in 2010.

An increase in young eel catch during the 2011 study period may be attributed to additional ramps, (four in 2011, as opposed to two in 2010), additional attraction water and the addition of scent attraction.

In contrast to 2010, both sides of the spillway captured nearly equal numbers of young eels, with the EFL spillway 2011 ramps collecting slightly more than the spillbay 50 2011 ramps. The absence of eels from ~189 to 299 mm is generally similar to previous year's collections by Normandeau Associates and USFWS. Attempts to collect this size range of eels with smaller-mesh pots (.25 inch) failed. Enkamat® is reportedly size-selective for eels less than 260 mm (Soloman and Beach 2004), but neither Enkamat® nor either type of pot deployed was successful catching eels in the 189 to 299 mm size range.

FIGURE 4.2-1 LOCATIONS OF EEL RAMPS AND POTS AT CONOWINGO DAM FOR THE 2010 AND 2011 UPSTREAM EEL SURVEYS

FIGURE 4.3-1: ENKAMAT® AND AKWADRAIN™ SUBSTRATE.

FIGURE 4.3-2: WEST SIDE ELVER RAMPS WITH ADDITIONAL ATTRACTION WATER, 2011.

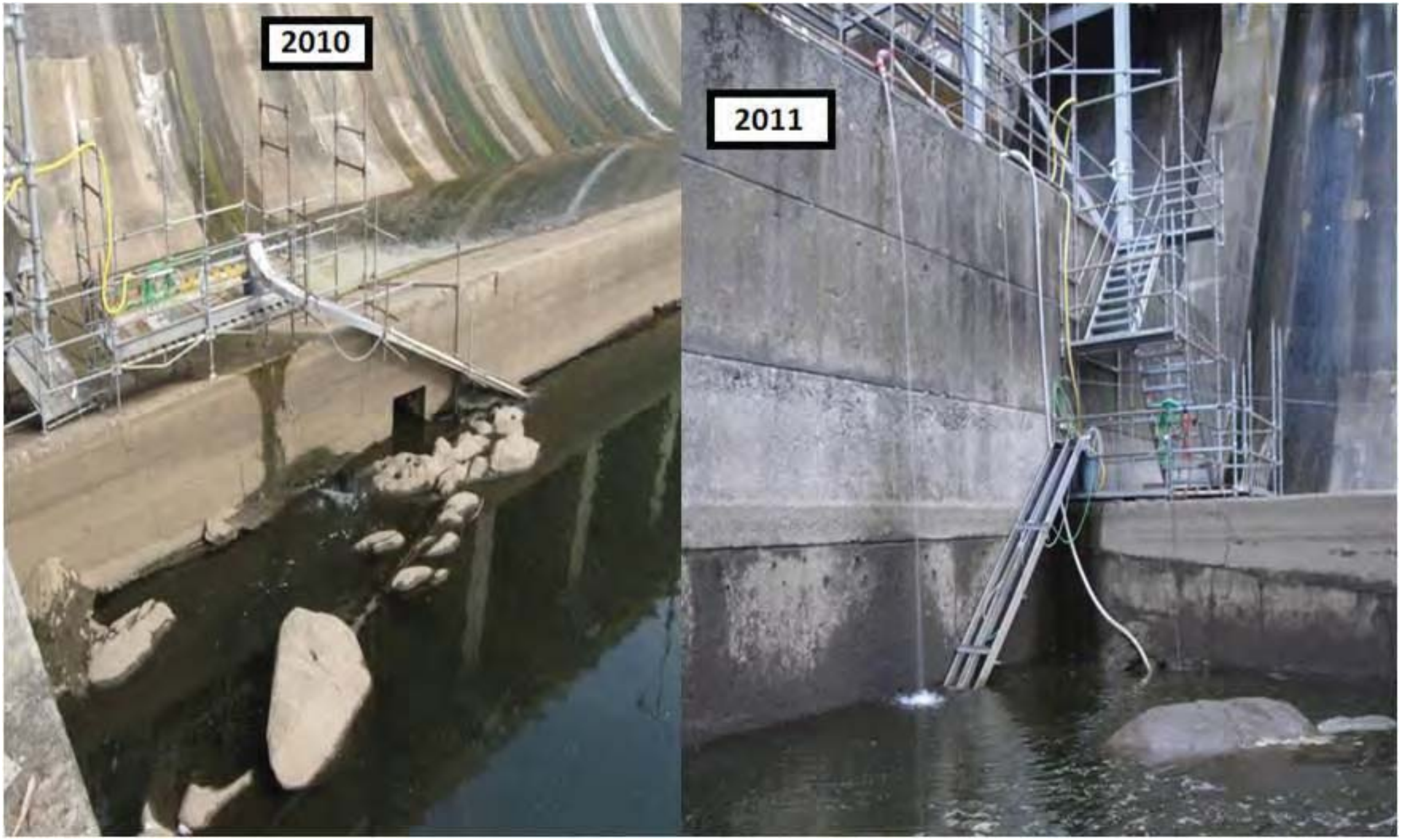


FIGURE 4.3-3: COMPARISON AND SAMPLING LOCATIONS OF 2010 AND 2011 WEST SPILLWAY RAMP LOCATION.

FIGURE 4.3-4: LOCATION AND CONFIGURATION OF EAST SIDE ELVER RAMPS IN 2010 AND 2011.

FIGURE 4.3-5: EAST RAMP WITH NATURAL ATTRACTION FLOW FROM INTERMITTENT STREAM, 2011.

5.0 UPSTREAM PASSAGE

This section of the report consists of a desktop analysis of the feasibility for potential upstream migrating eel passage facilities at the Conowingo Project. The analysis is based on engineering and biological considerations of upstream eel passage facilities at other hydroelectric projects and Conowingo specific studies on the size of the eels and the seasonality of the migration in the Susquehanna River. Preliminary cost data associated with various upstream passage facilities are also identified.

5.1 Background

Upstream eel passage for several eel species and varying sizes of eels has been successful at many hydroelectric facilities and water control dams around the world (Solomon and Beach 2004a). Eel ladders appear to be the most successful; however, eels have been passed through fish lifts (largely as incidental catch), traditional fish passes, such as Denil ladders (again largely incidental), as well as moved upstream with trap-and-transport programs.

The USFWS has studied upstream eel passage at Conowingo Dam since 2005. As stated in section 4.1, the temporary USFWS eel ramp is installed near the WFL on the west bank of the tailrace. These results will be used in conjunction with the results of Exelon’s eel sampling program, to evaluate passage options at Conowingo Dam.

Solomon and Beach (2004a) in a comprehensive review of upstream migrating eel passage facilities offered some fundamental design considerations for a passage facility. These were:

- The eels must be able to locate the passage entrance;
- The eels must be able to enter the structure without unnecessary stress;
- The eels must be able to complete passage through a facility without overexertion or too much stress (reduce fallback within the ramp);
- The eels must exit in an area to minimize entrainment through project turbines or spillage over the dam, alternatively the eels can be trapped at the top of the ramp and transported upstream (reduce drop-back after passing upstream);
- The structure must be operational under all head and tail water conditions experienced at the site during the migration period or, at the very least, for the prevailing conditions for the majority of the period;

- The structure should be protected from excessive predation;
- When possible, measures to determine passage effectiveness should be incorporated into the design of the structure; and
- Structures should be protected from high flows and debris and, if necessary, removed in the winter.

For the most part, all upstream eel passage facilities consist of the following: a climbing ramp with appropriate substrate; a thin layer of water flowing down the ramp to allow the eels to remain wetted and to provide some behavioral stimuli to encourage the eels to climb the ramp; and typically some larger volume of attraction flow to draw the eels to the entrance of the ramp. The length of the ramp, angle and the type of climbing substrate are the only things that physically differentiate most eel passage facilities.

An eel ladder is typically quite long and extends the full height of the dam. It transports the migrating eels, of their own volition, from the tailrace to the forebay. Because of the substantial height of some dams and the potential for steep climbing angles, the ramp of an eel ladder can frequently zigzag up the face of the dam, making it less steep, but also longer. Resting pools are sometimes located in the switchback locations. For a fish lift type passage facility, there typically is a relatively short climbing ramp which is used to attract, collect and deposit the eels into a transport vessel that is then mechanically lifted to the top of the dam where the eels are released into the forebay. In a trap and transport passage system, the eels are attracted via a short section of climbing ramp and are deposited into some form of holding facility. Periodically the collected eels are removed from the holding facility, transported, and then released at locations upstream of the dam.

There are advantages and disadvantages to each type of facility. In the next sections we will discuss these more thoroughly, particularly as they relate to the Conowingo Project.

5.1.1 Eel Ladders

Eel ladders for upstream passage essentially consist of five elements:

- Inclined ramp;
- Water flowing down the ramp to wet the eels and to encourage the upward climbing behavior;
- Climbing substrate that is suitable to the size of the eels;

- Attraction flow to draw the eels to the entrance of the ramp; and
- Holding tank or appropriate egress structure to gently release the eels into the forebay/upstream pond.
- There potentially is a sixth component: some form of a passage pipe or sluice to move the eels upstream of the forebay, thus minimizing possible entrainment and drop-back through project turbines.

Properly located and constructed eel ladders tend to function efficiently and effectively. Assuming the pumps and plumbing function properly; ladders can operate with minimal human intervention.

There are also disadvantages to ramps. They require a number of different pumps that can fail from overuse, clogging or power failure. One of the more significant potential disadvantages of an eel ramp at Conowingo is that the eels at this location are relatively small as the site is close to the ocean. As the majority of the eels will be small, the angle of the ramp or ramps may need to be reduced and additional resting pools added. This will increase the length of the ladder and the climbing time required to make the ascent, both of which can reduce efficiency and increase stress to the eels.

The ramp and supporting superstructure required at a Conowingo eel ladder will be large and potentially subject to damage due to high flows and ice. The structure would have to be protected from these potentially damaging events, particularly during the winter for ice and in the early spring during the freshet in order to allow continued passage of elvers and small yellow eels each year.

The angle of the ramp should be no greater than 45° and should include a cover to limit ambient light and provide overhead protection from predation (Solomon and Beach 2004a, 2004b). Table 5.1.1-1 provides a baseline slope and the associated length per 3.3 ft of head suggested for ramps associated with eel ladders. Substrate can consist of many different materials, including Enkamat, AkwaDrain, Milieu substrate, bristle/brush, or natural substances. The primary function of the substrate is to provide structure to assist climbing eels. Upstream eel passage has been monitored at the St. Lawrence-FDR power project on the St. Lawrence River for several years. Passage efficiency (the number of eels exiting the ladder divided by the number entering the ladder) was 86.7 percent during the 2010 survey period and was consistent with previous results in 2006 (83.2 percent), 2007 (84.4 percent), 2008 (88.2 percent) and 2009 (87.5 percent) (NYPA 2010). It should be noted that the St. Lawrence eels utilizing the ladder were, generally, larger (380 – 405 mm) than young eels that were taken with eel ramps in 2010 and 2011 at

Conowingo (76 – 195 MM). Table 5.1.1-2 provides information about ramps used for eel passage at other facilities with associated information about the facilities.

The widths of the eel ramps listed in Table 5.1.1-2 ranged from 1.0 to 2.3 ft. This is wide enough to accommodate most upstream eel passage needs. As a rule, wider does not necessarily mean greater passage. Most of the ramps had independent water sources and did not rely upon headwater, so water distribution within the ramp allowed the entire width to be used. Solomon and Beach (2004a, 2004b) recommend a width of 1.0 to 1.5 ft and a channel depth of 4.0 inches to pass elvers and yellow eels.

Flows for the ramps in the studies reviewed range from less than 1 to 36.2 gpm (0.002 to 0.17 cfs). Water depth measurements within the ramps were generally not made, but, depending on the slope, there was likely less than 0.2 inch water depth. It has been postulated that restricted water depth is essential for the efficient passage of small elvers (Solomon and Beach 2004a). Within the studies reviewed by Solomon and Beach (2004a, 2004b), the best passage results were obtained for ramps with water depths less than 0.8 inches for a 15° slope, 0.4 inches for a 30° slope and 0.2 inches for a 45° slope.

To minimize drop-back, a passage pipe has been used at several facilities to ensure that eels are introduced upstream at a safe distance from the turbines. Water in the pipe flows from the release location toward the ladder, and migrating eels naturally swim into the flowing water to transit the pipe There may be substrate in the pipe to reduce water velocity and to allow the eels or elvers to crawl more than swim; however, it is not required for passage. The substrate would be of similar material to a ramp. Debris fouling can be a problem, which is why pipe passes are better suited to large impoundments where settling can occur (Solomon and Beach 2004b). Pipe passes tend to require more maintenance and offer no advantages over open channel designs where the open channel is feasible, assuming the open channel can have a closed cover to minimize predation and to provide a dark environment for eel passage.

5.1.2 Lifts

Fish lifts have been used for a long time to pass fish above barriers, and they have been operating at Conowingo since 1972. Fish lifts have the ability to pass eels; however, only two lifts in France have been constructed exclusively for this purpose. Typically, a short section of climbing ramp deposits eels into a hopper that is periodically lifted by an electric winch and the fish are deposited above the barrier or into a facility that has access above the barrier. The major drawback of eel lifts is that they are expensive to construct, and have many mechanical parts that are subject to failure. They are, like eel ladders, subject to flow and ice damage. They also have the same restriction in that the eels typically are released close to the dam face where they are potentially subject to entrainment, and their use is generally restricted to high head situations (Solomon and Beach 2004b).

A number of fish lifts such as at the Holyoke Dam, in Springfield, Massachusetts pass eels; however, it is wholly coincidental with the operation of the lift for other species (e.g., American shad on the Connecticut River).

5.1.3 Trap and Transport

There are many trap-and-transport programs for elvers and small eels throughout the world. Several of the facilities described in Table 5.1.1-2 were actually "trap-pass" facilities or facilities where the eels ascend all or part way above an obstruction, exit the ramp into a holding tank or facility and are transported upstream. The USFWS currently has a trap-and-transport program below Conowingo Dam where the eels are captured near the WFL and are transported to various locations upstream.

The advantages to trap and transport are that the infrastructure requirements are less than a volitional system and essentially consist of just a short climbing ramp with appropriate flows, substrate and holding facilities. One significant advantage is that the eels can be released at numerous locations upstream, thus avoiding the likelihood of drop-back and entrainment and also potentially avoiding the need for additional passage facilities at other dams/hydro-projects upstream. As long as water quality is maintained in the collection and transport facilities, survival of elvers and yellow eels is typically very high.

Some of the disadvantages of trap and transport are that it requires manual collection of the eels and upstream transportation and the holding of eels can result in some additional stress and skin abrasion.

The upstream release location for transported eels is an important consideration. Releasing young eels into areas where their presence may impact other aquatic resources or where subsequent collection of maturing eels for downstream transport is a potential impact. Such impacts can be minimized by careful selection of the release locations in consultation with the appropriate resource agencies

5.2 Upstream Passage Options at Conowingo Project

A preliminary review of eel passage facilities on several river systems provided background and information on the practical alternatives for eel passage at Conowingo. At the St. Lawrence-FDR Power Project, with a comparable civil works configuration and operating head to Conowingo, a state-of-the-art eel passage facility was constructed in 2004 that passed eels with a mean length range of 380 to 405 mm. If an eel passage ladder is installed at Conowingo, it would likely include technologies similar to the 110-ft long eel ramp and 985-ft long upstream passage pipe at the St. Lawrence-FDR facility, although the size range of eels using the temporary ramps at Conowingo since 2005 is 76 to 195 mm with larger eels ranging from 256 to 770 mm being captured in eel pots. An additional difference in the St. Lawrence eel passage facility and any similar facility that may be constructed at the Conowingo Dam is the roadway over the Dam. Any design to move eels from the tailrace of the Dam to Conowingo Pond would need to bypass US Highway 1.

As summarized in Section 4.0, eels have been collected concurrently in 2010 and 2011 at three trial locations: the West bank of the tailrace near the WFL (USFWS), the spillway near the EFL (EFL Spillway Ramp 2010), and on the East bank below the dam (Spillbay 50 Ramp 2010). Over the course of the 2-year study, more eels were collected on the West bank followed by the East bank and the EFL.

Eel passage options were evaluated at both the East and West bank of Conowingo Dam. Based on data from 2010 and 2011, the West bank appears to be a better location because more eels were captured in this location and is summarized in Section 4.0. Three options were assessed for upstream passage facilities located on the West bank; two are presented for the East bank. They are described in more detail below.

For all potential eel ladder configurations, consideration was given to an exit location that will allow continued upstream movement with minimal drop-back. If the eels exit the ladder too close to the powerhouse, downstream currents could cause them to be entrained through the turbines, which could result in the need for a passage pipe or similar type structure to move the eels further upstream, away from the turbines.

5.2.1 West Bank Option 1, Trap and Transport

The first option presents a configuration for trap-and-transport operations, see Figure 5.2.1-1 for a plan view of the option and Figure 5.2.1-2 for an elevation view. For this option and the additional alternatives described below, the ramp entrance is designed to be at the minimum expected tailwater at El. 12 ft. As noted in Section 2.1.4, normal operating tailwater, with all units generating, is nominally El. 21.5 ft. It is not uncommon for tailwater elevations to fluctuate from El. 12.0 ft to El. 25.0 ft. The lower section of the ramp will have removable covers or grating to allow eels to enter with differing water surface elevations. For this option and all options presented subsequently, it is assumed that an attraction flow will be provided at the ramp entrance. The exact flow rate will be determined as field studies proceed. The attraction flow pumping system will also be used to provide water to wet the media of the ramp.

From the entrance, located near the downstream end of the WFL foundation, the ramp climbs to an elevation slightly above the parking lot elevation. The length of the proposed ramp is approximately 65 ft. It then exits into a collection tank housed in a small enclosed structure, which will also hold pumps, a compressor, and other necessary equipment. The proposed 45^{o} eel ramp would have a stairway running along the shore-side for personnel access, along with access platforms at the entrance and exit areas. The platform near the entrance would also be equipped with an access ramp to reach the entrance at low tailwater elevations.

The proposed eel ramp or trough for all west bank and east bank options would be approximately 3-ft wide. A sectional detail is presented on Figure 5.2.1-3. The ramp will provide two side by side 18-in wide channels for climbing media. The primary purpose for this is redundancy, having two eel ramps operating in tandem will reduce the likelihood that the system would suffer extended outages during the critical passage season. It will also allow for trials to determine the most effective media type for the size eels being observed in the system. Another consideration in this approach is that there may be different size eels using the system. The preliminary design provides for two side-by-side troughs with different media so that both various sized eels may efficiently use the same ramp.

The conceptual opinion of probable construction cost (Cost Opinion) for this alternative is presented as Table 5.2.1-1, with a total of $639,000. Also included in this table is an estimate of annual operational costs for staffing the facility and transporting eels to upstream tributaries, which was estimated as approximately $585,000 per year. The frequency of trips and duration of the passage season is uncertain at this time. For the operational costs presented, one trip per day was assumed to Buffalo Creek or a location of comparable distance from the project (300 mile round trip); this cost would be reduced with a shorter round-trip distance. The length of the season was assumed as six months. Purchase of one transport vehicle is included in the capital (non-operational) portion of the Cost Opinion. This transport vehicle would be a flat-bed pickup outfitted with a 1,500-gallon transport tank, two trash pumps and piping for water circulation, a dissolved oxygen injection system (two oxygen cylinders, a regulator, and hosing), and a temperature monitor. As mentioned above, the exact needs of the transport program are unknown. This transport vehicle was carried in the costs to include an allowance amount; the actual transport needs may differ.

5.2.2 West Bank Option 2, Eel Ladder with Pipe to West Shore

The second option for the West bank presents a configuration that would allow full volitional passage of eels from the tailrace to Conowingo Pond upstream of the dam. The plan view of this option is presented as Figure 5.2.2-1, with an elevation view shown in Figure 5.2.2-2.

The entrance to the eel ramp would be near the downstream end of the existing WFL foundation at El. 12 ft. At the base of this first section would be a personnel access platform to service the eel ramp entrance. This is proposed to be at El. 25 ft, which is the top of the WFL foundation structure. The ramp would run below the travel rail for the fish lift hopper at approximately 45° to the elevation of the existing asphalt with a stairway along the shore-side. For the options presented for the West and East banks, if there is a section of eel ramp there is generally a parallel stairway system with periodic landings and railings located immediately to one side.

At El. 46 ft, there would be a platform with a catwalk to the top of the existing retaining wall. This platform would hold a resting pool that could serve as an eel collection point if desired. It is also expected that the attraction water pumping system would be on this platform. For this and the other resting or transfer pools presented, the incoming eel ramp would exit 6-in above the water surface after an apex with short section of eel ramp without climbing media. The outgoing entrance section would begin 6-in below the water surface of the pool. This section of ramp would run at 45° towards the column of the powerhouse, to the right of the existing maintenance door. An access platform with railing would be fastened to the side of the building, at approximately El. 77.5 ft, with another resting pool. From here the eel ramp would turn to run along the powerhouse towards the West bank, climbing at approximately 35° until it reaches the headpond level and exits into the transfer pool. The total length of proposed eel ramp is approximately 180 ft.

The transfer pool would be on a platform at El. 106 ft, with a 6-in diameter insulated transfer pipe exiting the West side. The flow through the pipe will be on the order of 0.3 cfs, to provide a velocity in the pipe of approximately 1.5 fps. The transfer pipe would run at an approximately level grade towards the dam and US HWY 1. It will be necessary to bore beneath the roadway and encase the transfer pipe. The road is at approximately El. 117 ft in this location, providing suitable cover over the transport pipe proposed at El. 108 ft. The transfer pipe would end approximately 600-ft upstream of the dam (total length is approximately 835-ft) at a shoreline discharge facility, as shown on Figure 5.2.2-1 with a corresponding detail on Figure 5.2.2-3. The shoreline discharge facility will have a small structure to protect and secure the equipment, which will include the redundant pumping system for the transport pipe. This facility has the ability to deliver eels to the pond over the normal range of water surface elevations.

Within the shoreline discharge facility will be an exit pool, where the eels finish their up-current swim through the transfer pipe. The pool will have a short section of eel ramp, an apex, and then a section of trough with no climbing media into a 4-ft diameter iron pipe that will run along the slope of the river bank out into the Susquehanna River. This 4-ft pipe will have periodic 2-in diameter holes for the eels to exit the system into the river over the range of expected headpond levels. Above the pipe will be large angular stone or riprap for predator and ice/debris protection. The stone will need to be placed loosely to allow the eels to exit.

It should be noted that the portion of this option from the tailwater entrance to the resting pool at El. 46 ft could be constructed as a first phase and initially operated as a trap-and-transport facility until it is determined that the entrance is in a suitable location (enough eels are entering) and constructing the upper portion of the system to the headpond is warranted.

The Cost Opinion for this option was estimated to be $1,695,000 and is presented as Table 5.2.2-1, which presents capital cost only.

It is assumed that this and the other volitional passage alternatives would require full time oversight during the passage season. It is expected that one full time employee would be required for six months of the year (i.e. the assumed passage season), with an additional full time employee needed for the first and last month of the season. This would result in an order of magnitude cost of $200,000 annually. This does not include the additional labor and materials that will likely be necessary during the commissioning period of calibrating the equipment and facility for reliable operation, which would likely occur during the first several seasons.

5.2.3 West Bank Option 3, Partially Buried Ramp with Pipe to West Shore

The third upstream passage option evaluated for the West bank is presented as Figures 5.2.3-1 and 5.2.3-2. This alternative would provide full volitional passage over the dam and is also an approach that utilizes a ramp-to-pipe system similar to West Bank Option 2. The major difference for this alternative is that a portion of the eel ramp would be installed beneath the surface of the asphalt parking area near the administrative building. This design concept was pursued to limit interference with vehicle circulation and space needs for operations and maintenance staff.

The ramp entrance would be near the downstream end of the WFL foundation with an access platform and ramp as in the previous two options. The eel ramp would climb at approximately 20^o to the southern corner of the administration building; the majority of this section would be beneath the asphalt parking area. To provide access, a 5-ft wide trench with concrete retaining walls and floor would house the below-ground portion of the ramp covered with a grating capable of being driven over. The eel ramp would daylight to the left of the central door on the southeast side of the administration building and then enter a resting pool constructed at the asphalt grade with a water surface at approximately El. 49 ft. This pool could also be used as an eel collection point if desired. The total length of the eel ramp would be approximately 210 ft.

From the resting pool, the eel ramp climbs at 45° to the approximate headpond level along the southwest side of the administration building. It will be necessary to construct a steel support system for the eel ramp and access stairs and platforms, which could be partially integrated with the building structure. At El. 106 ft is an access platform with a transfer tank. The 6-in transfer pipe would exit this transfer tank and run approximately 785 ft to a shoreline discharge facility located upstream on the west shore of the river, in a similar location as in Option 2. The estimated costs for this alternative are presented in Table 5.2.3-1, with a total cost of $2,230,000.

As with Option 2, the portion of this option from the tailwater entrance to the resting pool at El. 46 ft could be constructed as a first phase and initially operated as a trap-and-transport facility until it is determined that the entrance is in a suitable location (enough eels are entering) and constructing the upper portion of the system to the headpond is warranted.

5.2.4 East Bank Eel Ramp

The passage options considered on the East bank include a volitional passage option that would pass eels from the tailrace to the headpond, and a trap-and-transport program that could be constructed as a first phase as described for Options 2 and 3 for the West bank.

Both of these options are presented on Figure 5.2.4-1, located at the East end of the spillway at the beginning of the non-overflow abutment section of the dam. The trap-and-transport option comprises the 35-ft long lower section of eel ramp running at 45° from the normal tailwater up to El. 38 ft, plus the resting pool at this elevation. The lower section of the ramp will have removable covers or grating to allow eels to enter with differing water surface elevations. The eel ramp would have a stairway with railing and access platform at the lower end. This part of the system could be installed as a stand-alone system prior to building the full eel ramp to the elevation of the headpond. If sufficient eels are collected, the remainder of the system could be implemented. Table 5.2.4-1 presents costs for this alternative including purchase of one transport vehicle and daily trips for stocking collected eels in upstream tributaries, including the corresponding annual operations, costs. The capital cost was estimated to be $622,000, with an annual operations cost of approximately $585,000 per year.

Constructing the entire system would provide full upstream passage from the tailrace elevation to the normal headpond level. The eel ramp would continue from the resting pool at 45° to the headpond level where it would exit into a transfer pool. The total length of proposed eel ramp is approximately 135-ft.

Eels would exit the transfer pool via a 6-in pipe cored through the dam below the expected minimum headpond elevation. The flow through the transfer pipe would be fed by the headpond and controlled by a gate. Screening or other predation control will be necessary on the upstream end of the transfer pipe. The cost for this option was estimated to be $1,125,000, as shown in Table 5.2.4-2.

TABLE 5.1.1-1 METRICS TO DETERMINE SLOPE AND LENGTH OF EEL RAMPS.

Slope	Length (ft.) for 3.3 feet of head
10°	19.0
15°	12.8
20°	9.5
30°	6.6
35°	5.6
45°	4.6

Source: Solomon and Beach 2004a, 2004b

TABLE 5.1.1-2 INFORMATION ON RAMPS ASSOCIATED WITH EEL PASSAGE FACILITIES.

Project Name	Project Location	Dam or Weir Height (ft.)	Passage Type	Substrate	Length (ft.)	Ramp Angle	Flow in Ramp (cfs)	Average Size (mm)	Eel Size (elver, small yellow)
Saunders (old ramp)	Cornwall, Ontario	82.0	Ramp	Artificial Vegetation	513.1	12°	0.08		small yellow
Saunders (new ramp)	Cornwall, Ontario		Ramp/Pipe	Eel-Ladder (Milieu)					small yellow
St. Lawrence-FDR	Massena, NY	82.0	Ramp/Pipe	Eel-Ladder	110/985	35°		380-405[1]	small yellow
Roanoke Rapids (north)	Roanoke Rapids, NC	92	Ramp	Eel-Ladder	105		0.08	170[2]	elver/small yellow
Roanoke Rapids (south)	Roanoke Rapids, NC	92	Ramp	Eel-Ladder	27		0.17	170	elver/small yellow
Fort Halifax Dam	Winslow, ME	16.1	Ramp	Enkamat®	24.3	30°	0.005		elver/small yellow
Benton Falls	Winslow, ME	24.0	Ramp	Enkamat®	52.8	39-47°	NA		elver/ small yellow
Greenville Dam	Norwich, CT	NA	Ramp	Bristle/ AkwaDrain™	52.2	27°	0.002-0.004		elver/small yellow
Westfield Dam	MA	9.8	Ramp	AkwaDrain™	NA	40°	0.01		elver/small yellow
Woronco Hydroelectric Project	MA	25	Ramp	AkwaDrain™	NA	N/A			elver/small yellow
Chambly Dam	Quebec, Canada	16.4	Ramp	Plastic	30.5	52°	0.02		small yellow
Beauharnois Dam	Quebec, Canada	78.7	Ramp	Eel-Ladder	170.0	up to 45°	0.01		small yellow
Upper Lode Weir	Tewkesbury, England	3.9	Ramp (V-shaped channel)	Coarse gravel/bristle	NA	10˚			Elver
Stanchard Pit	Tewkesbury, England	4.9	Ramp	Bristle	NA	45˚			Elver
Stanchard Pit	Tewkesbury, England	NA	Ramp	Bristle		16˚			elver
Strenshem Weir	River Avon, England	NA	Pipe	NA	6.6	40˚			elver/small yellow
Fladbury Weir	Warwickshire Avon, England	NA	Ramp	Bristle	50.2	30˚			elver
Eveshire Weir	Warwickshire Avon, England	NA	Ramp	Bristle	75.1	23˚			elver
Sunbury Lock	River Thames	NA	Ramp (channel)	Enkamat®	65.6	5.2˚			elver/small yellow
Sunbury Weir	River Thames	NA	Ramp	Bristle	38.4	10˚			elver/small yellow
Abingdon Weir	River Thames		Ramp	Bristle/baffle	5.9	9˚			elver/small yellow

Project Name	Project Location	Dam or Weir Height (ft.)	Passage Type	Substrate	Length (ft.)	Ramp Angle	Flow in Ramp (cfs)	Average Size (mm)	Eel Size (elver, small yellow)
Moulin a Pigné	Renne, France	5.3	Ramp	Bristle	NA	45°	NA		elver/small yellow
Pont-es-Omnès	St. Malo, France	11.8	Ramp	Bristle	NA	30°	NA		elver/small yellow
Chadbury Weir	Avon, England	5.0	Ramp	Bristle	30.8	9°	NA		elver/small yellow
Rophemel Dam	St. Malo, France	NA	Ramp	Bristle	NA	35°	NA		
Ville Hatte Dam	Jugon, France	45.9	Eel Lift	Bristle	16.4	35°	NA		elver/small yellow

1 = Range of mean lengths of eels collected from 2006 through 2010.

2 = Mean length of eels collected in 2010.

NA: Not Available

Table 5.2.1-1. Cost Opinion, West Eel Pass - Trap and Transport (Option 1)

Item No.	Item	Quantity	Unit	Unit Price	Cost
331	**Structures and Improvements**				
	Stairs	52	EA	$500	$26,000
	Handrail	60	LF	$150	$9,000
	Grating	80	SF	$50	$4,000
	Access Ladder	12	LF	$150	$1,800
	Concrete	22	CY	$800	$17,600
	Pre-Engineered Building (14' x 42')	588	SF	$25	$14,700
	Overhead Door	1	EA	$2,500	$2,500
	331 Subtotal*				**$76,000**
332	**Reservoirs, Dams, and Waterways**				
	Eel Ladder Tray	66	LF	$35	$2,310
	Eel Ladder Media	132	LF	$100	$13,200
	Eel Ladder Turn	2	EA	$500	$1,000
	Pipe (Attraction Flow)	150	LF	$25	$3,750
	Pump (Attraction Flow)	4	EA	$5,000	$20,000
	Compressor (Attraction Flow system)	2	EA	$2,500	$5,000
	Collection Tank	1	EA	$2,500	$2,500
	Eel Counter	2	EA	$10,000	$20,000
	PIT Tag Detector	2	EA	$10,000	$20,000
	Sheet Piling	1,000	SF	$30	$30,000
	Silt Curtain	1,000	SF	$5	$5,000
	Diversion and Care of Water	30	DAY	$1,000	$30,000
	Transport Tank (1,500 gal)	1	EA	$2,000	$2,000
	Trash Pump	2	EA	$1,500	$3,000
	Dissolved Oxygen Injection System	1	LS	$1,000	$1,000
	Temperature Monitor	1	EA	$500	$500
	332 Subtotal*				**$159,000**
334	**Accessory Electric Equipment**				
	Electrical (15% of 331 and 332)	1	LS	$35,250	$35,250
	Mechanical (10% of 331 and 332)	1	LS	$23,500	$23,500
	334 Subtotal*				**$59,000**
335	**Miscellaneous Power Plant Equipment**				
	Haul Truck	1	EA	$50,000	$50,000
	335 Subtotal*				**$50,000**

Mobilization/Demobilization (10%)*	**$34,000**
Subtotal Direct Cost	**$378,000**
Contingencies (25%)*	$95,000
Total Direct Cost	**$473,000**
Design (20%)*	$95,000
Permitting (10%)*	$47,000
Construction Administration (5%)*	$24,000
Total	**$639,000**

**Note: Rounded to nearest $1,000*

Item No.	**Item**	**Quantity**	**Unit**	**Unit Price**	**Cost**
901	**Annual Operations - Non-Labor**				
	Mileage *(assumes 300 mile round trip, per day)*	54,000	MI	$0.50	$27,000
	Fuel	18,000	GAL	$5	$90,000
	Salt (Stress Reduction)	5	TON	$500	$2,500
	Tank Refills (Oxygen)	1	LS	$1,000	$1,000
	901 Subtotal*				**$121,000**
902	**Annual Operations - Labor**				
	Eel Biologist *(assumes 7 months per year, full time)*	1,600	HR	$100	$160,000
	Eel Technician *(assumes 6 months per year, full time)*	1,440	HR	$75	$108,000
	Drivers *(assumes 6 months per year, full time)*	1,440	HR	$55	$79,200
	902 Subtotal*				**$347,000**

Subtotal Annual Operations Cost	**$468,000**
Contingencies (25%)*	$117,000
Annual Operations Total	**$585,000 /YR**

**Note: Rounded to nearest $1,000*

Table 5.2.2-1. Cost Opinion, West Eel Pass - Pipe to West Shore (Option 2)

Item No.	Item	Quantity	Unit	Unit Price	Cost
331	**Structures and Improvements**				
	Stairs	162	EA	$500	$81,000
	Handrail	210	LF	$150	$31,500
	Grating	385	SF	$50	$19,250
	Access Ladder	18	LF	$150	$2,700
	Concrete	74	CY	$800	$59,200
	3x3 Concrete	8	EA	$650	$5,200
	Base Plates & Hardware	8	EA	$50	$400
	Concrete Piers	5	EA	$1,500	$7,500
	Structural Steel	6,250	LB	$4	$25,000
	Pre-Engineered Building (18' x 10')	180	SF	$25	$4,500
	Clearing & Grading	0.33	AC	$15,000	$4,950
	Riprap	30	CY	$65	$1,950
	Fine Crushed Gravel	15	CY	$50	$750
	Access Road (12-ft wide, 12-in depth)	600	LF	$45	$27,000
	Jack & Bore Rte. 1	30	LF	$1,000	$30,000
	331 Subtotal*				**$301,000**
332	**Reservoirs, Dams, and Waterways**				
	Eel Ladder Tray	182	LF	$35	$6,370
	Eel Ladder Media	364	LF	$100	$36,400
	2" dia. Pipe (Attraction Flow)	320	LF	$25	$8,000
	Pump (Attraction Flow)	4	EA	$5,000	$20,000
	6" dia. Pipe w/Supports & Footings (Transport Flow)	835	LF	$100	$83,500
	Pump (Transport Flow)	2	EA	$7,500	$15,000
	Compressor (Attraction Flow & Transport System)	4	EA	$2,500	$10,000
	Collection/Transfer Tank	3	EA	$2,500	$7,500
	4-ft dia. Pipe, Ductile Iron	50	LF	$500	$25,000
	Screen	30	SF	$50	$1,500
	Eel Counter	4	EA	$10,000	$40,000
	PIT Tag Detector	4	EA	$10,000	$40,000
	Sheet Piling	2,300	SF	$30	$69,000
	Silt Curtain	2,300	SF	$5	$11,500
	Diversion and Care of Water	90	DAY	$1,000	$90,000
	332 Subtotal*				**$464,000**
334	**Accessory Electric Equipment**				
	Electrical (15% of 331 and 332)	1	LS	$114,750	$114,750
	Mechanical (10% of 331 and 332)	1	LS	$76,500	$76,500
	Electric Service	600	LF	$50	$30,000
	334 Subtotal*				**$221,000**

Mobilization/Demobilization (10%)*	**$99,000**
Subtotal Direct Cost	**$1,085,000**
Contingencies (25%)*	$271,000
Total Direct Cost	**$1,356,000**
Design (15%)*	$203,000
Permitting (5%)*	$68,000
Construction Administration (5%)*	$68,000
Total	**$1,695,000**

**Note: Rounded to nearest $1,000*

Table 5.2.3-1. Cost Opinion, West Eel Pass - Buried Trench, Pipe to West Shore (Option 3)

Item No.	Item	Quantity	Unit	Unit Price	Cost
331	**Structures and Improvements**				
	Stairs	172	EA	$500	$86,000
	Handrail	145	LF	$150	$21,750
	Grating	215	SF	$50	$10,750
	Access Ladder	12	LF	$150	$1,800
	Concrete	64	CY	$800	$51,200
	Structural Steel	20,000	LB	$4	$80,000
	Pre-Engineered Building (18' x 10')	180	SF	$25	$4,500
	Clearing & Grading	0.33	AC	$15,000	$4,950
	Riprap	30	CY	$65	$1,950
	Fine Crushed Gravel	15	CY	$50	$750
	Access Road (12-ft wide, 12-in depth)	600	LF	$45	$27,000
	Jack & Bore Rte. 1	30	LF	$1,000	$30,000
	Retaining Walls (Trench)	55	CY	$800	$44,000
	Trench H20 Grating	325	SF	$140	$45,500
	Excavate & Backfill Trench	750	CY	$100	$75,000
	Shoring	1,700	SF	$50	$85,000
	Demo & Reset Asphalt	1,500	SF	$20	$30,000
	Demo & Reset Sidewalk/Curb	400	SF	$30	$12,000
	Fencing/Bollards	1	LS	$10,000	$10,000
	331 Subtotal*				**$622,000**
332	**Reservoirs, Dams, and Waterways**				
	Eel Ladder Tray	212	LF	$35	$7,420
	Eel Ladder Media	424	LF	$100	$42,400
	2" dia. Pipe (Attraction Flow)	424	LF	$25	$10,600
	Pump (Attraction Flow)	4	EA	$5,000	$20,000
	6" dia. Pipe w/Supports & Footings (Transport Flow)	785	LF	$100	$78,500
	Pump (Transport Flow)	2	EA	$7,500	$15,000
	Compressor (Attraction Flow & Transport System)	4	EA	$2,500	$10,000
	Collection/Transfer Tank	2	EA	$2,500	$5,000
	4-ft dia. Pipe, Ductile Iron	50	LF	$500	$25,000
	Screen	30	SF	$50	$1,500
	Eel Counter	4	EA	$10,000	$40,000
	PIT Tag Detector	4	EA	$10,000	$40,000
	Sheet Piling	1,500	SF	$30	$45,000
	Silt Curtain	1,500	SF	$5	$7,500
	Diversion and Care of Water	60	DAY	$1,000	$60,000
	332 Subtotal*				**$408,000**
334	**Accessory Electric Equipment**				
	Electrical (15% of 331 and 332)	1	LS	$154,500	$154,500
	Mechanical (10% of 331 and 332)	1	LS	$103,000	$103,000
	Electric Service	600	LF	$50	$30,000
	334 Subtotal*				**$288,000**

Mobilization/Demobilization (10%)*	**$132,000**
Subtotal Direct Cost	**$1,450,000**
Contingencies (25%)*	$363,000
Total Direct Cost	**$1,813,000**
Design (15%)*	$272,000
Permitting (5%)*	$91,000
Construction Administration (3%)*	$54,000
Total	**$2,230,000**

**Note: Rounded to nearest $1,000*

Table 5.2.4-1. Cost Opinion, East Eel Pass - Trap and Transport (Option 1)

Item No.	Item	Quantity	Unit	Unit Price	Cost
331	**Structures and Improvements**				
	Stairs	36	EA	$500	$18,000
	Handrail	25	LF	$150	$3,750
	Grating	25	SF	$50	$1,250
	Access Ladder	12	LF	$150	$1,800
	Concrete	16	CY	$800	$12,800
	Base Plates & Hardware	16	EA	$50	$800
	Structural Steel	1,500	LB	$4	$6,000
	331 Subtotal*				**$44,000**
332	**Reservoirs, Dams, and Waterways**				
	Eel Ladder Tray	35	LF	$35	$1,225
	Eel Ladder Media	70	LF	$100	$7,000
	Pipe (Attraction Flow)	70	LF	$25	$1,750
	Pump (Attraction Flow)	4	EA	$5,000	$20,000
	Compressor (Attraction Flow system)	2	EA	$2,500	$5,000
	Collection Tank	1	EA	$2,500	$2,500
	Eel Counter	2	EA	$10,000	$20,000
	PIT Tag Detector	2	EA	$10,000	$20,000
	Sheet Piling	2,000	SF	$30	$60,000
	Silt Curtain	2,000	SF	$5	$10,000
	Diversion and Care of Water	30	DAY	$1,000	$30,000
	Transport Tank (1,500 gal)	1	EA	$2,000	$2,000
	Trash Pump	2	EA	$1,500	$3,000
	Dissolved Oxygen Injection System	1	LS	$1,000	$1,000
	Temperature Monitor	1	EA	$500	$500
	332 Subtotal*				**$184,000**
334	**Accessory Electric Equipment**				
	Electrical (15% of 331 and 332)	1	LS	$34,200	$34,200
	Mechanical (10% of 331 and 332)	1	LS	$22,800	$22,800
	334 Subtotal*				**$57,000**
335	**Miscellaneous Power Plant Equipment**				
	Haul Truck	1	EA	$50,000	$50,000
	335 Subtotal*				**$50,000**

Mobilization/Demobilization (10%)*	**$34,000**
Subtotal Direct Cost	**$369,000**
Contingencies (25%)*	$92,000
Total Direct Cost	**$461,000**
Design (20%)*	$92,000
Permitting (10%)*	$46,000
Construction Administration (5%)*	$23,000
Total	**$622,000**

**Note: Rounded to nearest $1,000*

Item No.	**Item**	**Quantity**	**Unit**	**Unit Price**	**Cost**
901	**Annual Operations - Non-Labor**				
	Mileage *(assumes 300 mile round trip, per day)*	54,000	MI	$0.50	$27,000
	Fuel	18,000	GAL	$5	$90,000
	Salt (Stress Reduction)	5	TON	$500	$2,500
	Tank Refills (Oxygen)	1	LS	$1,000	$1,000
	901 Subtotal*				**$121,000**
902	**Annual Operations - Labor**				
	Eel Biologist *(assumes 7 months per year, full time)*	1,600	HR	$100	$160,000
	Eel Technician *(assumes 6 months per year, full time)*	1,440	HR	$75	$108,000
	Drivers *(assumes 6 months per year, full time)*	1,440	HR	$55	$79,200
	902 Subtotal*				**$347,000**

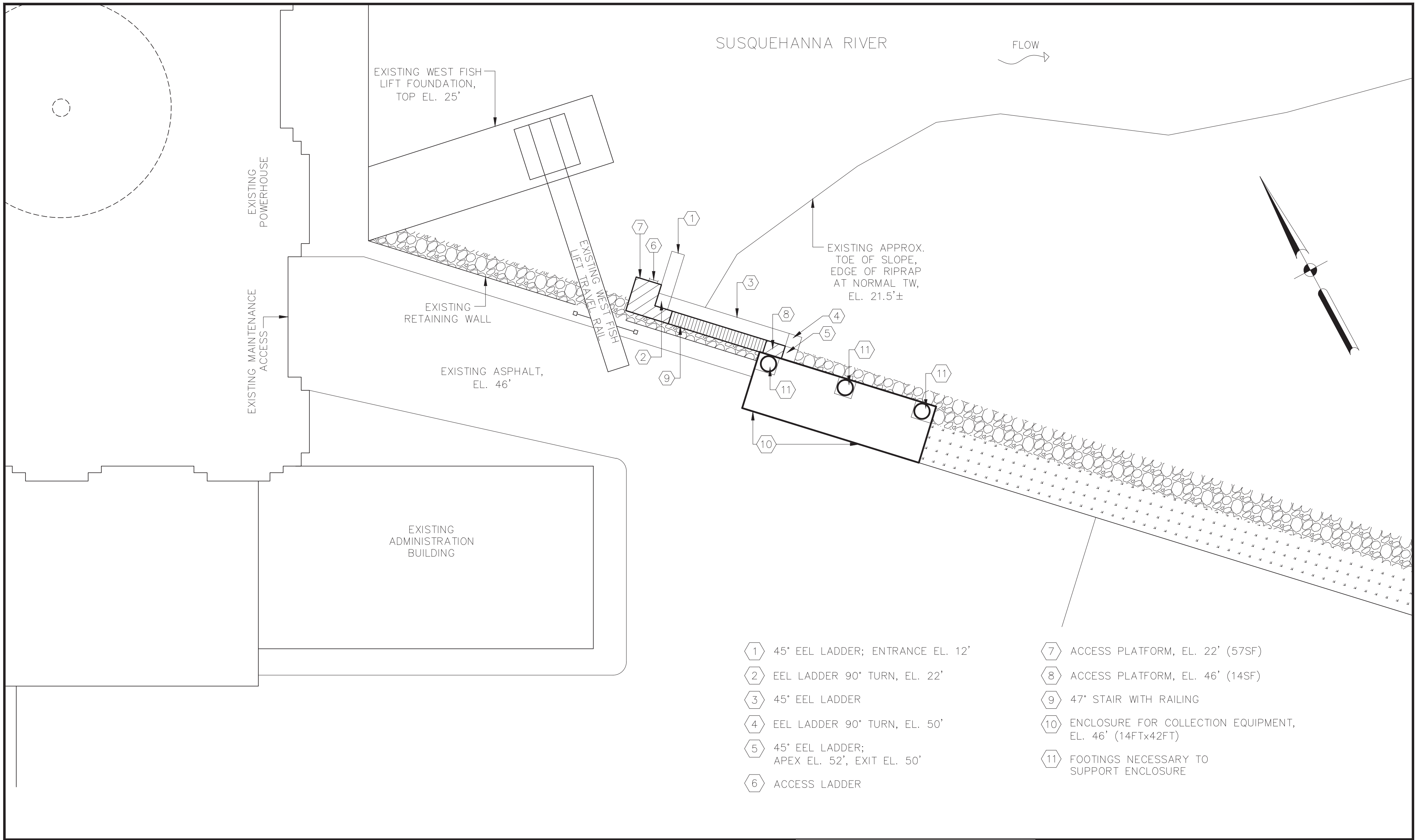
Subtotal Annual Operations Cost	**$468,000**
Contingencies (25%)*	$117,000
Annual Operations Total	**$585,000 /YR**

**Note: Rounded to nearest $1,000*

Table 5.2.4-2. Cost Opinion, East Eel Pass to Conowingo Pond (Option 2)

Item No.	Item	Quantity	Unit	Unit Price	Cost
331	**Structures and Improvements**				
	Stairs	172	EA	$500	$86,000
	Handrail	214	LF	$150	$32,100
	Grating	205	SF	$50	$10,250
	Access Ladder	12	LF	$150	$1,800
	Concrete	16	CY	$800	$12,800
	Base Plates & Hardware	16	EA	$50	$800
	Structural Steel	16,500	LB	$4	$66,000
	331 Subtotal*				**$210,000**
332	**Reservoirs, Dams, and Waterways**				
	Eel Ladder Tray	135	LF	$35	$4,725
	Eel Ladder Media	270	LF	$100	$27,000
	Pipe (Attraction Flow)	270	LF	$25	$6,750
	Pump (Attraction Flow)	4	EA	$5,000	$20,000
	Compressor (Attraction Flow and Transport Pipe)	4	EA	$2,500	$10,000
	Collection/Transfer Tank	2	EA	$2,500	$5,000
	6" dia. Pipe (Transport Flow)	10	LF	$100	$1,000
	Core Through Dam	10	LF	$2,000	$20,000
	Eel Counter	4	EA	$10,000	$40,000
	PIT Tag Detector	4	EA	$10,000	$40,000
	Sheet Piling	2,000	SF	$30	$60,000
	Silt Curtain	2,000	SF	$5	$10,000
	Diversion and Care of Water	30	DAY	$1,000	$30,000
	332 Subtotal*				**$274,000**
334	**Accessory Electric Equipment**				
	Electrical (15% of 331 and 332)	1	LS	$72,600	$72,600
	Mechanical (10% of 331 and 332)	1	LS	$48,400	$48,400
	334 Subtotal*				**$121,000**

Mobilization/Demobilization (10%)*	**$61,000**
Subtotal Direct Cost	**$666,000**
Contingencies (25%)*	$167,000
Total Direct Cost	**$833,000**
Design (20%)*	$167,000
Permitting (10%)*	$83,000
Construction Administration (5%)*	$42,000
Total	**$1,125,000**



⟨1⟩ 45° EEL LADDER; ENTRANCE EL. 12'
⟨2⟩ EEL LADDER 90° TURN, EL. 22'
⟨3⟩ 45° EEL LADDER
⟨4⟩ EEL LADDER 90° TURN, EL. 50'
⟨5⟩ 45° EEL LADDER; APEX EL. 52', EXIT EL. 50'
⟨6⟩ ACCESS LADDER
⟨7⟩ ACCESS PLATFORM, EL. 22' (57SF)
⟨8⟩ ACCESS PLATFORM, EL. 46' (14SF)
⟨9⟩ 47° STAIR WITH RAILING
⟨10⟩ ENCLOSURE FOR COLLECTION EQUIPMENT, EL. 46' (14FTx42FT)
⟨11⟩ FOOTINGS NECESSARY TO SUPPORT ENCLOSURE

NO.	DATE	ISSUED FOR	BY

DESIGNED
DRAWN
CHECKED
SECT.CHIEF
PROJ.ENGR.

10' 0 10' 20'
SCALE: 1" = 20'

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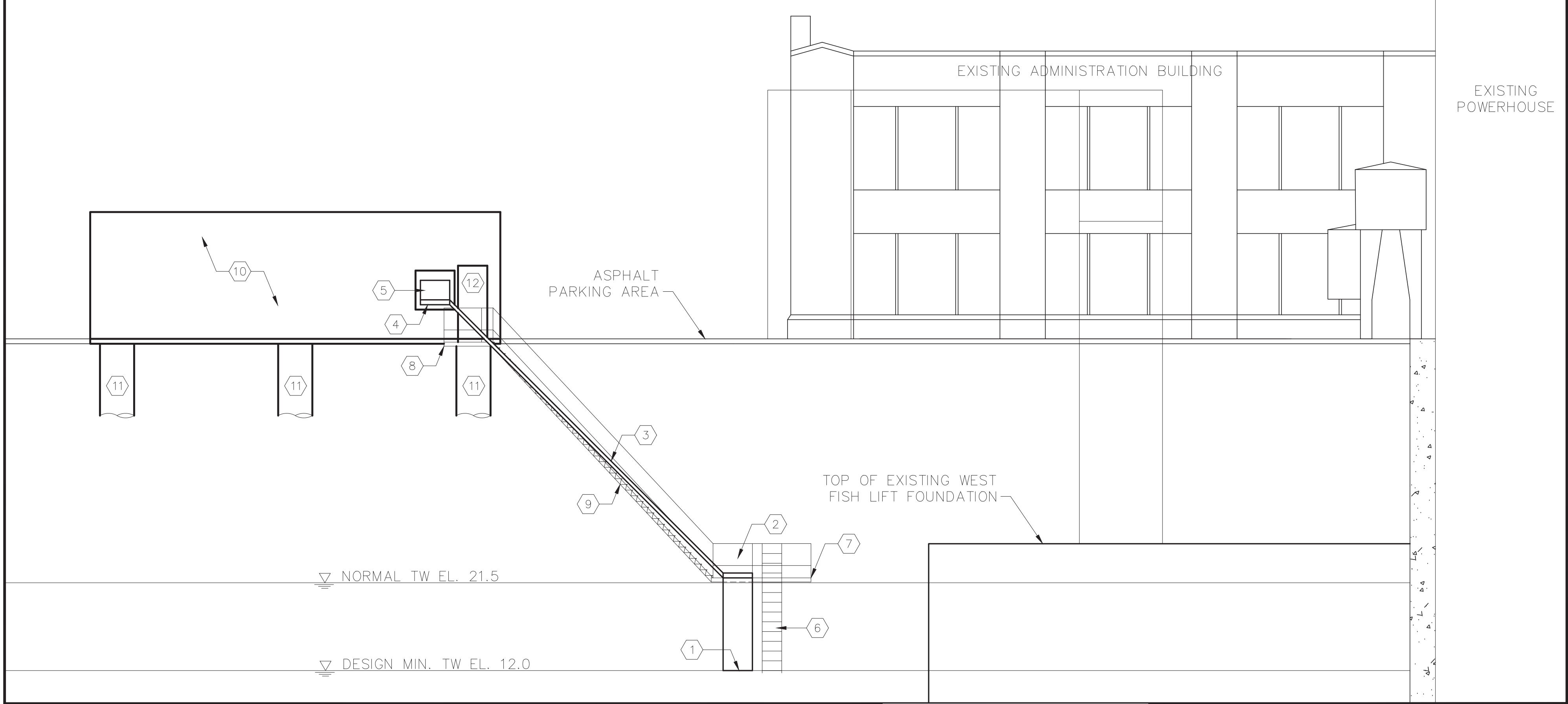
CONOWINGO RELICENSING
UPSTREAM ALTERNATIVES
WEST BANK, OPTION 1
TRAP AND TRANSPORT – PLAN

DATE AUGUST 2012
FIGURE NO: 5.2.1-1

⟨1⟩ 45° EEL LADDER; ENTRANCE EL. 12'
⟨2⟩ EEL LADDER 90° TURN, EL. 22'
⟨3⟩ 45° EEL LADDER
⟨4⟩ EEL LADDER 90° TURN, EL. 50'
⟨5⟩ 45° EEL LADDER; APEX EL. 52', EXIT EL. 50'
⟨6⟩ ACCESS LADDER
⟨7⟩ ACCESS PLATFORM, EL. 22' (57SF)
⟨8⟩ ACCESS PLATFORM, EL. 46' (14SF)
⟨9⟩ 47° STAIR WITH RAILING
⟨10⟩ ENCLOSURE FOR COLLECTION EQUIPMENT, EL. 46' (14FTx42FT)
⟨11⟩ FOOTINGS NECESSARY TO SUPPORT ENCLOSURE
⟨12⟩ DOOR



NO.	DATE	ISSUED FOR	BY

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DRAWN
CHECKED
SECT.CHIEF
PROJ.ENGR.

5' 0 5' 10'
SCALE: 1" = 10'

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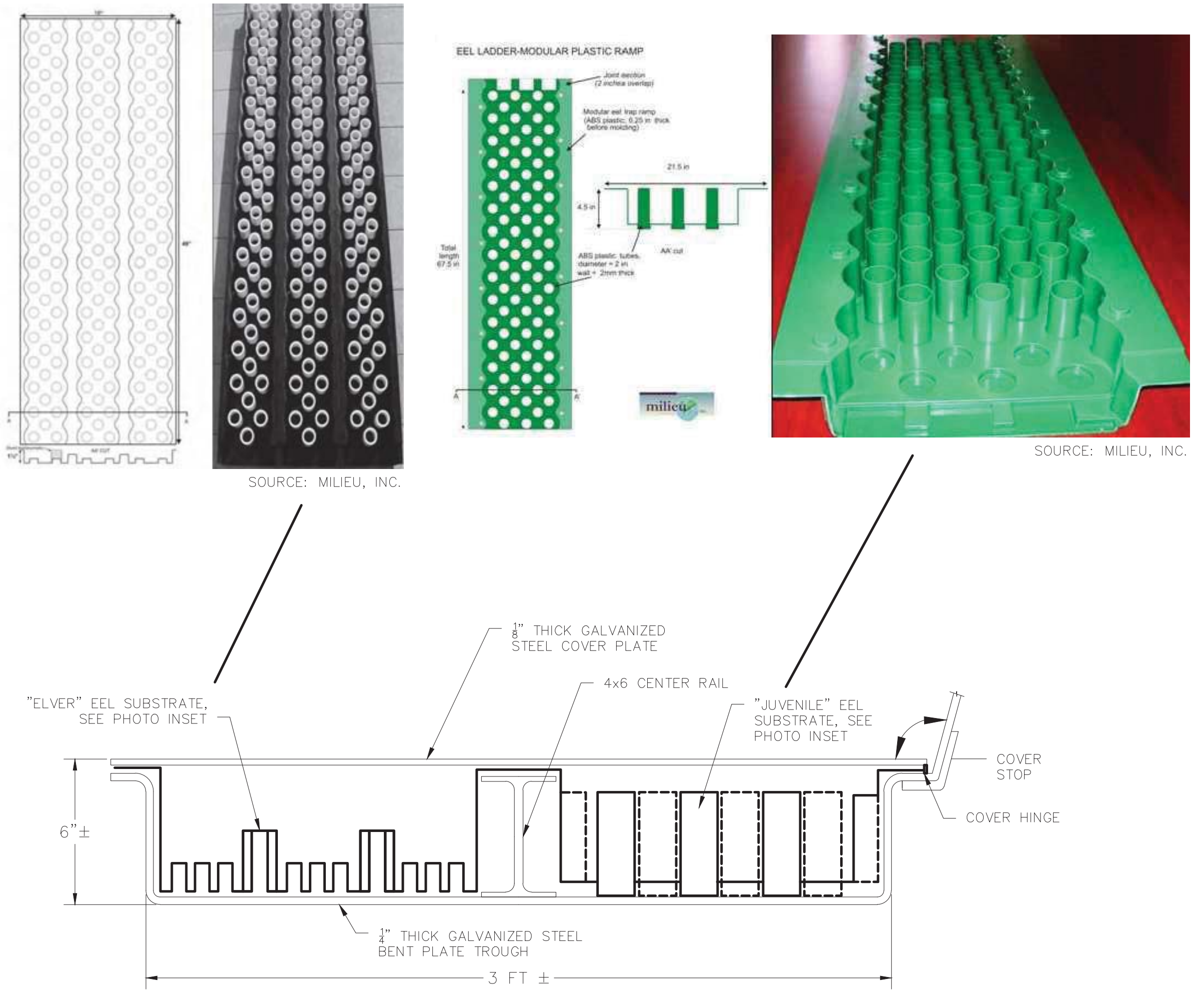
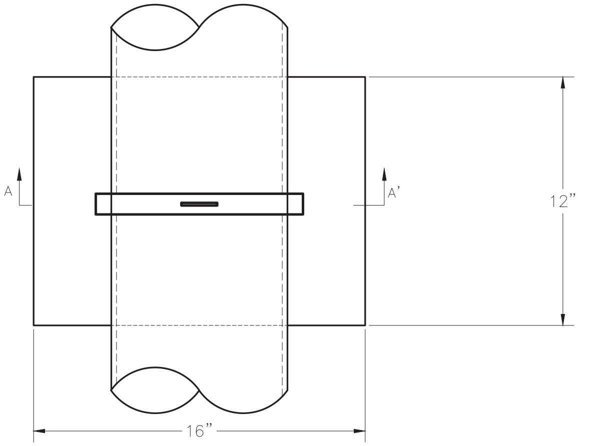
CONOWINGO RELICENSING
UPSTREAM ALTERNATIVES
WEST BANK, OPTION 1
TRAP AND TRANSPORT – ELEVATION

DATE AUGUST 2012
FIGURE NO: 5.2.1-2



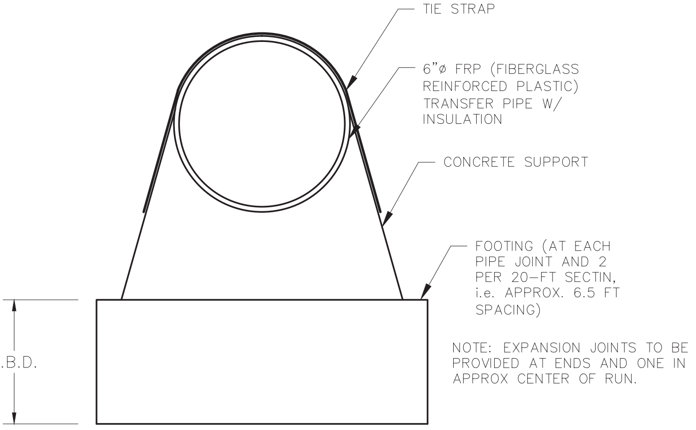
1 (4.2.1–3) EEL LADDER SECTION (TYPICAL)

Scale: 1" = 6"



2 (4.2.1–3) TRANSPORT PIPE PLAN

Scale: 1" = 6"



NOTE: EXPANSION JOINTS TO BE PROVIDED AT ENDS AND ONE IN APPROX CENTER OF RUN.

3 (4.2.1–3) TRANSPORT PIPE SECTION A–A'

Scale: 1" = 6"

NO.	DATE	ISSUED FOR	BY

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DRAWN ______
CHECKED ______
SECT.CHIEF ______
PROJ.ENGR. ______

3" 0 3" 6"
SCALE: 1" = 6"

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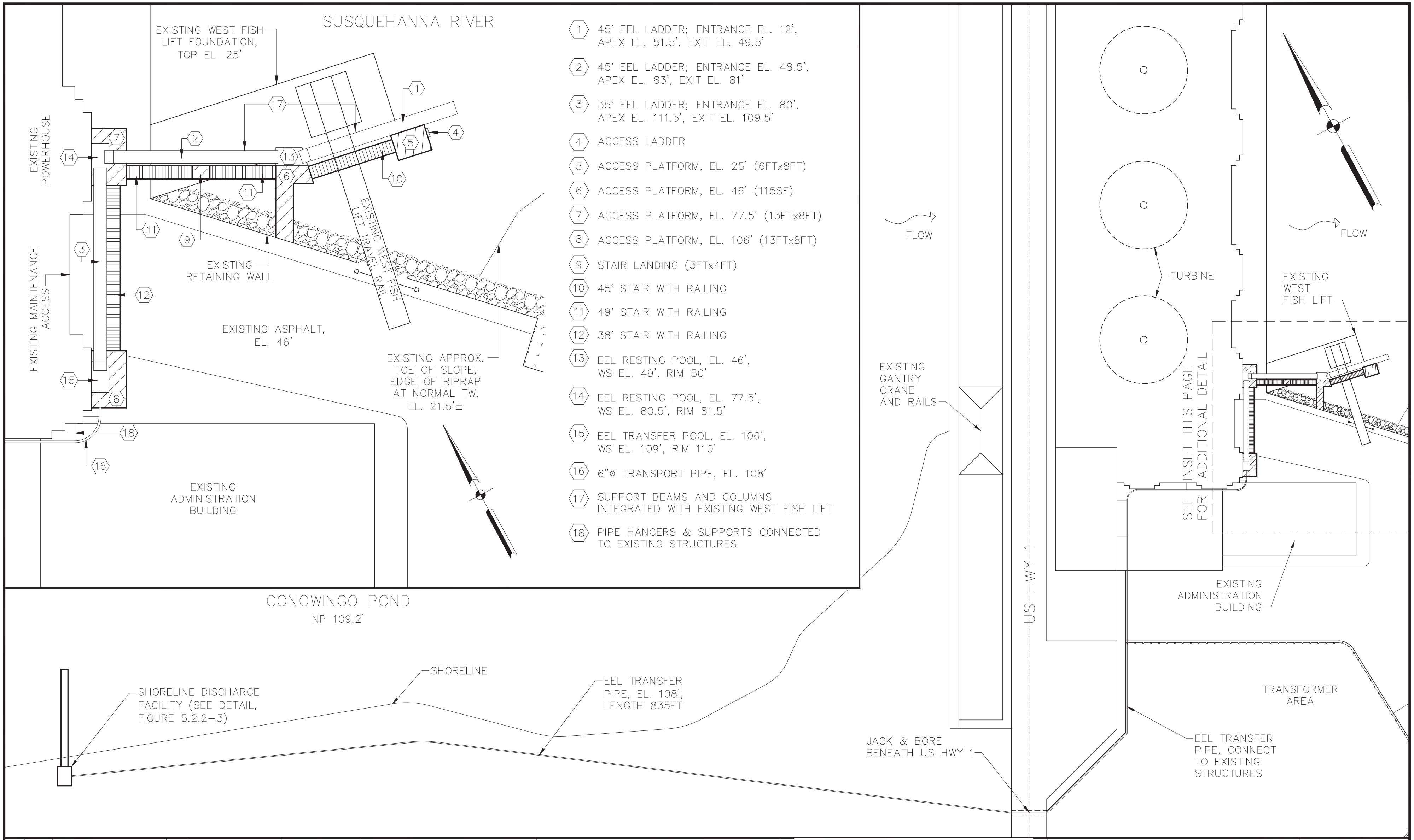
CONOWINGO RELICENSING

EEL PASSAGE DETAILS,
1 OF 2

DATE AUGUST 2012

FIGURE NO: 5.2.1–3



NO.	DATE	ISSUED FOR	BY

DESIGNED
DRAWN
CHECKED
SECT.CHIEF
PROJ.ENGR.

25' 0 25' 50'
SCALE: 1" = 50'
10' 0 10' 20'
SCALE: 1" = 20' (INSET)

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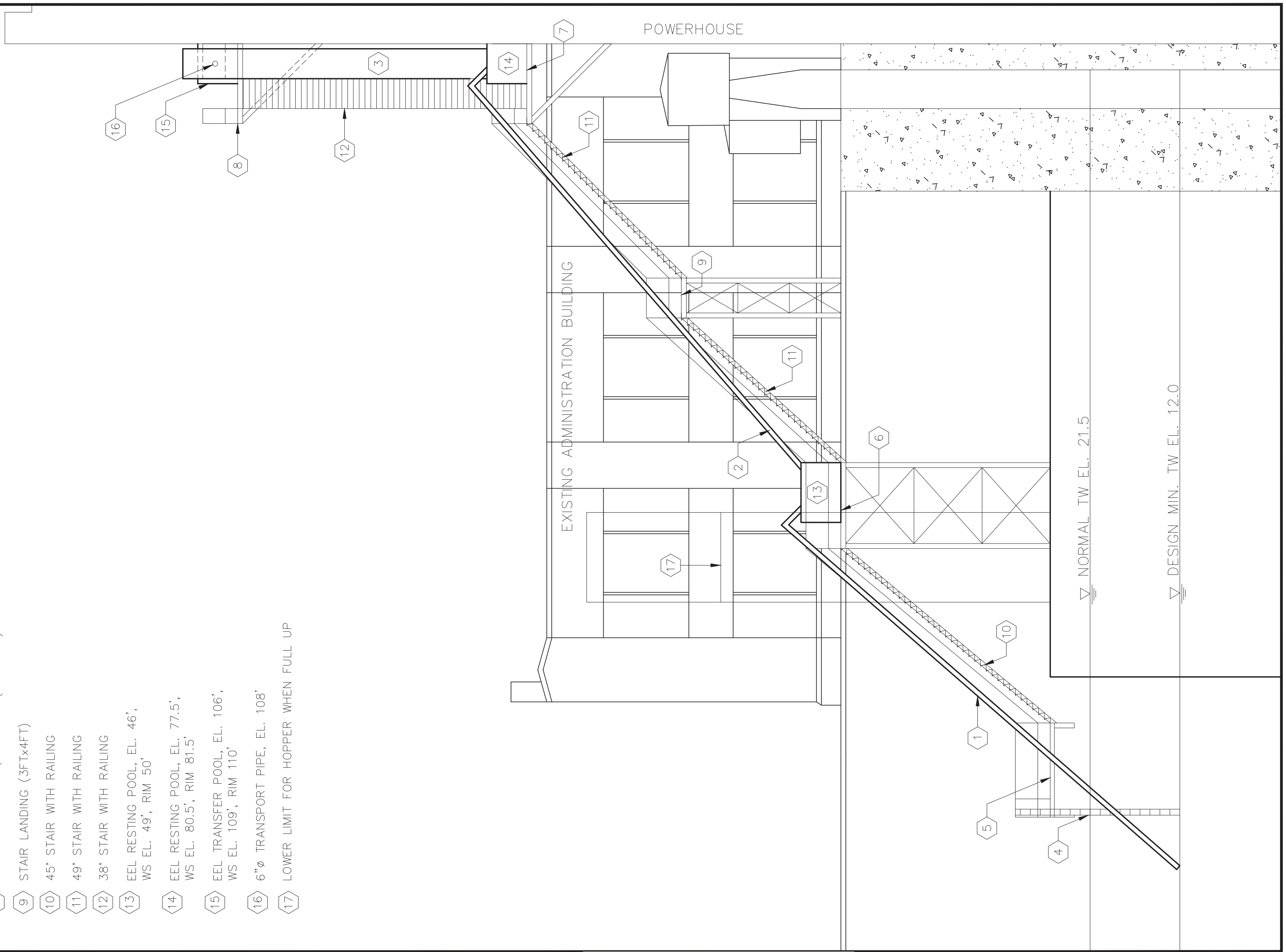
CONOWINGO RELICENSING
UPSTREAM ALTERNATIVES
WEST BANK, OPTION 2
EEL LADDER, PIPE TO WEST SHORE – PLAN

DATE AUGUST 2012
FIGURE NO: 5.2.2-1



1. 45° EEL LADDER; ENTRANCE EL. 12',
   APEX EL. 51.5', EXIT EL. 49.5'
2. 45° EEL LADDER; ENTRANCE EL. 48.5',
   APEX EL. 83', EXIT EL. 81'
3. 35° EEL LADDER; ENTRANCE EL. 80',
   APEX EL. 111.5', EXIT EL. 109.5'
4. ACCESS LADDER
5. ACCESS PLATFORM, EL. 25' (6FTx8FT)
6. ACCESS PLATFORM, EL. 46' (115SF)
7. ACCESS PLATFORM, EL. 77.5' (13FTx8FT)
8. ACCESS PLATFORM, EL. 106' (13FTx8FT)
9. STAIR LANDING (3FTx4FT)
10. 45° STAIR WITH RAILING
11. 49° STAIR WITH RAILING
12. 38° STAIR WITH RAILING
13. EEL RESTING POOL, EL. 46',
    WS EL. 49', RIM 50'
14. EEL RESTING POOL, EL. 77.5',
    WS EL. 80.5', RIM 81.5'
15. EEL TRANSFER POOL, EL. 106',
    WS EL. 109', RIM 110'
16. 6"ø TRANSPORT PIPE, EL. 108'
17. LOWER LIMIT FOR HOPPER WHEN FULL UP

NO.	DATE	ISSUED FOR	BY

DESIGNED ______
DRAWN ______
CHECKED ______
SECT.CHIEF ______
PROJ.ENGR. ______

5' 0 5' 10'
SCALE: 1" = 10'

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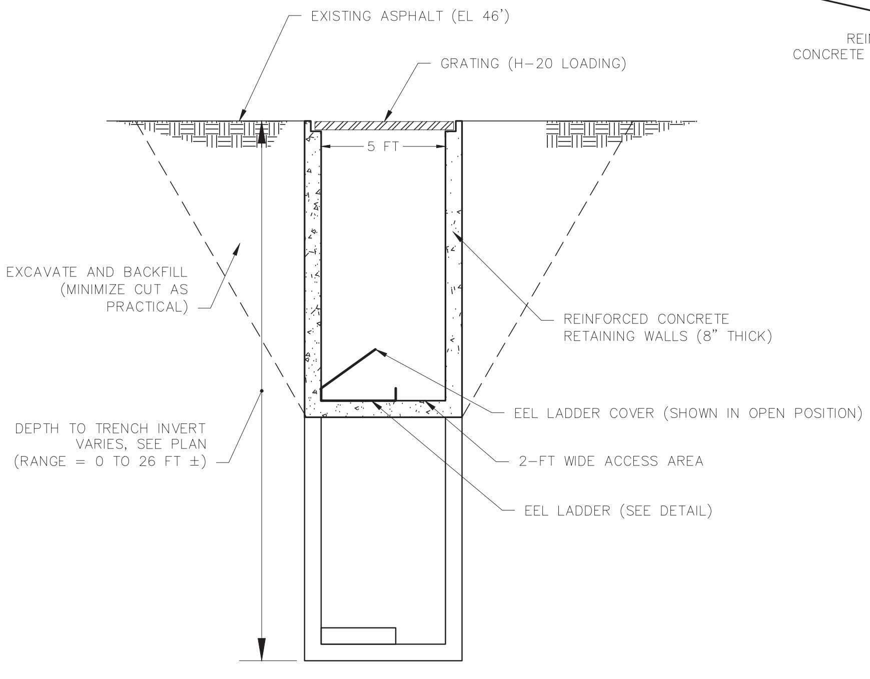
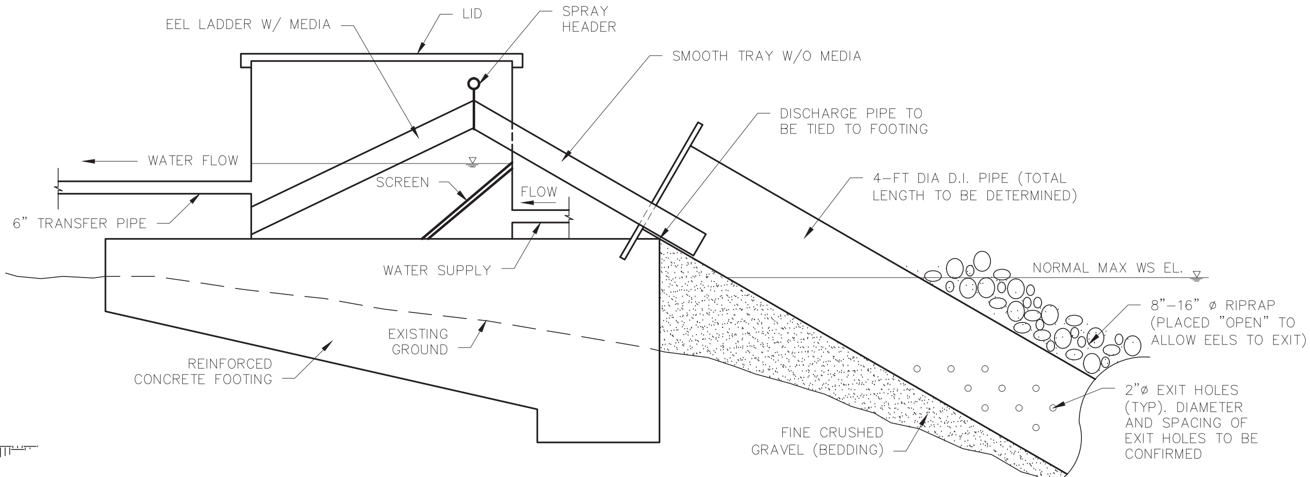
CONOWINGO RELICENSING
UPSTREAM ALTERNATIVES
WEST BANK, OPTION 2
EEL LADDER,
PIPE TO WEST SHORE – ELEVATION

DATE AUGUST 2012
FIGURE NO: 5.2.2-2



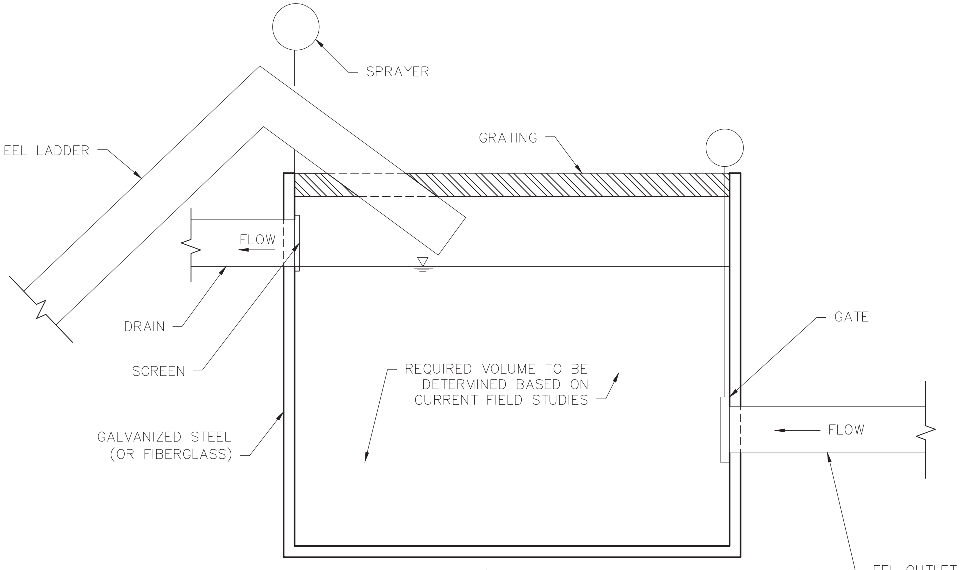
① 4.2.2-3 BURIED EEL LADDER SECTION (TYPICAL)

Scale: 1" = 5'



② 4.2.2-3 SHORELINE DISCHARGE FACILITY PROFILE

Scale: NOT TO SCALE



③ 4.2.2-3 EEL TRANSFER TANK (PIPE THROUGH DAM)

Scale: NOT TO SCALE

NO.	DATE	ISSUED FOR	BY

DESIGNED
DRAWN
CHECKED
SECT.CHIEF
PROJ.ENGR.

SCALE: AS SHOWN
2.5' 0 2.5' 5'
SCALE: 1" = 5'

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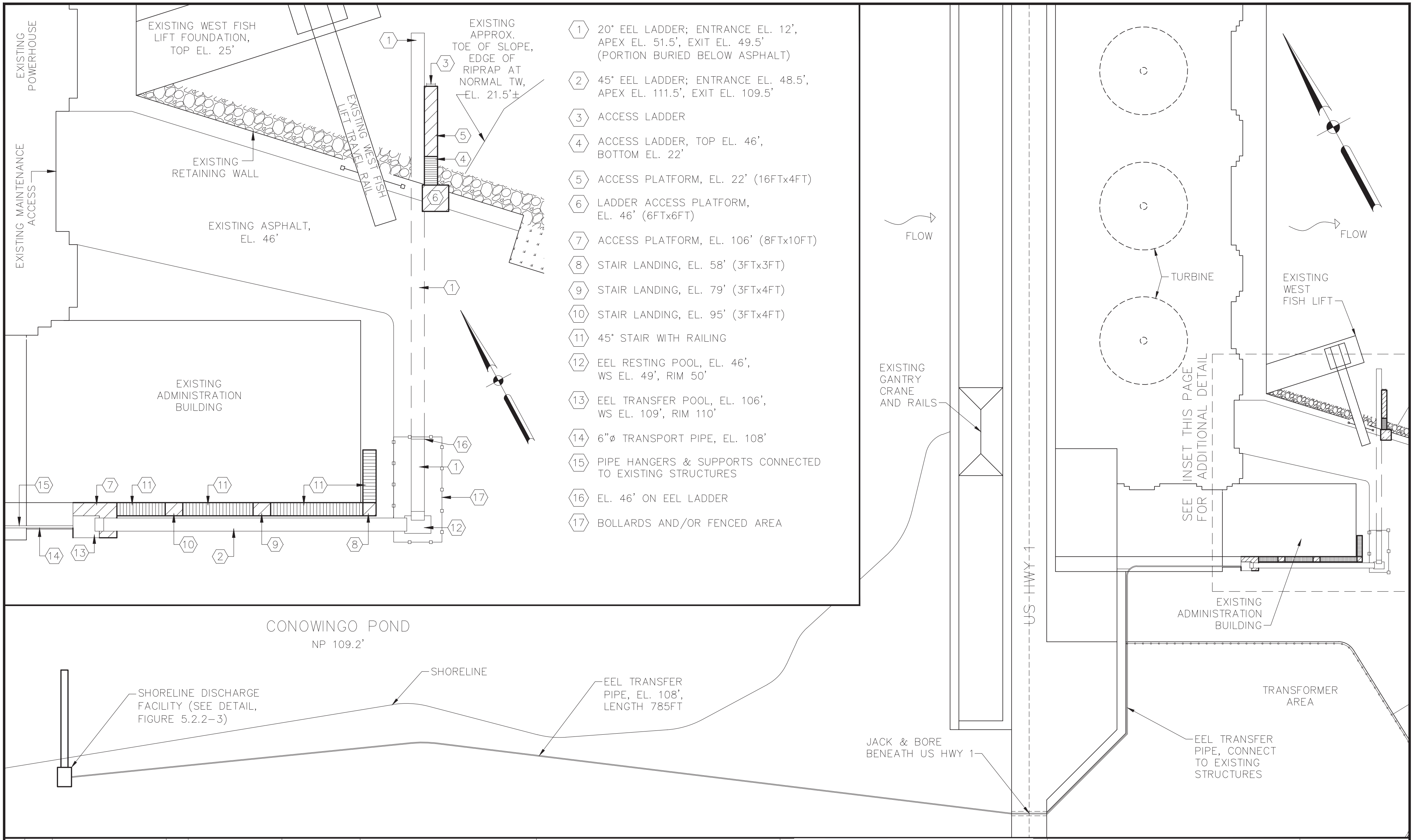
CONOWINGO RELICENSING
EEL PASSAGE DETAILS,
2 OF 2

DATE AUGUST 2012
FIGURE NO: 5.2.2-3



1. 20° EEL LADDER; ENTRANCE EL. 12', APEX EL. 51.5', EXIT EL. 49.5' (PORTION BURIED BELOW ASPHALT)
2. 45° EEL LADDER; ENTRANCE EL. 48.5', APEX EL. 111.5', EXIT EL. 109.5'
3. ACCESS LADDER
4. ACCESS LADDER, TOP EL. 46', BOTTOM EL. 22'
5. ACCESS PLATFORM, EL. 22' (16FTx4FT)
6. LADDER ACCESS PLATFORM, EL. 46' (6FTx6FT)
7. ACCESS PLATFORM, EL. 106' (8FTx10FT)
8. STAIR LANDING, EL. 58' (3FTx3FT)
9. STAIR LANDING, EL. 79' (3FTx4FT)
10. STAIR LANDING, EL. 95' (3FTx4FT)
11. 45° STAIR WITH RAILING
12. EEL RESTING POOL, EL. 46', WS EL. 49', RIM 50'
13. EEL TRANSFER POOL, EL. 106', WS EL. 109', RIM 110'
14. 6"ø TRANSPORT PIPE, EL. 108'
15. PIPE HANGERS & SUPPORTS CONNECTED TO EXISTING STRUCTURES
16. EL. 46' ON EEL LADDER
17. BOLLARDS AND/OR FENCED AREA

NO.	DATE	ISSUED FOR	BY

DESIGNED
DRAWN
CHECKED
SECT.CHIEF
PROJ.ENGR.

25' 0 25' 50'
SCALE: 1" = 50'
10' 0 10' 20'
SCALE: 1" = 20' (INSET)

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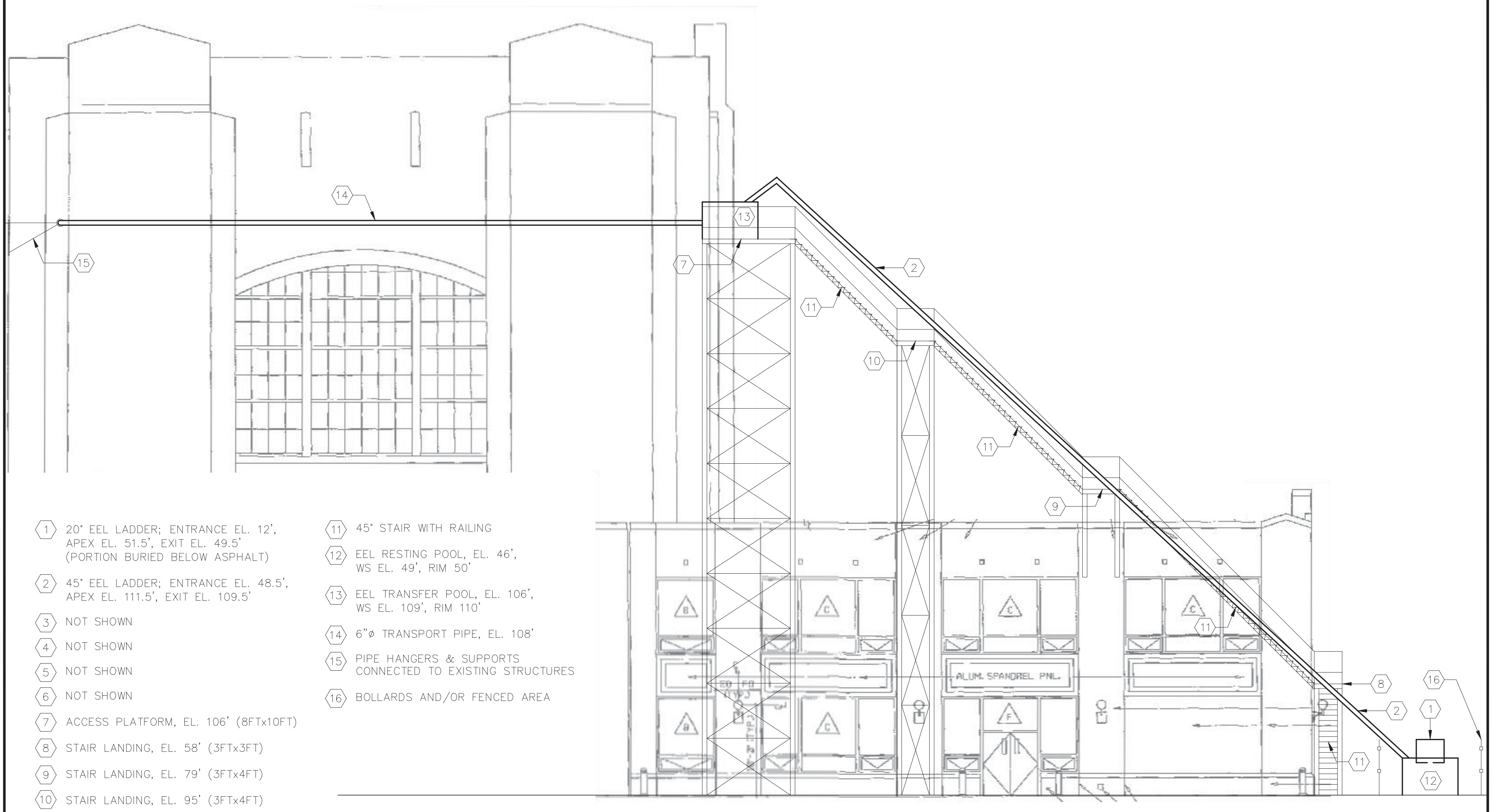
CONOWINGO RELICENSING
UPSTREAM ALTERNATIVES
WEST BANK, OPTION 3,
BURIED EEL LADDER,
PIPE TO WEST SHORE – PLAN

DATE AUGUST 2012
FIGURE NO: 5.2.3-1



1. 20° EEL LADDER; ENTRANCE EL. 12', APEX EL. 51.5', EXIT EL. 49.5' (PORTION BURIED BELOW ASPHALT)
2. 45° EEL LADDER; ENTRANCE EL. 48.5', APEX EL. 111.5', EXIT EL. 109.5'
3. NOT SHOWN
4. NOT SHOWN
5. NOT SHOWN
6. NOT SHOWN
7. ACCESS PLATFORM, EL. 106' (8FTx10FT)
8. STAIR LANDING, EL. 58' (3FTx3FT)
9. STAIR LANDING, EL. 79' (3FTx4FT)
10. STAIR LANDING, EL. 95' (3FTx4FT)
11. 45° STAIR WITH RAILING
12. EEL RESTING POOL, EL. 46', WS EL. 49', RIM 50'
13. EEL TRANSFER POOL, EL. 106', WS EL. 109', RIM 110'
14. 6"ø TRANSPORT PIPE, EL. 108'
15. PIPE HANGERS & SUPPORTS CONNECTED TO EXISTING STRUCTURES
16. BOLLARDS AND/OR FENCED AREA

NO.	DATE	ISSUED FOR	BY

DESIGNED
DRAWN
CHECKED
SECT.CHIEF
PROJ.ENGR.

5' 0 5' 10'
SCALE: 1" = 10'

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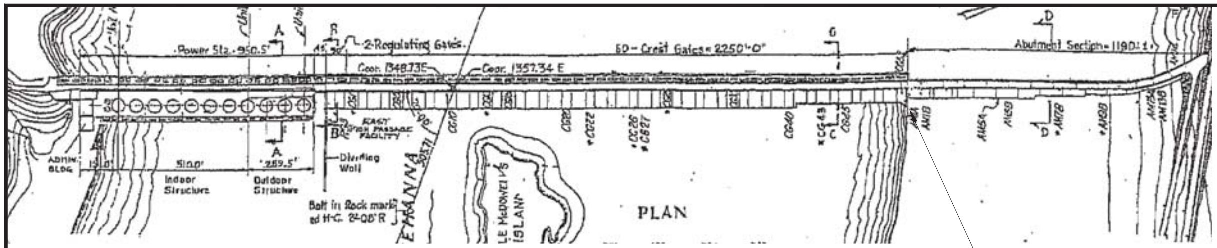
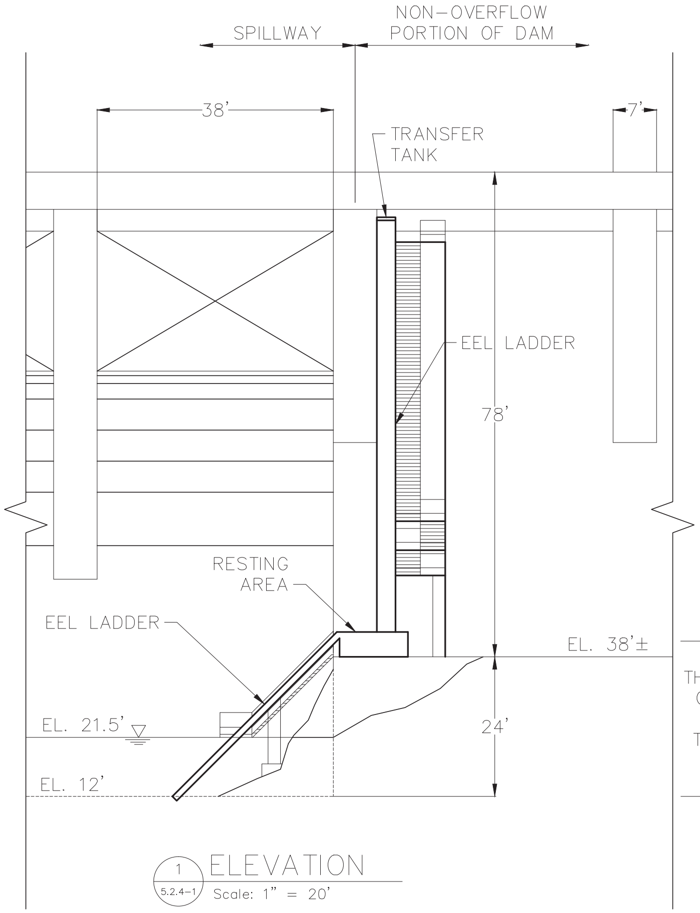
CONOWINGO RELICENSING
UPSTREAM ALTERNATIVES
WEST BANK, OPTION 3,
BURIED EEL LADDER,
PIPE TO WEST SHORE – ELEVATION

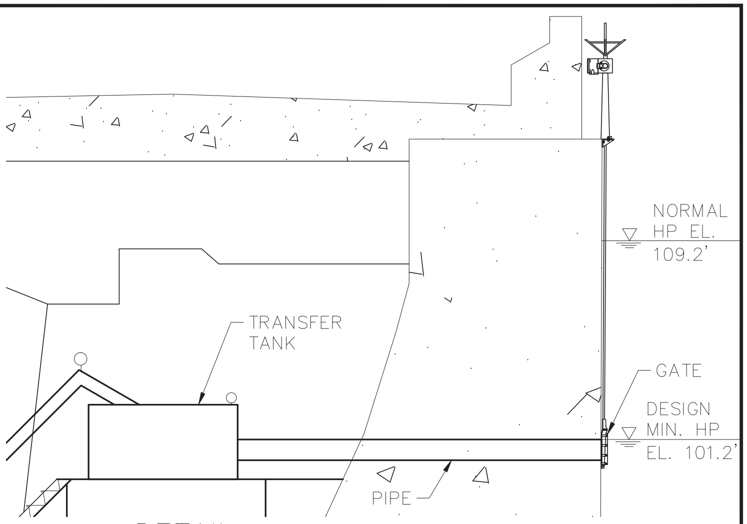
DATE AUGUST 2012

FIGURE NO: 5.2.3-2

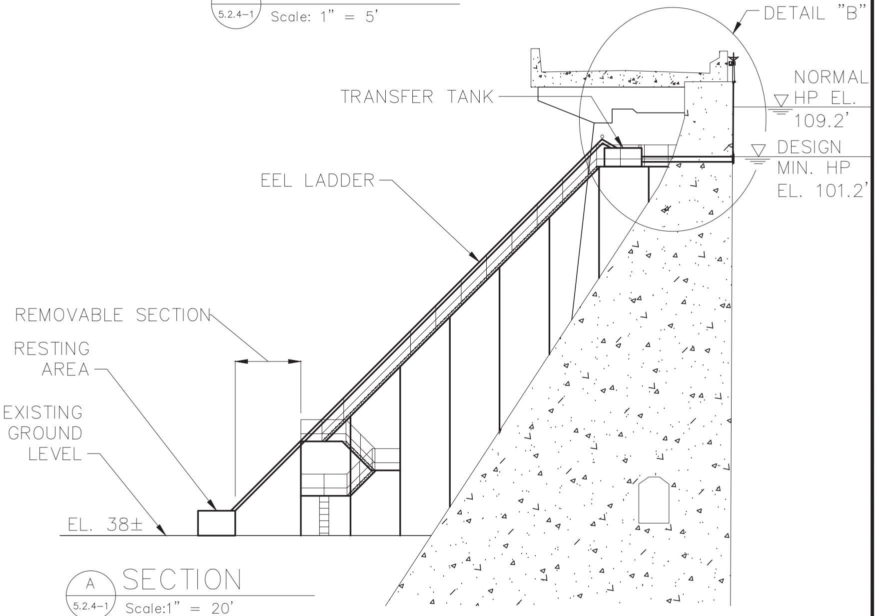




1 5.2.4–1 ELEVATION
Scale: 1" = 20'



B 5.2.4–1 DETAIL
Scale: 1" = 5'



A 5.2.4–1 SECTION
Scale:1" = 20'

NO.	DATE	ISSUED FOR	BY

DESIGNED
DRAWN
CHECKED
SECT.CHIEF
PROJ.ENGR.

2.5' 0 2.5' 5'
SCALE: 1" = 5'
10' 0 10' 20'
SCALE: 1" = 20'

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CONOWINGO RELICENSING

EAST EEL LADDER

DATE AUGUST 2012

FIGURE NO: 5.2.4–1

6.0 DOWNSTREAM PASSAGE

This following section of the study is an assessment of potential options for downstream passage of outmigrating adult eels at the Conowingo Project. This assessment is based on biological data on outmigrating adults, downstream passage measures considered at dams on other rivers throughout the world, and laboratory and field research related to potential downstream passage measures.

6.1 Background

The issue of providing downstream passage for adult eels involves very complex eel behavior and biology, engineering, and operational issues. Generally, few solutions have been found that effectively address downstream passage of eels at hydroelectric projects. The complexity of these issues is significantly compounded for a facility as large as Conowingo Dam and a river as large as the Susquehanna.

Given the complexity of potential downstream passage technologies and the uncertainty as to their applicability at Conowingo Dam, Exelon conducted a workshop on October 25 and 26, 2011 to discuss issues related to the downstream passage of adult eels in the Susquehanna River. At the workshop, experts on downstream passage of eels presented information on eel biology and behavior, technologies and approaches proposed for hydro facilities, their potential effectiveness, and the challenges presented for downstream passage of American eel at Conowingo. Presentation material and notes of the workshop are provided in Appendix A and are summarized in Section 6.2.

6.1.1 Downstream Passage Literature

A number of laboratory and field studies have been conducted throughout the world relative to downstream passage of American eel on North American rivers and the closely related European eel (*Anguilla anguilla)* on European rivers. Much of this research has been recently summarized in a report prepared by the New York Power Authority (NYPA, 2009). The report focused on a large hydroelectric dam on the St. Lawrence River (St. Lawrence Project) and provided a comprehensive assessment of many technologies and approaches associated with downstream passage of adult eels on a large river. A report prepared by EPRI (2010), included an assessment of the implications of downstream passage at Conowingo on the Susquehanna River eel population. These reports, other work referenced in these reports, and information presented at the October workshop provide information needed to consider downstream passage at Conowingo.

6.1.2 Downstream Passage on Susquehanna River

Historically, American eel had access to and occupied much of the Susquehanna River and tributaries, but the watershed today has changed substantially. The construction of dams on the River and its tributaries has limited access to upstream migrating eels and changed the nature of the habitat in the impoundments that were created. Other anthropogenic changes (*e.g*., habitat modifications, development, water quality impacts) have also affected habitats in the watershed.

Not withstanding the availability of downstream eel passage data at a variety of hydroelectric projects, the use of data at a specific project requires knowledge of the biology and behavior of eels in the specific river as well as information on current and future usage of habitat in that river. For the Susquehanna River, some of this information is available or is being collected, but other information is not known with enough specificity at this time.

USFWS (2012) analyzed silver eel migrations past Conowingo dam in 2011. Based on 88 tagged silver eels released in upper Conowingo Pond above the Muddy Run Pumped Storage Project, 79 eels (89.8%) were detected at receivers downstream of Conowingo Dam. As these eels were detected 14 km below the Dam, USFWS concluded that these 79 eels successfully migrated past the Dam and out of the Susquehanna River. Since spillage occurred for a number of days during which eels were outmigrating, it was not possible to determine whether eels passed the Dam through spillage or turbine passage. The remaining nine eels were not detected below the Dam so it is not known if they remained in the Pond, migrated after the end of the monitoring (late December, did not survive passage through the turbines or over the spillway , or the tags or tag battery failed, or the tags were damaged in turbine or spillway passage.

A downstream-passage program would require information on the timing of migration and its relation to rain, flow, water temperature, lunar cycles, and other potential migratory cues (Appendix A, Haro presentation). It is generally believed that the outmigration of eels occurs primarily at night in fall although the factors initiating migration are not well understood. In some instances, most eels outmigrate in a short period of time although outmigration has also been noted to extend over a three- or four-month period on the St. Lawrence River. The timing of migration may vary within the watershed with eels further upstream in smaller tributaries and lakes moving earlier than eels in the mainstem of a river. Environmental factors can suspend or terminate downstream migration.

Before implementing a program to restore eels to the watershed, it would be prudent to acquire pertinent information about eels in the Susquehanna River. As discussed at the October workshop (Appendix A, Haro presentation), this information includes characteristics of the outmigrating eels (*e.g*., run timing, average size class, number, sex ratio).

6.2 Downstream Passage Options

Numerous options have been considered for the downstream passage of outmigrating eels at hydroelectric facilities. These options can generally be considered as those related to 1) turbine passage, 2) deterring eels from turbines with guidance to a bypass, and 3) trapping and transporting eels past one or more facilities. The advantages and disadvantages associated with these options are discussed below and summarized in Table 6.2-1.

6.2.1 Turbine Passage (Appendix A, Richkus presentation)

The literature revealed some generic statements pertaining to survival rates of adult eels passing through different turbine types and which types of turbines might be more prudent to run during outmigration. Other options portrayed in the literature include the use of "fish-friendly" turbines as well as measures such as facility shutdown during adult migration. These options were discussed during the stakeholder workshop and are summarized below:

Preferential Operation of Francis Turbines: Various studies have estimated the survival of adult eels passing through turbines. Generally, these studies have found somewhat higher survival for large eels that pass through Francis turbines than those that pass through Kaplan turbines. Factors influencing survival include eel size, location of turbine entry, turbine load, and distance between vanes and runner blades.

At Conowingo, preferential operation of Francis units during the period of eel migration could increase the survival of outmigrating eels. Although the timing of eel outmigration has not been definitively established at Conowingo, it is expected to include the period in the fall when juvenile clupeids (American shad and river herrings) are also outmigrating. Studies at Conowingo have demonstrated that juvenile clupeids passing through the Kaplan turbines have better survival (95%) than those passing through the Francis units (89.9%)(Exelon RSP 3.2 Entrainment Study: Estimation of Survival of Juvenile American Shad Passed through Francis Turbines). Preferential operation of the Francis units to maximize survival of adult eels would presumably result in increased mortality of outmigrating juvenile clupeids. In addition, the Francis units are less efficient from an electrical generation perspective than the Kaplan units resulting in reduced power generation with preferential operation of these units.

Fish-Friendly Turbine: Alden Laboratories and the Department of Energy have developed and conducted laboratory tests of a turbine designed to improve the survival of fish passing through a turbine. In the laboratory, this "fish-friendly" turbine has shown turbine survival rates of 94% for adult eels less than 18 inches in length (EPRI 2011a).

At this time, no fish-friendly turbine has been installed at an operating hydroelectric project. A commercial version of the fish-friendly turbine has been designed for an additional unit at a small project in New York. This small unit would not be applicable for Conowingo Dam and could not be used to retrofit an existing Conowingo unit. Installation of a fish-friendly turbine at Conowingo would require a design specific to the Project. A simple retrofit of a new unit is not currently possible and would require substantial modifications to the existing powerhouse, water passages and other infrastructure, which would be accompanied by significant capital expenditures. Additionally, there are still questions as to the efficiency of these turbines to increase fish survival in a practical application and more research is needed before considering the applicability and practicality of this type of turbine at Conowingo.

Project Shutdown: Partial or complete shutdown of the Project during eel outmigration would prevent passage through the turbines and associated mortality. Spillage would provide the avenue for eels to pass the Project. The effectiveness of this option would depend on the ability to predict the timing of outmigration. Attempts to develop accurate models predicting eel migration have not been consistently successful.

Complete shutdown would eliminate turbine mortality but mortality or injury would be expected with passage via the spillway. As juvenile clupeids also outmigrate during fall, complete shutdown would result in them passing the Project through spillage with associated mortality. Complete shutdown would result in an associated loss of energy production.

An alternative to complete shutdown would be partial shutdown during night hours, the period when it is believed that eels migrate. However, studies on the St. Lawrence River show that about 25% of outmigrating eels pass the St. Lawrence Project during daylight hours. If some eels pass the Conowingo Project during daylight hours, these fish would be exposed to turbine impacts. Partial shutdown would also result in an associated loss of energy production. As juvenile clupeids migrate during evening, shutdown at night would result in their passage through spillage with associated mortality.

6.2.2 Deterrence/Guidance and Bypass (Appendix A, Richkus and Amaral presentations)

Methods to guide or deter fish at a facility have been used for juveniles and adults of resident and migratory fish. The deterrence/guidance devices may range from permanent and rigid, made from wood or metal, or temporary and flexible made from netting. A collection facility or bypass is generally associated with deterrence/guidance structures to collect fish for transport or pass fish beyond a barrier. In this case, deterrence/guidance structures are discussed in conjunction with bypass facilities.

There are numerous options for eel passage that employ some method to deter eels from the turbine intakes with guidance to one or more bypasses. The proposed methods for deterrence and guidance can be considered as technologies designed to use either behavioral stimuli to affect eel behavior to deter eels from the turbine intake or structural measures that physically prevent eels from entering the area of the turbine intakes. Typically, the deterrence measures are also designed to attempt to guide eels from the area of the turbines to a bypass for downstream passage. The advantages and disadvantages of these measures are summarized in Table 6.2-1 and discussed in the following sections.

Although deterrence measures are discussed as either behavioral or structural, all behavioral measures with the exception of induced flow require substantial physical structures. For example, components of any behavioral technology deployed upstream of the turbine intakes would require structural elements (*e.g.*, piers, steel members, personnel access, utility services). At large projects, these supporting physical elements can become very expensive to install and maintain. At Conowingo, such a structure could be full depth and 1,000 ft long if it were installed along the face of the turbine intake. Moreover, studies have suggested that behavioral measures are more effective if installed at an angle to the flow; such an installation at Conowingo would result in full-depth structures ranging from 1,350 ft in length (45 degree angle for flow) to 3,600 ft (15 degree angle). Given the debris loading in the river, there would be substantial maintenance effort and cost associated with these structures to ensure that this loading has a minimal effect on the behavioral stimulus.

Various studies have shown that eels in the immediate vicinity of dams exhibit exploratory behavior (NYPA 2009). This behavior has been observed in both laboratory tests and studies of eels in large and small rivers in North America. This behavior was observed at dams with and without physical structures (*e.g.*, bar racks) on the turbine intakes and at dams with no screening of the intakes. The exploratory behavior typically involves vertical movement throughout the water column and horizontal movements across the dam prior to passage.

As deterrence measures are designed to keep eels from passing through turbines, it is necessary to provide an avenue to allow eels to move past the dam. Since eels demonstrate exploratory behavior, it is likely that they can discover an appropriately designed and located bypass especially if the deterrence measure provides some guidance toward the bypass. Given eels' vertical and horizontal movements, more than one bypass may be needed at large dams for timely passage of outmigrants, and these bypasses may need to be located at different elevations in the forebay (*e.g.*, surface, midwater, near bottom). The use of bypasses, typically on small dams, by eels has ranged widely with bypass usage ranging from 12% to 50%.

6.2.2.1 Structural Methods (Appendix A, Richkus and Amaral presentations)

In contrast to measures that attempt to use behavioral stimuli to deter eels from the area of the turbine intakes, structural methods involve a physical barrier to deter fish from entering the area of the turbine intakes. The barrier is typically screens/bars although louvers and wedge-wire screens are alternatives. Barriers may be installed on the face of the power dam perpendicular to flow or at an angle to the flow. Most evaluations of barriers on downstream migrants have been conducted on anadromous species. Louvers have been effective at guiding anadromous species at several sites in the Northeast and on the West Coast.

Observations have shown that outmigrating eels have relatively unique behavior when approaching barriers. Eels typically approach a barrier head first and do not show a response until they physically contact the barrier after which they usually move upstream rapidly. Additionally, eels are sometimes easily impinged with relatively low flows (less that 1 m/s). When the barriers are perpendicular to the flow, eels have been observed to attempt to forcibly pass through the barrier, which often causes injury or impingement. Conversely, eels may be more readily guided along angled barriers. Laboratory studies have demonstrated that a barrier set at 15^o to the flow provided better guidance than a barrier set at 45^o; however, efficiency may vary with approach velocity and bar/louver spacing.

At Conowingo, angled physical barriers across the area of the turbine intakes would be very large. Given the high debris loading in the river, it is quite likely that these permanent structures would have substantial debris management requirements throughout the year. As the structure would be permanent, it is likely that some icing will occur during winter months with associated maintenance requirements. Additionally, debris loading, structure icing, and the presence of the screening will result in head loss and reduced generation.

A permanent physical barrier would affect other anadromous species (American shad, river herring) during multiple life stages. The barrier would affect adults passed upstream by the fish lifts and perhaps delay migration. Additionally, the barrier would affect juveniles as they migrate downstream. For example, it is proposed that outmigrating juvenile clupeids pass through the turbines; the associated survival of this passage is estimated to be 95%, based on preferential Kaplan operation (RMC 1994). If these fish were excluded from the turbine intakes, they would have to pass along the screens/louvers before finding and utilizing a bypass. The associated outmigration and survival rates are unknown and could be less than the rates associated with turbine passage. In addition a physical barrier could result in future upstream passage facilities with a less-than-optimal location and/or design.

6.2.2.2 Induced Flow (Appendix A, Richkus presentation)

The provision of flow to guide fish to a bypass has been considered for downstream passage at hydroelectric projects. These flows are intended to induce outmigrating fish to detect and follow this flow to the bypass rather than enter the area of the turbine intakes. The use of induced flows to guide movement has been investigated for some anadromous fish (*e.g.*, juvenile salmon), but has not been tested for eels. The use of induced flows for guidance has also not been tested on large rivers.

Data from studies involving induced flows have been inconsistent. Haro *et al*. (2000) reported that 10 of 13 (77%) radio-tagged eels passed through turbines rather than over a dam or through a bypass. Shultze (1999) found that eels passed through turbines until 50% of flow passed over the dam. Of 15 eels tracked by Durif *et al*. (2002), 10 eels (67%) passed over the dam, one eel (7%) passed through the turbines, and four eels (26%) used a bottom bypass; these data were collected in relation to a storm event (*i.e*., higher flows). As eels are thought to move downstream with the main flow (*i.e.,* flow through turbines), it is generally felt that the effectiveness of bypass flows is likely limited in the absence of barriers to deter fish from the turbines.

6.2.2.3 Behavioral Methods (Appendix A; Richkus and McGrath presentations)

Behavioral deterrents or attractants use a particular stimulus to elicit an instinctual response in fish to produce movement in a desired direction. Potentially successful behavioral stimuli may vary for a particular species and will likely vary depending on the infrastructure associated with a hydroelectric project. If a behavioral-based technology could be designed for outmigrating eels, it is likely to affect both resident species and outmigrating juvenile clupeids. The effects on these species are unknown, but would need to be considered. The behavioral methods investigated include:

Light: Light has been shown to produce an avoidance response in outmigrating eels. In small streams and rivers in Europe, diversion rates of 66% to 90% have been reported for the European eel. In a study on the St. Lawrence River, eels avoided a 300-ft long, high-intensity light field at night; an avoidance rate of 77.6% was estimated.

Although some studies have demonstrated avoidance of light by eels, other studies report little or no effect under some circumstances. One significant limitation of a light-based deterrence technology is water clarity. For the St. Lawrence River study, water clarity was very high (up to 30 ft) whereas water clarity on the Susquehanna at Conowingo is normally much lower. Habituation may also compromise the effectiveness of a light-based system as eels could be required to consistently avoid light along a long light-field. The effectiveness of a light-based system would be limited to night time. Although it is generally accepted that eel outmigration occurs at night, some movement may occur during daylight hours when a light-based system would be ineffective. On the St. Lawrence River, 25% of outmigrating eels moved downstream during the day; a conceptual model for this system estimated that diversion efficiency of a light-based system could range from 13% (some habituation) to 58.5% (no habituation) (NYPA 2009).

Sound: The use of low-frequency sound (infrasound) for diverting eels has had mixed results. Two studies by Sand *et al.* (2000, 2001) showed that eels responded positively to infrasound (11.8 Hz). The 2000 study was conducted on a small river in Europe and demonstrated potential value for diverting movement of downstream migrating eels. In contrast, current studies at the intake of a Belgium power plant intake have not yielded promising results. It is estimated that the area of effect of infrasound is limited to within approximately two to three meters of the source. Based on the equivocal results of studies to date and the limited area of effect, the potential effectiveness of infrasound for deterring and guiding eels, particularly for a long distance on a large river, is not considered promising.

Air Bubbles and Water Jets: The use of air bubbles and water jets to deter fish from entering areas of power plant intakes has been proposed for many years. No lasting response of eels to air bubbles and water jets has been reported. Eels rapidly habituated to these methods.

Electricity: Eels are very sensitive to electricity. There has been some success in eel diversion on small rivers in Europe with electric fields and screens, but this result has not been found consistently (Hadderingh and Jansen 1990). Although these results suggest the potential for the use of electricity, there are numerous obstacles with implementation of this technology for downstream migrating eels. One particular obstacle is implementing this method in a way that successfully deters and guides eels for a long distance without stunning them and increasing the likelihood of being carried into the area of the turbine intakes. Use of electricity could also have the potential for effects on the safety of humans as well as other fish.

Electromagnetic Fields: Studies in the laboratory have demonstrated that eels can detect and respond to electromagnetic fields, and some research suggests that eel may navigate via electromagnetic fields (NYPA 2009). Beyond these simple responses, little is known about the interaction of electromagnetic fields and eel behavior. Before this technology can be considered as the basis for a potential deterrence and guidance method for downstream migrating eels, extensive basic research would be required to determine the type of electromagnetic field that might affect migrating eel behavior, methods of projecting a field, and quantifying field intensity.

Chemical Attractants and Repellents: Fish are known to detect and respond to a wide range of water-soluble compounds. Laboratory studies demonstrate that some life stages of eels (*e.g.*, elvers) can detect and respond to small concentrations of chemicals. No information is available concerning whether eels at any life stage are repelled by a chemical compound.

There are several obstacles to the use of chemicals to deter outmigrating eels from the area of turbine intakes or to guide/attract them to a downstream bypass. Discharge of any compound – if one were to be found – would be difficult to effectively generate a "chemical barrier" (deterrence) or "chemical field" (guidance) in an environment where the direction of flow would be moving the deterrent/attractant substance downstream, away from the desired location of effect. Potential effects on other species would also have to be considered. In addition, the discharge of any chemical would be subject to regulatory constraints.

6.2.3 Trap and Transport (Appendix A, Richkus presentation)

The trapping and transport of downstream migrating eels is inherently different than the other downstream passage options. First, in the case of Conowingo, the facilities associated with trap and transport would not be located in the immediate vicinity of the Project. Thus, there would be no conflicts with other resources the Project is trying to protect in the vicinity of Conowingo Pond (*e.g.*, American shad). Conflicts with aquatic resources in other areas can be minimized by selecting appropriate locations for release (see Section 5.1.3). Second, trap and transport could allow passage past multiple dams. Finally, while trapping efficiency is unknown, it is known that there is extremely high transport survival for adult eels and that large eels tend to resume migration after release (NYPA 2009).

6.3 Discussion of Downstream Options at Conowingo

Following the presentations on downstream-passage options at the October 2011 eel passage workshop, stakeholders discussed the applicability of these options for the Conowingo Project. These discussions are captured in the meeting minutes (Appendix A) and are summarized below.

The discussion concluded that most of the behavioral-based options were not appropriate or feasible. Fish-friendly turbines, variations of turbine operation, structural deterrence/guidance systems with bypasses, and a trap-and-transport program were discussed in some detail. The discussion highlighted a number of questions and uncertainties related to fish-friendly turbines, variations of turbine operation, and structural deterrence/guidance systems with bypasses. It was suggested that a trap-and-transport program may be the most viable option for the lower Susquehanna River. This program could provide for both the reduction in mortality to outmigrating eels at more than one of the four hydroelectric projects on the lower river thereby increasing adults available to reproduce and providing ecosystem benefits resulting from the presence of eels in the watershed.

The stakeholders discussed elements of a potential trap-and-transport program. It was recognized that collection of eels in the mainstem of the river could be difficult due to the size of the river and associated flows. An ongoing USFWS program moving young eels from below Conowingo Dam to areas upstream of the dam has placed eels into several tributaries rather than the river itself. These locations were judged to be appropriate because there was substantial habitat suitable for eels. The placement of eels in tributaries would facilitate the subsequent collection of outmigrants from these streams as part of a trap-and-transport program. There were a number of locations in various tributaries as well as in the river where eel weirs were historically located. These locations could provide appropriate trapping points for the collection of eels for such a program. The consensus of the stakeholders was that a trap-and-transport program within tributaries would be an appropriate initial step.

It was agreed that this type of approach would likely take the form of a management plan. Initial efforts would be focused on stocking selected tributaries [upstream of York Haven] with upstream migrating eels that were captured at Conowingo Dam. These same tributaries would be targeted for collection of eels migrating downstream in the fall using a structural eel weir (see Figure 6.3-1 for a typical plan and profile). As these initial tributaries become saturated with established populations, the program could be expanded to other suitable tributaries. If the program continues to be successful and the populations thrive, efforts could be shifted to larger tributaries and eventually to the main stem of the river.

Capital costs for the initial phase of collection in two tributaries are presented as Table 6.3-1. This includes material and labor to install the eel weirs plus labor and transport equipment to capture and transfer the eels downstream of the dam.

The USFWS program is currently stocking eels collected from the Conowingo tailrace in Buffalo and Pine Creeks, near Kelly Point, PA and Ansonia, PA, respectively. The cost opinion developed includes capital costs for two eel weirs at these locations and one haul truck, assuming it could be used for both locations. The total capital cost was estimated to be approximately $201,500, which includes a 25% contingency, design, permitting, and construction administration. The annual operations cost was estimated to be approximately $266,000 per year, based on a 10-week season assuming one eel biologist and one eel technician could cover both sites on alternating days. Costs for a driver are also included, assuming one trip every other day. Exelon anticipates that the cost of a trap and transport program would be shared among the licensees of the four dams the eels would be required to pass.

For this initial cost opinion it was assumed that transport trips would occur every other day throughout the season. During the peak of the season there will probably be more frequent trips and at each end of the migration the frequency will likely be lower. An additional week was also assumed at the beginning and end of the season for mobilization/demobilization with two eel biologists and two eel technicians. The pilings and lowest layer of the eel weir are proposed to be left in place during the off season; the remainder of the structure would be removed then reinstalled each season. These values do not include costs to replace materials from deterioration or damage, it is expected that the materials will not last more than a few years.

Design of the weirs will be based on eel weirs successfully operated on other water bodies. This information will reflect both structural measures and operational experience including performance during high-flow events and periods of debris loading. Debris loading is expected to decrease collection efficiency so it will be necessary to periodically remove debris during the period of eel migration. Design will consider periods of high flow when eels are known to migrate; however, it may not be possible to achieve maximum collection efficiency during very high flows. Design issues identified with the initial weirs will be addressed, to the extent practicable, in subsequent weirs.

The discussion of a trap-and-transport program identified information needed to develop this program. In addition to the information identified in Section 6.2, information would be needed on:

- Extent and value of eel habitat upstream of York Haven Dam including tributaries, and
- Identification of areas in tributaries and in the Susquehanna River where eel weirs were used in the past.

TABLE 6.2-1: SUMMARY OF ADVANTAGES AND DISADVANTAGES FOR DOWNSTREAM PASSAGE OPTIONS FOR AMERICAN EEL AT CONOWINGO DAM.

Passage Method	**Advantage**	**Disadvantage**	**Comment**
Turbine Passage			
Preferential Operation of Francis Turbines	-Better Survival than Kaplan Turbines	-Conflicts with preferential passage of juvenile shad through Kaplan units (95% survival) vs. Francis units (85 - 90%)	-Mortality influenced by eel size, location of turbine entry, turbine load, and distance between vanes and runner blades
Fish-Friendly Turbine	-Lab tests show high survival (94%)	-Existing design for commercial unit not applicable for existing Conowingo units	-No survival data for eels larger than 18 inches
		-Retrofit at Conowingo would require extensive modification to existing water passages at extensive costs	
Project Shutdown	-No turbine mortality	-Loss of energy production	-Passage via spillage with unknown mortality
			-Passage of juvenile clupeids by spillage with unknown mortality
			-Effectiveness depends on ability to predict timing of outmigration
Guidance/Bypass			
Behavioral Methods			
Light	-Some studies show avoidance	-Turbidity limits effectiveness	-Large structure very expensive to install
		-Not effective during daylight	-High costs to operate and maintain
		-Large, full-depth structure required	-Multiple bypasses may be needed
		-Habituation could limit effectiveness	-Unknown effects on other species

		-High potential for debris loading	-Diversion efficiency for large river unknown; estimate for St. Lawrence was 13% to 59%
Sound	-One study showed positive diversion response to infrasound in small river	-Field of effect limited to within two to three meters of source	-Potential effectiveness in large rivers highly uncertain; literature equivocal
		-High potential for debris loading	-Large structure very expensive to install
		-Large, full-depth structure required	-High costs to operate and maintain
		-Habituation could limit effectiveness	-Multiple bypasses may be needed
			-Unknown effects on other species
Air Bubbles/Water Jets	-None	-No lasting response by eels	
		-Rapid habituation	
Electricity	-Eels very sensitive to electricity	-High potential for adverse effects to other species and human safety	-Challenges to install a system that would guide rather than stun eels
	-Some successful diversion using electric fields and screens but results inconsistent	-Large, full-depth structure required	-Multiple bypasses may be needed
Electromagnetic Fields	-Lab studies show eels can detect and respond to fields during some life stages		-Extensive basic research needed to determine potential to be effective guidance mechanism
			-Unknown effects on other species
Chemical Attractants and Repellents	-None	-Chemicals would be difficult to effectively deploy to control movement of outmigrating eels in large river	-Available information insufficient to estimate potential guidance effectiveness
		-Potential regulatory constraints	-Unknown effects on other species
Induced Flow	-None	-In absence of barriers at	-Guidance effectiveness not

		turbines, effectiveness of induced flow likely to be limited	tested in large rivers
			-Inconsistent results in bypass studies
			-Multiple bypasses may be needed
Structural Devices			
Bar Racks/Louvers	-Laboratory studies show angled barriers (screens and louvers) can guide eels	-Eels impinge on screens, often resulting in injury	-Shallow angles (e.g., 15 degrees) more effective than more acute angles (e.g., 45 degrees)
		-Impacts on generation	-High costs to operate and maintain
		-Large, full-depth structure required	-Multiple bypasses may be needed
		-High potential for debris loading	-Large structures may result in lower guidance efficiencies than demonstrated in laboratory tests
		-Screens could affect upstream migrants	
		-Screens could affect outmigrating clupeids	
Trap and Transport			
	-Effective in increasing the number of eels reaching upstream habitats (vs. volitional passage) in systems where eels have to pass multiple projects	-More feasible for small streams than large rivers -Dispersion of young eels from release location could affect percentage of released eels recaptured upon out migration.	-Cost effectiveness depends on ability to predict timing of outmigration
	-Ensures survival of virtually all captured outmigrating eels transported around projects		-Effectiveness in increasing number of successful outmigrants (vs. volitional passage from same areas) depends on ability to capture sufficient percentage of

			outmigrating eels
	-No impact on generation		-Overall effectiveness of program depends on upstream transport to locations that allow for capture of sufficient percentage of outmigrating eels without impacting other aquatic resources

Table 6.3-1. Cost Opinion, Downstream Passage: Trap and Transport with Eel Weir

Item No.	Item	Quantity	Unit	Unit Price	Cost
332	**Reservoirs, Dams, and Waterways**				
	Pilings	480	LF	$32.50	$15,600
	Weir Wall Lumber	760	SF	$5	$3,800
	Fasteners	1	LS	$500	$500
	Screen Slats	250	SF	$7.50	$1,875
	Cross Ties	100	LF	$8	$800
	Collection Trough & Net	1	EA	$500	$500
	Collection Tank	1	EA	$2,500	$2,500
	Rip-Rap	5	CY	$50	$250
	Per Weir Subtotal				$25,825
	Number of Tributaries Being Trapped	2			
	332 Subtotal*				**$52,000**
335	**Miscellaneous Power Plant Equipment**				
	Haul Truck (Assumes 1 can be used for both tribs)	1	EA	$50,000	$50,000
	Transport Tank (1,500 gal)	1	EA	$2,000	$2,000
	Trash Pump	2	EA	$1,500	$3,000
	Dissolved Oxygen Injection System	1	LS	$1,000	$1,000
	Temperature Monitor	1	EA	$500	$500
	335 Subtotal*				**$56,500**

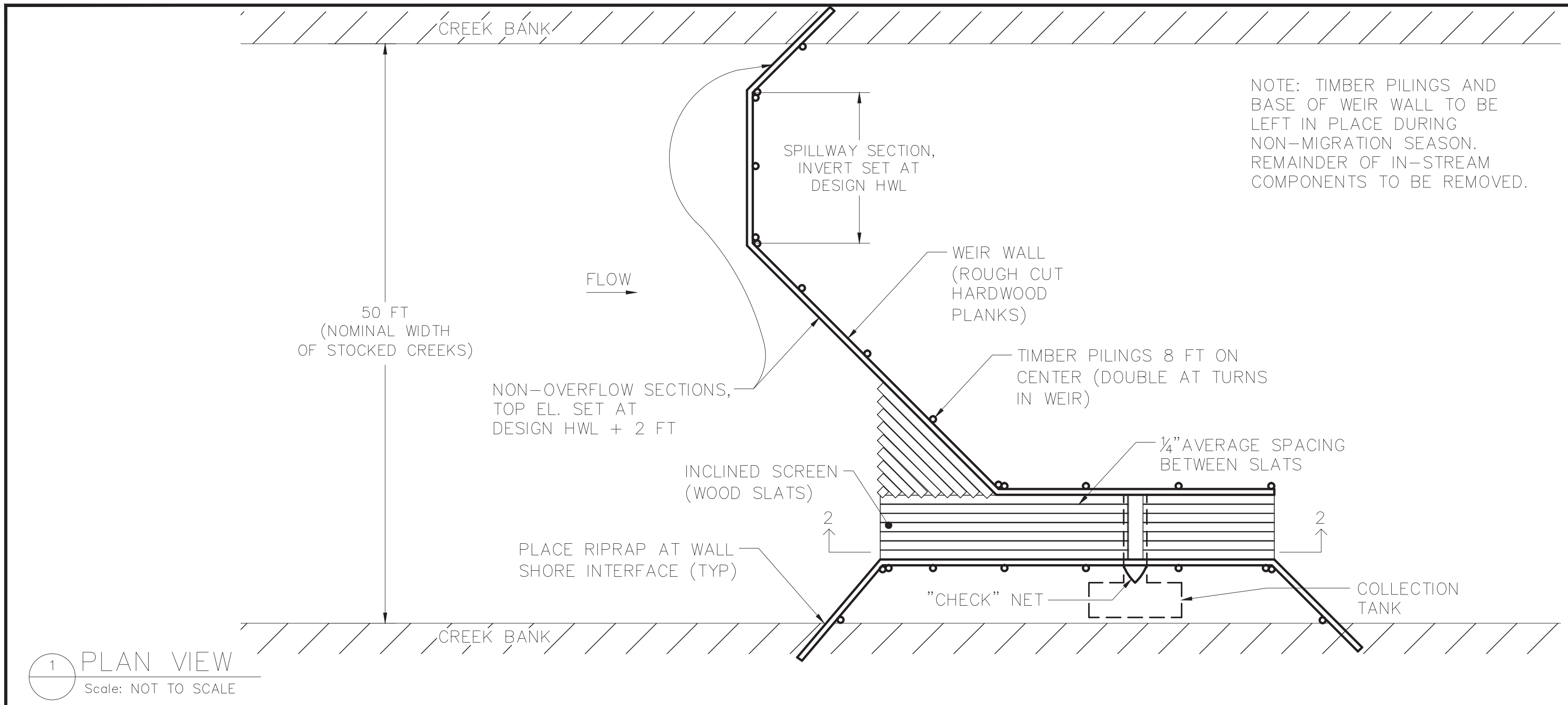
Mobilization/Demobilization (10%)*	**$11,000**
Subtotal Direct Cost	**$119,500**
Contingencies (25%)*	$30,000
Total Direct Cost	**$149,500**
Design (20%)*	$30,000
Permitting (10%)*	$15,000
Construction Administration (5%)*	$7,000
Total	**$201,500**

**Note: Rounded to nearest $1,000*

Item No.	**Item**	**Quantity**	**Unit**	**Unit Price**	**Cost**
901	**Annual Operations - Non-Labor**				
	Mileage *(assumes 440 mile round trip, every other day)*	15,000	MI	$0.50	$7,500
	Fuel	5,000	GAL	$5	$25,000
	Salt (Stress Reduction)	5	TON	$500	$2,500
	Tank Refills (Oxygen)	1	LS	$1,000	$1,000
	901 Subtotal*				**$36,000**
902	**Annual Operations - Labor**				
	Eel Biologist *(assumes 10 weeks per year, full time)*	900	HR	$100	$90,000
	Eel Technician *(assumes 10 weeks per year, full time)*	900	HR	$75	$67,500
	Drivers *(assumes 10 weeks per year, half time)*	350	HR	$55	$19,250
	(Bio. & Tech. time also includes 10 days x 2 staff for mob/demob)				
	902 Subtotal*				**$177,000**

Subtotal Annual Operations Cost	**$213,000**
Contingencies (25%)*	$53,000
Annual Operations Total	**$266,000 /YR**

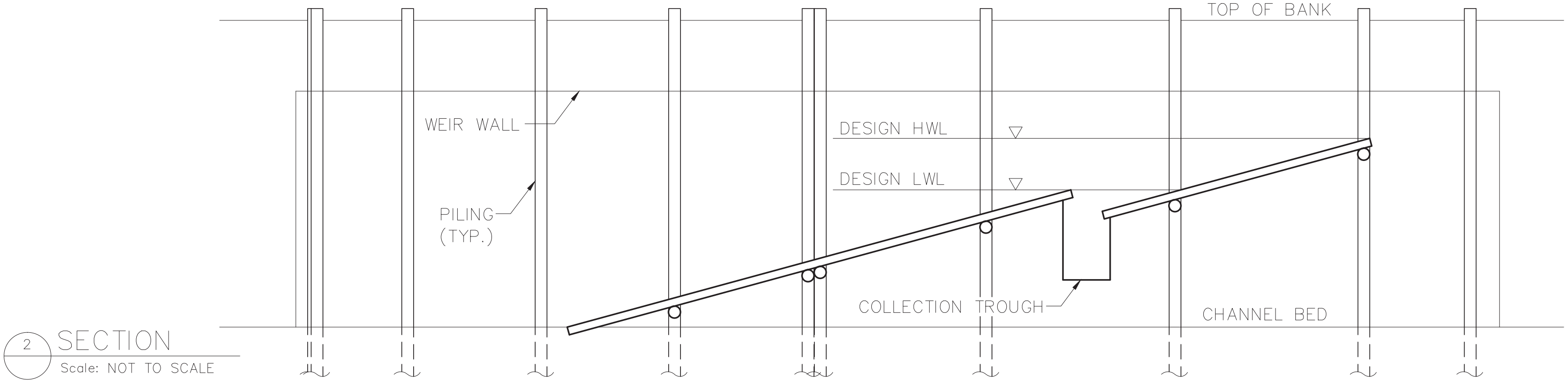
**Note: Rounded to nearest $1,000*



NOTE: TIMBER PILINGS AND BASE OF WEIR WALL TO BE LEFT IN PLACE DURING NON–MIGRATION SEASON. REMAINDER OF IN–STREAM COMPONENTS TO BE REMOVED.

① PLAN VIEW

Scale: NOT TO SCALE



② SECTION

Scale: NOT TO SCALE

NO.	DATE	ISSUED FOR	BY

DESIGNED
DRAWN
CHECKED
SECT.CHIEF
PROJ.ENGR.

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Exelon.

CONOWINGO RELICENSING

EEL WEIR

DATE AUGUST 2012

FIGURE NO: 6.3–1

7.0 POTENTIAL UPSTREAM AND DOWNSTREAM PASSAGE IMPACTS

In evaluating the impacts of an eel-passage program, one has to consider the expected overall upstream passage efficiency and the expected downstream passage survival. For volitional fish passage, overall upstream passage efficiency is a function of the percentage of fish that enter the fish passage facilities ("discovery rate") and the efficiency of the facility to pass eels that enter it ("in-ramp passage efficiency"). At the 82-ft high Moses-Saunders Power dam on the St. Lawrence River, recapture studies conducted over three years indicated a 38 to 45 percent ramp discovery rate of the tagged eels in the tailrace between the ramps on the American and Canadian sides of the dam. These estimates do not account for potential tagged eel mortality, tag loss or migration to available downstream habitats (*e.g.*, Lake St. Francis) over the three-year period. NYPA's eel passage facility on the American side of the Moses-Saunders dam had an average in-ramp passage efficiency of 86 percent based on five years of study. Based on these two percentages, overall passage efficiency was 33 to 39 percent for eels in the Moses-Saunders Dam tailrace. Little data exist to quantify passage efficiencies for eels that have entered ramps at shorter dams (10 to 40 ft). However, it is expected that shorter ramps at smaller dams and trap-and-transport facilities at larger dams would have a higher in-ramp passage efficiency than fully volitional ramps at larger dams (*e.g.*, the Moses-Saunders Power dam), and this efficiency would likely be approximately 90 to 95 percent (Pers. Communication, D. Desrochers, Aug. 2011). Given a similar ramp discovery rate (38 to 45 percent) as larger facilities; the overall passage efficiency at smaller dams would be 36 to 43 percent, based on 95 percent in-ramp passage efficiency.

Estimates of discovery rate and in-ramp passage efficiency for the eel ladder at the St. Lawrence-FDR Project can be used to assess potential volitional upstream passage on the Susquehanna River. A similar 38 to 45 percent ramp discovery rate at each dam along the Susquehanna may be expected. Different estimates may be used to determine the in-ramp passage efficiency of the lower Susquehanna River's larger dams (Conowingo, Holtwood and Safe Harbor) versus smaller dams (York Haven) or trap-and-transport facilities. Thus, the St. Lawrence overall efficiency estimate can be used to assess a fully volitional system at Conowingo, Holtwood, and Safe Harbor dams because the height of these dams (approximately 90, 55, and 75 ft, respectively) and length of an associated eel ramp would be similar to that at the St. Lawrence Project. However, it may be more appropriate to assume higher in-ramp passage efficiency for the smaller York Haven dam (9 to 17 ft). Table 7-1 illustrates individual dams' discovery rate, in-ramp passage efficiency and overall upstream passage efficiency for volitional upstream passage on the Susquehanna River. As shown in Table 7-1, approximately one-third of the eels in the Conowingo Tailrace would be expected to reach Conowingo Pond, with the remaining two-thirds remaining downstream of Conowingo Dam. As would be expected with any volitional passage, a portion of the migrating eels will become residents in the impoundments through which they pass so that the cumulative passage efficiency from Conowingo tailrace to the York Haven impoundment (1.3 to 2.5 percent) can be estimated as the product of the four dams' upstream passage efficiencies.

In contrast to volitional passage, the overall upstream passage efficiency of the trap-and-transport approach at Conowingo (height of eel ramp to trap equal to 30-38 ft) would be expected to be similar to the overall passage efficiency at a smaller dam (36 to 43 percent, based on a 95 percent in-ramp passage efficiency and a 38 to 45 percent ramp discovery rate). With an expected very low mortality associated with transport, the cumulative efficiency of transported fish upstream of York Haven (or any reasonable distance of transport) would remain constant relative to Conowingo's estimated passage rate.

Upon maturity, eels migrate downstream. If volitional passage was chosen, the eels would have to pass through the four dams' turbines. Survival estimates for downstream turbine passage is a function of turbine type and flow. Table 7-2 illustrates the proportion of flow through the types of turbines (*i.e.*, Francis or Kaplan) at each of the lower Susquehanna hydroelectric projects. Literature reports (EPRI 2011) silver eel mortality at Francis turbines ranges from 9 – 15.8 percent, while mortality at Kaplan turbines is reported to range from 25.2 – 37 percent. Based on the proportion of flow through turbine types at each facility and the range of survival estimates, Table 7-3 illustrates the expected survival of silver eels at each hydroelectric facility.

An alternative to volitional downstream passage would be a downstream trap and transport system where silver eels are trapped via eel weirs at upstream locations (in this case upstream of York Haven) and transported to a location downstream of Conowingo Dam. Eels transported upstream could be released into tributaries, impoundments, and/or the main stem of the river. Release locations would need to be carefully selected so that the collection of downstream migrants does not impact other aquatic resources.

There is very little information on the efficiency of eel-weir type of collection facilities, particularly for a mainstem location on a large river such as the Susquehanna. Based on discussions with Alex Haro of the U.S Geological Survey (USGS) Conte Anadromous Research Laboratory (A. Haro, Personal Communication, January 2012) it appears reasonable to assume trap efficiencies ranging from 50 to 95 percent. Given very low expected transport mortality, we would expect the cumulative trap-and-transport efficiency to also be 50 to 95 percent.

In order to assess the potential number of silver eels available for outmigration to the Sargasso Sea as well as the potential abundance of eels distributed via passage to upstream areas, it was necessary to construct an eel passage survival model for several passage scenarios. For scenarios involving volitional passage, these models include: a) low-end estimates of upstream passage efficiency and downstream survival for volitional passage (Figure 7-1); b) high-end estimates of upstream passage efficiency and downstream survival for volitional passage (Figure 7-2); c) trap-and-transport efficiency to upstream of York Haven with low-end downstream passage survival (Figure 7-3); and d) trap-and-transport efficiency to upstream of York Haven with high-end downstream passage survival (Figure 7-4).

We also evaluated scenarios involving upstream and downstream passage via only trap and transport. Given the lack of downstream trapping efficiency literature and the fact that yellow eels may leave a tributary where stocked prior to outmigration as silver eels, we did a sensitivity analysis with downstream trapping efficiencies of 25, 50, 75 and 95 percent. The analysis results, using low end upstream trap and transport efficiency, are illustrated in Figures 7-5 – 7-7. These scenarios assume low end turbine passage survival rates for outmigrating silver eels not successfully trapped. Figure 7-8 illustrates results for high end upstream trap and transport efficiency, high end downstream survival for outmigrating silver eels not successfully trapped, and a high end (95 percent) downstream trap and transport efficiency.

The scenarios evaluated above allow consideration of various resource management objectives relative to these scenarios. If the sole resource management objective is to provide the most silver eels leaving the Susquehanna River for the journey to the Sargasso Sea, low-end estimates for upstream and downstream volitional passage is estimated to provide a return of 90.0 percent of the eels downstream of Conowingo Dam (Figure 7-1). This scenario has such a high return rate of fish to the Sargasso Sea primarily because a large percentage (67%) of the eels never migrate upstream of Conowingo Dam. For upstream and downstream trap-and transportation options, the number of eels returning to the Sargasso Sea depends on the capture efficiency of the eel-weir structure. The percent of returning eels varies from 81.3 percent at the 25 percent capture rate (Figure 7-5) to over 90 percent for high capture rates (93.8 percent at a 75 percent capture rate and 98.7 percent at a 95 percent capture rate; Figures 7-7 and 7-8).

If the sole resource management objective is to maximize eel abundance upstream of York Haven Dam, this goal would be accomplished with an option involving a trap-and transportation program. Programs involving volitional passage at the four dams result in only 1.3 percent to 2.5 percent of the eels below Conowingo Dam reaching the river above York Haven (Figures 7-1 and 7-2). In contrast, a trap-and-transportation program is estimated to provide for 36 percent to 43 percent of the eels below Conowingo to the river above York Haven (Figures 7-3 through 7-8). The options involving volitional passage will distribute eels in the impoundments behind Conowingo, Holtwood, and Safe Harbor dams in addition to the river above York Haven; a trap-and-transportation program delivering eels to the river above York Haven would not result in eels in the three impoundments in the lower river.

If an upstream and downstream eel-passage program sought to balance the two resource objectives discussed above, an upstream and downstream trap-and-transport program would be the best approach. It is estimated that upstream transport would provide far more eels upstream of York Haven (36 to 43 percent) than a volitional program (1.3 to 2.5 percent). Although the number of silver eels provided for transportation to the river below Conowingo Dam to begin the journey to the Sargasso Sea is dependent on the capture rate, the lower capture rates of the eel weir (25 and 50 percent) provide a number of silver eels (81.3 and 87.5 percent; Figures 7-5 and 7-6, respectively) that is slightly less than provided by the best scenario involving voluntary upstream and downstream passage (90.0 percent; Figure 7-1). At higher eel weir capture rates (75 and 95 percent), the number of silver eels provided (greater than 93.8 percent; Figures 7-7 and 7-8, respectively) would approximate or exceed the number of silver eels provided by the best volitional scenario.

TABLE 7-1: LOWER SUSQUEHANNA RIVER DAMS – POTENTIAL UPSTREAM PASSAGE EFFICIENCY

Dam	Approx. Dam Height (ft)	Low End			High End		
		Discovery Rate	In-Ramp Passage Efficiency	Overall Passage Efficiency	Discovery Rate	In-Ramp Passage Efficiency	Overall Passage Efficiency
Conowingo	90	0.38	0.86	0.33	0.45	0.86	0.39
Holtwood	55	0.38	0.86	0.33	0.45	0.86	0.39
Safe Harbor	75	0.38	0.86	0.33	0.45	0.86	0.39
York Haven	9-17	0.38	0.95	0.36	0.45	0.95	0.43

TABLE 7-2: PROPORTION OF FLOW THRU FRANCIS AND KAPLAN (PROPELLER) TURBINES AT EACH OF THE HYDROELECTRIC FACILITIES ON THE MAINSTEM OF THE SUSQUEHANNA RIVER.

Dam	Proportion of Flow through Turbine Type	
	Francis	**Kaplan**
York Haven	0.65	0.35
Safe Harbor	0.00	1.00
Holtwood[7]	0.51	0.49
Conowingo	0.55	0.45

TABLE 7-3: LOWER SUSQUEHANNA RIVER HYDROELECTRIC PROJECTS' EXPECTED POWERHOUSE SURVIVAL ESTIMATES FOR OUTMIGRATING SILVER EELS. MODIFIED FROM EPRI (2011).

Turbine Type	Low End		High End	
	Mortality Rate (%)	Source	Mortality Rate (%)	Source
Francis	9.0	RMC (1995)	15.8	Desrochers (1995)
Kaplan	25.2	NA and Skalski (2000); Desrochers (1995)	37.0	NIMO (1995)

Dam	Low-End Powerhouse Survival Rate (%)	High-End Powerhouse Survival Rate (%)
York Haven	80.9	81.1
Safe Harbor	63.0	74.8
Holtwood	77.2	79.6
Conowingo	78.3	79.9

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[7] Holtwood's post-expansion setup with two additional Kaplan turbines is used in this analysis.

FIGURE 7-1: FLOW CHART DIAGRAM OUTLINING VOLITIONAL UPSTREAM AND DOWNSTREAM EEL PASSAGE THROUGH THE LOWER SUSQUEHANNA. ASSUMES LOW END UPSTREAM AND DOWNSTREAM PASSAGE RATES.

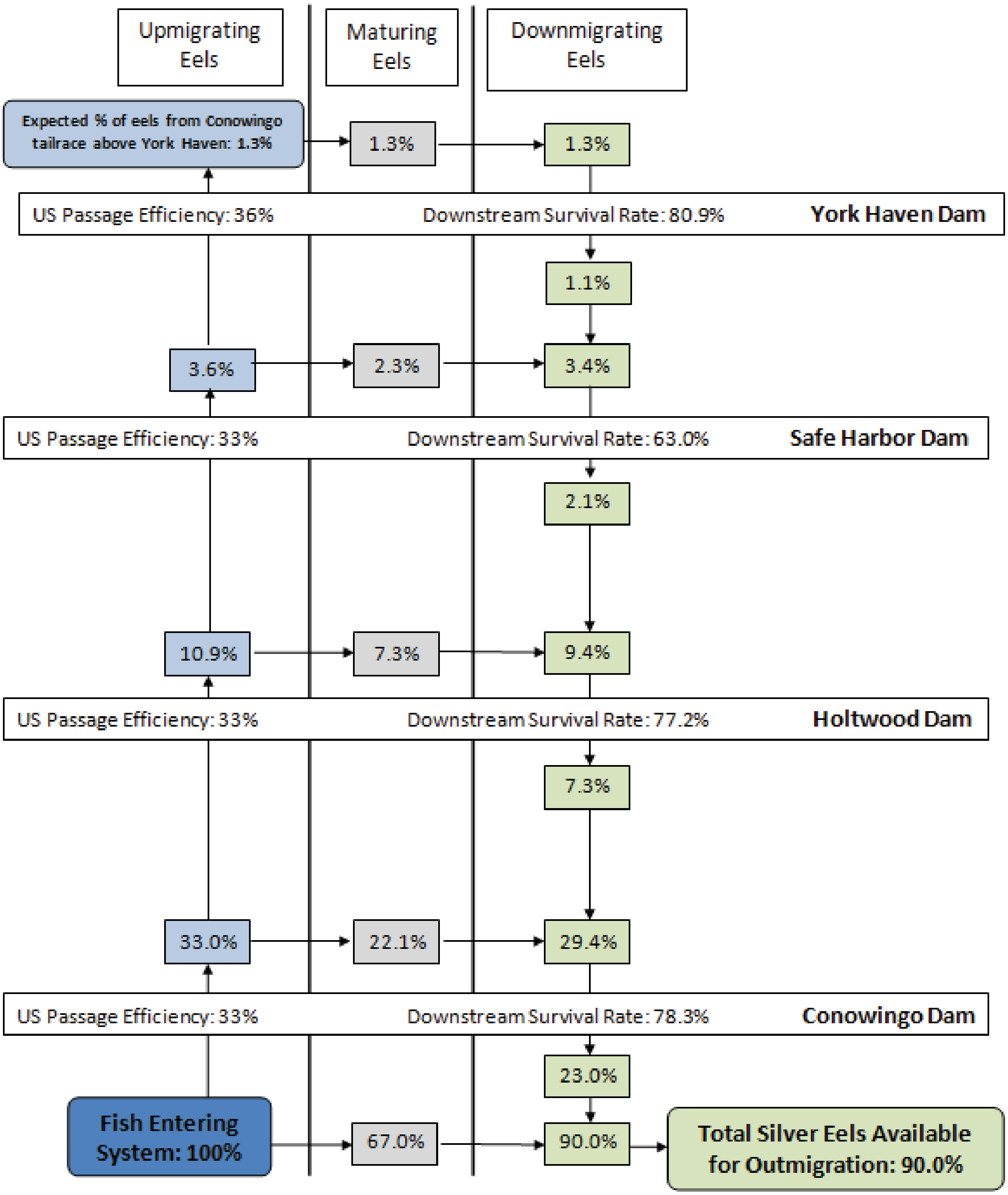


FIGURE 7-2: FLOW CHART DIAGRAM OUTLINING VOLITIONAL UPSTREAM AND DOWNSTREAM EEL PASSAGE THROUGH THE LOWER SUSQUEHANNA. ASSUMES HIGH END UPSTREAM AND DOWNSTREAM PASSAGE RATES.

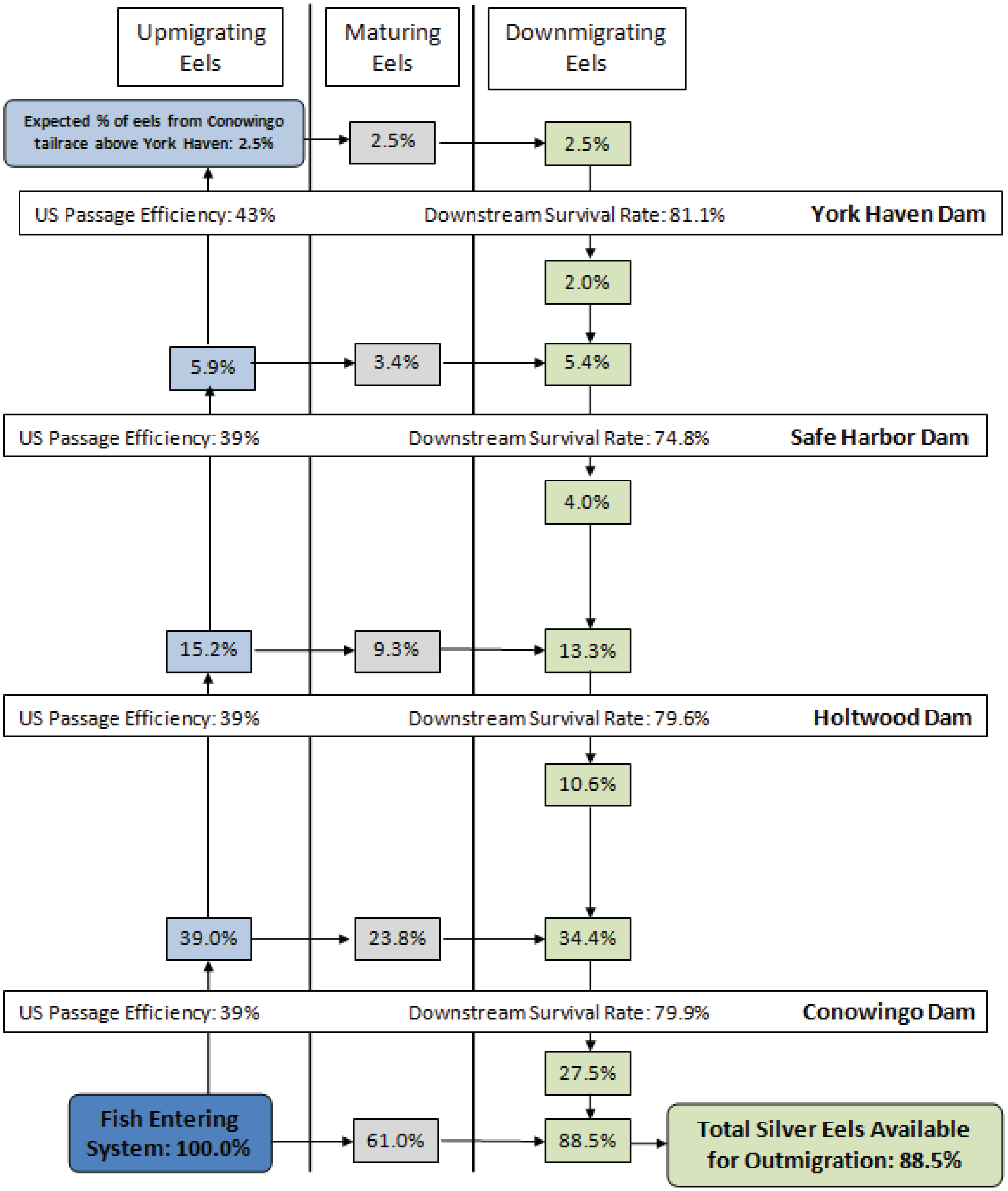


FIGURE 7-3: FLOW CHART DIAGRAM OUTLINING TRAP AND TRUCK UPSTREAM PASSAGE AND VOLITIONAL DOWNSTREAM EEL PASSAGE THROUGH THE LOWER SUSQUEHANNA. ASSUMES LOW END DOWNSTREAM PASSAGE RATES.

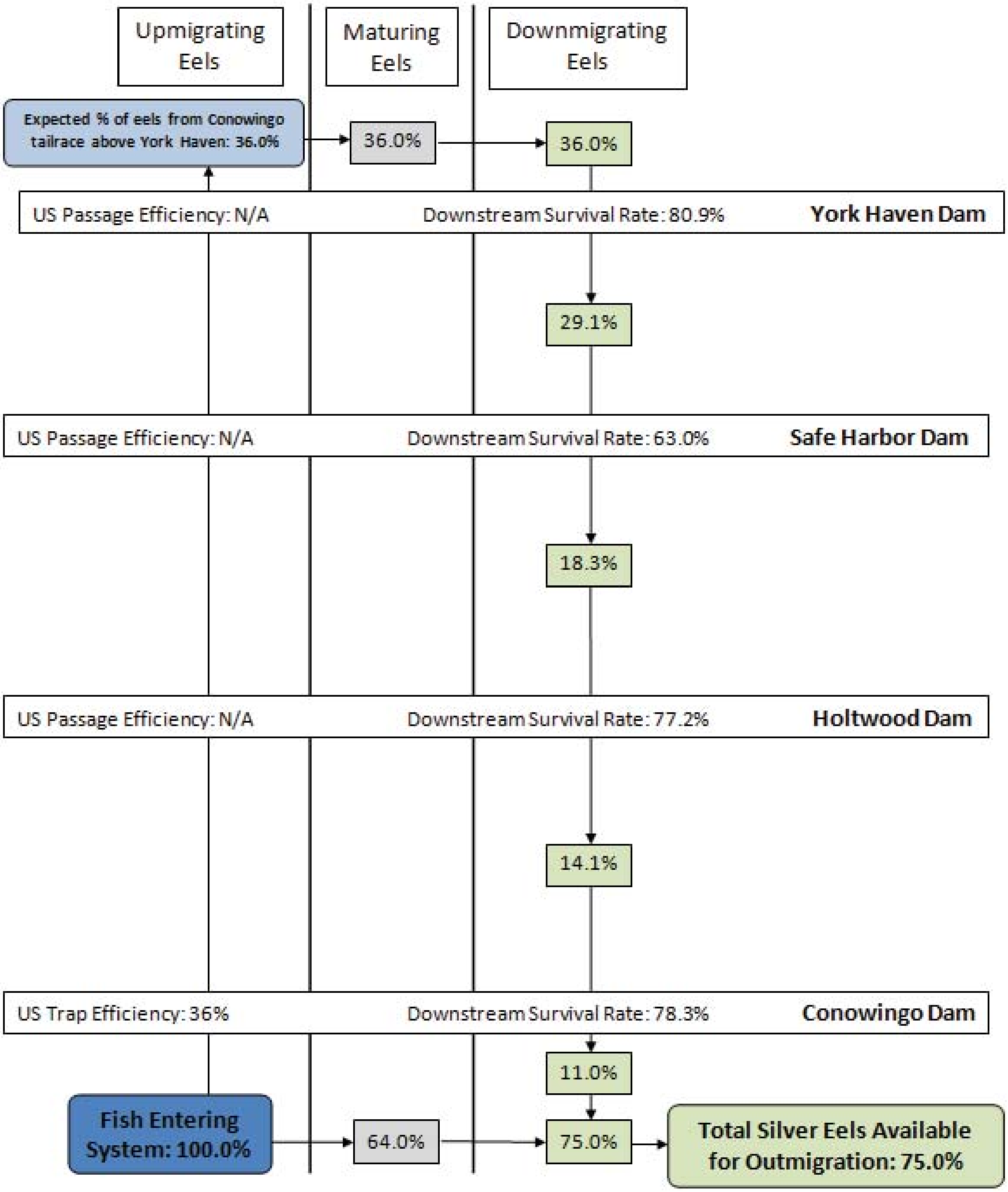


FIGURE 7-4: FLOW CHART DIAGRAM OUTLINING TRAP AND TRUCK UPSTREAM PASSAGE AND VOLITIONAL DOWNSTREAM EEL PASSAGE THROUGH THE LOWER SUSQUEHANNA. ASSUMES HIGH END DOWNSTREAM PASSAGE RATES.

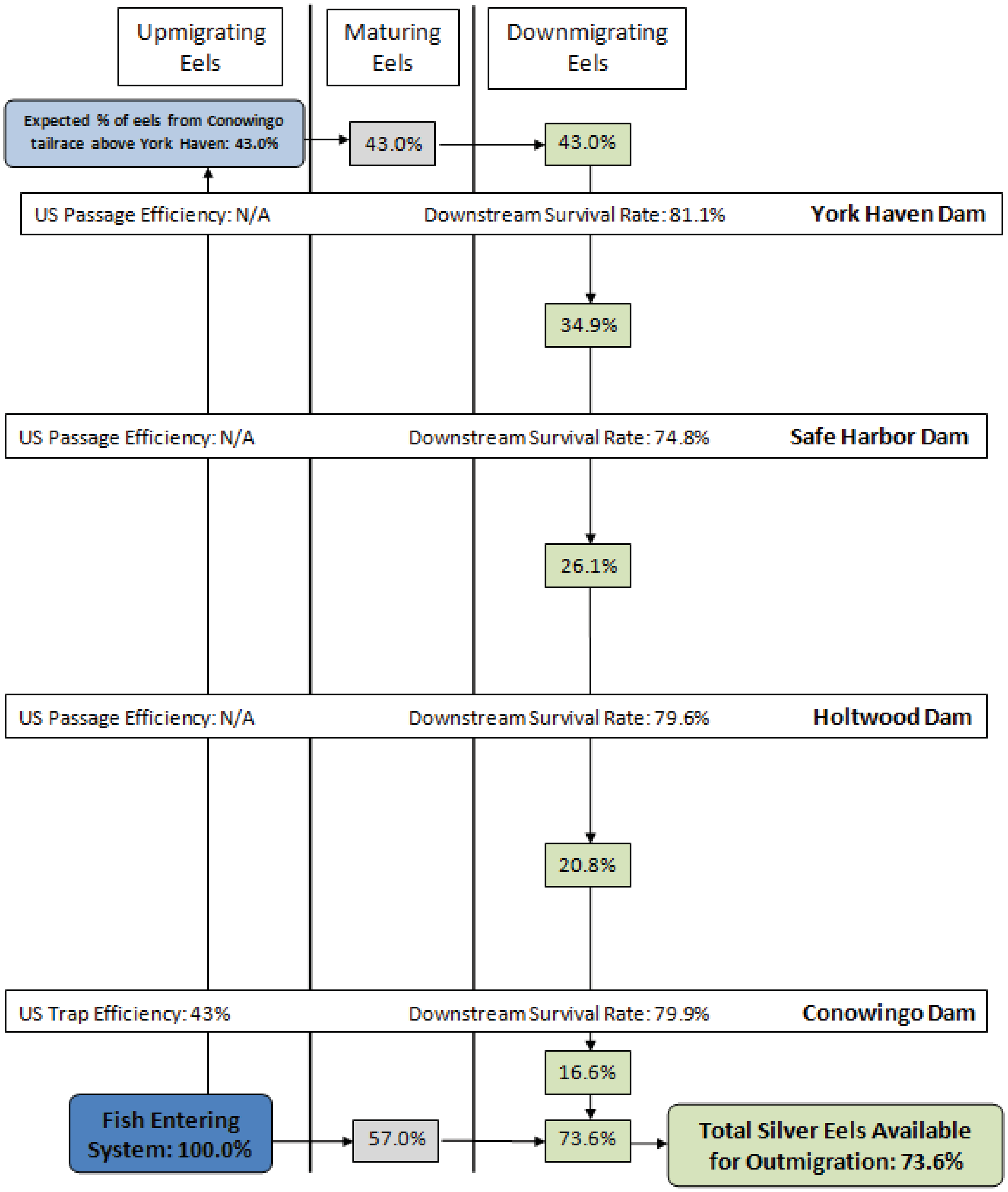


FIGURE 7-5: LOW END UPSTREAM AND DOWNSTREAM TRAP AND TRANSPORT WITH 25% DOWNSTREAM TRAP EFFICIENCY

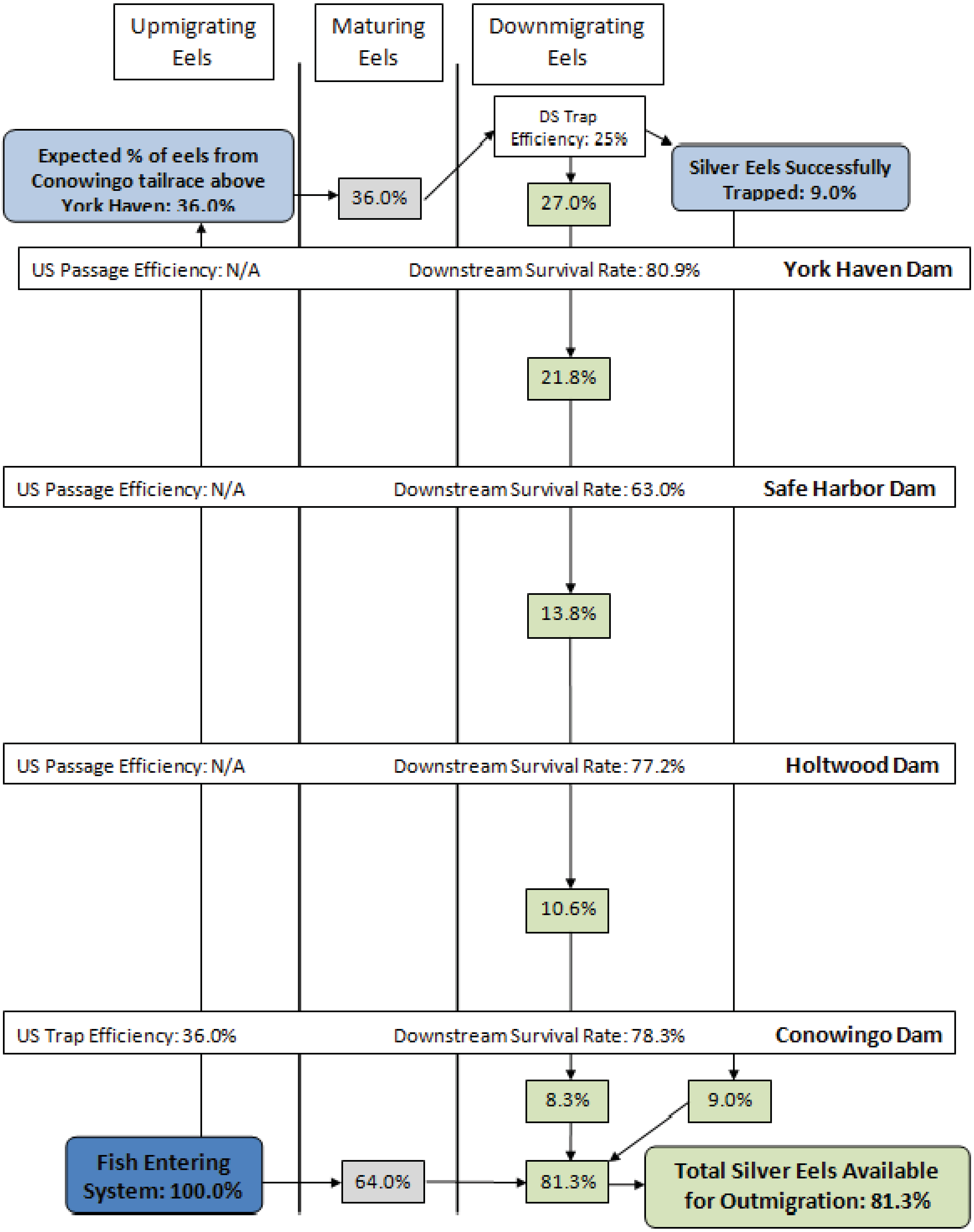


FIGURE 7-6: LOW END UPSTREAM AND DOWNSTREAM TRAP AND TRANSPORT, WITH 50% DOWNSTREAM TRAP EFFICIENCY

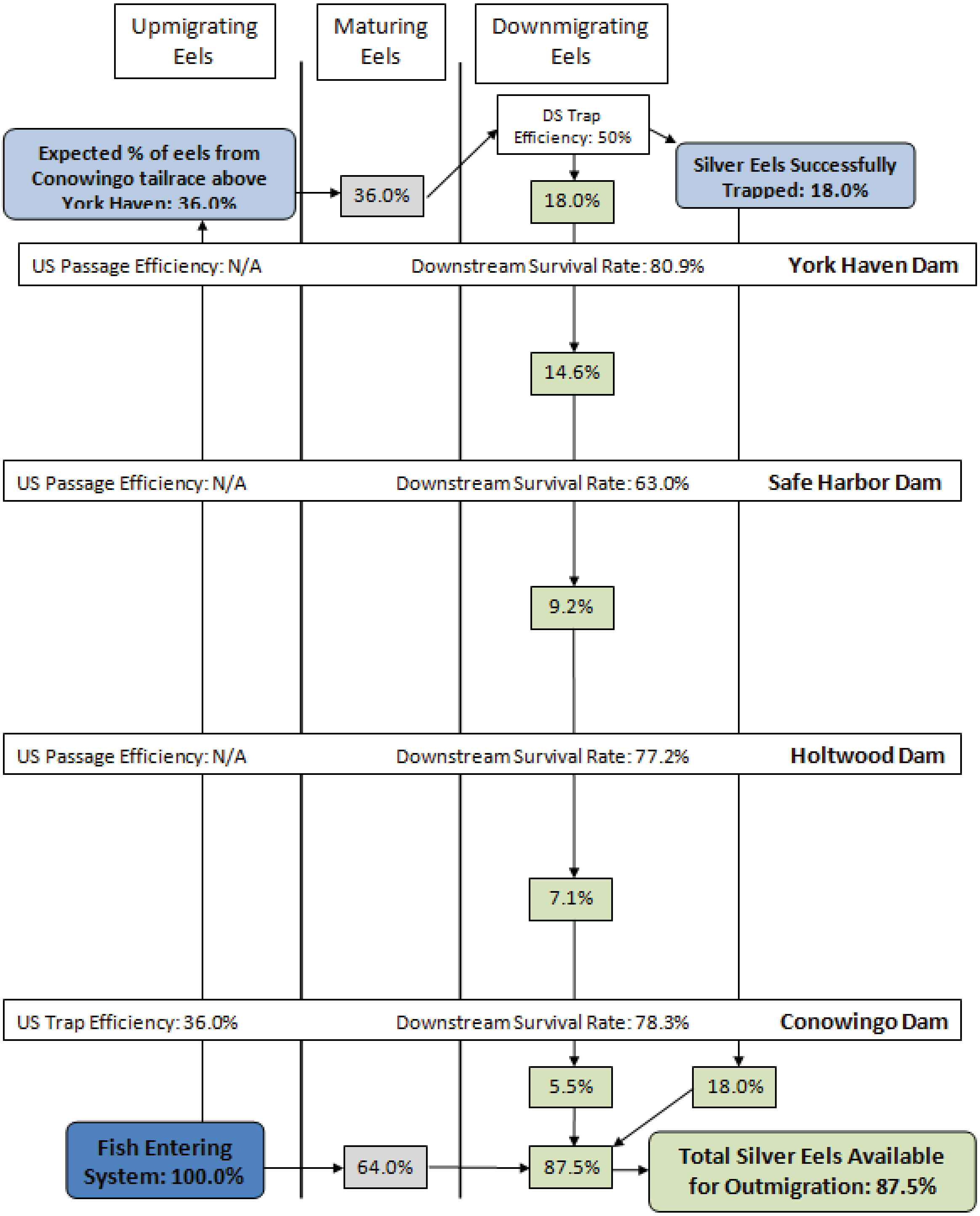


FIGURE 7-7: LOW END UPSTREAM AND DOWNSTREAM TRAP AND TRANSPORT WITH 75% DOWNSTREAM TRAP EFFICIENCY

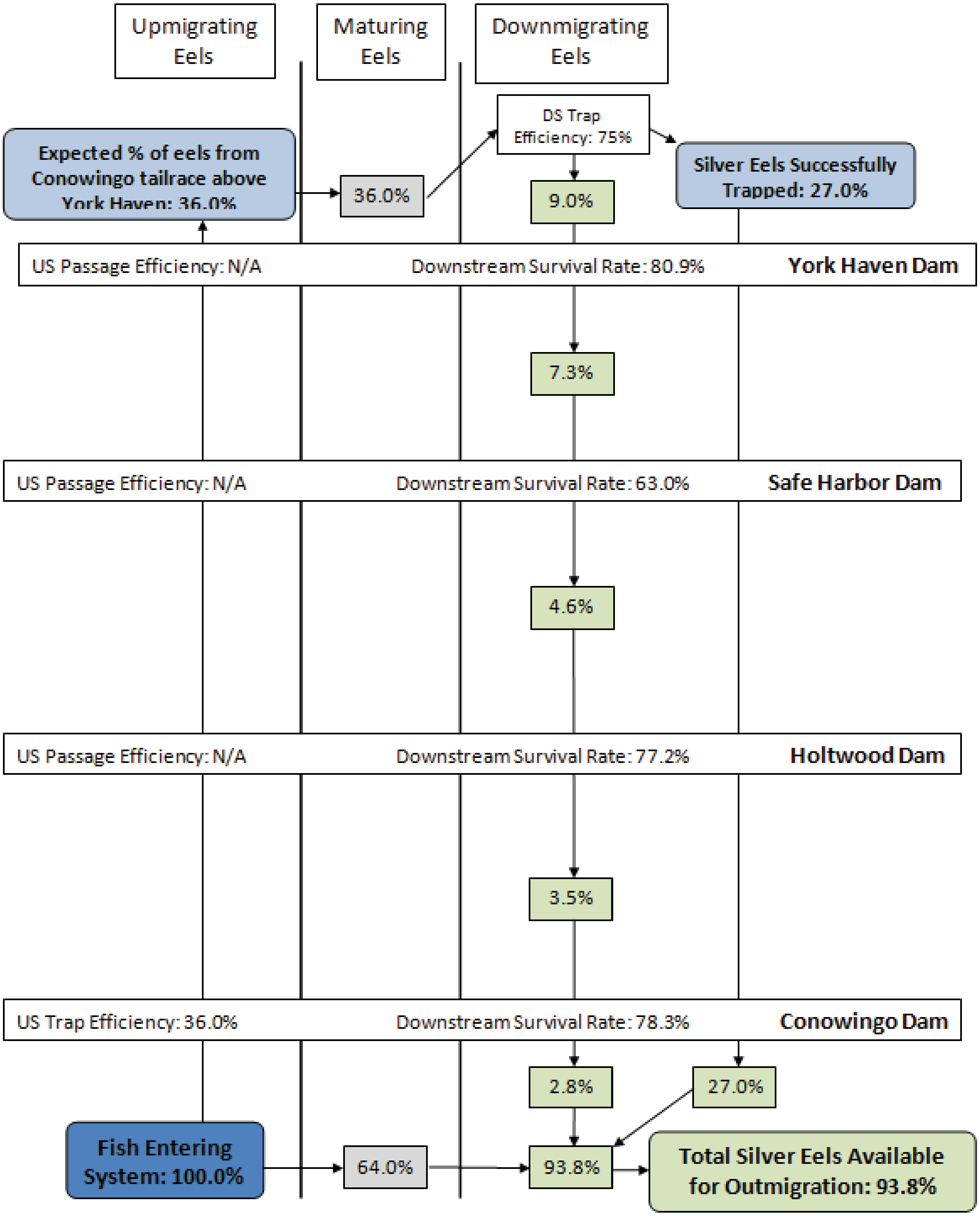
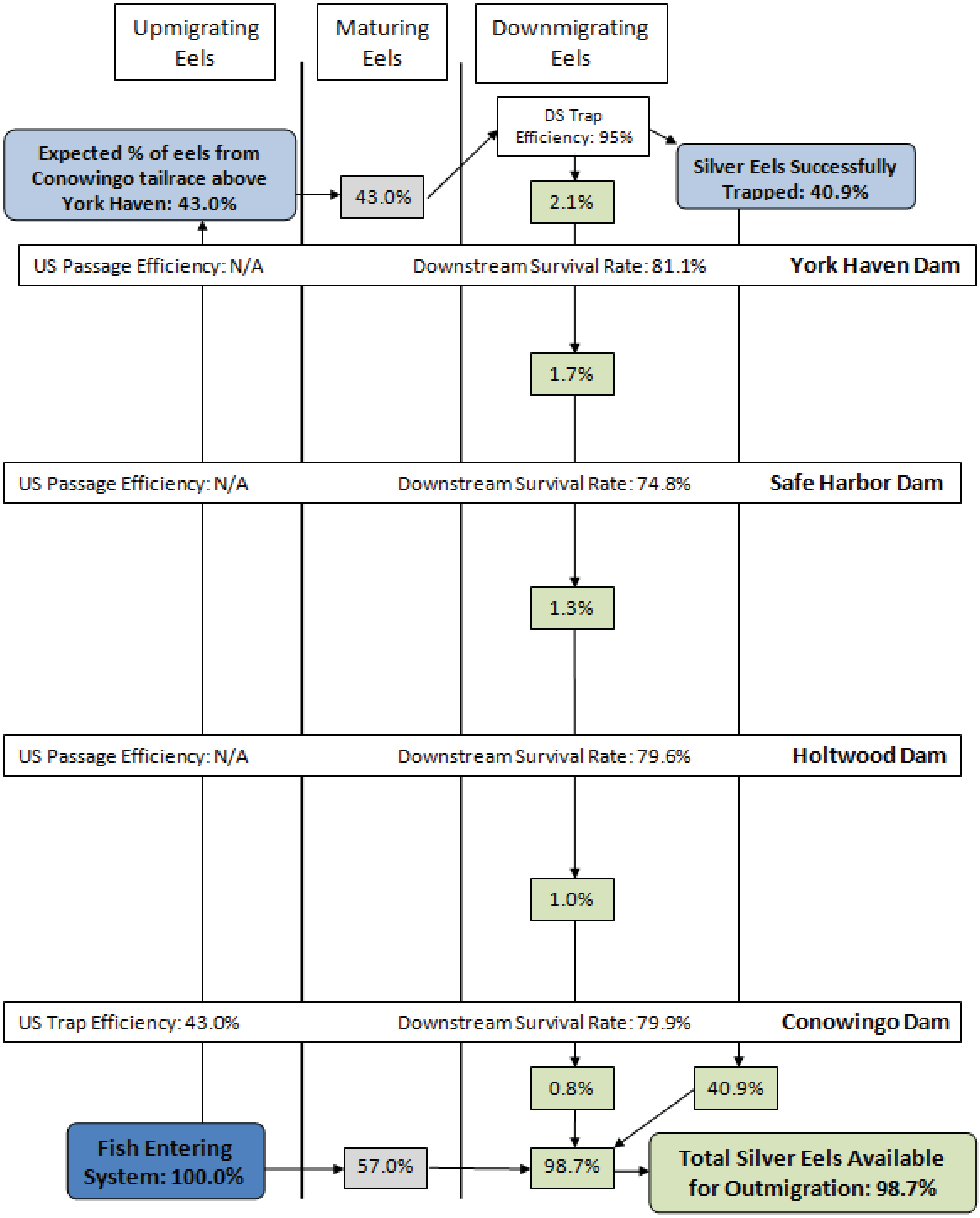


FIGURE 7-8: HIGH END UPSTREAM AND DOWNSTREAM TRAP AND TRANSPORT WITH 95% DOWNSTREAM TRAP EFFICIENCY



8.0 CONCLUSIONS

No range-wide estimate of American eel abundance exists. Such an estimate is hampered by the panmictic nature of the species and the fact that individuals from a single population randomly spread over an extremely large and diverse geographic range in fresh, estuarine and marine waters. Additionally their growth rates and sex ratios vary dependent upon their geographical location and environmental variables further making population estimates very difficult (DOI 2007).

Absent information on range-wide abundance, the DOI has relied on trends in regional indices to draw inferences regarding the status of the overall population. Specifically, the DOI analyzed trends in four glass eel indices and four yellow eel indices across the species range. Of these indices, the DOI found that trends in the glass eel indices were more indicative of the population's reproductive success and hence overall stability than were yellow eel indices (DOI 2007).

Trends in the four glass eel indices analyzed by the DOI showed stable abundance over a 13-15 year period, beginning in 1989. Based on this analysis, the DOI found the species to be stable in its 12-month finding on a petition to list American eel as threatened or endangered (DOI 2007).

DOI did not rely on yellow eel indices to draw conclusions about the overall population abundance, but it did acknowledge that these indices were a good indicator of regional or local conditions. The DOI specifically cited the yellow eel index for the Chesapeake Bay, noting that the trend in this index showed a significant decline (50 percent) over the 1994 to 2004 period. The reasons for this decline in abundance of yellow eels in the Chesapeake Bay are not clear. The potential list of reasons could include local factors (*e.g.*, commercial harvest) or population level factors (*e.g.*, shifting ocean currents and the subsequent dispersal of leptocephali from the Sargasso Sea) or some combination of these or other factors.

At a local level, there are no abundance indices available for the Susquehanna River. The MBSS has compiled eel data in several Chesapeake Bay tributaries, including Deer and Octoraro Creeks, which are tributaries to the Susquehanna with confluences downstream of Conowingo Dam. An analysis of these data (EPRI 2011) indicated that the densities in Deer Creek (0.292-0.347 eels/m^2) and Octoraro Creek (0.347 eels/m^2) were in the middle to lower end of the density estimate range for all Chesapeake Bay tributaries analyzed (total range 0.253-0.975 eels/m^2).

At Conowingo Dam, studies have been conducted by the DOI over the period 2005-present, utilizing a ramp facility located near the WFL. The annual catch at this facility ranged from 19 to 42,059 young eels. The larger catches occurred over the period 2008-2010. The number of yellow eels caught over this period has ranged from 25 to 208. The size range of young eels and yellow eels caught over the period 2005-2010 was 76-195 mm and 256-770 mm, respectively.

Exelon collected eels at two locations in the spillway in 2010 and 2011. Of these locations, the location known as spillbay 50 (extreme eastern side of the spillway) captured slightly more young eels (697) than the EFL spillway ramps (569). The overall size range of the young eels caught by Exelon was 92-188 mm; while the overall size range of yellow eels caught was 300-689 mm.

Based on the study findings to date by the USFWS and Exelon, eel passage facilities were conceptually designed and costed for both the WFL and spillbay 50 locations. Facilities analyzed included both eel ladders and trap-and-transport facilities. As illustrated in Table 8-1, the capital costs for the various alternatives ranged from $622,000 (EFL trap and transport) to $2,230,000 (WFL partially buried eel ramp) with annual O&M costs ranging from $200,000/yr to $585,000/yr. All alternatives considered appear to be technically feasible from an engineering perspective, but additional field biological data are needed before final siting.

From a resource-management perspective, the choice of methods for achieving upstream and downstream passage of American eel depends on the resource goals of an overall program. If the sole resource management objective is to provide the most silver eels leaving the Susquehanna River for the journey to the Sargasso Sea, volitional upstream and downstream passage is estimated to provide the most silver eels downstream of Conowingo Dam. If the sole resource-management objective is to maximize eel abundance upstream of York Haven Dam, this goal would be accomplished with an option involving a trap-and transportation program. If an upstream and downstream eel-passage program sought to balance the two resource objectives discussed above, an upstream and downstream trap-and-transport program would be the best approach. If capture efficiencies for the downstream trap-and-transport program are high (approximately 75% or more), this program would also provide more silver eels leaving the river than the volitional approach. It should be noted that inter-annual variability of glass eels returning to the Susquehanna River make predictions of long-term benefits of any potential program uncertain.

TABLE 8-1: SUMMARY OF UPSTREAM EEL PASSAGE ALTERNATIVES

Alternative	Brief Description	Capital Costs (2011 Dollars)	Annual Operation Costs, if Applicable (2011 Dollars)
West Bank - Trap and Transport	Limited length ramp with collection facility in existing parking lot.	$639,000	$585,000
West Bank - Volitional Passage near West Fish Lift	Full eel ramp with resting pools from tailrace to pond elevation, sited near West Fish Lift superstructure.	$1,695,000	$200,000 per year (assumed personnel cost)
West Bank - Volitional Passage near Administration Building	Full eel ramp with resting pools from tailrace to pond elevation, portion buried beneath parking lot daylighting near Administration Building.	$2,230,000	$200,000 per year (assumed personnel cost)
East Bank - Trap and Transport	Limited length ramp with collection facility in existing access area, below non-overflow section of dam.	$622,000	$585,000
East Bank - Volitional Passage	Full eel ramp with resting pools from tailrace below spillbay 50 to pond, cored through top of dam.	$1,125,000	$200,000 per year (assumed personnel cost)

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APPENDIX A CONOWINGO EEL WORKSHOP MEETING MINUTES AND PRESENTATIONS FROM OCTOBER 25 AND 26

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Via Electronic Filing

November 29, 2011

Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Re: Conowingo Hydroelectric Project, FERC Project No. 405, Muddy Run Pumped Storage Project, FERC Project No. 2355, Filing of the Meeting Notes Summary

Dear Secretary Bose:

Exelon Corporation, on behalf of its wholly-owned subsidiary, Exelon Generation Company, LLC (Exelon), encloses for filing a Meeting Notes Summary for the relicensing of the Conowingo Hydroelectric Project (Conowingo Project), FERC Project No. 405, and the Muddy Run Pumped Storage Project, FERC Project No. 2355. If you have any questions regarding the above, please do not hesitate to contact Colleen Hicks. Thank you for your assistance in this matter.

Respectfully submitted,

Colleen E Hicks

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CC: Distribution List-Attachment I

Conowingo and Muddy Run Project FERC Relicensing
Initial Study Report Meeting
Meeting Notes Summary
October 25-26, 2011

Conowingo Visitors Center
4948 Conowingo Road, Darlington, MD

List of Attendees: See Attachment A

Tuesday, October 25, 2011 (Presentations)

Introductions and Meeting Purpose

Tom Sullivan (Gomez and Sullivan) welcomed the group and introduced the general structure of the two-day meeting. The meeting agenda, the anticipated schedule and the background for the meeting were reviewed. Tom Sullivan mentioned that the agenda would be adjusted slightly as Doug Dixon from EPRI would not be able to attend the meeting and would not be presenting the review of the American eel in the Susquehanna River.

Eel Biology and Downstream Behavior: Alex Haro (USGS) gave a presentation on Eel Biology and Downstream Migratory Behavior (Attachment B).

Radio Telemetry of American Eel at the NYPA Moses-Saunders Hydroelectric Project: Kevin McGrath (Gomez and Sullivan) gave a presentation on a downstream American eel telemetry study conducted at the NYPA St. Lawrence-FDR Power Project (Attachment C).

Evaluation of Bar Racks and Louvers for Protecting Eels at Hydro Intakes: Steve Amaral (Alden Lab) gave a presentation on his research related to bar rack and louver exclusion devices (Attachment D).

Review of Research and Technology on Passage and Protection of Downstream Migrating Eels: Bill Richkus (Versar) gave a presentation on his work related to the evaluation of downstream passage and protection measures for American eel (Attachment E).

Wednesday, October 26, 2011

Introductions and Meeting Purpose

Tom Sullivan (Gomez and Sullivan) opened the meeting and welcomed everyone. Parties introduced themselves and gave their affiliation. Tom Sullivan opened up the discussion by asking if there were any downstream technologies that could be taken off the table as impractical in relation to the Conowingo Hydroelectric Project (Conowingo). Bill Richkus (Versar) recommended that chemical attractants/repellents, sound, and induced flows and bubble curtains could be removed from further consideration as not applicable at Conowingo. Don Pugh (American Rivers) also suggested that lights are not feasible at Conowingo. The discussion then moved to other potential downstream passage measures.

Reducing Turbine Mortality-Steve Minkkinen (USFWS) stated that it would be important to determine the typical nighttime Conowingo operation during the adult eel outmigration season and suggested that selective turbine operation may help reduce turbine mortality. He asked for historical operational data including percentage of time of spill, percentage of time of various flows, and the typical turbine operation combinations used during outmigration.

Steve Amaral (Alden) suggested reducing load would reduce injury and mortality; he also suggested that knowing the difference in mortality rates between the Kaplan and Francis turbines at Conowingo would be helpful. Alex Haro (USGS) asked if there have been any mortality studies for eels on these specific turbines and Tom Sullivan (GSE) indicated there have not been.

Larry Miller (USFWS) asked what the wicket gate spacing is for the Conowingo turbines, and what the hydraulic operation range is for the turbines. Kirk Smith (GSE) indicated that the Kaplans range from approximately 7200 to 9600 cfs. He indicated that the capacities of the Francis turbines are 4200 to 6700 cfs for all units except 2 and 5 and 2000 to 6300 cfs for units 2 and 5.

Larry Miller (USFWS) asked if there is preferential unit operation as part of Conowingo Station operating protocols, and Tom Sullivan (GSE) said that load conditions are input into a computer program that provides the most efficient turbine combination for energy production given the load conditions.

Kevin McGrath (GSE) indicated that there were differences in the mortality rates of eels through Kaplan and Francis turbines in the St. Lawrence River. These differences depended on configuration of the leading edge of the blade, wicket gate spacing, gap distance between the blade and casing, number of blades, and rotational speed. Sheila Eyler (USFWS) indicated that there was no spill mortality on the Shenandoah River projects during her investigations.

The stakeholder group indicated that the potential conflicting needs of downstream migrating juvenile shad should be weighed with the needs of the adult eel when considering any preferential turbine operations.

Fish Friendly Turbines-Steve Amaral (Alden) reviewed the specifications for the School Street Project fish friendly turbine being installed on the Mohawk River, and indicated that it is rated for about 2000 cfs, which may not work well for a project the size of Conowingo. He mentioned that rotational speed, number of blades, design in relation to pressure changes and shear stress as well as a thicker leading edge all make the turbine more fish friendly than traditional turbines. It was mentioned that an approximate 3-50% attraction flow was necessary to draw eels. Alex Haro (USGS) indicated that 3% would not be nearly enough to be effective at Conowingo.

Bypass Facilities-Kevin McCaffrey (GSE) opened the discussion by providing the approximate lengths of diversion structures for a potential bypass facility at Conowingo: a 15° diversion structure would be 3650 feet long; a 30° diversion structure would be 1900 feet long and a 45° diversion structure would be 1350 feet long. Kevin indicated that construction of these types of structures would likely be cost prohibitive. Mike Hendricks (PFBC) asked how this would affect shad migration (upstream and downstream, adult and juvenile) and how would resident fish orient to the structure.

Alex Haro suggested that careful thought be used before a guidance/louver/bar rack system is investigated and that efficiencies of these structures be looked at in detail. Sheila Eyler (USWFS) suggested that Exelon conduct a turbine mortality study at Conowingo before diversion/passage options be considered in great detail.

Alex Haro mentioned that some deep bypass gates have been successful but that there are a lot of unknowns associated with this methodology. He stated that many applications are considering multiple openings as opposed to just one for a deep bypass and that the whole issue is very problematic. He mentioned that it is very important to know how eels approach the dam and potential bypass openings to ensure that they are in the most effective position. It was also discussed that multiple openings may be necessary unless the trash rack spacing is approximately 1-2 inches.

Trap and Transport- Sean Seaman (MDNR) suggested that downstream trap and transport may be the most viable option on the lower Susquehanna River for downstream eel passage. Bill Richkus (Versar) suggested that catching eels upstream of York Haven would be the best location. Mike Hendricks (PFBC) suggested that any trap and transport program must take juvenile shad mortality into account. He also indicated that York Haven Dam would be viable trapping spot for adult eels as well. Jim Spontak suggested starting the trap and transport program within the tributaries, as initial step.

Larry Miller (USFWS) stated that there are ecosystem benefits of eel population growth and not just a benefit to the eel themselves. Michael Helfrich (Riverkeeper) suggested that it would be beneficial to have eels in the lower basin for eastern elliptio propagation. Steve Minkkinen (USFWS) said USFWS is sampling in Buffalo and Pine creeks to evaluate the success of their current upstream trap and transport program.

It was suggested by the stakeholder group that there may potentially be some Endangered Species Act considerations with a trap and transport program, if American eel are eventually listed.

The stakeholder group agreed that a meeting be organized that includes MD, PA, and NY biologists and managers to determine basic management goals and research for a upstream and downstream trap and transport program for eels in the Susquehanna River. Alex Haro (USGS) suggested that some basic information needs be collected before a full fledged program is implemented as there is currently a general lack of information on American eel in the Susquehanna River.

Muddy Run 3.5 – Nearfield Effects of the Muddy Run Project (Doug Royer)

Doug Royer (Normandeau) presented the Nearfield Effects of the Muddy Run Project study report (Attachment F).

Larry Miller (USFWS) suggested that the fish susceptible for entrainment at Muddy Run should be the number of fish that made it to Holtwood as opposed to the total fish in the study or fish that made it to Sicily Island; he suggested this would change the entrainment rate considerably. He also suggested that averaging all fish holding below Sicily Island as a total residence time may mask any operations that cause them to hold longer or pass more quickly.

Bob Sadzinski (MDNR) suggested that a table be developed illustrating the operating conditions that each tagged fish was exposed to during the study, to determine impacts of pumping operation.

Conowingo 3.3 – Biological and Engineering Studies of the American Eel at the Conowingo Project (Chris Avalos, Kevin McCaffrey)

Chris Avalos (Normandeau) presented the 2011 upstream eel sampling study results (Attachment G). Chris indicated that the elvers did not necessarily prefer one substrate over the other. He indicated that attraction flow seemed to be the most important factor and that Akwadrain substrate is much easier to work with than the Enkamat substrate.

Bill Richkus (Versar) asked whether there was a distinct size classification for an elver. Alex Haro (USGS) indicated that there is not and that it has been highly controversial topic in the research community.

Steve Minkkinen (USFWS) said USFWS had good sampling results in 2011 near the tailrace area and that they caught 86,000 eels in their ramp. They have essentially kept the same design for 4 years and have not concentrated on researching different designs. He mentioned that there is a good correlation between the Maryland coastal glass eel surveys and the catch at Conowingo the following year.

Larry Miller (USFWS) indicated that a typical fishway prescription written by the USFWS requires two (2) locations for eel ramps. Steve Minkkinen (USFWS) suggested that the west side of the spillway may have some merit and that the entrance gallery should be as close to shore as possible.

Kevin McCaffrey (GSE) presented the engineering options analyzed for upstream eel passage at Conowingo (Attachment H).

Mike Hendricks (PFBC) indicated that Exelon is greatly overestimating the trucking costs for the eel trap and transport program and that the overall costs could be cut substantially. Ian Park (USFWS) said USFWS transports 8000 eels in approximately 80 gallons of water, and suggested that the trucks costed in trap and transport passage options are unnecessarily large. Steve Minkkinen (USFWS) indicated that the USFWS is more interested in a trap and transport program for upstream eel passage than a fully volitional ramp at this point.

Bob Sadzinski (MDNR) asked that Exelon consider the feasibility of capturing eels in the river on the east side, downstream of the dam, as well as downstream locations on the west side.

Shad Population Model (Steve Leach)

Steve Leach (Normandeau) reviewed the model variables and asked the stakeholder group whether some of the values can be fixed or if ranges can be agreed upon. The current age structure ratios were agreed upon by the stakeholder group. It was determined that NetR will not be a pre-determined range and that ranges should be set for other biological variables and NetR would be back-calculated by matching known conditions.

It was determined that sex ratios should be run at 40 and 60% instead of one set number.

For repeat spawners, it was agreed that a range of 10-30% would be used and then those numbers would be added to the next repeat spawner percentage (i.e., 10% becomes 11% the next year; 30% would become 33% and so on). Some of the stakeholders are currently examining how repeat spawning numbers affect the returning adults (i.e., sensitivity).

The input for spawning below York Haven was discussed. It was suggested to use a percentage of the population up to a cap and until the carrying capacity is reached.

Tom Sullivan concluded the meeting and thanked everyone for their participation.

Attachment A-List of Attendees

Name	Affiliation	Email Address	10/25/2011	10/26/2011
Aaron Henning	SRBC	ahenning@srbc.net	Present	Present
Al Ryan	Exelon	halfred.ryan@exeloncorp.com	Present	Present
Sheila Eyler	USFWS	sheila_eyler@fws.gov	Present	Present
Steve Minkkinen	USFWS	steve_minkkinen@fws.gov	Present	Present
Bill Richkus	Versar	brichkus@versar.com	Present	Present
Ian Park	USFWS	ian_park@fws.gov	Present	Present
Josh Tryninewski	PFBC	jtryninews@pa.gov	Present	Present
Bob Sadzinski	MDNR	bsadzinski@dnr.state.md.us	Present	Present
Colleen Hicks	Exelon	colleen.hicks@exeloncorp.com	Present	Present
Dilip Mathur	Normandeau	dmathur@normandeau.com	Present	Present
Don Capecci	PPL	dcapecci@pplweb.com	Present	Present
Don Pugh	American Rivers	don.pugh@yahoo.com	Present	Present
Gary Lemay	Gomez and Sullivan	glemay@gomezandsullivan.com		Present
Jay Ryan	VNF	jtr@vnf.com	Present	Present
Jim Spontak	PA DEP	jspontak@state.pa.us	Present	Present
Julia Wood	VNF	jsw@vnf.com	Present	Present
Kevin McCaffery	Gomez and Sullivan	kmccaffery@gomezandsullivan.com	Present	Present
Kimberly Long	Exelon	kimberly.long@exeloncorp.com	Present	Present
Kirk Smith	Gomez and Sullivan	ksmith@gomezandsullivan.com	Present	Present
Larry Miller	USFWS	larry_m_miller@fws.gov	Present	Present
Michael Helfrich	Lower Susquehanna Riverkeeper	lowsusriver@hotmail.com	Present	Phone
Alex Haro	USGS	aharo@usgs.gov	Present	Present
Thomas Tatham	Consultant	thomastath@aol.com	Present	Present
Kevin McGrath	Consultant	kjmwp1@gmail.com	Present	Present
Mike Hendricks	PFBC	mihendrick@state.pa.us	Present	Present
Chris Frese	Kleinscmidt	chris.frese@kleinschmidtUSA.com	Present	Present
Ray Bleistine	Normandeau	rbleistine@normandeau.com	Present	Present

Name	Affiliation	Email Address	10/25/2011	10/26/2011
Shawn Seaman	MDNR/PPRP	sseaman@dnr.state.md.us	Present	Present
Steve Leach	Normandeau	sleach@normandeau.com	Present	Present
Steve Shreiner	Versar	sschreiner@gmail.com	Present	Present
Tim Brush	Normandeau	tbrush@normandeau.com	Phone	Phone
Tom Hoffman	Gomez and Sullivan	thoffman@gomezandsullivan.com	Present	Present
Tom Sullivan	Gomez and Sullivan	tsullivan@gomezandsullivan.com	Present	Present
Wade Cope	SRBC	wcope@srbc.net	Present	Present

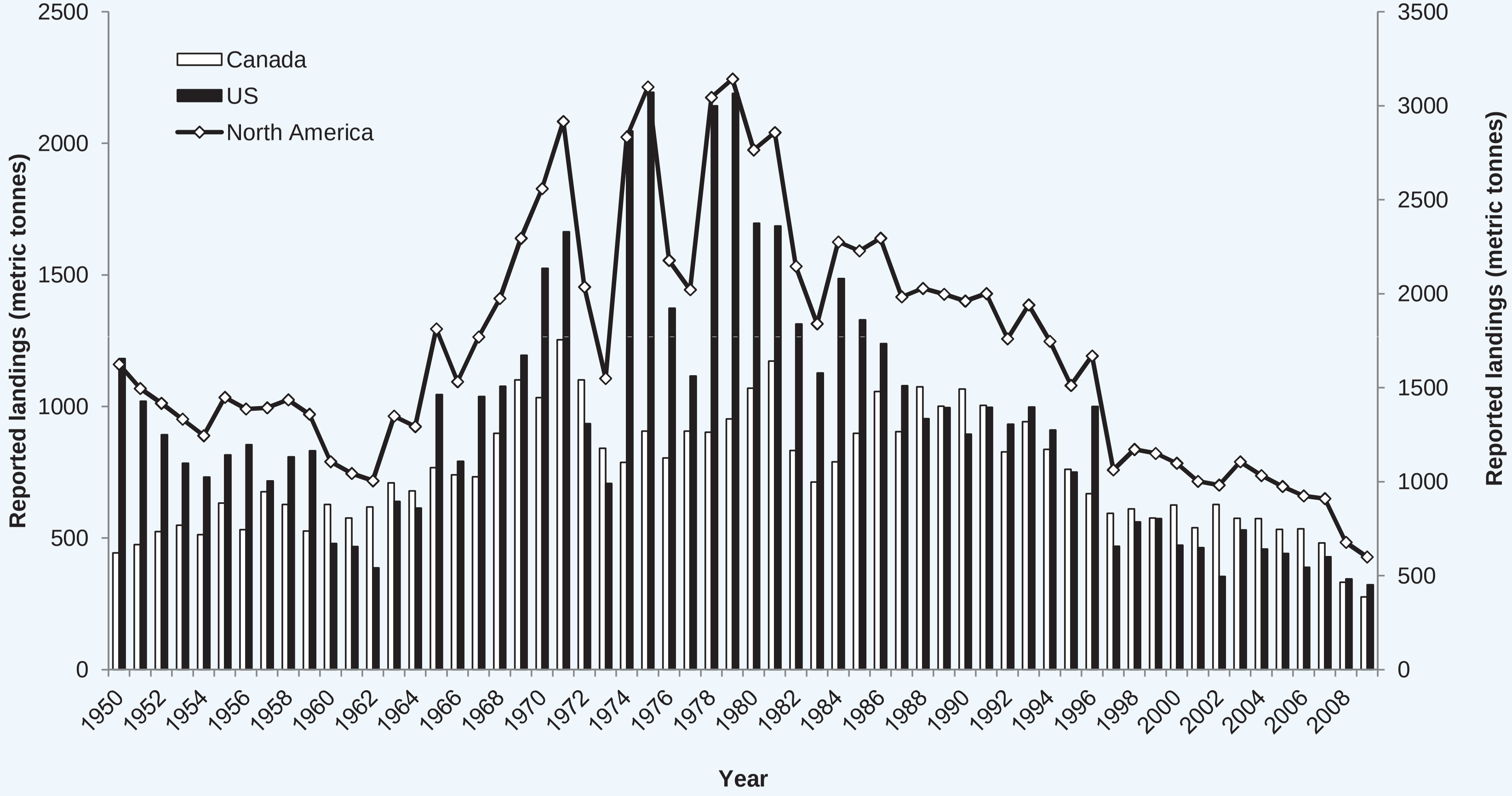
Attachment B-Eel Biology and Downstream Behavior

Eel Biology and Downstream Migratory Behavior

Alex Haro
U.S. Geological Survey
S.O. Conte Anadromous Fish Research Laboratory
Turners Falls, Massachusetts

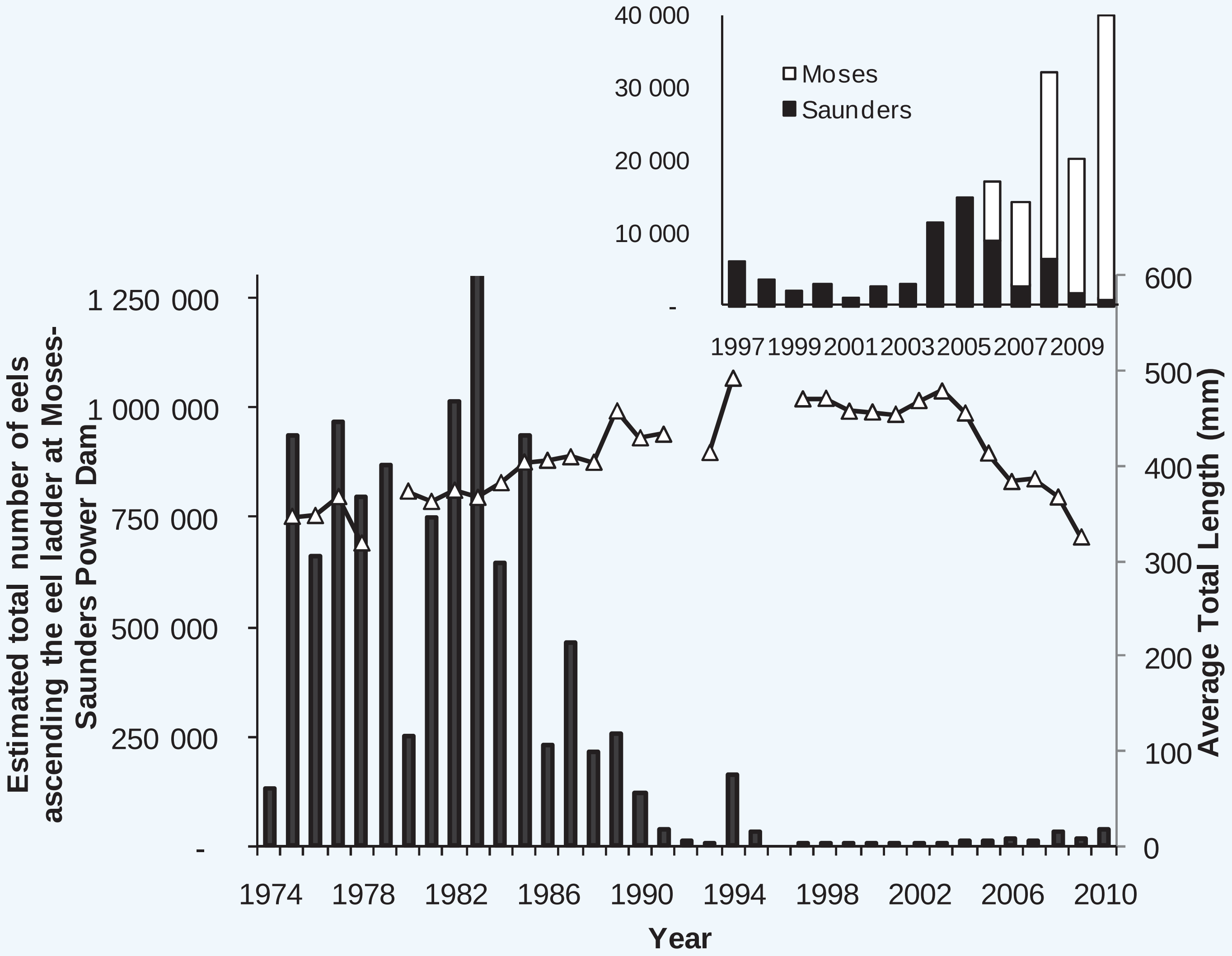
Conowingo/Muddy Run Fish Passage Meeting
October 25-26, 2011
Darlington, MD

Recent decrease in eel population as evidenced by reduction in landings…

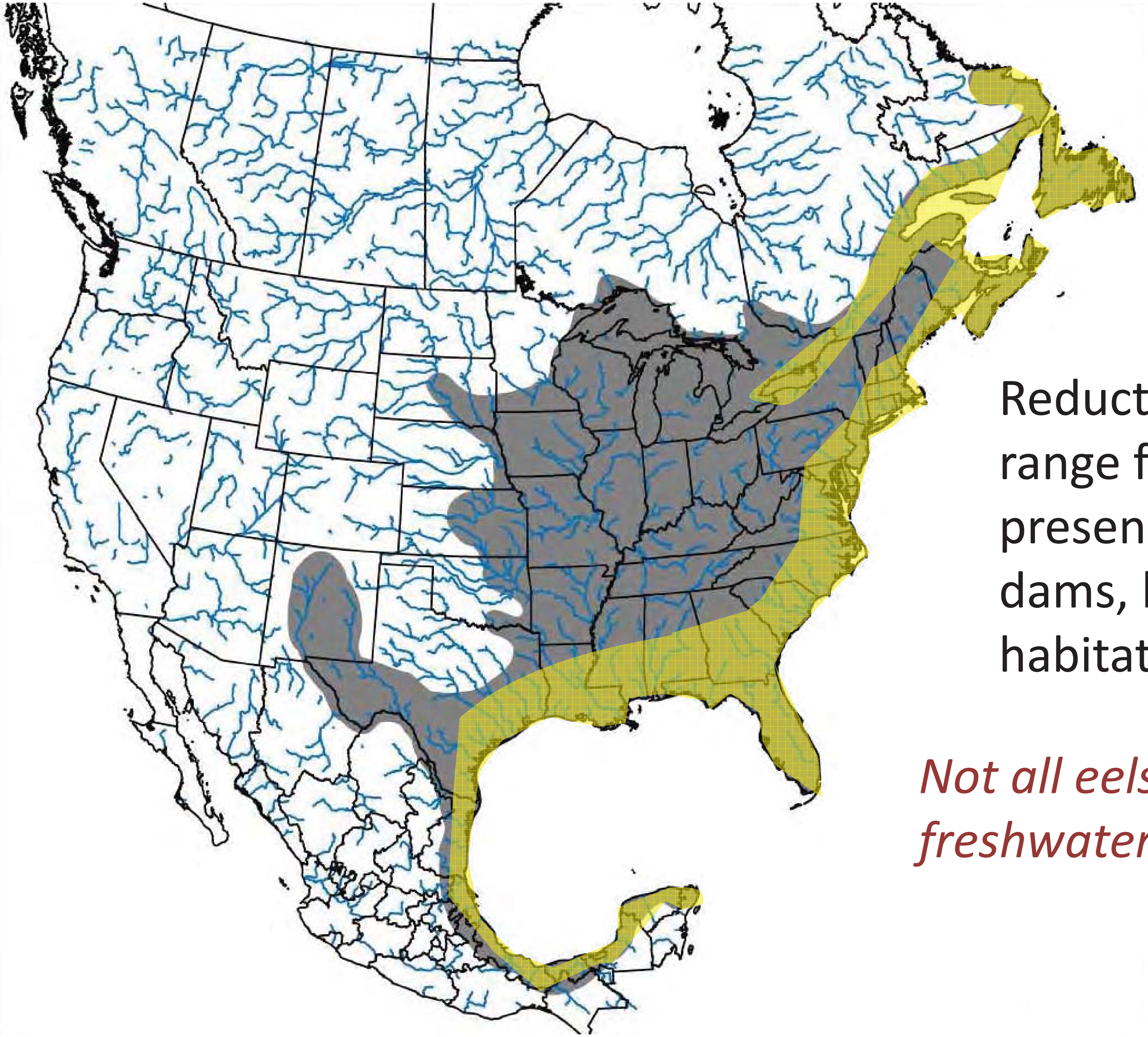


Source: Committee on the Status of Endangered Wildlife in Canada 2006, & V. Tremblay, pers. comm.

…and decrease in recruitment



Source: Committee on the Status of Endangered Wildlife in Canada 2006, & V. Tremblay, pers. comm.

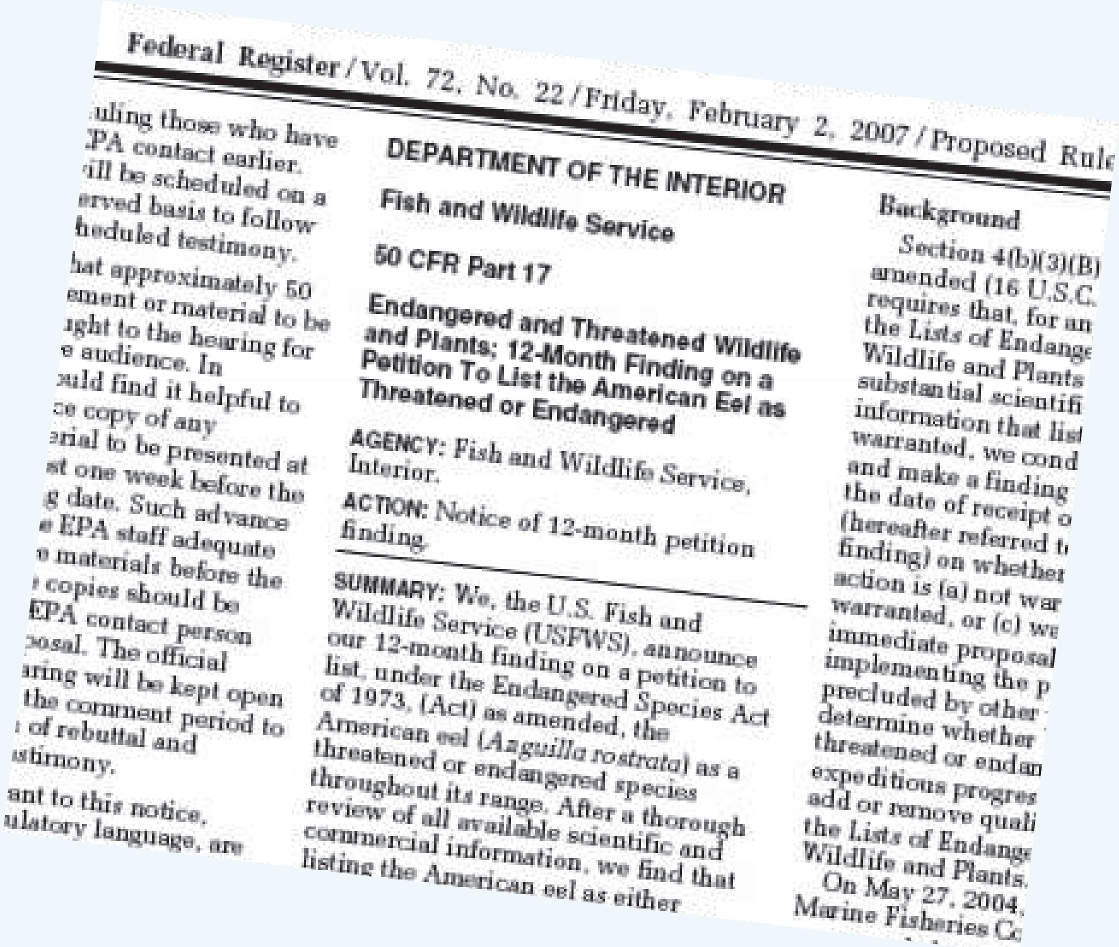


Reduction in range from presence of dams, loss of habitat?

Not all eels enter freshwater

Petitions to list the American eel as a Federally Endangered Species

- 2004 and 2010
- Not listed as Endangered or Threatened
- No other status assigned



Federal Register / Vol. 72, No. 22 / Friday, February 2, 2007 / Proposed Rul

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DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List the American Eel as Threatened or Endangered

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice of 12-month petition finding.

SUMMARY: We, the U.S. Fish and Wildlife Service (USFWS), announce our 12-month finding on a petition to list, under the Endangered Species Act of 1973, (Act) as amended, the American eel (*Anguilla rostrata*) as a threatened or endangered species throughout its range. After a thorough review of all available scientific and commercial information, we find that listing the American eel as either

Background

Section 4(b)(3)(B)
amended (16 U.S.C.
requires that, for an
the Lists of Endange
Wildlife and Plants
substantial scientifi
information that lis
warranted, we cond
and make a finding
the date of receipt o
(hereafter referred t
finding) on whether
action is (a) not war
warranted, or (c) wa
immediate proposal
implementing the p
precluded by other
determine whether
threatened or endan
expeditious progres
add or remove quali
the Lists of Endange
Wildlife and Plants.
On May 27, 2004,
Marine Fisheries Co

Atlantic States Marine Fisheries Commission
Addendum II to the Fishery Management Plan For American Eel (2008)

Recommendations for Federal Energy Regulatory Commission Relicensing

… the Commission requests that member states and jurisdictions request special consideration for American eel in the Federal Energy Regulatory Commission relicensing process. This consideration should include, but not be limited to, ***improving upstream passage and downstream passage, and collecting data on both means of passage****.*

Recommendations for Improving American Eel Passage at Non-Federally Licensed Dams

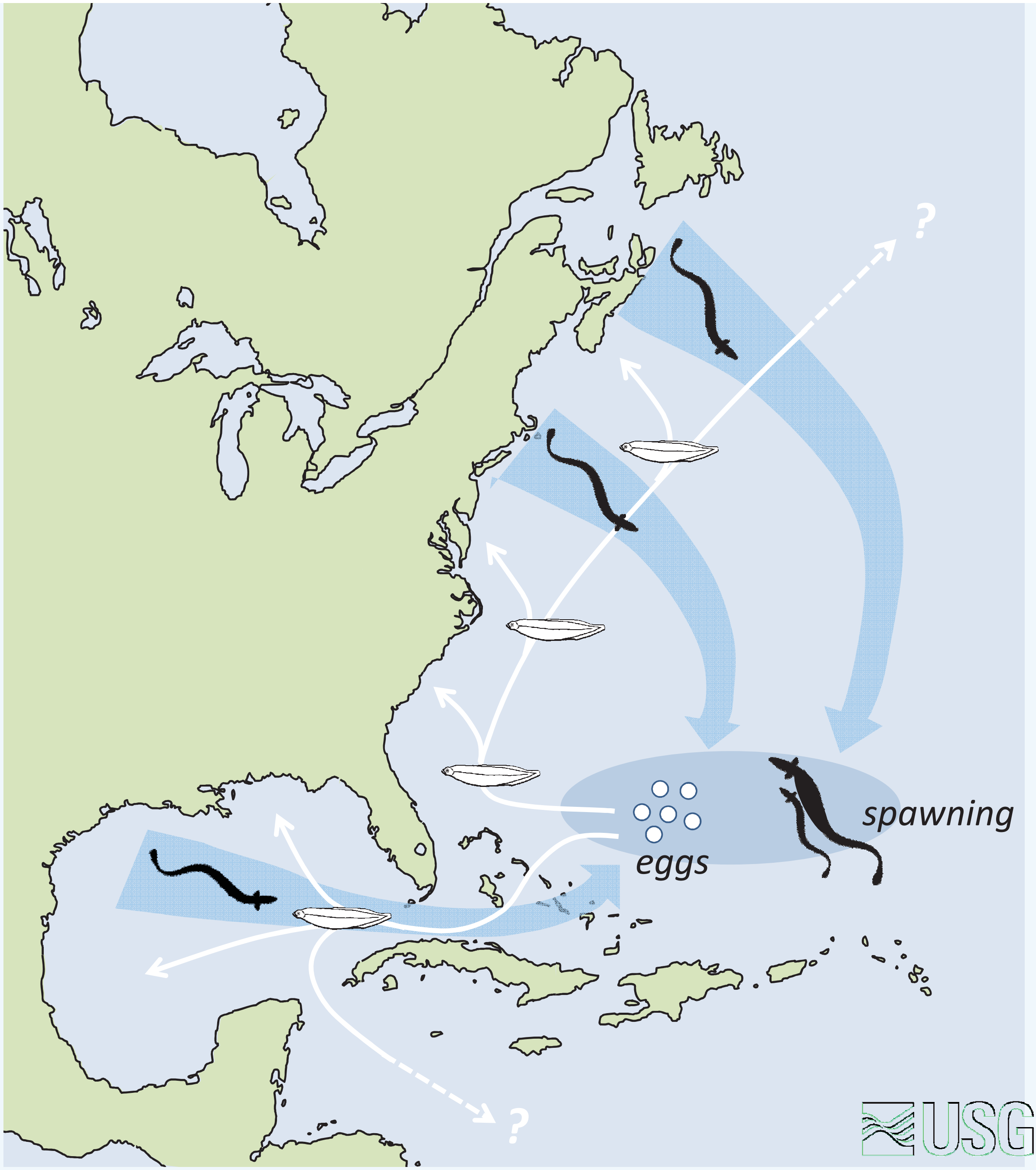
Of the 33,663 dams located on the Atlantic and Gulf Coasts that potentially hinder American eel movement, 95% are not licensed by the federal government. Therefore, the states should strive to remove these obstructions where feasible. If removal is not feasible, then ***upstream and downstream passage should be improved*** *to provide access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel consistent with the goal of the FMP.*

Canada:

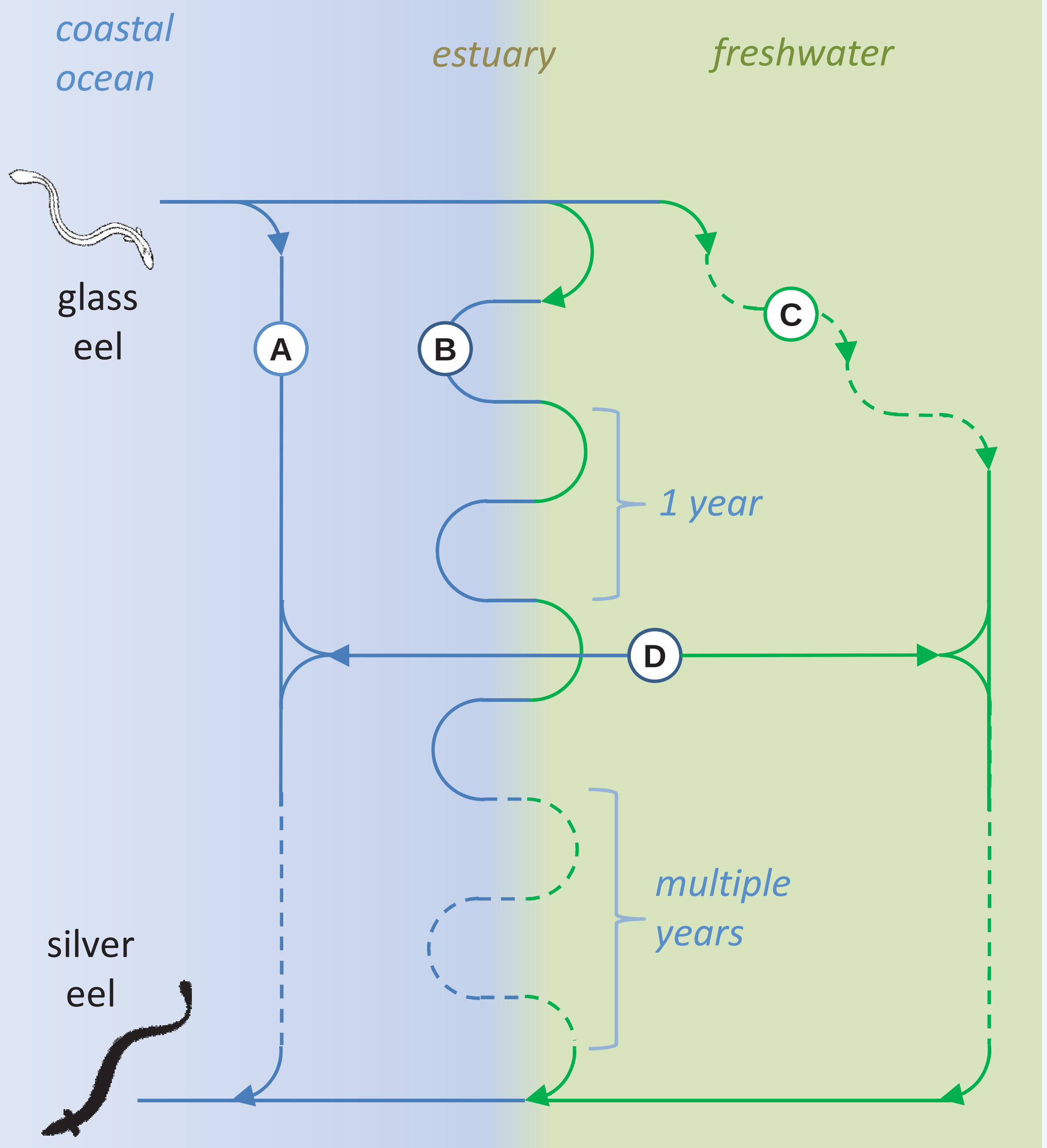
- Designated a *Species of Special Concern* by the Committee on the Status of Endangered Wildlife in Canada in April 2006

- An American eel management plan is being prepared by the Canadian Eel Working Group (CEWG). One of the short-term goals of the plan is to reduce eel mortality by 50% by 2010 through license buybacks. Negotiations are under way with power companies in Ontario and Quebec to develop an overall plan to reduce dam-related mortalities.

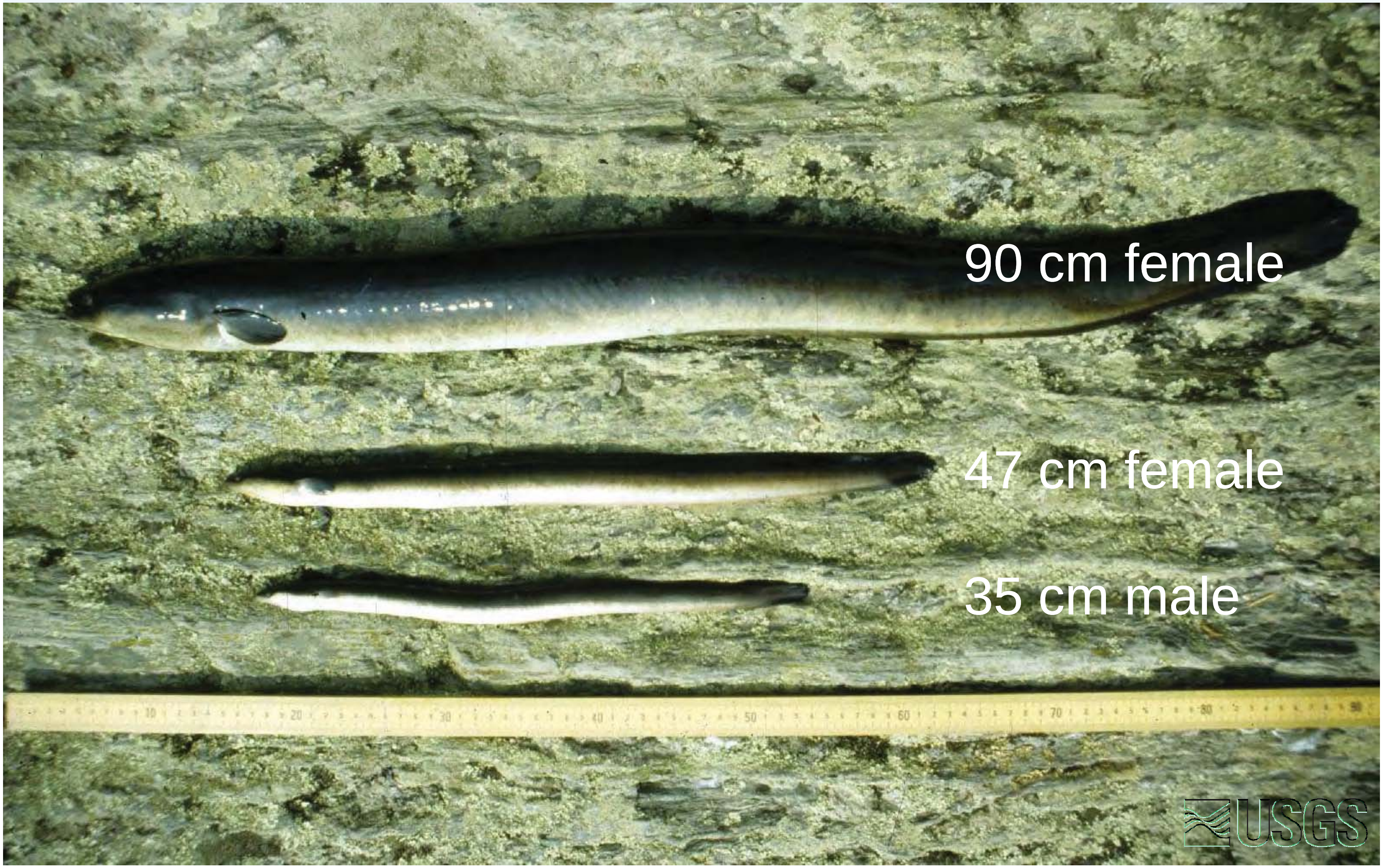
American Eel Life History



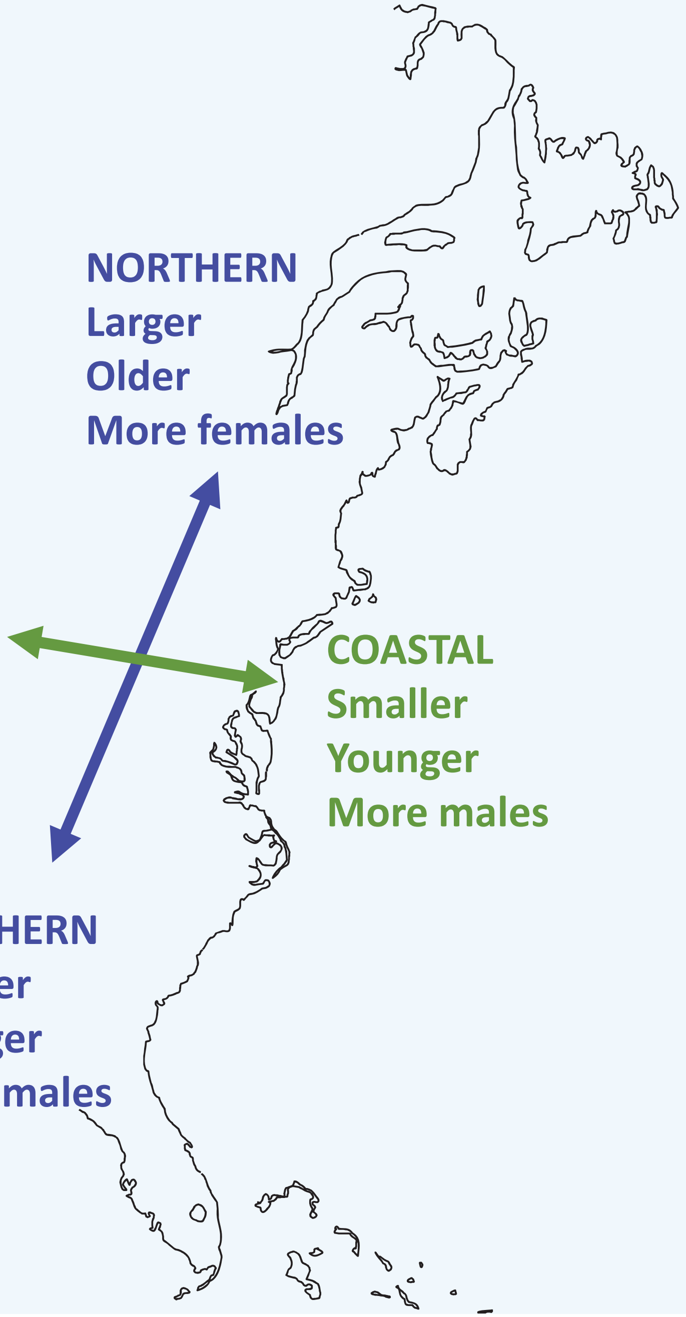
Variability in Life History During the Coastal/ Freshwater Growth Phase



Variability in size, age, and reproductive value of males and females – *all silver-phase, downstream migrants*



Old Paradigm for sex/size/age distribution: *Latitude & Distance Inland*



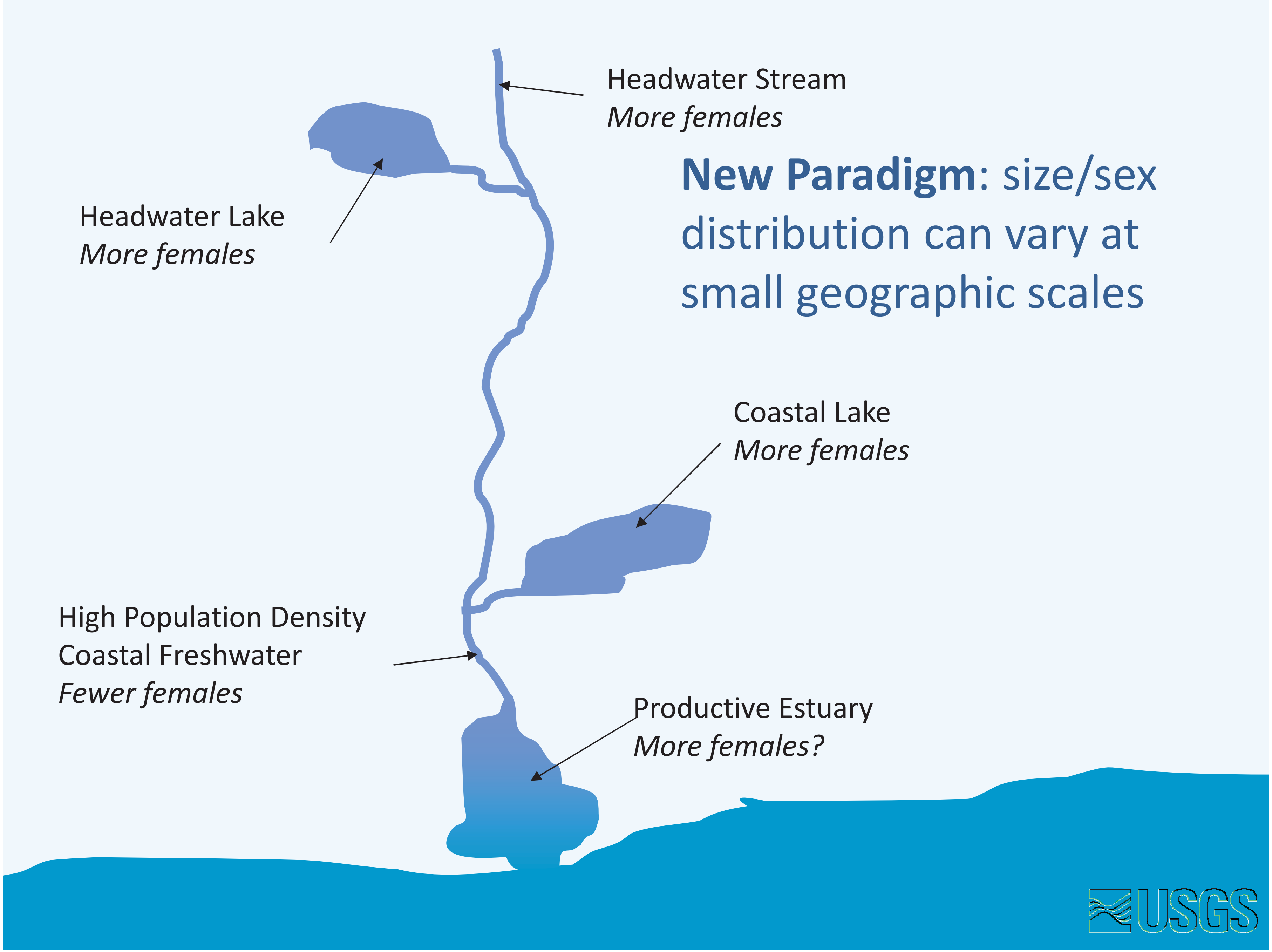
NORTHERN
Larger
Older
More females

INLAND
Larger
Older
More females

COASTAL
Smaller
Younger
More males

SOUTHERN
Smaller
Younger
More males

New Paradigm: size/sex distribution can vary at small geographic scales



Headwater Stream
More females

Headwater Lake
More females

Coastal Lake
More females

High Population Density
Coastal Freshwater
Fewer females

Productive Estuary
More females?

Importance of Environmental Sex Determination in Emigration

- Males: use a *time-minimizing* strategy in emigration (i.e., emigrating at the minimum size required for successful migration to the Sargasso Sea)
- Females: use a *size-maximizing* strategy (e.g., emigrating at older ages and larger sizes to maximize egg production before spawning)
- Females may actually adopt a trade-off between the two strategies which is dependent on environment-specific growth rate (i.e., less favorable growth conditions = migrate at smaller size)

Importance of Eels to Upstream Ecosystems

- Eels occur in virtually all types of freshwater habitats: ecological generalist
- In some habitats, may be the dominant fish species in both numbers and biomass
- Host to several freshwater mussel species, possibly a unique host to some
- Trophic generalist, prey for a variety of other species

Upstream eel passes

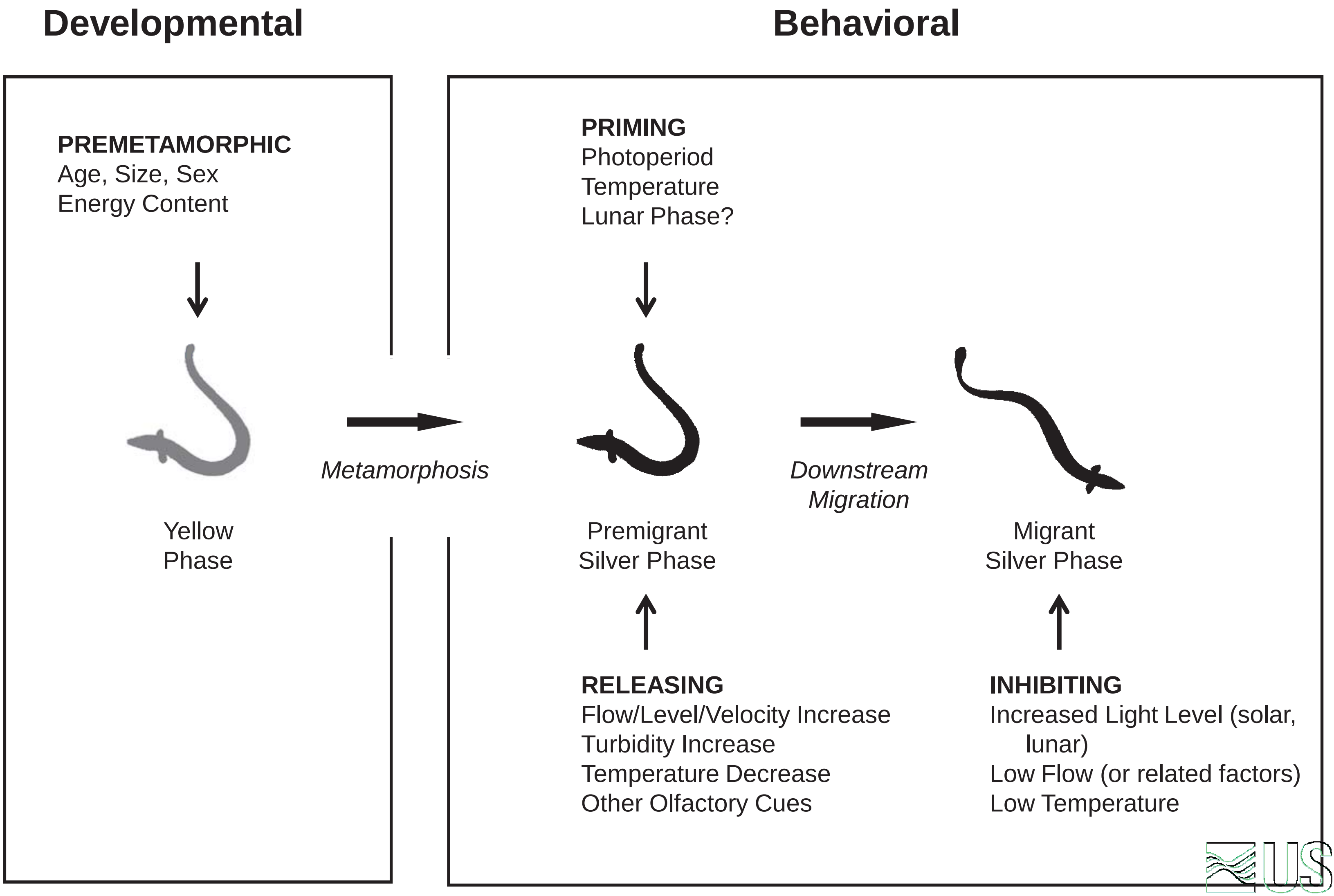
- Simple, cheap to construct
- Can be highly effective

High turbine mortality and injury for eels – 5 to 100%

Downstream Migration: General Behaviors

Metamorphosis from territorial, benthic predator to pelagic, riverine and oceanic migrant

Developmental and Behavioral Phases of Metamorphosis and Migration



Developmental

Behavioral

PREMETAMORPHIC
Age, Size, Sex
Energy Content

Yellow
Phase

Metamorphosis

PRIMING
Photoperiod
Temperature
Lunar Phase?

Premigrant
Silver Phase

Downstream Migration

Migrant
Silver Phase

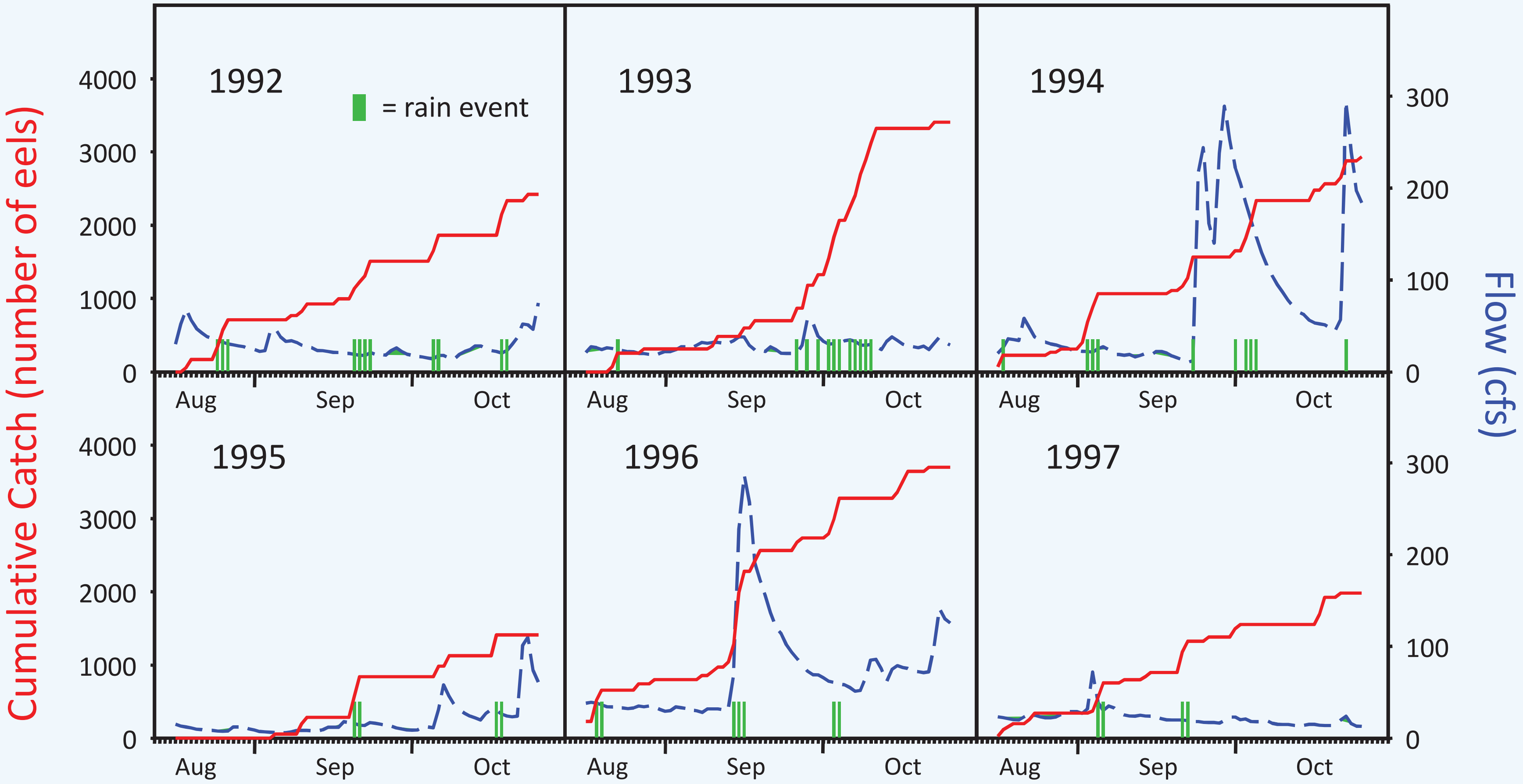
RELEASING
Flow/Level/Velocity Increase
Turbidity Increase
Temperature Decrease
Other Olfactory Cues

INHIBITING
Increased Light Level (solar, lunar)
Low Flow (or related factors)
Low Temperature

Commercial weir data form the basis of our knowledge about downstream migration timing

Silver eel weir at Sebois Stream, Maine

Six Year Catch Dataset from Maine Eel Weir



Data from European Eel also reflects influence of rain/flow on migration

Vøllestad et al. 1986

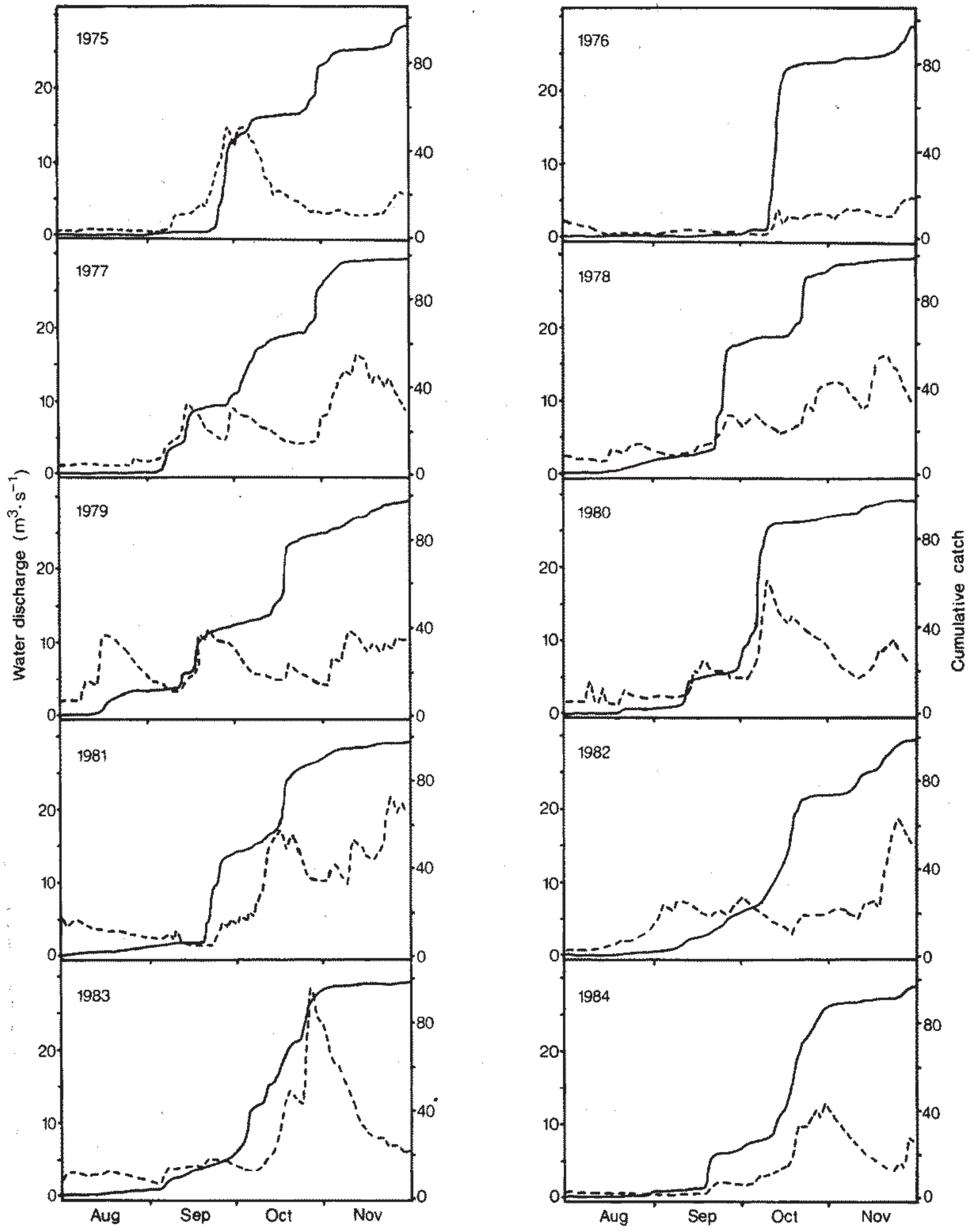
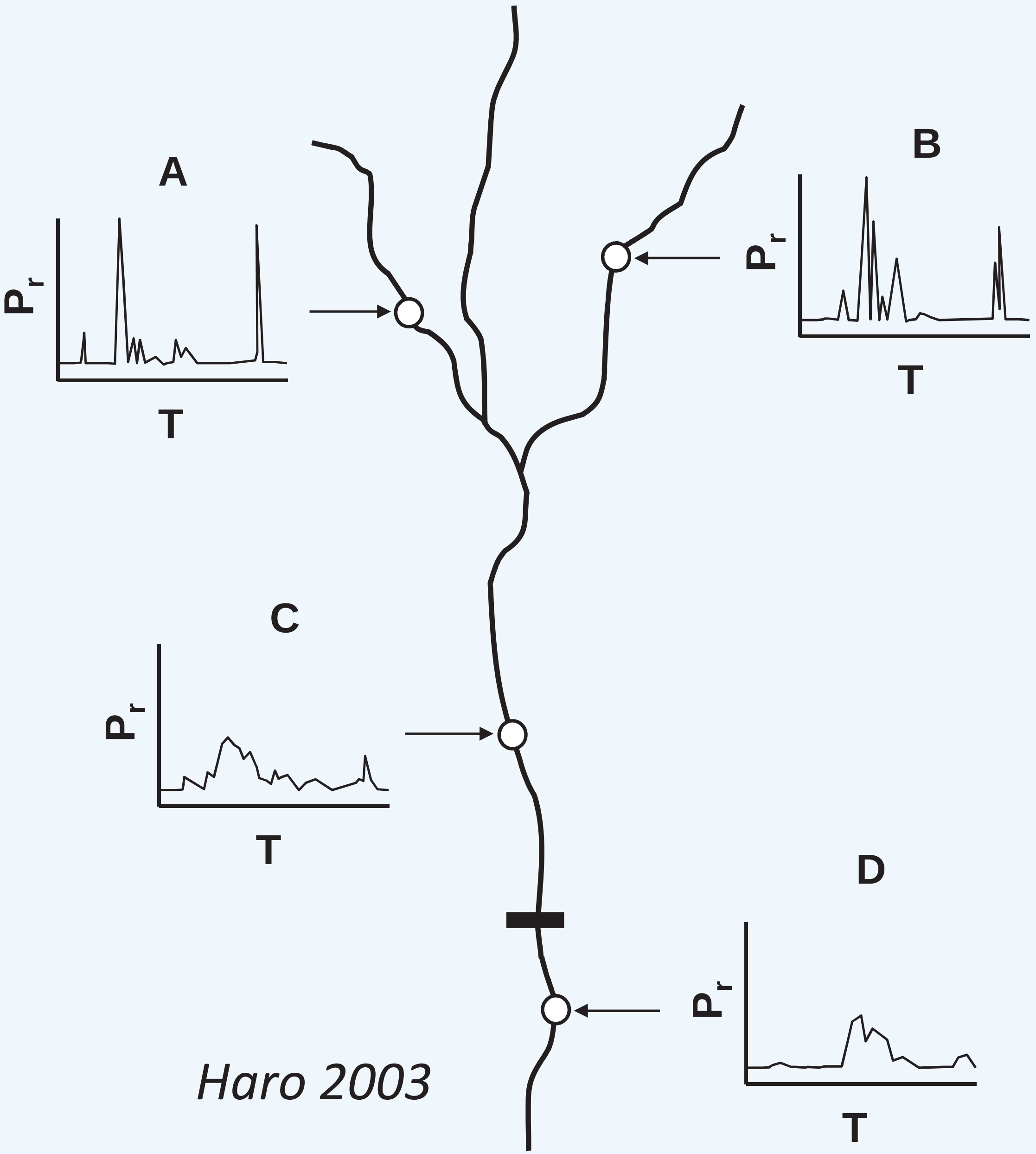


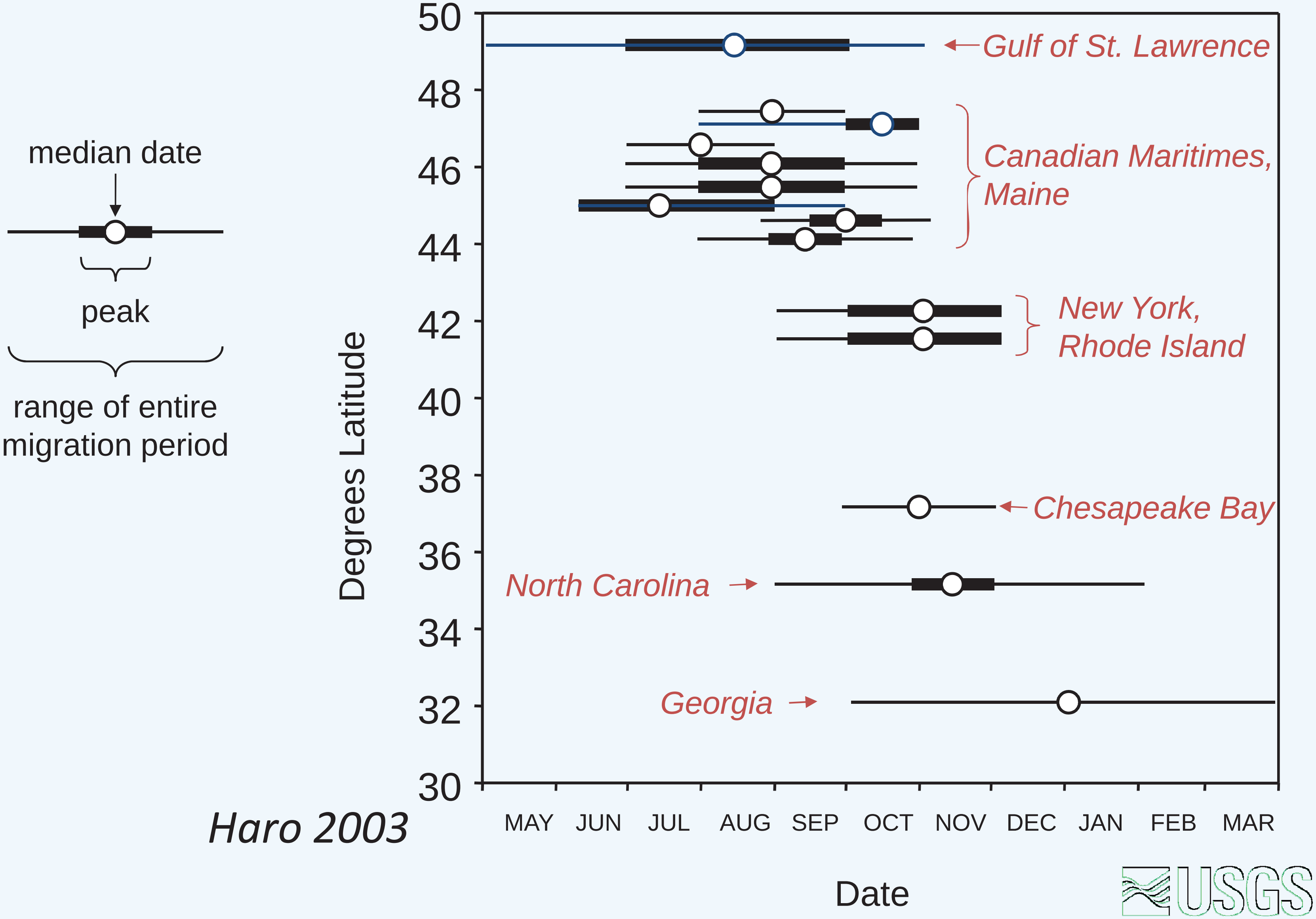
FIG. 1. Cumulative capture of descending silver eels in the fish trap (——) and water discharge (---) in the River Imsa during 1975–84.

Duration and timing of migration may vary in different parts of a watershed



Haro 2003

Latitudinal trend in emigration date of American eels



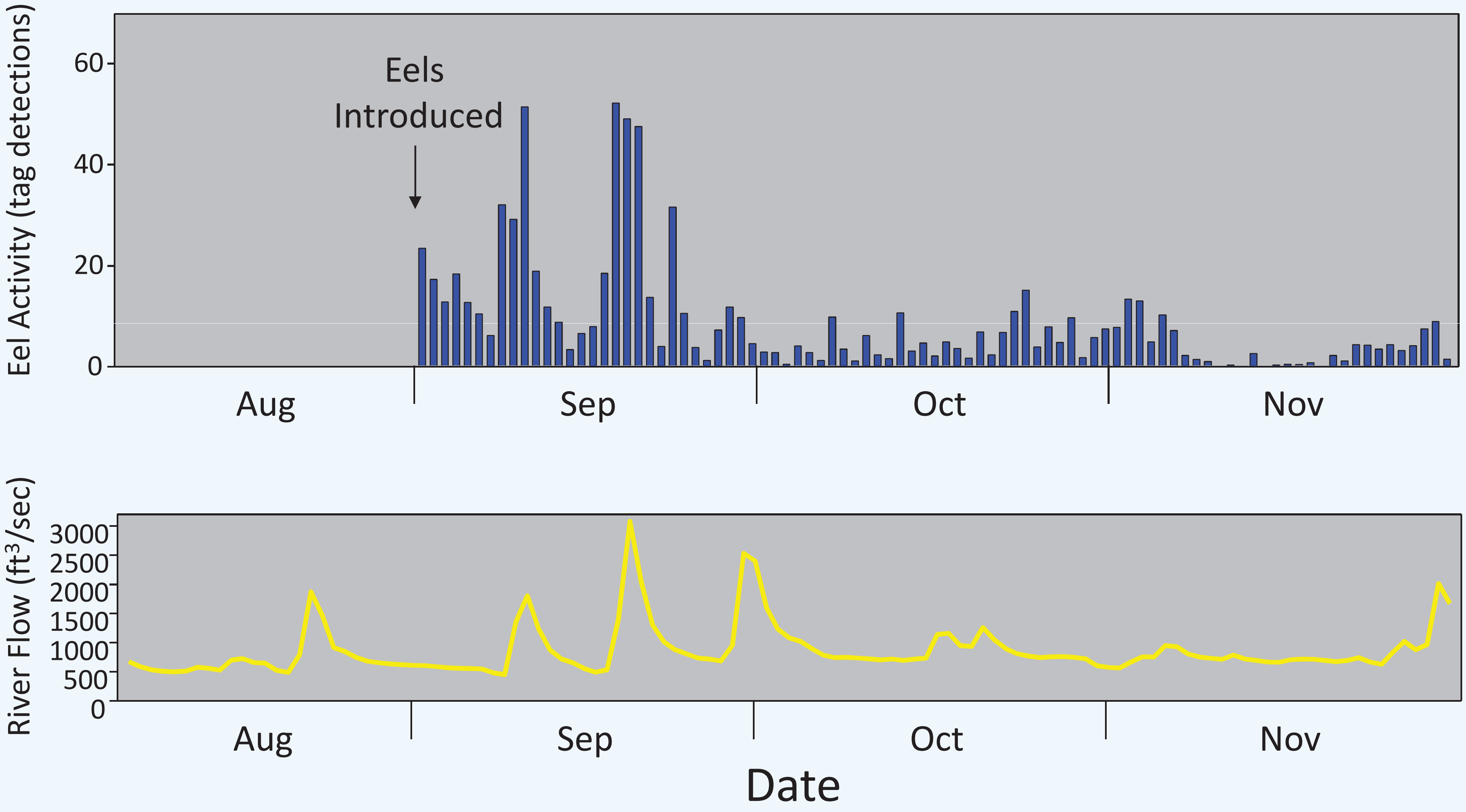
Haro 2003

Migratory Activity & Environmental Cues

Farmington River, CT
B. Eltz thesis study

Europe -MIGROMAT

Activity monitor data – American silver eels

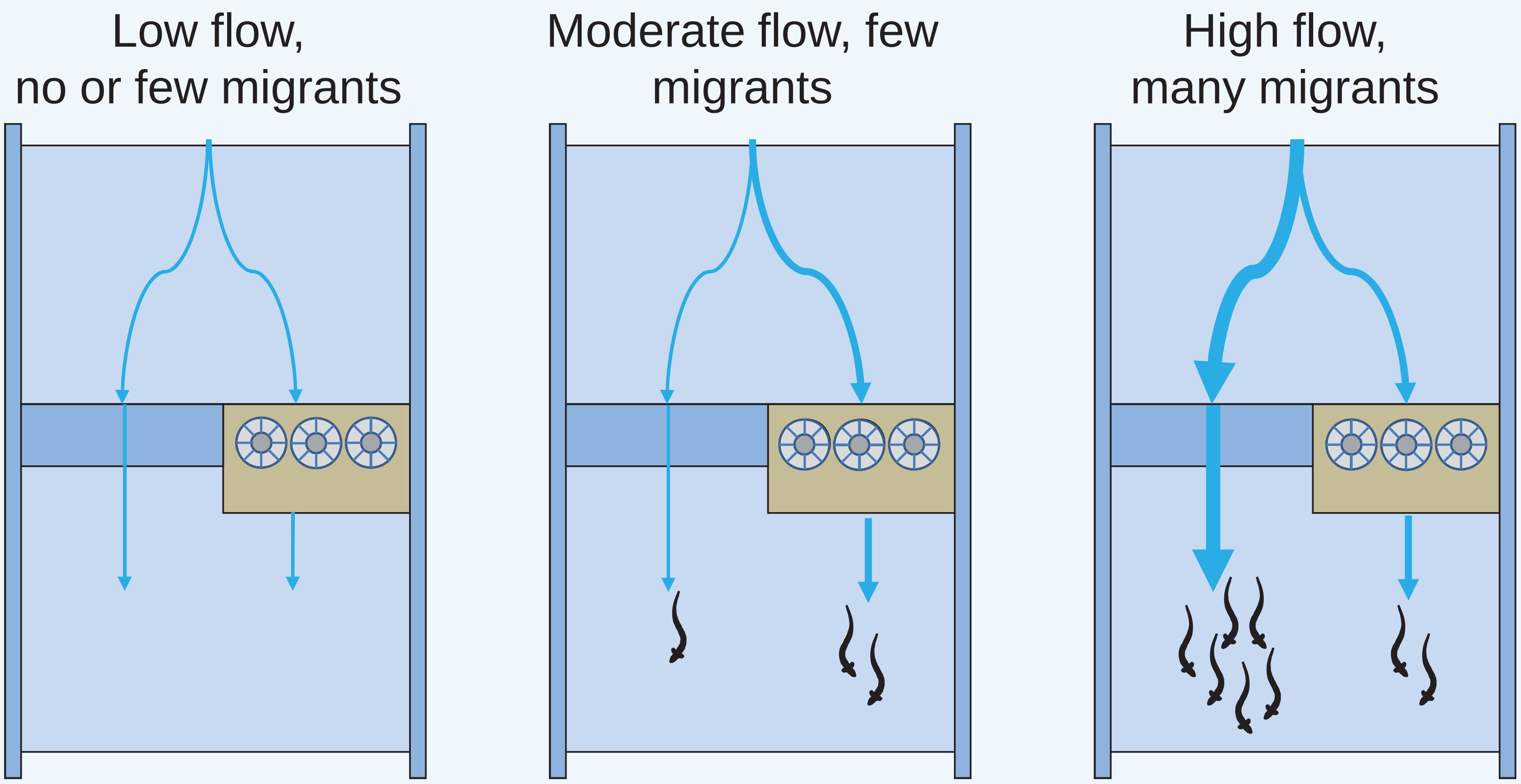


Other Aspects of General Downstream Migratory Behaviors

- Movements primarily at night
- Occupy all depths during migration
- Selective tidal stream transport in tidal reaches
- Tend to follow dominant flows
- Reactive to visual, chemical, and sound stimuli
- Environmental conditions can suspend or terminate downstream migration

Downstream Migration: Dam & Forebay Environments

Relationships of migration timing, flow, and station operation



Low flow,
no or few migrants

Moderate flow, few
migrants

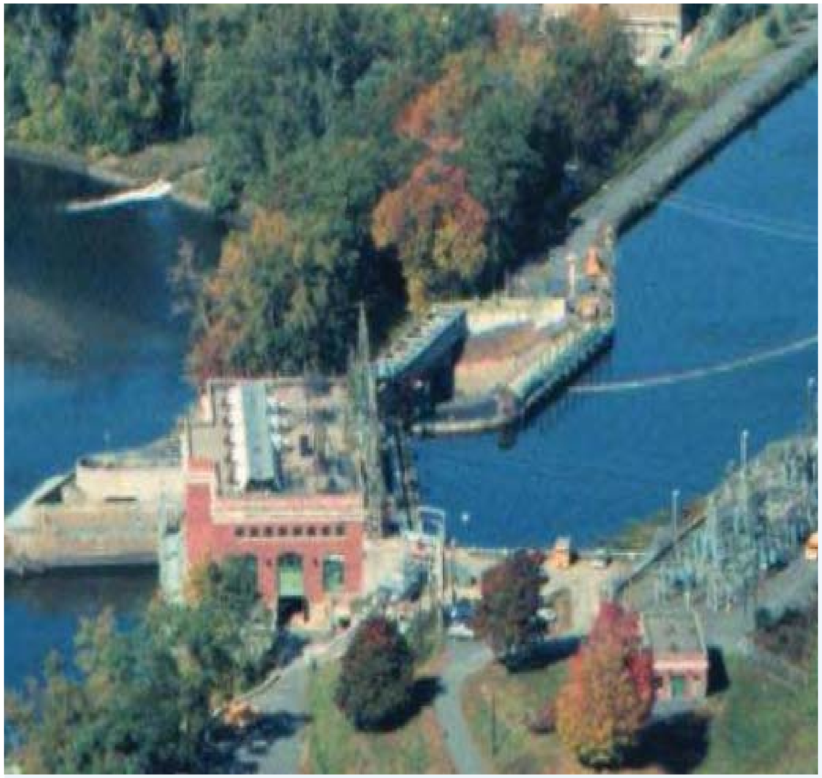
High flow,
many migrants

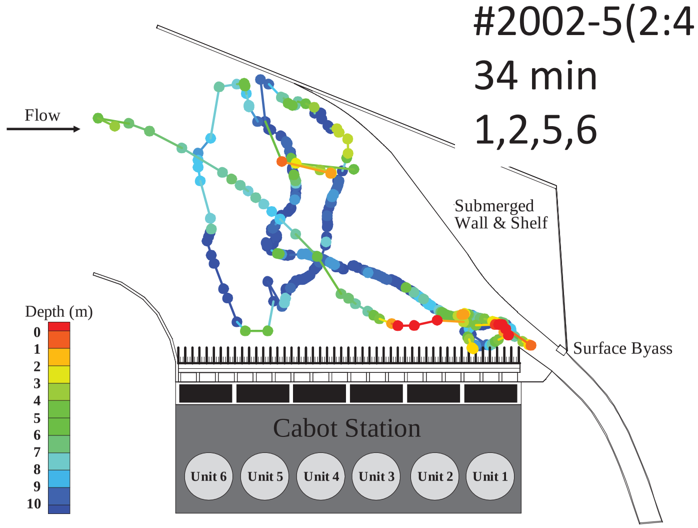
Additional issue of potential spill mortality

Use of Bypass Structures

Cabot Station (Turners Falls, Connecticut River)
surface bypass entrance

Passage of eels through entrance of Cabot surface bypass





#2002-5(2:4)

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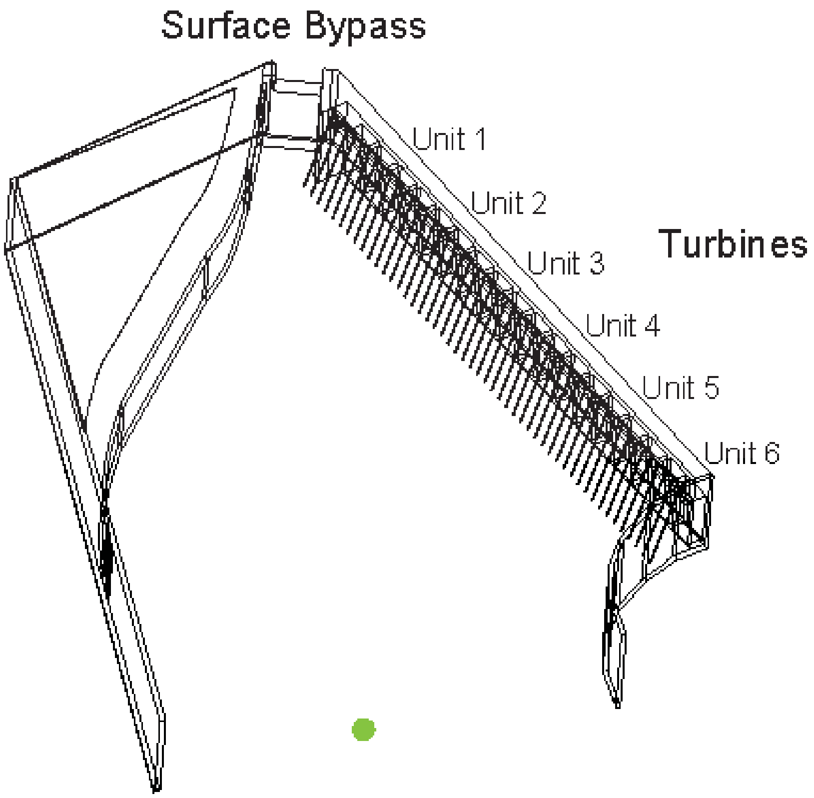
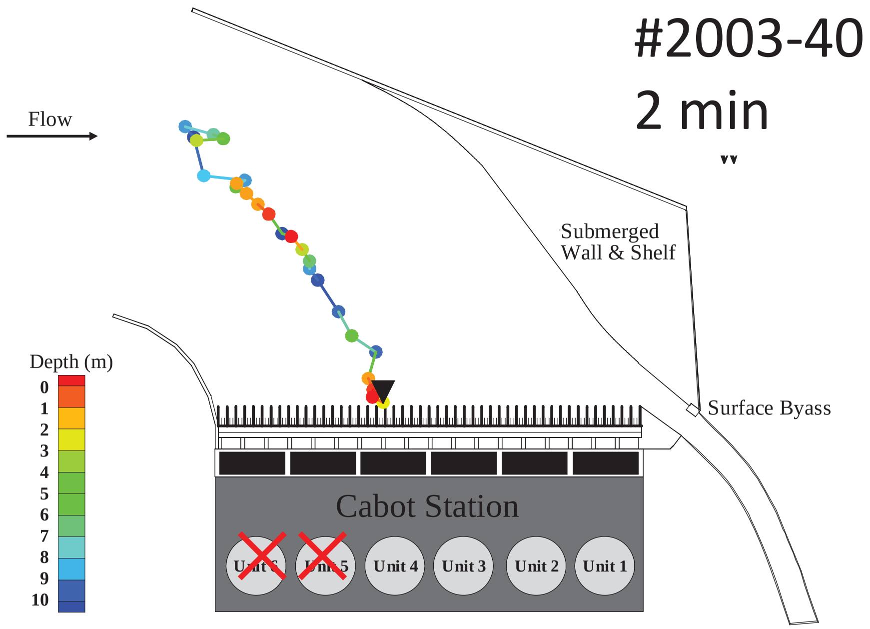
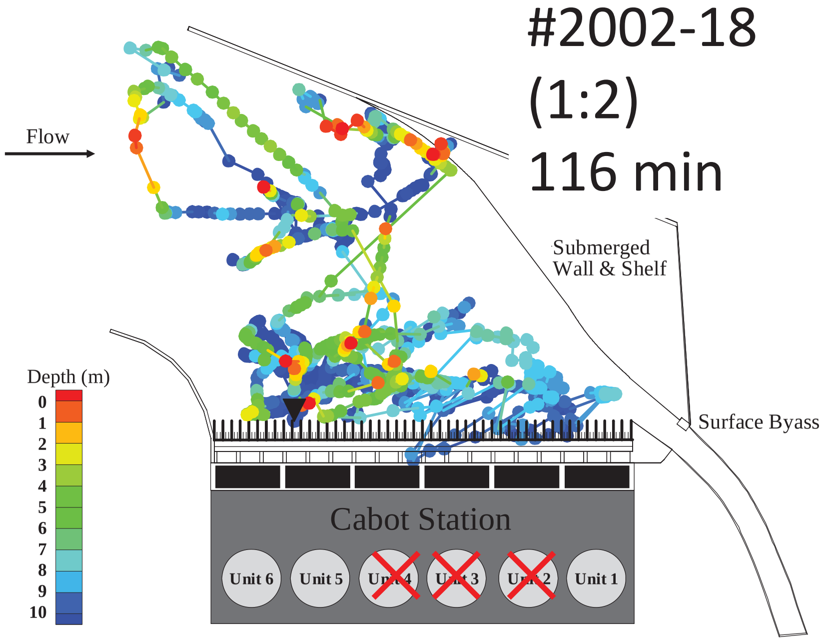
1,2,5,6

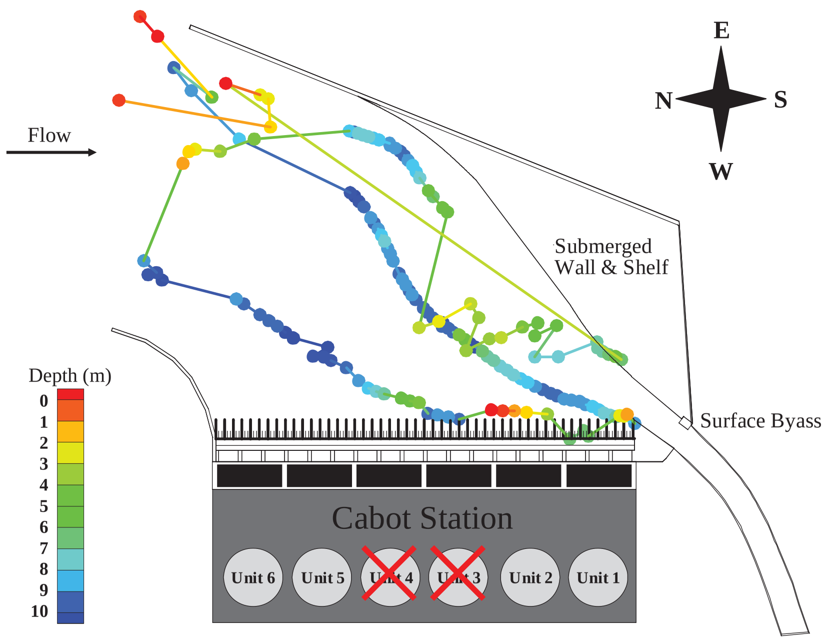


#2003-40
2 min



#2002-18
(1:2)
116 min




Flow
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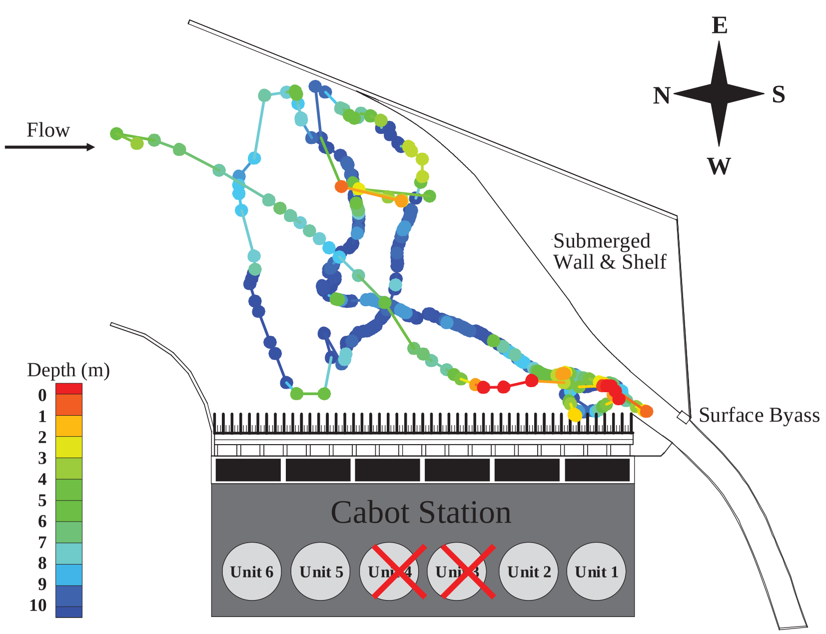
N
S
W
Submerged Wall & Shelf
Surface Byass
Depth (m)
0
1
2
3
4
5
6
7
8
9
10
Cabot Station
Unit 6
Unit 5
Unit 4
Unit 3
Unit 2
Unit 1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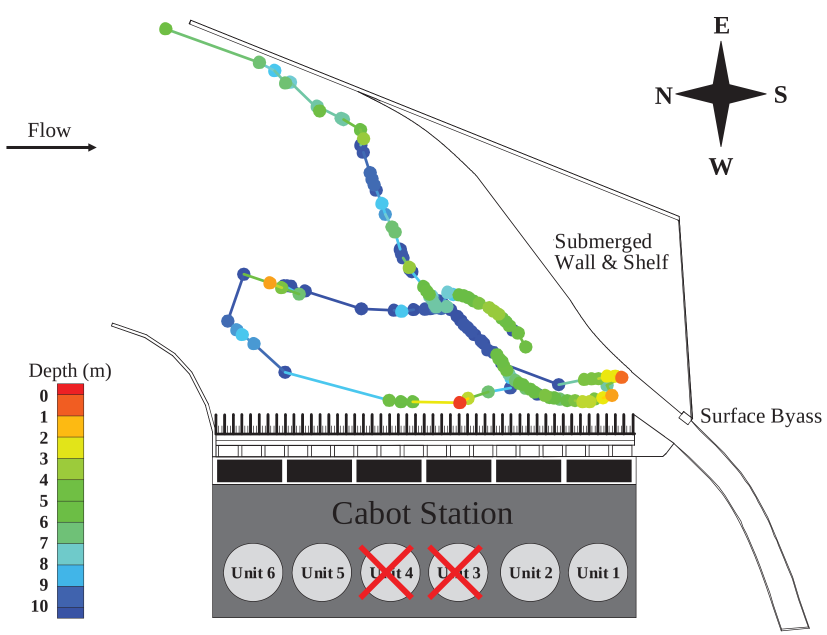
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Surface Byass
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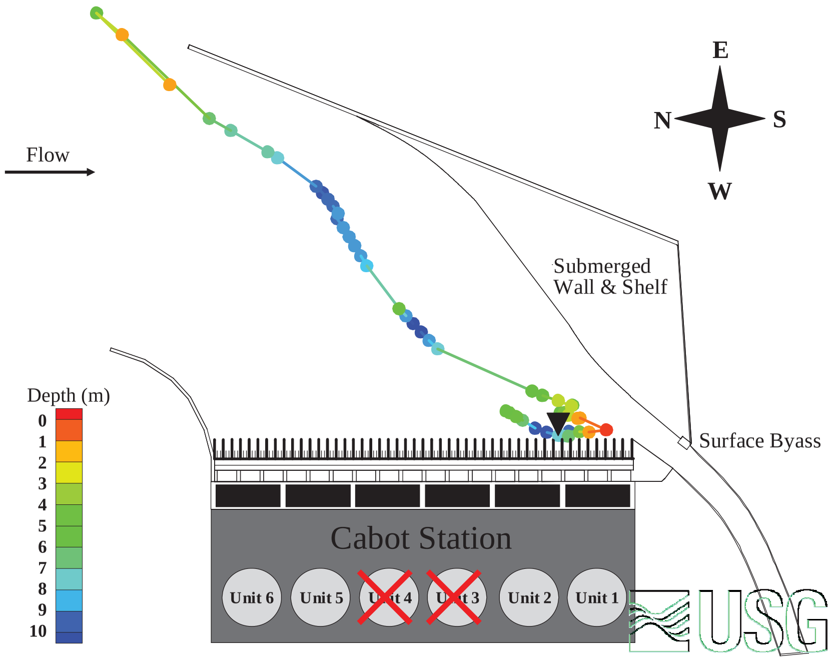
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Cabot Station
Unit 6
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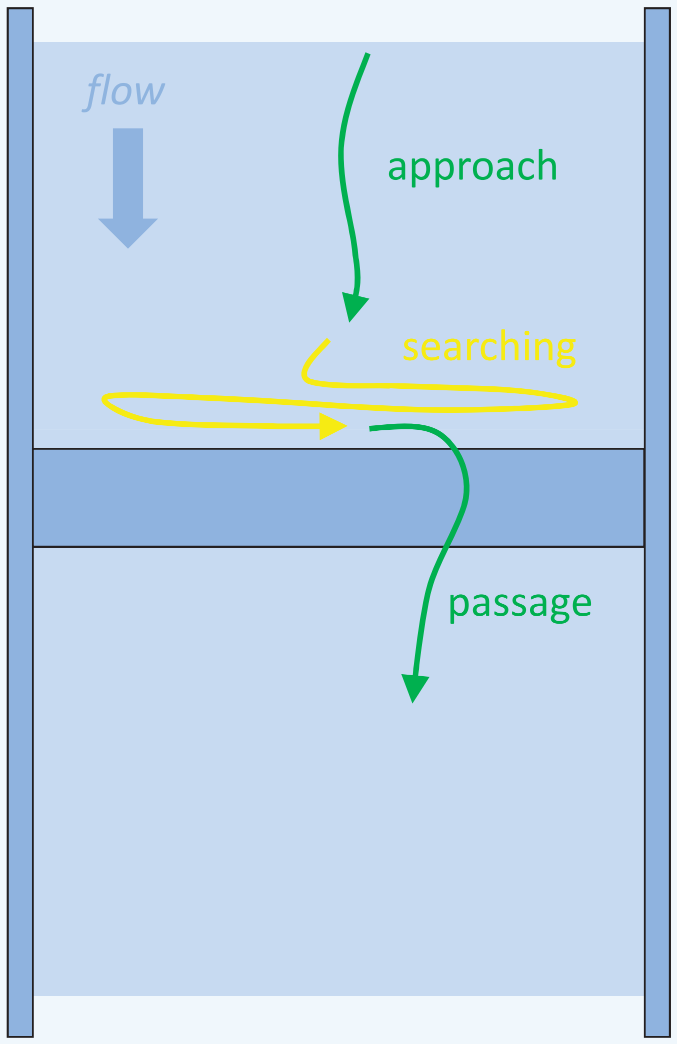
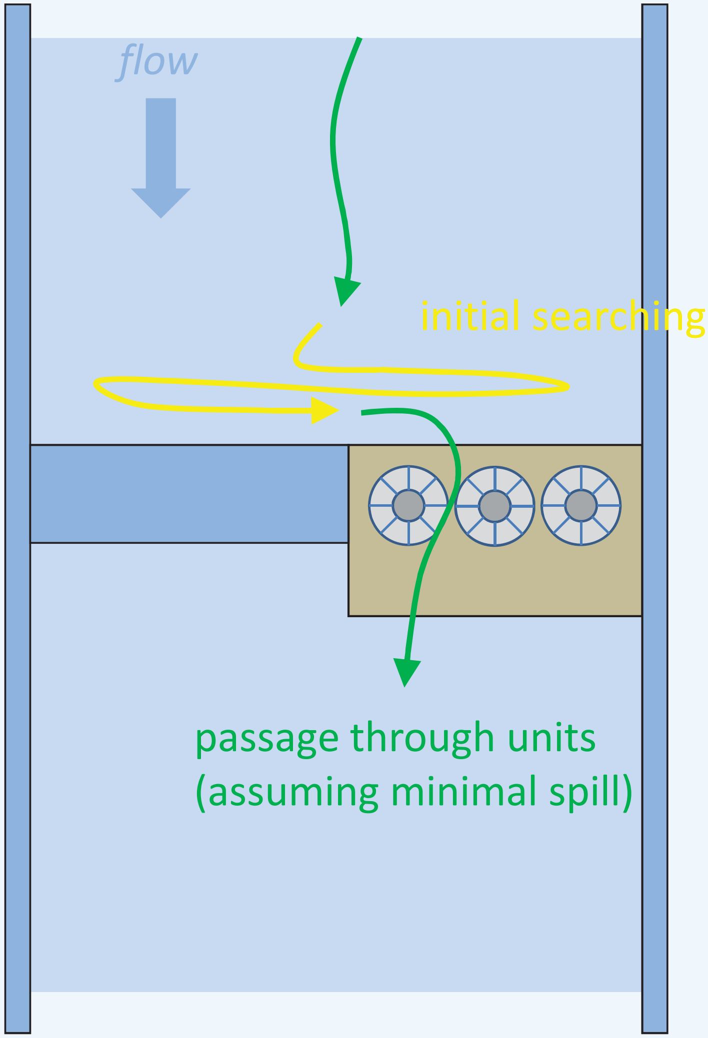
Unit 3
Unit 2
Unit 1

Generalized Behavioral Model of Eel Passage at Dams

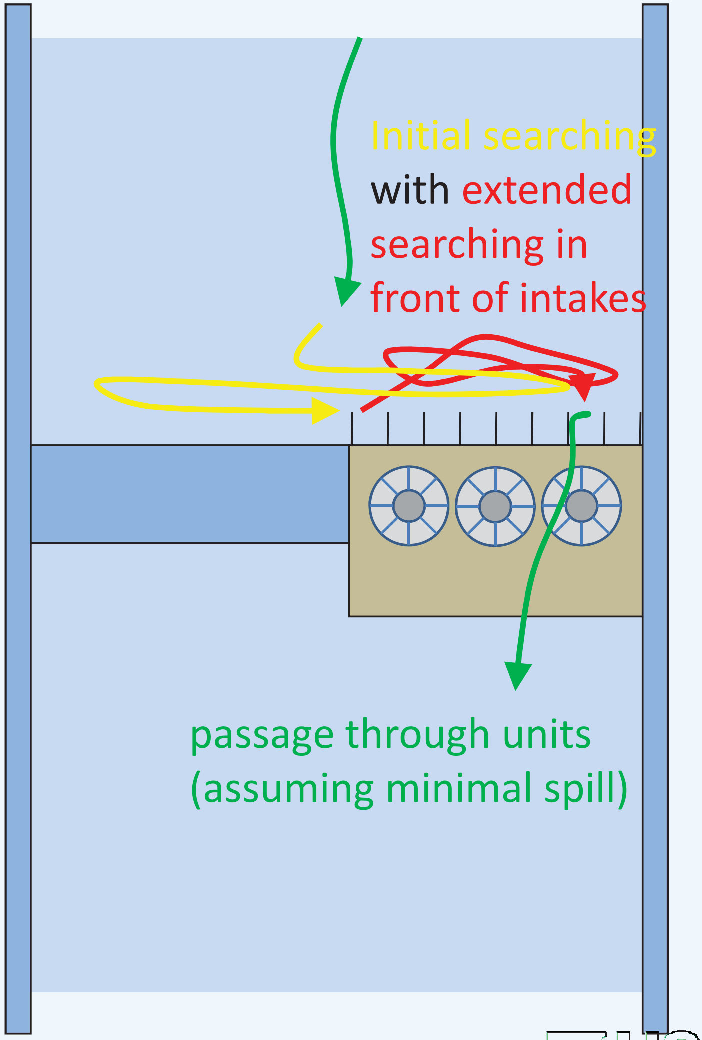
Dam with no hydro



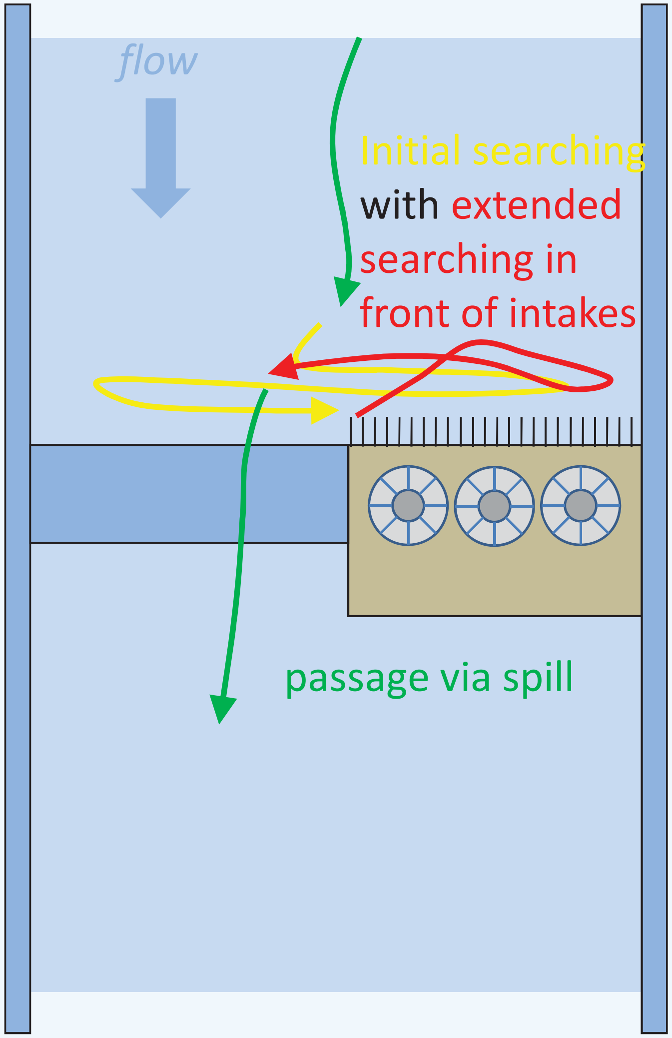
Dam with hydro
– *no exclusion*



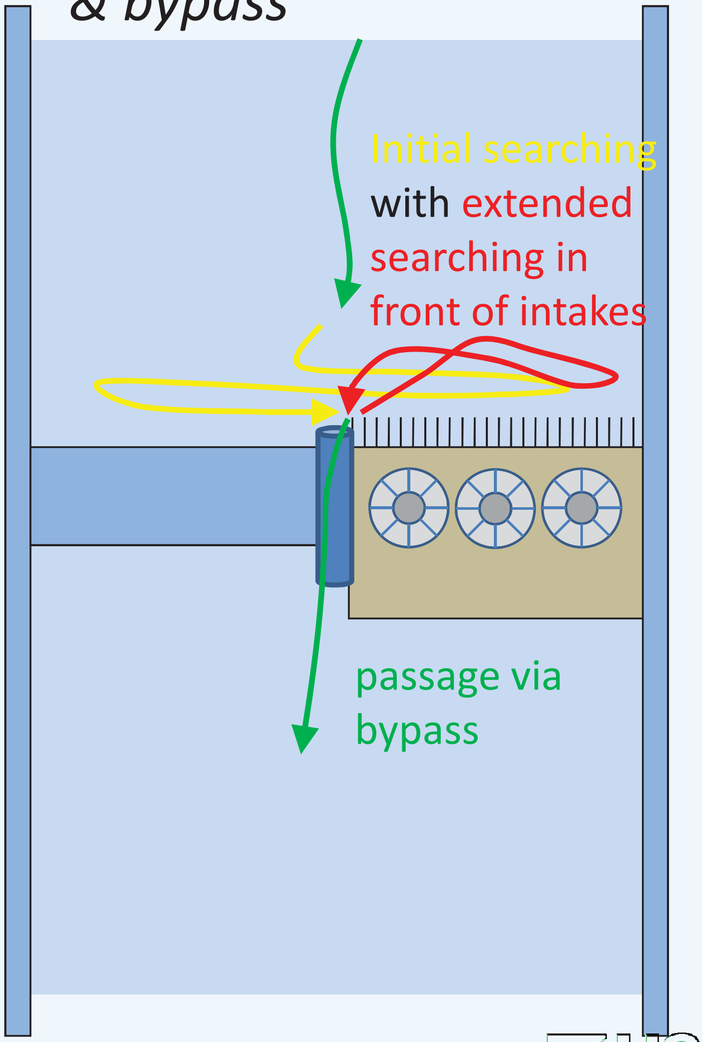
Dam with hydro
– *partial exclusion*



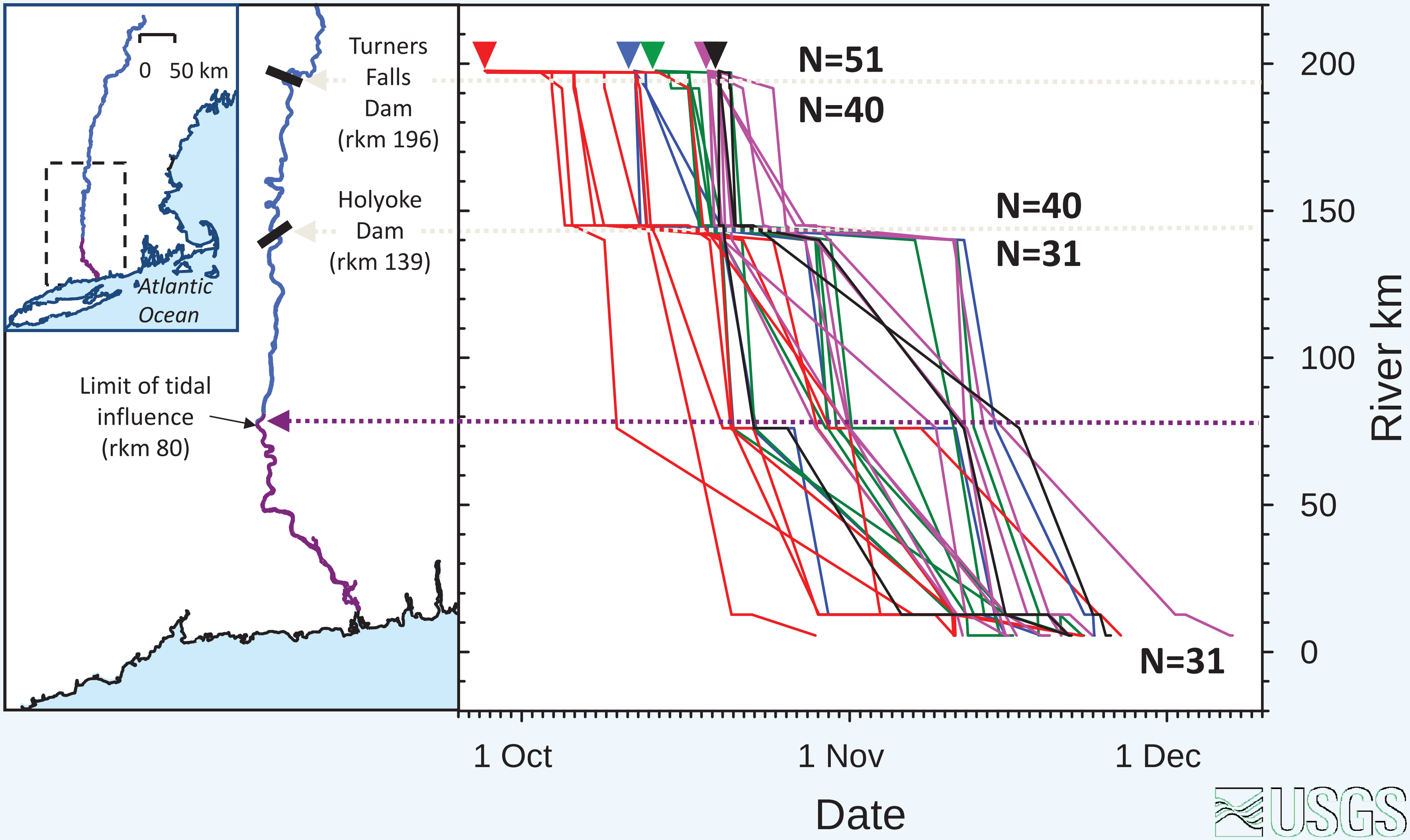
Dam with hydro
– complete exclusion



Dam with hydro
– complete exclusion
& bypass



Downstream movement of telemetered silver eels in the Connecticut River – *delays at dams*



USGS

Important Questions Relevant to Eel Biology & Migration for the Susquehannah:

- What is the extent and value of eel habitat upstream of mainstem Susquehannah dams?
- How important are eels to upstream ecosystems?
- What happens to juvenile eels that don’t pass upstream of Conowingo Dam?
- What are the current demographics of the eel population throughout the Susquehannah watershed? How do they compare to similar undammed rivers (e.g., Delaware)?
- What are the characteristics of the downstream run of eels in the Susquehannah (timing, numbers, sex ratio), and how do they relate to rain/flows or other potential migratory cues?
- What are the effects of dams on upstream population size, demographics, and escapement of adults?

Attachment C-Radio Telemetry of American Eel at the NYPA Moses-Saunders Hydroelectric Project

AMERICAN EEL TELEMETRY STUDY
ST. LAWRENCE RIVER
ST. LAWRENCE-FDR POWER PROJECT

Summer/Fall, 2000

Presented by Kevin McGrath
Gomez and Sullivan Engineers
kjmwp1@gmail.com

Study supported and conducted by
New York Power Authority

Conowingo Project
Downstream Eel Meeting
October 2011

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Primary Objective:

To gather information on downstream migrating eel movement patterns above and in the near-vicinity of the Moses-Saunders Power Dam

Secondary Objective:

Determine if eels concentrate in any area which would lend itself to collection or guidance

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