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December 1, 2009

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Re: Silver Lake Hydroelectric Project, FERC Project No. 11478
Article 401 (B) Dissolved Oxygen and Temperature Monitoring Report
Article 403 Reaeration Baffle Plan

Dear Secretary Bose:

The Silver Lake Hydroelectric Project (Project No. 11478) was issued an original FERC license on February 26, 2009. The Project is located on Sucker Brook in Addison County, Vermont and is owned and operated by Central Vermont Public Service Corporation (CVPS). A Water Quality Certification (WQC) was issued for the Project by the State of Vermont on December 5, 2008. The new license and Condition I of the WQC (included in the license as Appendix A) required CVPS to monitor dissolved oxygen and temperature conditions weekly from July through September directly below the Goshen Dam outlet during the first full season of operation after license issuance.

Attached for submittal is the report presenting the results of the 2009 water quality monitoring event at the Silver Lake Hydroelectric Project. This report also addresses the requirements in Article 403 of the license which relate to developing a plan for installing a reaeration baffle at the outflow of the Goshen Dam control structure to enhance water quality conditions.

Condition I of the WQC requires that CVPS file a report of its findings with the Vermont Agency of Natural Resources (VANR) by December 1 following the sampling period. In addition, Article 401 (B) of the license requires that CVPS submit their documentation of completion of the report to FERC by December 1, 2009. Likewise, Article 403 of the license requires consultation with VANR and the U.S. Fish and Wildlife Service (USFWS). A draft of this report was submitted to the VANR and USFWS on October 9, 2009 for review and comment. The comments received were addressed in the final report.

Please contact me if you have any questions. Thank you.

Sincerely,

Jason George
Environmental Scientist

C: J. Cueto, VANR
M. Grader, USFWS
M. Scarzello, CVPS
B. Eliason, CVPS

Enclosure

**SILVER LAKE HYDROELECTRIC PROJECT**
**FERC Project No. 11478**

# Water Quality Monitoring Report

# 2009 Results

*Sugar Hill Reservoir and Goshen Dam*

**Central Vermont Public Service Corp.**
**77 Grove St.**
**Rutland, VT 05701**

**December 1, 2009**

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## 1.0 Background

This report presents the results of the 2009 water quality monitoring conducted at the Silver Lake Hydroelectric Project, and has been prepared to the address the requirements of the Federal Energy Regulatory Commission (FERC) license and associated Vermont water quality certification.

The Silver Lake Hydroelectric Project (Project), located on Sucker Brook in Addison County, Vermont, was issued a new federal license on February 26, 2009. The Project (FERC No. 11478) is owned and operated by Central Vermont Public Service Corporation (CVPS). The new license and associated water quality certification (issued by the State of Vermont to CVPS on December 8, 2008) require that dissolved oxygen and temperature conditions downstream of Goshen Dam be monitored during the first full season after license issuance.

A quality assurance/quality control plan (QA/QC) describing the water quality sampling study design was filed with the Vermont Agency of Natural Resources (VANR) on May 12, 2009. Comments were received and incorporated into the final QA/QC, which was filed with FERC on June 23, 2009. The QA/QC plan provides the details of sampling protocols and procedures for water quality monitoring at the Project. The QA/QC plan is attached to this report in Appendix A.

Certification Condition I in the water quality certification was included in the FERC license by ordering paragraph D and License Article 403, states:

- *Condition I: Maintenance of Dissolved Oxygen Standards below Goshen Dam*. During the first full season of operation after license issuance, dissolved oxygen and temperature conditions shall be monitored weekly from July through September directly below the Goshen Dam outlet when a dissolved oxygen profile in the reservoir near the outlet discloses stratified conditions. The applicant shall collect dissolved oxygen and temperature data at Stations A, A-1, A-2, and A-3 (as described in the 1992 water quality study) and a dissolved oxygen/temperature profile at a reservoir sampling station near the outlet. Records shall include the reservoir elevation and the downstream flow release at the time of sampling. If samples at Station A are found to be substandard, the proposed baffle system shall be installed and tested to determine if it will assure maintenance of standards. A quality assurance/quality control plan shall be filed with the Department prior to initiating such a study. By December 1 following the sampling period, the applicant shall file a report of its findings and data. The Department may require additional investigation or remedial measures based on the study results.

Regarding the reaeration baffle, License Article 403 states:

- *Reaeration Baffle Plan*. If the dissolved oxygen and temperature monitoring report readings indicate a substandard water quality condition (less than 6.0 milligrams per liter and 70 percent saturation), the licensee shall file for Commission approval, a plan for installing a reaeration baffle at the outflow of the Goshen control structure. The plan shall, at a minimum, include functional design drawings showing the specifications of the reaeration screens and a schedule for the screens installation and removal between July 1 and September 1, annually.

## 1.1 Project Description and Operation

The Project consists of three major components: 1) Sugar Hill storage reservoir and Goshen Dam, 2) Sucker Brook diversion dam, 3) and the Silver Lake Development as shown in Figure 1.1-1. The water quality monitoring was conducted in Sugar Hill Reservoir and in Sucker Brook downstream of Goshen Dam.

Goshen Dam creates the Sugar Hill storage reservoir, the most upstream portion of the Project. There is an emergency spillway at one end of the dam that serves only to pass very high flows. Under normal conditions, flows from the reservoir are released and regulated by a set of control valves located on the downstream face of the dam. A minimum flow release of at least 2.5 cfs is maintained continuously, and additional flows are provided as necessary to meet the reservoir's operating rule curve and to supply flows via Sucker Brook to Silver Lake which in turn feed the powerhouse turbine.

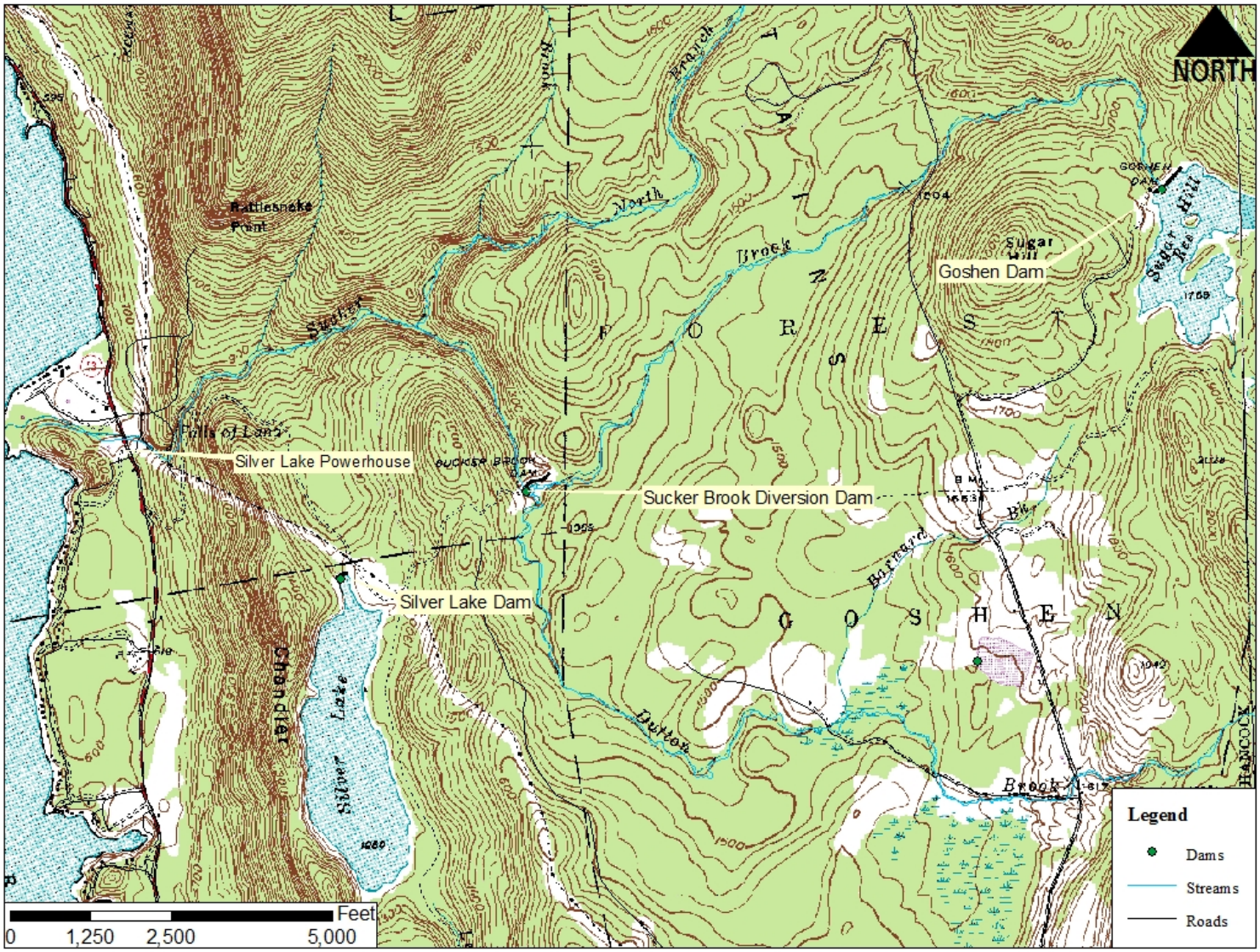
At the lower end of the Goshen Dam outlet is a baffled structure designed primarily to provide reaeration to flows released from Sugar Hill storage reservoir. This reaeration baffle has been used by CVPS annually since the 1992 water quality testing. Water quality sampling was initially performed in 2009 without the baffle structure installed to measure baseline conditions, as described in the methods section of this report.

## 1.2 Vermont Water Quality Standards

Sucker Brook and its tributaries found below 2,500 feet in elevation have been designated by the Vermont Water Resources Board as Class B waters. The Water Resources Board has also designated all water bodies in the drainage as cold water fish habitat. The numerical water quality standards applicable to this study include:

- The dissolved oxygen standard for cold water fish habitat streams is 6.0 milligrams per liter (mg/L) and 70 percent saturation unless higher concentrations are imposed for areas that serve as salmonid spawning or nursery areas important to the establishment or maintenance of the fishery resource.

**Figure 1.1-1: Silver Lake Hydroelectric Project Facilities Layout.**



## 2.0 Methods

This study was conducted in accordance with the general methods and equipment described in the QA/QC Plan attached in Appendix A. Details of the 2009 sampling program are summarized below.

### 2.1 Sampling Objectives

The goal of this study was to collect dissolved oxygen (DO) and water temperature measurements at the Project. The study objectives include:

1) Determine compliance with Vermont water quality standards;
2) Document the extent of reservoir stratification persisting under the new operating rule;
3) If substandard water quality conditions are found, install and test the baffle structure to determine whether reaeration is sufficient to assure downstream compliance; and
4) Develop a plan for baffle installation, if necessary.

### 2.2 Sampling Locations

Water quality measurements were collected from five stations as described in Table 2.2-1. The stations include four locations in Sucker Brook downstream of the Goshen Dam outlet and one station in the deep spot of Sugar Hill Reservoir. The sampling locations were initially inspected on April 20, 2009 to support the development of the QA/QC plan. A field visit was then conducted on June 30, 2009 to establish the sampling sites.

The water quality measurements obtained from Sucker Brook were collected from the thalweg, approximately mid-channel and mid-depth. The location of the sampling point at Station A (outlet) is in the natural channel directly downstream of the turbulent area as shown on Plate 2, Appendix B. The sampling location in the reservoir was verified as the deep spot and was approximately 11 meters (36 feet) deep on June 30, 2009. The reservoir elevation at this time was approximately 1,764 feet. Representative photographs of the sampling stations are included in Appendix B.

A map showing the sampling stations to scale is shown in Figure 2.2-1. Note that there is an old beaver dam located in Sucker Brook just downstream of Site A-1. This beaver dam is inactive and still allows Sucker Brook to flow freely, however the channel is slightly deeper and wider at Station A-1 (see Plate 3, Appendix B).

**Table 2.2-1: Silver Lake Project Water Quality Sampling Locations.**

| Station Identification | Station Description |
|---|---|
| Profile | Sugar Hill Reservoir deep spot near the outlet |
| A | Just downstream of outfall of Goshen Dam |
| A-1 | Approximately 200 feet below outfall of Goshen Dam |
| A-2 | Approximately 400 feet below outfall of Goshen Dam |
| A-3 | Approximately 600 feet below outfall of Goshen Dam |

## 2.3 Sampling Methodology

Weekly sampling was conducted by CVPS personnel, which received training on proper measurement and data recording techniques by Gomez and Sullivan Engineers, P.C. on June 30, 2009. Measurements were obtained approximately once per week from July 1 through September 18, 2009 using a portable hand held dissolved oxygen and temperature meter (YSI Model 55) equipped with a 50-foot cable.

During each sampling event, the downstream stations were visited first thing in the morning just before dawn. Once the measurements were taken from Sucker Brook, a vertical profile was then collected from Sugar Hill Reservoir at one meter (3.3 feet) intervals. Vertical profile measurements of the reservoir were not performed pre-dawn, because stratification is generally not affected by diurnal cycles in dissolved oxygen and temperature. Whereas, in the shallower flowing waters downstream of the dam, it is likely that dissolved oxygen levels will be the lowest just before sunrise.

All field data and observations were recorded in field notebooks or on waterproof field data sheets.

## 2.4 Baffle Structure

Water quality sampling was initially performed without the baffle structure installed to measure baseline conditions. In response to a DO measurement recorded at Station A on September 9, the baffle structure was reinstalled and water quality measurements repeated the next morning. The baffle structure remained in place for the remainder of the sampling season.

An original sketch of the baffle structure, taken from the response to the Second Set of Additional Information Request (CVPS, 1996) is shown in the QA/QC Plan (Appendix A). A photograph of the installed baffle structure taken during the 2009 monitoring is shown on Plate 8, Appendix B.

## 2.5 Quality Control Measures

Data were collected in adherence with the approved QA/QC Plan in Appendix A. The QA/QC methods included:

- Pre-sampling instrument inspection and calibration
- Zero oxygen standard check
- Replicate readings collected once per day
- End of day meter calibration check
- Data review

Water quality instrumentation used during this study was maintained and calibrated according to the manufacturer's instructions. The equipment performance specifications are shown in Table 2.5-1.

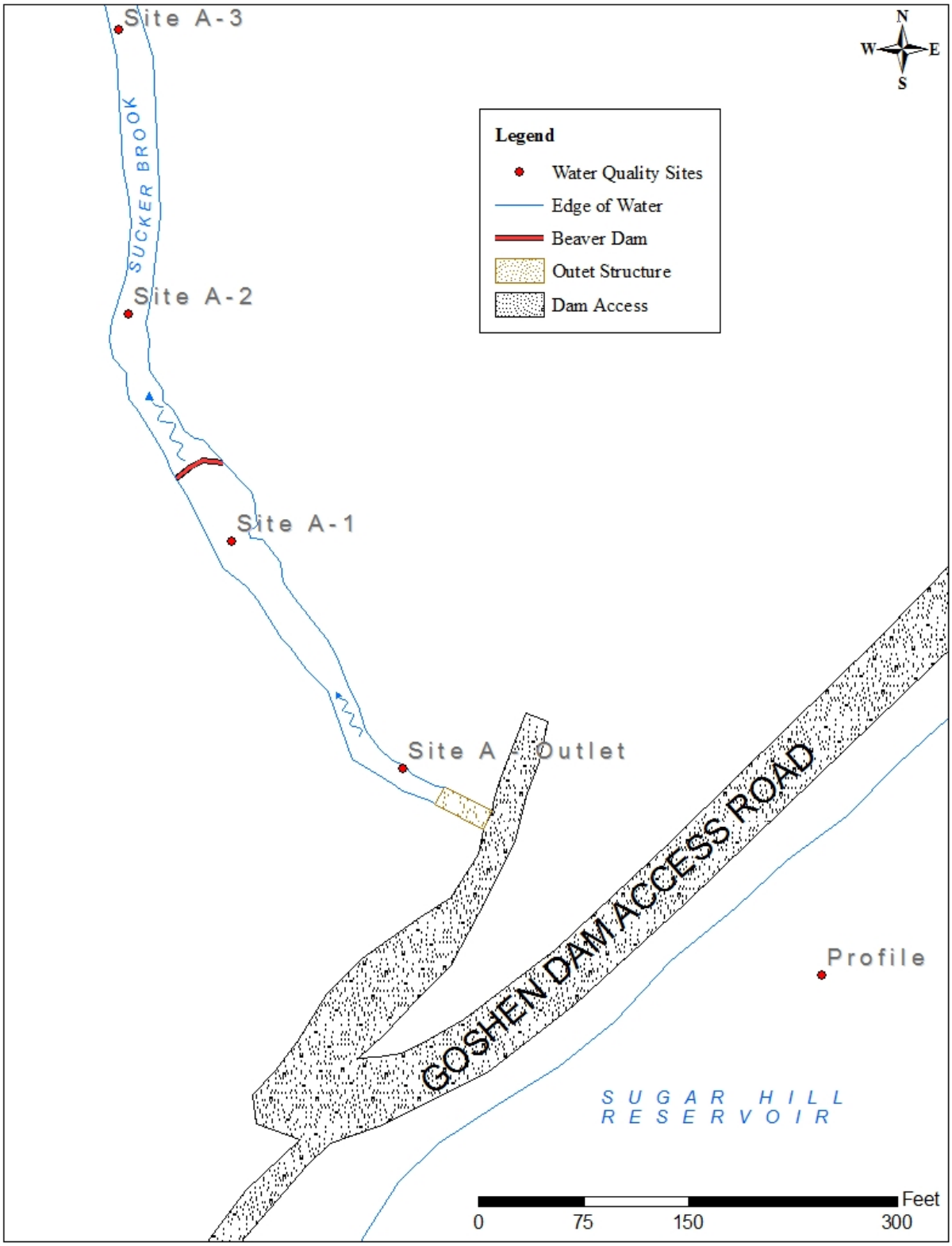
The results of the zero oxygen standard check performed prior to each sampling event indicated that the meter was capable of measuring anoxic conditions. In addition, the replicate samples collected once per sampling event were always within the accuracy range of the sampling equipment. The end of day calibration did not suggest any data anomalies or meter calibration problems.

The complete data set was also reviewed by Gomez and Sullivan Engineers, P.C. There were no data rejected due to calibration problems or as a result of the data review.

**Table 2.5-1: YSI Model 55 Equipment Specifications.**

| Parameter | Range | Accuracy | Resolution |
|---|---|---|---|
| Dissolved Oxygen | 0 to 20 mg/L | ± 0.3 mg/L | 0.01 mg/L |
| Temperature | -5 to +45 °C | ± 0.2 °C | 0.1 °C |

**Figure 2.2-1: Sketch of Sucker Brook downstream of Goshen Dam.**




Data Source: Water Quality Sites and tream Features collected using GPS. Goshen Dam and reservoir shoreline digitized in GIS from VT statewide black and white orthophotos (1:5000).

## 3.0 Results

### 3.1 Environmental Conditions

Despite the higher than normal precipitation during July and August, the data collection effort was performed in order to gain baseline information. September 2009 proved to be much drier than normal which allowed for data collection during conditions when the reservoir had low hypolimnetic dissolved oxygen and CVPS was releasing the minimum flow of 2.5 cfs below Goshen Dam. Table 3.1-1 shows the monthly air temperatures and precipitation for July – September 2009 at Rutland, VT compared to climate normals.

**Table 3.1-1: Summer 2009 Monthly Average Air Temperatures and Total Precipitation in Rutland, VT.**

| Month | Air Temperature (°F) | | | Precipitation (inches) | | |
|---|---|---|---|---|---|---|
| | Mean (2009) | Normal (1971-2000) | Departure | Total (2009) | Normal (1971-2000) | Departure |
| July | 66.1 | 69.8 | -3.7 | 9.30 | 4.58 | +4.72 |
| August | 67.7 | 67.8 | -0.1 | 7.71 | 4.18 | +3.53 |
| September | 57.3 | 59.4 | -2.1 | 2.27 | 3.90 | -1.63 |

Source: NOAA Online Weather Data for Rutland.

### 3.2 Operations

Operational data for the Silver Lake Project was provided by CVPS to correspond with the dates of water quality monitoring in 2009. Records include the reservoir elevation and the downstream flow release at the time of sampling. Sugar Hill Reservoir elevation data were obtained from CVPS's SCADA system and downstream flow releases were obtained from operational records of valve settings, which were used to calculate flow releases. Minimum flows of 2.5 cfs were provided to Sucker Brook starting on August 22. Prior to this, continuous discharges from Goshen Dam ranged from 20.8 to 3.5 cfs.

### 3.3 Reservoir Profiles

Sugar Hill Reservoir profile results are shown in Figure 3.3-1 through 3.3-6. The first profile collected on July 1 indicates that the reservoir was thermally stratified having a defined thermocline between the 3 and 4 meter measurements (10-13 feet). The bottom measurement, collected at 11 meters (36 feet), revealed that dissolved oxygen was 5.75 mg/L and 56.4 percent saturation. It should be noted that the outlet through Goshen Dam is located at an elevation of 1,720 feet, which corresponds to the bottom of the reservoir. The outlet is protected by wooden trashracks. When examining the water quality conditions of the Goshen Dam discharge, the corresponding measurements collected from the bottom of the reservoir during the profile are representative of water passing through the outlet valves.

Profiles collected later in the summer reveal that anoxic conditions are prevalent in the hypolimnion (bottom layer) in Sugar Hill Reservoir throughout August. Outlet discharge and reservoir elevation during each sampling event are noted on the profile figures.

## 3.4 Sucker Brook Results

Table 3.4-1 shows the weekly water quality results from Site A, A-1, A-2 and A-3 in Sucker Brook. As mentioned, discharges through Goshen Dam are from the bottom of the reservoir. To determine the processes taking place from the outlet at the dam to the discharge into Sucker Brook, the profile measurement at 10 meters (35 feet) is included with the Sucker Brook measurements for each sampling event. Note that occasionally a profile measurement was collected as deep as 11 meters, but Table 3.4-1 shows the measurement collected at 10 meters (referred to as "Reservoir Bottom") for consistency. The table shows fairly consistent water temperatures between the reservoir bottom and Station A at the outlet, however, DO increases substantially as the water from the reservoir is discharged into Sucker Brook, even without baffle installation.

Sucker Brook results presented in Table 3.4-1 show that the dissolved oxygen levels generally increase slightly as Sucker Brook flows away from the outlet. On three dates (August 21 and 28, and September 9) the measurements collected from Sucker Brook revealed dissolved oxygen saturation below 70 percent. The lowest dissolved oxygen measured in Sucker Brook was 64.6% and 6.11 mg/L from Station A on August 21. These three dates cases have several things in common: 1) The corresponding DO levels were above 6.0 mg/L, 2) Goshen Dam discharge was set at minimum flow (2.5 cfs) at the time of the measurement, and 3) The DO saturation recovered to above 70 percent by Station A-2, 400 feet downstream of the outlet.

## 3.5 Proposed Reaeration Baffle Plan

To test the corrective action of the baffle structure on downstream aeration rates, the baffle structure was installed on September 9, 2009 after a reading of 67% was measured at the outlet (Station A). The water quality was resampled the next day. Assuming the profile data was consistent with the previous day, it appears that the baffle structure was effective in increasing the dissolved oxygen at the outlet as the reading on September 10, 2009 was 71.9%.

In accordance with License Article 403, because the dissolved oxygen readings indicate a substandard water quality condition (less than 6.0 milligrams per liter and 70 percent saturation), included in this report is a plan for installing a reaeration baffle at the outflow of the Goshen control structure.

In subsequent years, CVPS proposes to install the reaeration baffle structure starting on July 1. Although Article 403 specifies that the schedule for the baffle installation and removal should be between July 1 and September 1, annually, CVPS proposes to keep the baffle structure in place through the month of September to address the potential for required mitigation during extended dry periods, as was the case this summer in late August and into September. CVPS would prefer, however, to retain the flexibility for early removal of the baffle after September 1 if high flows are anticipated.

The reaeration baffle is essentially a screen made from stainless steel rods. The dimension are 22" wide by 56" long and the baffle is attached to the downstream face of the wooden stoplogs in the Goshen outlet structure approximately five feet above the concrete surface of the outlet. The device provides passive aeration by allowing the discharge from the outlet to flow through the V- notch weir and through the horizontal plane of the screen, the bars of which are ¼" diameter spaced ½" apart. The flow passing through the screen is aerated further as it falls onto the concrete sill of the outlet structure and into Sucker Brook. The functional design drawings of the baffle structure are included as Figure 3.5-1.

### 3.6 Conclusions

CVPS monitored dissolved oxygen and temperature conditions at the Silver Lake Project directly below the Goshen Dam outlet on a weekly basis from July through September during the first full season of operation after license issuance in accordance with Condition I of the Vermont water quality certification and the approved quality assurance/quality control plan. The results indicate that flow releases through Goshen Dam result in dissolved oxygen levels to increase substantially as the water from the reservoir bottom is discharged into Sucker Brook, even without baffle installation.

The results also revealed that on three occasions the dissolved oxygen measurements collected from Sucker Brook were below the state standard of 70 percent saturation, ranging from 64.6 to 68.8 percent saturation. On these occasions, the Goshen Dam discharge was set at minimum flow (2.5 cfs) and the corresponding dissolved oxygen levels in Sucker Brook were above 6.0 mg/L.

To address the substandard conditions, CVPS is proposing to install the reaeration baffle structure on an annual basis starting on July 1, and keep the baffle structure in place through the month of September, as necessary, to address the potential for required mitigation during extended dry periods. Based on the water quality measurements collected after baffle installation in 2009, it appears that the baffle structure was effective at raising the dissolved oxygen at the outlet to levels that were in compliance with state water quality standards.

CVPS believes that the annual installation of the reaeration baffle will be effective at maintaining dissolved oxygen levels in Sucker Brook downstream of Goshen Dam and that no additional remedial measures are necessary.

## 4.0 Consultation

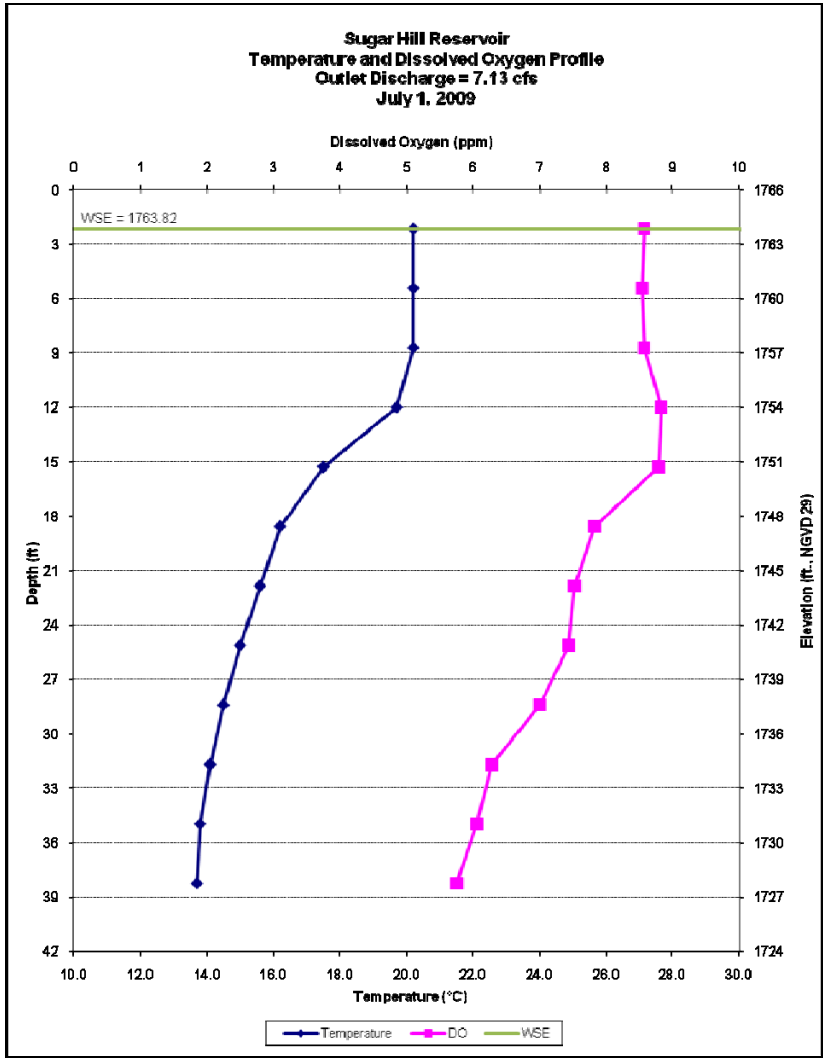
A draft of this report was submitted to the VANR and USFWS on October 9, 2009 for review and comment. Comments were received from VANR and USFWS on November 4 and 9, 2009, respectively.

In accordance with License Article 403, CVPS is required to submit to FERC documentation of its consultation with the VANR and USFWS. A copy of the correspondence received is contained in Appendix C. The specific comments received were incorporated into this final report. In their comments on the draft report, VANR with concurrence from USFWS requested additional sampling, as follows:

> *The Department requests that one sampling round during the next summer drought condition to determine whether the dissolved oxygen standards are being met under what is likely to be worse-case conditions for downstream water quality. Drought conditions would be conditions that necessitate matching reservoir inflow after drawing the reservoir to elevation 1757.5 feet pursuant to the summer operating rule.*

In response to this request, CVPS proposes to conduct weekly dissolved oxygen and temperature sampling when the next summer drought conditions are encountered at the Project (i.e., conditions that require outflows to match inflows to Sugar Hill Reservoir after drawing the reservoir to elevation 8.0 feet below full pool pursuant to the summer operating rule). CVPS will conduct the monitoring in accordance with the methods presented in the approved QA/QC Plan. The reaeration baffle will be in place as proposed in the previous section. The results of the sampling during drought conditions will be reported to VANR, USFWS, and FERC, as appropriate.

**Figure 3.3-1: Vertical Profiles Collected from Sugar Hill Reservoir – July 1 and July 10, 2009.**



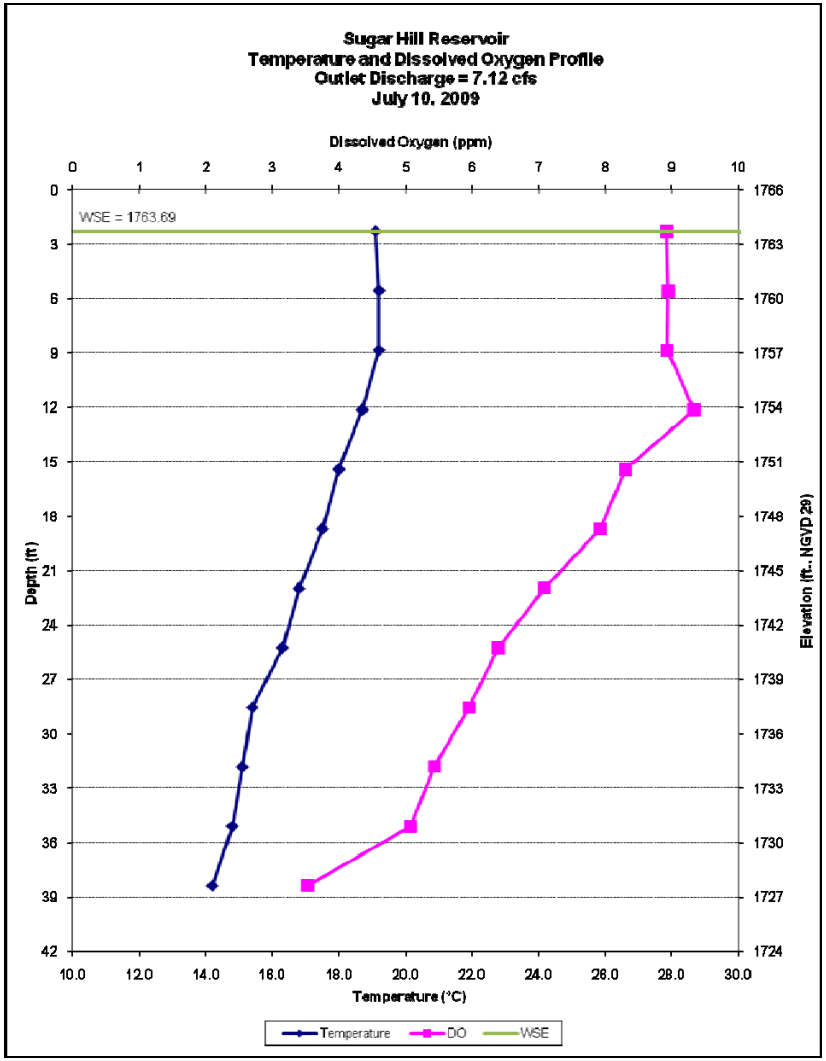
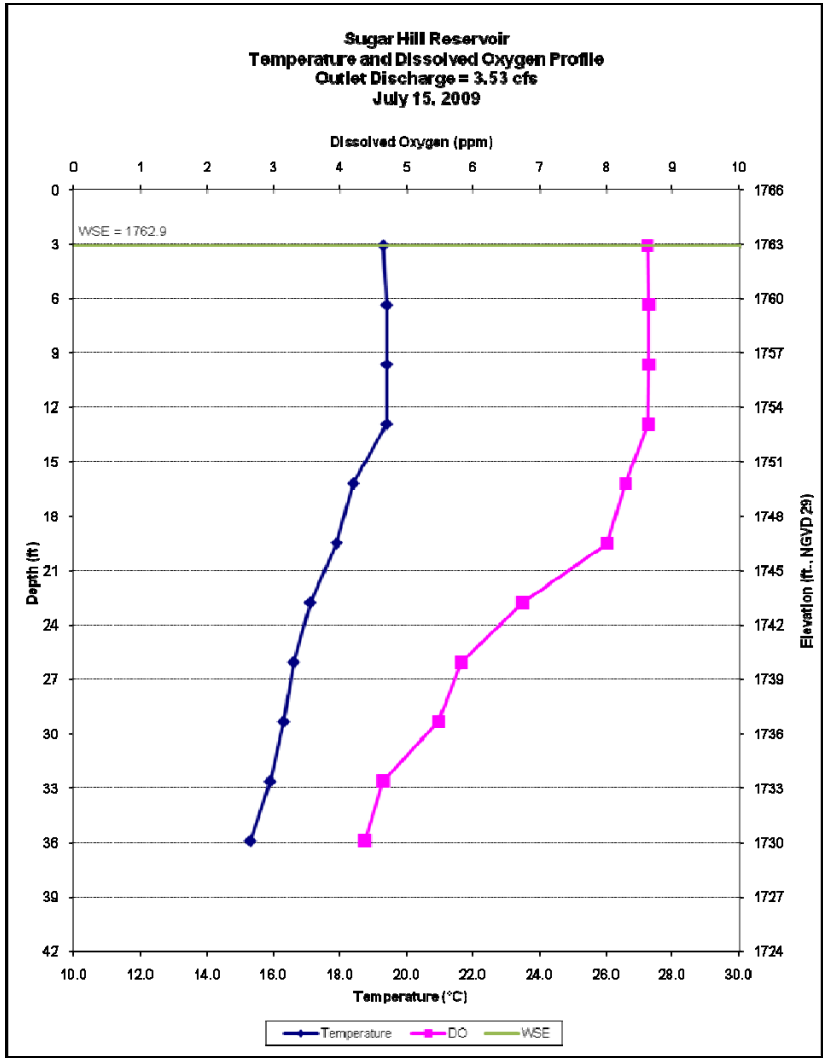
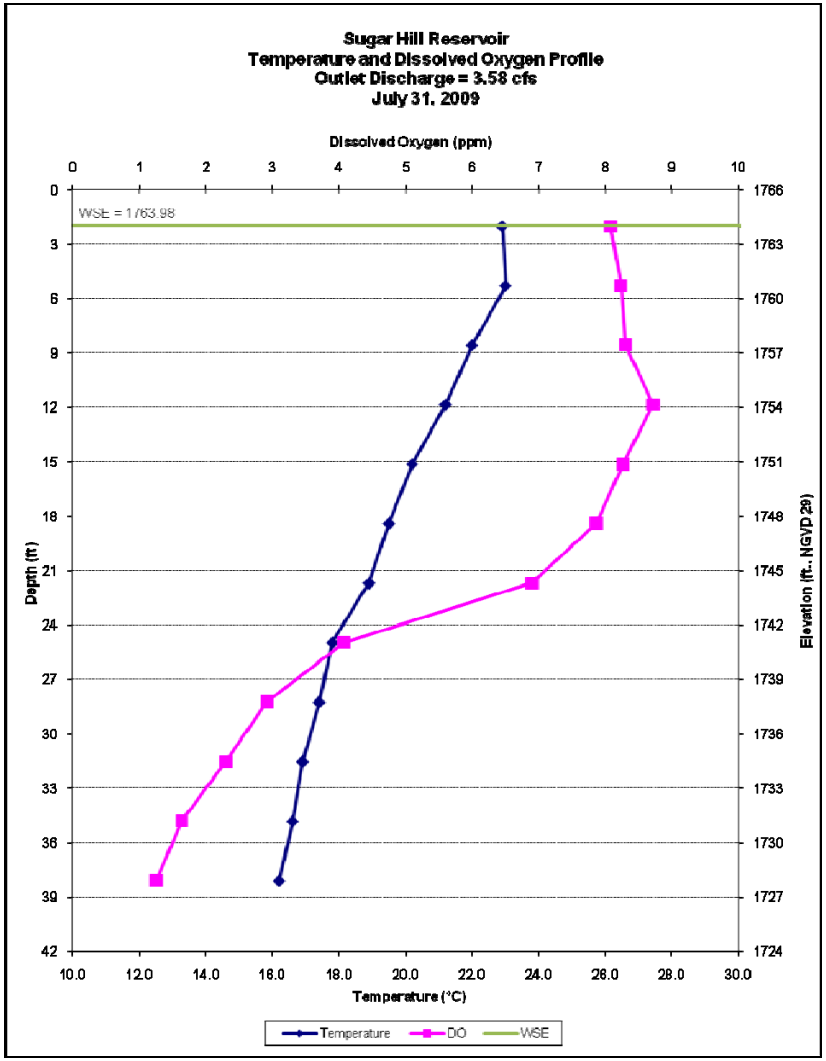



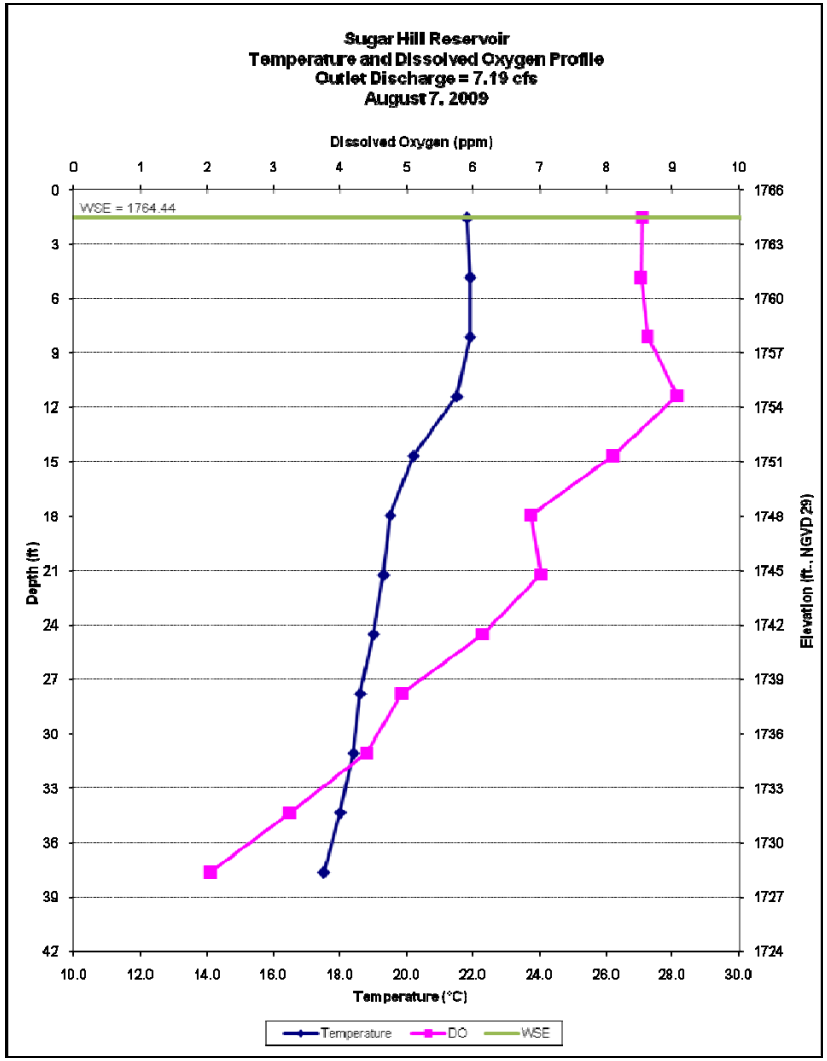
**Figure 3.3-2: Vertical Profiles Collected from Sugar Hill Reservoir – July 15 and July 31, 2009.**




Note: Profile was not obtained on July 24, 2009 due to conflict with boat availability.

**Figure 3.3-3: Vertical Profiles Collected from Sugar Hill Reservoir – August 7 and August 14, 2009.**



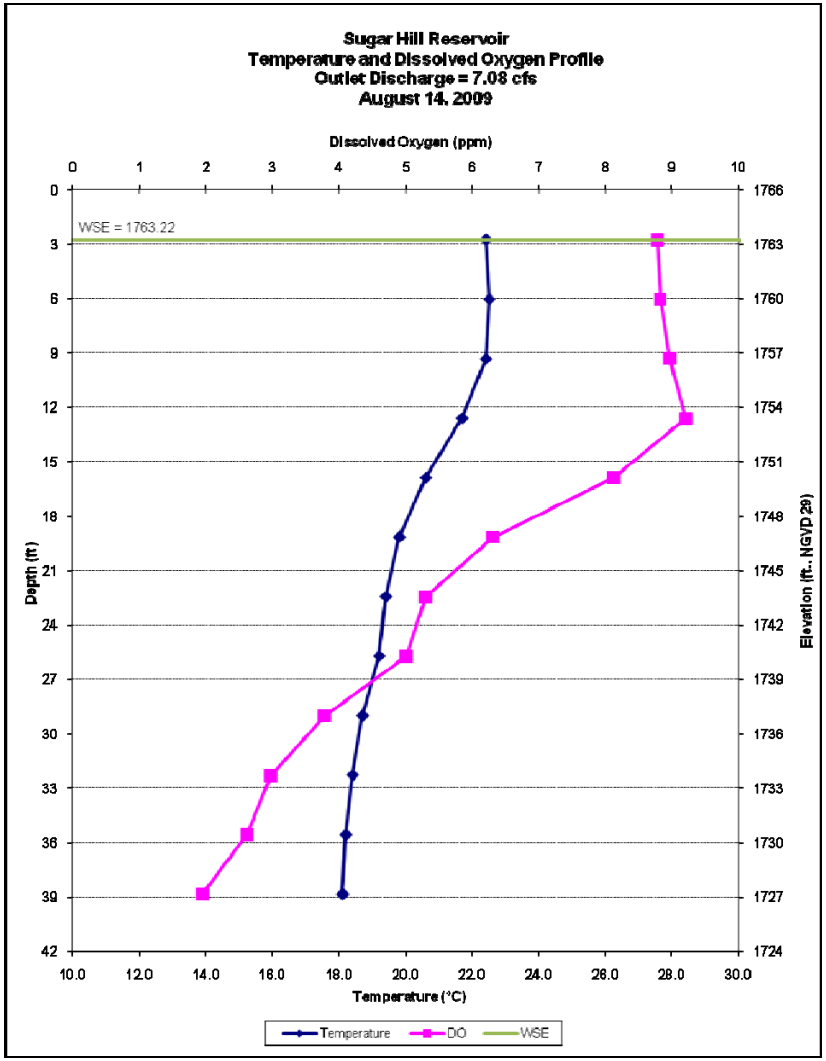
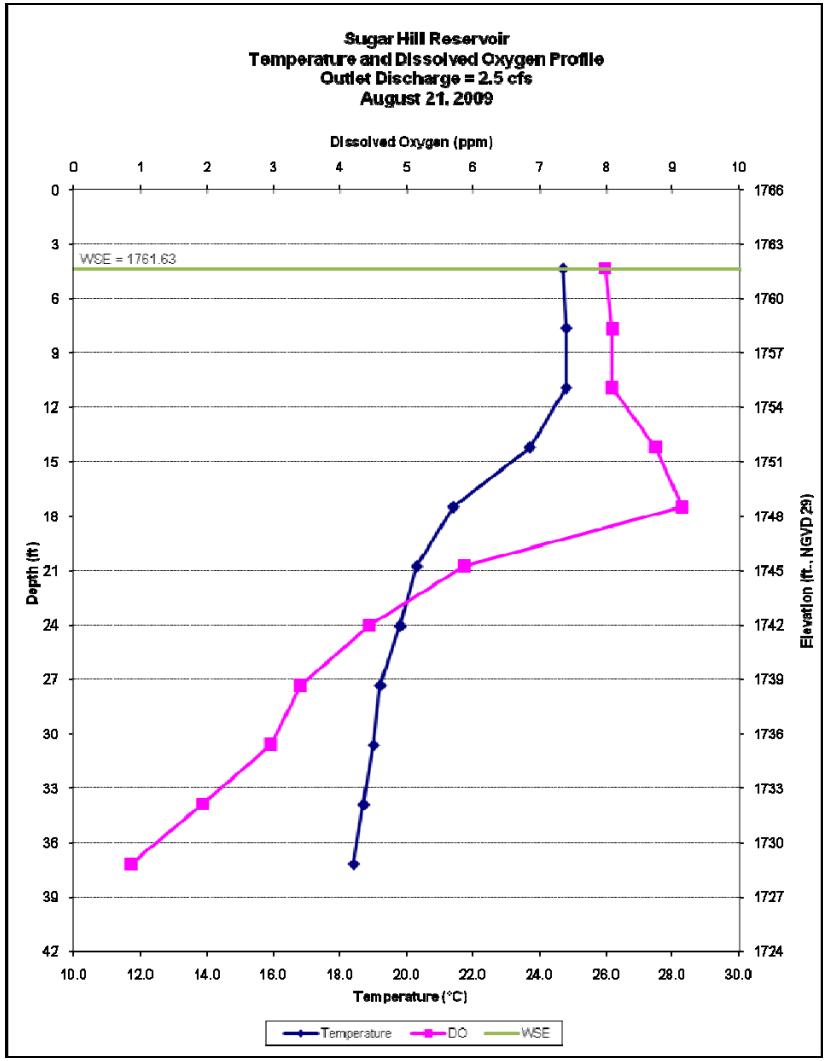



**Figure 3.3-4: Vertical Profiles Collected from Sugar Hill Reservoir – August 21 and August 28, 2009.**



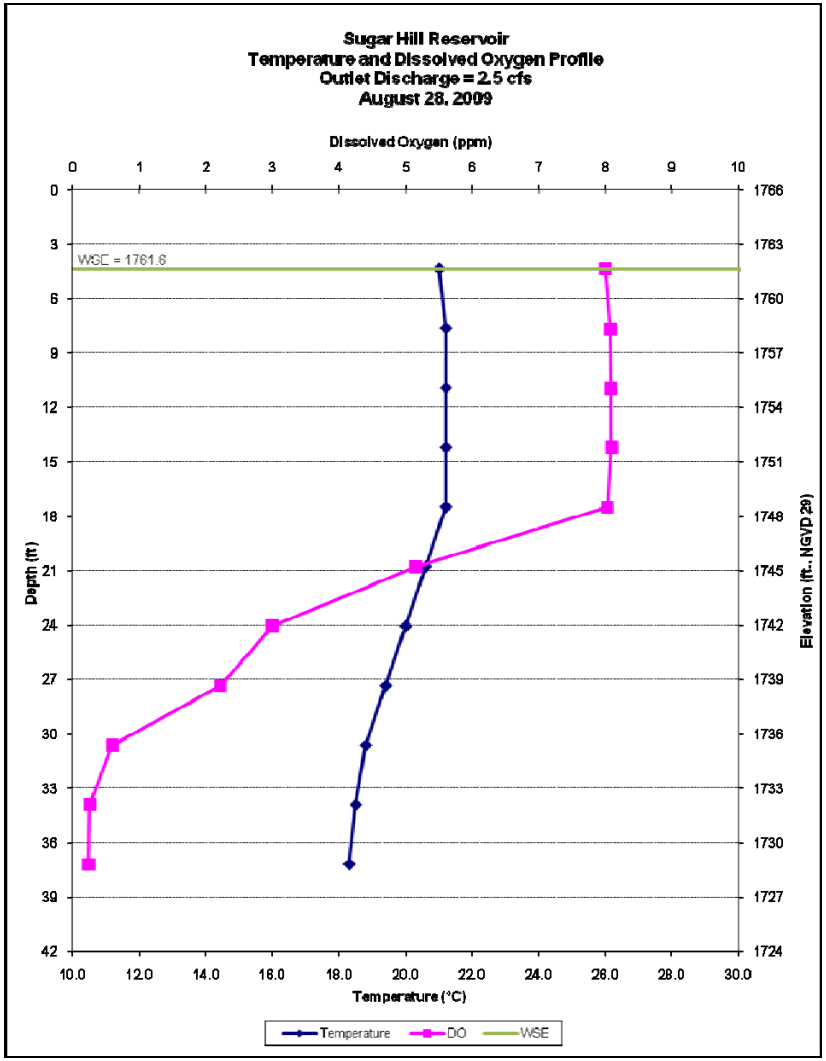
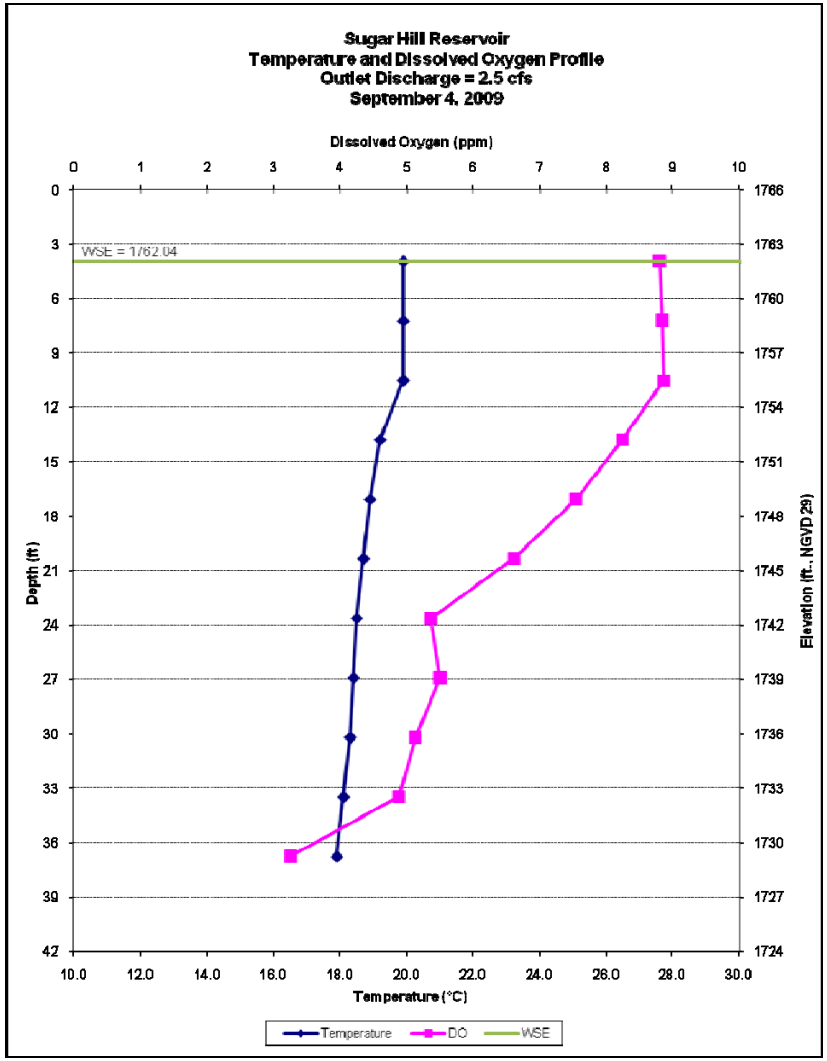



**Figure 3.3-5: Vertical Profiles Collected from Sugar Hill Reservoir – September 4 and September 9, 2009.**



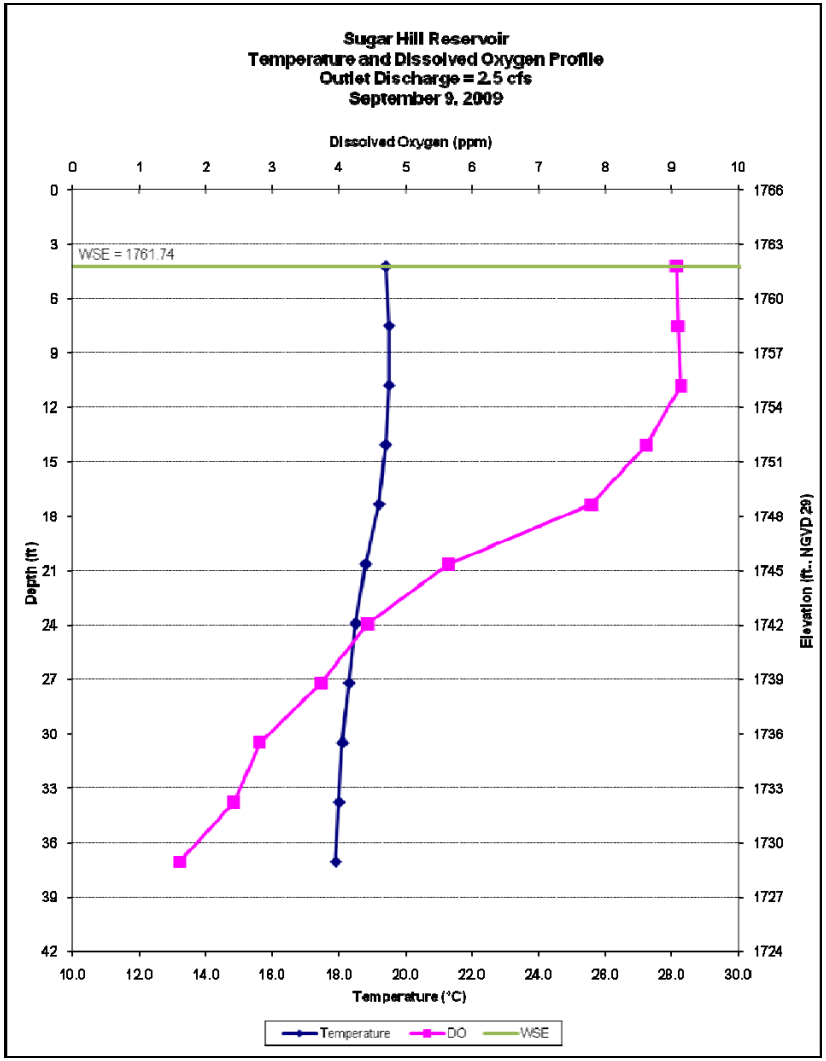



**Figure 3.3-6: Vertical Profile Collected from Sugar Hill Reservoir – September 18, 2009.**

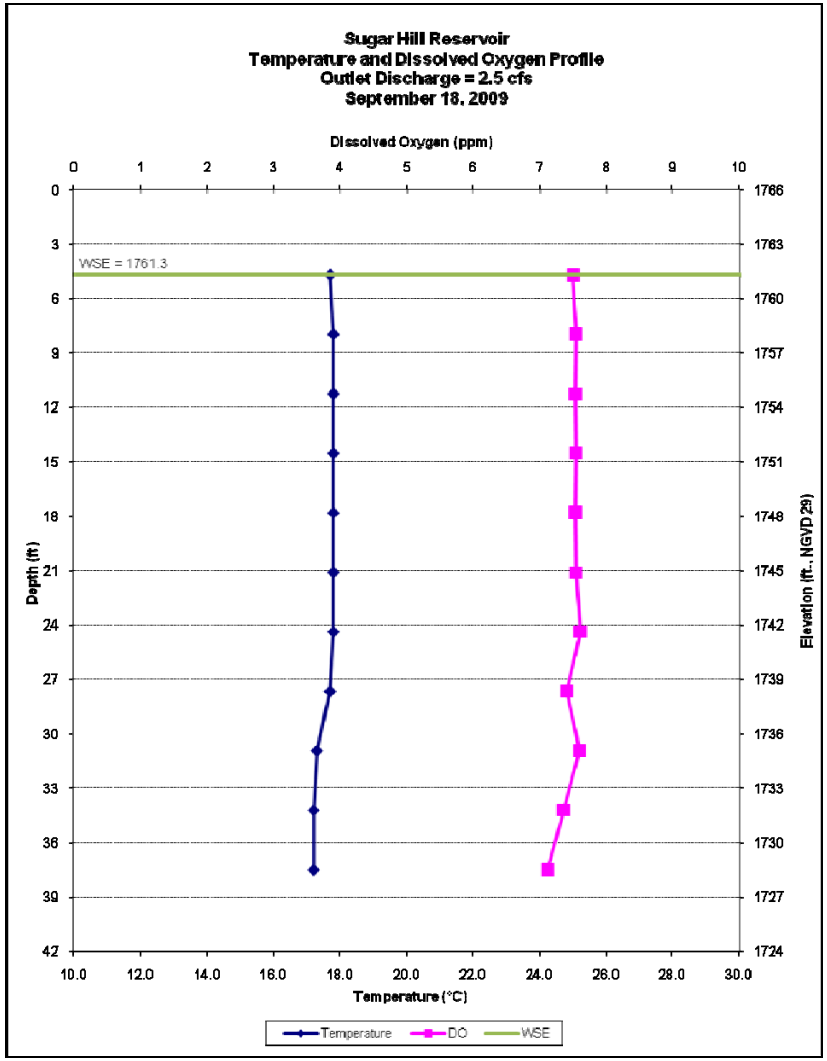


**Table 3.4-1: Sucker Brook Dissolved Oxygen and Water Temperature Results.**

| Date/Time Outlet Discharge | Station | Temperature (°C) | DO (mg/L) | DO (% sat) |
|---|---|---|---|---|
| 7/1/09, 5:49 7.13 cfs | Reservoir Bottom | 13.8 | 6.05 | 58.5 |
| | A | 13.7 | 8.65 | 85.0 |
| | A-1 | 13.7 | 8.89 | 85.7 |
| | A-2 | 13.7 | 8.87 | 85.7 |
| | A-3 | 13.7 | 9.05 | 86.5 |
| 7/10/09, 5:15 7.12 cfs | Reservoir Bottom | 14.8 | 5.07 | 50.9 |
| | A | 14.8 | 8.63 | 85.1 |
| | A-1 | 14.7 | 8.65 | 85.4 |
| | A-2 | 14.7 | 8.72 | 85.8 |
| | A-3 | 14.5 | 8.99 | 88.4 |
| 7/15/09, 5:06 3.53 cfs | Reservoir Bottom | 15.3 | 4.37 | 43.6 |
| | A | 15.3 | 8.16 | 81.5 |
| | A-1 | 15.2 | 8.19 | 81.7 |
| | A-2 | 15.2 | 8.20 | 81.5 |
| | A-3 | 15.1 | 8.47 | 84.3 |
| 7/24/09, 5:06 3.53 cfs | Reservoir Bottom | no profile collected | | |
| | A | 15.3 | 7.59 | 76.6 |
| | A-1 | 15.7 | 7.74 | 78.0 |
| | A-2 | 15.6 | 8.01 | 80.0 |
| | A-3 | 15.6 | 8.23 | 82.5 |
| 7/31/09, 5:30 3.58 cfs | Reservoir Bottom | 16.6 | 1.64 | 16.9 |
| | A | 16.5 | 7.34 | 75.2 |
| | A-1 | 16.4 | 7.44 | 76.2 |
| | A-2 | 16.3 | 7.48 | 76.2 |
| | A-3 | 16.3 | 7.91 | 80.8 |
| 8/7/09, 5:27 7.19 cfs | Reservoir Bottom | 18.0 | 3.24 | 34.2 |
| | A | 17.4 | 7.66 | 80.1 |
| | A-1 | 17.5 | 7.33 | 76.8 |
| | A-2 | 17.4 | 7.81 | 81.5 |
| | A-3 | 17.1 | 7.95 | 82.8 |
| 8/14/09, 5:38 7.08 cfs | Reservoir Bottom | 18.2 | 2.62 | 27.8 |
| | A | 17.7 | 7.33 | 77.4 |
| | A-1 | 17.9 | 7.53 | 79.6 |
| | A-2 | 17.8 | 7.73 | 81.4 |
| | A-3 | 17.7 | 7.83 | 81.9 |

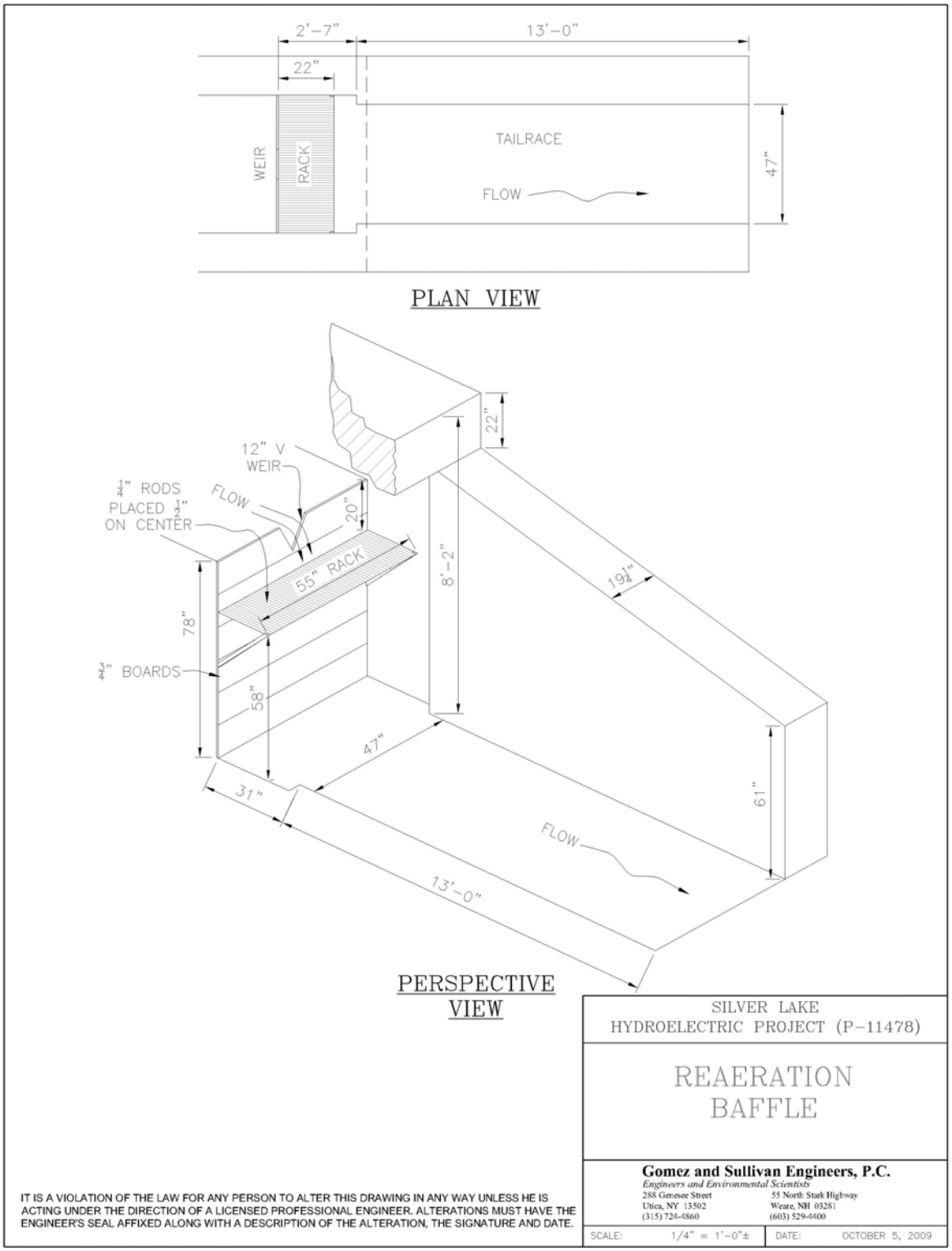
Note: "Reservoir Bottom" measurements collected from 10 meters (33 feet) deep. Table continued on next page.

**Table 3.4-1 (Continued): Sucker Brook Dissolved Oxygen and Water Temperature Results.**

| Date/Time Outlet Discharge | Station | Temperature (°C) | DO (mg/L) | DO (% sat) |
|---|---|---|---|---|
| 8/21/09, 5:27 2.5 cfs | Reservoir Bottom | 18.4 | 0.86 | 9.1 |
| | A | 18.2 | 6.11 | 64.6 |
| | A-1 | 18.1 | 6.48 | 68.8 |
| | A-2 | 18.0 | 6.73 | 70.8 |
| | A-3 | 17.8 | 7.16 | 75.3 |
| 8/28/09, 6:01 2.5 cfs | Reservoir Bottom | 18.3 | 0.24 | 2.6 |
| | A | 17.9 | 6.38 | 67.6 |
| | A-1 | 17.7 | 6.53 | 68.6 |
| | A-2 | 17.2 | 6.87 | 71.4 |
| | A-3 | 16.9 | 7.59 | 78.4 |
| 9/4/09, 5:54 2.5 cfs | Reservoir Bottom | 17.9 | 3.26 | 34.1 |
| | A | 17.2 | 7.44 | 78.6 |
| | A-1 | 17.5 | 7.39 | 77.4 |
| | A-2 | 17.2 | 7.47 | 77.2 |
| | A-3 | 16.9 | 8.03 | 83.0 |
| 9/9/09, 6:01 2.5 cfs | Reservoir Bottom | 17.9 | 1.61 | 17.2 |
| | A | 17.3 | 6.42 | 67.0 |
| | A-1 | 17.4 | 7.02 | 73.0 |
| | A-2 | 17.1 | 7.25 | 74.8 |
| | A-3 | 16.8 | 7.38 | 76.7 |
| 9/10/09, 6:12 2.5 cfs | Reservoir Bottom | no profile collected | | |
| | A | 17.7 | 6.84 | 71.9 |
| | A-1 | 17.4 | 7.10 | 74.3 |
| | A-2 | 16.9 | 7.24 | 73.9 |
| | A-3 | 16.6 | 7.90 | 81.1 |
| 9/18/09, 6:40 2.5 cfs | Reservoir Bottom | 17.2 | 7.12 | 74.0 |
| | A | 16.7 | 8.36 | 86.8 |
| | A-1 | 16.4 | 8.24 | 84.6 |
| | A-2 | 16.5 | 8.07 | 82.9 |
| | A-3 | 16.3 | 8.13 | 83.0 |

Note: "Reservoir Bottom" measurements collected from 10 meters (33 feet) deep. Reaeration Baffle installed after sampling on September 9, 2009.

**Figure 3.5-1: Outlet Baffle Structure Design Drawing.**



## Appendix A: QA/QC Plan

GOMEZ AND SULLIVAN
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June 23, 2009

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Re: Silver Lake Hydroelectric Project, FERC Project No. 11478
Quality Assurance / Quality Control Plan for Water Quality Monitoring

Dear Secretary Bose:

The Silver Lake Hydroelectric Project (FERC Project No. 11478) was issued an original FERC license on February 26, 2009. The Project is located on Sucker Brook in Addison County, Vermont and is owned and operated by Central Vermont Public Service Corporation (CVPS).

Condition I of the Vermont Agency of Natural Resources (VANR) Water Quality Certificate, issued December 5, 2008, which is Appendix A of the FERC license, requires CVPS to monitor dissolved oxygen and temperature conditions weekly from July through September directly below the Goshen Dam. Prior to initiating the study, Condition I also requires that CVPS develop a quality assurance/quality control (QA/QC) plan for the water quality study, and file the plan with VANR prior to initiating the study. Article 401 (A) of the license requires that the QA/QC Plan be submitted to FERC within 6 months of license issuance (by August 26, 2009) after approval from VANR. The draft QA/QC plan was submitted to the VANR to allow for comment and approval on May 12, 2009. Comments on the draft plan were received from VANR on June 12, 2009 and are addressed in the final plan. CVPS is targeting July 1 for commencement of the water quality study.

Attached for filing is the final QA/QC Plan for water quality monitoring at the Silver Lake Hydroelectric Project. Please contact me if you have any questions. Thank you.

Sincerely,

Jason George
Environmental Scientist

C: M. Scarzello, CVPS
B. Eliason, CVPS
J. Cueto, VANR

Enclosure: Silver Lake QA/QC Plan

**SILVER LAKE HYDROELECTRIC PROJECT**
**FERC Project No. 11478**

# Quality Assurance / Quality Control Plan for Water Quality Monitoring

*Sugar Hill Reservoir and Goshen Dam*

**Central Vermont Public Service Corp.**
**77 Grove St.**
**Rutland, VT 05701**

**June, 2009**

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## List of Abbreviations

| | |
|---|---|
| AIR | Additional Information Request |
| CVPS | Central Vermont Public Service Corporation |
| °C | degrees Celsius |
| cfs | cubic feet per second |
| DEC | Vermont Department of Environmental Conservation |
| DI | deionized water |
| DO | dissolved oxygen |
| FERC | Federal Energy Regulatory Commission |
| KCL | potassium chloride |
| mg/L | milligrams per liter |
| QA/QC | quality assurance/quality control |
| USGS | United States Geological Survey |
| WQC | Water Quality Certification |

# 1.0 Introduction

The Silver Lake Hydroelectric Project (Project), located on Sucker Brook in Addison County, Vermont, was issued a new license by the Federal Energy Regulatory Commission (FERC) on February 26, 2009. The Project (FERC No. 11478) is owned and operated by Central Vermont Public Service Corporation (CVPS). The new license and associated water quality certificate (issued by the State of Vermont to CVPS on December 8, 2008) require that dissolved oxygen and temperature conditions downstream of Goshen dam be monitored during the first full season after license issuance.

The new license requires that a quality assurance/quality control plan be filed with the Vermont Department of Environmental Conservation (DEC) prior to the commencement of water quality sampling. This quality control/quality assurance (QA/QC) plan provides the details of sampling protocols and procedures for CVPS to adhere to while conducting water quality monitoring at the Silver Lake Hydroelectric Project.

## 1.1 Project Description and Operation

The Project consists of three major components: 1) Sugar Hill storage reservoir and Goshen dam, 2) Sucker Brook diversion dam, 3) and the Silver Lake Development as shown in Figure 1.1-1. The water quality monitoring is required in Sugar Hill reservoir and in Sucker Brook downstream of Goshen dam.

Goshen dam creates the Sugar Hill storage reservoir, the most upstream portion of the Project. There is an emergency spillway at one end of the dam that serves only to pass very high flows. Under normal conditions, flows from the reservoir are released and regulated by a set of control valves located on the downstream face of the dam. A minimum flow release of at least 2.5 cfs is maintained continuously, and additional flows are provided as necessary to meet the reservoir's operating rule curve and to supply flows via Sucker Brook to Silver Lake which in turn feed the powerhouse turbine.

Sugar Hill reservoir and Silver Lake capture the annual spring runoff and release water from storage to provide year-round flow releases. Goshen dam is used for flow regulation and enhancement of downstream power production. It does not have any power generation capabilities. Flow is released from Sugar Hill reservoir through a 232-foot-long, 4-foot-square conduit equipped with valve nest consisting of two 6-inch diameter, two 8-inch diameter, and one 10-inch diameter steel gate valves that discharge into Sucker Brook.

Sugar Hill reservoir has a normal water surface elevation of 1,763 feet United States Geological Survey datum (USGS). As a requirement of the FERC license, CVPS is bound to water level restrictions in Sugar Hill reservoir as follows: fluctuate the reservoir between 1,765.5 feet and 1,757.5 feet USGS from May 1 through December 31, then fluctuate the reservoir between 1,760.5 feet and 1,747.5 feet USGS from January 1 through April 30. The maximum depth is approximately 50 feet at normal full pond. Figure 1.1-2 presents the bathymetric map for Sugar Hill reservoir, as presented in the original license application (CVPS, 1994). There is no leakage through the dam (CVPS, 1995: AIR #4).

As stated in the Vermont water quality certification (WQC), at the lower end of the conduit is a baffled outlet structure designed to dissipate energy, prevent winter freezing, and provide reaeration. This structure was damaged during the flood of 2008, and will be repaired prior to the 2009 monitoring. The license and WQC is written such that the water quality testing is to be done prior to baffle installation, as described below. Note that the reaeration baffle was in place during the 1992 water quality testing.

## 1.2 Related License Requirements

Certification Condition I in the Vermont WQC, which requires the monitoring and possible installation of a baffle system, was included in the FERC license by ordering paragraph D and Article 403.

- *VT WQC Condition I: Maintenance of Dissolved Oxygen Standards below Goshen Dam*. During the first full season of operation after license issuance, dissolved oxygen and temperature conditions shall be monitored weekly from July through September directly below the Goshen Dam outlet when a dissolved oxygen profile in the reservoir near the outlet discloses stratified conditions. The applicant shall collect dissolved oxygen and temperature data at Stations a, a-1, a-2, and a-3 (as described in the 1992 water quality study) and a dissolved oxygen/temperature profile at a reservoir sampling station near the outlet. Records shall include the reservoir elevation and the downstream flow release at the time of sampling. If samples at Station a are found to be substandard, the proposed baffle system shall be installed and tested to determine if it will assure maintenance of standards. A quality assurance/quality control plan shall be filed with the Department prior to initiating such a study. By December 1 following the sampling period, the applicant shall file a report of its findings and data. The Department may require additional investigation or remedial measures based on the study results.

Additional license requirements that may affect the water quality monitoring tasks described within are as follows:

- *VT WQC Condition B: Reservoir and Flow Management*. The Project shall be operated in accordance with the minimum flow and reservoir level management schedules described above.

- *VT WQC Condition C: Ramping plan at Goshen Dam*. The applicant shall develop a ramping plan for the adjustment of the valve system at Goshen Dam in order to control the rate of change of downstream flows and protect downstream aquatic organisms. The plan shall cover both up ramping and down ramping.

- *VT WQC Condition G: Operating plan for Sugar Hill Reservoir*. The applicant shall develop an operating plan for Sugar Hill Reservoir, indicating how the dam shall be operated to conform to the goals of the operating rules contained in Condition B.

If the monitoring indicates substandard conditions, the license and certification requires that the baffle system be installed and tested to determine if the system can ensure maintenance of state standards.

- *License Article 403: Reaeration Baffle Plan*. If the dissolved oxygen and temperature monitoring report readings indicate a substandard water quality condition (less than 6.0 milligrams per liter and 70 percent saturation), the licensee shall file for Commission approval, a plan for installing a reaeration baffle at the outflow of the Goshen control structure. The plan shall, at a minimum, include functional design drawings showing the specifications of the reaeration screens and a schedule for the screens installation and removal between July 1 and September 1, annually.

## 1.3 Vermont Water Quality Standards

Sucker Brook and its tributaries found below 2,500 feet in elevation have been designated by the Vermont Water Resources Board as Class B waters. The Water Resources Board has also designated all water

bodies in the drainage as cold water fish habitat. The numerical water quality standards applicable to this study include:

- The dissolved oxygen standard for cold water fish habitat streams is 6.0 milligrams per liter (mg/L) and 70 percent saturation unless higher concentrations are imposed for areas that serve as salmonid spawning or nursery areas important to the establishment or maintenance of the fishery resource.

The Vermont DEC, in their WQC, did not indicate that higher dissolved oxygen concentrations were imposed for Sucker Brook.

**Figure 1.1-1: Silver Lake Hydroelectric Project Facilities Layout.**

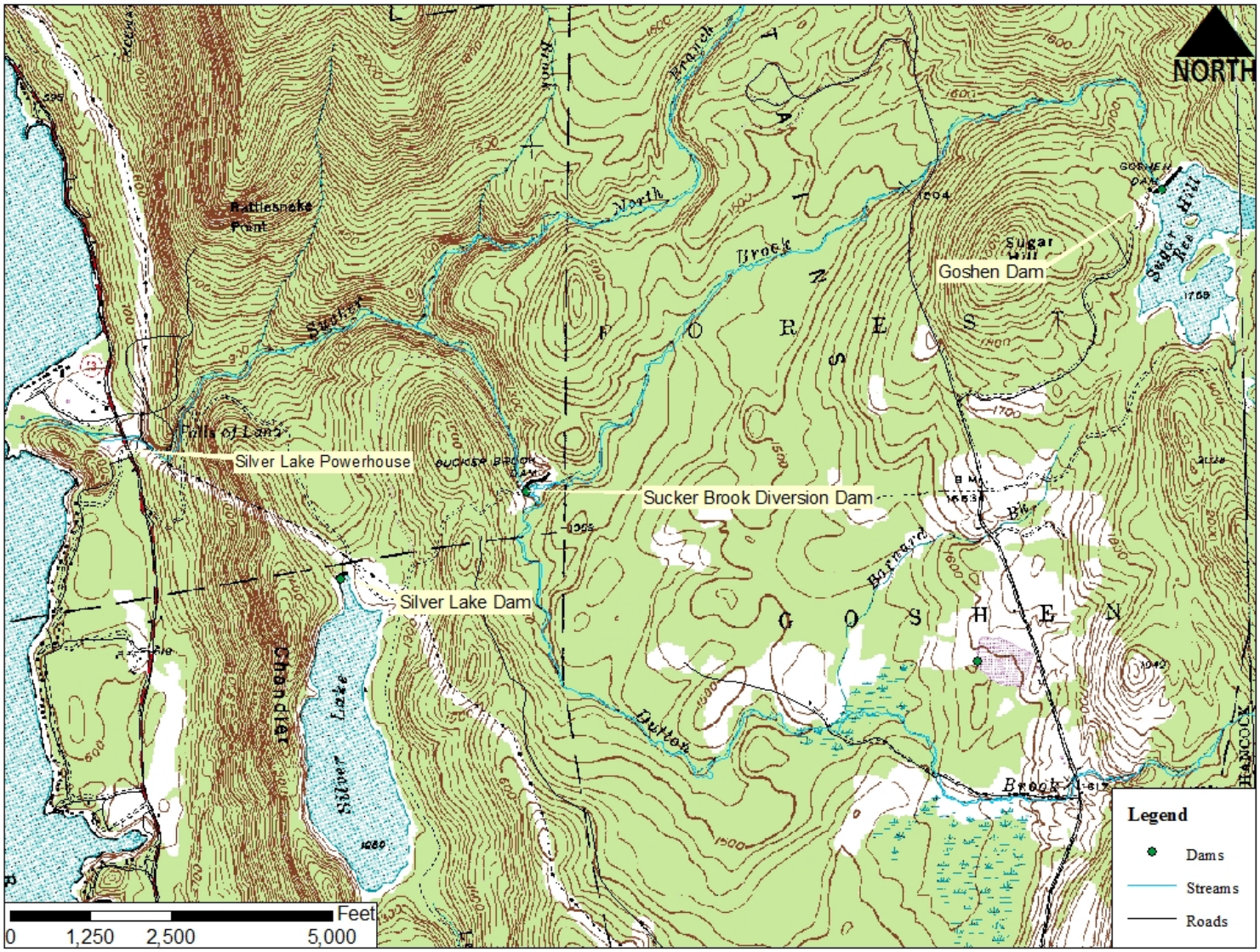
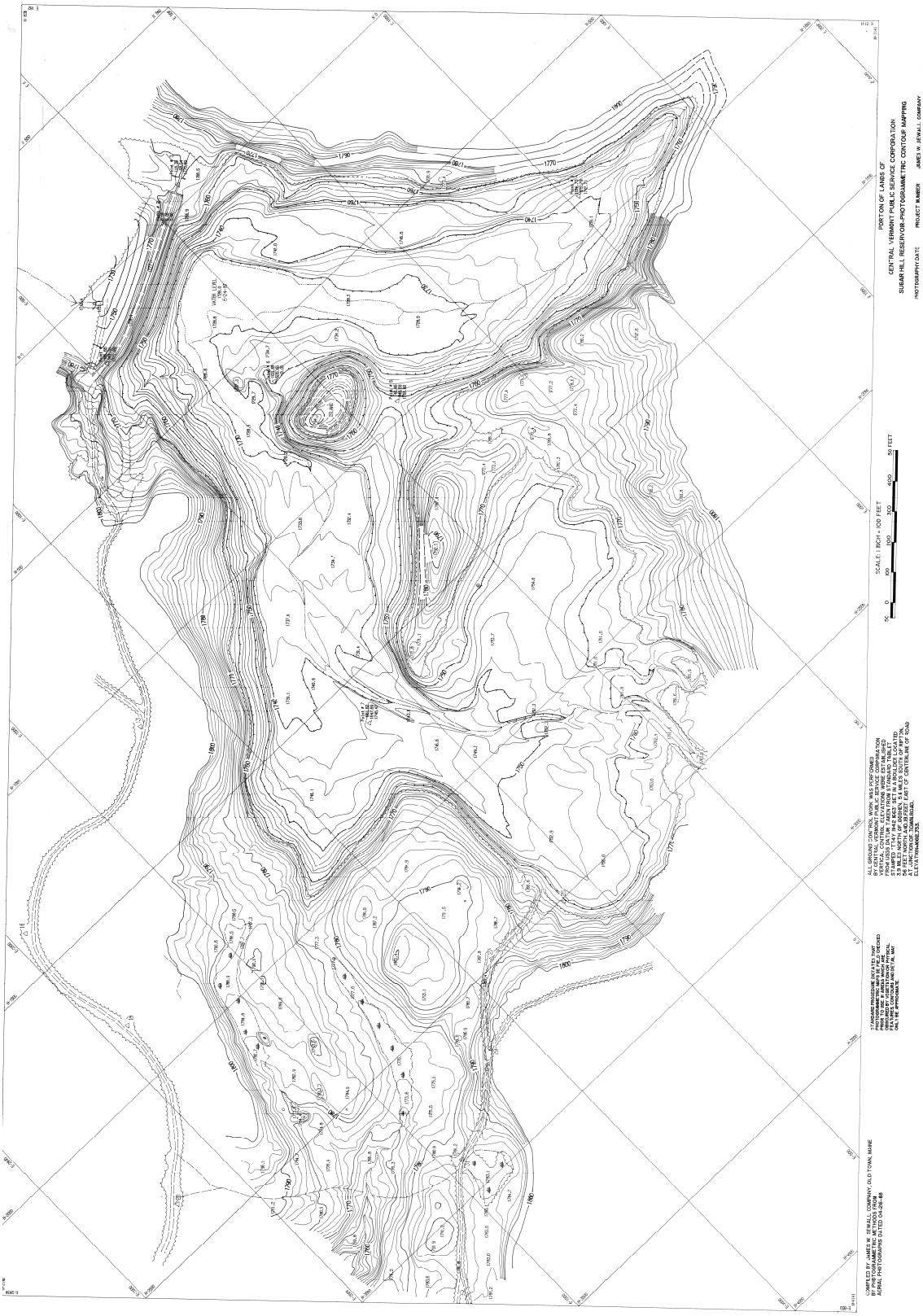


**Figure 1.1-2: Sugar Hill Reservoir Bathymetric Map.**



## 2.0 Water Quality Sampling Plan

### 2.1 Sampling Objectives

The goal of this study is to collect dissolved oxygen (DO) and water temperature measurements at the Project to determine compliance with Vermont water quality standards. The study objectives include: 1) document the extent of reservoir stratification persisting under the new operating rule; 2) determine whether the reaeration provided by the baffle structure is sufficient to assure compliance with dissolved oxygen standards downstream; and 3) an assessment of downstream reaeration rates.

### 2.2 Sampling Locations

Sampling efforts conducted by CVPS in 1991-1992 were used to determine sampling locations for this investigation. Per the Vermont WQC, CVPS shall collect dissolved oxygen and temperature data at Stations A, A-1, A-2, and A-3 (as identified in the 1992 water quality study) and a dissolved oxygen/temperature profile at a reservoir sampling station near the outlet. The samples collected from Sucker Brook will be measured in the thalweg, approximately mid-channel and mid-depth. During the initial sampling event, the sampling location in the reservoir will be verified as the deep spot. The proposed sampling locations are described in Table 2.2-1 and shown in Figure 2.2-1.

**Table 2.2-1: Silver Lake Project Water Quality Sampling Locations.**

| Station Identification | Station Description |
|---|---|
| Profile | Sugar Hill Reservoir deep spot near the outlet |
| A | At the outfall of the Goshen Dam control structure |
| A-1 | Approximately 200 feet below Outfall of Goshen Dam |
| A-2 | Approximately 400 feet below Outfall of Goshen Dam |
| A-3 | Approximately 600 feet below Outfall of Goshen Dam |

The profile measurements will be collected near the outlet of Sugar Hill Reservoir. The intake for this structure draws from Sugar Hill Reservoir at a depth of 40 feet; consequently, temperature stratification takes place.

The proposed downstream sampling locations were inspected on April 20, 2009 to verify sampling locations and determine the changes in channel configuration since the 1992 sampling. Representative photographs of the sampling area are located in Appendix A. The location of the sampling point at Station A (outlet) is in the natural channel directly downstream of the turbulent area as shown on Plate 1, Appendix A.

The dissolved oxygen deficiencies documented in 1992 may have been influenced in part by beaver activity. The downstream samples were taken to track the reaeration process. The first two were collected amongst a series of beaver dams, causing the water to flow very slowly. The last of the three was taken beyond the last beaver flowage where the topographic gradient increases (CVPS, 1993). Nevertheless, the dissolved oxygen standard must be met at the outlet, where there is no beaver effect.

## 2.3 Sampling Frequency

Starting in July, the Project will be visited once per week to conduct water quality measurements. CVPS will consider the forecasted weather in scheduling the weekly sampling and target dry weather periods to the extent allowable. A vertical profile will be collected weekly from Sugar Hill reservoir. Pre-dawn DO sampling will also be performed on a weekly basis at the sampling locations listed in Table 2.2-1. Vertical profile measurements of the reservoir will not be performed pre-dawn, because stratification is generally not affected by diurnal cycles in dissolved oxygen and temperature. Whereas, in the shallower flowing waters downstream of the dam, it is likely that dissolved oxygen levels will be the lowest just before sunrise. This is because photosynthesis, which creates oxygen, does not occur at night, leaving the dominant process of respiration, during which photosynthetic organisms consume oxygen, thereby resulting in lower dissolved oxygen levels just before dawn.

VANR in their comments submitted on the draft plan, said the plan should address the installation and testing of the baffle structure. An original sketch of the baffle structure, taken from the response to the Second Set of Additional Information Request (CVPS, 1996) is shown in Figure 2.3-1. Water quality sampling will initially be performed without the baffle structure installed to measure baseline conditions. If, on any sampling date, monitoring indicates substandard conditions at the outlet, CVPS will arrange to install the baffle structure and resample as soon as practical. The baffle structure will then remain in place for the remainder of the sampling season.

## 2.4 Sampling Equipment

The weekly measurements will be collected with a portable hand held dissolved oxygen and temperature meter - a YSI Model 55 dissolved oxygen meter equipped with a 50-foot cable. The equipment performance specifications are shown in Table 2.4-1.

**Table 2.4-1: YSI Model 55 Equipment Specifications.**

| Parameter | Range | Accuracy | Resolution |
|---|---|---|---|
| Dissolved Oxygen | 0 to 20 mg/L | ± 0.3 mg/L | 0.01 mg/L |
| Temperature | -5 to +45 °C | ± 0.2 °C | 0.1 °C |

## 2.5 Sample Collection

Only personnel trained or experienced in the measurement and data recording techniques provided in this document shall conduct monitoring. All field data and observations will be recorded in a field notebook or field data sheets, examples of which are located in Appendix B.

It is important to recognize that dissolved oxygen is consumed across the sensor during the measurement. It is therefore essential that the sample be continuously stirred at the sensor location. If water stagnation occurs, the readings will be artificially low. Stirring may be accomplished by mechanically moving the sample around the probe tip, or by rapidly moving the probe through the sample. When sampling in the reservoir, drop the sensor at 1 meter intervals with last reading 1 meter above bottom. At each depth, wait for the readings to stabilize (while stirring) and record value in the field notebook or field data sheet. To collect a sample, perform the following steps:

1. Ensure the meter has been calibrated and the appropriate quality control procedures have been followed, as outlined in the next section.

2. Place the sensor into the body of water at the desired sampling depth.

3. Allow at least 60 seconds for temperature equilibration. Record the temperature.

4. Gently move the sensor up and down at the desired sampling depth at a rate of approximately one foot per second for approximately 30 seconds before measuring dissolved oxygen. If the water velocity at the point of measurement is less than about 1 ft/s, use a stirring device or stir by hand to increase the velocity. (To hand stir, raise and lower the sensor at a rate of about 1 ft/s, but do not break the surface of the water.)

5. On the field data sheet, record the dissolved oxygen (mg/L and % saturation). The reading should stabilize to within ±0.2 mg/L.

6. Return the sensor to the storage chamber.

## 2.6 Quality Control Measures

Water quality instrumentation used during this study shall be properly maintained and calibrated according to the applicable instructions provided by the manufacturer and contained within this document. The QA/QC procedures are detailed below.

### 2.6.1 Pre-Measurement Meter Inspection

Perform the following checks on the portable DO meter the day before each scheduled sampling date.

1. To be sure that the sensor inside the meter's calibration/storage chamber remains moist, pull the probe out and add sufficient deionized (DI) water to the sponge inside the calibration chamber.

2. The wet sponge creates a 100% saturated air environment within the chamber for ideal calibration conditions. Ensure that the DO sensor does not contact the wet sponge.

3. Unscrew the black protective housing from the end of the sensor and examine the sensor for any obvious air bubbles trapped beneath the membrane surface or wrinkles in the membrane. If bubbles or wrinkles are detected, use Step a through Step g, below, to replace the membrane. (On the field data sheet, record the performed maintenance.) Otherwise, proceed with Step 4, below.

    a. Unscrew and remove the probe sensor guard.
    b. Remove the old membrane and O-ring.
    c. Thoroughly rinse the sensor tip with DI water.
    d. Refill the sensor with KCL solution to a visible meniscus.
    e. Tap the bottom of the cap with your finger a few times to remove any trapped air bubbles.

f. Carefully install a new membrane and replace the O-ring.
g. Shake off any excess probe solution and rinse the sensor thoroughly with distilled water to prevent corrosion.
h. Check that there are no rips or folds in the membrane and that there are no bubbles under the membrane.

4. Replace the protective sensor guard, rinse the sensor, and return the sensor to the calibration chamber.

5. After membrane replacement, allow a minimum of 2 to 6 hours for the new membrane to condition before calibration and use. For greater stability during calibration allow the new membrane to soak in tap water overnight prior to calibration. If conditions necessitate using the sensor and new membrane before the recommended overnight conditioning time, more frequent calibration checks and possibly recalibration are necessary for accurate DO measurements.

### 2.6.2 Meter Calibration

The portable DO meter will be calibrated prior to use each day in accordance with the manufacturer's procedures. Calibration results will be documented on the applicable field data sheet. The calibration procedure outlined as Step 1 through Step 6 below is administered at the beginning of each sampling event. The meter must remain on during the entire sampling event, or it must be recalibrated. The wet sponge creates a 100% saturated air environment with the chamber for ideal calibration conditions. Ensure that the DO sensor does not contact the wet sponge by inserting the sensor only until the rubber seal is flush with the outer edge of the chamber. To calibrate the meter, perform the following steps:

1. Wet the inside of the calibration chamber with water. Then pour out the water (but leave a few drops). Remove any water droplets on the sensor membrane and insert the sensor into the chamber (this ensures 100-percent humidity).

2. Turn on the meter and allow it to warm up. Allow 15 minutes for the meter to equilibrate.

3. Once the readings have stabilized after fifteen minutes of warm up, hold down both the up arrow and down arrow keys in order to CALIBRATE.

4. Use the up arrow and down arrow keys to adjust the number that corresponds with the elevation you are at during calibration in hundreds of feet (i.e., 17 on the meter refers to 1,700 feet).

5. After adjusting the reading, press ENTER. The meter display will then prompt for salinity compensation. Press ENTER to set the salinity at 0.0. The meter will display a saturation percentage (e.g., 99%) to which it was calibrated. On the field data sheet, record the calibration value.

6. Ensure that the meter remains "on" throughout the sampling day. If the meter is turned "off", repeat Step 1 through Step 5.

### 2.6.3 Zero Oxygen Standard Check

To verify that dissolved oxygen sensor is capable of measuring anoxic conditions, a check will be performed in a zero oxygen standard solution. The procedure outlined here is only administered at the beginning of each sampling day, not prior to each individual dissolved oxygen/temperature measurement. After the meter is calibrated, perform the following a zero oxygen standard check.

1. Place the sensor in a zero oxygen environment (sodium sulfite), and allow 2-3 minutes for the meter to equilibrate.

2. On the field data sheet, record the concentration (mg/L) and saturation (%).

3. Thoroughly rinse the sensor with deionized water, blot dry, and insert in calibration chamber.

### 2.6.4 Replicate Sampling

As a quality assurance check on the water quality meter, a replicate measurement should be conducted at least once per day, or after every tenth measurement. It is often desirable to collect a replicate sample at some point during the vertical profile measurements. Once the vertical profile measurements are collected, place the sensor at a random depth to collect a replicate measurement. Avoid the thermocline because temperature and dissolved oxygen gradients can express subtle changes in relation to depth in this layer of the reservoir. Record the replicate measurements on the field data sheet.

### 2.6.5 End of Day Calibration Check

While the sensor is in the calibration chamber, check the DO calibration at the end of the day.

1. Allow approximately 10 minutes for the reading to stabilize. This ensures that the theoretical 100% saturation is achieved in the storage chamber. On the field data sheet, record the dissolved oxygen % saturation.

Reminder that the meter should remain “on” until the last site has been tested. If the meter is turned “off” prior to the end of the sampling day, the meter must be turned “on” and allowed a 15-minute warm-up period prior to calibration and additional sampling.

**Figure 2.2-1: Proposed Sampling Locations.**

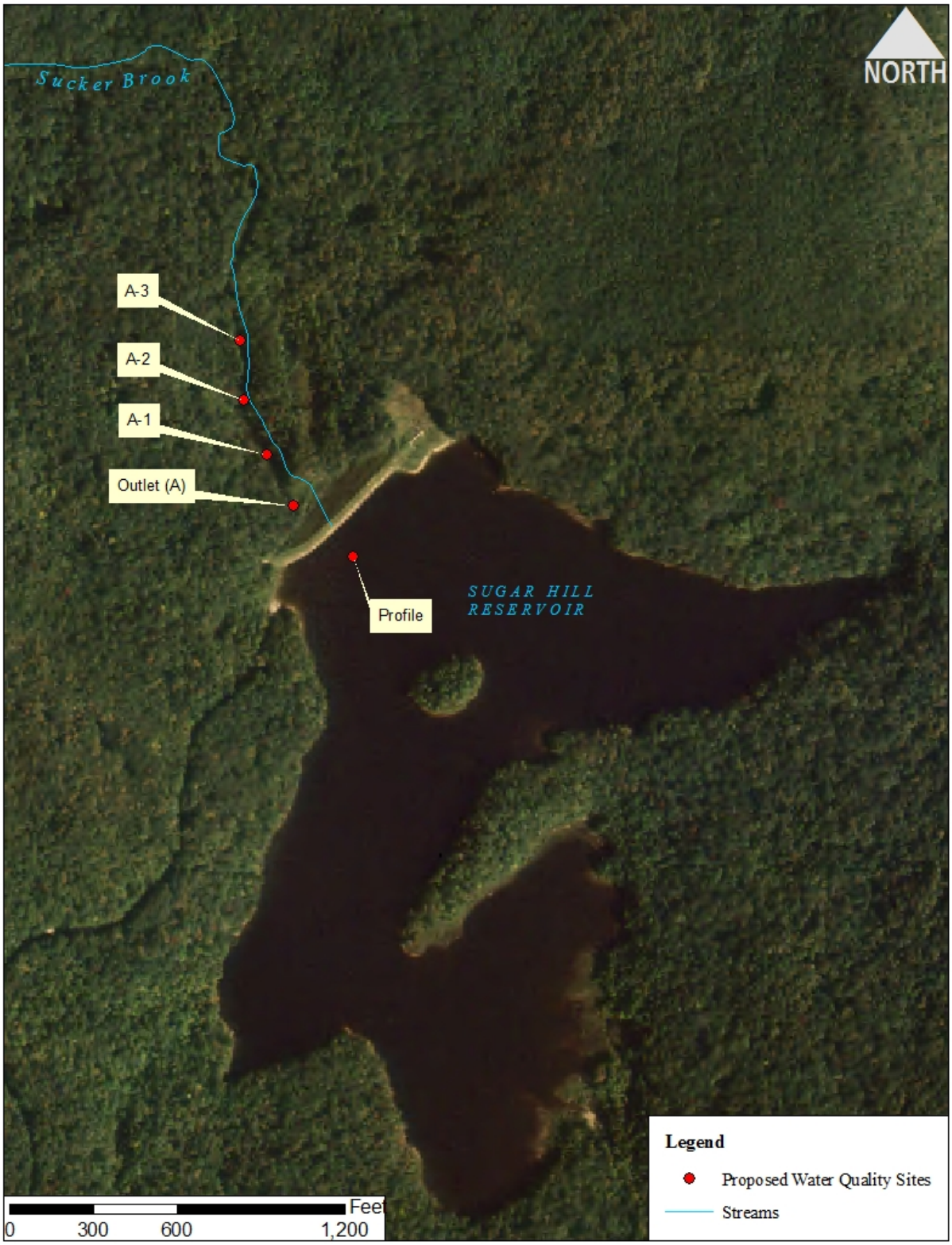
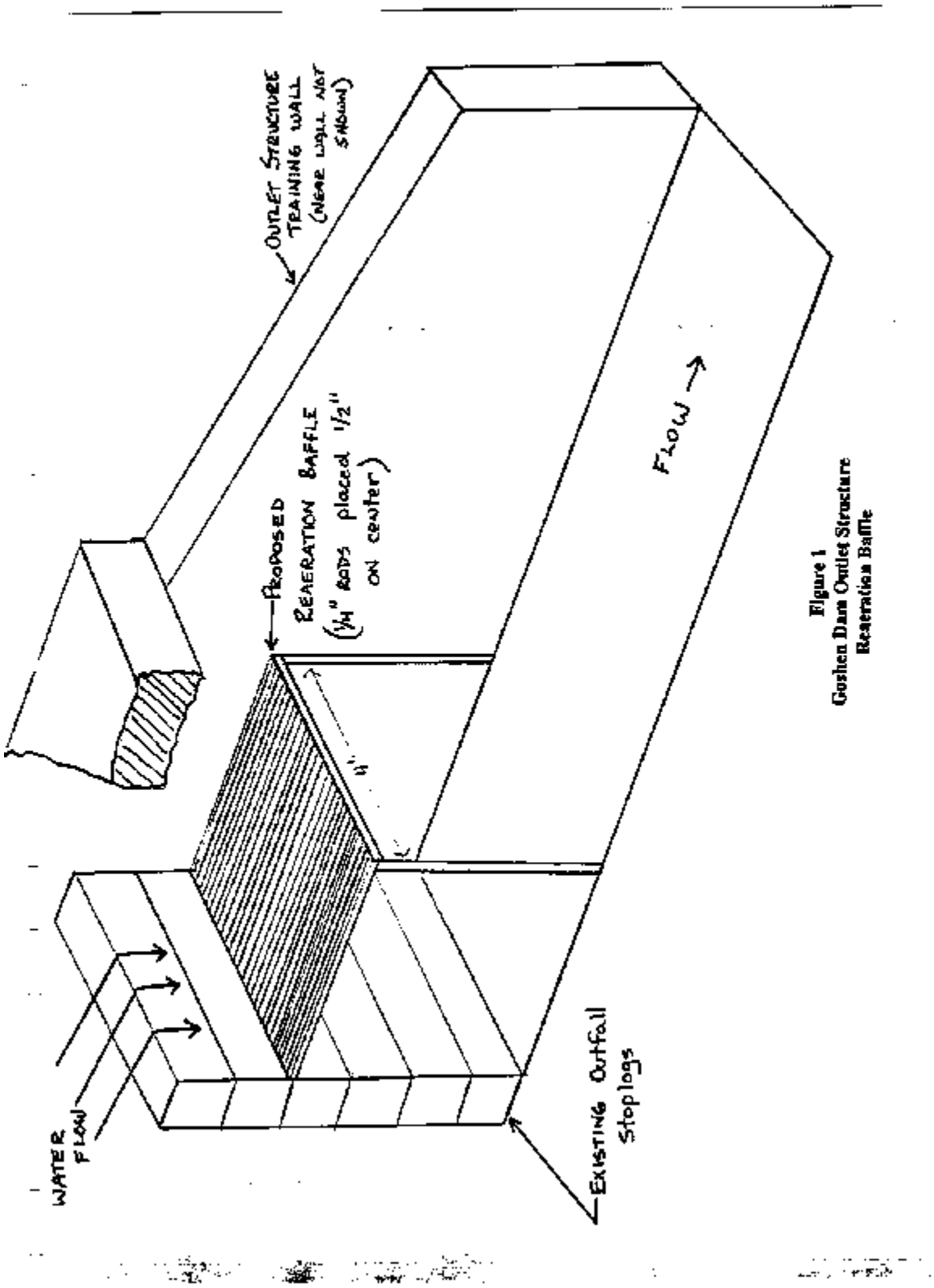


**Figure 2.3-1: Sketch of Existing Outlet Baffle Structure.**



## 3.0 Recordkeeping and Reporting

### 3.1 Water Quality Data

Water quality measurements will be recorded in a field notebook or on field data sheets (Appendix B) on the day of sampling. Data will include dissolved oxygen and water temperature measurements, general weather and flow conditions, and QA/QC data records.

### 3.2 Operations

Data will be obtained from CVPS regarding the reservoir elevation and the downstream flow release at the time of sampling. There is a pond level sensor in Sugar Hill Reservoir which is tied into the control center in Rutland. Water levels are controlled by manually adjusting the outlet gates. The control center in Rutland and the operators are in daily contact to determine what adjustments are needed to comply with the reservoir elevation and downstream flow requirements.

Operators check the release at least weekly and make adjustments as needed. If the control center anticipates dramatic shifts in weather, then proactive changes can be made to the valve system to allow for more storage, etc. The valve gate openings at the time of sampling will be obtained from the CVPS operator.

### 3.3 Data Report

As required by condition I of the Vermont water quality certification in appendix A of the FERC license, CVPS will file a dissolved oxygen and temperature monitoring report. The report will be filed with the VT DEC to allow for comment. VT DEC may require additional investigation or remedial measures based on the results. Per license article 401 (b), CVPS is required to file documentation of completion of the Dissolved Oxygen and Temperature Monitoring Report with FERC by December 1. This report will include the results including a sketch plan showing the beaver dam locations, the extent of associated backwater in the channel, and the sampling station locations as well as a discussion on the need for the reaeration baffle at the outlet, per license article 403.

## 4.0 Schedule and Consultation

As specified in Condition I, this quality assurance/quality control plan shall be filed with the VT DEC prior to initiating the water quality monitoring study. The weekly water quality sampling will begin in July. Therefore, the draft QA/QC was submitted to the VT DEC to allow for comment and approval on May 12, 2009.

Comments on the draft plan received from VT DEC on June 12, 2009 were addressed in the final version of this plan. Copies of correspondence are included in Appendix C. Per Article 401 (a) of the FERC license, the QA/QC plan is required to be submitted to FERC within 6 months of license issuance (August 26, 2009).

Per Article 401 (b) of the FERC license, the Report is due at FERC by December 1. The schedule for the water quality monitoring at the Project is shown in Table 4.0-1 below.

**Table 4.0-1: Schedule for Water Quality Monitoring**

| Date | Task/Milestone |
|---|---|
| May 12, 2009 | QA/QC Plan submitted to VT DEC for Review |
| June 12, 2009 | Approval of QA/QC Plan from VT DEC |
| June 23, 2009 | Submit Agency Approved QA/QC Plan to FERC |
| July 1 – September 30 | Weekly Water Quality Sampling Conducted |
| October 15 | Draft Report Filed with VT DEC |
| November 15 | Comments provided from VT DEC on Draft Report |
| December 1 | Final Water Quality Report Filed with FERC* |

* Will indicate whether baffle installation is required based on the results, per license article 403.

## 5.0 References and Bibliography


Central Vermont Public Service Corporation. 1992 Pre Dawn Dissolved Oxygen Sampling Silver Lake Hydro-Electric Generation Facility. March 12, 1993. Prepared by Jeffrey A. Wallin and W. William Martinez.

Central Vermont Public Service Corporation. May 1994. Application for Initial License for Major Water Power Project 5 Megawatts or Less, Silver Lake Hydroelectric Project. Prepared by Kleinschmidt Associates, Pittsfield, ME.

Central Vermont Public Service Corporation. Submitted to FERC on February 21, 1995. Additional Information for Silver Lake Project No. 11478.

Federal Energy Regulatory Commission. Issued February 26, 2009. Order on Offer of Settlement and Issuing New License for Project No. 11478. FERC, Washington, D.C.

NHDES. Ambient River Monitoring Program. May 2002. Standard Operating Procedures: Temperature and Dissolved Oxygen. Concord, NH.

USGS. Techniques of Water-Resources Investigations, book 9, chap. A6., section 6.2, Dissolved Oxygen. Version 2.1. June, 2006. http://pubs.water.usgs.gov/twri9A6.

Vermont DEC. Water Quality Division Field Methods Manual. April, 2006.

YSI Incorporated. 2007. YSI Model 55 Operations Manual. YSI, Inc., Yellow Springs, OH.

## Appendix A: Photographs

Plate 1: Goshen Dam Outlet.

Plate 2: Sucker Brook Downstream View from Outlet.

Plate 3: Upstream View of Old Beaver Dam in Sucker Brook Downstream of Goshen Dam Outlet.

Plate 4: Downstream View of Sucker Brook Downstream of Old Beaver Dam.

## Appendix B: Field Data Sheets

**Silver Lake Hydroelectric Project**
**Water Quality Monitoring**

Project: _____
Personnel: _____
Date/Time: _____
Meter Type Model: _____ Serial No: _____
Flow Conditions: _____
Reservoir Elevation (SCADA): _____
Outlet Valve Setting (get from operator): _____
Weather Conditions: _____

## Quality Assurance

### Initial Calibration Data

Date: _____
Time: _____
Location: _____
Elevation: _____
Calibration results:
Calibration value (% sat): _____
Temperature ($^{o}$C): _____
DO (%): _____
DO (mg/L): _____

Notes:

### Zero Oxygen Standard Check

Date: _____
Time: _____
Location: _____

Temperature ($^{o}$C): _____
DO (%): _____
DO (mg/L): _____

Note:

### End of Day Calibration Check

Date/Time: _____
Location: _____

*Reading in Calibration Chamber*
Temperature ($^{o}$C): _____
DO (%): _____
DO (mg/L): _____

Notes: _____
_____
_____

## Field Measurements

### Site A (Outlet)

Sample Time: _____
Sample Depth: _____
Temperature ($^{o}$C): _____
DO (%): _____
DO (mg/L): _____

Note:

### Site A-1

Sample Time: _____
Sample Depth: _____
Temperature ($^{o}$C): _____
DO (%): _____
DO (mg/L): _____

Note:

### Site A-2

Sample Time: _____
Sample Depth: _____
Temperature ($^{o}$C): _____
DO (%): _____
DO (mg/L): _____

Note:

### Site A-3

Sample Time: _____
Sample Depth: _____
Temperature ($^{o}$C): _____
DO (%): _____
DO (mg/L): _____

Note:

# TEMPERATURE/DISSOLVED OXYGEN PROFILE
# FIELD DATA SHEET

Project: Silver Lake Hydroelectric Project  Personnel:_____

Date: _____  Begin Time: _____ End Time: _____

Meter: _____  Calibration Date and Time: _____

| DEPTH (meters) | TEMPERATURE ($^{o}$C) | DISSOLVED OXYGEN (mg/L) | DISSOLVED OXYGEN (% Saturation) |
|---|---|---|---|
| Surface | | | |
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| **Replicate:** | | | |
| **Note Maximum Depth:** | | | |

Weather:_____

Notes:_____

_____

_____

## Appendix C: Agency Correspondence

GOMEZ AND SULLIVAN
Engineers, P.C.

55 North Stark Highway
Weare, NH 03281
T - (603) 529-4400
F - (603) 529-4411

May 12, 2009

Jeffrey R. Cueto, P.E., Chief Hydrologist
Vermont Department of Environmental Conservation
Facilities Engineering Division, Laundry Bldg.
103 South Main Street
Waterbury, VT 05671-0511

Re: Silver Lake Hydroelectric Project, FERC Project No. 11478
Draft Quality Assurance / Quality Control Plan for Water Quality Monitoring

Dear Mr. Cueto:

The Silver Lake Hydroelectric Project (FERC Project No. 11478) was issued an original FERC license on February 26, 2009. The Project is located on Sucker Brook in Addison County, Vermont and is owned and operated by Central Vermont Public Service Corporation (CVPS).

Condition I of the Vermont Agency of Natural Resources (VANR) Water Quality Certificate, issued December 5, 2008, which is Appendix A of the FERC license, requires CVPS to monitor dissolved oxygen and temperature conditions weekly from July through September directly below the Goshen Dam outlet when a dissolved oxygen profile in Sugar Hill Reservoir near the outlet discloses stratified conditions.

Prior to initiating the study, Condition I also requires that CVPS develop a quality assurance/quality control (QA/QC) plan for the water quality study, and file the plan with VANR prior to initiating the study. Article 401 (A) of the license requires that the QA/QC Plan be submitted to FERC within 6 months of license issuance (by August 26, 2009) after approval from VANR. CVPS is targeting July 1 for commencement of the water quality study.

Attached for your review is the Draft QA/QC Plan for water quality monitoring at the Silver Lake Hydroelectric Project. If you could provide your comments on the draft plan to me on or before June 15, 2009, it would be greatly appreciated. Please contact me if you have any questions. Thank you.

Sincerely,

Jason George
Environmental Scientist

C: M. Scarzello, CVPS
B. Eliason, CVPS

Enclosure: Silver Lake Draft QA/QC Plan

VERMONT

**Vermont Department of Environmental Conservation** *Agency of Natural Resources*
Dam Safety and Hydrology Section
103 South Main Street [phone] 802-241-3758
Waterbury, VT 05671-0511 [fax] 802-244-4516
**http://www.anr.state.vt.us/dec/fed/dss.htm**

TRANSMITTED ELECTRONICALLY

June 12, 2009

Jason George, Environmental Scientist
Gomez and Sullivan Engineers, P.C.
55 North Stark Highway
Weare, NH 03281

RE: Silver Lake Hydroelectric Project – FERC No. 11478
Sugar Hill Reservoir Water Quality Study Plan

Dear Mr. George:

On behalf of Central Vermont Public Service Corporation by letter dated May 12, 2009, you filed a draft water quality study plan with the Department for the Silver Lake Hydroelectric Project in accordance with Condition I of the Project water quality certification. The plan covers dissolved oxygen sampling planned for July – September 2009 as related to reservoir stratification and potential outlet dissolved oxygen deficits at Goshen Dam. Herein the Department provides its comments.

Section 2.1. I would suggest adding that study objectives include 1) a determination as to whether significant reservoir stratification persists under the new operating rule; 2) if so, whether the reaeration provided by the baffle is sufficient to assure compliance with dissolved oxygen standards downstream; and 3) an assessment of downstream reaeration rates.

Section 2.2. There is a statement that beaver activity downstream of Goshen Dam may have influenced the dissolved oxygen deficiencies documented in 1992. It may be correct that the beaver flowages affect downstream reaeration rates, but the reservoir stratification is the main influence that needs to be addressed. Technically, the dissolved oxygen standard must be met at the outlet, where there is no beaver effect. For the one sampling date that included collection of samples immediately downstream (August 28, 1992), dissolved oxygen concentrations did improve over the 600-foot downstream reach despite the beaver influence. If the beaver dams are still ponding water, I would suggest that the report include a sketch plan showing the beaver dam locations, the extent of backwater, and the sampling station locations.

Please clarify the location of the sampling point at the outlet. Is it in the natural channel directly downstream of the turbulent area as shown on Plate 1 in Appendix A?

Section 2.3. Since the plan is to visit the site weekly, it may make sense to collect the pre-dawn downstream samples and then do the reservoir profile each week. The text suggests that the reservoir profiles will be done first to determine whether the reservoir is stratified, but that station will probably be done after dawn. Since mobilization takes the most time, you might want to just go ahead and do the downstream samples before checking to see if the reservoir is stratified. You may also want to try to time any sampling to a certain extent based on forecasted weather. For example, if there is a dry period, it would be good to get out and sample before a forecasted rain event.

The plan should address the installation and testing of the baffle structure. If on a sampling date you find substandard conditions at the outlet, I am not sure whether the plan is to have CVPS immediately install the baffle structure and resample, all before dawn, or to arrange something for the next day.

Sections 3.3 and 4.0. When you file the study report with my department, we will need to make a determination under Condition I of the certification as to whether the sampling triggers *additional investigation or remedial measures*. So it is not just a consultative process with the Department before filing the final report with FERC.

Finding 55 of the water quality certification mentions that the license application did not include the reservoir data. If the data is still available, please include it in the report.

Please feel free to contact me if you should have questions.

Very truly yours,

Jeffrey R. Cueto, P.E.
Chief Hydrologist

c Peter LaFlamme, Director, Water Quality Division
Susan Warren, Water Quality Division
Jim Kellogg, Water Quality Division
Michael Scarzello, P.E., CVPS
Melissa Grader, USF&WS

## Jason George

**From:** Melissa_Grader@fws.gov
**Sent:** Wednesday, September 23, 2009 12:48 PM
**To:** Jason George
**Cc:** 'Eliason, Beth'; 'Joseph Enrico'; 'Scarzello, Michael'; jeff.cueto@state.vt.us
**Subject:** Re: Silver Lake Hydro Project - compliance plans under Article 401 (A)
**Attachments:** pic16941.gif

Thanks Jason,

We received the CD containing the three compliance plans you developed in consultation with the VT ANR for the Silver Lake Hydro Project, located on Sucker Brook in Addison County, Vermont. We have no comments on the Debris Disposal Plan, the QA/QC Plan, or the Recreational Facility Design Plan.

We would appreciate receiving a copy of the draft Water Quality Report prior to you filing a final report with the Commission.

Thank you for the opportunity to comment.

Sincerely,
Melissa Grader
~~~
~~~

Please let me know if you have any questions or comments.  FERC had asked that I report back to them with a record of our consultation.  Thanks.

Jason George
Gomez and Sullivan Engineers, P.C.
55 North Stark Highway
Weare, NH  03281
603.529.4400

## Appendix B: Photographs

Plate 1: Goshen Dam Outlet.
Date: April 20, 2009

Plate 2: Sucker Brook Downstream View from Outlet, Site A (Outlet).
Date: April 20, 2009

Plate 3: Sucker Brook Site A-1; Upstream View from Old Beaver Dam.
Date: June 30, 2009

Plate 4: Downstream View of Sucker Brook Looking Towards Site A-2.
Date: April 20, 2009

Plate 5: Upstream View of Sucker Brook Site A-2.
Date: June 30, 2009

Plate 6: Downstream View of Sucker Brook Site A-3.
Date: June 30, 2009

Plate 7: View of Profile Location (blue buoy) in Sugar Hill Reservoir from Goshen Dam.
Date: June 30, 2009

Plate 8: Reaeration Baffle Structure.
Date: September 24, 2009

## Appendix C: Agency Correspondence

**Vermont Department of Environmental Conservation**
Dam Safety and Hydrology Section
103 South Main Street [phone] 802-241-3758
Waterbury, VT 05671-0511 [fax] 802-244-4516
**http://www.anr.state.vt.us/dec/fed/dss.htm**

*Agency of Natural Resources*

TRANSMITTED ELECTRONICALLY

November 4, 2009

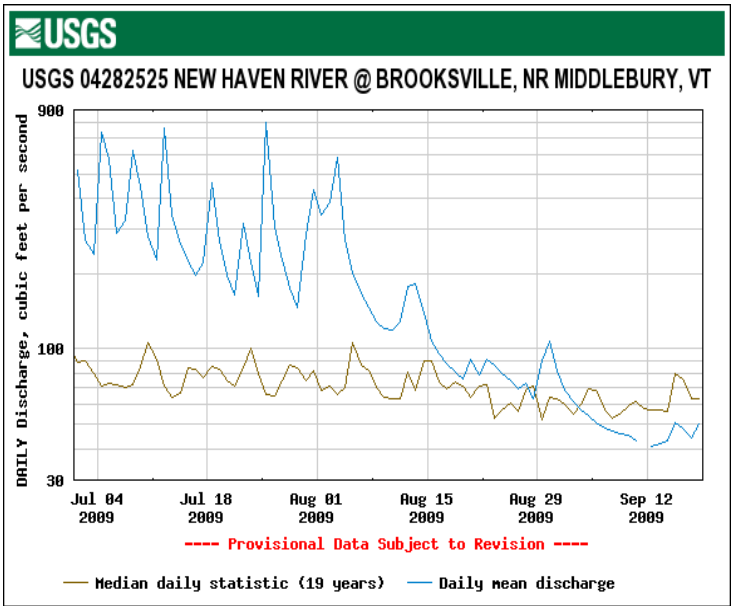
Jason George, Environmental Scientist
Gomez and Sullivan Engineers, P.C.
55 North Stark Highway
Weare, NH 03281

RE: Silver Lake Hydroelectric Project – FERC No. 11478
Draft Water Quality Monitoring Report for Sugar Hill Reservoir and Sucker Brook

Dear Mr. George:

On behalf of Central Vermont Public Service Corporation by letter dated October 9, 2009, you filed a draft water quality monitoring report with the Department in accordance with Condition I of the Project water quality certification and Article 403 of the federal license for the Silver Lake Hydroelectric Project. Condition I requires the monitoring of dissolved oxygen concentrations and temperature below Goshen Dam during the first full summer season of operation following license issuance and testing of the baffle system for reaeration should substandard dissolved oxygen conditions be disclosed by the monitoring. You provided a draft plan of study to the Department by letter dated May 12, 2009; the Department commented on the plan by letter dated June 12, 2009; and you revised the plan to our satisfaction and filed it with FERC. Herein the Department provides its comments.

CVPS personnel sampled water quality weekly from July 1 through September 18, 2009, including vertical profiles of dissolved oxygen and temperature in the reservoir near the outlet conduit and at several stations directly downstream of the dam. As shown by the following graph of flows for the nearby New Haven River, conditions were relatively wet until September.



As background on the issue, I am attaching page 12 of the water quality certification and an excerpt from Exhibit E of the license application. The Exhibit E excerpt includes the downstream sampling results for 1991 and 1992. Consistent with earlier dissolved oxygen sampling, the reservoir exhibited a marked temperature and dissolved oxygen gradient in 2009 with extremely low dissolved oxygen concentrations near the bottom withdrawal zone.[1] Since the outlet conduit is pressurized, the only opportunities for oxygen entrainment are at and downstream of the control valves. The outlet conduit draws from the most oxygen depleted zone of the reservoir.

Generally, the temperature data for Station A (about 30 feet downstream of the outlet according to Figure 2.2-1) corresponds fairly closely with the temperature data for the lowest point in the reservoir profile.[2] The dissolved oxygen concentrations near the bottom of the reservoir fell below 2 mg/l in late July and below 1 mg/l in late August. By September 18, the reservoir had destratified; the profile was almost isothermal, and the dissolved oxygen concentration throughout the profile was between 7 and 8 mg/l. Although the withdrawal zone is nearly anoxic at times, Station A exhibited substantially higher dissolved oxygen concentrations, often by as much as 5 or 6 mg/l. The existing discharge structural characteristics at the outlet cause effective aeration even without the baffle in place. The baffle was installed on September 10 and apparently increased the concentration by 0.4 mg/l, although it is not clear why the existing outlet by itself had caused greater increases in dissolved oxygen overall earlier in the season. On July 31, for example, the reservoir conditions were very similar, but the dissolved oxygen concentration increased 6.0 mg/l between the stations on that date and only 4.8 mg/l on September 9. Perhaps it related to the higher discharge of 3.6 cfs in July as opposed to 2.5 cfs in September. The following table compares the lowest dissolved oxygen concentrations in the profiles with the corresponding Station A values.

| Date | D.O. at Low Point of Reservoir Profile | | D.O. at Station A | | Increase in D.O. | |
|---|---|---|---|---|---|---|
| | mg/l | % Saturation | mg/l | % Saturation | mg/l | % Saturation |
| July 1 | 5.7 | 55 | 8.6 | 83 | 2.9 | 28 |
| July 10 | 3.6 | 36 | 8.6 | 85 | 5.0 | 49 |
| July 15 | 4.4 | 44 | 8.2 | 82 | 3.8 | 38 |
| July 31 | 1.3 | 13 | 7.3 | 75 | 6.0 | 62 |
| August 7 | 2.2 | 23 | 7.7 | 80 | 5.5 | 57 |
| August 14 | 2.0 | 21 | 7.3 | 77 | 5.3 | 56 |
| August 21 | 0.8 | 8 | 6.1 | 65 | 5.3 | 57 |
| August 28 | 0.3 | 3 | 6.4 | 67 | 6.1 | 64 |
| September 4 | 3.3 | 34 | 7.4 | 77 | 4.1 | 43 |
| September 9 | 1.6 | 17 | 6.4 | 67 | 4.8 | 50 |
| September 10 w/baffle | 1.6 | 17 | 6.8 | 72 | 5.2 | 55 |
| September 18 w/baffle | 7.2 | 74 | 8.4 | 87 | 1.2 | 13 |

Note: Highlighted values are substandard (less than 6 mg/l or 70% saturation).

The turbulence at the outlet corrects much of the deficit. CVPS's proposal to maintain the baffle in place for the entire period of July through September would provide some additional slight benefit. As indicated in the water

[1] Normal operation during the summer is to manage the reservoir water surface between elevations 1760.5 feet and 1765.5 feet. During the 2009 sampling, the reservoir elevation was within that range on each of the sampling dates. The outlet conduit is a four-foot square concrete box with valve control at the outlet end. The water quality certification contains conflicting information regarding its inlet invert elevation, perhaps related to the 1995 survey correction. Table 1 uses a value of 1720 feet, but Finding 55 uses a value of 1717 feet. Since the correction was plus three feet, the 1720-foot value may be the correct one. The reservoir sampling station included samples down to an elevation of about 1728 feet.

[2] There may be a transcription error in Table 3.4-1. On August 7, the reservoir "bottom" temperature is shown as 18.0°C, but the profile in Figure 3.3-3 shows about 17.4°C.

quality certification, the further recovery of dissolved oxygen in the reach below Goshen Dam is relatively limited due to the low gradient of Sucker Brook. The data from 2009 is highly variable in that regard. In a few cases, the concentration increased about 1 mg/l in the 600-foot reach. On September 18, it declined.

Technical violations of the dissolved oxygen standards were common during the 1991 and 1992 sampling at Station A. I was unable to obtain the reservoir profile data for those sampling periods. There would probably be some utility in trying to understand why the data from 1991 and 1992 shows worse dissolved oxygen conditions than 2009. It likely relates to the fact those summers were much drier. Reservoir management under the new license is not markedly different from historic operation.

The reservoir will continue to have a dramatic impact on downstream water quality. Operation with the baffle in place achieved the threshold water quality standards for dissolved oxygen in 2009, but there is no certainty that the threshold standards will be met in more typical or drier summers, especially when outflows are reduced below 2.5 cfs. The Department requests that one sampling round during the next summer drought condition to determine whether the dissolved oxygen standards are being met under what is likely to be worse-case conditions for downstream water quality. Drought conditions would be conditions that necessitate matching reservoir inflow after drawing the reservoir to elevation 1757.5 feet pursuant to the summer operating rule.

When you finalize the report, please include a discussion of the QA/QC review of the data (reference Section 3.1 of the study plan). Also, Figure 2.2-1 shows the location of the beaver dam in the downstream reach but it does not show the extent of the backwater. Please add that information (reference Section 3.3 of the study plan). Section 1.1 of the study report indicates that the baffle structure is designed in part to prevent winter freezing. It also states that the baffle is only in place during the summer, which I believe is correct. I was also under the impression that the baffle has not been installed every year since 1992 as it had fallen into disrepair.

You may want to correct the footers for the report pages that show the reservoir profile data as they refer to the Lamoille Project instead of Silver Lake.

Please feel free to contact me if you should have questions.

Very truly yours,

Jeffrey R. Cueto

Jeffrey R. Cueto, P.E.
Chief Hydrologist

c Peter LaFlamme, Director, Water Quality Division
Susan Warren, Water Quality Division
Chet Mackenzie, VT Fish and Wildlife Dept.
Gregory Smith, US Forest Service
Steve Roy, US Forest Service
Melissa Grader, USF&WS
Michael Scarzello, P.E., CVPS
Beth Eliason, CVPS

Encl. wqc and Exhibit E excerpts

**Impact of lake/reservoir stratification on downstream water quality:**

53. Thermal stratification of reservoirs and lakes during the summer can create oxygen-depleted conditions in their deeper zones. Unlike natural lakes, water from some reservoirs and lakes with artificial outlets is often discharged from low-level outlets instead of the lake surface, passing the low dissolved oxygen conditions downstream.

54. Sampling efforts were undertaken by the applicant in the summers of 1991 and 1992 within Sugar Hill Reservoir; directly downstream of Goshen Dam and at distances downstream of 200 feet, 400 feet, 600 feet, and 5,000 feet (at the bridge crossing of Forest Road #32); at the discharge point of the diversion conduit into Silver Lake; at the tailrace discharge of the powerhouse; and in Sucker Brook just upstream of tailrace confluence and 1/4 mile below the tailwater confluence.

***Sugar Hill Reservoir***

55. Dissolved oxygen profiles completed on July 16, 1991 display stratification characteristics. Near the reservoir outlet, the lowermost ten feet of water was measured at less than 20% oxygen saturation (*Application for Initial License for Major Water Power Project - 5 Megawatts or Less - Silver Lake Hydroelectric Project,* May 1994, Volume I, p. E1-16). The license application does not contain the specific data set discussed in the narrative, so it is not clear precisely what the spatial location of the sampling data is relative to the outlet. According to Exhibit F, sheets 1 and 2 of the license application, the deepest area of the reservoir bed is at about elevation 1714 feet msl, assuming the area has not been filled by sedimentation, and the outlet intake is between elevation 1717 and 1721 feet msl. It is, therefore, reasonable to assume that the outlet entrains oxygen-depleted water.

56. The baffle system at the discharge end of the outlet raises the dissolved oxygen concentration of the water. Data was collected from mid-July through August 1992 to supplement data collected on June 14 and July 26, 1991 data in evaluating how effective the baffle system is in protecting downstream water quality. Sampling completed on August 28, 1992 included several sampling stations in the 600-foot segment below the Goshen Dam outlet to examine recovery due to reaeration by the natural stream channel. The baffle system was generally able to bring the water close to or above minimum dissolved oxygen standards of 6 mg/l and 70% saturation. The lowest dissolved oxygen concentration of 5.5 mg/l (59% saturation at 15.6 deg C) was recorded on July 26, 1991. The recovery sampling completed on August 28, 1992 indicated that the baffle system brought the dissolved oxygen level up to 5.8 mg/l and 62% saturation and that full standards were achieved within 400 feet of the outlet (6.7 mg/l and 71% saturation); saturation was attained by the time Forest Road #32 was reached 5,000 feet downstream. Reaeration rates immediately below the dam are somewhat limited by the relatively shallow gradient of Sucker Brook through this reach.

57. In its response to AIR No. 9 (*Additional Information Second Set, Silver Lake Project No. 11478,* CVPS, February 1996), the applicant proposes to conduct a post-licensing water quality study to determine if stratification problems persist after the new reservoir water level management rule is implemented. If a dissolved oxygen problem does occur, a reaeration baffle would be installed and tested to determine if dissolved oxygen standards can be met using the baffle.

### 1.3.2 Threatened and Endangered Species

The Federal list of threatened and endangered animal species mentions three transitory animals, the bald eagle, the peregrine falcon, and the eastern cougar, that may be present in this area (see letter dated August 29, 1991 in Appendix A). Historic records indicate that peregrine falcons nested in the ledges east of Silver Lake, in an area just outside of the project boundary. However, a search of the Vermont Nongame and Natural Heritage Program's database revealed that there are no known occurrences of rare animals in the project area.

By respective letters dated August 29, 1991 and September 17, 1991, the USFWS and the VANR confirmed that, under their jurisdiction, no rare, threatened, or endangered wildlife species are known to occur within the project area.

### 1.3.3 Natural Areas and Critical Habitat

There are no recognized critical habitat areas located within the Silver Lake Project area. However, the project is located in the western portion of the Green Mountain National Forest. This portion of the National Forest contains two managed wilderness areas that are not affected by the project, the Breadloaf Wilderness and the Bristol Cliffs Wilderness.

## 1.4 Water Quality and Quantity

### 1.4.1 Water Quality

The Sucker Brook drainage, as well as Sugar Hill reservoir and Silver Lake, have been designated as Class B coldwater fish habitat by the

Vermont Water Resources Board. This designation requires a minimum dissolved oxygen concentration of 6 mg/l or 70% saturation at all times. Vermont Water Quality Standards are listed in Appendix F.

Data were collected for the Sugar Hill reservoir and Silver Lake impoundment during mid-day on July 16, 1991. During this sampling, the water quality in the Sugar Hill reservoir appeared to generally support the existing coldwater fishery management, assuming that water temperature does not rise further than what was observed (20-22°C down to 10 ft depth, 14-19°C at greater depths). Dissolved oxygen (D.O.) was consistently at or near 100% saturation in the upper 10 ft of the water column, and was well within a concentration range suitable to trout for a depth of at least an additional 5 ft (80-94% saturation). In the upstream half of the reservoir, D.O. levels immediately above the bottom were relatively low (22-63% saturation). In the deep trough at the downstream end of the reservoir, near the outlet, the lowermost 10 ft of the water column was stratified with D.O. levels deficient for trout (12-20% saturation). D.O. levels significantly improved, however, upon passing through the baffles in the outlet structure (approximately 66% saturation).

During the July 16, 1991 sampling, Silver Lake's temperature and D.O. were satisfactory at all locations and depths for a coldwater lake. The maximum depth sounded was 75 ft, with a pronounced thermocline existing below a depth of 14 ft. Temperature above the 14-ft depth was 21-23°C and saturation was 93-110%. Below the thermocline, temperature ranged from 6-13°C with 71-100% saturation.

In order to supplement the data gathered during the July 16, 1991 sampling and as part of environmental studies conducted at the request of resource agencies, CVPS collected water quality data in the Silver Lake project area under the normal mode of operation with a continuously maintained minimum flow of 2.5 cfs below Goshen dam (see Appendix G). Pre-dawn samples were taken weekly under worst case situations (*e.g.*, summer low flow, unit on line) from mid-

July through August, 1992. Additional data from samples taken on June 14 and July 26, 1991 were also provided. Table E-1 gives the results of the 1991 and 1992 sampling efforts. The data collected at the six sampling locations (see Figure 1 in Appendix G) indicate that the water quality conditions, on a whole throughout the project, maintain a high standard.

The Sugar Hill reservoir is used to store spring run-off and typically by early June, the reservoir has filled and the gate is set for the minimum summer flow release of 2.5 cfs (1 CFSM). The June 14, 1991 data show that D.O. concentrations of the discharge water is well above the standard in early summer, however, by mid July the reservoir is thermally stratified. This progression is again apparent in the July, 1992 data which show the samples taken at the outlet structure of Goshen dam exhibited slightly substandard D.O. concentrations or percent saturation on six of the eight sampling dates.

As mentioned above, the preliminary investigations on July 16, 1991 found that the percent saturation in the hypolimnion was 12-20%. The Sugar Hill outlet draws from the hypolimnion and discharges the water through an energy dissipation baffle where reaeration takes place. The lowest recorded saturation at the base of the outlet structure was 59%.

On August 28, 1992, three additional samples were taken at staggered locations immediately below the discharge of Goshen dam to track reaeration within the natural streambed. Topography just below the outlet structure is flat with numerous beaver dams restricting flow. The beaver dams are presently inactive and several of them are breached. Samples taken through the series of dams showed that D.O. concentration levels (mg/l) meet the standard for Class B waters within 200 ft of the dam outlet. Both concentration and saturation were well above standards at the end of the series of beaver dams (approximately 600 ft below the dam) where the stream took on a steeper gradient.

# TABLE E-1

PRE-DAWN DISSOLVED OXYGEN SAMPLING, SILVER LAKE HYDROELECTRIC GENERATING FACILITY
CENTRAL VT PUBLIC SERVICE CORPORATION

June 14, 1991

| STA | TIME | WATER TEMP °C | D.O. CONCEN. | % SAT. |
|---|---|---|---|---|
| a | 0405 | 9.8 | 8.4 | 79 |
| b | 0420 | 8.9 | 10.2 | 94 |
| c | 0445 | 10.5 | 10.1 | 95 |
| d | 0515 | 17.1 | 8.1 | 88 |
| e | 0520 | 11.0 | 10.1 | 94 |
| f | 0532 | 16.7 | 8.9 | 93 |

July 26, 1991

| STA | TIME | WATER TEMP °C | D.O. CONCEN. | % SAT. |
|---|---|---|---|---|
| a | 0526 | 15.6 | 5.5 | 59 |
| b | 0545 | 14.8 | 9.6 | 100 |
| c | 0605 | 16.6 | 9.5 | 102 |
| d | 0620 | 25.2 | 7.0 | 86 |
| e | 0624 | 18.4 | 9.1 | 99 |
| f | 0636 | 24.8 | 7.4 | 91 |

July 22, 1992

| STA | TIME | WATER TEMP °C | D.O. CONCEN. | % SAT. |
|---|---|---|---|---|
| a | 0430 | 13.0 | 7.1 | 72 |
| | | | 7.2 | 72 |
| b | 0415 | 11.1 | 10.1 | 97 |
| | | | 10.1 | 97 |
| c | 0505 | 13.2 | 10.6 | 106 |
| | | | 10.8 | 108 |
| d | 0525 | 21.0 | 8.9 | 102 |
| | | | 8.9 | 102 |
| e | 0545 | 13.8 | 9.3 | 92 |
| | | | 9.6 | 95 |
| f | 0555 | 20.5 | 10.2 | 116 |
| | | | 10.2 | 116 |

July 30, 1992

| STA | TIME | WATER TEMP °C | D.O. CONCEN. | % SAT. |
|---|---|---|---|---|
| a | 0430 | 13.7 | 8.4 | 68 |
| | | | 6.6 | 68 |
| b | 0408 | 12.3 | 10.1 | 94 |
| | | | 10.0 | 94 |
| c | 0505 | 13.5 | 10.3 | 103 |
| | | | 10.3 | 103 |
| d | 0530 | 21.1 | 7.9 | 91 |
| | | | 7.9 | 91 |
| e | 0540 | 14.6 | 9.1 | 91 |
| | | | 8.9 | 89 |
| f | 0551 | 20.7 | 8.8 | 96 |
| | | | 8.8 | 96 |

August 4, 1992

| STA | TIME | WATER TEMP °C | D.O. CONCEN. | % SAT. |
|---|---|---|---|---|
| a | 0410 | 14.4 | 5.7 | 59 |
| | | | 5.8 | 60 |
| b | 0430 | 13.7 | 9.5 | 96 |
| c | 0505 | 14.6 | 9.4 | 97 |
| d | 0530 | 19.7 | 7.5 | 84 |
| | | | 7.9 | 88 |
| e | 0540 | 15.5 | 8.4 | 86 |
| | | | 8.5 | 87 |
| f | 0550 | 19.6 | 8.6 | 96 |

August 15, 1992

| STA | TIME | WATER TEMP °C | D.O. CONCEN. | % SAT. |
|---|---|---|---|---|
| a | 0415 | 14.9 | 5.8 | 60 |
| | | | 6.3 | 66 |
| b | 0435 | 13.3 | 9.8 | 98 |
| | | | 9.9 | 99 |
| c | 0505 | 13.6 | 10.2 | 102 |
| | | | 10.6 | 106 |
| d | 0530 | 19.7 | 7.9 | 88 |
| | | | 8.6 | 96 |
| e | 0545 | 13.7 | 10.0 | 98 |
| | | | 10.2 | 100 |
| f | 0554 | 18.6 | 9.3 | 102 |
| | | 19.4 | 9.3 | 103 |

August 22, 1992

| STA | TIME | WATER TEMP °C | D.O. CONCEN. | % SAT. |
|---|---|---|---|---|
| a | 0407 | 15.3 | 6.3 | 67 |
| | | | 6.6 | 70 |
| b | 0425 | 12.9 | 10.4 | 104 |
| c | 0450 | 12.8 | 10.8 | 107 |
| | | | 10.8 | 107 |
| d | 0515 | 19.1 | 8.7 | 96 |
| | | | 8.9 | 98 |
| e | 0522 | 13.1 | 9.6 | 93 |
| f | 0540 | 16.7 | 9.8 | 107 |
| | | | 9.8 | 107 |

August 28, 1992

| STA | TIME | WATER TEMP °C | D.O. CONCEN. | % SAT. |
|---|---|---|---|---|
| a | 0415 | 15.6 | 5.8 | 62 |
| | | | 5.8 | 62 |
| a-1 | 0429 | 15.5 | 6.4 | 68 |
| a-2 | 0438 | 15.4 | 6.7 | 71 |
| a-3 | 0450 | 15.4 | 7.4 | 79 |
| b | 0515 | 15.1 | 9.4 | 99 |
| c | | | | |
| d | 0545 | 22.2 | 8.0 | 98 |
| | | | 7.6 | 96 |
| e | 0550 | 18.1 | 8.4 | 91 |
| | | | 8.2 | 88 |
| f | 0601 | 22.1 | 8.6 | 103 |
| | | | 8.6 | 100 |

| Station | Location |
|---|---|
| a | Outfall of Goshen Dam, Sugar Hill Reservoir |
| a-1 | Approx. 200 feet below Outfall of Goshen Dam |
| a-2 | Approx. 400 feet below Outfall of Goshen Dam |
| a-3 | Approx. 600 feet below Outfall of Goshen Dam |
| b | Bridge crossing of Forest Road 32 and Sucker Brook |
| c | Outfall of the Diversion Dam into Silver Lake |
| d | Tailwater discharge of Silver Lake hydroelectric plant |
| e | Sucker Brook just upstream of tailwater confluence |
| f | Sucker Brook ¼ mile below confluence with tailwater |

## Jason George

**From:** Melissa_Grader@fws.gov
**Sent:** Monday, November 09, 2009 1:47 PM
**To:** Jason George
**Cc:** Cueto, Jeff; Wentworth, Rod; 'Mike Scarzello'; Steve Roy
**Subject:** Re: Sugar Hill Reservoir 2009 Water Quality Study
**Attachments:** pic09514.gif

Hi Jason,

The FWS concurs with the VANR's comments and recommendations regarding the Sugar Hill Reservoir 2009 Water Quality Study. We support gathering additional water quality data under more typical, low-flow, high temperature conditions to ensure that the baffle is acting to achieve threshold water quality standards for dissolved oxygen.

Sincerely,
Melissa
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**><{{{˜>** ***Jeffrey R. Cueto, P.E., Chief Hydrologist***
**><{{{˜>** VT Department of Environmental Conservation
**><{{{˜>** Dam Safety and Hydrology Section
**><{{{˜>** Facilities Engineering Division, Laundry Bldg.
**><{{{˜>** 103 South Main Street, Waterbury, VT 05671-0511
**><{{{˜>** (802) 241-3758
**><{{{˜>** jeff.cueto@state.vt.us[attachment "ConditionI_WQstudySHR.pdf" deleted by Melissa Grader/R5/FWS/DOI]