

WHITE WATER ASSOCIATES, INC.

**City of Crystal Falls Hydroelectric Project
(Project No. 11402-013)
Water Quality Monitoring Study**

Report for 2007 Monitoring

Submitted to:

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INTRODUCTION

This final report describes results for the Water Quality Monitoring Study conducted July to August 2007 for the City of Crystal Falls (licensee) at the City of Crystal Falls Hydroelectric Project (FERC Project No. 11402) located on the Paint River in Crystal Falls, Iron County, Michigan. This study was conducted to comply with FERC Order Amending the Water Quality Monitoring Plan Under Article 404, issued May 12, 2004 (Appendix A) based on consulting agency recommendations regarding the previous study concluded in 2002. This study is being conducted by an independent ecological consulting firm White Water Associates, Inc. (WWA), under contract with the licensee, with oversight by the Michigan Department of Natural Resources (MDNR) and United States Fish and Wildlife Service (USFWS).

The Water Quality Monitoring Plan submitted by the licensee was prepared by its contractor Mead and Hunt (appears at the end of Appendix A). The FERC order on the plan (also in Appendix A, after the amended order) modified the proposed two-year monitoring term to a three-year term. In addition, it set forth reporting schedules and provided the opportunity for agency comments to be made regarding annual reports. The order also specified special reporting instances should water quality measurements fail to meet standards set by Article 404.

As an outcome of the 2002 final interim report, the recommendation was made to reduce the long-term monitoring schedule to a frequency of once every five years, accepted in correspondence on the draft report by MDNR reviewer Jessica Mistak, Fisheries Biologist (Appendix H). The MDNR recommendation was to include the entire two month low flow period of July and August, however, rather than the one-month mid-July to mid-August period WWA proposed. This study's timing corresponds with these monitoring recommendations, conducting the study five years from the previous study for the months of July and August, with dissolved oxygen and temperature profiles during that period.

This report was distributed as a draft product for the purpose of agency comments, which are included in Appendix I.

This report is comprised of five principal sections, including this one (the Introduction). The next section will describe the general area of the hydroelectric project and the specific monitoring sites. The Methodology section describes four aspects of the study: (1) Upstream Water Quality Profiles, (2) Upstream Temperature Monitoring, (3) Downstream Dissolved

Oxygen and Temperature Monitoring, and (4) Data Management and Analysis. (Except where noted, the Description of the General Area and Methodology sections are identical to those of the 2002 annual report.) The Findings section presents our observations and data collected from the field, and provides an analysis of the data. The Discussion section reviews monitoring results and discusses agency comments.

DESCRIPTION OF THE GENERAL AREA AND MONITORING SITES

The study area is composed of two sites: an upstream site at the upper outer end of the floating platform (“catwalk”) from which the barrier net is suspended, and the downstream site below the dam on the west side (river right). Throughout this report, these sites are referred to simply as upstream and downstream. (See Figure 1, Appendix B.)

Servicing the upstream site was reliable and convenient thanks to the floating platform. This substantial structure is composed of wooden rafts connected into two large floating limbs oriented at approximate right angles to one another. The limb that is placed cross-current is 96 feet long. The limb that is oriented upstream-downstream was 72 feet long. The structure is held in place by steel cables that are stretched between anchor points on the dam, island, and western shore. Just outside the barrier net, at the outer corner of the two limbs, was the upstream site for deploying water quality monitoring equipment and taking profiles every ten days, the frequency being a recommendation begun with the 2002 monitoring effort.

The downstream site was chosen for its security, remoteness, consistent depth, and relation to the dam. It was approximately 100 feet downstream. The study plan prepared by Mead and Hunt and referenced in the FERC order indicated that positions be approximately 500 feet above and below the dam. Convenience and security dictated that these distances be reduced; however, the intent of the plan held—to measure water quality parameters at proper depth, well above and below the dam. In addition, the downstream site corresponded with the location of past deployment of similar equipment, lending to historical comparisons. Since the downstream monitoring site was upstream of the confluence with the spillway and associated oxygenation, the site likely may represent the “worst case” scenario for dissolved oxygen conditions.

The aptness of depths of the two sites for this study was supported by historical data. In 1992, White Water Associates conducted aquatic and terrestrial studies within the Crystal Falls project area as part of the relicensing requirements (Paint River Ecology and Water Quality Study, White Water Associates, 1992). Bathymetry measures at two-foot contours were conducted throughout the impoundment including the area of the barrier net. From that data, depth at the upstream deployment site was determined to be among the deepest locations of the impoundment (as specified by the plan describing the site selection for dissolved oxygen and temperature profiles) at around 14 feet or 4.5 meters. From similar experience, the depth of the downstream site was known to typically be from 3 to 4 feet (1 meter) during the study period.

METHODOLOGY

For the Water Quality Monitoring Study, we followed the study protocol outlined in the licensee's monitoring plan prepared by its contractor, Mead and Hunt, filed with the Commission in November 1996, as modified in the order approving the plan issued April 10, 1997 (Appendix A), with the exception of profiles and data collection every ten days rather than weekly, as noted above. This section details the methods we used for this 2007 study under four subheadings: (1) Upstream Water Quality Profiles, (2) Upstream Temperature Monitoring, (3) Downstream Dissolved Oxygen and Temperature Monitoring, and (4) Data Management and Analysis.

Upstream Water Quality Profiles

Upstream water quality was measured by means of a portable YSI dissolved oxygen and temperature probe connected by a cable marked at intervals. According to the plan and its approving order, measures were required at 1-meter intervals. Measures of temperature and dissolved oxygen were taken approximately every ten days at the upstream site, starting July 9 just after the monitoring cycle began and ending August 25 shortly before it concluded.

Upstream Temperature Monitoring

In addition to affording a location for water quality profiles, the upstream site was the point of deployment for a temperature probe, Ryan TempMentor II, programmed to record temperature hourly. The temperature probe was factory calibrated before the study. The probe and datalogger, joined in a buoyant plastic cannister, were suspended from a weighted chain about 6 feet (2 meters) below the surface. Every ten days, when the site was visited for profiles, the probe was checked to make sure it was functioning properly; data was downloaded via a laptop computer at both a midpoint and the season's end. The unit collected data from July 1 through August 31.

Downstream Dissolved Oxygen and Temperature Monitoring

Visits no more than ten days apart were scheduled to service the Hydrolab Datasonde 3 probe deployed below the dam. The datasonde was programmed to measure dissolved oxygen and temperature hourly, as well as several related water quality and operational parameters. Standard service included calibration checks and downloading of data. Low-flow membranes were used for the unit's dissolved oxygen probe. A single datasonde was used during the course the study. Any interruptions in readings due to servicing were noted for purposes of data management and analysis. The units collected data from July 1 through August 31.

The downstream site was a steep scramble down a heavily wooded hillside adjacent to the hydroelectric facility, minimizing the opportunity for theft or destruction. For further protection, the unit was encased in an slightly oversized PVC tube with holes on the probe end, chained to a tree on the riverbank. Weights held either end of the tube down to prevent shifting.

Data Management and Analysis

The upstream temperature probe requires special software to communicate and download data. The result is two files associated with each download: a data file (basically a long string of temperature measurements with no indication of time or date) and a header file (data manually entered in the tempmentor during setup and deployment, including the start time/date and interval). These two files together allowed preparation of Excel spreadsheets giving all

hourly measurements of temperature, together with daily maximums, minimums, and averages. These results were graphed to show a line of points for daily average, with a vertical bar through each point giving the maximum and minimum readings for that day. The tables and graphs were formatted to display one month of data at a time.

The downstream dissolved oxygen and temperature probe was slightly more sophisticated in its data handling than the upstream probe. The unit's internal data files allowed storing date and time with each reading. Nonetheless, the data had to be arrayed in an Excel spreadsheet table for proper presentation, including calculation of daily averages, maximums, and minimums, and graphing. The graphs were the same format as those prepared for the upstream site. Any data loss due to servicing was noted on the spreadsheet. The results were formatted to display one month of data at a time.

A comparison of temperatures collected hourly at upstream and downstream sites was produced. First, a spreadsheet was created to show a long list of data points for the two sites. Second, the difference between downstream site and upstream site was calculated. Third, the resulting table was used to produce graphs, broken down by month, showing all the raw data. As an additional step, the differences were arrayed similarly to those tables and graphs previously described to present daily averages, maximums, and minimums of these differences.

A graph showing both temperature and dissolved oxygen during the full monitoring season was prepared. Another graph showing upstream and downstream temperatures during the season was also prepared.

As indicated in the study plan, computer data are being provided to the agencies, MDNR and USFWS, as part of the submission for review. For convenience of the reviewer, we compiled all the raw data into a single final "processed raw" data file for each location, appended date/time where necessary (upstream data), and included any annotations useful to the reviewer regarding service interruptions and calibration. Besides these processed raw data files, the tabular and graphic presentations were also provided. The files provided at the review stage were all in Excel 2002 format. An accompanying README.XLS file describes all the individual files making up that submission.

FINDINGS

In this section, we describe our findings within the four categories just described under Data Management and Analysis in the Methodology.

Upstream Water Quality Profiles

Measurements of dissolved oxygen and temperature at 1-meter intervals were taken about every ten days starting July 9 and ending August 25, 2007. The results of those measures and subsequent calculation of percent oxygen saturation are presented in Appendix C. At no time was there any dissolved oxygen readings below 5.0 mg/L (the exceedence limit) even near the bottom of the 4-meter range in depths, and readings were usually substantially higher. Temperature readings ranged with the depth, from surface depth highs of 26.6VC to mid to bottom depth lows of 19.7VC during July and August; these readings were compared to data from the remote temperature probe taken during the same time period.

Upstream Temperature Monitoring

Readings of the Ryan TempMentor, the unit responsible for upstream temperature measurements, were collected at a fixed depth of about 6 feet (2 meters) rather than taken as a profile across the water column as described in the previous section. Continuous hourly measures allowed presenting and graphing all data points from its deployment July 1 through the end of the study August 31. Temperature readings ranged from a high of 27.8VC in early August to a low of 17.5VC in late August, and averaged 22.6VC for the entire span. The results are shown in tables and graphs for these two months (Appendix D). Weekly averages, maximums, and minimums are presented in the following table:

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Upstream	Temperature (°C)		
Year: 2007	Average	Maximum	Minimum
July 1-7	22.4	25.7	20.4
July 8-14	23.0	27.8	19.0
July 15-21	21.3	24.2	18.5
July 22-28	24.4	27.1	21.1
July 29-August 4	26.0	27.8	24.2
August 5-11	23.9	26.0	22.3
August 12-18	22.5	25.0	19.5
August 19-25	19.2	21.2	17.5
August 26-31	20.7	22.3	19.5

Downstream Dissolved Oxygen and Temperature Monitoring

The Hydrolab Datasonde 3 responsible for downstream measurements recorded dissolved oxygen in addition to temperature. This record on a continuous hourly basis allowed presentation of the data, in tabular and graphic forms, from the unit's deployment July 1 through August 31. The results are shown for these two months in Appendix E (temperature) and Appendix F (dissolved oxygen).

The unit initially deployed operated in a consistent and calibrated manner throughout the deployment. Independent checks using a handheld YSI dissolved oxygen meter at the regular service visits yielded measurements within ± 0.66 mg/L of the unit's calibration; similar checks with a handheld Hach LDO dissolved oxygen meter were actually slightly higher than the datasonde reading (by between 0.12 and 0.6 mg/L). The standard specified by Article 404 is dissolved oxygen measurements of 5.0 mg/L or above, and the raw data indicated no excursions occurred from the standard; the unit required no replacement during two months' deployment.

In some past studies, DO data collected were at times corrected with a fixed correction or graduated post-correction factor based on independent field measures. Based on operational

Crystal Falls Water Quality Monitoring Study, Annual Report for 2007 Monitoring

parameters throughout this season's monitoring, no corrections were applied. Data files submitted to the agencies and the graphs and tables included in Appendix F are all based on raw, uncorrected data. The weekly averages, maximums, and minimums for temperature and dissolved oxygen are as follows:

Downstream	Temperature (°C)		
Year: 2007	Average	Maximum	Minimum
July 1-7	22.37	24.72	20.52
July 8-14	23.07	26.95	19.29
July 15-21	21.24	23.54	18.79
July 22-28	24.19	27.05	21.24
July 29-August 4	25.91	27.43	24.34
August 5-11	23.88	25.69	22.51
August 12-18	22.53	25.07	19.64
August 19-25	22.42	20.99	19.53
August 26-31	20.73	22.18	19.67

Downstream	Dissolved Oxygen (mg/L)		
Year: 2007	Average	Maximum	Minimum
July 1-7	7.64	8.14	7.18
July 8-14	7.56	8.80	6.52
July 15-21	8.41	9.17	7.38
July 22-28	7.63	8.82	6.29
July 29-August 4	7.09	7.66	6.27
August 5-11	7.17	8.11	6.40
August 12-18	7.45	8.16	6.70
August 19-25	7.85	8.33	7.22
August 26-31	7.56	8.06	6.73

Comparison Between Hourly Temperatures at Sites

Continuous hourly temperature readings upstream and downstream of the dam allowed comparisons hour by hour between upstream and downstream sites. The data are presented in tabular and graphic forms in Appendix G for the four months involved. In addition to the daily averages, maximums, and minimums reported in those tables, the following is a table showing these differences compiled over a weekly basis:

Delta Temperature VC (Downstream Minus Upstream)			
Year: 2007	Average	Maximum	Minimum
July 1-7	0.0	0.4	-1.1
July 8-14	0.0	0.4	-1.0
July 15-21	-0.1	0.4	-1.3
July 22-28	-0.2	0.2	-1.0
July 29-August 4	-0.1	0.5	-0.9
August 5-11	-0.1	0.3	-0.8
August 12-18	0.1	0.4	-0.8
August 19-25	0.0	0.4	-1.3
August 26-31	0.0	0.3	-0.7

Delta temperature in this case means “downstream minus upstream” so a positive number indicates that the temperature downstream was higher than the temperature upstream. Looking at the averages in the previous table, it seems that the unit downstream, in all but one case, had weekly averages equal to or lower than the upstream unit, but differences of this magnitude could be due to variations in tunings of the factory-calibrated units. Swings in the positive direction never exceeded 0.5VC. Swings in the negative direction (i.e., temperature upstream higher than temperature downstream) were as great as -1.3VC. At no time, did the “downstream minus upstream” temperature difference exceed the delta standard of 5VC.

DISCUSSION AND RECOMMENDATIONS

Water quality measurements for the entire 2007 monitoring season were within normal ranges expected of this study setting and time period. Dissolved oxygen and temperature profiles were typical, with both decreasing slightly with depth. Differences in temperature readings upstream and downstream of the dam were low, less than 1.3 degrees C, at all times. Dissolved oxygen readings below the dam never fell below the standard of 5.0 mg/L. This year's results mirrors those of previous years, the most recent being 2002.

The visits every ten days to service the downstream monitoring probe meant that any maintenance, calibration, or exceedence problems were dealt with reasonably soon. The plan originally submitted to and approved by FERC calls for calibration visits every two weeks and data download visits every week.

The adopted pattern of five year intervals between two-month monitoring periods worked well this year. We anticipate the same pattern will serve the resource well in years ahead, the next study period being 2012.

Reviewing a draft copy of the report sent by e-mail December 13, 2007, Jessica Mistak, Senior Fisheries Biologist, Michigan DNR (Marquette, MI) had no additional comments, since there were no deviations for either dissolved oxygen or temperature during the July and August study period. Also P. Tyler Yasenak, U.S. Fish and Wildlife Service (Green Bay, WI) had no comments regarding the draft report.

APPENDIX A

Study Plan, Order, and Article 404

UNITED STATES OF AMERICA 107 FERC ¶ 62,135
FEDERAL ENERGY REGULATORY COMMISSION

City of Crystal Falls

Project No. 11402-057

ORDER AMENDING WATER QUALITY MONITORING PLAN
UNDER ARTICLE 404

(Issued May 12, 2004)

On December 29, 2003, the City of Crystal Falls (licensee) filed a request to amend article 404 to reduce the water quality monitoring schedule and the data collection interval. The monitoring schedule was set forth in paragraph (B) of the Order Approving Water Quality Monitoring Plan, issued April 10, 1997, for the Crystal Falls Project. The project is located on the Paint River in Iron County, Michigan.

BACKGROUND AND PROPOSED AMENDMENT

Paragraph (B) requires the licensee to annually monitor dissolved oxygen concentrations and water temperature at the project for the remainder of the license term. Annual reports are required to be filed, with the Commission, for the first 3 years of monitoring. The reports shall include agency comments, the licensee's response to agency comments, and any recommendations, for Commission approval, on modifying the water quality monitoring plan.

The licensee is requesting that the plan be modified to reduce the water quality monitoring schedule from annually to once every five years. In addition, the licensee requests to change the data collection interval from the existing June 1 to September 30 interval to July 1 to August 31. According to the licensee, this proposed schedule is a direct result of negotiations with the Michigan Department of Natural Resources (MDNR), and was also referred to in the February 10, 2003 Water Quality Monitoring Study previously filed with the Commission. According to that study, water quality measurements for the entire 2002 monitoring season were within normal ranges. Results were also within normal ranges in 2000 and 2001. The recommendation in the draft report for the 2002 monitoring, that was distributed to the MDNR and the U.S. Fish and Wildlife (FWS), was that monitoring be done once every five years for one a one-month period from mid-July to mid-August. The licensee has not proposed any changes to the study methodology.

P-11402-057

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By letter dated January 3, 2003, the MDNR concurred with the five year monitoring schedule, but requested that the study period be for two months rather than one. The licensee changed the proposed revised monitoring interval to be for two months. No comments were received from the FWS.

DISCUSSION AND CONCLUSION

We agree, based on the results of the first three years of monitoring, that it is appropriate to change the frequency of water quality monitoring at the project from annually to once every five years. The two month period proposed for data collection covers the low-flow period and should ensure that any temperature or dissolved oxygen deviations are recorded. The last study was completed in 2002, so the next study will be for 2007, and due to the Commission by February 2008. The Water Quality Monitoring Plan should be amended.

The Director orders:

(A) The Water Quality Monitoring Plan, approved April 10, 1997, is amended so that the licensee shall monitor dissolved oxygen concentrations and water temperature at the project every 5 years, beginning in 2007, from July 1 through August 31. The licensee shall file the monitoring results with the Commission, by February 15 of the year following monitoring. The results shall include agency comments, the licensee's response to agency comments, and any recommendations for modifying the water quality monitoring plan. Any modifications to the water quality monitoring plan shall be filed for Commission approval.

(B) This order constitutes final agency action. Requests for rehearing by the Commission may be filed within 30 days from the date of issuance of this order, pursuant to 18 C.F.R. ' 385.713.

George H. Taylor
Branch Chief, Biological Resources Branch
Division of Hydropower Administration
and Compliance

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

City of Crystal Falls) Project No. 11402-013

ORDER APPROVING WATER QUALITY MONITORING PLAN

(Issued April 10, 1997)

City of Crystal Falls (licensee) filed for Commission approval, on November 19, 1996, and supplemented on November 20, 1996, a water quality monitoring plan. This plan is required by article 404 of the license for the Crystal Falls Project, issued on October 18, 1995. 1/ The project is located on the Paint River in Iron County, Michigan.

Article 404 requires the licensee to consult with Michigan Department of Natural Resources (MDNR) and the U.S. Fish and Wildlife Service (FWS) and develop a plan to monitor dissolved oxygen concentrations (DO) and water temperature levels at the project. 2/

LICENSEE'S PROPOSED PLAN

The licensee plans to monitor DO for two years in conjunction with implementation of the licensee's barrier net study. 1/ Specifically, the licensee proposes to continuously monitor water temperature and DO at mid-depth approximately 500 feet downstream of the dam and approximately 500 feet upstream of the impoundment (water temperature only) from June through September. One-meter increment profiles of water temperature and DO will be taken once a week from June through September and twice during the month of February for water temperature and DO.

The licensee plans to use Hydrolab DataSonde III probes for the water quality monitoring. Water temperature and DO will be

- 1/ 73 FERC ¶ 62,036. See also Order on Rehearing, issued on May 17, 1996 (75 FERC ¶ 61,174).
- 2/ State standards require a DO of at least 5 milligrams/liter (mg/l) and the waters downstream shall not receive a heat load that would warm the receiving water at the edge of the mixing zone by more than 5° F above natural water temperatures. Further, the Paint River shall not receive a heat load that would warm the receiving water at the edge of the mixing zone to temperatures greater than monthly maximums.
- 3/ This plan was approved in the Order Modifying and Approving Plan for the Installation and Monitoring of a Barrier Net, issued on May 10, 1996 (75 FERC ¶ 62,102).

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recorded hourly during the monitoring period. The licensee plans to calibrate the continuous monitoring probes every two weeks during the monitoring period and the profile probes prior to each sample, according to manufacturer's instructions.

The licensee plans to download DO and water temperature data weekly. At this time, the data will be reviewed to determine if a deviation from state standards has occurred. If a deviation in DO or water temperature occurs, the licensee plans to inform the agencies immediately and determine what, if any, mitigative measures are necessary. If additional measures are implemented, the licensee plans to download data daily to more closely monitor changes in water quality in response to the measures implemented. In the event of DO falling below state standards, the licensee plans to increase spillage. If water temperature standards are exceeded, the licensee plans to immediately contact the agencies to determine what, if any, measures can be taken.

The licensee plans to submit a report to the agencies and to the Commission each year of the two-year monitoring period. This report would include DO and water temperature daily averages, minimum and maximums, and DO and water temperature profile data. The report would also provide comparisons between upstream and downstream water temperature. If at no time within the two-year monitoring period the water quality standards have been exceeded, the licensee will consider the project to have no adverse effect on water quality and will discontinue the monitoring.

AGENCY COMMENTS

The MDNR commented on the proposed plan in a letter dated April 1, 1996. The FWS did not provide comments on the proposed plan.

The MDNR recommends the monitoring period extend from May-October for at least three years. After three years, the licensee may request to change the frequency of monitoring. The MDNR also recommends that water temperature be monitored continuously given that violations could occur in any season. Monitoring locations should be selected in consultation with MDNR.

The MDNR requests that all monitoring equipment be validated with an independent measurement system such as a National Bureau of Standards thermometer for temperature and a Winkler analysis for DO at the end of each unattended monitoring period. Further, 70 percent of the DO data should be verified as accurate to within 1 milligram/liter (mg/l) of the true DO value. Weekly service visits should be scheduled for quality assurance. Further, the MDNR suggests a real-time evaluation of the data to provide for immediate detection of a deviation from state standards.

Regarding reports, the MDNR requests that DO values be compared hourly to the state DO standard and delta temperature values be compared instantaneously. Plausible explanations for any deviations should be provided in the reports, along with a description of the effectiveness of any measures implemented to improve water quality. The MDNR also requests quarterly transmittals of raw data along with information pertaining to the calibration of equipment during that quarter.

Other comments by MDNR were incorporated into the licensee's proposed plan.

DISCUSSION

The licensee's proposed water quality monitoring plan includes those requirements stipulated in article 404 of the license. Implementation of the proposed plan should enable the licensee to monitor the effects of project operation on water temperatures and DO. Calibration of the monitoring equipment according to manufacturer's recommendations, as proposed by the licensee, should be adequate to ensure accurate data are collected. To the extent practicable, the licensee should choose monitoring locations in coordination with the MDNR and FWS.

Article 404 of the license states the purpose of the plan is to ensure that water quality below the project, as measured immediately downstream of the project tailrace, maintain the Michigan standards for DO and water temperature. Further, article 404 requires the licensee develop operating procedures to address when deviations from state standards occur.

Monitoring from June-September, as proposed by the licensee, encompasses the period when warmer temperatures are expected, thus affecting low DO. Therefore, deviations from state standards should be detected upon implementation of the licensee's proposed plan. However, monitoring for only two years, as proposed by the licensee, will not meet the purpose of the plan. Article 404 requires monitoring to ensure state water quality standards are met. The licensee cannot meet this goal if monitoring is discontinued.

Commission staff acknowledges that water quality data collected prior to licensing indicate project operations do not result in violations of the state water quality standards. 4/ If after implementation of monitoring, the data still indicates that project operations do not adversely affect water quality in the project area, the licensee may file a request to modify the water

4/ See the Environmental Assessment for Application for License for the Crystal Falls Project, issued on October 18, 1995 (73 FERC ¶ 62,036).

quality monitoring plan, as recommended by the MDNR. Any recommendations to amend the water quality monitoring plan should be filed for Commission approval, as discussed below.

Providing annual reports to the agencies and immediately contacting the FWS and MDNR upon detection of any deviation from the state standards, as proposed, should provide the agencies with the results of the monitoring in a timely manner. These reports should include, to the extent possible, explanations for any deviations and the effectiveness of any measures implemented to improve water quality, as recommended by MDNR. Quarterly reports of water quality data, as requested by MDNR, are not necessary. The licensee did not provide a schedule for submitting these reports to the agencies or to the Commission. The licensee should provide annual report(s) to these agencies by December 15 of each year of monitoring.

It is only necessary to provide the annual report to the Commission for the first three years of monitoring. Our review of the annual report for a three year period will allow us to evaluate water quality during project operations. The annual report to the Commission should be filed by February 15 of the year following monitoring. The filing should include agency comments, the licensee's response to agency comments, and any recommendations, for Commission approval, for modifying or discontinuing water quality monitoring. Each agency should be given 30 days to comment. If there are no changes to the water quality monitoring plan, the licensee should continue to provide the annual reports to the consulted agencies as identified in the licensee's proposed plan. So that the Commission can monitor compliance with article 404, the licensee should notify the Commission of any deviation from the state standards for DO and water temperature.

The MDNR recommends the licensee analyze data in real time to immediately determine if a problem in water quality exists. The licensee proposes to retrieve data biweekly. Given that the available data indicates no existing water quality problems, as discussed above, the licensee's schedule appears adequate. Further, when the licensee does detect a problem, the licensee plans to retrieve data daily, after contacting the agencies to determine what measures should be implemented in efforts to improve water quality. Therefore, the licensee can timely note any improvements in water quality resulting from any measures implemented.

The licensee proposes to consult with the FWS and MDNR to determine what measures are appropriate in efforts to improve water quality. The licensee specifies that the most likely measure to improve DO is to increase spill. This should be adequate. However, if additional measures are necessary, or if the parties disagree on which measures are appropriate, the

Commission should determine which, if any, additional measures are necessary to improve water quality.

The licensee's water quality monitoring plan, with the modifications discussed, should be adequate to monitor the requirements of article 404 and should be approved.

The Director orders:

(A) The licensee's water quality monitoring plan, filed with the Commission on November 19, 1996, and supplemented on November 20, 1996, as modified in paragraph (B), is approved.

(B) The licensee shall monitor dissolved oxygen concentrations and water temperature at the project for the remainder of the license term. The licensee shall file annual reports with the Commission for the first three years of monitoring. These reports shall be filed by February 15 of the year following monitoring and shall include agency comments, the licensee's response to agency comments, and any recommendations, for Commission approval, on modifying the water quality monitoring plan.

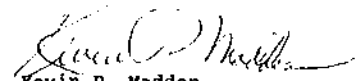
(C) If DO or water temperature, as measured by the approved monitoring system, falls below that required by article 404, the licensee shall file a report with the Commission within 30 days of the date the data becomes available indicating an incident has occurred. The report should, to the extent possible, identify the cause, severity, and duration of the incident, and any observed or reported adverse environmental impacts resulting from the incident. The report should also include: (1) operational data necessary to determine compliance with article 404; (2) a description of any corrective measures implemented at the time of occurrence and the measures implemented or proposed to ensure that similar incidents do not recur; and (3) comments or correspondence, if any, received from the resource agencies regarding the incident. Based on the report and the Commission's evaluation of the incident, the Commission shall reserve the right to require modifications to project facilities and operations to ensure future compliance.

(D) Unless otherwise directed in this order, the licensee shall file an original and seven copies of any filing required by this order with:

The Secretary
Federal Energy Regulatory Commission
Mail Code: DLC, HL-11.2
888 First Street, NE
Washington, DC 20426

In addition, the licensee shall serve copies of these filings on any entity specified in this order to be consulted on matters related to these filings. Proof of service on these entities shall accompany the filings with the Commission.

(E) This order constitutes final agency action. Requests for rehearing by the Commission may be filed within 30 days of the date of issuance of this order, pursuant to CFR § 385.713.


Kevin P. Madden
Acting Director
Office of Hydropower Licensing

A Plan for Monitoring Dissolved Oxygen and Temperature Levels in the Paint River in the vicinity of the Crystal Falls Hydroelectric Facility

Introduction

On October 18, 1995, the Federal Energy Regulatory Commission issued a license for the City of Crystal Falls to continue to operate and maintain the 1,000-kilowatt Crystal Falls Hydroelectric Project, No. 11402, located on the Paint River in Iron County, Michigan. This license is subject to various articles. Among those articles, Article 404 specifies that "Within 6 months of the license issuance, the Licensee shall file with the Commission, for approval, a plan to monitor dissolved oxygen (DO) and temperature levels in the Paint River downstream of the project. This report is intended to provide the plans for implementation of the DO and temperature monitoring program in accordance with Article 404.

Article 404 of the Commissions's license, requires that the water quality data (DO and temperature) would be compared to Michigan State water quality standards. According to these standards (R323.1041), the Crystal Falls hydroelectric project should not influence DO or temperature beyond specified limits as follows: a DO of at least 5 mg/l should be maintained; and a heat load shall not be received that would warm the waters at the edge of the mixing zone by more than 5°C above natural water temperatures, or greater than monthly maximums.

A draft plan for monitoring DO and temperature was prepared and forwarded to the appropriate resource agencies for review in February, 1996. The Michigan Departments of Natural Resources and Environmental Quality prepared a joint reply and the Fish and Wildlife Service concurred with their comments – these entities are hereinafter referred to as the "Agencies." A copy of the draft plan, and the Agencies' comments are attached. The draft plan intended to monitor dissolved oxygen and temperature in the Crystal Falls impoundment and at a downstream location only during the times when the activities related to the proposed Barrier Net Effectiveness Study would be in operation. This allowed the city to combine efforts and maintain study costs for water quality monitoring to within the FERC's proposed \$15,000 cost estimate (FERC Environmental Assessment, page 65). This original plan has been substantially revised as follows to reflect the Agencies' comments and due to the fact that the original Barrier Net Effectiveness Study plan has also been substantially revised.

Study Plan

We propose to continuously monitor both temperature and DO in a mid-depth placement approximately 500 feet below the dam in the Paint River during the months of June through September. Additionally, temperature will be continuously monitored at a mid-depth placement in the Paint River approximately 500 feet upstream of the Crystal Falls impoundment area. A one-meter-increment profile of temperature and DO will be obtained from the deepest part of the impoundment once a week during the months of June through September, and twice during the month of February.

The water quality monitoring plan is proposed to take place in conjunction with the Barrier Net Effectiveness Plan. That is, the site visits used to perform weekly fisheries studies for the effectiveness of the barrier net would be also used to download and recalibrate the continuous monitoring probes, and to conduct weekly profiles of the impoundment. Thus, it is proposed to conduct the water quality monitoring plan during the same two years that are proposed for the Barrier Net Effectiveness Study.

Monitoring Equipment

We propose to use Hydrolab DataSonde III probes for temperature and DO monitoring. The probes would be calibrated according to the manufacturers recommended procedure every two weeks throughout the continuous monitoring period. The continuous monitoring probes would be recalibrated bi-weekly throughout the deployment period and the profiling probe would be calibrated prior to each sample.

Schedule

Continuous monitoring would record temperature and DO hourly during the deployment period. The profile of the impoundment would produce instantaneous data. It is proposed to conduct water quality monitoring for a period of two years. If at no time within this two year period the water quality standards have been exceeded the Crystal Falls Hydroelectric Project should be considered as not having the potential to violate state water quality standards and water quality monitoring would be discontinued. If, however, at any time during the monitoring period, water quality standards are substantially exceeded, the applicant shall inform the Agencies of the deviation from the established limits and, in consultation with the Agencies, the applicant may modify the water sampling procedures to more closely verify the extent and source of the water quality problem and success of any mitigation procedure.

Reporting and Compliance

It is intended to download temperature and DO data from the continuous monitoring

probes weekly throughout the deployment period. At each download, it will be determined if there has been a violation of the water quality standards during the preceding week, and if this violation is still occurring; if so, the Agencies would be immediately notified by telephone and procedures to mitigate the violation would be attempted. If there is a violation of the 5 mg/L dissolved oxygen level at the downstream location, it is proposed that the most likely procedure would be to implement spillage from the impoundment surface waters to aerate the water below the dam. If this plan is invoked, the downstream dissolved oxygen levels would be downloaded daily to monitor the success of this effort. The amount of spillage would be modified according to the success of this effort in increasing the DO as determined by the daily monitoring. The Agencies would be kept apprised of this effort. We have no plan, nor has the Agencies offered a solution, to mitigate any violation of the Delta Temperature Standard. It is proposed to report any violation of the Delta Temperature Standard to the Agencies immediately upon its discovery and at that time determine what, if any, solution might exist to the problem.

In addition to the above reporting procedures, we would prepare an annual report to the FERC and the Agencies. This report would include a computer diskette with all raw data from the continuous and weekly monitoring efforts. In addition to the raw data, a summary of the data by daily average, minimum, and maximum DO, and temperature at the continuous monitoring sites and weekly profiles from the impoundment would be provided. This report would also include an upstream/downstream comparison of the Temperature Delta Standard.

Agency Comments

The agency recommendations have been accommodated into our revised plan as follows:

- a) **Monitoring locations and equipment.** We have added a site upstream for temperature measurements. We intend to calibrate our probes according to the manufacturers recommended procedure. We do not understand their request for a 70% data quality goal – all continuous monitoring probes would be recalibrated bi-weekly regardless of their accuracy to a calibration standard. We have agreed to monitor at one-meter intervals within the deepest part of the impoundment once a week from June through September.
- b) **Monitoring Schedule.** We propose to monitor temperature and DO only during the months of June through September. It is unlikely that DO would be less than 5 mg/L during May or October and continuous monitoring during winter months is not feasible due to extreme weather conditions which would make access and equipment malfunctioning a problem. We will agree to provide a temperature and DO profile of the impoundment twice during the month of February to determine if there exists a potential for ice cover to deplete DO within the impoundment during the period of this event's greatest likelihood.

c) Data Reporting. We propose to provide an annual report to the FERC and the Agencies. This report would include a computer diskette of all raw data and a graphical and tabular presentation of daily minimum, maximum, and average temperature and DO values as measured during the previous year. This report will also note any violations of the Delta Temperature Standard or DO violations and rationale for any lapses in the data. We do not propose to measure any other water quality parameters as suggested such as stream flow, chlorophyll level, or instream chemistry. We do not understand what is meant by the recommendation for "instantaneous" comparisons of temperature values.

d) Detection and Notification. Data would be downloaded weekly from the continuous monitoring probes (at the time of the weekly temperature/oxygen profile of the impoundment). The comment of the Agencies seems to suggest that an hourly downloading and reporting is preferred but we do not understand how this is possible. Other than the annual report described above, no other reports would be made to the agency unless there is a recorded violation of the water quality standards. If such a violation in either the Delta Temperature Standard or the 5 mg/L DO limit is found, then the Agencies would be immediately notified by telephone and a remediation or mitigation procedure would be invoked. We would, as suggested, notify both the Chief of Surface Water Quality Division of the Michigan Department of Environmental Quality, and the FERC Program Manager for the Michigan Department of Natural Resources within one working day of any detected water quality standard violations.

e) Mitigative measures. If water quality standards are violated we intend to notify and work with the Agencies to mitigate those violations. The exact nature of the mitigation measure would depend upon the significance of the violation and the environmental conditions contributing to or otherwise affecting the ability of the applicant to remediate or mitigate the violation.

f) Initial monitoring period. We disagree with the requirement for long term monitoring. An initial period of two years should be adequate to assess whether there exists the potential for significant effects of the hydropower facility on the Paint River water quality. Furthermore, the FERC Environmental Assessment concluded that the water quality monitoring plan should cost about \$15,000. It is our estimate that the plan we have proposed will somewhat exceed that estimate. To extend the monitoring plan beyond two years would substantially and unreasonably exceed that estimate. Extended monitoring is regarded as necessary only if the initial two-year monitoring indicates that there is potential for significant water quality degradation from the hydropower operations that warrant further monitoring to develop and/or monitor long-term mitigation measures.

Article 404. Within 6 months of license issuance, the Licensee shall file with the Commission, for approval, a plan to monitor dissolved oxygen (DO) and temperature levels in the Paint River downstream of the project.

The purpose of this monitoring plan is to ensure that streamflows below the project, as measured immediately downstream of the project tailrace, maintain the Michigan standards for DO concentration and temperature.

The monitoring plan shall include provisions for (1) monitoring of DO concentrations and temperature levels in the impoundment and downstream, with sensor locations and sampling frequently determined in consultation with the Michigan Department of Natural Resources (MDNR) and the U.S. Fish and Wildlife Service (FWS); and (2) the preparation of operating procedures developed in consultation with MDNR and FWS to address water quality conditions which deviate from the above limits.

The Licensee shall prepare the plan after consultation with MDNR and FWS. The water quality monitoring plan shall include a schedule for:

- (a) implementation of the program within 24 months from the date of issuance of this license;
- (b) consultation with MDNR and FWS concerning the results of the monitoring; and
- (c) filing the requests, agency comments, and Licensee's response to agency comments with the Commission.

The Licensee shall include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies, and specific descriptions of how the agencies' comments are accommodated by the plan. The Licensee shall allow a minimum of 30 days for the agencies to comment and make recommendations before filing the plan with the Commission. If the Licensee does not adopt a recommendation, the filing shall include the Licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. Upon Commission approval, the Licensee shall implement the DO concentration and temperature monitoring plan, including any changes required by the Commission.

APPENDIX B

Map

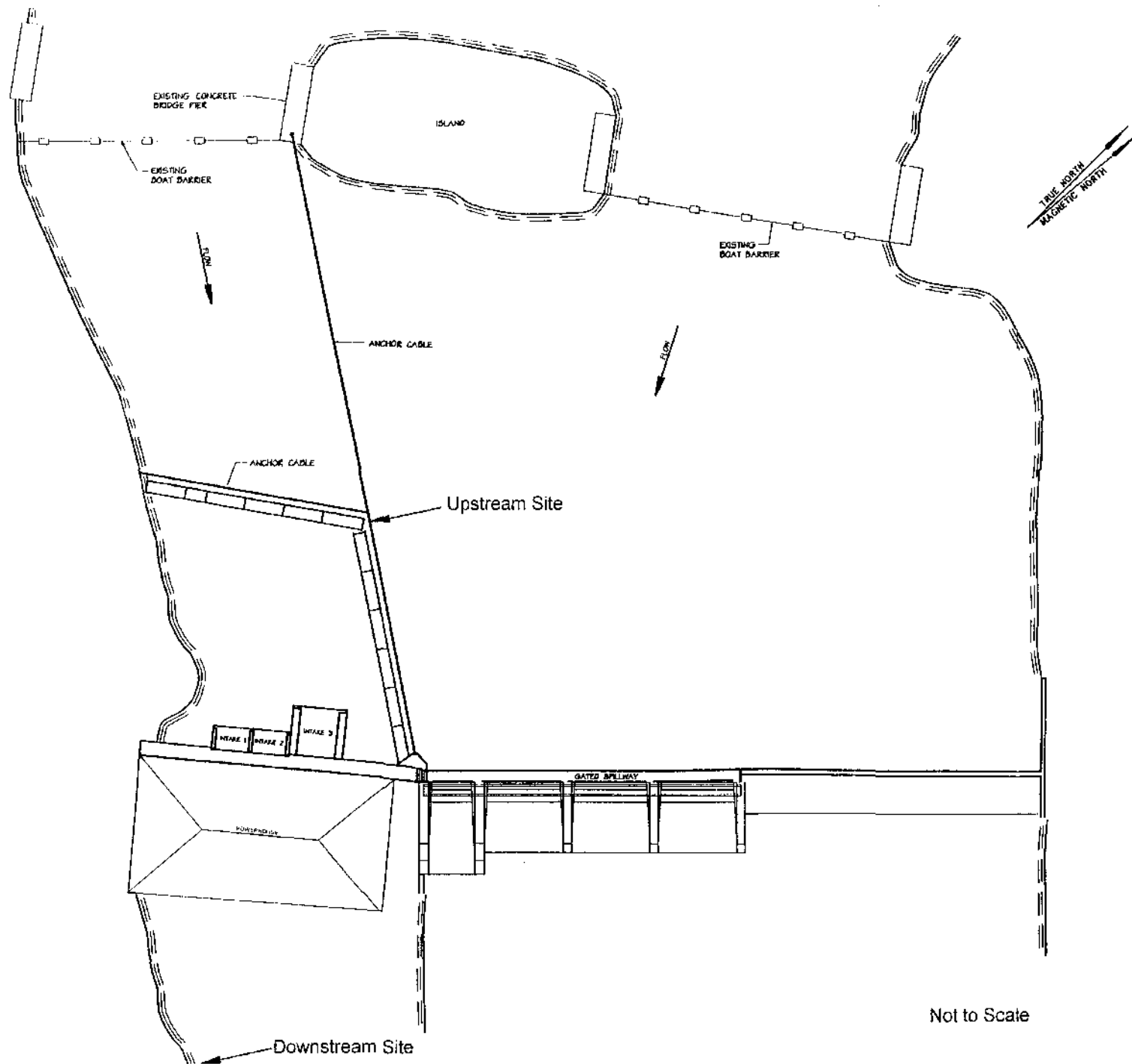


FIGURE: Map of Water Quality Monitoring Sample Points

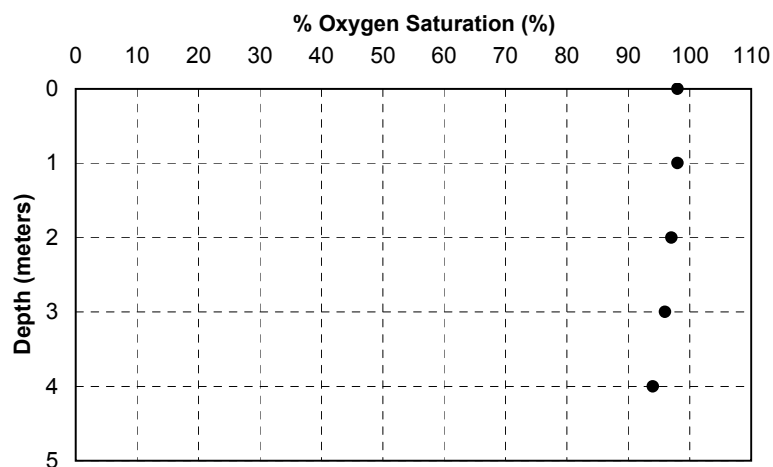
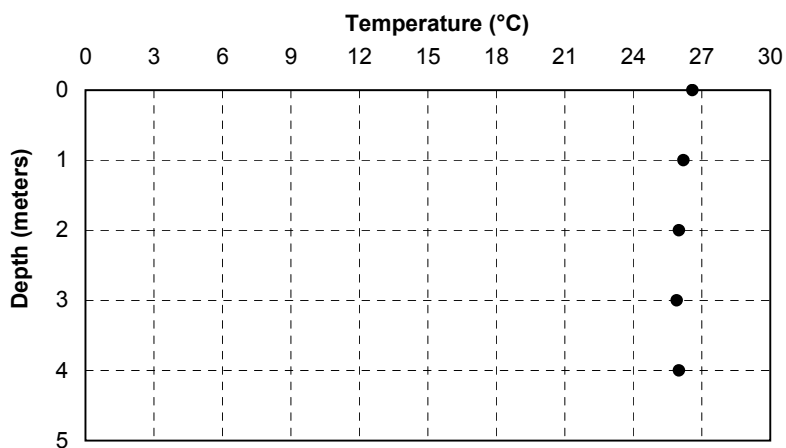
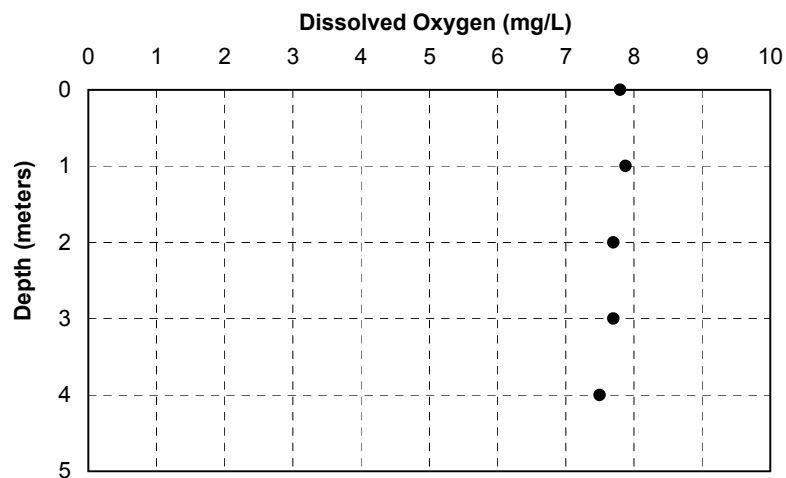
Source: Modified from
Mead & Hunt,
Consulting Engineers,
Madison, Wisconsin

APPENDIX C

Upstream Water Quality Profiles

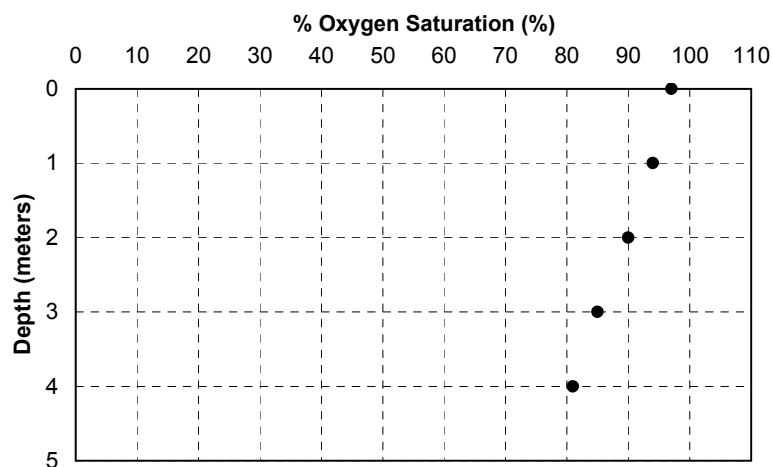
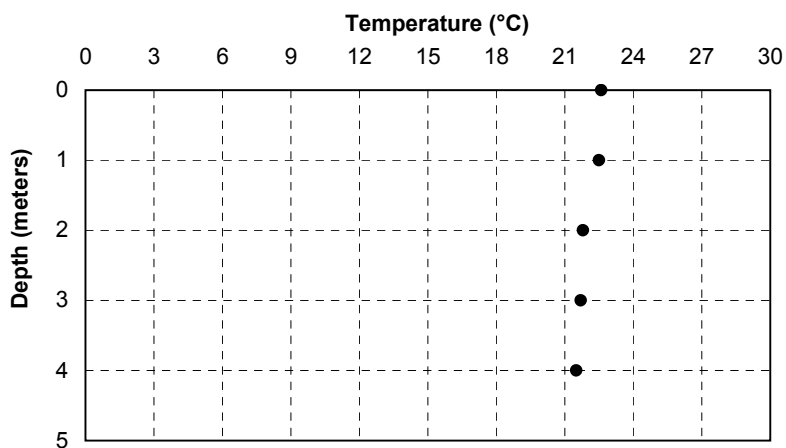
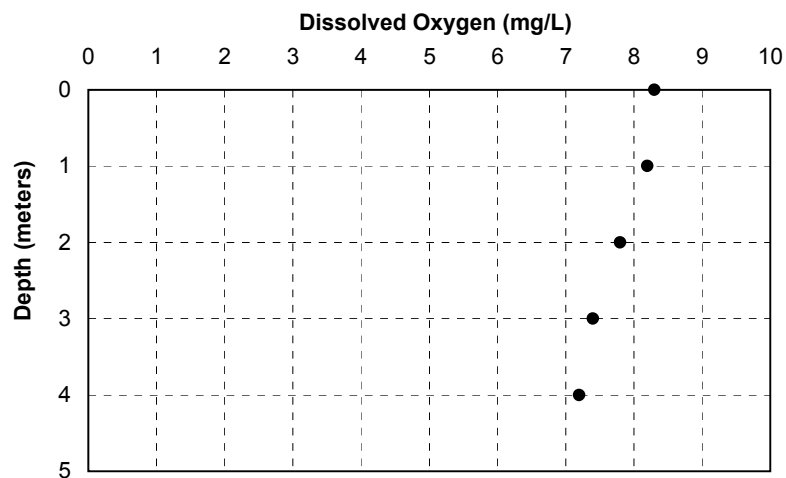
Crystal Falls Hydroelectric Project

Limnological Profiles	Depth (meters)	Dissolved		% Oxygen	
		Oxygen (mg/L)	Temperature (°C)	Saturation (%)	
July 9, 2007 3:30 pm	0.0	7.8	26.6	98	
	1.0	7.9	26.2	98	
	2.0	7.7	26.0	97	
	3.0	7.7	25.9	96	
	4.0	7.5	26.0	94	



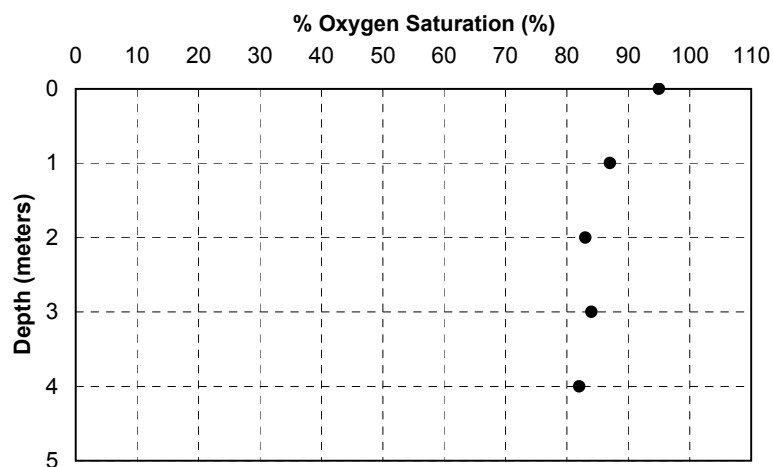
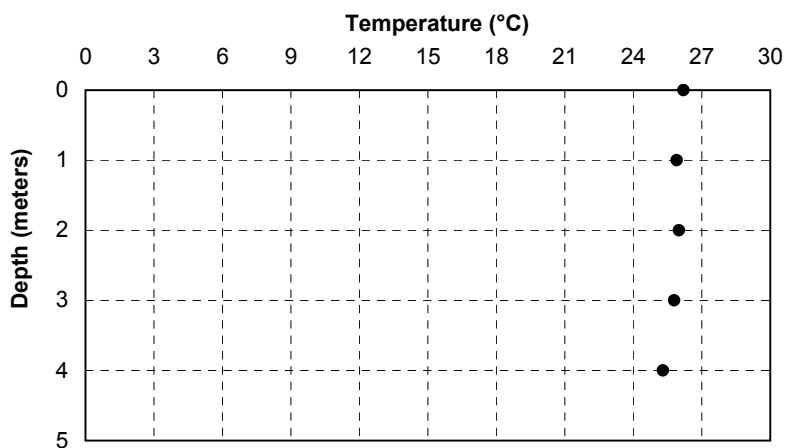
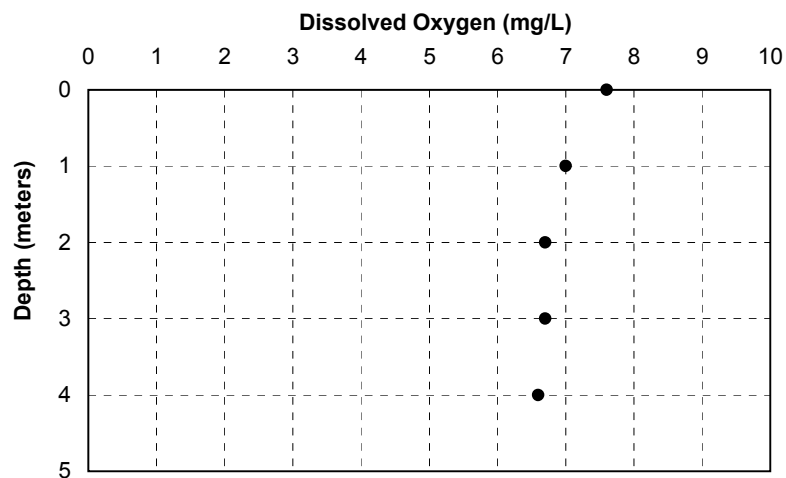
Crystal Falls Hydroelectric Project

Limnological Profiles	Depth (meters)	Dissolved		% Oxygen	
		Oxygen (mg/L)	Temperature (°C)	Saturation (%)	
July 17, 2007 4:00 pm	0.0	8.3	22.6	97	
	1.0	8.2	22.5	94	
	2.0	7.8	21.8	90	
	3.0	7.4	21.7	85	
	4.0	7.2	21.5	81	



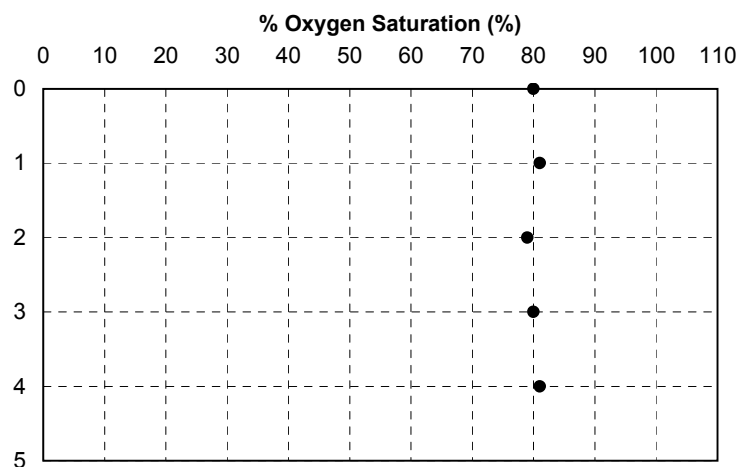
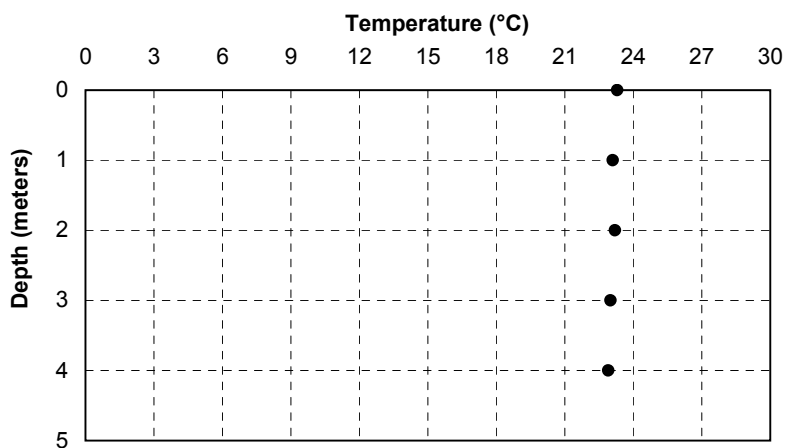
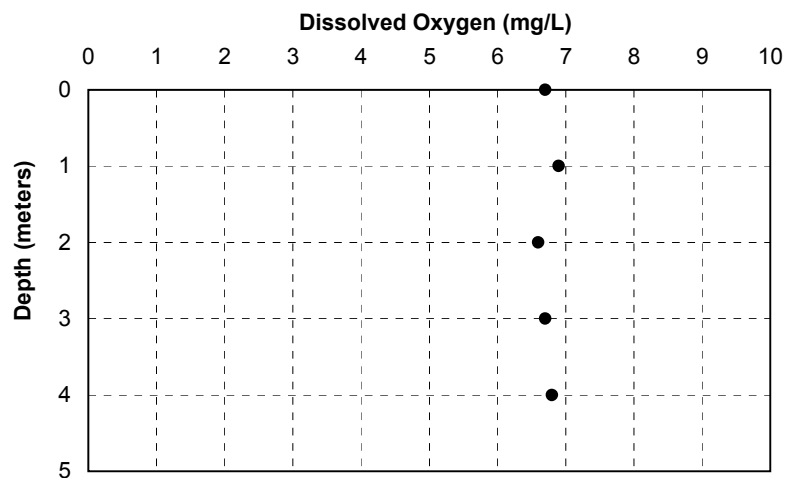
Crystal Falls Hydroelectric Project

Limnological Profiles	Depth (meters)	Dissolved		% Oxygen	
		Oxygen (mg/L)	Temperature (°C)	Saturation (%)	
July 27, 2007 10:45 am	0.0	7.6	26.2	95	
	1.0	7.0	25.9	87	
	2.0	6.7	26.0	83	
	3.0	6.7	25.8	84	
	4.0	6.6	25.3	82	



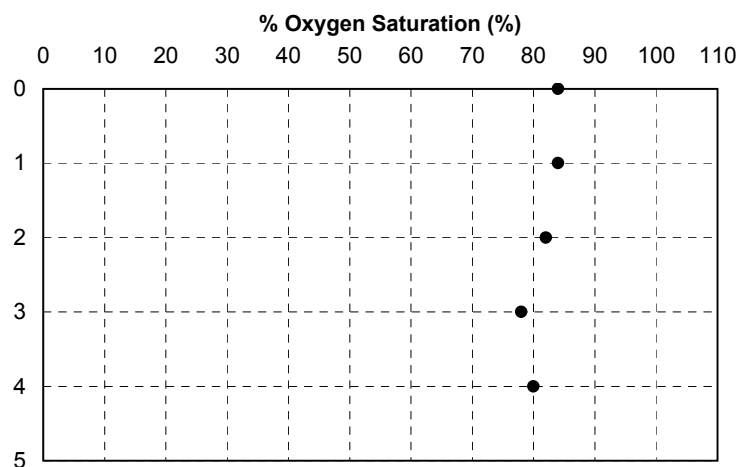
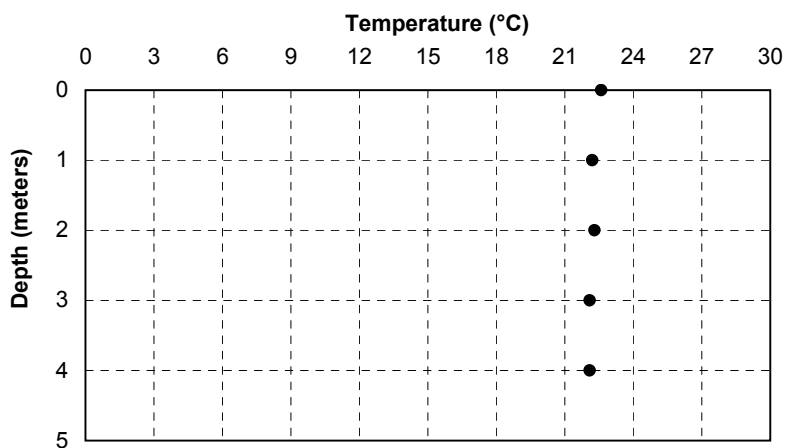
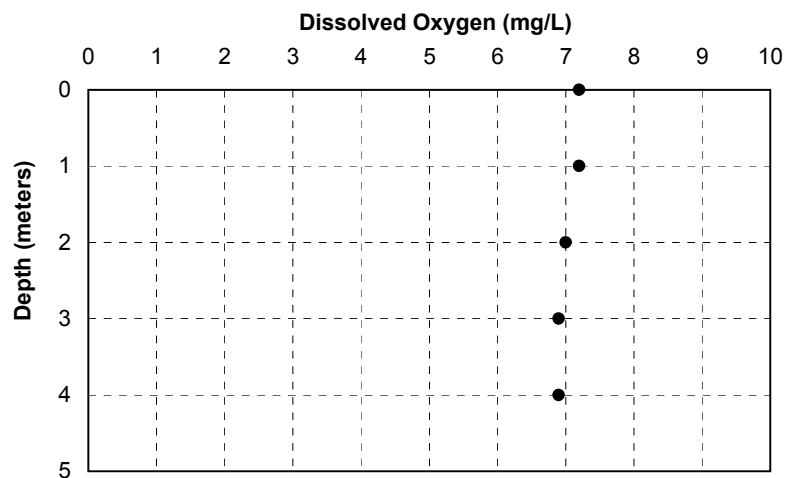
Crystal Falls Hydroelectric Project

Limnological Profiles	Depth (meters)	Dissolved		% Oxygen	
		Oxygen (mg/L)	Temperature (°C)	Saturation (%)	
August 6, 2007 10:50 am	0.0	6.7	23.3	80	
	1.0	6.9	23.1	81	
	2.0	6.6	23.2	79	
	3.0	6.7	23.0	80	
	4.0	6.8	22.9	81	



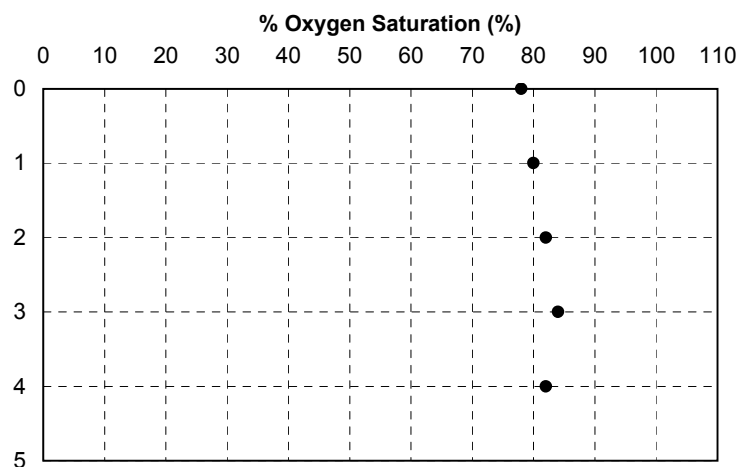
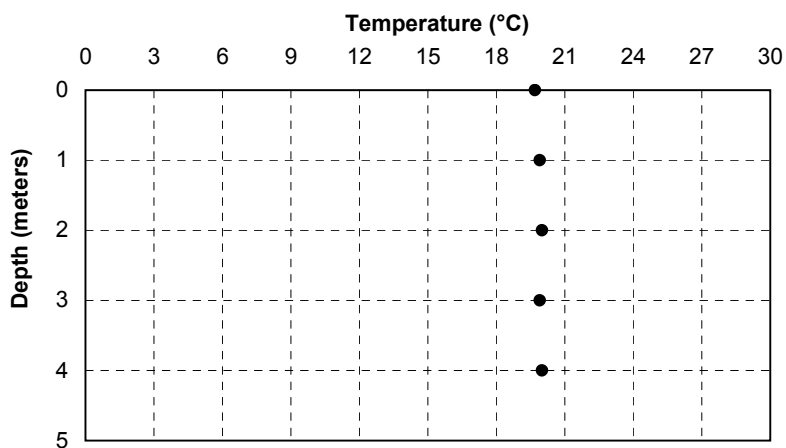
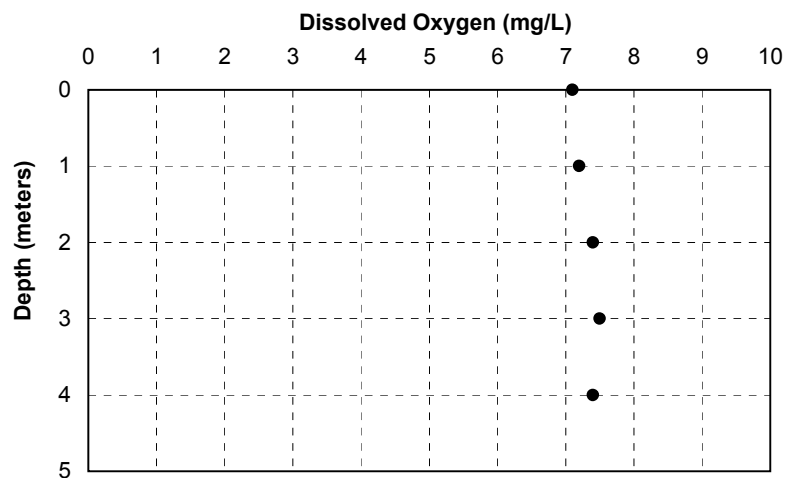
Crystal Falls Hydroelectric Project

Limnological Profiles	Depth (meters)	Dissolved		% Oxygen	
		Oxygen (mg/L)	Temperature (°C)	Saturation (%)	
August 15, 2007 10:40 am	0.0	7.2	22.6	84	
	1.0	7.2	22.2	84	
	2.0	7.0	22.3	82	
	3.0	6.9	22.1	78	
	4.0	6.9	22.1	80	



Crystal Falls Hydroelectric Project

Limnological Profiles	Depth (meters)	Dissolved		% Oxygen	
		Oxygen (mg/L)	Temperature (°C)	Saturation (%)	
August 25, 2007 10:45 am	0.0	7.1	19.7	78	
	1.0	7.2	19.9	80	
	2.0	7.4	20.0	82	
	3.0	7.5	19.9	84	
	4.0	7.4	20.0	82	



APPENDIX D

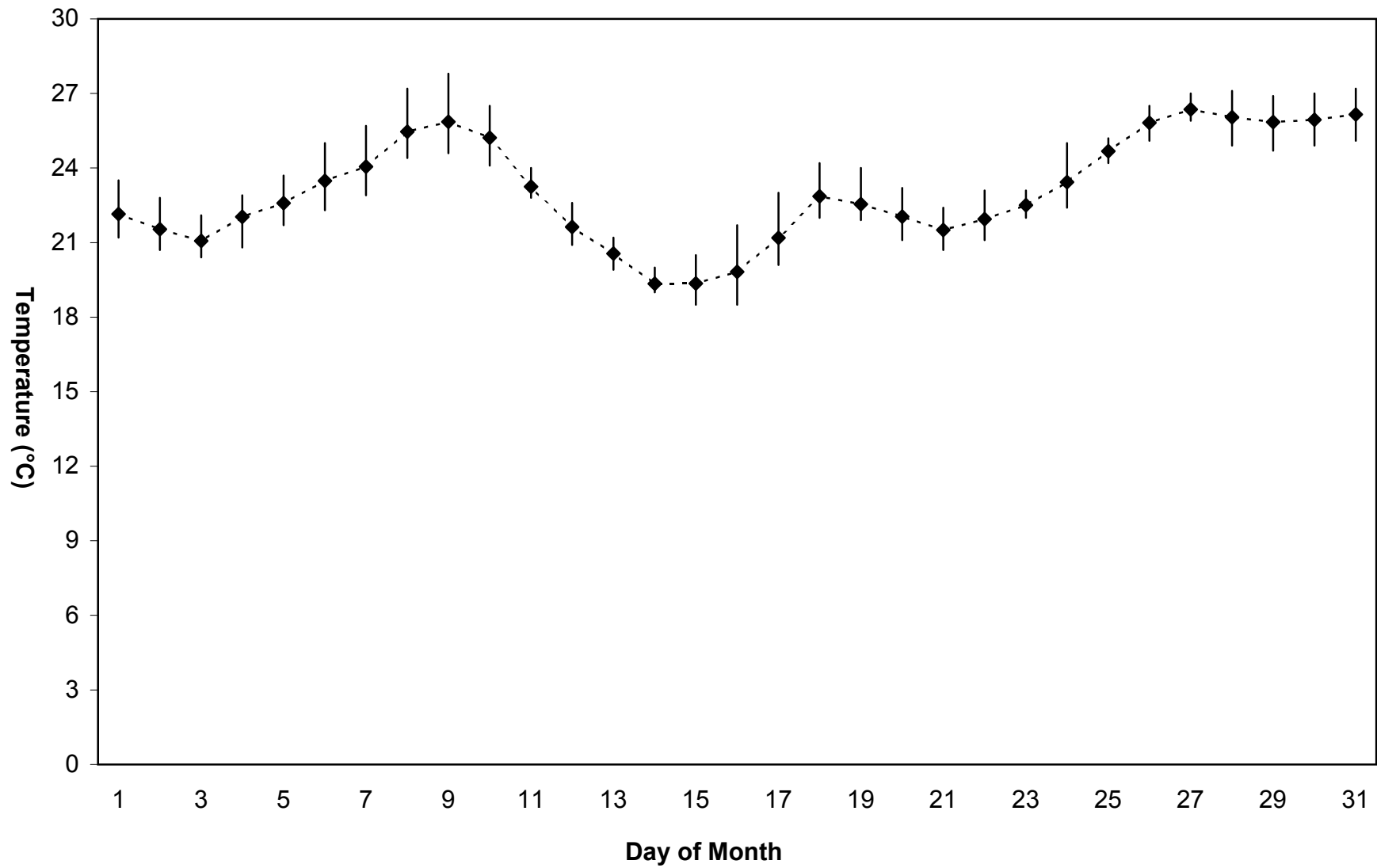
Upstream Temperature Monitoring

Hourly Temperature Readings: Crystal Falls Hydroelectric Project (Upstream of Dam), July 2007

	Day of Month																														
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	22.3	22.8	20.7	22.2	22.1	22.9	24.1	25.4	25.1	26.5	24.0	22.6	20.8	20.0	19.0	19.6	21.5	22.9	24.0	21.8	22.3	22.2	22.9	23.1	24.2	25.4	26.2	26.2	26.1	26.2	26.5
1:00a	22.1	22.6	20.6	22.5	22.2	22.8	23.9	25.4	25.0	26.2	23.7	22.5	20.7	19.9	19.0	19.4	21.4	22.9	23.6	21.7	22.0	22.1	22.8	22.9	24.4	25.4	26.2	25.9	25.9	26.2	26.2
2:00a	21.9	22.5	20.7	22.3	22.0	22.7	23.6	25.1	25.0	25.9	23.5	22.4	20.6	19.7	18.7	19.3	21.2	22.7	23.5	21.7	21.8	21.8	22.6	22.8	24.4	25.3	26.1	25.8	25.8	25.8	26.2
3:00a	21.7	22.3	20.5	22.0	21.8	22.6	23.2	25.0	25.0	25.8	23.4	22.1	20.5	19.4	18.7	19.1	21.0	22.6	23.2	21.5	21.6	21.7	22.5	22.8	24.6	25.3	26.0	25.6	25.6	25.7	26.0
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5:00a	21.4	22.0	20.4	21.5	21.7	22.5	23.2	24.6	24.9	25.3	23.2	22.0	20.2	19.4	18.6	19.1	20.5	22.3	22.8	21.4	21.2	21.4	22.1	22.5	25.0	25.1	26.0	25.2	25.1	25.4	25.6
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8:00a	21.2	21.5	20.4	20.8	21.7	22.3	22.9	24.5	24.7	24.9	22.9	21.5	19.9	19.3	18.5	18.6	20.1	22.0	22.3	21.1	20.7	21.1	22.0	22.4	24.6	25.2	25.9	24.9	24.7	24.9	25.2
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11:00a	21.7	21.4	20.7	21.6	22.2	23.0	23.6	24.9	25.1	24.9	23.2	21.4	20.3	19.2	19.2	19.5	20.5	22.0	22.2	21.5	21.0	21.4	22.2	22.9	24.6	25.8	*	25.5	25.3	25.1	25.5
12:00p	21.8	21.4	20.8	22.0	22.5	23.2	23.8	25.0	25.5	25.0	23.2	21.5	20.5	19.2	19.4	19.8	20.7	22.3	22.3	21.8	21.4	21.5	22.3	23.0	24.5	26.2	26.3	25.9	25.8	25.3	25.9
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3:00p	22.3	21.2	21.4	22.2	23.7	24.3	24.9	26.8	26.5	25.3	23.5	21.5	21.1	19.1	20.2	20.6	21.3	22.9	22.5	22.5	21.5	22.0	22.6	24.4	24.6	26.1	26.9	26.8	26.2	26.2	26.9
4:00p	22.4	21.2	21.5	22.9	23.7	24.3	24.7	27.2	26.9	25.5	23.5	21.5	21.2	19.4	20.5	20.4	21.4	23.2	22.4	22.8	21.6	22.0	22.6	25.0	24.7	26.2	27.0	27.1	26.4	26.4	27.2
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9:00p	23.4	20.9	22.1	22.4	23.3	24.9	25.4	25.8	27.3	24.6	23.0	21.2	20.7	19.2	19.9	21.1	22.6	24.0	22.0	22.9	22.1	23.0	23.0	24.0	24.9	26.5	26.5	26.8	26.8	27.0	26.5
10:00p	23.2	20.8	22.0	22.3	23.2	24.4	25.4	25.8	27.1	24.4	22.9	21.1	20.4	19.1	19.8	21.7	22.9	24.1	22.0	22.7	22.4	23.0	23.1	24.4	25.1	26.3	26.5	26.5	26.5	26.9	26.5
11:00p	22.9	20.7	21.6	22.3	23.1	24.4	25.7	25.4	26.8	24.1	22.8	20.9	20.2	19.0	19.6	21.5	23.0	24.2	21.9	22.5	22.4	23.1	23.0	24.2	25.2	26.2	26.2	26.3	26.5	26.8	26.5
Max.	23.5	22.8	22.1	22.9	23.7	25.0	25.7	27.2	27.8	26.5	24.0	22.6	21.2	20.0	20.5	21.7	23.0	24.2	24.0	23.2	22.4	23.1	23.1	25.0	25.2	26.5	27.0	27.1	26.9	27.0	27.2
Min.	21.2	20.7	20.4	20.8	21.7	22.3	22.9	24.4	24.6	24.1	22.8	20.9	19.9	19.0	18.5	18.5	20.1	22.0	21.9	21.1	20.7	21.1	22.0	22.4	24.2	25.1	25.9	24.9	24.7	24.9	25.1
Avg.	22.2	21.5	21.1	22.0	22.6	23.5	24.1	25.5	25.9	25.2	23.3	21.6	20.6	19.3	19.4	19.8	21.2	22.9	22.5	22.0	21.5	21.9	22.5	23.4	24.7	25.8	26.4	26.0	25.8	25.9	26.2

* Service point (missing data)

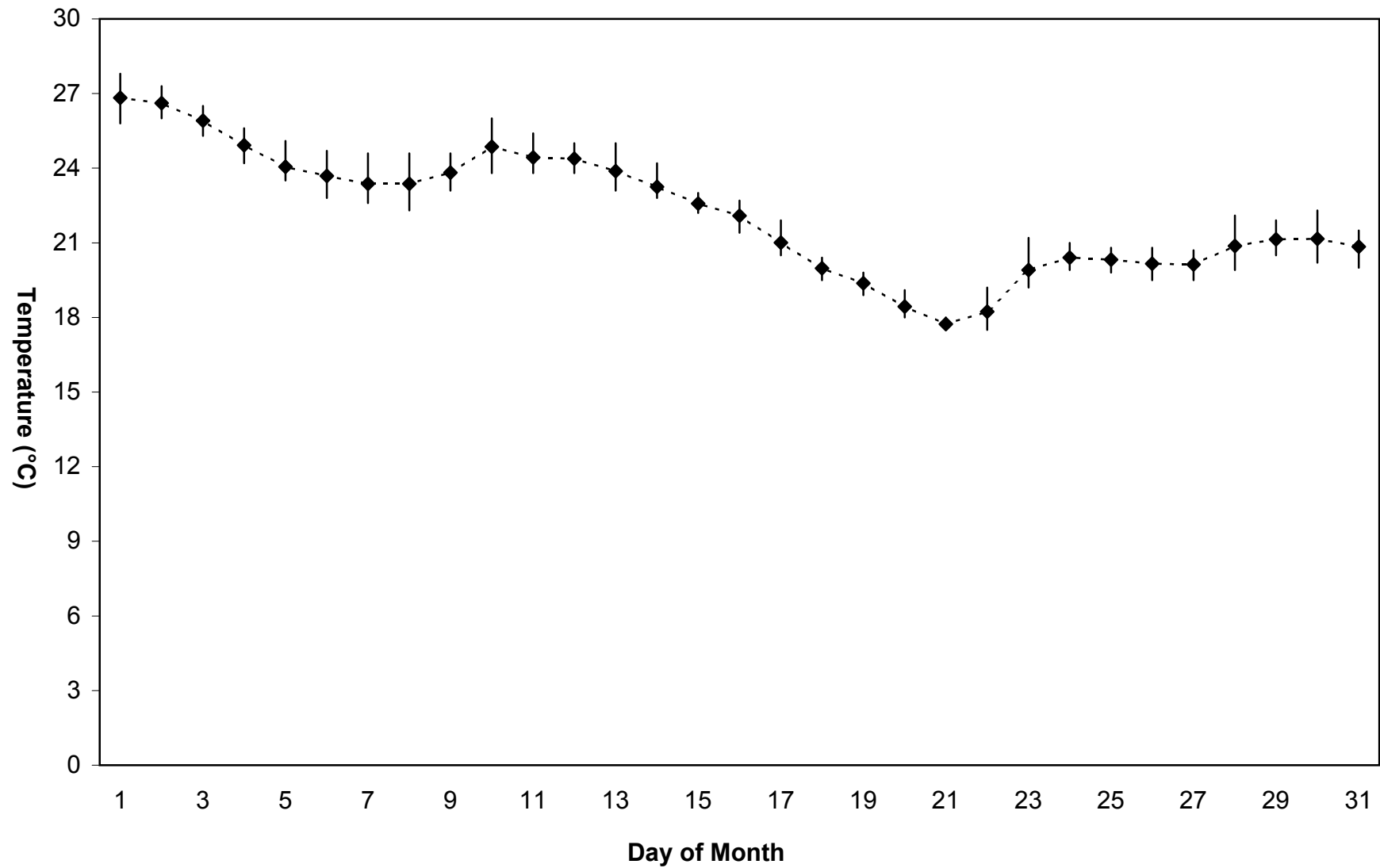
**Average Daily Temperature Readings
Crystal Falls Hydroelectric Project (Upstream of Dam)
July 2007**



Hourly Temperature Readings: Crystal Falls Hydroelectric Project (Upstream of Dam), August 2007

	Day of Month																														
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	26.9	27.1	26.5	25.6	25.1	23.4	23.9	23.4	24.1	24.6	25.4	24.6	24.2	24.2	22.9	22.6	21.9	20.4	19.8	19.1	18.0	17.6	19.3	20.6	20.4	20.4	20.5	20.5	21.9	20.9	21.3
1:00a	26.9	26.8	26.3	25.4	25.0	23.3	23.7	23.2	24.0	24.7	25.3	24.6	24.0	23.9	22.9	22.4	21.7	20.3	19.6	19.0	18.0	17.6	19.2	20.5	20.3	20.2	20.4	20.6	21.5	20.8	21.1
2:00a	26.8	26.8	26.2	25.2	24.7	23.3	23.5	23.1	24.1	24.7	25.0	24.4	23.8	23.8	22.8	22.3	21.5	20.1	19.5	19.0	17.9	17.6	19.4	20.4	20.2	20.1	20.2	20.4	21.3	20.7	20.9
3:00a	26.6	26.5	26.0	25.0	24.6	23.2	23.3	22.9	24.0	24.6	25.0	24.4	23.8	23.6	22.7	22.0	21.4	20.1	19.4	19.0	17.8	17.6	19.8	20.3	20.2	20.0	20.1	20.3	21.1	20.6	20.8
4:00a	26.4	26.5	25.9	24.9	24.5	23.1	23.1	22.7	23.8	24.4	24.7	24.2	23.6	23.4	22.6	22.0	21.4	19.9	19.3	18.8	17.9	17.6	19.8	20.3	20.1	19.9	20.1	20.2	21.0	20.6	20.6
5:00a	26.2	26.3	25.8	24.7	24.6	23.1	23.0	22.6	23.6	24.2	24.5	24.1	23.4	23.2	22.5	21.8	21.2	19.9	19.2	18.6	17.8	17.6	19.8	20.3	20.0	19.7	19.9	20.1	21.0	20.4	20.5
6:00a	26.1	26.2	25.6	24.6	24.2	22.9	22.9	22.5	23.4	24.1	24.4	23.9	23.3	22.9	22.4	21.7	21.1	19.7	19.1	18.6	17.7	17.6	19.7	20.2	19.9	19.6	19.8	20.1	20.8	20.4	20.3
7:00a	26.0	26.1	25.4	24.4	24.1	22.9	22.8	22.4	23.2	23.9	24.2	23.9	23.2	22.9	22.3	21.5	21.0	19.5	19.0	18.6	17.7	17.5	19.6	20.1	19.9	19.6	19.7	20.0	20.7	20.3	20.2
8:00a	25.8	26.0	25.3	24.2	24.0	22.8	22.7	22.3	23.1	23.9	24.1	23.8	23.1	22.9	22.3	21.5	20.8	19.6	19.0	18.5	17.7	17.6	19.6	20.0	19.8	19.5	19.6	19.9	20.6	20.2	20.1
9:00a	25.8	26.0	25.3	24.2	23.9	22.8	22.6	22.4	23.1	23.8	24.0	23.8	23.1	22.8	22.3	21.5	20.7	19.5	18.9	18.4	17.6	17.6	19.5	20.0	19.9	19.5	19.6	19.9	20.6	20.3	20.0
10:00a	25.8	26.0	25.3	24.4	23.8	23.0	22.6	22.5	23.1	24.0	23.9	23.9	23.2	22.8	22.2	21.4	20.6	19.6	19.0	18.4	17.6	17.6	19.6	19.9	19.9	19.6	19.6	20.0	20.5	20.5	20.2
11:00a	26.5	26.1	25.4	24.4	23.7	23.1	22.7	22.6	23.2	24.2	23.8	23.9	23.3	22.9	22.2	21.7	20.7	19.6	19.1	18.3	17.7	17.8	19.7	19.9	20.0	19.7	19.5	20.3	20.6	20.7	20.5
12:00p	26.5	26.3	25.6	24.4	23.8	23.5	22.9	23.0	23.3	24.4	23.8	24.1	23.5	22.9	22.3	21.9	20.8	19.7	19.2	18.3	17.7	18.2	19.6	20.0	20.2	19.8	19.6	20.7	20.8	21.0	20.5
1:00p	26.7	26.5	25.8	24.6	23.8	23.8	22.9	23.3	23.6	24.6	23.9	24.4	23.8	23.1	22.3	22.0	20.9	19.9	19.3	18.2	17.7	18.1	19.6	20.2	20.3	20.0	19.8	20.9	21.0	21.2	20.8
2:00p	27.0	26.9	26.1	25.0	23.8	24.2	23.0	23.2	23.6	25.0	23.9	24.6	23.8	23.2	22.4	22.3	21.0	20.1	19.5	18.2	17.7	18.5	19.2	20.4	20.5	20.1	19.9	21.0	21.2	21.4	21.2
3:00p	27.2	27.0	26.2	25.0	23.9	24.1	23.2	23.8	23.7	25.3	23.9	24.7	23.9	23.4	22.5	22.6	21.0	20.2	19.6	18.3	17.7	19.0	19.4	20.8	20.5	20.5	20.1	21.4	21.5	21.9	21.4
4:00p	27.4	27.3	26.4	25.1	23.9	24.6	23.2	24.2	23.9	25.4	24.2	24.9	24.1	23.5	22.6	22.6	21.0	20.2	19.6	18.3	17.7	19.1	19.9	20.9	20.8	20.5	20.4	21.4	21.7	22.1	21.5
5:00p	27.7	27.3	26.5	25.1	23.8	24.4	24.4	24.4	24.1	25.9	24.3	25.0	25.0	23.4	22.6	22.7	21.0	20.3	19.7	18.3	17.6	19.0	20.0	21.0	20.8	20.7	20.5	21.7	21.5	22.3	21.5
6:00p	27.7	27.2	26.5	25.1	23.9	24.6	24.6	24.6	24.2	25.8	24.5	25.0	25.0	23.4	22.9	22.6	20.9	20.4	19.8	18.2	17.7	19.1	20.3	20.8	20.8	20.8	20.6	22.1	21.5	22.3	21.4
7:00p	27.8	27.1	26.2	25.1	23.9	24.7	24.6	24.6	24.4	26.0	24.6	24.8	24.6	23.2	22.9	22.4	20.9	20.3	19.7	18.2	17.7	19.0	20.7	20.8	20.8	20.8	20.6	22.0	21.5	22.2	21.4
8:00p	27.7	26.9	26.2	25.4	23.7	24.6	24.3	24.4	24.4	25.9	24.7	24.7	24.4	23.2	23.0	22.3	20.8	20.2	19.7	18.1	17.7	19.1	21.2	20.7	20.7	20.8	20.7	22.1	21.4	22.0	21.2
9:00p	27.7	26.8	26.1	25.6	23.6	24.6	23.9	24.6	24.6	25.9	24.7	24.6	24.2	23.2	22.9	22.2	20.7	20.1	19.5	18.1	17.7	19.2	21.1	20.6	20.7	20.8	20.7	22.0	21.4	21.8	21.1
10:00p	27.5	26.6	25.9	25.4	23.6	24.3	23.6	24.2	24.6	25.7	24.9	24.6	24.4	23.1	22.8	22.0	20.6	20.0	19.3	18.0	17.7	19.0	20.8	20.5	20.6	20.7	20.7	21.7	21.2	21.7	21.0
11:00p	27.3	26.5	25.4	25.3	23.5	24.1	23.5	24.1	24.6	25.6	24.6	24.3	24.4	23.0	22.6	22.0	20.5	19.9	19.2	18.0	17.7	19.1	20.8	20.5	20.5	20.6	20.6	21.7	21.0	21.5	20.8
Max.	27.8	27.3	26.5	25.6	25.1	24.7	24.6	24.6	24.6	26.0	25.4	25.0	25.0	24.2	23.0	22.7	21.9	20.4	19.8	19.1	18.0	19.2	21.2	21.0	20.8	20.8	20.7	22.1	21.9	22.3	21.5
Min.	25.8	26.0	25.3	24.2	23.5	22.8	22.6	22.3	23.1	23.8	23.8	23.8	23.1	22.8	22.2	21.4	20.5	19.5	18.9	18.0	17.6	17.5	19.2	19.9	19.8	19.5	19.5	19.9	20.5	20.2	20.0
Avg.	26.8	26.6	25.9	24.9	24.1	23.7	23.4	23.4	23.8	24.9	24.4	24.4	23.9	23.2	22.6	22.1	21.0	20.0	19.4	18.4	17.7	18.2	19.9	20.4	20.3	20.2	20.1	20.9	21.1	21.2	20.8

**Average Daily Temperature Readings
Crystal Falls Hydroelectric Project (Upstream of Dam)
August 2007**



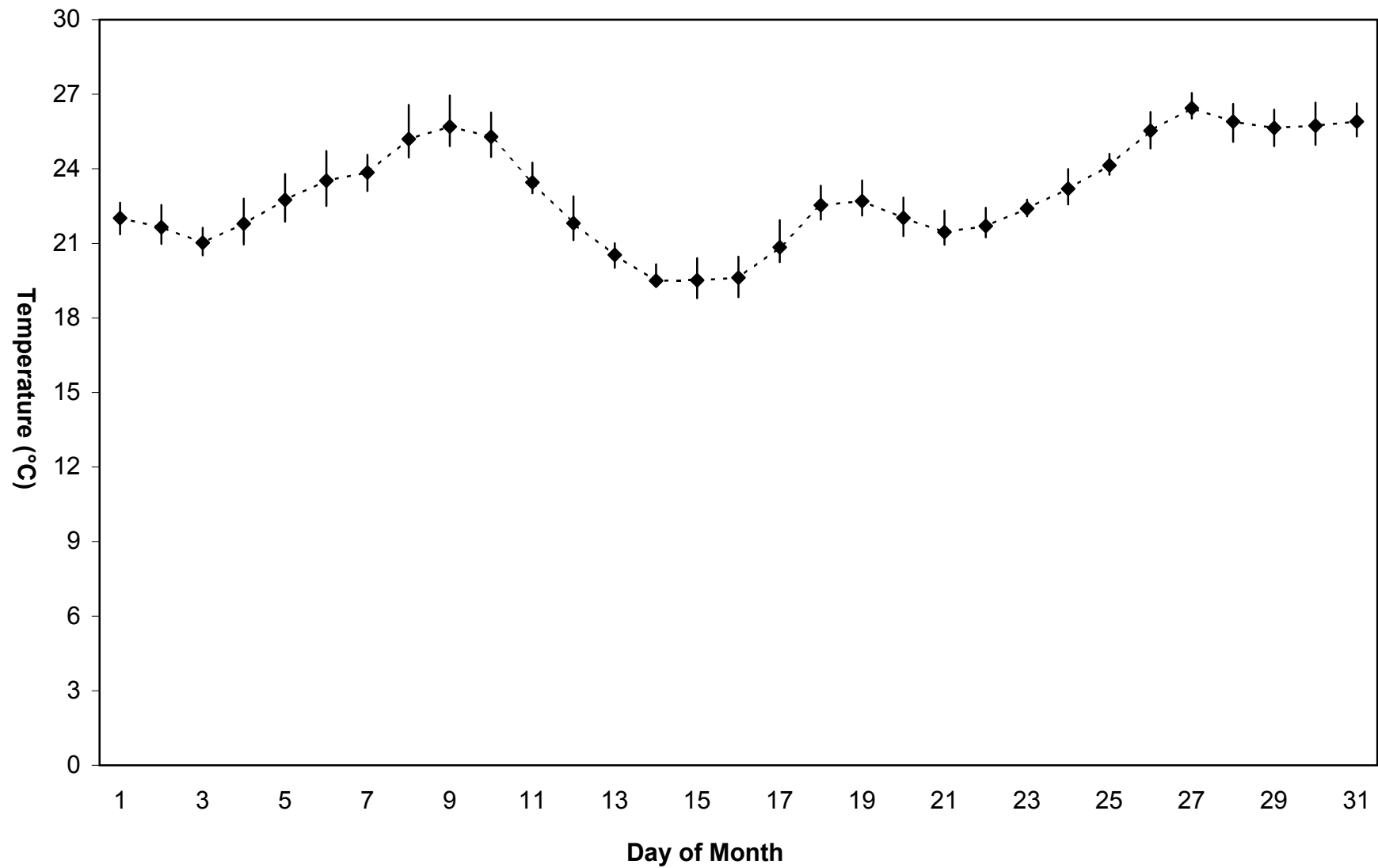
APPENDIX E

Downstream Temperature Monitoring

Hourly Temperature Readings: Crystal Falls Hydroelectric Project (Downstream of Dam), July 2007

	Day of Month																														
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	22.44	22.55	20.91	21.38	22.32	23.23	24.17	24.67	25.28	26.27	24.25	22.89	21.01	20.16	19.21	19.76	20.47	22.10	23.47	22.05	22.32	21.63	22.43	22.76	23.76	24.82	26.27	26.23	26.10	25.73	26.04
1:00a	22.26	22.53	20.85	21.50	22.25	23.11	23.99	24.74	25.24	26.08	24.01	22.76	20.87	19.98	19.10	19.60	20.50	22.23	23.54	21.96	22.12	21.61	22.41	22.76	23.76	24.96	26.23	26.06	25.95	25.67	25.93
2:00a	22.09	22.41	20.80	21.54	22.19	23.02	23.81	24.76	25.20	25.91	23.81	22.60	20.73	19.83	19.05	19.46	20.56	22.26	23.45	21.87	21.93	21.61	22.41	22.76	23.79	24.96	26.21	25.89	25.78	25.59	25.87
3:00a	21.93	22.30	20.73	21.47	22.12	22.89	23.65	24.76	25.19	25.74	23.67	22.43	20.59	19.71	19.00	19.34	20.59	22.32	23.34	21.77	21.73	21.59	22.39	22.73	23.87	25.02	26.17	25.73	25.61	25.50	25.78
4:00a	21.79	22.18	20.66	21.36	22.09	22.80	23.50	24.71	25.15	25.61	23.52	22.25	20.45	19.62	18.95	19.21	20.59	22.30	23.16	21.66	21.52	21.52	22.30	22.73	23.92	25.09	26.12	25.54	25.43	25.43	25.67
5:00a	21.64	22.05	20.61	21.29	22.03	22.69	23.36	24.67	25.07	25.41	23.36	22.07	20.31	19.55	18.90	19.08	20.52	22.18	23.00	21.52	21.33	21.43	22.26	22.68	24.03	25.11	26.10	25.39	25.26	25.32	25.56
6:00a	21.50	21.93	20.56	21.15	21.95	22.60	23.21	24.63	25.00	25.28	23.21	21.89	20.17	19.48	18.83	18.95	20.43	22.12	22.85	21.43	21.17	21.33	22.18	22.62	24.05	25.13	26.06	25.26	25.11	25.20	25.45
7:00a	21.42	21.84	20.52	21.08	21.89	22.53	23.11	24.54	24.93	25.15	23.11	21.75	20.05	19.46	18.79	18.86	20.29	22.02	22.68	21.33	21.03	21.26	22.14	22.59	24.08	25.17	26.06	25.15	24.98	25.07	25.35
8:00a	21.36	21.73	20.54	20.99	21.87	22.51	23.11	24.49	24.91	25.02	23.03	21.64	20.02	19.46	18.79	18.83	20.24	21.98	22.55	21.29	20.94	21.24	22.10	22.57	24.07	25.24	26.04	25.09	24.91	25.00	25.30
9:00a	21.43	21.63	20.59	20.96	21.96	22.59	23.15	24.47	24.93	24.96	23.05	21.61	20.05	19.39	18.86	18.90	20.26	21.96	22.46	21.33	20.96	21.26	22.09	22.64	24.03	25.32	26.02	25.13	24.91	24.96	25.30
10:00a	21.56	21.56	20.68	21.08	22.10	22.76	23.23	24.45	24.96	24.93	23.14	21.59	20.21	19.34	19.02	19.10	20.29	21.95	22.37	21.49	21.05	21.27	22.12	22.76	24.01	25.41	26.10	25.28	25.02	24.96	25.41
11:00a	21.61	21.52	20.73	21.29	22.30	23.00	23.47	24.67	25.13	24.93	23.21	21.57	20.33	19.34	19.22	19.31	20.40	22.00	22.39	21.61	21.10	21.33	22.18	22.87	24.05	25.58	26.23	25.46	25.15	25.11	25.54
12:00p	21.70	21.50	20.85	21.57	22.51	23.20	23.70	24.78	25.33	24.98	23.38	21.63	20.45	19.31	19.41	19.52	20.52	22.10	22.53	21.82	21.22	21.40	22.25	23.09	24.12	25.71	26.38	25.67	25.35	25.33	25.74
1:00p	21.86	21.47	20.94	21.89	22.78	23.50	23.92	24.96	25.58	25.02	23.45	21.70	20.59	19.33	19.65	19.60	20.71	22.34	22.66	22.02	21.29	21.50	22.34	23.30	24.14	25.73	26.57	25.86	25.58	25.52	25.89
2:00p	21.93	21.43	21.13	21.96	23.12	23.79	24.19	25.33	25.82	25.17	23.61	21.70	20.68	19.34	19.90	19.88	20.82	22.59	22.66	22.12	21.36	21.61	22.39	23.57	24.21	25.76	26.74	26.04	25.76	25.76	26.14
3:00p	22.05	21.40	21.33	22.00	23.41	24.03	24.34	25.78	26.08	25.24	23.68	21.70	20.82	19.31	20.12	20.00	20.99	22.80	22.64	22.23	21.47	21.75	22.44	23.88	24.28	25.76	26.91	26.25	25.99	25.99	26.36
4:00p	22.16	21.34	21.47	22.64	23.70	24.27	24.27	26.19	26.34	25.54	23.68	21.71	20.89	19.38	20.31	20.02	21.08	23.03	22.57	22.37	21.49	21.79	22.48	23.97	24.34	25.74	26.99	26.42	26.17	26.21	26.63
5:00p	22.28	21.34	21.49	22.80	23.74	24.52	24.19	26.53	26.38	25.65	23.68	21.73	20.91	19.43	20.35	20.02	21.24	23.21	22.51	22.59	21.54	21.93	22.55	23.99	24.38	25.74	27.05	26.53	26.31	26.42	26.63
6:00p	22.37	21.29	21.59	22.73	23.79	24.71	24.22	26.57	26.67	25.54	23.65	21.64	20.85	19.50	20.40	20.02	21.29	23.29	22.48	22.76	21.52	22.05	22.59	23.83	24.43	25.80	27.01	26.57	26.38	26.59	26.48
7:00p	22.50	21.27	21.57	22.68	23.77	24.72	24.21	26.21	26.78	25.35	23.56	21.56	20.82	19.52	20.31	20.10	21.42	23.23	22.44	22.84	21.50	22.19	22.66	23.76	24.38	25.92	26.95	26.57	26.17	26.67	26.27
8:00p	22.57	21.20	21.63	22.55	23.68	24.69	24.32	25.97	26.95	25.17	23.43	21.40	20.71	19.46	20.23	20.16	21.50	23.20	22.35	22.80	21.50	22.34	22.71	23.74	24.34	26.04	26.84	26.61	26.08	26.57	26.14
9:00p	22.57	21.12	21.63	22.43	23.56	24.56	24.41	25.73	26.80	24.89	23.29	21.31	20.57	19.43	20.10	20.26	21.66	23.18	22.28	22.75	21.54	22.37	22.75	23.70	24.30	26.23	26.68	26.44	25.95	26.53	26.04
10:00p	22.64	21.05	21.47	22.39	23.45	24.47	24.45	25.61	26.59	24.69	23.14	21.22	20.45	19.38	20.02	20.38	21.82	23.25	22.19	22.62	21.57	22.41	22.76	23.72	24.41	26.25	26.53	26.33	25.84	26.38	25.99
11:00p	22.60	20.98	21.33	22.35	23.36	24.33	24.56	25.43	26.42	24.47	23.02	21.13	20.29	19.29	19.90	20.47	21.93	23.32	22.12	22.50	21.63	22.43	22.76	23.74	24.61	26.29	26.38	26.21	25.76	26.19	26.01
Max.	22.64	22.55	21.63	22.80	23.79	24.72	24.56	26.57	26.95	26.27	24.25	22.89	21.01	20.16	20.40	20.47	21.93	23.32	23.54	22.84	22.32	22.43	22.76	23.99	24.61	26.29	27.05	26.61	26.38	26.67	26.63
Min.	21.36	20.98	20.52	20.96	21.87	22.51	23.11	24.45	24.91	24.47	23.02	21.13	20.02	19.29	18.79	18.83	20.24	21.95	22.12	21.29	20.94	21.24	22.09	22.57	23.76	24.82	26.02	25.09	24.91	24.96	25.30
Avg.	22.01	21.65	21.03	21.80	22.75	23.52	23.86	25.19	25.70	25.29	23.46	21.81	20.53	19.50	19.52	19.62	20.84	22.54	22.70	22.03	21.45	21.70	22.40	23.20	24.14	25.53	26.44	25.90	25.65	25.74	25.90

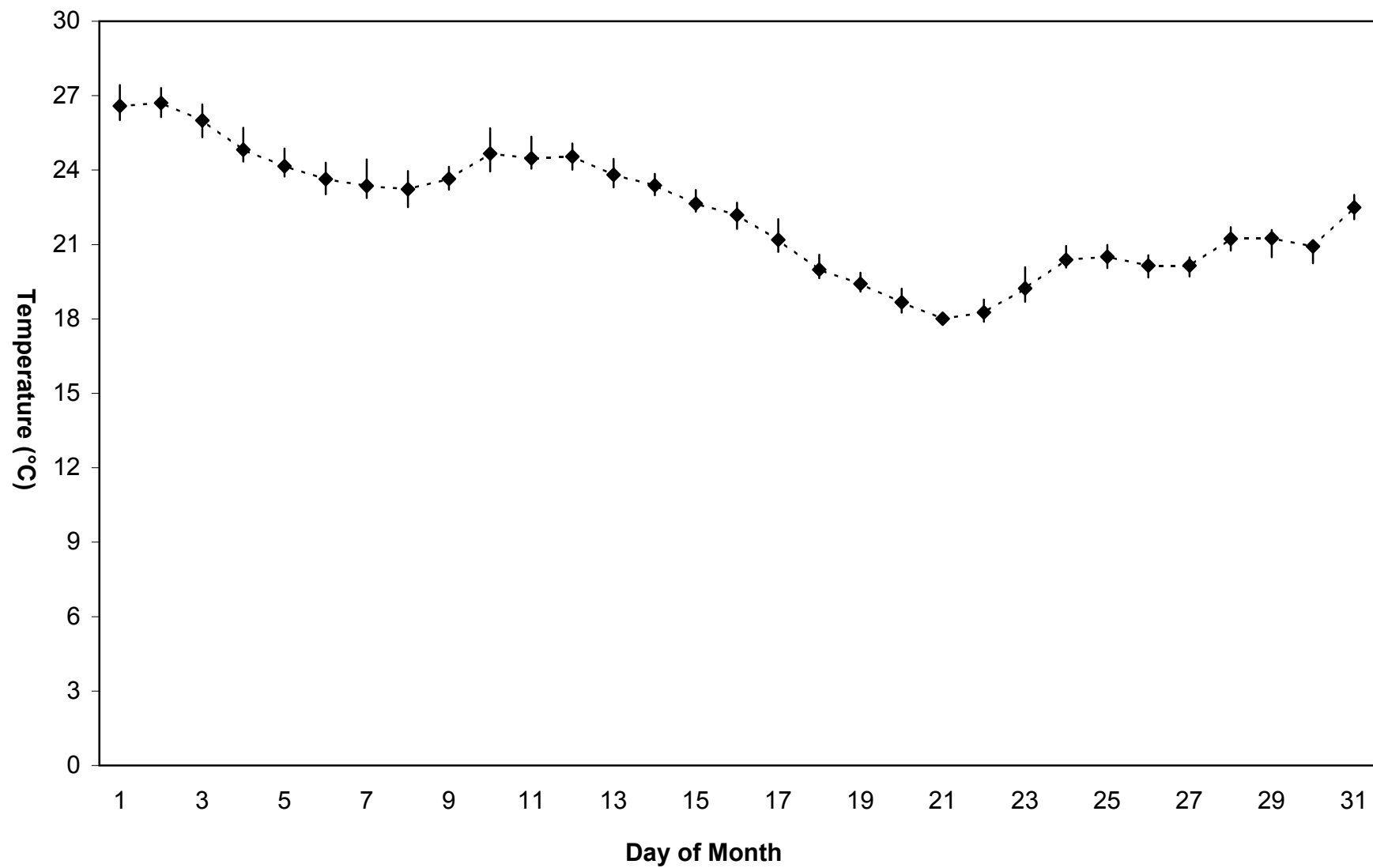
**Average Daily Temperature Readings
Crystal Falls Hydroelectric Project (Downstream of Dam)
July 2007**



Hourly Temperature Readings: Crystal Falls Hydroelectric Project (Downstream of Dam), August 2007

	Day of Month																														
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	26.10	26.82	26.65	25.71	24.87	23.67	23.59	23.45	23.61	24.08	25.35	24.56	24.45	23.85	23.20	22.57	22.03	20.59	19.86	19.22	18.20	17.94	18.69	20.09	20.59	20.56	20.49	21.29	20.94	22.43	22.70
1:00a	26.25	26.74	26.51	25.54	24.78	23.61	23.52	23.32	23.63	24.08	25.22	24.54	24.30	23.76	23.09	22.51	21.91	20.47	19.76	19.17	18.16	17.94	18.69	20.16	20.50	20.43	20.40	21.29	21.19	21.42	22.57
2:00a	26.34	26.65	26.38	25.35	24.69	23.54	23.43	23.20	23.63	24.14	25.07	24.50	24.16	23.63	22.98	22.39	21.77	20.33	19.64	19.10	18.13	17.94	18.71	20.14	20.43	20.31	20.31	21.24	21.10	21.24	22.43
3:00a	26.36	26.59	26.21	25.19	24.54	23.45	23.30	23.05	23.63	24.19	24.91	24.45	24.01	23.52	22.87	22.25	21.63	20.19	19.53	19.05	18.09	17.94	18.78	20.09	20.36	20.19	20.24	21.15	20.99	21.05	22.34
4:00a	26.29	26.51	26.04	25.00	24.47	23.38	23.18	22.94	23.59	24.23	24.76	24.39	23.85	23.38	22.78	22.12	21.49	20.07	19.41	18.98	18.08	17.92	18.93	20.12	20.29	20.09	20.16	21.12	20.91	20.89	22.27
5:00a	26.21	26.44	25.86	24.85	24.41	23.29	23.11	22.80	23.48	24.19	24.63	24.30	23.70	23.27	22.69	22.00	21.36	19.95	19.31	18.93	18.06	17.92	19.05	20.12	20.24	19.96	20.07	21.05	20.82	20.71	22.23
6:00a	26.12	26.34	25.69	24.67	24.30	23.18	23.03	22.68	23.39	24.14	24.49	24.21	23.56	23.18	22.62	21.86	21.22	19.83	19.22	18.86	18.04	17.91	19.12	20.12	20.17	19.86	19.98	20.94	20.73	20.57	22.16
7:00a	26.04	26.25	25.50	24.52	24.21	23.11	22.96	22.57	23.32	24.05	24.36	24.12	23.41	23.09	22.53	21.73	21.08	19.72	19.15	18.79	17.99	17.91	19.14	20.16	20.09	19.76	19.90	20.85	20.64	20.45	22.07
8:00a	26.01	26.17	25.37	24.41	24.14	23.03	22.91	22.51	23.25	23.97	24.25	24.05	23.32	23.02	22.48	21.64	20.96	19.67	19.10	18.74	17.97	17.91	19.14	20.12	20.05	19.67	19.83	20.78	20.56	20.33	22.02
9:00a	26.02	26.14	25.32	24.38	24.07	23.05	22.87	22.51	23.21	23.94	24.17	24.01	23.30	22.98	22.44	21.63	20.87	19.64	19.10	18.67	17.96	17.89	19.17	20.09	20.05	19.67	19.77	20.75	20.49	20.24	22.05
10:00a	26.10	26.19	25.35	24.34	24.05	23.12	22.89	22.60	23.23	24.03	24.12	24.07	23.36	22.98	22.39	21.64	20.84	19.65	19.14	18.62	17.94	17.94	19.17	20.07	20.10	19.71	19.71	20.77	20.50	20.24	22.05
11:00a	26.19	26.31	25.45	24.38	24.01	23.23	22.93	22.69	23.32	24.19	24.07	24.17	23.39	23.02	22.35	21.79	20.87	19.69	19.17	18.57	17.92	17.96	19.14	20.07	20.24	19.74	19.74	20.84	20.61	20.35	22.19
12:00p	26.31	26.46	25.59	24.43	23.97	23.43	22.93	22.87	23.41	24.39	24.07	24.36	23.50	23.11	22.32	21.95	20.94	19.71	19.22	18.54	17.97	18.11	19.10	20.14	20.28	19.84	19.79	20.99	20.82	20.52	22.25
1:00p	26.48	26.65	25.82	24.56	23.96	23.59	22.98	23.02	23.48	24.60	24.05	24.52	23.56	23.30	22.32	22.05	21.03	19.81	19.31	18.52	17.97	18.25	19.00	20.24	20.43	19.95	19.88	21.17	21.03	20.70	22.36
2:00p	26.74	26.86	26.01	24.61	23.97	23.81	23.05	23.21	23.57	24.74	24.07	24.67	23.65	23.43	22.37	22.19	21.15	19.90	19.39	18.50	17.99	18.42	18.95	20.38	20.59	20.07	19.95	21.31	21.24	20.84	22.55
3:00p	26.99	27.05	26.19	24.67	23.99	24.05	23.16	23.45	23.70	24.97	24.12	24.85	23.74	23.54	22.46	22.37	21.19	19.96	19.48	18.50	18.01	18.60	18.96	20.59	20.73	20.16	20.10	21.52	21.42	21.01	22.71
4:00p	27.03	27.19	26.38	24.78	24.01	24.23	23.32	23.70	23.79	25.20	24.19	24.96	23.88	23.63	22.51	22.51	21.24	19.98	19.55	18.54	18.01	18.69	19.19	20.71	20.94	20.26	20.24	21.64	21.70	21.15	22.80
5:00p	27.20	27.31	26.50	24.87	24.01	24.28	23.70	23.87	23.87	25.39	24.27	25.07	24.16	23.63	22.57	22.68	21.22	20.00	19.60	18.54	17.97	18.71	19.39	20.91	20.98	20.33	20.31	21.68	21.95	21.29	22.88
6:00p	27.29	27.31	26.51	24.87	23.99	24.30	24.10	23.92	23.97	25.59	24.30	25.07	24.16	23.61	22.68	22.69	21.17	20.09	19.64	18.52	17.99	18.71	19.62	20.94	20.99	20.43	20.38	21.70	22.18	21.33	23.00
7:00p	27.43	27.26	26.46	24.87	23.96	24.23	24.43	23.96	24.08	25.69	24.43	25.00	24.07	23.56	22.76	22.64	21.10	20.12	19.64	18.47	17.97	18.76	19.69	20.94	20.96	20.50	20.42	21.63	22.18	21.33	22.84
8:00p	27.37	27.14	26.33	24.87	23.92	24.14	24.17	23.94	24.12	25.67	24.56	24.95	24.01	23.48	22.82	22.50	20.98	20.12	19.60	18.40	17.97	18.78	19.88	20.89	20.91	20.54	20.45	21.57	22.18	21.19	22.91
9:00p	27.27	27.03	26.17	24.87	23.87	23.96	23.90	23.85	24.14	25.63	24.63	24.87	23.99	23.43	22.80	22.39	20.91	20.09	19.52	18.33	17.96	18.74	19.96	20.80	20.85	20.57	20.47	21.49	22.07	21.06	22.89
10:00p	27.05	26.87	26.02	24.93	23.81	23.81	23.70	23.77	24.14	25.56	24.65	24.71	23.96	23.36	22.75	22.28	20.80	20.03	19.38	18.28	17.96	18.69	20.05	20.73	20.77	20.57	20.45	21.40	21.93	20.92	22.80
11:00p	26.89	26.76	25.87	24.89	23.74	23.70	23.57	23.70	24.08	25.45	24.61	24.58	23.92	23.29	22.66	22.16	20.70	19.95	19.29	18.25	17.96	18.69	20.09	20.66	20.66	20.52	20.45	21.31	21.75	20.84	22.73
Max.	27.43	27.31	26.65	25.71	24.87	24.30	24.43	23.96	24.14	25.69	25.35	25.07	24.45	23.85	23.20	22.69	22.03	20.59	19.86	19.22	18.20	18.78	20.09	20.94	20.99	20.57	20.49	21.70	21.59	20.71	23.00
Min.	26.01	26.14	25.32	24.34	23.74	23.03	22.87	22.51	23.21	23.94	24.05	24.01	23.30	22.98	22.32	21.63	20.70	19.64	19.10	18.25	17.92	17.89	18.69	20.07	20.05	19.67	19.71	20.75	20.49	20.24	22.02
Avg.	26.59	26.71	26.01	24.82	24.16	23.63	23.36	23.23	23.65	24.67	24.47	24.54	23.81	23.38	22.64	22.19	21.19	19.98	19.42	18.67	18.01	18.26	19.23	20.39	20.51	20.15	20.15	21.23	21.25	20.92	22.49

**Average Daily Temperature Readings
Crystal Falls Hydroelectric Project (Downstream of Dam)
August 2007**



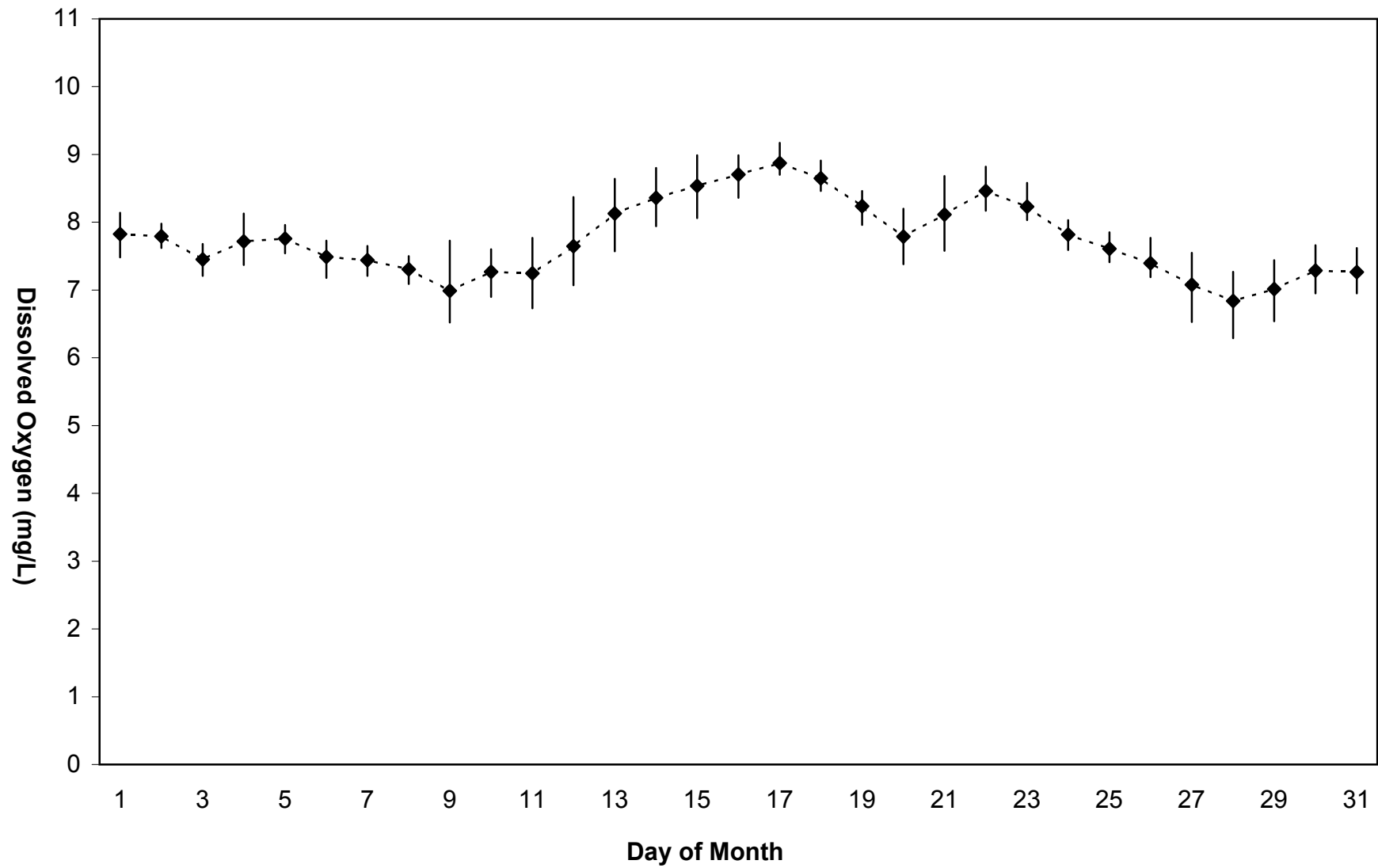
APPENDIX F

Downstream Dissolved Oxygen Monitoring

Hourly Dissolved Oxygen Readings: Crystal Falls Hydroelectric Project (Downstream of Dam), July 2007

Time	Day of Month																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	8.03	7.98	7.56	7.38	7.96	7.73	7.65	7.48	7.05	7.59	7.26	7.59	8.20	8.50	8.58	8.90	8.85	8.91	8.46	7.98	8.20	8.42	8.58	8.03	7.53	7.77	7.26	7.18	7.26	7.19	7.28
1:00a	7.95	7.98	7.51	7.37	7.89	7.73	7.61	7.47	6.94	7.60	7.14	7.50	8.10	8.42	8.43	8.84	8.84	8.84	8.40	7.86	8.24	8.35	8.54	8.02	7.47	7.76	7.20	7.10	7.18	7.28	7.26
2:00a	7.86	7.96	7.44	7.42	7.83	7.59	7.54	7.45	6.84	7.55	7.02	7.44	8.03	8.32	8.36	8.72	8.77	8.81	8.32	7.76	8.20	8.31	8.53	8.01	7.45	7.65	7.14	6.95	7.16	7.33	7.29
3:00a	7.77	7.94	7.39	7.45	7.80	7.54	7.46	7.44	6.75	7.49	6.95	7.40	7.94	8.24	8.29	8.63	8.76	8.73	8.25	7.65	8.14	8.32	8.53	7.98	7.41	7.59	7.02	6.82	7.07	7.33	7.35
4:00a	7.69	7.94	7.37	7.44	7.73	7.44	7.40	7.36	6.71	7.39	6.89	7.34	7.85	8.16	8.22	8.59	8.77	8.66	8.17	7.56	8.05	8.32	8.49	8.03	7.45	7.54	6.95	6.68	6.98	7.21	7.29
5:00a	7.61	7.88	7.32	7.47	7.66	7.37	7.33	7.28	6.67	7.28	6.84	7.28	7.77	8.07	8.15	8.55	8.75	8.58	8.16	7.48	7.96	8.35	8.39	8.00	7.44	7.48	6.85	6.57	6.86	7.12	7.16
6:00a	7.54	7.87	7.28	7.46	7.62	7.29	7.29	7.22	6.61	7.16	6.78	7.19	7.68	8.00	8.10	8.48	8.71	8.56	8.09	7.42	7.85	8.29	8.27	7.87	7.46	7.45	6.75	6.44	6.72	7.07	7.10
7:00a	7.48	7.83	7.25	7.45	7.58	7.25	7.26	7.15	6.56	7.06	6.73	7.12	7.65	7.94	8.06	8.41	8.72	8.56	8.04	7.39	7.75	8.25	8.17	7.73	7.47	7.39	6.63	6.34	6.64	7.03	7.05
8:00a	7.48	7.78	7.21	7.49	7.54	7.18	7.24	7.15	6.54	6.96	6.75	7.08	7.60	7.98	8.06	8.36	8.71	8.57	8.02	7.38	7.66	8.18	8.12	7.66	7.49	7.35	6.56	6.29	6.55	6.95	6.95
9:00a	7.52	7.71	7.21	7.53	7.56	7.19	7.21	7.12	6.52	6.94	6.81	7.07	7.57	8.00	8.09	8.37	8.70	8.54	7.96	7.41	7.62	8.20	8.10	7.63	7.48	7.28	6.53	6.30	6.54	6.95	6.96
10:00a	7.57	7.68	7.21	7.55	7.61	7.23	7.21	7.13	6.54	6.91	6.89	7.11	7.66	8.00	8.18	8.42	8.72	8.58	7.99	7.46	7.58	8.17	8.08	7.59	7.52	7.29	6.57	6.36	6.59	6.96	6.97
11:00a	7.58	7.64	7.27	7.66	7.67	7.29	7.27	7.18	6.56	6.92	7.02	7.18	7.78	8.05	8.31	8.52	8.70	8.58	8.03	7.55	7.60	8.24	8.10	7.64	7.56	7.32	6.66	6.44	6.66	6.99	7.07
12:00p	7.68	7.63	7.36	7.68	7.72	7.34	7.38	7.22	6.63	6.90	7.18	7.34	7.91	8.13	8.42	8.62	8.73	8.62	8.14	7.63	7.67	8.31	8.11	7.74	7.60	7.38	6.89	6.57	6.75	7.10	7.20
1:00p	7.79	7.68	7.41	7.78	7.76	7.39	7.36	7.27	6.70	6.97	7.32	7.51	8.06	8.25	8.52	8.71	8.84	8.68	8.25	7.73	7.81	8.41	8.14	7.75	7.63	7.25	7.05	6.70	6.88	7.22	7.26
2:00p	7.85	7.75	7.52	7.78	7.79	7.42	7.41	7.36	6.77	7.05	7.43	7.65	8.21	8.37	8.65	8.74	8.84	8.73	8.32	7.80	7.98	8.50	8.10	7.76	7.67	7.28	7.22	6.85	6.98	7.32	7.34
3:00p	7.90	7.76	7.60	7.84	7.82	7.50	7.48	7.44	6.78	7.12	7.48	7.80	8.33	8.49	8.75	8.76	8.92	8.70	8.36	7.86	8.12	8.61	8.15	7.85	7.76	7.33	7.35	7.00	7.15	7.39	7.45
4:00p	7.97	7.77	7.65	7.91	7.83	7.53	7.51	7.45	6.91	7.34	7.53	7.96	8.47	8.58	8.88	8.79	9.01	8.73	8.38	7.92	8.30	8.70	8.11	7.89	7.79	7.19	7.46	7.08	7.27	7.48	7.62
5:00p	8.01	7.77	7.68	8.03	7.82	7.59	7.56	7.50	7.62	7.52	7.61	8.09	8.57	8.65	8.93	8.82	9.15	8.68	8.41	8.01	8.41	8.76	8.17	7.84	7.83	7.24	7.55	7.17	7.43	7.56	7.52
6:00p	8.09	7.79	7.68	8.08	7.83	7.64	7.59	7.45	7.73	7.52	7.68	8.22	8.61	8.72	8.98	8.89	9.17	8.62	8.41	8.14	8.53	8.77	8.20	7.81	7.85	7.23	7.48	7.21	7.44	7.66	7.48
7:00p	8.14	7.80	7.67	8.13	7.87	7.67	7.57	7.39	7.66	7.53	7.76	8.32	8.64	8.79	8.98	8.99	9.16	8.62	8.42	8.19	8.63	8.82	8.21	7.86	7.79	7.31	7.45	7.23	7.38	7.63	7.46
8:00p	8.12	7.81	7.65	8.10	7.87	7.71	7.61	7.30	7.73	7.50	7.73	8.37	8.64	8.80	8.99	8.98	9.11	8.68	8.41	8.19	8.68	8.82	8.18	7.81	7.73	7.33	7.40	7.27	7.34	7.59	7.47
9:00p	8.08	7.76	7.60	8.07	7.88	7.72	7.59	7.25	7.69	7.46	7.77	8.34	8.63	8.76	8.98	8.99	9.07	8.58	8.33	8.17	8.64	8.72	8.13	7.78	7.71	7.40	7.36	7.20	7.22	7.59	7.38
10:00p	8.06	7.70	7.52	8.09	7.83	7.73	7.51	7.15	7.63	7.39	7.72	8.31	8.60	8.74	8.97	8.92	8.99	8.54	8.25	8.15	8.58	8.63	8.10	7.72	7.68	7.37	7.30	7.19	7.14	7.52	7.24
11:00p	8.03	7.62	7.46	8.06	7.76	7.69	7.49	7.09	7.58	7.31	7.66	8.26	8.59	8.68	8.98	8.88	8.94	8.46	8.12	8.20	8.49	8.59	8.03	7.66	7.80	7.33	7.23	7.22	7.11	7.39	7.18
Max.	8.14	7.98	7.68	8.13	7.96	7.73	7.65	7.50	7.73	7.60	7.77	8.37	8.64	8.80	8.99	8.99	9.17	8.91	8.46	8.20	8.68	8.82	8.58	8.03	7.85	7.77	7.55	7.27	7.44	7.66	7.62
Min.	7.48	7.62	7.21	7.37	7.54	7.18	7.21	7.09	6.52	6.90	6.73	7.07	7.57	7.94	8.06	8.36	8.70	8.46	7.96	7.38	7.58	8.17	8.03	7.59	7.41	7.19	6.53	6.29	6.54	6.95	6.95
Avg.	7.83	7.79	7.45	7.72	7.76	7.49	7.44	7.30	6.99	7.27	7.25	7.64	8.13	8.36	8.54	8.70	8.87	8.65	8.24	7.79	8.11	8.46	8.23	7.82	7.61	7.40	7.08	6.84	7.01	7.29	7.26

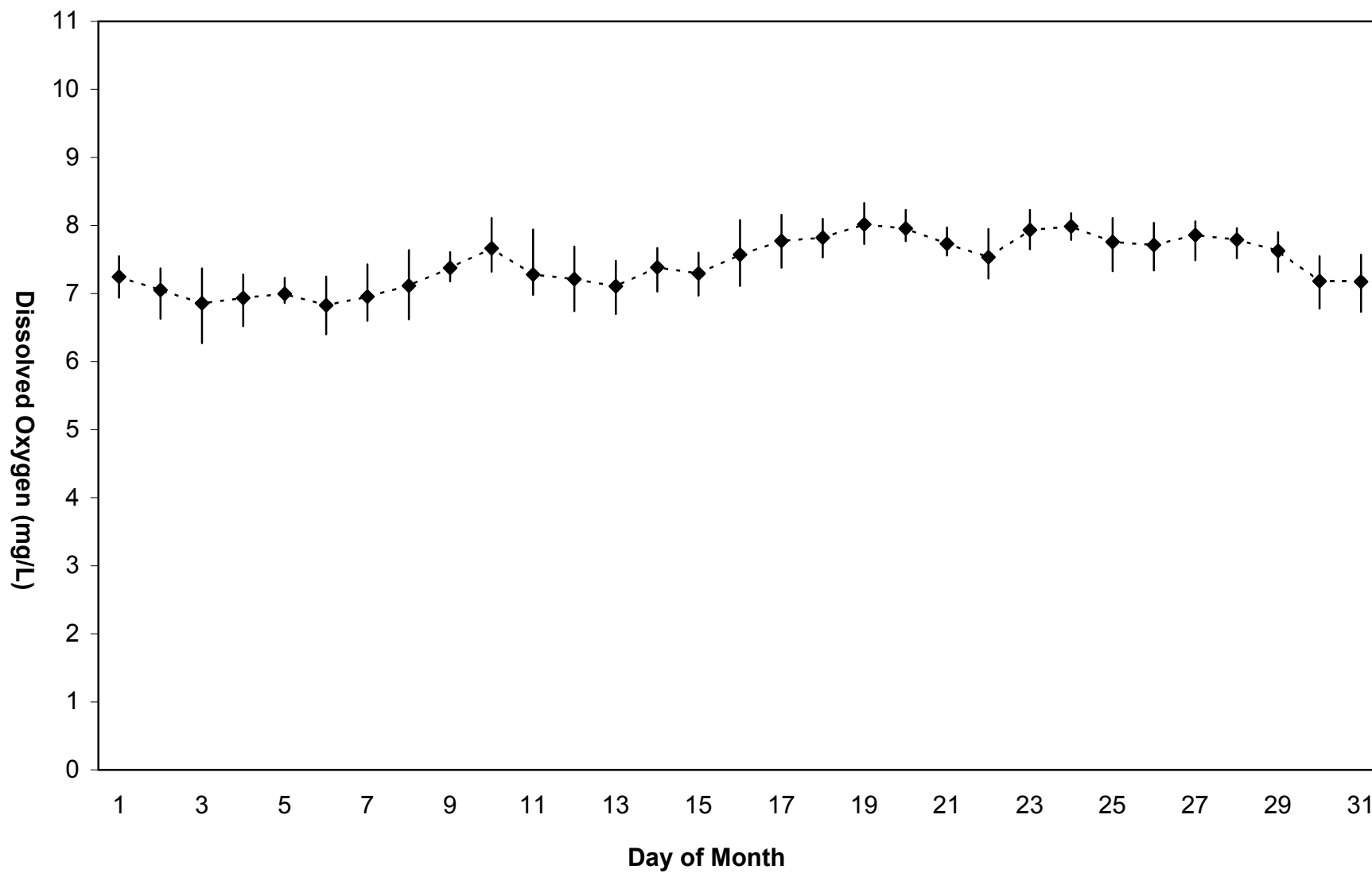
**Average Daily Dissolved Oxygen Readings
Crystal Falls Hydroelectric Project (Downstream of Dam)
July 2007**



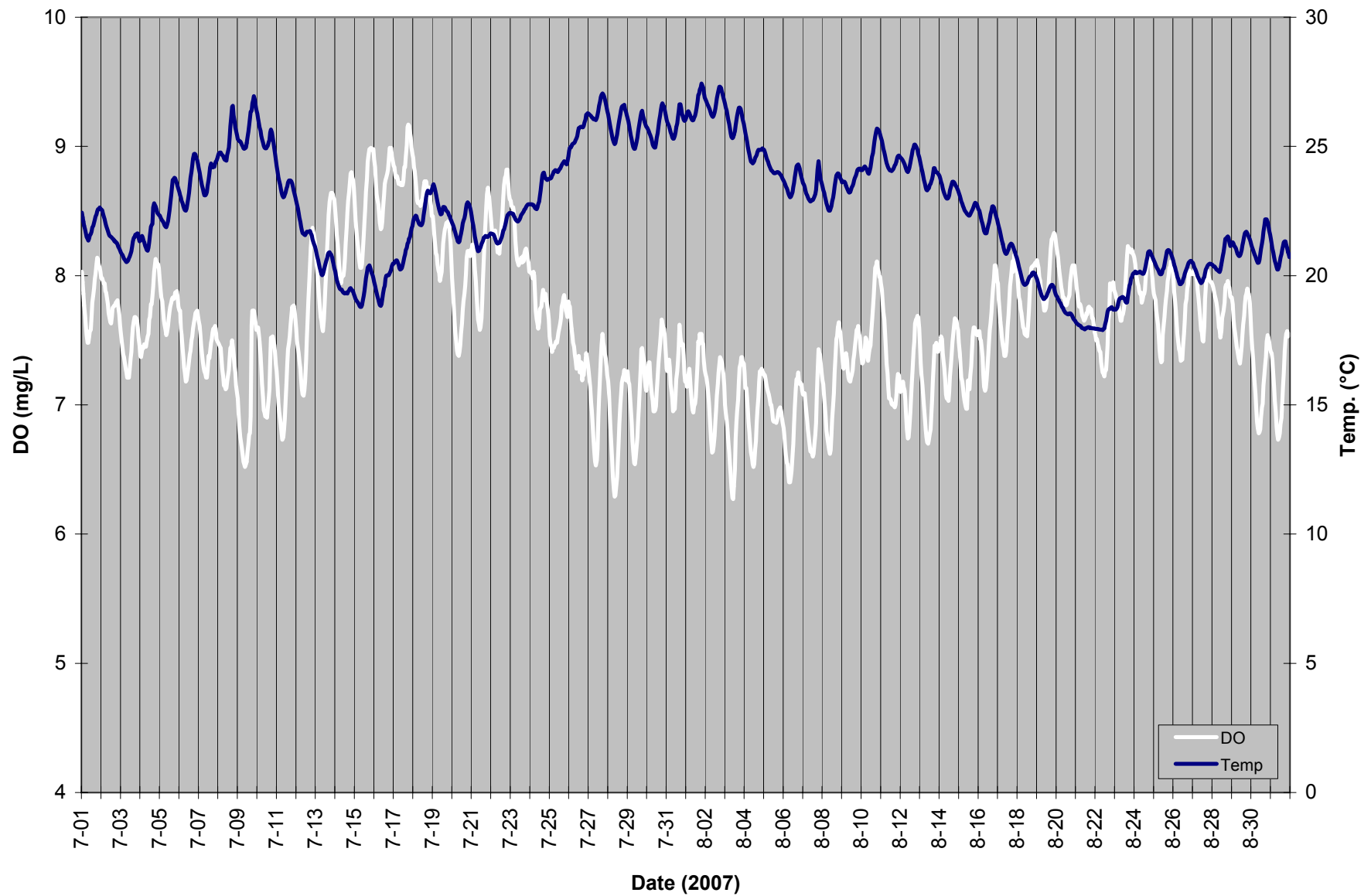
Hourly Dissolved Oxygen Readings: Crystal Falls Hydroelectric Project (Downstream of Dam), August 2007

Time	Day of Month																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	7.20	7.24	7.00	7.25	7.23	6.82	7.08	7.19	7.40	7.37	7.94	7.10	7.46	7.43	7.48	7.57	7.94	8.00	8.12	8.23	7.97	7.54	7.87	8.14	7.86	7.99	8.01	7.93	7.83	7.55	7.41
1:00a	7.14	7.21	6.94	7.13	7.23	6.76	7.09	7.16	7.33	7.32	7.89	7.13	7.32	7.46	7.40	7.57	7.82	7.91	8.09	8.18	7.91	7.50	7.85	8.09	7.83	7.88	8.02	7.91	7.78	7.46	7.40
2:00a	7.15	7.17	6.88	7.13	7.20	6.67	7.09	7.05	7.28	7.33	7.80	7.11	7.23	7.53	7.30	7.51	7.72	7.83	8.06	8.14	7.85	7.51	7.82	8.02	7.81	7.80	8.06	7.88	7.66	7.36	7.35
3:00a	7.23	7.11	6.81	7.06	7.15	6.61	7.02	6.98	7.33	7.36	7.72	7.18	7.15	7.51	7.21	7.50	7.64	7.80	7.99	8.07	7.80	7.47	7.78	7.98	7.73	7.73	8.03	7.85	7.60	7.26	7.23
4:00a	7.28	7.02	6.73	6.97	7.12	6.55	6.96	6.90	7.38	7.43	7.66	7.14	7.07	7.40	7.18	7.45	7.59	7.74	7.96	8.02	7.76	7.45	7.75	7.94	7.68	7.64	8.00	7.82	7.56	7.18	7.14
5:00a	7.20	6.92	6.63	6.87	7.10	6.54	6.88	6.80	7.40	7.52	7.55	7.11	6.99	7.34	7.13	7.37	7.52	7.71	7.89	7.96	7.78	7.42	7.75	7.92	7.62	7.55	7.96	7.79	7.50	7.08	7.03
6:00a	7.11	6.82	6.54	6.78	7.08	6.46	6.81	6.74	7.35	7.51	7.44	7.03	6.89	7.29	7.07	7.23	7.46	7.66	7.85	7.91	7.76	7.41	7.70	7.88	7.53	7.48	7.89	7.75	7.45	6.97	6.94
7:00a	7.01	6.72	6.46	6.69	7.04	6.40	6.76	6.70	7.26	7.47	7.32	6.91	6.81	7.19	7.03	7.14	7.43	7.60	7.81	7.88	7.72	7.33	7.65	7.86	7.43	7.43	7.82	7.68	7.42	6.87	6.83
8:00a	6.96	6.63	6.36	6.63	7.00	6.40	6.69	6.66	7.21	7.34	7.24	6.81	6.75	7.08	6.99	7.11	7.38	7.59	7.78	7.83	7.69	7.29	7.65	7.87	7.37	7.41	7.75	7.60	7.37	6.82	6.77
9:00a	6.94	6.64	6.28	6.59	7.00	6.44	6.64	6.62	7.19	7.39	7.13	6.74	6.71	7.05	6.97	7.13	7.38	7.55	7.73	7.83	7.67	7.25	7.69	7.79	7.33	7.34	7.68	7.58	7.34	6.78	6.73
10:00a	6.99	6.68	6.27	6.54	6.94	6.49	6.64	6.65	7.18	7.43	7.05	6.75	6.70	7.05	6.97	7.19	7.41	7.54	7.73	7.82	7.65	7.24	7.70	7.81	7.34	7.35	7.58	7.52	7.32	6.79	6.75
11:00a	7.01	6.76	6.37	6.52	6.88	6.61	6.63	6.76	7.21	7.46	7.05	6.82	6.73	7.03	7.19	7.27	7.49	7.57	7.75	7.78	7.66	7.22	7.74	7.85	7.54	7.35	7.56	7.57	7.37	6.81	6.78
12:00p	7.06	6.87	6.50	6.54	6.87	6.70	6.60	6.89	7.23	7.56	7.04	6.94	6.77	7.10	7.12	7.39	7.60	7.53	7.80	7.77	7.68	7.26	7.80	7.86	7.62	7.45	7.50	7.67	7.45	6.90	6.85
1:00p	7.17	6.96	6.74	6.66	6.87	6.85	6.62	7.00	7.27	7.64	7.01	7.06	6.81	7.22	7.12	7.49	7.70	7.60	7.84	7.78	7.71	7.27	7.93	7.89	7.68	7.55	7.49	7.70	7.54	6.98	6.90
2:00p	7.32	7.07	6.86	6.72	6.87	6.98	6.69	7.09	7.35	7.75	7.00	7.17	6.93	7.31	7.22	7.58	7.81	7.72	7.91	7.81	7.70	7.36	8.06	7.98	7.76	7.65	7.61	7.73	7.62	7.01	7.02
3:00p	7.49	7.16	6.95	6.86	6.86	7.12	6.77	7.25	7.39	7.84	7.01	7.27	7.04	7.39	7.30	7.63	7.92	7.84	8.00	7.83	7.75	7.46	8.16	8.06	7.82	7.78	7.82	7.79	7.69	7.15	7.14
4:00p	7.47	7.25	7.04	6.96	6.88	7.20	6.86	7.39	7.45	7.95	6.99	7.42	7.19	7.48	7.42	7.72	7.99	7.95	8.10	7.85	7.76	7.65	8.23	8.13	7.88	7.82	7.91	7.91	7.78	7.24	7.24
5:00p	7.55	7.31	7.18	7.06	6.92	7.19	7.07	7.51	7.52	8.06	6.98	7.49	7.34	7.56	7.53	7.82	8.05	8.06	8.20	7.95	7.75	7.72	8.21	8.16	7.96	7.90	8.01	7.93	7.84	7.31	7.42
6:00p	7.51	7.37	7.29	7.18	6.96	7.25	7.24	7.53	7.58	8.08	7.00	7.63	7.46	7.62	7.60	7.90	8.11	8.07	8.28	8.00	7.73	7.94	8.21	8.18	7.99	7.93	8.04	7.93	7.86	7.37	7.50
7:00p	7.55	7.35	7.32	7.26	6.97	7.18	7.43	7.60	7.58	8.11	7.08	7.66	7.45	7.67	7.60	7.98	8.03	8.07	8.29	8.06	7.74	7.89	8.19	8.18	8.06	8.01	8.01	7.96	7.90	7.49	7.55
8:00p	7.48	7.33	7.37	7.24	6.98	7.16	7.40	7.64	7.61	8.06	7.19	7.67	7.48	7.66	7.58	8.08	8.16	8.08	8.31	8.08	7.67	7.90	8.18	8.15	8.06	8.04	7.98	7.92	7.87	7.54	7.57
9:00p	7.47	7.30	7.37	7.28	6.95	7.17	7.39	7.59	7.55	8.03	7.24	7.69	7.44	7.65	7.56	8.08	8.16	8.09	8.33	8.07	7.67	7.93	8.20	8.07	8.11	8.01	7.96	7.91	7.86	7.52	7.53
10:00p	7.33	7.23	7.32	7.26	6.90	7.16	7.32	7.56	7.52	7.99	7.23	7.68	7.41	7.60	7.54	8.05	8.16	8.10	8.32	8.08	7.62	7.95	8.17	7.99	8.09	8.02	7.95	7.84	7.79	7.49	7.55
11:00p	7.27	7.15	7.32	7.25	6.86	7.11	7.24	7.47	7.44	7.99	7.16	7.59	7.44	7.58	7.56	7.96	8.09	8.08	8.28	8.02	7.56	7.89	8.16	7.91	8.07	8.02	7.95	7.83	7.68	7.43	7.54
Max.	7.55	7.37	7.37	7.28	7.23	7.25	7.43	7.64	7.61	8.11	7.94	7.69	7.48	7.67	7.60	8.08	8.16	8.10	8.33	8.23	7.97	7.95	8.23	8.18	8.11	8.04	8.06	7.96	7.90	7.55	7.57
Min.	6.94	6.63	6.27	6.52	6.86	6.40	6.60	6.62	7.18	7.32	6.98	6.74	6.70	7.03	6.97	7.11	7.38	7.53	7.73	7.77	7.56	7.22	7.65	7.79	7.33	7.34	7.49	7.52	7.32	6.78	6.73
Avg.	7.25	7.05	6.86	6.93	6.99	6.83	6.96	7.11	7.38	7.67	7.28	7.21	7.11	7.38	7.29	7.57	7.77	7.82	8.02	7.96	7.73	7.54	7.94	7.99	7.76	7.71	7.86	7.79	7.63	7.18	7.17

**Average Daily Dissolved Oxygen Readings
Crystal Falls Hydroelectric Project (Downstream of Dam)
August 2007**



2007: Dissolved oxygen and temperature at Crystal Falls Hydroelectric Project, downstream



APPENDIX G

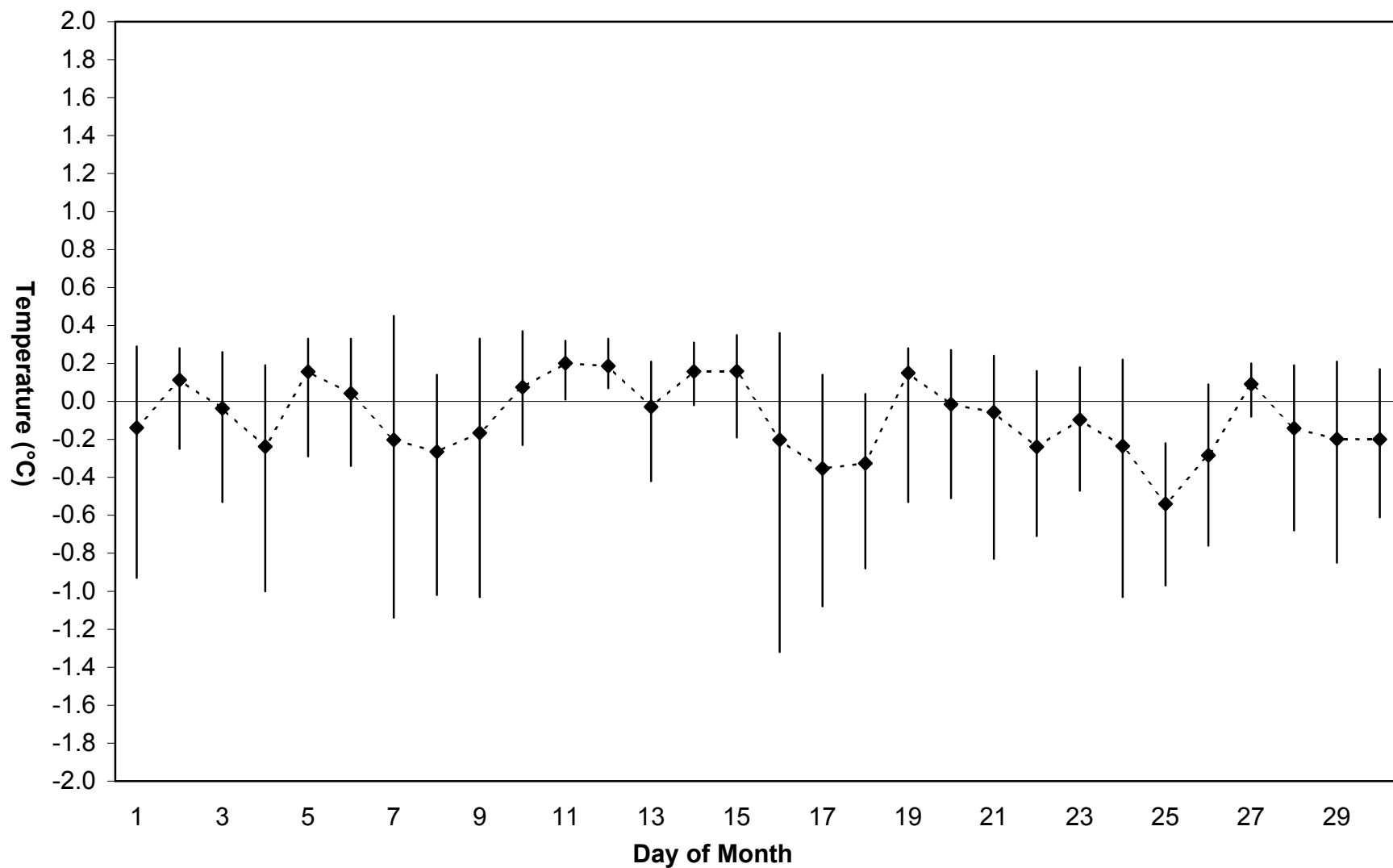
Comparison Between Hourly Temperatures at Sites

Hourly Delta Temperature Calculations: Crystal Falls Hydroelectric Project (Downstream Minus Upstream), July 2007

Time	Day of Month																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	0.1	-0.3	0.2	-0.8	0.2	0.3	0.1	-0.7	0.2	-0.2	0.3	0.3	0.2	0.2	0.2	-1.0	-0.8	-0.5	0.3	0.0	-0.6	-0.5	-0.3	-0.4	-0.6	0.1	0.0	0.0	-0.5	-0.5	
1:00a	0.2	-0.1	0.3	-1.0	0.1	0.3	0.1	-0.7	0.2	-0.1	0.3	0.3	0.2	0.1	0.1	0.2	-0.9	-0.7	-0.1	0.3	0.1	-0.5	-0.4	-0.1	-0.6	-0.4	0.0	0.2	0.1	-0.5	-0.3
2:00a	0.2	-0.1	0.1	-0.8	0.2	0.3	0.2	-0.3	0.2	0.0	0.3	0.2	0.1	0.1	0.4	0.2	-0.6	-0.4	-0.1	0.2	0.1	-0.2	-0.2	0.0	-0.6	-0.3	0.1	0.1	0.0	-0.2	-0.3
3:00a	0.2	0.0	0.2	-0.5	0.3	0.3	0.4	-0.2	0.2	-0.1	0.3	0.3	0.1	0.3	0.3	0.2	-0.4	-0.3	0.1	0.3	0.1	-0.1	-0.1	-0.1	-0.7	-0.3	0.2	0.1	0.0	-0.2	-0.2
4:00a	0.3	0.1	0.3	-0.3	0.3	0.2	0.3	0.1	0.3	0.2	0.3	0.1	0.1	0.2	0.3	0.2	-0.2	-0.1	0.1	0.3	0.1	0.0	0.0	0.1	-0.9	-0.1	-0.1	0.1	0.1	0.0	0.0
5:00a	0.2	0.1	0.2	-0.2	0.3	0.2	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.3	0.0	0.0	-0.1	0.2	0.1	0.1	0.0	0.2	0.2	-1.0	0.0	0.1	0.2	0.2	-0.1	0.0
6:00a	0.2	0.1	0.2	-0.3	0.3	0.3	0.2	0.0	0.3	0.2	0.1	0.2	0.1	0.2	0.2	0.3	0.1	0.0	0.3	0.2	0.2	0.1	0.2	0.2	-0.8	0.0	0.2	0.2	0.1	0.1	0.1
7:00a	0.2	0.1	0.1	0.0	0.2	0.2	0.2	0.1	0.3	0.1	0.2	0.3	0.2	0.2	0.3	0.4	0.1	0.0	0.2	0.2	0.2	0.2	0.1	0.2	-0.6	0.1	0.1	0.1	0.1	0.2	0.1
8:00a	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.0	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.2	0.1	0.0	0.3	0.2	0.2	0.1	0.1	0.2	-0.5	0.0	0.1	0.2	0.2	0.1	0.1
9:00a	0.0	0.2	0.2	0.1	0.2	0.1	0.1	0.0	0.2	0.1	0.2	0.2	0.2	0.1	0.3	0.0	0.1	0.0	0.3	0.1	0.1	0.1	0.1	0.0	-0.6	-0.1	0.1	0.1	0.2	0.1	0.2
10:00a	0.0	0.2	0.2	-0.2	0.1	0.2	0.0	-0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.0	-0.1	0.3	0.1	0.1	0.0	0.1	0.0	-0.5	-0.3	0.2	0.1	0.1	0.1	0.3
11:00a	-0.1	0.1	0.0	-0.3	0.1	0.0	-0.1	-0.2	0.0	0.0	0.0	0.2	0.0	0.1	0.0	-0.2	-0.1	0.0	0.2	0.1	0.1	-0.1	0.0	0.0	-0.6	-0.2	*	0.0	-0.2	0.0	0.0
12:00p	-0.1	0.1	0.1	-0.4	0.0	0.0	-0.1	-0.2	-0.2	0.0	0.2	0.1	-0.1	0.1	0.0	-0.3	-0.2	-0.2	0.2	0.0	-0.2	-0.1	-0.1	0.1	-0.4	-0.5	0.1	-0.2	-0.4	0.0	-0.2
1:00p	-0.4	0.1	-0.3	-0.4	0.2	-0.1	-0.1	-0.5	-0.3	-0.2	0.1	0.1	-0.2	0.1	0.0	-0.3	-0.1	0.0	0.2	-0.1	-0.2	-0.2	-0.1	0.0	-0.5	-0.3	0.1	-0.3	-0.3	-0.1	-0.3
2:00p	-0.4	0.1	0.0	-0.1	-0.1	-0.2	-0.5	-0.3	-0.4	-0.2	0.1	0.2	-0.4	0.0	0.0	-0.6	-0.2	0.0	0.3	-0.2	0.0	-0.1	-0.1	0.0	-0.4	-0.4	0.1	-0.5	-0.2	-0.4	-0.4
3:00p	-0.3	0.2	-0.1	-0.2	-0.3	-0.3	-0.6	-1.0	-0.4	-0.1	0.2	0.2	-0.3	0.2	-0.1	-0.6	-0.3	-0.1	0.1	-0.3	0.0	-0.3	-0.2	-0.5	-0.3	-0.3	0.0	-0.6	-0.2	-0.2	-0.5
4:00p	-0.2	0.1	0.0	-0.3	0.0	0.0	-0.4	-1.0	-0.6	0.0	0.2	0.2	-0.3	0.0	-0.2	-0.4	-0.3	-0.2	0.2	-0.4	-0.1	-0.2	-0.1	-1.0	-0.4	-0.5	0.0	-0.7	-0.2	-0.2	-0.6
5:00p	-0.2	0.1	-0.3	-0.1	0.1	-0.2	-0.4	-0.6	-0.5	0.0	0.2	0.2	-0.3	0.2	0.1	-0.4	-0.3	-0.5	0.2	-0.5	-0.1	-0.4	-0.1	-0.7	-0.5	-0.8	0.1	-0.4	-0.1	-0.4	-0.6
6:00p	-0.5	0.2	-0.4	-0.2	0.2	-0.3	-0.5	-0.2	-1.0	0.1	0.3	0.2	-0.3	0.1	0.2	-0.4	-0.3	-0.6	0.2	-0.3	-0.1	-0.4	-0.2	-0.8	-0.4	-0.7	0.1	-0.5	-0.5	-0.3	-0.7
7:00p	-0.3	0.1	-0.2	0.1	0.3	-0.1	-0.5	-0.1	-1.0	0.3	0.3	0.2	-0.2	0.1	0.1	-0.3	-0.3	-0.6	0.1	-0.4	0.0	-0.7	-0.1	-0.8	-0.2	-0.6	0.1	-0.5	-0.6	-0.2	-0.5
8:00p	-0.9	0.2	-0.5	-0.1	0.2	-0.1	-0.7	-0.2	-0.7	0.3	0.2	0.1	-0.1	0.2	0.1	-0.2	-0.6	-0.7	0.3	-0.3	0.0	-0.6	-0.2	-0.7	-0.3	-0.4	0.0	-0.5	-0.7	-0.4	-0.5
9:00p	-0.8	0.2	-0.5	0.0	0.3	-0.3	-1.0	-0.1	-0.5	0.3	0.3	0.1	-0.1	0.2	0.2	-0.8	-0.9	-0.8	0.3	-0.1	-0.6	-0.6	-0.3	-0.3	-0.6	-0.3	0.2	-0.4	-0.9	-0.5	-0.5
10:00p	-0.6	0.3	-0.5	0.1	0.3	0.1	-0.9	-0.2	-0.5	0.3	0.2	0.1	0.1	0.3	0.2	-1.3	-1.1	-0.9	0.2	-0.1	-0.8	-0.6	-0.3	-0.7	-0.7	-0.1	0.0	-0.2	-0.7	-0.5	-0.5
11:00p	-0.3	0.3	-0.3	0.1	0.3	-0.1	-1.1	0.0	-0.4	0.4	0.2	0.2	0.1	0.3	0.3	-1.0	-1.1	-0.9	0.2	0.0	-0.8	-0.7	-0.2	-0.5	-0.6	0.1	0.2	-0.1	-0.7	-0.6	-0.5
Max.	0.3	0.3	0.3	0.2	0.3	0.3	0.4	0.1	0.3	0.4	0.3	0.3	0.2	0.3	0.4	0.4	0.1	0.0	0.3	0.3	0.2	0.2	0.2	0.2	-0.2	0.1	0.2	0.2	0.2	0.2	0.3
Min.	-0.9	-0.3	-0.5	-1.0	-0.3	-0.3	-1.1	-1.0	-1.0	-0.2	0.0	0.1	-0.4	0.0	-0.2	-1.3	-1.1	-0.9	-0.5	-0.5	-0.8	-0.7	-0.5	-1.0	-1.0	-0.8	-0.1	-0.7	-0.9	-0.6	-0.7
Avg.	-0.1	0.1	0.0	-0.2	0.2	0.0	-0.2	-0.3	-0.2	0.1	0.2	0.2	0.0	0.2	0.2	-0.2	-0.4	-0.3	0.1	0.0	-0.1	-0.2	-0.1	-0.2	-0.5	-0.3	0.1	-0.1	-0.2	-0.2	-0.3

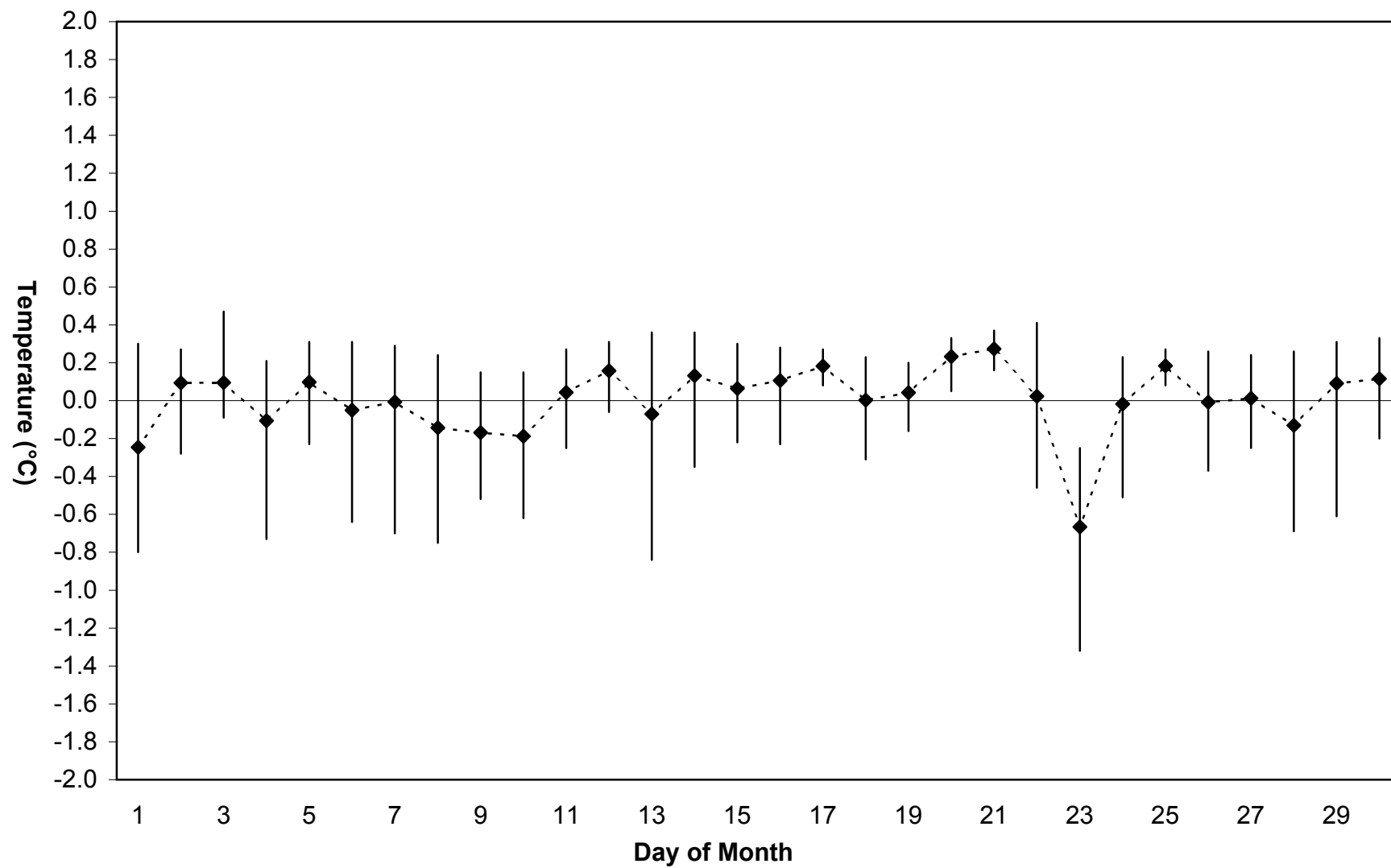
* Service point (missing data)

Average Delta Temperature Calculations: Crystal Falls Hydroelectric Project (Downstream Minus Upstream), July 2007



Hourly Delta Temperature Calculations: Crystal Falls Hydroelectric Project (Downstream Minus Upstream), August 2007

Time	Day of Month																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	-0.8	-0.3	0.1	0.1	-0.2	0.3	-0.3	0.1	-0.5	-0.5	0.0	0.0	0.3	-0.3	0.3	0.0	0.1	0.2	0.1	0.1	0.2	0.3	-0.6	-0.5	0.2	0.2	0.0	-0.1	-0.6	0.3	0.1
1:00a	-0.6	-0.1	0.2	0.1	-0.2	0.3	-0.2	0.1	-0.4	-0.6	-0.1	-0.1	0.3	-0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.3	-0.5	-0.3	0.2	0.2	0.0	-0.2	-0.2	0.3	0.1
2:00a	-0.5	-0.2	0.2	0.2	0.0	0.2	-0.1	0.1	-0.5	-0.6	0.1	0.1	0.4	-0.2	0.2	0.1	0.3	0.2	0.1	0.1	0.2	0.3	-0.7	-0.3	0.2	0.2	0.1	0.0	-0.1	0.3	0.2
3:00a	-0.2	0.1	0.2	0.2	-0.1	0.3	0.0	0.2	-0.4	-0.4	-0.1	0.1	0.2	-0.1	0.2	0.3	0.2	0.1	0.1	0.1	0.3	0.3	-1.0	-0.2	0.2	0.2	0.1	0.1	0.0	0.3	0.1
4:00a	-0.1	0.0	0.1	0.1	0.0	0.3	0.1	0.2	-0.2	-0.2	0.1	0.2	0.3	0.0	0.2	0.1	0.1	0.2	0.1	0.2	0.2	0.3	-0.9	-0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.1
5:00a	0.0	0.1	0.1	0.2	-0.2	0.2	0.1	0.2	-0.1	0.0	0.1	0.2	0.3	0.1	0.2	0.2	0.2	0.1	0.1	0.3	0.3	0.3	-0.8	-0.2	0.2	0.3	0.2	0.1	0.1	0.3	0.1
6:00a	0.0	0.1	0.1	0.1	0.1	0.3	0.1	0.2	0.0	0.0	0.1	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.3	0.3	0.3	-0.6	-0.1	0.3	0.3	0.2	0.1	0.1	0.2	0.1
7:00a	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.2	0.3	0.4	-0.5	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.1
8:00a	0.2	0.2	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.3	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.3	0.3	-0.5	0.1	0.3	0.2	0.2	0.3	0.2	0.3	0.1
9:00a	0.2	0.1	0.0	0.2	0.2	0.3	0.3	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.2	0.3	0.4	0.3	-0.3	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.2
10:00a	0.3	0.2	0.1	-0.1	0.3	0.1	0.3	0.1	0.1	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.1	0.2	0.3	0.3	-0.4	0.2	0.2	0.1	0.1	0.2	0.3	0.1	0.2
11:00a	-0.3	0.2	0.1	0.0	0.3	0.1	0.2	0.1	0.1	0.0	0.3	0.3	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.3	0.2	0.2	-0.6	0.2	0.2	0.0	0.2	0.1	0.2	0.1	0.0
12:00p	-0.2	0.2	0.0	0.0	0.2	-0.1	0.0	-0.1	0.1	0.0	0.3	0.3	0.0	0.2	0.0	0.1	0.1	0.0	0.0	0.2	0.3	-0.1	-0.5	0.1	0.1	0.0	0.2	-0.1	0.2	0.0	0.2
1:00p	-0.2	0.1	0.0	0.0	0.2	-0.2	0.1	-0.3	-0.1	0.0	0.2	0.1	-0.2	0.2	0.0	0.1	0.1	-0.1	0.0	0.3	0.3	0.1	-0.6	0.0	0.1	-0.1	0.1	-0.1	0.2	0.0	0.0
2:00p	-0.3	0.0	-0.1	-0.4	0.2	-0.4	0.1	0.0	0.0	-0.3	0.2	0.1	-0.2	0.2	0.0	-0.1	0.1	-0.2	-0.1	0.3	0.3	-0.1	-0.3	0.0	0.1	0.0	0.1	-0.1	0.1	0.0	-0.2
3:00p	-0.2	0.1	0.0	-0.3	0.1	-0.1	0.0	-0.4	0.0	-0.3	0.2	0.2	-0.2	0.1	0.0	-0.2	0.2	-0.2	-0.1	0.2	0.3	-0.4	-0.4	-0.2	0.2	-0.3	0.0	-0.2	0.0	-0.2	-0.3
4:00p	-0.4	-0.1	0.0	-0.3	0.1	-0.4	0.1	-0.5	-0.1	-0.2	0.0	0.1	-0.2	0.1	-0.1	-0.1	0.2	-0.2	-0.1	0.2	0.3	-0.4	-0.7	-0.2	0.1	-0.2	-0.2	0.0	-0.1	-0.2	-0.2
5:00p	-0.5	0.0	0.0	-0.2	0.2	-0.1	-0.7	-0.5	-0.2	-0.5	0.0	0.1	-0.8	0.2	0.0	0.0	0.2	-0.3	-0.1	0.2	0.4	-0.3	-0.6	-0.1	0.2	-0.4	-0.2	-0.3	0.2	-0.1	-0.2
6:00p	-0.4	0.1	0.0	-0.2	0.1	-0.3	-0.5	-0.7	-0.2	-0.2	-0.2	0.1	-0.8	0.2	-0.2	0.1	0.3	-0.3	-0.2	0.3	0.3	-0.4	-0.7	0.1	0.2	-0.4	-0.2	-0.6	0.2	-0.1	-0.1
7:00p	-0.4	0.2	0.3	-0.2	0.1	-0.5	-0.2	-0.6	-0.3	-0.3	-0.2	0.2	-0.5	0.4	-0.1	0.2	0.2	-0.2	-0.1	0.3	0.3	-0.2	-1.0	0.1	0.2	-0.3	-0.2	-0.5	0.1	0.0	-0.2
8:00p	-0.3	0.2	0.1	-0.5	0.2	-0.5	-0.1	-0.5	-0.3	-0.2	-0.1	0.3	-0.4	0.3	-0.2	0.2	0.2	-0.1	-0.1	0.3	0.3	-0.3	-1.3	0.2	0.2	-0.3	-0.3	-0.6	0.2	0.1	-0.1
9:00p	-0.4	0.2	0.1	-0.7	0.3	-0.6	0.0	-0.8	-0.5	-0.3	-0.1	0.3	-0.2	0.2	-0.1	0.2	0.2	0.0	0.0	0.2	0.3	-0.5	-1.1	0.2	0.2	-0.2	-0.2	-0.7	0.1	0.1	-0.2
10:00p	-0.4	0.3	0.1	-0.5	0.2	-0.5	0.1	-0.4	-0.5	-0.1	-0.3	0.1	-0.4	0.3	-0.1	0.3	0.2	0.0	0.1	0.3	0.3	-0.3	-0.8	0.2	0.2	-0.1	-0.3	-0.6	0.2	0.1	-0.2
11:00p	-0.4	0.3	0.5	-0.4	0.2	-0.4	0.1	-0.4	-0.5	-0.2	0.0	0.3	-0.5	0.3	0.1	0.2	0.2	0.1	0.1	0.3	0.3	-0.4	-0.7	0.2	0.2	-0.1	-0.2	-0.5	0.3	0.1	-0.1
Max.	0.3	0.3	0.5	0.2	0.3	0.3	0.3	0.2	0.1	0.2	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.3	0.4	0.4	-0.3	0.2	0.3	0.3	0.2	0.3	0.3	0.3	0.2
Min.	-0.8	-0.3	-0.1	-0.7	-0.2	-0.6	-0.7	-0.8	-0.5	-0.6	-0.3	-0.1	-0.8	-0.3	-0.2	-0.2	0.1	-0.3	-0.2	0.1	0.2	-0.5	-1.3	-0.5	0.1	-0.4	-0.3	-0.7	-0.6	-0.2	-0.3
Avg.	-0.2	0.1	0.1	-0.1	0.1	-0.1	0.0	-0.1	-0.2	-0.2	0.0	0.2	-0.1	0.1	0.1	0.1	0.2	0.0	0.0	0.2	0.3	0.0	-0.7	0.0	0.2	0.0	0.0	-0.1	0.1	0.1	0.0

Average Delta Temperature Calculations: Crystal Falls Hydroelectric Project (Downstream Minus Upstream), Aug. 2007

APPENDIX H

Agency Comments to Draft Annual Report for 2002 Monitoring



STATE OF MICHIGAN

JENNIFER M. GRANHOLM
GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
LANSING

K. L. COOL
DIRECTOR

Refer to: 4202.2.76

January 3, 2003

Mr. Kent Premo
White Water Associates, Inc.
429 River Lane, P.O. Box 27
Amasa, MI 49903

Subject: City of Crystal Falls Hydroelectric Project (FERC No. 11402)
Comments on the 2002 Water Quality Monitoring Draft Report

Dear Mr. Premo:

The Michigan Department of Natural Resources (MDNR) is in receipt of your draft copy of the Water Quality Monitoring study dated December 13, 2002. In this report, results for the 2002 City of Crystal Falls Hydroelectric Project Water Quality Monitoring Plan were submitted. In addition, monitoring results were compared for the years 2000 through 2002.

Monitoring methods and results were in compliance with the Federal Energy Regulatory Commission (FERC) Order Approving Water Quality Monitoring Plan. Except for one instance explained by calibration error in 2001, the Crystal Falls Hydroelectric Project did not influence DO or water temperature beyond limits specified by the State of Michigan.

As a result of this compliance, White Water Associates, Inc. has asked for a reduced long-term monitoring schedule. Water quality monitoring is proposed on the frequency of once every five years with a reduction from June through September data collection to only mid-July through mid-August. It is further proposed that long term monitoring be conducted in the same manner as 2002.

MDNR is pleased with the three years of monitoring results. Because water quality violations could potentially occur at any time over the license period, MDNR agrees that is important to conduct periodic monitoring over the term of the license. MDNR concurs that long-term monitoring, beginning in 2007 and every five years thereafter, is appropriate. However, rather than limiting the monitoring to only mid-July through mid-August, MDNR would like to see monitoring include the entire two month low flow period of July and August. Two months of monitoring data during the low flow period will ensure detection of any water quality problems and provide resource protection. All monitoring and reporting protocols shall remain the same as conducted in 2002.

Thank you for the opportunity to comment. If you have any questions, please contact me.

Sincerely,

A handwritten signature in cursive script that reads "Jessica Mistak".

Jessica Mistak, Fisheries Biologist
Marquette Fisheries Station
484 Cherry Creek Rd
Marquette, MI 49855
906-249-1611 ext 308
mistakjl@michigan.gov

cc: Ms. Sharon Hanshue, MDNR
Ms. Janet Smith, USFS

APPENDIX I

Agency Comments to Draft Annual Report for 2007 Monitoring

Delivered-To: white-wa-kent.premo@white-water-associates.com
Date: Fri, 4 Jan 2008 15:13:20 -0500
X-Mailer: Groupwise 6.5
From: "Jessica Mistak" <mistakjl@michigan.gov>
Subject: Re: City of Crystal Falls Hydro Report (water quality)
To: "Premo, Kent" <kent.premo@white-water-associates.com>, "Yasenak, Tyler" <tyler_yasenak@fws.gov>
X-Antivirus: AVG for E-mail 7.5.516 [269.17.13/1206]

Kent,
The Michigan DNR has reviewed the Draft 2007 Water Quality Report for the City of Crystal Falls. Since no deviations were noted for either DO or temperature during the July and August study period, we have no additional comments.

Thank you for keeping us informed,
Jessica

Jessica Mistak, Senior Fisheries Biologist
DNR Marquette Fisheries Station
484 Cherry Creek Rd
Marquette, MI 49855
906-249-1611 ext. 308
FAX 906-249-3190

>>> Kent Premo <kent.premo@white-water-associates.com> 12/13/2007 11:37:29 AM >>>
Attached is a 57-page PDF (cf07_water_quality_report.pdf) of the draft 2007 water quality report for the City of Crystal Falls Hydroelectric Project (No. 11402-013) for your review and comment. Let me know if you wish to have a hard copy of the report and a CD-ROM including the report and raw data files and spreadsheets, the basis for graphs and tables presented here. Otherwise, I will plan to simply e-mail you the finished report upon its completion.

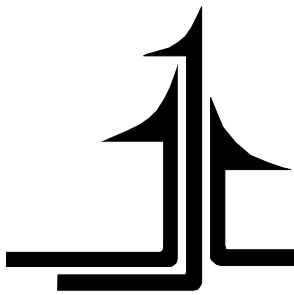
The report needs to be filed with FERC by February 15, 2008. Therefore, I'd like to have your comments by February 1 if possible.

Thanks very much for your consideration. Please reply to this message so I know you received it.

Best regards,

Kent Premo

Kent Premo
White Water Associates, Inc.
429 River Lane, P.O. Box 27
Amasa, Michigan 49903
Phone: (906) 822-7889
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E-mail: kent.premo@white-water-associates.com
<http://www.white-water-associates.com>



WHITE WATER ASSOCIATES, INC.

**City of Crystal Falls Hydroelectric Project
(Project No. 11402-013)
Water Quality Monitoring Study**

Report for 2007 Monitoring

Submitted to:

City of Crystal Falls, Electric Department
Attention: David Graff
401 Superior Ave.
Crystal Falls, MI

Submitted by:

White Water Associates, Inc.
429 River Lane, P.O. Box 27
Amasa, Michigan 49903

Contact Person: Kent Premo
Phone: (906) 822-7889
E-mail: whitewtr@up.net
Web: www.white-water-associates.com

Date: December 13, 2007

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APPENDIX B: Map

APPENDIX C: Upstream Water Quality Profiles

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APPENDIX E: Downstream Temperature Monitoring

APPENDIX F: Downstream Dissolved Oxygen Monitoring

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APPENDIX H: Agency Comments to Draft Annual Report for 2002 Monitoring

APPENDIX I: Agency Comments to Draft Annual Report for 2007 Monitoring

INTRODUCTION

This final report describes results for the Water Quality Monitoring Study conducted July to August 2007 for the City of Crystal Falls (licensee) at the City of Crystal Falls Hydroelectric Project (FERC Project No. 11402) located on the Paint River in Crystal Falls, Iron County, Michigan. This study was conducted to comply with FERC Order Amending the Water Quality Monitoring Plan Under Article 404, issued May 12, 2004 (Appendix A) based on consulting agency recommendations regarding the previous study concluded in 2002. This study is being conducted by an independent ecological consulting firm White Water Associates, Inc. (WWA), under contract with the licensee, with oversight by the Michigan Department of Natural Resources (MDNR) and United States Fish and Wildlife Service (USFWS).

The Water Quality Monitoring Plan submitted by the licensee was prepared by its contractor Mead and Hunt (appears at the end of Appendix A). The FERC order on the plan (also in Appendix A, after the amended order) modified the proposed two-year monitoring term to a three-year term. In addition, it set forth reporting schedules and provided the opportunity for agency comments to be made regarding annual reports. The order also specified special reporting instances should water quality measurements fail to meet standards set by Article 404.

As an outcome of the 2002 final interim report, the recommendation was made to reduce the long-term monitoring schedule to a frequency of once every five years, accepted in correspondence on the draft report by MDNR reviewer Jessica Mistak, Fisheries Biologist (Appendix H). The MDNR recommendation was to include the entire two month low flow period of July and August, however, rather than the one-month mid-July to mid-August period WWA proposed. This study's timing corresponds with these monitoring recommendations, conducting the study five years from the previous study for the months of July and August, with dissolved oxygen and temperature profiles during that period.

This report was distributed as a draft product for the purpose of agency comments, which are included in Appendix I.

This report is comprised of five principal sections, including this one (the Introduction). The next section will describe the general area of the hydroelectric project and the specific monitoring sites. The Methodology section describes four aspects of the study: (1) Upstream Water Quality Profiles, (2) Upstream Temperature Monitoring, (3) Downstream Dissolved

Oxygen and Temperature Monitoring, and (4) Data Management and Analysis. (Except where noted, the Description of the General Area and Methodology sections are identical to those of the 2002 annual report.) The Findings section presents our observations and data collected from the field, and provides an analysis of the data. The Discussion section reviews monitoring results and discusses agency comments.

DESCRIPTION OF THE GENERAL AREA AND MONITORING SITES

The study area is composed of two sites: an upstream site at the upper outer end of the floating platform (“catwalk”) from which the barrier net is suspended, and the downstream site below the dam on the west side (river right). Throughout this report, these sites are referred to simply as upstream and downstream. (See Figure 1, Appendix B.)

Servicing the upstream site was reliable and convenient thanks to the floating platform. This substantial structure is composed of wooden rafts connected into two large floating limbs oriented at approximate right angles to one another. The limb that is placed cross-current is 96 feet long. The limb that is oriented upstream-downstream was 72 feet long. The structure is held in place by steel cables that are stretched between anchor points on the dam, island, and western shore. Just outside the barrier net, at the outer corner of the two limbs, was the upstream site for deploying water quality monitoring equipment and taking profiles every ten days, the frequency being a recommendation begun with the 2002 monitoring effort.

The downstream site was chosen for its security, remoteness, consistent depth, and relation to the dam. It was approximately 100 feet downstream. The study plan prepared by Mead and Hunt and referenced in the FERC order indicated that positions be approximately 500 feet above and below the dam. Convenience and security dictated that these distances be reduced; however, the intent of the plan held—to measure water quality parameters at proper depth, well above and below the dam. In addition, the downstream site corresponded with the location of past deployment of similar equipment, lending to historical comparisons. Since the downstream monitoring site was upstream of the confluence with the spillway and associated oxygenation, the site likely may represent the “worst case” scenario for dissolved oxygen conditions.

The aptness of depths of the two sites for this study was supported by historical data. In 1992, White Water Associates conducted aquatic and terrestrial studies within the Crystal Falls project area as part of the relicensing requirements (Paint River Ecology and Water Quality Study, White Water Associates, 1992). Bathymetry measures at two-foot contours were conducted throughout the impoundment including the area of the barrier net. From that data, depth at the upstream deployment site was determined to be among the deepest locations of the impoundment (as specified by the plan describing the site selection for dissolved oxygen and temperature profiles) at around 14 feet or 4.5 meters. From similar experience, the depth of the downstream site was known to typically be from 3 to 4 feet (1 meter) during the study period.

METHODOLOGY

For the Water Quality Monitoring Study, we followed the study protocol outlined in the licensee's monitoring plan prepared by its contractor, Mead and Hunt, filed with the Commission in November 1996, as modified in the order approving the plan issued April 10, 1997 (Appendix A), with the exception of profiles and data collection every ten days rather than weekly, as noted above. This section details the methods we used for this 2007 study under four subheadings: (1) Upstream Water Quality Profiles, (2) Upstream Temperature Monitoring, (3) Downstream Dissolved Oxygen and Temperature Monitoring, and (4) Data Management and Analysis.

Upstream Water Quality Profiles

Upstream water quality was measured by means of a portable YSI dissolved oxygen and temperature probe connected by a cable marked at intervals. According to the plan and its approving order, measures were required at 1-meter intervals. Measures of temperature and dissolved oxygen were taken approximately every ten days at the upstream site, starting July 9 just after the monitoring cycle began and ending August 25 shortly before it concluded.

Upstream Temperature Monitoring

In addition to affording a location for water quality profiles, the upstream site was the point of deployment for a temperature probe, Ryan TempMentor II, programmed to record temperature hourly. The temperature probe was factory calibrated before the study. The probe and datalogger, joined in a buoyant plastic cannister, were suspended from a weighted chain about 6 feet (2 meters) below the surface. Every ten days, when the site was visited for profiles, the probe was checked to make sure it was functioning properly; data was downloaded via a laptop computer at both a midpoint and the season's end. The unit collected data from July 1 through August 31.

Downstream Dissolved Oxygen and Temperature Monitoring

Visits no more than ten days apart were scheduled to service the Hydrolab Datasonde 3 probe deployed below the dam. The datasonde was programmed to measure dissolved oxygen and temperature hourly, as well as several related water quality and operational parameters. Standard service included calibration checks and downloading of data. Low-flow membranes were used for the unit's dissolved oxygen probe. A single datasonde was used during the course the study. Any interruptions in readings due to servicing were noted for purposes of data management and analysis. The units collected data from July 1 through August 31.

The downstream site was a steep scramble down a heavily wooded hillside adjacent to the hydroelectric facility, minimizing the opportunity for theft or destruction. For further protection, the unit was encased in an slightly oversized PVC tube with holes on the probe end, chained to a tree on the riverbank. Weights held either end of the tube down to prevent shifting.

Data Management and Analysis

The upstream temperature probe requires special software to communicate and download data. The result is two files associated with each download: a data file (basically a long string of temperature measurements with no indication of time or date) and a header file (data manually entered in the tempmentor during setup and deployment, including the start time/date and interval). These two files together allowed preparation of Excel spreadsheets giving all

hourly measurements of temperature, together with daily maximums, minimums, and averages. These results were graphed to show a line of points for daily average, with a vertical bar through each point giving the maximum and minimum readings for that day. The tables and graphs were formatted to display one month of data at a time.

The downstream dissolved oxygen and temperature probe was slightly more sophisticated in its data handling than the upstream probe. The unit's internal data files allowed storing date and time with each reading. Nonetheless, the data had to be arrayed in an Excel spreadsheet table for proper presentation, including calculation of daily averages, maximums, and minimums, and graphing. The graphs were the same format as those prepared for the upstream site. Any data loss due to servicing was noted on the spreadsheet. The results were formatted to display one month of data at a time.

A comparison of temperatures collected hourly at upstream and downstream sites was produced. First, a spreadsheet was created to show a long list of data points for the two sites. Second, the difference between downstream site and upstream site was calculated. Third, the resulting table was used to produce graphs, broken down by month, showing all the raw data. As an additional step, the differences were arrayed similarly to those tables and graphs previously described to present daily averages, maximums, and minimums of these differences.

A graph showing both temperature and dissolved oxygen during the full monitoring season was prepared. Another graph showing upstream and downstream temperatures during the season was also prepared.

As indicated in the study plan, computer data are being provided to the agencies, MDNR and USFWS, as part of the submission for review. For convenience of the reviewer, we compiled all the raw data into a single final "processed raw" data file for each location, appended date/time where necessary (upstream data), and included any annotations useful to the reviewer regarding service interruptions and calibration. Besides these processed raw data files, the tabular and graphic presentations were also provided. The files provided at the review stage were all in Excel 2002 format. An accompanying README.XLS file describes all the individual files making up that submission.

FINDINGS

In this section, we describe our findings within the four categories just described under Data Management and Analysis in the Methodology.

Upstream Water Quality Profiles

Measurements of dissolved oxygen and temperature at 1-meter intervals were taken about every ten days starting July 9 and ending August 25, 2007. The results of those measures and subsequent calculation of percent oxygen saturation are presented in Appendix C. At no time was there any dissolved oxygen readings below 5.0 mg/L (the exceedence limit) even near the bottom of the 4-meter range in depths, and readings were usually substantially higher. Temperature readings ranged with the depth, from surface depth highs of 26.6VC to mid to bottom depth lows of 19.7VC during July and August; these readings were compared to data from the remote temperature probe taken during the same time period.

Upstream Temperature Monitoring

Readings of the Ryan TempMentor, the unit responsible for upstream temperature measurements, were collected at a fixed depth of about 6 feet (2 meters) rather than taken as a profile across the water column as described in the previous section. Continuous hourly measures allowed presenting and graphing all data points from its deployment July 1 through the end of the study August 31. Temperature readings ranged from a high of 27.8VC in early August to a low of 17.5VC in late August, and averaged 22.6VC for the entire span. The results are shown in tables and graphs for these two months (Appendix D). Weekly averages, maximums, and minimums are presented in the following table:

Crystal Falls Water Quality Monitoring Study, Annual Report for 2007 Monitoring

Upstream	Temperature (°C)		
Year: 2007	Average	Maximum	Minimum
July 1-7	22.4	25.7	20.4
July 8-14	23.0	27.8	19.0
July 15-21	21.3	24.2	18.5
July 22-28	24.4	27.1	21.1
July 29-August 4	26.0	27.8	24.2
August 5-11	23.9	26.0	22.3
August 12-18	22.5	25.0	19.5
August 19-25	19.2	21.2	17.5
August 26-31	20.7	22.3	19.5

Downstream Dissolved Oxygen and Temperature Monitoring

The Hydrolab Datasonde 3 responsible for downstream measurements recorded dissolved oxygen in addition to temperature. This record on a continuous hourly basis allowed presentation of the data, in tabular and graphic forms, from the unit's deployment July 1 through August 31. The results are shown for these two months in Appendix E (temperature) and Appendix F (dissolved oxygen).

The unit initially deployed operated in a consistent and calibrated manner throughout the deployment. Independent checks using a handheld YSI dissolved oxygen meter at the regular service visits yielded measurements within ± 0.66 mg/L of the unit's calibration; similar checks with a handheld Hach LDO dissolved oxygen meter were actually slightly higher than the datasonde reading (by between 0.12 and 0.6 mg/L). The standard specified by Article 404 is dissolved oxygen measurements of 5.0 mg/L or above, and the raw data indicated no excursions occurred from the standard; the unit required no replacement during two months' deployment.

In some past studies, DO data collected were at times corrected with a fixed correction or graduated post-correction factor based on independent field measures. Based on operational

Crystal Falls Water Quality Monitoring Study, Annual Report for 2007 Monitoring

parameters throughout this season's monitoring, no corrections were applied. Data files submitted to the agencies and the graphs and tables included in Appendix F are all based on raw, uncorrected data. The weekly averages, maximums, and minimums for temperature and dissolved oxygen are as follows:

Downstream	Temperature (°C)		
Year: 2007	Average	Maximum	Minimum
July 1-7	22.37	24.72	20.52
July 8-14	23.07	26.95	19.29
July 15-21	21.24	23.54	18.79
July 22-28	24.19	27.05	21.24
July 29-August 4	25.91	27.43	24.34
August 5-11	23.88	25.69	22.51
August 12-18	22.53	25.07	19.64
August 19-25	22.42	20.99	19.53
August 26-31	20.73	22.18	19.67

Downstream	Dissolved Oxygen (mg/L)		
Year: 2007	Average	Maximum	Minimum
July 1-7	7.64	8.14	7.18
July 8-14	7.56	8.80	6.52
July 15-21	8.41	9.17	7.38
July 22-28	7.63	8.82	6.29
July 29-August 4	7.09	7.66	6.27
August 5-11	7.17	8.11	6.40
August 12-18	7.45	8.16	6.70
August 19-25	7.85	8.33	7.22
August 26-31	7.56	8.06	6.73

Comparison Between Hourly Temperatures at Sites

Continuous hourly temperature readings upstream and downstream of the dam allowed comparisons hour by hour between upstream and downstream sites. The data are presented in tabular and graphic forms in Appendix G for the four months involved. In addition to the daily averages, maximums, and minimums reported in those tables, the following is a table showing these differences compiled over a weekly basis:

Delta Temperature VC (Downstream Minus Upstream)			
Year: 2007	Average	Maximum	Minimum
July 1-7	0.0	0.4	-1.1
July 8-14	0.0	0.4	-1.0
July 15-21	-0.1	0.4	-1.3
July 22-28	-0.2	0.2	-1.0
July 29-August 4	-0.1	0.5	-0.9
August 5-11	-0.1	0.3	-0.8
August 12-18	0.1	0.4	-0.8
August 19-25	0.0	0.4	-1.3
August 26-31	0.0	0.3	-0.7

Delta temperature in this case means “downstream minus upstream” so a positive number indicates that the temperature downstream was higher than the temperature upstream. Looking at the averages in the previous table, it seems that the unit downstream, in all but one case, had weekly averages equal to or lower than the upstream unit, but differences of this magnitude could be due to variations in tunings of the factory-calibrated units. Swings in the positive direction never exceeded 0.5VC. Swings in the negative direction (i.e., temperature upstream higher than temperature downstream) were as great as -1.3VC. At no time, did the “downstream minus upstream” temperature difference exceed the delta standard of 5VC.

DISCUSSION AND RECOMMENDATIONS

Water quality measurements for the entire 2007 monitoring season were within normal ranges expected of this study setting and time period. Dissolved oxygen and temperature profiles were typical, with both decreasing slightly with depth. Differences in temperature readings upstream and downstream of the dam were low, less than 1.3 degrees C, at all times. Dissolved oxygen readings below the dam never fell below the standard of 5.0 mg/L. This year's results mirrors those of previous years, the most recent being 2002.

The visits every ten days to service the downstream monitoring probe meant that any maintenance, calibration, or exceedence problems were dealt with reasonably soon. The plan originally submitted to and approved by FERC calls for calibration visits every two weeks and data download visits every week.

The adopted pattern of five year intervals between two-month monitoring periods worked well this year. We anticipate the same pattern will serve the resource well in years ahead, the next study period being 2012.

Reviewing a draft copy of the report sent by e-mail December 13, 2007, Jessica Mistak, Senior Fisheries Biologist, Michigan DNR (Marquette, MI) had no additional comments, since there were no deviations for either dissolved oxygen or temperature during the July and August study period. Also P. Tyler Yasenak, U.S. Fish and Wildlife Service (Green Bay, WI) had no comments regarding the draft report.

APPENDIX A

Study Plan, Order, and Article 404

UNITED STATES OF AMERICA 107 FERC ¶ 62,135
FEDERAL ENERGY REGULATORY COMMISSION

City of Crystal Falls

Project No. 11402-057

ORDER AMENDING WATER QUALITY MONITORING PLAN
UNDER ARTICLE 404

(Issued May 12, 2004)

On December 29, 2003, the City of Crystal Falls (licensee) filed a request to amend article 404 to reduce the water quality monitoring schedule and the data collection interval. The monitoring schedule was set forth in paragraph (B) of the Order Approving Water Quality Monitoring Plan, issued April 10, 1997, for the Crystal Falls Project. The project is located on the Paint River in Iron County, Michigan.

BACKGROUND AND PROPOSED AMENDMENT

Paragraph (B) requires the licensee to annually monitor dissolved oxygen concentrations and water temperature at the project for the remainder of the license term. Annual reports are required to be filed, with the Commission, for the first 3 years of monitoring. The reports shall include agency comments, the licensee's response to agency comments, and any recommendations, for Commission approval, on modifying the water quality monitoring plan.

The licensee is requesting that the plan be modified to reduce the water quality monitoring schedule from annually to once every five years. In addition, the licensee requests to change the data collection interval from the existing June 1 to September 30 interval to July 1 to August 31. According to the licensee, this proposed schedule is a direct result of negotiations with the Michigan Department of Natural Resources (MDNR), and was also referred to in the February 10, 2003 Water Quality Monitoring Study previously filed with the Commission. According to that study, water quality measurements for the entire 2002 monitoring season were within normal ranges. Results were also within normal ranges in 2000 and 2001. The recommendation in the draft report for the 2002 monitoring, that was distributed to the MDNR and the U.S. Fish and Wildlife (FWS), was that monitoring be done once every five years for one a one-month period from mid-July to mid-August. The licensee has not proposed any changes to the study methodology.

By letter dated January 3, 2003, the MDNR concurred with the five year monitoring schedule, but requested that the study period be for two months rather than one. The licensee changed the proposed revised monitoring interval to be for two months. No comments were received from the FWS.

DISCUSSION AND CONCLUSION

We agree, based on the results of the first three years of monitoring, that it is appropriate to change the frequency of water quality monitoring at the project from annually to once every five years. The two month period proposed for data collection covers the low-flow period and should ensure that any temperature or dissolved oxygen deviations are recorded. The last study was completed in 2002, so the next study will be for 2007, and due to the Commission by February 2008. The Water Quality Monitoring Plan should be amended.

The Director orders:

(A) The Water Quality Monitoring Plan, approved April 10, 1997, is amended so that the licensee shall monitor dissolved oxygen concentrations and water temperature at the project every 5 years, beginning in 2007, from July 1 through August 31. The licensee shall file the monitoring results with the Commission, by February 15 of the year following monitoring. The results shall include agency comments, the licensee's response to agency comments, and any recommendations for modifying the water quality monitoring plan. Any modifications to the water quality monitoring plan shall be filed for Commission approval.

(B) This order constitutes final agency action. Requests for rehearing by the Commission may be filed within 30 days from the date of issuance of this order, pursuant to 18 C.F.R. ' 385.713.

George H. Taylor
Branch Chief, Biological Resources Branch
Division of Hydropower Administration
and Compliance

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

City of Crystal Falls) Project No. 11402-013

ORDER APPROVING WATER QUALITY MONITORING PLAN

(Issued April 10, 1997)

City of Crystal Falls (licensee) filed for Commission approval, on November 19, 1996, and supplemented on November 20, 1996, a water quality monitoring plan. This plan is required by article 404 of the license for the Crystal Falls Project, issued on October 18, 1995. 1/ The project is located on the Paint River in Iron County, Michigan.

Article 404 requires the licensee to consult with Michigan Department of Natural Resources (MDNR) and the U.S. Fish and Wildlife Service (FWS) and develop a plan to monitor dissolved oxygen concentrations (DO) and water temperature levels at the project. 2/

LICENSEE'S PROPOSED PLAN

The licensee plans to monitor DO for two years in conjunction with implementation of the licensee's barrier net study. 1/ Specifically, the licensee proposes to continuously monitor water temperature and DO at mid-depth approximately 500 feet downstream of the dam and approximately 500 feet upstream of the impoundment (water temperature only) from June through September. One-meter increment profiles of water temperature and DO will be taken once a week from June through September and twice during the month of February for water temperature and DO.

The licensee plans to use Hydrolab DataSonde III probes for the water quality monitoring. Water temperature and DO will be

- 1/ 73 FERC ¶ 62,036. See also Order on Rehearing, issued on May 17, 1996 (75 FERC ¶ 61,174).
- 2/ State standards require a DO of at least 5 milligrams/liter (mg/l) and the waters downstream shall not receive a heat load that would warm the receiving water at the edge of the mixing zone by more than 5° F above natural water temperatures. Further, the Paint River shall not receive a heat load that would warm the receiving water at the edge of the mixing zone to temperatures greater than monthly maximums.
- 3/ This plan was approved in the Order Modifying and Approving Plan for the Installation and Monitoring of a Barrier Net, issued on May 10, 1996 (75 FERC ¶ 62,102).

Project No. 11402-013

-2-

recorded hourly during the monitoring period. The licensee plans to calibrate the continuous monitoring probes every two weeks during the monitoring period and the profile probes prior to each sample, according to manufacturer's instructions.

The licensee plans to download DO and water temperature data weekly. At this time, the data will be reviewed to determine if a deviation from state standards has occurred. If a deviation in DO or water temperature occurs, the licensee plans to inform the agencies immediately and determine what, if any, mitigative measures are necessary. If additional measures are implemented, the licensee plans to download data daily to more closely monitor changes in water quality in response to the measures implemented. In the event of DO falling below state standards, the licensee plans to increase spillage. If water temperature standards are exceeded, the licensee plans to immediately contact the agencies to determine what, if any, measures can be taken.

The licensee plans to submit a report to the agencies and to the Commission each year of the two-year monitoring period. This report would include DO and water temperature daily averages, minimum and maximums, and DO and water temperature profile data. The report would also provide comparisons between upstream and downstream water temperature. If at no time within the two-year monitoring period the water quality standards have been exceeded, the licensee will consider the project to have no adverse effect on water quality and will discontinue the monitoring.

AGENCY COMMENTS

The MDNR commented on the proposed plan in a letter dated April 1, 1996. The FWS did not provide comments on the proposed plan.

The MDNR recommends the monitoring period extend from May-October for at least three years. After three years, the licensee may request to change the frequency of monitoring. The MDNR also recommends that water temperature be monitored continuously given that violations could occur in any season. Monitoring locations should be selected in consultation with MDNR.

The MDNR requests that all monitoring equipment be validated with an independent measurement system such as a National Bureau of Standards thermometer for temperature and a Winkler analysis for DO at the end of each unattended monitoring period. Further, 70 percent of the DO data should be verified as accurate to within 1 milligram/liter (mg/l) of the true DO value. Weekly service visits should be scheduled for quality assurance. Further, the MDNR suggests a real-time evaluation of the data to provide for immediate detection of a deviation from state standards.

Regarding reports, the MDNR requests that DO values be compared hourly to the state DO standard and delta temperature values be compared instantaneously. Plausible explanations for any deviations should be provided in the reports, along with a description of the effectiveness of any measures implemented to improve water quality. The MDNR also requests quarterly transmittals of raw data along with information pertaining to the calibration of equipment during that quarter.

Other comments by MDNR were incorporated into the licensee's proposed plan.

DISCUSSION

The licensee's proposed water quality monitoring plan includes those requirements stipulated in article 404 of the license. Implementation of the proposed plan should enable the licensee to monitor the effects of project operation on water temperatures and DO. Calibration of the monitoring equipment according to manufacturer's recommendations, as proposed by the licensee, should be adequate to ensure accurate data are collected. To the extent practicable, the licensee should choose monitoring locations in coordination with the MDNR and FWS.

Article 404 of the license states the purpose of the plan is to ensure that water quality below the project, as measured immediately downstream of the project tailrace, maintain the Michigan standards for DO and water temperature. Further, article 404 requires the licensee develop operating procedures to address when deviations from state standards occur.

Monitoring from June-September, as proposed by the licensee, encompasses the period when warmer temperatures are expected, thus affecting low DO. Therefore, deviations from state standards should be detected upon implementation of the licensee's proposed plan. However, monitoring for only two years, as proposed by the licensee, will not meet the purpose of the plan. Article 404 requires monitoring to ensure state water quality standards are met. The licensee cannot meet this goal if monitoring is discontinued.

Commission staff acknowledges that water quality data collected prior to licensing indicate project operations do not result in violations of the state water quality standards. 4/ If after implementation of monitoring, the data still indicates that project operations do not adversely affect water quality in the project area, the licensee may file a request to modify the water

4/ See the Environmental Assessment for Application for License for the Crystal Falls Project, issued on October 18, 1995 (73 FERC ¶ 62,036).

quality monitoring plan, as recommended by the MDNR. Any recommendations to amend the water quality monitoring plan should be filed for Commission approval, as discussed below.

Providing annual reports to the agencies and immediately contacting the FWS and MDNR upon detection of any deviation from the state standards, as proposed, should provide the agencies with the results of the monitoring in a timely manner. These reports should include, to the extent possible, explanations for any deviations and the effectiveness of any measures implemented to improve water quality, as recommended by MDNR. Quarterly reports of water quality data, as requested by MDNR, are not necessary. The licensee did not provide a schedule for submitting these reports to the agencies or to the Commission. The licensee should provide annual report(s) to these agencies by December 15 of each year of monitoring.

It is only necessary to provide the annual report to the Commission for the first three years of monitoring. Our review of the annual report for a three year period will allow us to evaluate water quality during project operations. The annual report to the Commission should be filed by February 15 of the year following monitoring. The filing should include agency comments, the licensee's response to agency comments, and any recommendations, for Commission approval, for modifying or discontinuing water quality monitoring. Each agency should be given 30 days to comment. If there are no changes to the water quality monitoring plan, the licensee should continue to provide the annual reports to the consulted agencies as identified in the licensee's proposed plan. So that the Commission can monitor compliance with article 404, the licensee should notify the Commission of any deviation from the state standards for DO and water temperature.

The MDNR recommends the licensee analyze data in real time to immediately determine if a problem in water quality exists. The licensee proposes to retrieve data biweekly. Given that the available data indicates no existing water quality problems, as discussed above, the licensee's schedule appears adequate. Further, when the licensee does detect a problem, the licensee plans to retrieve data daily, after contacting the agencies to determine what measures should be implemented in efforts to improve water quality. Therefore, the licensee can timely note any improvements in water quality resulting from any measures implemented.

The licensee proposes to consult with the FWS and MDNR to determine what measures are appropriate in efforts to improve water quality. The licensee specifies that the most likely measure to improve DO is to increase spill. This should be adequate. However, if additional measures are necessary, or if the parties disagree on which measures are appropriate, the

Commission should determine which, if any, additional measures are necessary to improve water quality.

The licensee's water quality monitoring plan, with the modifications discussed, should be adequate to monitor the requirements of article 404 and should be approved.

The Director orders:

(A) The licensee's water quality monitoring plan, filed with the Commission on November 19, 1996, and supplemented on November 20, 1996, as modified in paragraph (B), is approved.

(B) The licensee shall monitor dissolved oxygen concentrations and water temperature at the project for the remainder of the license term. The licensee shall file annual reports with the Commission for the first three years of monitoring. These reports shall be filed by February 15 of the year following monitoring and shall include agency comments, the licensee's response to agency comments, and any recommendations, for Commission approval, on modifying the water quality monitoring plan.


(C) If DO or water temperature, as measured by the approved monitoring system, falls below that required by article 404, the licensee shall file a report with the Commission within 30 days of the date the data becomes available indicating an incident has occurred. The report should, to the extent possible, identify the cause, severity, and duration of the incident, and any observed or reported adverse environmental impacts resulting from the incident. The report should also include: (1) operational data necessary to determine compliance with article 404; (2) a description of any corrective measures implemented at the time of occurrence and the measures implemented or proposed to ensure that similar incidents do not recur; and (3) comments or correspondence, if any, received from the resource agencies regarding the incident. Based on the report and the Commission's evaluation of the incident, the Commission shall reserve the right to require modifications to project facilities and operations to ensure future compliance.

(D) Unless otherwise directed in this order, the licensee shall file an original and seven copies of any filing required by this order with:

The Secretary
Federal Energy Regulatory Commission
Mail Code: DLC, HL-11.2
888 First Street, NE
Washington, DC 20426

In addition, the licensee shall serve copies of these filings on any entity specified in this order to be consulted on matters related to these filings. Proof of service on these entities shall accompany the filings with the Commission.

(E) This order constitutes final agency action. Requests for rehearing by the Commission may be filed within 30 days of the date of issuance of this order, pursuant to CFR § 385.713.


Kevin P. Madden
Acting Director
Office of Hydropower Licensing

A Plan for Monitoring Dissolved Oxygen and Temperature Levels in the Paint River in the vicinity of the Crystal Falls Hydroelectric Facility

Introduction

On October 18, 1995, the Federal Energy Regulatory Commission issued a license for the City of Crystal Falls to continue to operate and maintain the 1,000-kilowatt Crystal Falls Hydroelectric Project, No. 11402, located on the Paint River in Iron County, Michigan. This license is subject to various articles. Among those articles, Article 404 specifies that "Within 6 months of the license issuance, the Licensee shall file with the Commission, for approval, a plan to monitor dissolved oxygen (DO) and temperature levels in the Paint River downstream of the project. This report is intended to provide the plans for implementation of the DO and temperature monitoring program in accordance with Article 404.

Article 404 of the Commissions's license, requires that the water quality data (DO and temperature) would be compared to Michigan State water quality standards. According to these standards (R323.1041), the Crystal Falls hydroelectric project should not influence DO or temperature beyond specified limits as follows: a DO of at least 5 mg/l should be maintained; and a heat load shall not be received that would warm the waters at the edge of the mixing zone by more than 5°C above natural water temperatures, or greater than monthly maximums.

A draft plan for monitoring DO and temperature was prepared and forwarded to the appropriate resource agencies for review in February, 1996. The Michigan Departments of Natural Resources and Environmental Quality prepared a joint reply and the Fish and Wildlife Service concurred with their comments – these entities are hereinafter referred to as the "Agencies." A copy of the draft plan, and the Agencies' comments are attached. The draft plan intended to monitor dissolved oxygen and temperature in the Crystal Falls impoundment and at a downstream location only during the times when the activities related to the proposed Barrier Net Effectiveness Study would be in operation. This allowed the city to combine efforts and maintain study costs for water quality monitoring to within the FERC's proposed \$15,000 cost estimate (FERC Environmental Assessment, page 65). This original plan has been substantially revised as follows to reflect the Agencies' comments and due to the fact that the original Barrier Net Effectiveness Study plan has also been substantially revised.

Study Plan

We propose to continuously monitor both temperature and DO in a mid-depth placement approximately 500 feet below the dam in the Paint River during the months of June through September. Additionally, temperature will be continuously monitored at a mid-depth placement in the Paint River approximately 500 feet upstream of the Crystal Falls impoundment area. A one-meter-increment profile of temperature and DO will be obtained from the deepest part of the impoundment once a week during the months of June through September, and twice during the month of February.

The water quality monitoring plan is proposed to take place in conjunction with the Barrier Net Effectiveness Plan. That is, the site visits used to perform weekly fisheries studies for the effectiveness of the barrier net would be also used to download and recalibrate the continuous monitoring probes, and to conduct weekly profiles of the impoundment. Thus, it is proposed to conduct the water quality monitoring plan during the same two years that are proposed for the Barrier Net Effectiveness Study.

Monitoring Equipment

We propose to use Hydrolab DataSonde III probes for temperature and DO monitoring. The probes would be calibrated according to the manufacturers recommended procedure every two weeks throughout the continuous monitoring period. The continuous monitoring probes would be recalibrated bi-weekly throughout the deployment period and the profiling probe would be calibrated prior to each sample.

Schedule

Continuous monitoring would record temperature and DO hourly during the deployment period. The profile of the impoundment would produce instantaneous data. It is proposed to conduct water quality monitoring for a period of two years. If at no time within this two year period the water quality standards have been exceeded the Crystal Falls Hydroelectric Project should be considered as not having the potential to violate state water quality standards and water quality monitoring would be discontinued. If, however, at any time during the monitoring period, water quality standards are substantially exceeded, the applicant shall inform the Agencies of the deviation from the established limits and, in consultation with the Agencies, the applicant may modify the water sampling procedures to more closely verify the extent and source of the water quality problem and success of any mitigation procedure.

Reporting and Compliance

It is intended to download temperature and DO data from the continuous monitoring

probes weekly throughout the deployment period. At each download, it will be determined if there has been a violation of the water quality standards during the preceding week, and if this violation is still occurring; if so, the Agencies would be immediately notified by telephone and procedures to mitigate the violation would be attempted. If there is a violation of the 5 mg/L dissolved oxygen level at the downstream location, it is proposed that the most likely procedure would be to implement spillage from the impoundment surface waters to aerate the water below the dam. If this plan is invoked, the downstream dissolved oxygen levels would be downloaded daily to monitor the success of this effort. The amount of spillage would be modified according to the success of this effort in increasing the DO as determined by the daily monitoring. The Agencies would be kept apprised of this effort. We have no plan, nor has the Agencies offered a solution, to mitigate any violation of the Delta Temperature Standard. It is proposed to report any violation of the Delta Temperature Standard to the Agencies immediately upon its discovery and at that time determine what, if any, solution might exist to the problem.

In addition to the above reporting procedures, we would prepare an annual report to the FERC and the Agencies. This report would include a computer diskette with all raw data from the continuous and weekly monitoring efforts. In addition to the raw data, a summary of the data by daily average, minimum, and maximum DO, and temperature at the continuous monitoring sites and weekly profiles from the impoundment would be provided. This report would also include an upstream/downstream comparison of the Temperature Delta Standard.

Agency Comments

The agency recommendations have been accommodated into our revised plan as follows:

- a) **Monitoring locations and equipment.** We have added a site upstream for temperature measurements. We intend to calibrate our probes according to the manufacturers recommended procedure. We do not understand their request for a 70% data quality goal – all continuous monitoring probes would be recalibrated bi-weekly regardless of their accuracy to a calibration standard. We have agreed to monitor at one-meter intervals within the deepest part of the impoundment once a week from June through September.
- b) **Monitoring Schedule.** We propose to monitor temperature and DO only during the months of June through September. It is unlikely that DO would be less than 5 mg/L during May or October and continuous monitoring during winter months is not feasible due to extreme weather conditions which would make access and equipment malfunctioning a problem. We will agree to provide a temperature and DO profile of the impoundment twice during the month of February to determine if there exists a potential for ice cover to deplete DO within the impoundment during the period of this event's greatest likelihood.

c) Data Reporting. We propose to provide an annual report to the FERC and the Agencies. This report would include a computer diskette of all raw data and a graphical and tabular presentation of daily minimum, maximum, and average temperature and DO values as measured during the previous year. This report will also note any violations of the Delta Temperature Standard or DO violations and rationale for any lapses in the data. We do not propose to measure any other water quality parameters as suggested such as stream flow, chlorophyll level, or instream chemistry. We do not understand what is meant by the recommendation for "instantaneous" comparisons of temperature values.

d) Detection and Notification. Data would be downloaded weekly from the continuous monitoring probes (at the time of the weekly temperature/oxygen profile of the impoundment). The comment of the Agencies seems to suggest that an hourly downloading and reporting is preferred but we do not understand how this is possible. Other than the annual report described above, no other reports would be made to the agency unless there is a recorded violation of the water quality standards. If such a violation in either the Delta Temperature Standard or the 5 mg/L DO limit is found, then the Agencies would be immediately notified by telephone and a remediation or mitigation procedure would be invoked. We would, as suggested, notify both the Chief of Surface Water Quality Division of the Michigan Department of Environmental Quality, and the FERC Program Manager for the Michigan Department of Natural Resources within one working day of any detected water quality standard violations.

e) Mitigative measures. If water quality standards are violated we intend to notify and work with the Agencies to mitigate those violations. The exact nature of the mitigation measure would depend upon the significance of the violation and the environmental conditions contributing to or otherwise affecting the ability of the applicant to remediate or mitigate the violation.

f) Initial monitoring period. We disagree with the requirement for long term monitoring. An initial period of two years should be adequate to assess whether there exists the potential for significant effects of the hydropower facility on the Paint River water quality. Furthermore, the FERC Environmental Assessment concluded that the water quality monitoring plan should cost about \$15,000. It is our estimate that the plan we have proposed will somewhat exceed that estimate. To extend the monitoring plan beyond two years would substantially and unreasonably exceed that estimate. Extended monitoring is regarded as necessary only if the initial two-year monitoring indicates that there is potential for significant water quality degradation from the hydropower operations that warrant further monitoring to develop and/or monitor long-term mitigation measures.

Article 404. Within 6 months of license issuance, the Licensee shall file with the Commission, for approval, a plan to monitor dissolved oxygen (DO) and temperature levels in the Paint River downstream of the project.

The purpose of this monitoring plan is to ensure that streamflows below the project, as measured immediately downstream of the project tailrace, maintain the Michigan standards for DO concentration and temperature.

The monitoring plan shall include provisions for (1) monitoring of DO concentrations and temperature levels in the impoundment and downstream, with sensor locations and sampling frequently determined in consultation with the Michigan Department of Natural Resources (MDNR) and the U.S. Fish and Wildlife Service (FWS); and (2) the preparation of operating procedures developed in consultation with MDNR and FWS to address water quality conditions which deviate from the above limits.

The Licensee shall prepare the plan after consultation with MDNR and FWS. The water quality monitoring plan shall include a schedule for:

- (a) implementation of the program within 24 months from the date of issuance of this license;
- (b) consultation with MDNR and FWS concerning the results of the monitoring; and
- (c) filing the requests, agency comments, and Licensee's response to agency comments with the Commission.

The Licensee shall include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies, and specific descriptions of how the agencies' comments are accommodated by the plan. The Licensee shall allow a minimum of 30 days for the agencies to comment and make recommendations before filing the plan with the Commission. If the Licensee does not adopt a recommendation, the filing shall include the Licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. Upon Commission approval, the Licensee shall implement the DO concentration and temperature monitoring plan, including any changes required by the Commission.

APPENDIX B

Map

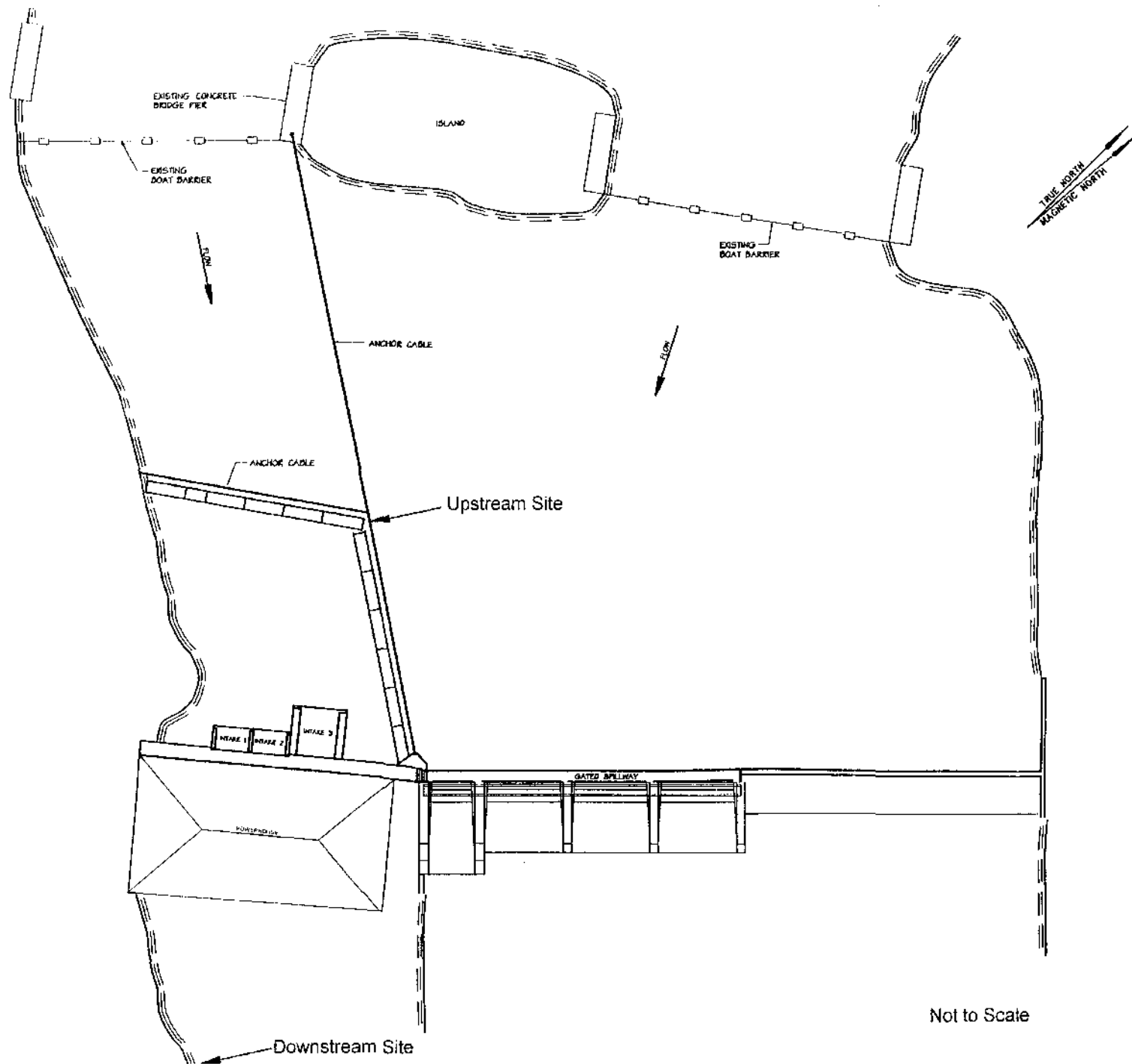


FIGURE: Map of Water Quality Monitoring Sample Points

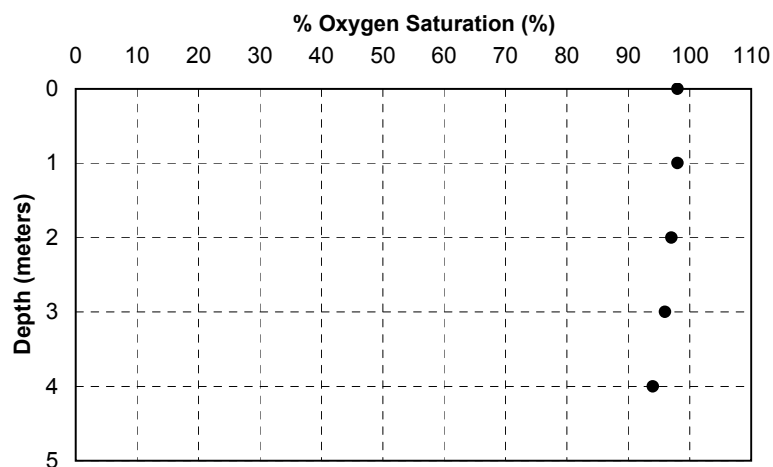
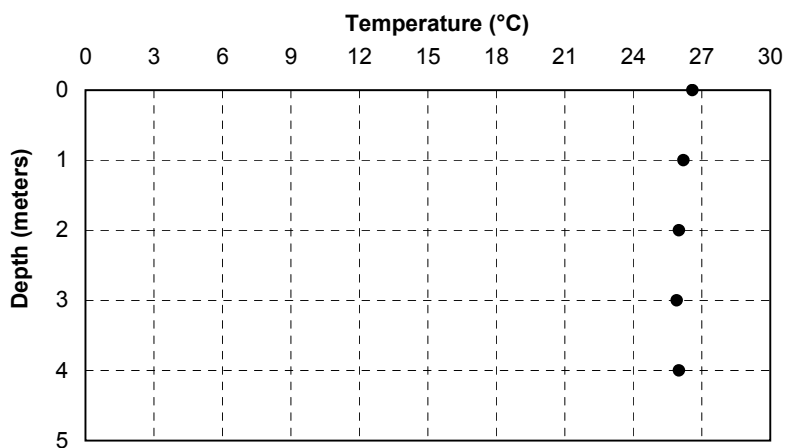
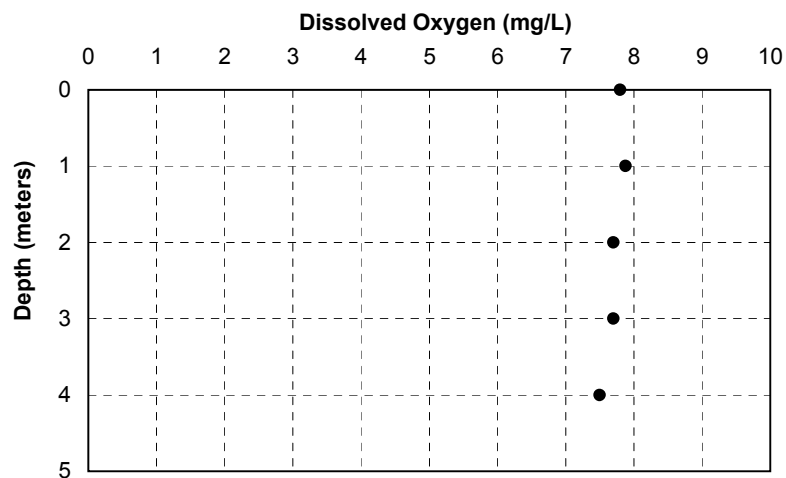
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Mead & Hunt,
Consulting Engineers,
Madison, Wisconsin

APPENDIX C

Upstream Water Quality Profiles

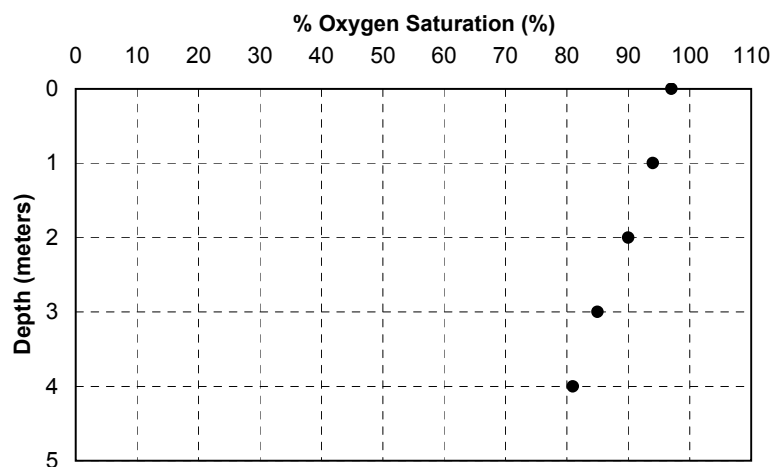
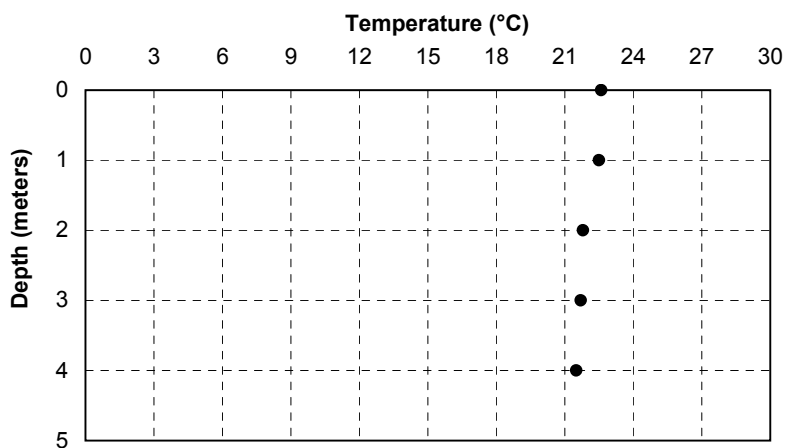
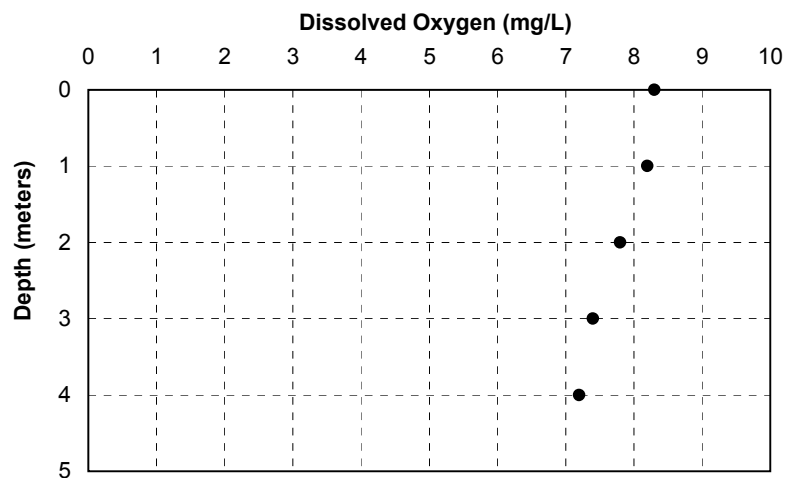
Crystal Falls Hydroelectric Project

Limnological Profiles	Depth (meters)	Dissolved Oxygen (mg/L)	Temperature (°C)	% Oxygen Saturation (%)
July 9, 2007 3:30 pm	0.0	7.8	26.6	98
	1.0	7.9	26.2	98
	2.0	7.7	26.0	97
	3.0	7.7	25.9	96
	4.0	7.5	26.0	94



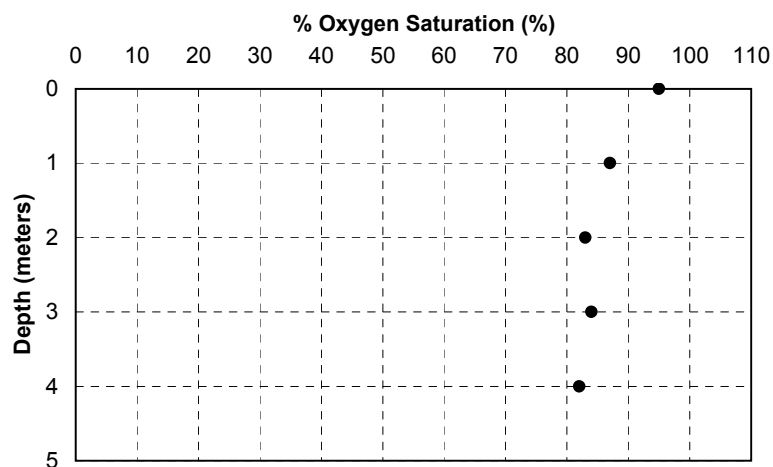
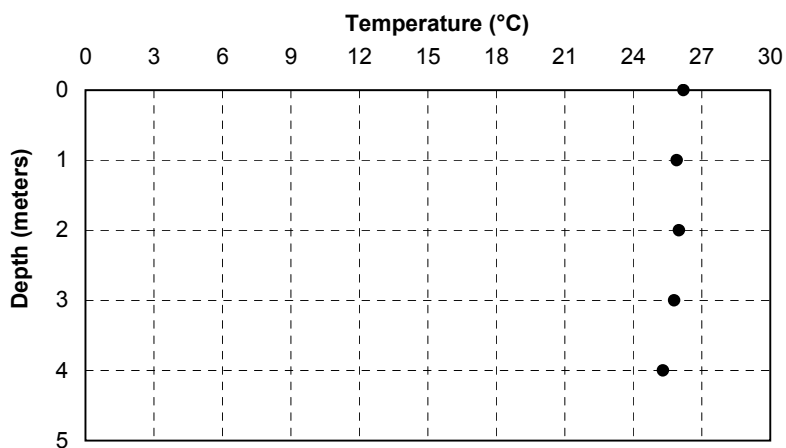
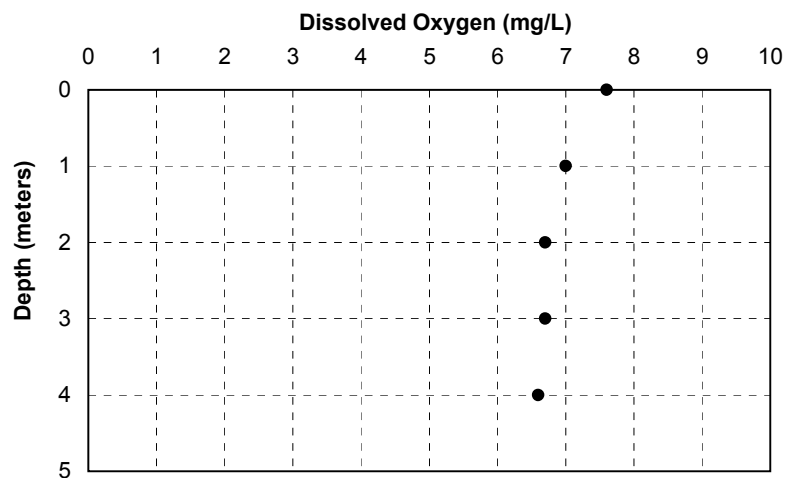
Crystal Falls Hydroelectric Project

Limnological Profiles	Depth (meters)	Dissolved		% Oxygen	
		Oxygen (mg/L)	Temperature (°C)	Saturation (%)	
July 17, 2007 4:00 pm	0.0	8.3	22.6	97	
	1.0	8.2	22.5	94	
	2.0	7.8	21.8	90	
	3.0	7.4	21.7	85	
	4.0	7.2	21.5	81	



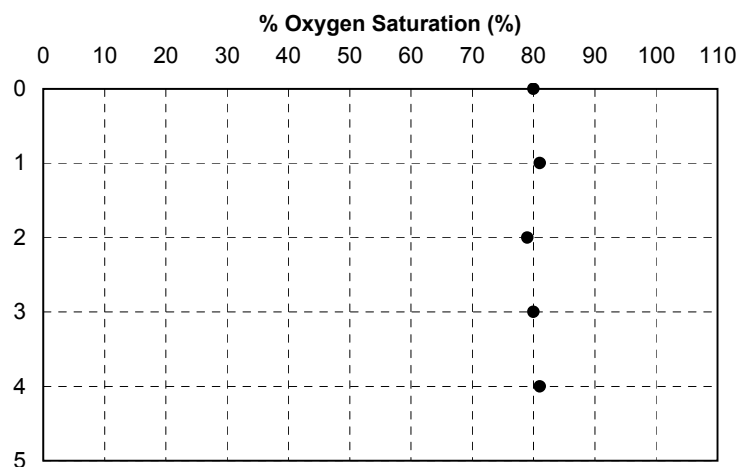
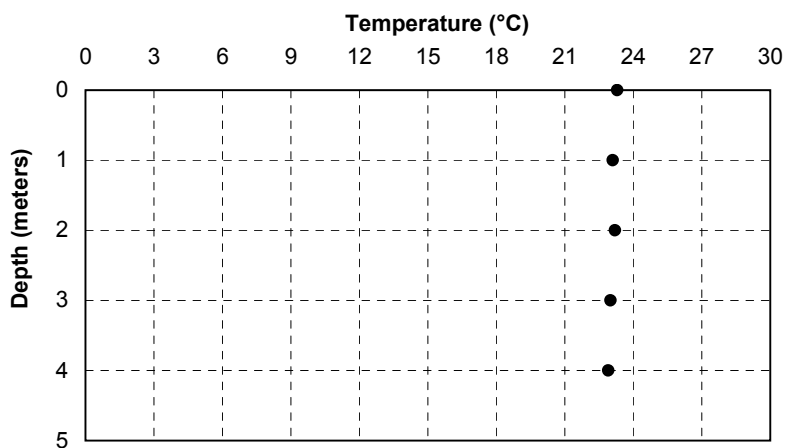
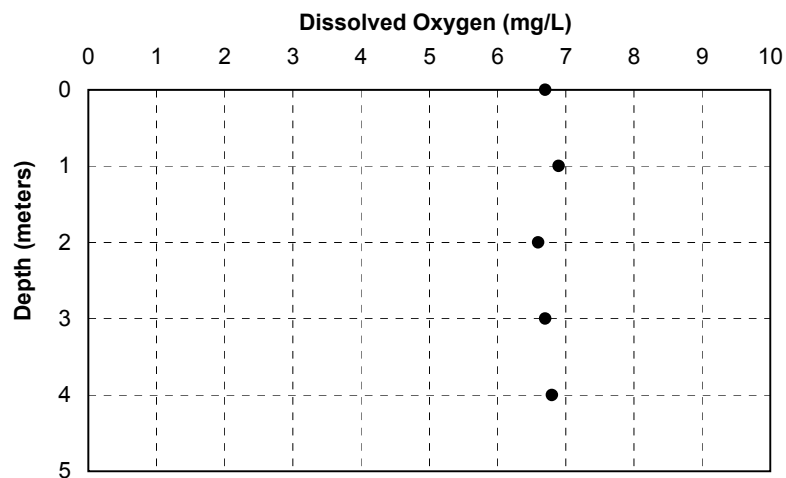
Crystal Falls Hydroelectric Project

Limnological Profiles	Depth (meters)	Dissolved		% Oxygen	
		Oxygen (mg/L)	Temperature (°C)	Saturation (%)	
July 27, 2007 10:45 am	0.0	7.6	26.2	95	
	1.0	7.0	25.9	87	
	2.0	6.7	26.0	83	
	3.0	6.7	25.8	84	
	4.0	6.6	25.3	82	



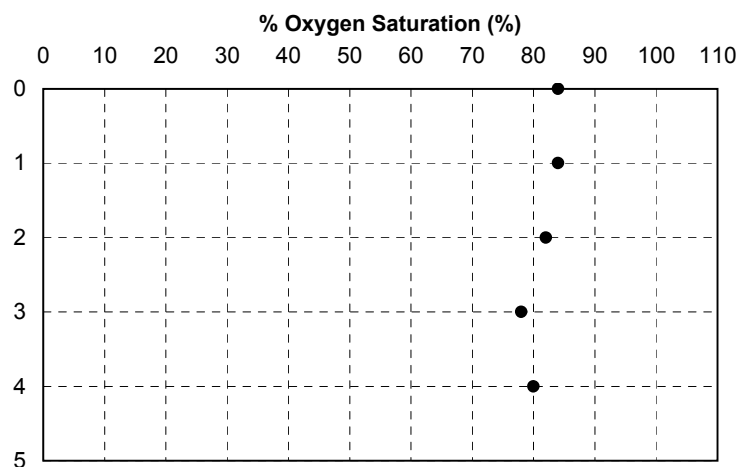
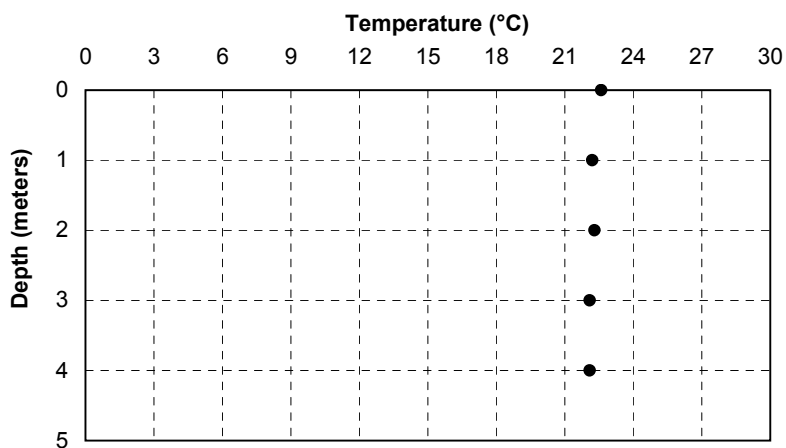
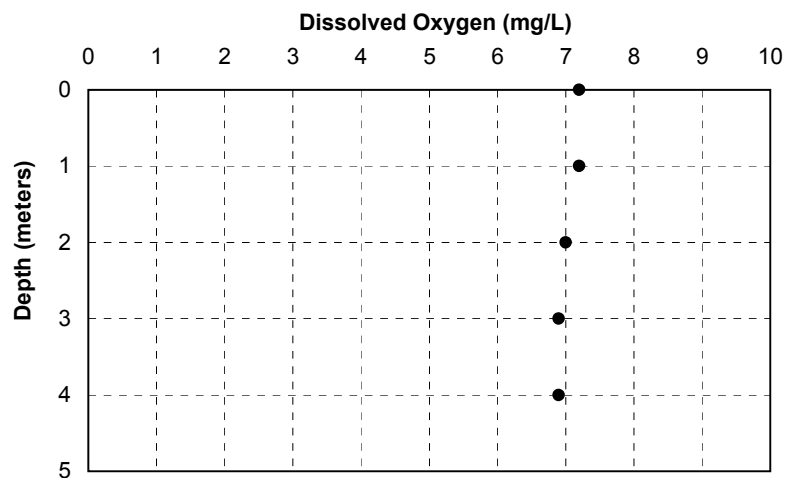
Crystal Falls Hydroelectric Project

Limnological Profiles	Depth (meters)	Dissolved		% Oxygen	
		Oxygen (mg/L)	Temperature (°C)	Saturation (%)	
August 6, 2007 10:50 am	0.0	6.7	23.3	80	
	1.0	6.9	23.1	81	
	2.0	6.6	23.2	79	
	3.0	6.7	23.0	80	
	4.0	6.8	22.9	81	



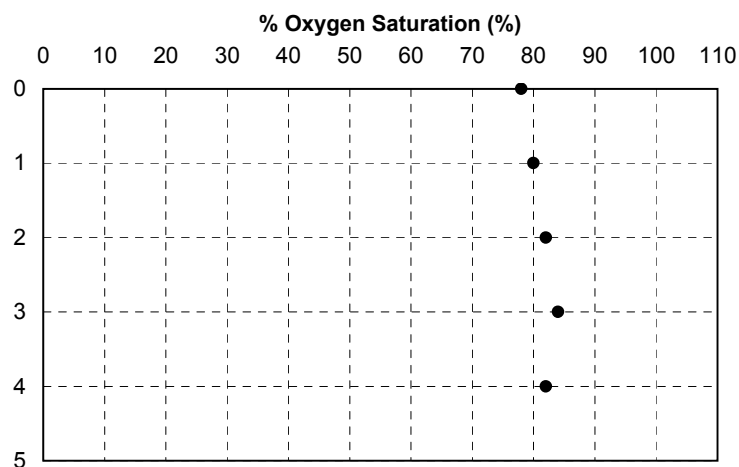
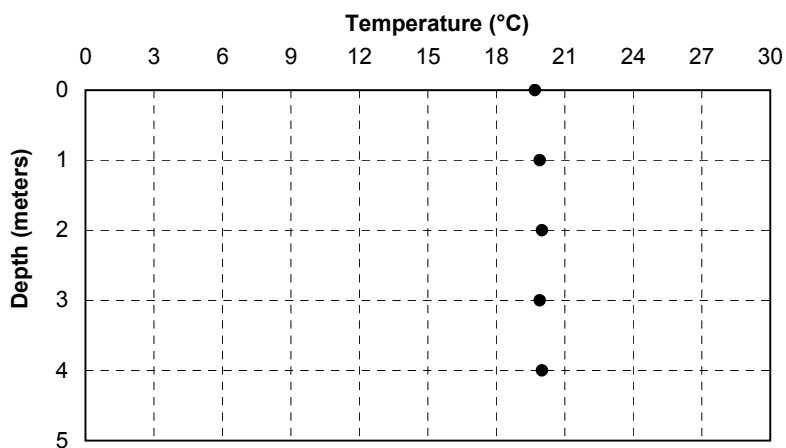
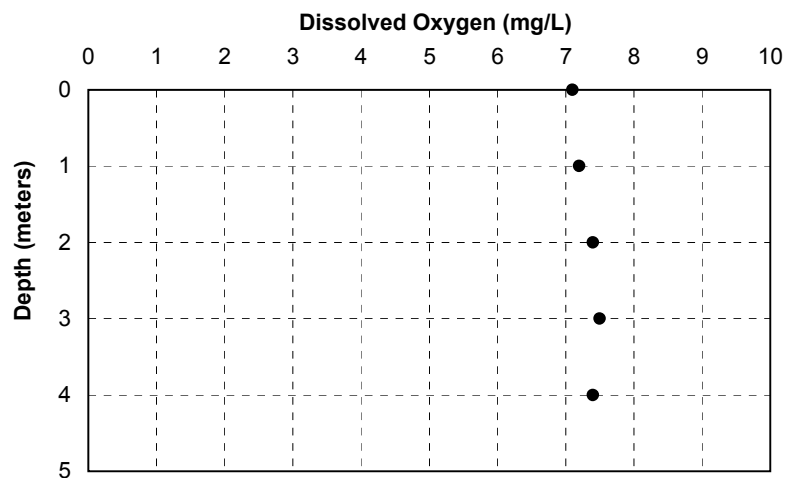
Crystal Falls Hydroelectric Project

Limnological Profiles	Depth (meters)	Dissolved		% Oxygen	
		Oxygen (mg/L)	Temperature (°C)	Saturation (%)	
August 15, 2007 10:40 am	0.0	7.2	22.6	84	
	1.0	7.2	22.2	84	
	2.0	7.0	22.3	82	
	3.0	6.9	22.1	78	
	4.0	6.9	22.1	80	



Crystal Falls Hydroelectric Project

Limnological Profiles	Depth (meters)	Dissolved		% Oxygen	
		Oxygen (mg/L)	Temperature (°C)	Saturation (%)	
August 25, 2007 10:45 am	0.0	7.1	19.7	78	
	1.0	7.2	19.9	80	
	2.0	7.4	20.0	82	
	3.0	7.5	19.9	84	
	4.0	7.4	20.0	82	



APPENDIX D

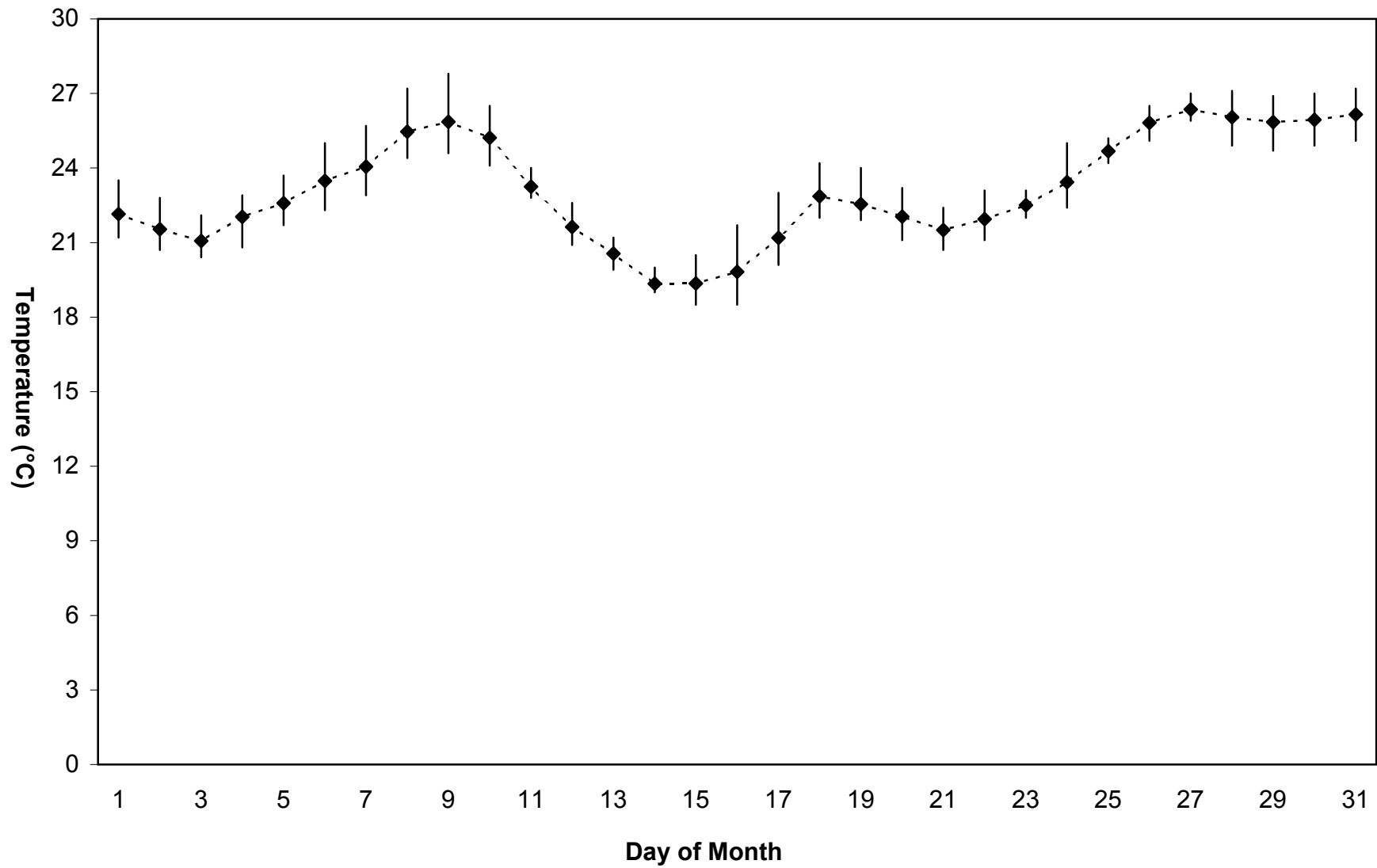
Upstream Temperature Monitoring

Hourly Temperature Readings: Crystal Falls Hydroelectric Project (Upstream of Dam), July 2007

	Day of Month																														
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	22.3	22.8	20.7	22.2	22.1	22.9	24.1	25.4	25.1	26.5	24.0	22.6	20.8	20.0	19.0	19.6	21.5	22.9	24.0	21.8	22.3	22.2	22.9	23.1	24.2	25.4	26.2	26.2	26.1	26.2	26.5
1:00a	22.1	22.6	20.6	22.5	22.2	22.8	23.9	25.4	25.0	26.2	23.7	22.5	20.7	19.9	19.0	19.4	21.4	22.9	23.6	21.7	22.0	22.1	22.8	22.9	24.4	25.4	26.2	25.9	25.9	26.2	26.2
2:00a	21.9	22.5	20.7	22.3	22.0	22.7	23.6	25.1	25.0	25.9	23.5	22.4	20.6	19.7	18.7	19.3	21.2	22.7	23.5	21.7	21.8	21.8	22.6	22.8	24.4	25.3	26.1	25.8	25.8	25.8	26.2
3:00a	21.7	22.3	20.5	22.0	21.8	22.6	23.2	25.0	25.0	25.8	23.4	22.1	20.5	19.4	18.7	19.1	21.0	22.6	23.2	21.5	21.6	21.7	22.5	22.8	24.6	25.3	26.0	25.6	25.6	25.7	26.0
4:00a	21.5	22.1	20.4	21.7	21.8	22.6	23.2	24.6	24.9	25.4	23.2	22.1	20.3	19.4	18.6	19.0	20.8	22.4	23.1	21.4	21.4	21.5	22.3	22.6	24.8	25.2	26.2	25.4	25.3	25.4	25.7
5:00a	21.4	22.0	20.4	21.5	21.7	22.5	23.2	24.6	24.9	25.3	23.2	22.0	20.2	19.4	18.6	19.1	20.5	22.3	22.8	21.4	21.2	21.4	22.1	22.5	25.0	25.1	26.0	25.2	25.1	25.4	25.6
6:00a	21.3	21.8	20.4	21.4	21.7	22.3	23.0	24.6	24.7	25.1	23.1	21.7	20.1	19.3	18.6	18.6	20.3	22.1	22.6	21.2	21.0	21.2	22.0	22.4	24.8	25.1	25.9	25.1	25.0	25.1	25.4
7:00a	21.2	21.7	20.4	21.1	21.7	22.3	22.9	24.4	24.6	25.0	22.9	21.5	19.9	19.3	18.5	18.5	20.2	22.0	22.5	21.1	20.8	21.1	22.0	22.4	24.7	25.1	26.0	25.0	24.9	24.9	25.3
8:00a	21.2	21.5	20.4	20.8	21.7	22.3	22.9	24.5	24.7	24.9	22.9	21.5	19.9	19.3	18.5	18.6	20.1	22.0	22.3	21.1	20.7	21.1	22.0	22.4	24.6	25.2	25.9	24.9	24.7	24.9	25.2
9:00a	21.4	21.4	20.4	20.9	21.8	22.5	23.0	24.5	24.7	24.9	22.9	21.4	19.9	19.3	18.6	18.9	20.2	22.0	22.2	21.2	20.9	21.2	22.0	22.6	24.6	25.4	25.9	25.0	24.7	24.9	25.1
10:00a	21.6	21.4	20.5	21.3	22.0	22.6	23.2	24.5	24.8	24.8	23.0	21.4	20.1	19.2	18.9	19.0	20.3	22.0	22.1	21.4	21.0	21.3	22.0	22.8	24.5	25.7	25.9	25.2	24.9	24.9	25.1
11:00a	21.7	21.4	20.7	21.6	22.2	23.0	23.6	24.9	25.1	24.9	23.2	21.4	20.3	19.2	19.2	19.5	20.5	22.0	22.2	21.5	21.0	21.4	22.2	22.9	24.6	25.8	*	25.5	25.3	25.1	25.5
12:00p	21.8	21.4	20.8	22.0	22.5	23.2	23.8	25.0	25.5	25.0	23.2	21.5	20.5	19.2	19.4	19.8	20.7	22.3	22.3	21.8	21.4	21.5	22.3	23.0	24.5	26.2	26.3	25.9	25.8	25.3	25.9
1:00p	22.3	21.4	21.2	22.3	22.6	23.6	24.0	25.5	25.9	25.2	23.3	21.6	20.8	19.2	19.6	19.9	20.8	22.3	22.5	22.1	21.5	21.7	22.4	23.3	24.6	26.0	26.5	26.2	25.9	25.6	26.2
2:00p	22.3	21.3	21.1	22.1	23.2	24.0	24.7	25.6	26.2	25.4	23.5	21.5	21.1	19.3	19.9	20.5	21.0	22.6	22.4	22.3	21.4	21.7	22.5	23.6	24.6	26.2	26.6	26.5	26.0	26.2	26.5
3:00p	22.3	21.2	21.4	22.2	23.7	24.3	24.9	26.8	26.5	25.3	23.5	21.5	21.1	19.1	20.2	20.6	21.3	22.9	22.5	22.5	21.5	22.0	22.6	24.4	24.6	26.1	26.9	26.8	26.2	26.2	26.9
4:00p	22.4	21.2	21.5	22.9	23.7	24.3	24.7	27.2	26.9	25.5	23.5	21.5	21.2	19.4	20.5	20.4	21.4	23.2	22.4	22.8	21.6	22.0	22.6	25.0	24.7	26.2	27.0	27.1	26.4	26.4	27.2
5:00p	22.5	21.2	21.8	22.9	23.6	24.7	24.6	27.1	26.9	25.6	23.5	21.5	21.2	19.2	20.3	20.4	21.5	23.7	22.3	23.1	21.6	22.3	22.6	24.7	24.9	26.5	27.0	26.9	26.4	26.8	27.2
6:00p	22.9	21.1	22.0	22.9	23.6	25.0	24.7	26.8	27.7	25.4	23.4	21.4	21.2	19.4	20.2	20.4	21.6	23.9	22.3	23.1	21.6	22.5	22.8	24.6	24.8	26.5	26.9	27.1	26.9	26.9	27.2
7:00p	22.8	21.2	21.8	22.6	23.5	24.8	24.7	26.3	27.8	25.1	23.3	21.4	21.0	19.4	20.2	20.4	21.7	23.8	22.3	23.2	21.5	22.9	22.8	24.6	24.6	26.5	26.8	27.1	26.8	26.9	26.8
8:00p	23.5	21.0	22.1	22.6	23.5	24.8	25.0	26.2	27.6	24.9	23.2	21.3	20.8	19.3	20.1	20.4	22.1	23.9	22.1	23.1	21.5	22.9	22.9	24.4	24.6	26.4	26.8	27.1	26.8	27.0	26.6
9:00p	23.4	20.9	22.1	22.4	23.3	24.9	25.4	25.8	27.3	24.6	23.0	21.2	20.7	19.2	19.9	21.1	22.6	24.0	22.0	22.9	22.1	23.0	23.0	24.0	24.9	26.5	26.5	26.8	26.8	27.0	26.5
10:00p	23.2	20.8	22.0	22.3	23.2	24.4	25.4	25.8	27.1	24.4	22.9	21.1	20.4	19.1	19.8	21.7	22.9	24.1	22.0	22.7	22.4	23.0	23.1	24.4	25.1	26.3	26.5	26.5	26.5	26.9	26.5
11:00p	22.9	20.7	21.6	22.3	23.1	24.4	25.7	25.4	26.8	24.1	22.8	20.9	20.2	19.0	19.6	21.5	23.0	24.2	21.9	22.5	22.4	23.1	23.0	24.2	25.2	26.2	26.2	26.3	26.5	26.8	26.5
Max.	23.5	22.8	22.1	22.9	23.7	25.0	25.7	27.2	27.8	26.5	24.0	22.6	21.2	20.0	20.5	21.7	23.0	24.2	24.0	23.2	22.4	23.1	23.1	25.0	25.2	26.5	27.0	27.1	26.9	27.0	27.2
Min.	21.2	20.7	20.4	20.8	21.7	22.3	22.9	24.4	24.6	24.1	22.8	20.9	19.9	19.0	18.5	18.5	20.1	22.0	21.9	21.1	20.7	21.1	22.0	22.4	24.2	25.1	25.9	24.9	24.7	24.9	25.1
Avg.	22.2	21.5	21.1	22.0	22.6	23.5	24.1	25.5	25.9	25.2	23.3	21.6	20.6	19.3	19.4	19.8	21.2	22.9	22.5	22.0	21.5	21.9	22.5	23.4	24.7	25.8	26.4	26.0	25.8	25.9	26.2

* Service point (missing data)

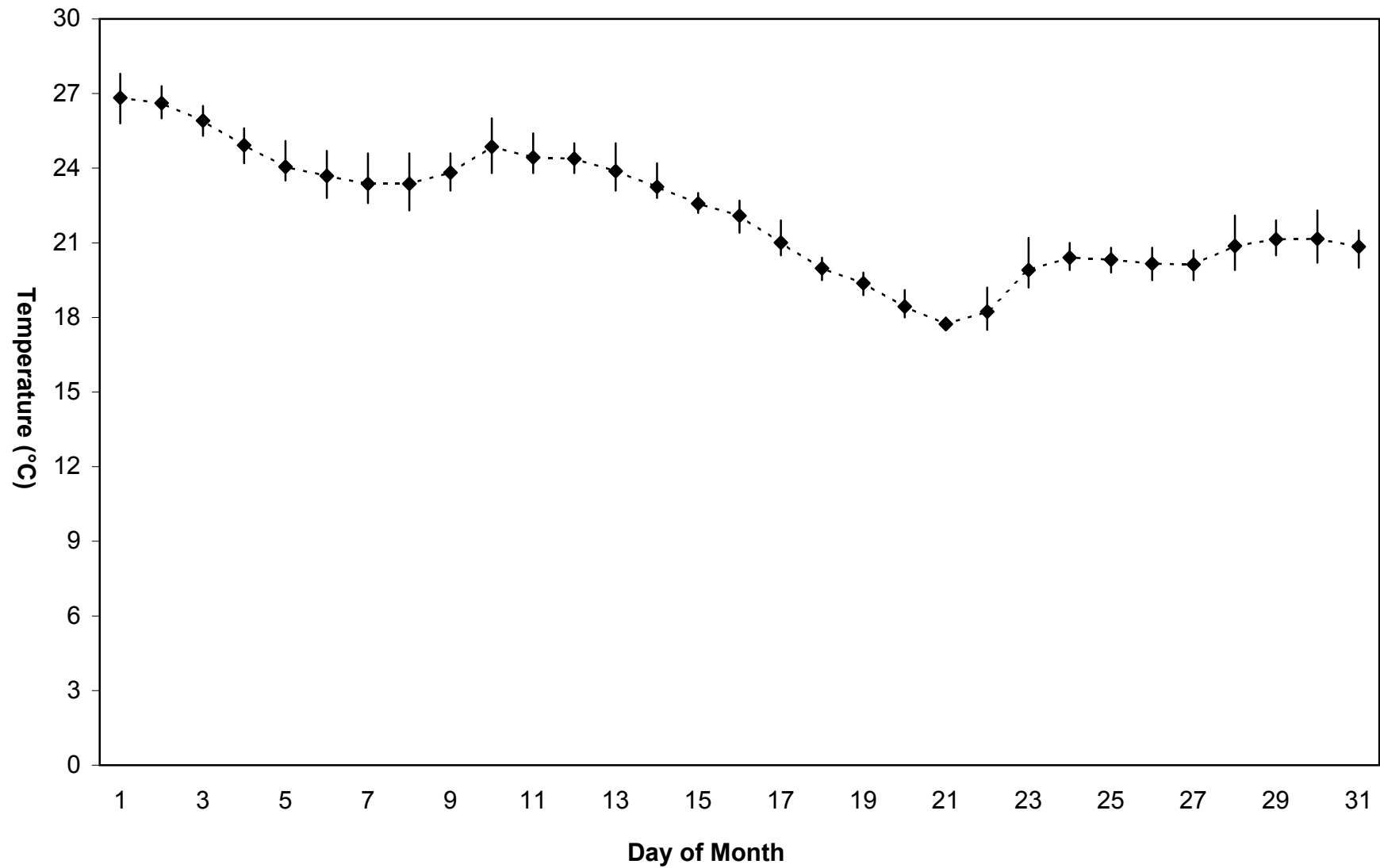
**Average Daily Temperature Readings
Crystal Falls Hydroelectric Project (Upstream of Dam)
July 2007**



Hourly Temperature Readings: Crystal Falls Hydroelectric Project (Upstream of Dam), August 2007

	Day of Month																														
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	26.9	27.1	26.5	25.6	25.1	23.4	23.9	23.4	24.1	24.6	25.4	24.6	24.2	24.2	22.9	22.6	21.9	20.4	19.8	19.1	18.0	17.6	19.3	20.6	20.4	20.4	20.5	20.5	21.9	20.9	21.3
1:00a	26.9	26.8	26.3	25.4	25.0	23.3	23.7	23.2	24.0	24.7	25.3	24.6	24.0	23.9	22.9	22.4	21.7	20.3	19.6	19.0	18.0	17.6	19.2	20.5	20.3	20.2	20.4	20.6	21.5	20.8	21.1
2:00a	26.8	26.8	26.2	25.2	24.7	23.3	23.5	23.1	24.1	24.7	25.0	24.4	23.8	23.8	22.8	22.3	21.5	20.1	19.5	19.0	17.9	17.6	19.4	20.4	20.2	20.1	20.2	20.4	21.3	20.7	20.9
3:00a	26.6	26.5	26.0	25.0	24.6	23.2	23.3	22.9	24.0	24.6	25.0	24.4	23.8	23.6	22.7	22.0	21.4	20.1	19.4	19.0	17.8	17.6	19.8	20.3	20.2	20.0	20.1	20.3	21.1	20.6	20.8
4:00a	26.4	26.5	25.9	24.9	24.5	23.1	23.1	22.7	23.8	24.4	24.7	24.2	23.6	23.4	22.6	22.0	21.4	19.9	19.3	18.8	17.9	17.6	19.8	20.3	20.1	19.9	20.1	20.2	21.0	20.6	20.6
5:00a	26.2	26.3	25.8	24.7	24.6	23.1	23.0	22.6	23.6	24.2	24.5	24.1	23.4	23.2	22.5	21.8	21.2	19.9	19.2	18.6	17.8	17.6	19.8	20.3	20.0	19.7	19.9	20.1	21.0	20.4	20.5
6:00a	26.1	26.2	25.6	24.6	24.2	22.9	22.9	22.5	23.4	24.1	24.4	23.9	23.3	22.9	22.4	21.7	21.1	19.7	19.1	18.6	17.7	17.6	19.7	20.2	19.9	19.6	19.8	20.1	20.8	20.4	20.3
7:00a	26.0	26.1	25.4	24.4	24.1	22.9	22.8	22.4	23.2	23.9	24.2	23.9	23.2	22.9	22.3	21.5	21.0	19.5	19.0	18.6	17.7	17.5	19.6	20.1	19.9	19.6	19.7	20.0	20.7	20.3	20.2
8:00a	25.8	26.0	25.3	24.2	24.0	22.8	22.7	22.3	23.1	23.9	24.1	23.8	23.1	22.9	22.3	21.5	20.8	19.6	19.0	18.5	17.7	17.6	19.6	20.0	19.8	19.5	19.6	19.9	20.6	20.2	20.1
9:00a	25.8	26.0	25.3	24.2	23.9	22.8	22.6	22.4	23.1	23.8	24.0	23.8	23.1	22.8	22.3	21.5	20.7	19.5	18.9	18.4	17.6	17.6	19.5	20.0	19.9	19.5	19.6	19.9	20.6	20.3	20.0
10:00a	25.8	26.0	25.3	24.4	23.8	23.0	22.6	22.5	23.1	24.0	23.9	23.9	23.2	22.8	22.2	21.4	20.6	19.6	19.0	18.4	17.6	17.6	19.6	19.9	19.9	19.6	19.6	20.0	20.5	20.5	20.2
11:00a	26.5	26.1	25.4	24.4	23.7	23.1	22.7	22.6	23.2	24.2	23.8	23.9	23.3	22.9	22.2	21.7	20.7	19.6	19.1	18.3	17.7	17.8	19.7	19.9	20.0	19.7	19.5	20.3	20.6	20.7	20.5
12:00p	26.5	26.3	25.6	24.4	23.8	23.5	22.9	23.0	23.3	24.4	23.8	24.1	23.5	22.9	22.3	21.9	20.8	19.7	19.2	18.3	17.7	18.2	19.6	20.0	20.2	19.8	19.6	20.7	20.8	21.0	20.5
1:00p	26.7	26.5	25.8	24.6	23.8	23.8	22.9	23.3	23.6	24.6	23.9	24.4	23.8	23.1	22.3	22.0	20.9	19.9	19.3	18.2	17.7	18.1	19.6	20.2	20.3	20.0	19.8	20.9	21.0	21.2	20.8
2:00p	27.0	26.9	26.1	25.0	23.8	24.2	23.0	23.2	23.6	25.0	23.9	24.6	23.8	23.2	22.4	22.3	21.0	20.1	19.5	18.2	17.7	18.5	19.2	20.4	20.5	20.1	19.9	21.0	21.2	21.4	21.2
3:00p	27.2	27.0	26.2	25.0	23.9	24.1	23.2	23.8	23.7	25.3	23.9	24.7	23.9	23.4	22.5	22.6	21.0	20.2	19.6	18.3	17.7	19.0	19.4	20.8	20.5	20.5	20.1	21.4	21.5	21.9	21.4
4:00p	27.4	27.3	26.4	25.1	23.9	24.6	23.2	24.2	23.9	25.4	24.2	24.9	24.1	23.5	22.6	22.6	21.0	20.2	19.6	18.3	17.7	19.1	19.9	20.9	20.8	20.5	20.4	21.4	21.7	22.1	21.5
5:00p	27.7	27.3	26.5	25.1	23.8	24.4	24.4	24.4	24.1	25.9	24.3	25.0	25.0	23.4	22.6	22.7	21.0	20.3	19.7	18.3	17.6	19.0	20.0	21.0	20.8	20.7	20.5	21.7	21.5	22.3	21.5
6:00p	27.7	27.2	26.5	25.1	23.9	24.6	24.6	24.6	24.2	25.8	24.5	25.0	25.0	23.4	22.9	22.6	20.9	20.4	19.8	18.2	17.7	19.1	20.3	20.8	20.8	20.8	20.6	22.1	21.5	22.3	21.4
7:00p	27.8	27.1	26.2	25.1	23.9	24.7	24.6	24.6	24.4	26.0	24.6	24.8	24.6	23.2	22.9	22.4	20.9	20.3	19.7	18.2	17.7	19.0	20.7	20.8	20.8	20.8	20.6	22.0	21.5	22.2	21.4
8:00p	27.7	26.9	26.2	25.4	23.7	24.6	24.3	24.4	24.4	25.9	24.7	24.7	24.4	23.2	23.0	22.3	20.8	20.2	19.7	18.1	17.7	19.1	21.2	20.7	20.7	20.8	20.7	22.1	21.4	22.0	21.2
9:00p	27.7	26.8	26.1	25.6	23.6	24.6	23.9	24.6	24.6	25.9	24.7	24.6	24.2	23.2	22.9	22.2	20.7	20.1	19.5	18.1	17.7	19.2	21.1	20.6	20.7	20.8	20.7	22.0	21.4	21.8	21.1
10:00p	27.5	26.6	25.9	25.4	23.6	24.3	23.6	24.2	24.6	25.7	24.9	24.6	24.4	23.1	22.8	22.0	20.6	20.0	19.3	18.0	17.7	19.0	20.8	20.5	20.6	20.7	20.7	21.7	21.2	21.7	21.0
11:00p	27.3	26.5	25.4	25.3	23.5	24.1	23.5	24.1	24.6	25.6	24.6	24.3	24.4	23.0	22.6	22.0	20.5	19.9	19.2	18.0	17.7	19.1	20.8	20.5	20.5	20.6	20.6	21.7	21.0	21.5	20.8
Max.	27.8	27.3	26.5	25.6	25.1	24.7	24.6	24.6	24.6	26.0	25.4	25.0	25.0	24.2	23.0	22.7	21.9	20.4	19.8	19.1	18.0	19.2	21.2	21.0	20.8	20.8	20.7	22.1	21.9	22.3	21.5
Min.	25.8	26.0	25.3	24.2	23.5	22.8	22.6	22.3	23.1	23.8	23.8	23.8	23.1	22.8	22.2	21.4	20.5	19.5	18.9	18.0	17.6	17.5	19.2	19.9	19.8	19.5	19.5	19.9	20.5	20.2	20.0
Avg.	26.8	26.6	25.9	24.9	24.1	23.7	23.4	23.4	23.8	24.9	24.4	24.4	23.9	23.2	22.6	22.1	21.0	20.0	19.4	18.4	17.7	18.2	19.9	20.4	20.3	20.2	20.1	20.9	21.1	21.2	20.8

**Average Daily Temperature Readings
Crystal Falls Hydroelectric Project (Upstream of Dam)
August 2007**



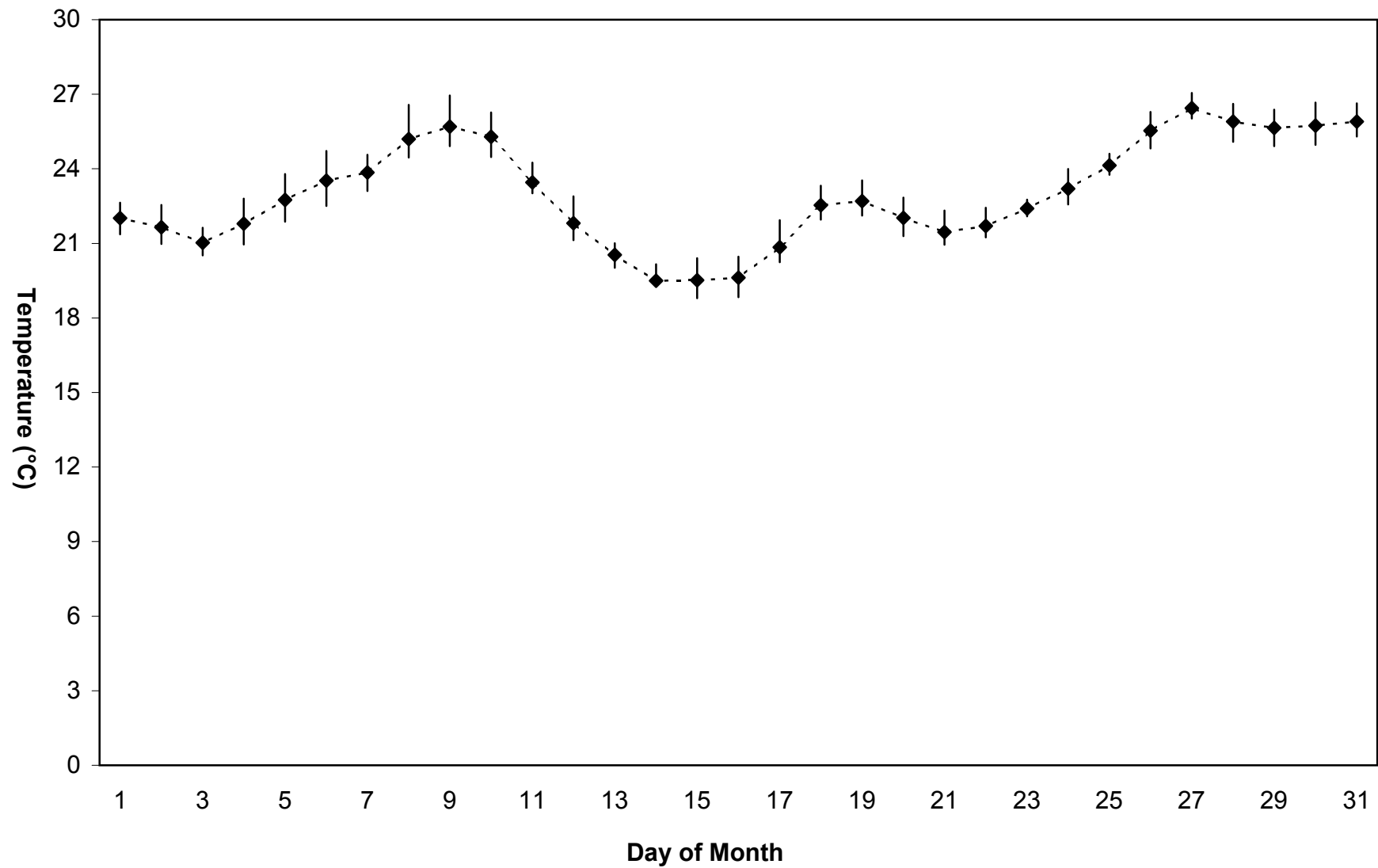
APPENDIX E

Downstream Temperature Monitoring

Hourly Temperature Readings: Crystal Falls Hydroelectric Project (Downstream of Dam), July 2007

	Day of Month																														
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	22.44	22.55	20.91	21.38	22.32	23.23	24.17	24.67	25.28	26.27	24.25	22.89	21.01	20.16	19.21	19.76	20.47	22.10	23.47	22.05	22.32	21.63	22.43	22.76	23.76	24.82	26.27	26.23	26.10	25.73	26.04
1:00a	22.26	22.53	20.85	21.50	22.25	23.11	23.99	24.74	25.24	26.08	24.01	22.76	20.87	19.98	19.10	19.60	20.50	22.23	23.54	21.96	22.12	21.61	22.41	22.76	23.76	24.96	26.23	26.06	25.95	25.67	25.93
2:00a	22.09	22.41	20.80	21.54	22.19	23.02	23.81	24.76	25.20	25.91	23.81	22.60	20.73	19.83	19.05	19.46	20.56	22.26	23.45	21.87	21.93	21.61	22.41	22.76	23.79	24.96	26.21	25.89	25.78	25.59	25.87
3:00a	21.93	22.30	20.73	21.47	22.12	22.89	23.65	24.76	25.19	25.74	23.67	22.43	20.59	19.71	19.00	19.34	20.59	22.32	23.34	21.77	21.73	21.59	22.39	22.73	23.87	25.02	26.17	25.73	25.61	25.50	25.78
4:00a	21.79	22.18	20.66	21.36	22.09	22.80	23.50	24.71	25.15	25.61	23.52	22.25	20.45	19.62	18.95	19.21	20.59	22.30	23.16	21.66	21.52	21.52	22.30	22.73	23.92	25.09	26.12	25.54	25.43	25.43	25.67
5:00a	21.64	22.05	20.61	21.29	22.03	22.69	23.36	24.67	25.07	25.41	23.36	22.07	20.31	19.55	18.90	19.08	20.52	22.18	23.00	21.52	21.33	21.43	22.26	22.68	24.03	25.11	26.10	25.39	25.26	25.32	25.56
6:00a	21.50	21.93	20.56	21.15	21.95	22.60	23.21	24.63	25.00	25.28	23.21	21.89	20.17	19.48	18.83	18.95	20.43	22.12	22.85	21.43	21.17	21.33	22.18	22.62	24.05	25.13	26.06	25.26	25.11	25.20	25.45
7:00a	21.42	21.84	20.52	21.08	21.89	22.53	23.11	24.54	24.93	25.15	23.11	21.75	20.05	19.46	18.79	18.86	20.29	22.02	22.68	21.33	21.03	21.26	22.14	22.59	24.08	25.17	26.06	25.15	24.98	25.07	25.35
8:00a	21.36	21.73	20.54	20.99	21.87	22.51	23.11	24.49	24.91	25.02	23.03	21.64	20.02	19.46	18.79	18.83	20.24	21.98	22.55	21.29	20.94	21.24	22.10	22.57	24.07	25.24	26.04	25.09	24.91	25.00	25.30
9:00a	21.43	21.63	20.59	20.96	21.96	22.59	23.15	24.47	24.93	24.96	23.05	21.61	20.05	19.39	18.86	18.90	20.26	21.96	22.46	21.33	20.96	21.26	22.09	22.64	24.03	25.32	26.02	25.13	24.91	24.96	25.30
10:00a	21.56	21.56	20.68	21.08	22.10	22.76	23.23	24.45	24.96	24.93	23.14	21.59	20.21	19.34	19.02	19.10	20.29	21.95	22.37	21.49	21.05	21.27	22.12	22.76	24.01	25.41	26.10	25.28	25.02	24.96	25.41
11:00a	21.61	21.52	20.73	21.29	22.30	23.00	23.47	24.67	25.13	24.93	23.21	21.57	20.33	19.34	19.22	19.31	20.40	22.00	22.39	21.61	21.10	21.33	22.18	22.87	24.05	25.58	26.23	25.46	25.15	25.11	25.54
12:00p	21.70	21.50	20.85	21.57	22.51	23.20	23.70	24.78	25.33	24.98	23.38	21.63	20.45	19.31	19.41	19.52	20.52	22.10	22.53	21.82	21.22	21.40	22.25	23.09	24.12	25.71	26.38	25.67	25.35	25.33	25.74
1:00p	21.86	21.47	20.94	21.89	22.78	23.50	23.92	24.96	25.58	25.02	23.45	21.70	20.59	19.33	19.65	19.60	20.71	22.34	22.66	22.02	21.29	21.50	22.34	23.30	24.14	25.73	26.57	25.86	25.58	25.52	25.89
2:00p	21.93	21.43	21.13	21.96	23.12	23.79	24.19	25.33	25.82	25.17	23.61	21.70	20.68	19.34	19.90	19.88	20.82	22.59	22.66	22.12	21.36	21.61	22.39	23.57	24.21	25.76	26.74	26.04	25.76	25.76	26.14
3:00p	22.05	21.40	21.33	22.00	23.41	24.03	24.34	25.78	26.08	25.24	23.68	21.70	20.82	19.31	20.12	20.00	20.99	22.80	22.64	22.23	21.47	21.75	22.44	23.88	24.28	25.76	26.91	26.25	25.99	25.99	26.36
4:00p	22.16	21.34	21.47	22.64	23.70	24.27	24.27	26.19	26.34	25.54	23.68	21.71	20.89	19.38	20.31	20.02	21.08	23.03	22.57	22.37	21.49	21.79	22.48	23.97	24.34	25.74	26.99	26.42	26.17	26.21	26.63
5:00p	22.28	21.34	21.49	22.80	23.74	24.52	24.19	26.53	26.38	25.65	23.68	21.73	20.91	19.43	20.35	20.02	21.24	23.21	22.51	22.59	21.54	21.93	22.55	23.99	24.38	25.74	27.05	26.53	26.31	26.42	26.63
6:00p	22.37	21.29	21.59	22.73	23.79	24.71	24.22	26.57	26.67	25.54	23.65	21.64	20.85	19.50	20.40	20.02	21.29	23.29	22.48	22.76	21.52	22.05	22.59	23.83	24.43	25.80	27.01	26.57	26.38	26.59	26.48
7:00p	22.50	21.27	21.57	22.68	23.77	24.72	24.21	26.21	26.78	25.35	23.56	21.56	20.82	19.52	20.31	20.10	21.42	23.23	22.44	22.84	21.50	22.19	22.66	23.76	24.38	25.92	26.95	26.57	26.17	26.67	26.27
8:00p	22.57	21.20	21.63	22.55	23.68	24.69	24.32	25.97	26.95	25.17	23.43	21.40	20.71	19.46	20.23	20.16	21.50	23.20	22.35	22.80	21.50	22.34	22.71	23.74	24.34	26.04	26.84	26.61	26.08	26.57	26.14
9:00p	22.57	21.12	21.63	22.43	23.56	24.56	24.41	25.73	26.80	24.89	23.29	21.31	20.57	19.43	20.10	20.26	21.66	23.18	22.28	22.75	21.54	22.37	22.75	23.70	24.30	26.23	26.68	26.44	25.95	26.53	26.04
10:00p	22.64	21.05	21.47	22.39	23.45	24.47	24.45	25.61	26.59	24.69	23.14	21.22	20.45	19.38	20.02	20.38	21.82	23.25	22.19	22.62	21.57	22.41	22.76	23.72	24.41	26.25	26.53	26.33	25.84	26.38	25.99
11:00p	22.60	20.98	21.33	22.35	23.36	24.33	24.56	25.43	26.42	24.47	23.02	21.13	20.29	19.29	19.90	20.47	21.93	23.32	22.12	22.50	21.63	22.43	22.76	23.74	24.61	26.29	26.38	26.21	25.76	26.19	26.01
Max.	22.64	22.55	21.63	22.80	23.79	24.72	24.56	26.57	26.95	26.27	24.25	22.89	21.01	20.16	20.40	20.47	21.93	23.32	23.54	22.84	22.32	22.43	22.76	23.99	24.61	26.29	27.05	26.61	26.38	26.67	26.63
Min.	21.36	20.98	20.52	20.96	21.87	22.51	23.11	24.45	24.91	24.47	23.02	21.13	20.02	19.29	18.79	18.83	20.24	21.95	22.12	21.29	20.94	21.24	22.09	22.57	23.76	24.82	26.02	25.09	24.91	24.96	25.30
Avg.	22.01	21.65	21.03	21.80	22.75	23.52	23.86	25.19	25.70	25.29	23.46	21.81	20.53	19.50	19.52	19.62	20.84	22.54	22.70	22.03	21.45	21.70	22.40	23.20	24.14	25.53	26.44	25.90	25.65	25.74	25.90

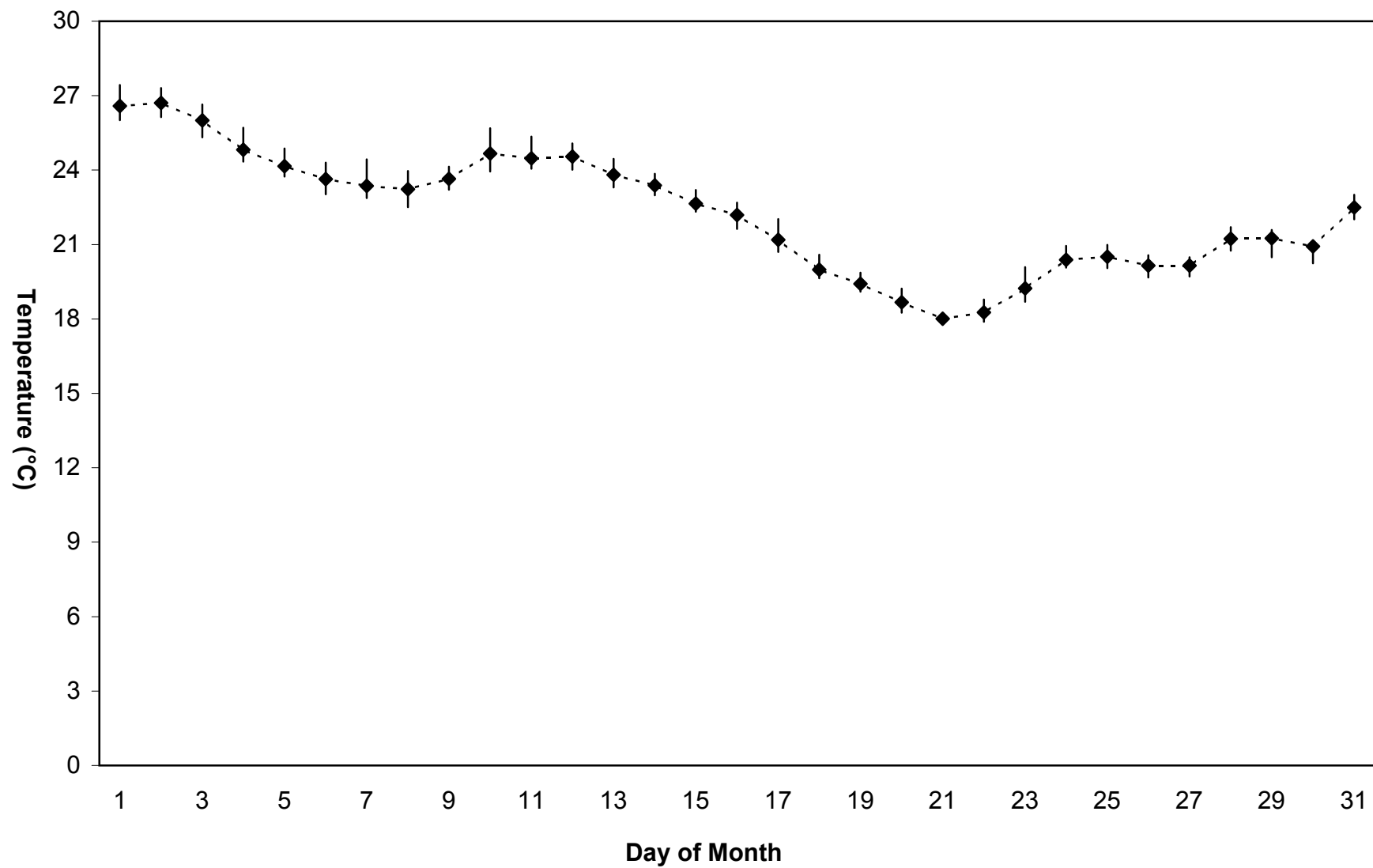
**Average Daily Temperature Readings
Crystal Falls Hydroelectric Project (Downstream of Dam)
July 2007**



Hourly Temperature Readings: Crystal Falls Hydroelectric Project (Downstream of Dam), August 2007

	Day of Month																														
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	26.10	26.82	26.65	25.71	24.87	23.67	23.59	23.45	23.61	24.08	25.35	24.56	24.45	23.85	23.20	22.57	22.03	20.59	19.86	19.22	18.20	17.94	18.69	20.09	20.59	20.56	20.49	21.29	20.94	22.43	22.70
1:00a	26.25	26.74	26.51	25.54	24.78	23.61	23.52	23.32	23.63	24.08	25.22	24.54	24.30	23.76	23.09	22.51	21.91	20.47	19.76	19.17	18.16	17.94	18.69	20.16	20.50	20.43	20.40	21.29	21.19	21.42	22.57
2:00a	26.34	26.65	26.38	25.35	24.69	23.54	23.43	23.20	23.63	24.14	25.07	24.50	24.16	23.63	22.98	22.39	21.77	20.33	19.64	19.10	18.13	17.94	18.71	20.14	20.43	20.31	20.31	21.24	21.10	21.24	22.43
3:00a	26.36	26.59	26.21	25.19	24.54	23.45	23.30	23.05	23.63	24.19	24.91	24.45	24.01	23.52	22.87	22.25	21.63	20.19	19.53	19.05	18.09	17.94	18.78	20.09	20.36	20.19	20.24	21.15	20.99	21.05	22.34
4:00a	26.29	26.51	26.04	25.00	24.47	23.38	23.18	22.94	23.59	24.23	24.76	24.39	23.85	23.38	22.78	22.12	21.49	20.07	19.41	18.98	18.08	17.92	18.93	20.12	20.29	20.09	20.16	21.12	20.91	20.89	22.27
5:00a	26.21	26.44	25.86	24.85	24.41	23.29	23.11	22.80	23.48	24.19	24.63	24.30	23.70	23.27	22.69	22.00	21.36	19.95	19.31	18.93	18.06	17.92	19.05	20.12	20.24	19.96	20.07	21.05	20.82	20.71	22.23
6:00a	26.12	26.34	25.69	24.67	24.30	23.18	23.03	22.68	23.39	24.14	24.49	24.21	23.56	23.18	22.62	21.86	21.22	19.83	19.22	18.86	18.04	17.91	19.12	20.12	20.17	19.86	19.98	20.94	20.73	20.57	22.16
7:00a	26.04	26.25	25.50	24.52	24.21	23.11	22.96	22.57	23.32	24.05	24.36	24.12	23.41	23.09	22.53	21.73	21.08	19.72	19.15	18.79	17.99	17.91	19.14	20.16	20.09	19.76	19.90	20.85	20.64	20.45	22.07
8:00a	26.01	26.17	25.37	24.41	24.14	23.03	22.91	22.51	23.25	23.97	24.25	24.05	23.32	23.02	22.48	21.64	20.96	19.67	19.10	18.74	17.97	17.91	19.14	20.12	20.05	19.67	19.83	20.78	20.56	20.33	22.02
9:00a	26.02	26.14	25.32	24.38	24.07	23.05	22.87	22.51	23.21	23.94	24.17	24.01	23.30	22.98	22.44	21.63	20.87	19.64	19.10	18.67	17.96	17.89	19.17	20.09	20.05	19.67	19.77	20.75	20.49	20.24	22.05
10:00a	26.10	26.19	25.35	24.34	24.05	23.12	22.89	22.60	23.23	24.03	24.12	24.07	23.36	22.98	22.39	21.64	20.84	19.65	19.14	18.62	17.94	17.94	19.17	20.07	20.10	19.71	19.71	20.77	20.50	20.24	22.05
11:00a	26.19	26.31	25.45	24.38	24.01	23.23	22.93	22.69	23.32	24.19	24.07	24.17	23.39	23.02	22.35	21.79	20.87	19.69	19.17	18.57	17.92	17.96	19.14	20.07	20.24	19.74	19.74	20.84	20.61	20.35	22.19
12:00p	26.31	26.46	25.59	24.43	23.97	23.43	22.93	22.87	23.41	24.39	24.07	24.36	23.50	23.11	22.32	21.95	20.94	19.71	19.22	18.54	17.97	18.11	19.10	20.14	20.28	19.84	19.79	20.99	20.82	20.52	22.25
1:00p	26.48	26.65	25.82	24.56	23.96	23.59	22.98	23.02	23.48	24.60	24.05	24.52	23.56	23.30	22.32	22.05	21.03	19.81	19.31	18.52	17.97	18.25	19.00	20.24	20.43	19.95	19.88	21.17	21.03	20.70	22.36
2:00p	26.74	26.86	26.01	24.61	23.97	23.81	23.05	23.21	23.57	24.74	24.07	24.67	23.65	23.43	22.37	22.19	21.15	19.90	19.39	18.50	17.99	18.42	18.95	20.38	20.59	20.07	19.95	21.31	21.24	20.84	22.55
3:00p	26.99	27.05	26.19	24.67	23.99	24.05	23.16	23.45	23.70	24.97	24.12	24.85	23.74	23.54	22.46	22.37	21.19	19.96	19.48	18.50	18.01	18.60	18.96	20.59	20.73	20.16	20.10	21.52	21.42	21.01	22.71
4:00p	27.03	27.19	26.38	24.78	24.01	24.23	23.32	23.70	23.79	25.20	24.19	24.96	23.88	23.63	22.51	22.51	21.24	19.98	19.55	18.54	18.01	18.69	19.19	20.71	20.94	20.26	20.24	21.64	21.70	21.15	22.80
5:00p	27.20	27.31	26.50	24.87	24.01	24.28	23.70	23.87	23.87	25.39	24.27	25.07	24.16	23.63	22.57	22.68	21.22	20.00	19.60	18.54	17.97	18.71	19.39	20.91	20.98	20.33	20.31	21.68	21.95	21.29	22.88
6:00p	27.29	27.31	26.51	24.87	23.99	24.30	24.10	23.92	23.97	25.59	24.30	25.07	24.16	23.61	22.68	22.69	21.17	20.09	19.64	18.52	17.99	18.71	19.62	20.94	20.99	20.43	20.38	21.70	22.18	21.33	23.00
7:00p	27.43	27.26	26.46	24.87	23.96	24.23	24.43	23.96	24.08	25.69	24.43	25.00	24.07	23.56	22.76	22.64	21.10	20.12	19.64	18.47	17.97	18.76	19.69	20.94	20.96	20.50	20.42	21.63	22.18	21.33	22.84
8:00p	27.37	27.14	26.33	24.87	23.92	24.14	24.17	23.94	24.12	25.67	24.56	24.95	24.01	23.48	22.82	22.50	20.98	20.12	19.60	18.40	17.97	18.78	19.88	20.89	20.91	20.54	20.45	21.57	22.18	21.19	22.91
9:00p	27.27	27.03	26.17	24.87	23.87	23.96	23.90	23.85	24.14	25.63	24.63	24.87	23.99	23.43	22.80	22.39	20.91	20.09	19.52	18.33	17.96	18.74	19.96	20.80	20.85	20.57	20.47	21.49	22.07	21.06	22.89
10:00p	27.05	26.87	26.02	24.93	23.81	23.81	23.70	23.77	24.14	25.56	24.65	24.71	23.96	23.36	22.75	22.28	20.80	20.03	19.38	18.28	17.96	18.69	20.05	20.73	20.77	20.57	20.45	21.40	21.93	20.92	22.80
11:00p	26.89	26.76	25.87	24.89	23.74	23.70	23.57	23.70	24.08	25.45	24.61	24.58	23.92	23.29	22.66	22.16	20.70	19.95	19.29	18.25	17.96	18.69	20.09	20.66	20.66	20.52	20.45	21.31	21.75	20.84	22.73
Max.	27.43	27.31	26.65	25.71	24.87	24.30	24.43	23.96	24.14	25.69	25.35	25.07	24.45	23.85	23.20	22.69	22.03	20.59	19.86	19.22	18.20	18.78	20.09	20.94	20.99	20.57	20.49	21.70	21.59	20.71	23.00
Min.	26.01	26.14	25.32	24.34	23.74	23.03	22.87	22.51	23.21	23.94	24.05	24.01	23.30	22.98	22.32	21.63	20.70	19.64	19.10	18.25	17.92	17.89	18.69	20.07	20.05	19.67	19.71	20.75	20.49	20.24	22.02
Avg.	26.59	26.71	26.01	24.82	24.16	23.63	23.36	23.23	23.65	24.67	24.47	24.54	23.81	23.38	22.64	22.19	21.19	19.98	19.42	18.67	18.01	18.26	19.23	20.39	20.51	20.15	20.15	21.23	21.25	20.92	22.49

**Average Daily Temperature Readings
Crystal Falls Hydroelectric Project (Downstream of Dam)
August 2007**



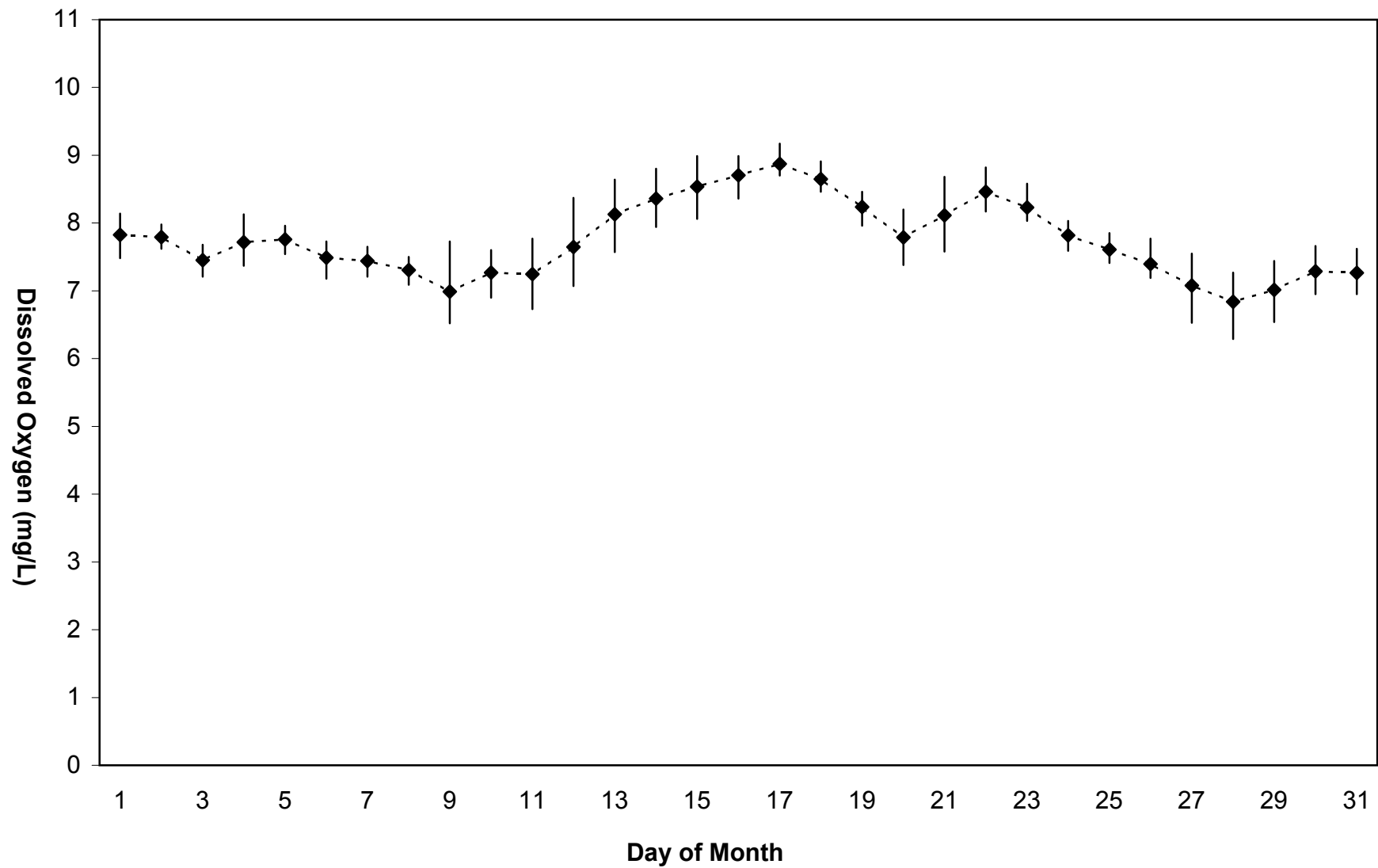
APPENDIX F

Downstream Dissolved Oxygen Monitoring

Hourly Dissolved Oxygen Readings: Crystal Falls Hydroelectric Project (Downstream of Dam), July 2007

Time	Day of Month																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	8.03	7.98	7.56	7.38	7.96	7.73	7.65	7.48	7.05	7.59	7.26	7.59	8.20	8.50	8.58	8.90	8.85	8.91	8.46	7.98	8.20	8.42	8.58	8.03	7.53	7.77	7.26	7.18	7.26	7.19	7.28
1:00a	7.95	7.98	7.51	7.37	7.89	7.73	7.61	7.47	6.94	7.60	7.14	7.50	8.10	8.42	8.43	8.84	8.84	8.84	8.40	7.86	8.24	8.35	8.54	8.02	7.47	7.76	7.20	7.10	7.18	7.28	7.26
2:00a	7.86	7.96	7.44	7.42	7.83	7.59	7.54	7.45	6.84	7.55	7.02	7.44	8.03	8.32	8.36	8.72	8.77	8.81	8.32	7.76	8.20	8.31	8.53	8.01	7.45	7.65	7.14	6.95	7.16	7.33	7.29
3:00a	7.77	7.94	7.39	7.45	7.80	7.54	7.46	7.44	6.75	7.49	6.95	7.40	7.94	8.24	8.29	8.63	8.76	8.73	8.25	7.65	8.14	8.32	8.53	7.98	7.41	7.59	7.02	6.82	7.07	7.33	7.35
4:00a	7.69	7.94	7.37	7.44	7.73	7.44	7.40	7.36	6.71	7.39	6.89	7.34	7.85	8.16	8.22	8.59	8.77	8.66	8.17	7.56	8.05	8.32	8.49	8.03	7.45	7.54	6.95	6.68	6.98	7.21	7.29
5:00a	7.61	7.88	7.32	7.47	7.66	7.37	7.33	7.28	6.67	7.28	6.84	7.28	7.77	8.07	8.15	8.55	8.75	8.58	8.16	7.48	7.96	8.35	8.39	8.00	7.44	7.48	6.85	6.57	6.86	7.12	7.16
6:00a	7.54	7.87	7.28	7.46	7.62	7.29	7.29	7.22	6.61	7.16	6.78	7.19	7.68	8.00	8.10	8.48	8.71	8.56	8.09	7.42	7.85	8.29	8.27	7.87	7.46	7.45	6.75	6.44	6.72	7.07	7.10
7:00a	7.48	7.83	7.25	7.45	7.58	7.25	7.26	7.15	6.56	7.06	6.73	7.12	7.65	7.94	8.06	8.41	8.72	8.56	8.04	7.39	7.75	8.25	8.17	7.73	7.47	7.39	6.63	6.34	6.64	7.03	7.05
8:00a	7.48	7.78	7.21	7.49	7.54	7.18	7.24	7.15	6.54	6.96	6.75	7.08	7.60	7.98	8.06	8.36	8.71	8.57	8.02	7.38	7.66	8.18	8.12	7.66	7.49	7.35	6.56	6.29	6.55	6.95	6.95
9:00a	7.52	7.71	7.21	7.53	7.56	7.19	7.21	7.12	6.52	6.94	6.81	7.07	7.57	8.00	8.09	8.37	8.70	8.54	7.96	7.41	7.62	8.20	8.10	7.63	7.48	7.28	6.53	6.30	6.54	6.95	6.96
10:00a	7.57	7.68	7.21	7.55	7.61	7.23	7.21	7.13	6.54	6.91	6.89	7.11	7.66	8.00	8.18	8.42	8.72	8.58	7.99	7.46	7.58	8.17	8.08	7.59	7.52	7.29	6.57	6.36	6.59	6.96	6.97
11:00a	7.58	7.64	7.27	7.66	7.67	7.29	7.27	7.18	6.56	6.92	7.02	7.18	7.78	8.05	8.31	8.52	8.70	8.58	8.03	7.55	7.60	8.24	8.10	7.64	7.56	7.32	6.66	6.44	6.66	6.99	7.07
12:00p	7.68	7.63	7.36	7.68	7.72	7.34	7.38	7.22	6.63	6.90	7.18	7.34	7.91	8.13	8.42	8.62	8.73	8.62	8.14	7.63	7.67	8.31	8.11	7.74	7.60	7.38	6.89	6.57	6.75	7.10	7.20
1:00p	7.79	7.68	7.41	7.78	7.76	7.39	7.36	7.27	6.70	6.97	7.32	7.51	8.06	8.25	8.52	8.71	8.84	8.68	8.25	7.73	7.81	8.41	8.14	7.75	7.63	7.25	7.05	6.70	6.88	7.22	7.26
2:00p	7.85	7.75	7.52	7.78	7.79	7.42	7.41	7.36	6.77	7.05	7.43	7.65	8.21	8.37	8.65	8.74	8.84	8.73	8.32	7.80	7.98	8.50	8.10	7.76	7.67	7.28	7.22	6.85	6.98	7.32	7.34
3:00p	7.90	7.76	7.60	7.84	7.82	7.50	7.48	7.44	6.78	7.12	7.48	7.80	8.33	8.49	8.75	8.76	8.92	8.70	8.36	7.86	8.12	8.61	8.15	7.85	7.76	7.33	7.35	7.00	7.15	7.39	7.45
4:00p	7.97	7.77	7.65	7.91	7.83	7.53	7.51	7.45	6.91	7.34	7.53	7.96	8.47	8.58	8.88	8.79	9.01	8.73	8.38	7.92	8.30	8.70	8.11	7.89	7.79	7.19	7.46	7.08	7.27	7.48	7.62
5:00p	8.01	7.77	7.68	8.03	7.82	7.59	7.56	7.50	7.62	7.52	7.61	8.09	8.57	8.65	8.93	8.82	9.15	8.68	8.41	8.01	8.41	8.76	8.17	7.84	7.83	7.24	7.55	7.17	7.43	7.56	7.52
6:00p	8.09	7.79	7.68	8.08	7.83	7.64	7.59	7.45	7.73	7.52	7.68	8.22	8.61	8.72	8.98	8.89	9.17	8.62	8.41	8.14	8.53	8.77	8.20	7.81	7.85	7.23	7.48	7.21	7.44	7.66	7.48
7:00p	8.14	7.80	7.67	8.13	7.87	7.67	7.57	7.39	7.66	7.53	7.76	8.32	8.64	8.79	8.98	8.99	9.16	8.62	8.42	8.19	8.63	8.82	8.21	7.86	7.79	7.31	7.45	7.23	7.38	7.63	7.46
8:00p	8.12	7.81	7.65	8.10	7.87	7.71	7.61	7.30	7.73	7.50	7.73	8.37	8.64	8.80	8.99	8.98	9.11	8.68	8.41	8.19	8.68	8.82	8.18	7.81	7.73	7.33	7.40	7.27	7.34	7.59	7.47
9:00p	8.08	7.76	7.60	8.07	7.88	7.72	7.59	7.25	7.69	7.46	7.77	8.34	8.63	8.76	8.98	8.99	9.07	8.58	8.33	8.17	8.64	8.72	8.13	7.78	7.71	7.40	7.36	7.20	7.22	7.59	7.38
10:00p	8.06	7.70	7.52	8.09	7.83	7.73	7.51	7.15	7.63	7.39	7.72	8.31	8.60	8.74	8.97	8.92	8.99	8.54	8.25	8.15	8.58	8.63	8.10	7.72	7.68	7.37	7.30	7.19	7.14	7.52	7.24
11:00p	8.03	7.62	7.46	8.06	7.76	7.69	7.49	7.09	7.58	7.31	7.66	8.26	8.59	8.68	8.98	8.88	8.94	8.46	8.12	8.20	8.49	8.59	8.03	7.66	7.80	7.33	7.23	7.22	7.11	7.39	7.18
Max.	8.14	7.98	7.68	8.13	7.96	7.73	7.65	7.50	7.73	7.60	7.77	8.37	8.64	8.80	8.99	8.99	9.17	8.91	8.46	8.20	8.68	8.82	8.58	8.03	7.85	7.77	7.55	7.27	7.44	7.66	7.62
Min.	7.48	7.62	7.21	7.37	7.54	7.18	7.21	7.09	6.52	6.90	6.73	7.07	7.57	7.94	8.06	8.36	8.70	8.46	7.96	7.38	7.58	8.17	8.03	7.59	7.41	7.19	6.53	6.29	6.54	6.95	6.95
Avg.	7.83	7.79	7.45	7.72	7.76	7.49	7.44	7.30	6.99	7.27	7.25	7.64	8.13	8.36	8.54	8.70	8.87	8.65	8.24	7.79	8.11	8.46	8.23	7.82	7.61	7.40	7.08	6.84	7.01	7.29	7.26

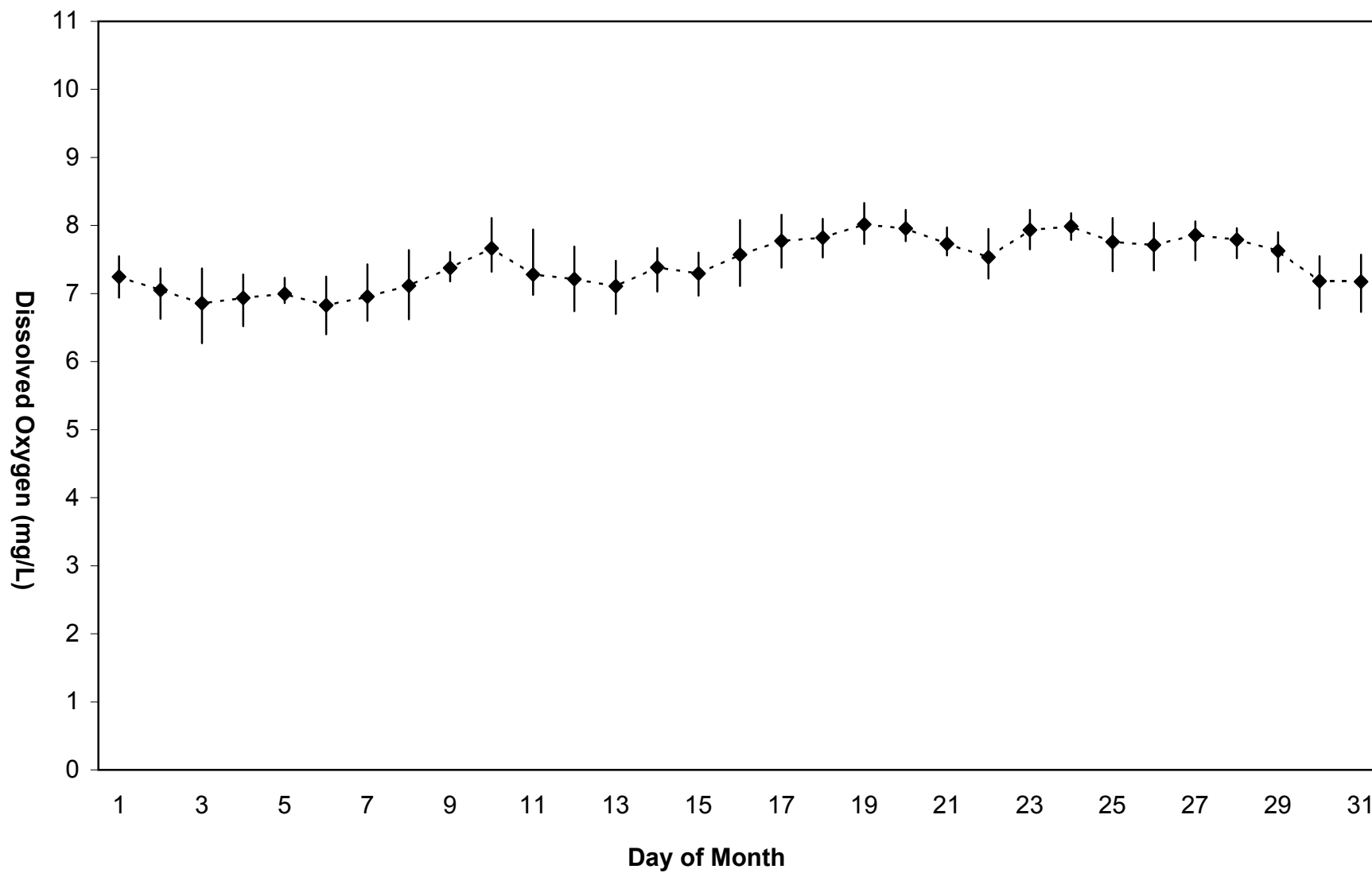
**Average Daily Dissolved Oxygen Readings
Crystal Falls Hydroelectric Project (Downstream of Dam)
July 2007**



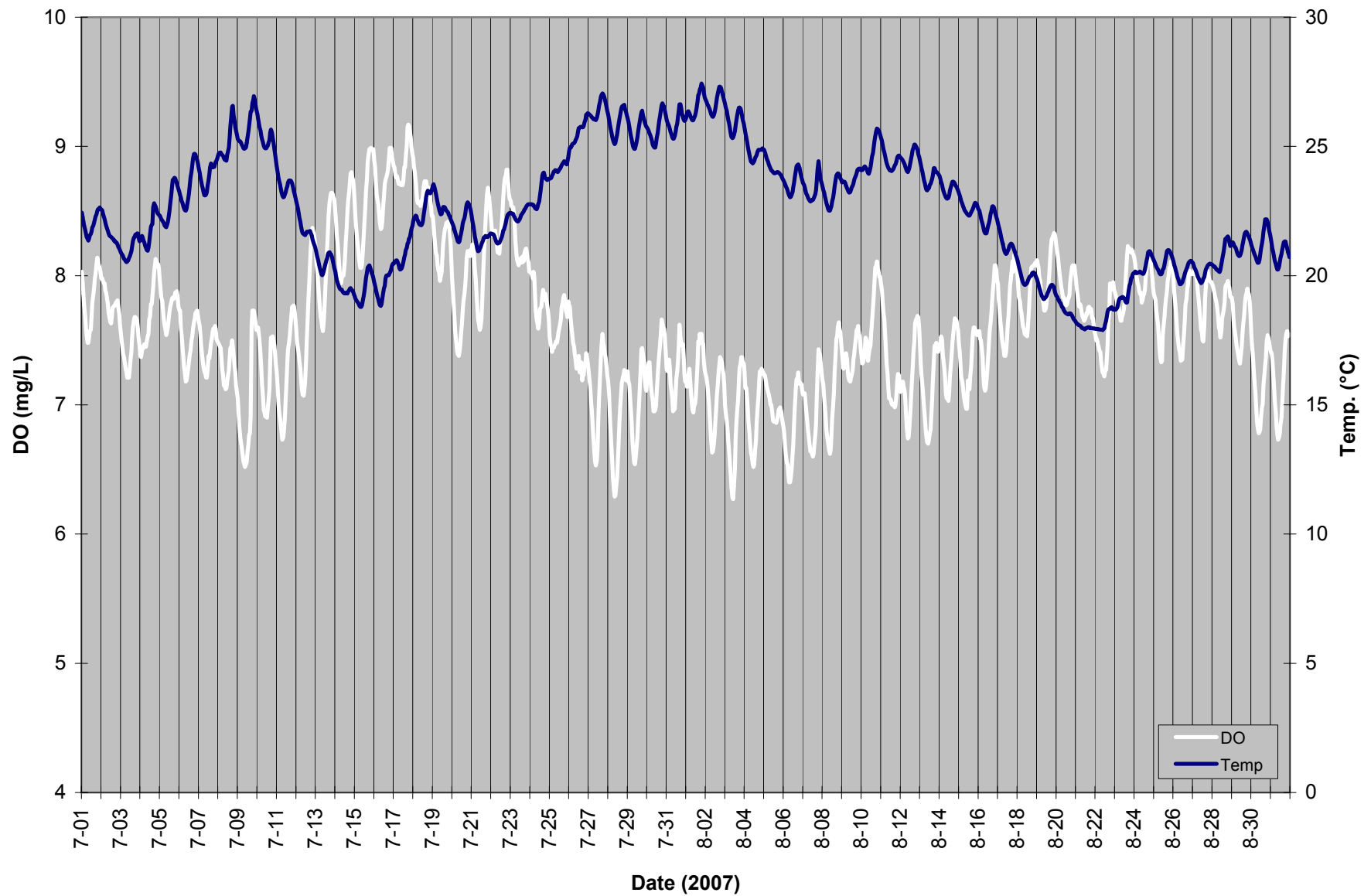
Hourly Dissolved Oxygen Readings: Crystal Falls Hydroelectric Project (Downstream of Dam), August 2007

	Day of Month																														
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	7.20	7.24	7.00	7.25	7.23	6.82	7.08	7.19	7.40	7.37	7.94	7.10	7.46	7.43	7.48	7.57	7.94	8.00	8.12	8.23	7.97	7.54	7.87	8.14	7.86	7.99	8.01	7.93	7.83	7.55	7.41
1:00a	7.14	7.21	6.94	7.13	7.23	6.76	7.09	7.16	7.33	7.32	7.89	7.13	7.32	7.46	7.40	7.57	7.82	7.91	8.09	8.18	7.91	7.50	7.85	8.09	7.83	7.88	8.02	7.91	7.78	7.46	7.40
2:00a	7.15	7.17	6.88	7.13	7.20	6.67	7.09	7.05	7.28	7.33	7.80	7.11	7.23	7.53	7.30	7.51	7.72	7.83	8.06	8.14	7.85	7.51	7.82	8.02	7.81	7.80	8.06	7.88	7.66	7.36	7.35
3:00a	7.23	7.11	6.81	7.06	7.15	6.61	7.02	6.98	7.33	7.36	7.72	7.18	7.15	7.51	7.21	7.50	7.64	7.80	7.99	8.07	7.80	7.47	7.78	7.98	7.73	7.73	8.03	7.85	7.60	7.26	7.23
4:00a	7.28	7.02	6.73	6.97	7.12	6.55	6.96	6.90	7.38	7.43	7.66	7.14	7.07	7.40	7.18	7.45	7.59	7.74	7.96	8.02	7.76	7.45	7.75	7.94	7.68	7.64	8.00	7.82	7.56	7.18	7.14
5:00a	7.20	6.92	6.63	6.87	7.10	6.54	6.88	6.80	7.40	7.52	7.55	7.11	6.99	7.34	7.13	7.37	7.52	7.71	7.89	7.96	7.78	7.42	7.75	7.92	7.62	7.55	7.96	7.79	7.50	7.08	7.03
6:00a	7.11	6.82	6.54	6.78	7.08	6.46	6.81	6.74	7.35	7.51	7.44	7.03	6.89	7.29	7.07	7.23	7.46	7.66	7.85	7.91	7.76	7.41	7.70	7.88	7.53	7.48	7.89	7.75	7.45	6.97	6.94
7:00a	7.01	6.72	6.46	6.69	7.04	6.40	6.76	6.70	7.26	7.47	7.32	6.91	6.81	7.19	7.03	7.14	7.43	7.60	7.81	7.88	7.72	7.33	7.65	7.86	7.43	7.43	7.82	7.68	7.42	6.87	6.83
8:00a	6.96	6.63	6.36	6.63	7.00	6.40	6.69	6.66	7.21	7.34	7.24	6.81	6.75	7.08	6.99	7.11	7.38	7.59	7.78	7.83	7.69	7.29	7.65	7.87	7.37	7.41	7.75	7.60	7.37	6.82	6.77
9:00a	6.94	6.64	6.28	6.59	7.00	6.44	6.64	6.62	7.19	7.39	7.13	6.74	6.71	7.05	6.97	7.13	7.38	7.55	7.73	7.83	7.67	7.25	7.69	7.79	7.33	7.34	7.68	7.58	7.34	6.78	6.73
10:00a	6.99	6.68	6.27	6.54	6.94	6.49	6.64	6.65	7.18	7.43	7.05	6.75	6.70	7.05	6.97	7.19	7.41	7.54	7.73	7.82	7.65	7.24	7.70	7.81	7.34	7.35	7.58	7.52	7.32	6.79	6.75
11:00a	7.01	6.76	6.37	6.52	6.88	6.61	6.63	6.76	7.21	7.46	7.05	6.82	6.73	7.03	7.19	7.27	7.49	7.57	7.75	7.78	7.66	7.22	7.74	7.85	7.54	7.35	7.56	7.57	7.37	6.81	6.78
12:00p	7.06	6.87	6.50	6.54	6.87	6.70	6.60	6.89	7.23	7.56	7.04	6.94	6.77	7.10	7.12	7.39	7.60	7.53	7.80	7.77	7.68	7.26	7.80	7.86	7.62	7.45	7.50	7.67	7.45	6.90	6.85
1:00p	7.17	6.96	6.74	6.66	6.87	6.85	6.62	7.00	7.27	7.64	7.01	7.06	6.81	7.22	7.12	7.49	7.70	7.60	7.84	7.78	7.71	7.27	7.93	7.89	7.68	7.55	7.49	7.70	7.54	6.98	6.90
2:00p	7.32	7.07	6.86	6.72	6.87	6.98	6.69	7.09	7.35	7.75	7.00	7.17	6.93	7.31	7.22	7.58	7.81	7.72	7.91	7.81	7.70	7.36	8.06	7.98	7.76	7.65	7.61	7.73	7.62	7.01	7.02
3:00p	7.49	7.16	6.95	6.86	6.86	7.12	6.77	7.25	7.39	7.84	7.01	7.27	7.04	7.39	7.30	7.63	7.92	7.84	8.00	7.83	7.75	7.46	8.16	8.06	7.82	7.78	7.82	7.79	7.69	7.15	7.14
4:00p	7.47	7.25	7.04	6.96	6.88	7.20	6.86	7.39	7.45	7.95	6.99	7.42	7.19	7.48	7.42	7.72	7.99	7.95	8.10	7.85	7.76	7.65	8.23	8.13	7.88	7.82	7.91	7.91	7.78	7.24	7.24
5:00p	7.55	7.31	7.18	7.06	6.92	7.19	7.07	7.51	7.52	8.06	6.98	7.49	7.34	7.56	7.53	7.82	8.05	8.06	8.20	7.95	7.75	7.72	8.21	8.16	7.96	7.90	8.01	7.93	7.84	7.31	7.42
6:00p	7.51	7.37	7.29	7.18	6.96	7.25	7.24	7.53	7.58	8.08	7.00	7.63	7.46	7.62	7.60	7.90	8.11	8.07	8.28	8.00	7.73	7.94	8.21	8.18	7.99	7.93	8.04	7.93	7.86	7.37	7.50
7:00p	7.55	7.35	7.32	7.26	6.97	7.18	7.43	7.60	7.58	8.11	7.08	7.66	7.45	7.67	7.60	7.98	8.03	8.07	8.29	8.06	7.74	7.89	8.19	8.18	8.06	8.01	8.01	7.96	7.90	7.49	7.55
8:00p	7.48	7.33	7.37	7.24	6.98	7.16	7.40	7.64	7.61	8.06	7.19	7.67	7.48	7.66	7.58	8.08	8.16	8.08	8.31	8.08	7.67	7.90	8.18	8.15	8.06	8.04	7.98	7.92	7.87	7.54	7.57
9:00p	7.47	7.30	7.37	7.28	6.95	7.17	7.39	7.59	7.55	8.03	7.24	7.69	7.44	7.65	7.56	8.08	8.16	8.09	8.33	8.07	7.67	7.93	8.20	8.07	8.11	8.01	7.96	7.91	7.86	7.52	7.53
10:00p	7.33	7.23	7.32	7.26	6.90	7.16	7.32	7.56	7.52	7.99	7.23	7.68	7.41	7.60	7.54	8.05	8.16	8.10	8.32	8.08	7.62	7.95	8.17	7.99	8.09	8.02	7.95	7.84	7.79	7.49	7.55
11:00p	7.27	7.15	7.32	7.25	6.86	7.11	7.24	7.47	7.44	7.99	7.16	7.59	7.44	7.58	7.56	7.96	8.09	8.08	8.28	8.02	7.56	7.89	8.16	7.91	8.07	8.02	7.95	7.83	7.68	7.43	7.54
Max.	7.55	7.37	7.37	7.28	7.23	7.25	7.43	7.64	7.61	8.11	7.94	7.69	7.48	7.67	7.60	8.08	8.16	8.10	8.33	8.23	7.97	7.95	8.23	8.18	8.11	8.04	8.06	7.96	7.90	7.55	7.57
Min.	6.94	6.63	6.27	6.52	6.86	6.40	6.60	6.62	7.18	7.32	6.98	6.74	6.70	7.03	6.97	7.11	7.38	7.53	7.73	7.77	7.56	7.22	7.65	7.79	7.33	7.34	7.49	7.52	7.32	6.78	6.73
Avg.	7.25	7.05	6.86	6.93	6.99	6.83	6.96	7.11	7.38	7.67	7.28	7.21	7.11	7.38	7.29	7.57	7.77	7.82	8.02	7.96	7.73	7.54	7.94	7.99	7.76	7.71	7.86	7.79	7.63	7.18	7.17

**Average Daily Dissolved Oxygen Readings
Crystal Falls Hydroelectric Project (Downstream of Dam)
August 2007**



2007: Dissolved oxygen and temperature at Crystal Falls Hydroelectric Project, downstream



APPENDIX G

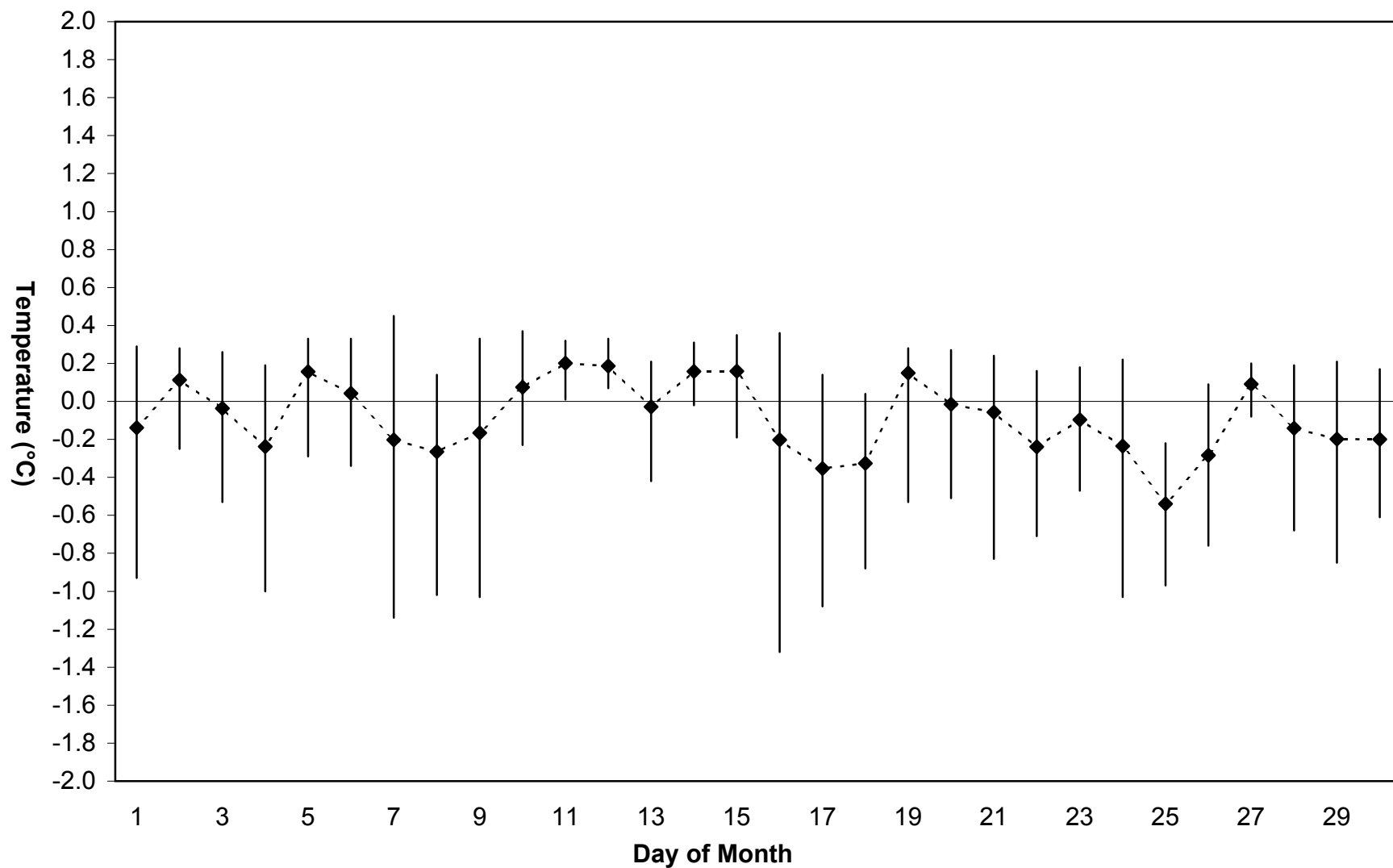
Comparison Between Hourly Temperatures at Sites

Hourly Delta Temperature Calculations: Crystal Falls Hydroelectric Project (Downstream Minus Upstream), July 2007

Time	Day of Month																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	0.1	-0.3	0.2	-0.8	0.2	0.3	0.1	-0.7	0.2	-0.2	0.3	0.3	0.2	0.2	0.2	-1.0	-0.8	-0.5	0.3	0.0	-0.6	-0.5	-0.3	-0.4	-0.6	0.1	0.0	0.0	-0.5	-0.5	
1:00a	0.2	-0.1	0.3	-1.0	0.1	0.3	0.1	-0.7	0.2	-0.1	0.3	0.3	0.2	0.1	0.1	0.2	-0.9	-0.7	-0.1	0.3	0.1	-0.5	-0.4	-0.1	-0.6	-0.4	0.0	0.2	0.1	-0.5	-0.3
2:00a	0.2	-0.1	0.1	-0.8	0.2	0.3	0.2	-0.3	0.2	0.0	0.3	0.2	0.1	0.1	0.4	0.2	-0.6	-0.4	-0.1	0.2	0.1	-0.2	-0.2	0.0	-0.6	-0.3	0.1	0.1	0.0	-0.2	-0.3
3:00a	0.2	0.0	0.2	-0.5	0.3	0.3	0.4	-0.2	0.2	-0.1	0.3	0.3	0.1	0.3	0.3	0.2	-0.4	-0.3	0.1	0.3	0.1	-0.1	-0.1	-0.1	-0.7	-0.3	0.2	0.1	0.0	-0.2	-0.2
4:00a	0.3	0.1	0.3	-0.3	0.3	0.2	0.3	0.1	0.3	0.2	0.3	0.1	0.1	0.2	0.3	0.2	-0.2	-0.1	0.1	0.3	0.1	0.0	0.0	0.1	-0.9	-0.1	-0.1	0.1	0.1	0.0	0.0
5:00a	0.2	0.1	0.2	-0.2	0.3	0.2	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.3	0.0	0.0	-0.1	0.2	0.1	0.1	0.0	0.2	0.2	-1.0	0.0	0.1	0.2	0.2	-0.1	0.0
6:00a	0.2	0.1	0.2	-0.3	0.3	0.3	0.2	0.0	0.3	0.2	0.1	0.2	0.1	0.2	0.2	0.3	0.1	0.0	0.3	0.2	0.2	0.1	0.2	0.2	-0.8	0.0	0.2	0.2	0.1	0.1	0.1
7:00a	0.2	0.1	0.1	0.0	0.2	0.2	0.2	0.1	0.3	0.1	0.2	0.3	0.2	0.2	0.3	0.4	0.1	0.0	0.2	0.2	0.2	0.2	0.1	0.2	-0.6	0.1	0.1	0.1	0.1	0.2	0.1
8:00a	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.0	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.2	0.1	0.0	0.3	0.2	0.2	0.1	0.1	0.2	-0.5	0.0	0.1	0.2	0.2	0.1	0.1
9:00a	0.0	0.2	0.2	0.1	0.2	0.1	0.1	0.0	0.2	0.1	0.2	0.2	0.2	0.1	0.3	0.0	0.1	0.0	0.3	0.1	0.1	0.1	0.1	0.0	-0.6	-0.1	0.1	0.1	0.2	0.1	0.2
10:00a	0.0	0.2	0.2	-0.2	0.1	0.2	0.0	-0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.0	-0.1	0.3	0.1	0.1	0.0	0.1	0.0	-0.5	-0.3	0.2	0.1	0.1	0.1	0.3
11:00a	-0.1	0.1	0.0	-0.3	0.1	0.0	-0.1	-0.2	0.0	0.0	0.0	0.2	0.0	0.1	0.0	-0.2	-0.1	0.0	0.2	0.1	0.1	-0.1	0.0	0.0	-0.6	-0.2	*	0.0	-0.2	0.0	0.0
12:00p	-0.1	0.1	0.1	-0.4	0.0	0.0	-0.1	-0.2	-0.2	0.0	0.2	0.1	-0.1	0.1	0.0	-0.3	-0.2	-0.2	0.2	0.0	-0.2	-0.1	-0.1	0.1	-0.4	-0.5	0.1	-0.2	-0.4	0.0	-0.2
1:00p	-0.4	0.1	-0.3	-0.4	0.2	-0.1	-0.1	-0.5	-0.3	-0.2	0.1	0.1	-0.2	0.1	0.0	-0.3	-0.1	0.0	0.2	-0.1	-0.2	-0.2	-0.1	0.0	-0.5	-0.3	0.1	-0.3	-0.3	-0.1	-0.3
2:00p	-0.4	0.1	0.0	-0.1	-0.1	-0.2	-0.5	-0.3	-0.4	-0.2	0.1	0.2	-0.4	0.0	0.0	-0.6	-0.2	0.0	0.3	-0.2	0.0	-0.1	-0.1	0.0	-0.4	-0.4	0.1	-0.5	-0.2	-0.4	-0.4
3:00p	-0.3	0.2	-0.1	-0.2	-0.3	-0.3	-0.6	-1.0	-0.4	-0.1	0.2	0.2	-0.3	0.2	-0.1	-0.6	-0.3	-0.1	0.1	-0.3	0.0	-0.3	-0.2	-0.5	-0.3	-0.3	0.0	-0.6	-0.2	-0.2	-0.5
4:00p	-0.2	0.1	0.0	-0.3	0.0	0.0	-0.4	-1.0	-0.6	0.0	0.2	0.2	-0.3	0.0	-0.2	-0.4	-0.3	-0.2	0.2	-0.4	-0.1	-0.2	-0.1	-1.0	-0.4	-0.5	0.0	-0.7	-0.2	-0.2	-0.6
5:00p	-0.2	0.1	-0.3	-0.1	0.1	-0.2	-0.4	-0.6	-0.5	0.0	0.2	0.2	-0.3	0.2	0.1	-0.4	-0.3	-0.5	0.2	-0.5	-0.1	-0.4	-0.1	-0.7	-0.5	-0.8	0.1	-0.4	-0.1	-0.4	-0.6
6:00p	-0.5	0.2	-0.4	-0.2	0.2	-0.3	-0.5	-0.2	-1.0	0.1	0.3	0.2	-0.3	0.1	0.2	-0.4	-0.3	-0.6	0.2	-0.3	-0.1	-0.4	-0.2	-0.8	-0.4	-0.7	0.1	-0.5	-0.5	-0.3	-0.7
7:00p	-0.3	0.1	-0.2	0.1	0.3	-0.1	-0.5	-0.1	-1.0	0.3	0.3	0.2	-0.2	0.1	0.1	-0.3	-0.3	-0.6	0.1	-0.4	0.0	-0.7	-0.1	-0.8	-0.2	-0.6	0.1	-0.5	-0.6	-0.2	-0.5
8:00p	-0.9	0.2	-0.5	-0.1	0.2	-0.1	-0.7	-0.2	-0.7	0.3	0.2	0.1	-0.1	0.2	0.1	-0.2	-0.6	-0.7	0.3	-0.3	0.0	-0.6	-0.2	-0.7	-0.3	-0.4	0.0	-0.5	-0.7	-0.4	-0.5
9:00p	-0.8	0.2	-0.5	0.0	0.3	-0.3	-1.0	-0.1	-0.5	0.3	0.3	0.1	-0.1	0.2	0.2	-0.8	-0.9	-0.8	0.3	-0.1	-0.6	-0.6	-0.3	-0.3	-0.6	-0.3	0.2	-0.4	-0.9	-0.5	-0.5
10:00p	-0.6	0.3	-0.5	0.1	0.3	0.1	-0.9	-0.2	-0.5	0.3	0.2	0.1	0.1	0.3	0.2	-1.3	-1.1	-0.9	0.2	-0.1	-0.8	-0.6	-0.3	-0.7	-0.7	-0.1	0.0	-0.2	-0.7	-0.5	-0.5
11:00p	-0.3	0.3	-0.3	0.1	0.3	-0.1	-1.1	0.0	-0.4	0.4	0.2	0.2	0.1	0.3	0.3	-1.0	-1.1	-0.9	0.2	0.0	-0.8	-0.7	-0.2	-0.5	-0.6	0.1	0.2	-0.1	-0.7	-0.6	-0.5
Max.	0.3	0.3	0.3	0.2	0.3	0.3	0.4	0.1	0.3	0.4	0.3	0.3	0.2	0.3	0.4	0.4	0.1	0.0	0.3	0.3	0.2	0.2	0.2	0.2	-0.2	0.1	0.2	0.2	0.2	0.2	0.3
Min.	-0.9	-0.3	-0.5	-1.0	-0.3	-0.3	-1.1	-1.0	-1.0	-0.2	0.0	0.1	-0.4	0.0	-0.2	-1.3	-1.1	-0.9	-0.5	-0.5	-0.8	-0.7	-0.5	-1.0	-1.0	-0.8	-0.1	-0.7	-0.9	-0.6	-0.7
Avg.	-0.1	0.1	0.0	-0.2	0.2	0.0	-0.2	-0.3	-0.2	0.1	0.2	0.2	0.0	0.2	0.2	-0.2	-0.4	-0.3	0.1	0.0	-0.1	-0.2	-0.1	-0.2	-0.5	-0.3	0.1	-0.1	-0.2	-0.2	-0.3

* Service point (missing data)

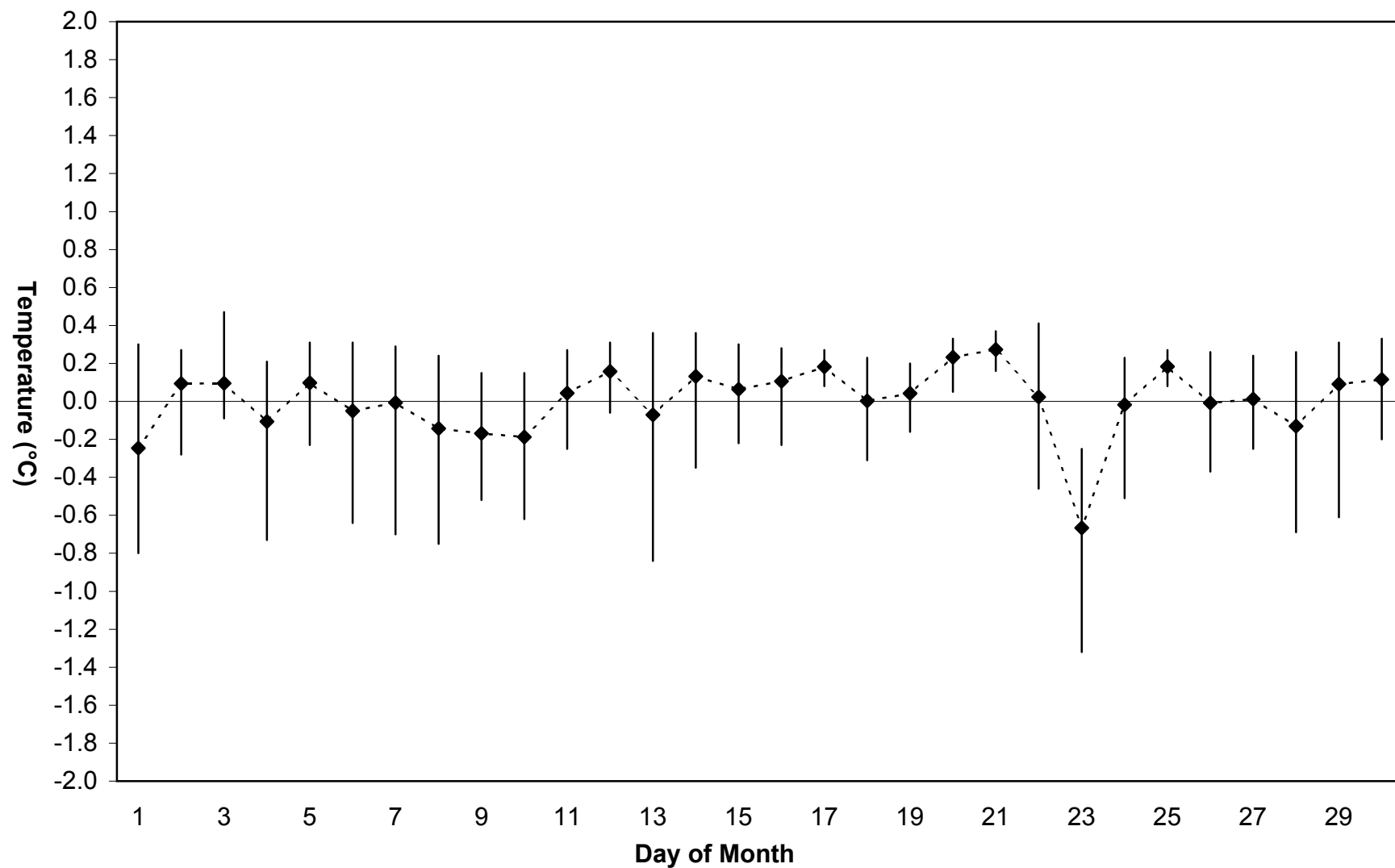
Average Delta Temperature Calculations: Crystal Falls Hydroelectric Project (Downstream Minus Upstream), July 2007



Hourly Delta Temperature Calculations: Crystal Falls Hydroelectric Project (Downstream Minus Upstream), August 2007

Time	Day of Month																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
12:00a	-0.8	-0.3	0.1	0.1	-0.2	0.3	-0.3	0.1	-0.5	-0.5	0.0	0.0	0.3	-0.3	0.3	0.0	0.1	0.2	0.1	0.1	0.2	0.3	-0.6	-0.5	0.2	0.2	0.0	-0.1	-0.6	0.3	0.1
1:00a	-0.6	-0.1	0.2	0.1	-0.2	0.3	-0.2	0.1	-0.4	-0.6	-0.1	-0.1	0.3	-0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.3	-0.5	-0.3	0.2	0.2	0.0	-0.2	-0.2	0.3	0.1
2:00a	-0.5	-0.2	0.2	0.2	0.0	0.2	-0.1	0.1	-0.5	-0.6	0.1	0.1	0.4	-0.2	0.2	0.1	0.3	0.2	0.1	0.1	0.2	0.3	-0.7	-0.3	0.2	0.2	0.1	0.0	-0.1	0.3	0.2
3:00a	-0.2	0.1	0.2	0.2	-0.1	0.3	0.0	0.2	-0.4	-0.4	-0.1	0.1	0.2	-0.1	0.2	0.3	0.2	0.1	0.1	0.1	0.3	0.3	-1.0	-0.2	0.2	0.2	0.1	0.1	0.0	0.3	0.1
4:00a	-0.1	0.0	0.1	0.1	0.0	0.3	0.1	0.2	-0.2	-0.2	0.1	0.2	0.3	0.0	0.2	0.1	0.1	0.2	0.1	0.2	0.2	0.3	-0.9	-0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.1
5:00a	0.0	0.1	0.1	0.2	-0.2	0.2	0.1	0.2	-0.1	0.0	0.1	0.2	0.3	0.1	0.2	0.2	0.2	0.1	0.1	0.3	0.3	0.3	-0.8	-0.2	0.2	0.3	0.2	0.1	0.1	0.3	0.1
6:00a	0.0	0.1	0.1	0.1	0.1	0.3	0.1	0.2	0.0	0.0	0.1	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.3	0.3	0.3	-0.6	-0.1	0.3	0.3	0.2	0.1	0.1	0.2	0.1
7:00a	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.2	0.3	0.4	-0.5	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.1
8:00a	0.2	0.2	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.3	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.3	0.3	-0.5	0.1	0.3	0.2	0.2	0.3	0.2	0.3	0.1
9:00a	0.2	0.1	0.0	0.2	0.2	0.3	0.3	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.2	0.3	0.4	0.3	-0.3	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.2
10:00a	0.3	0.2	0.1	-0.1	0.3	0.1	0.3	0.1	0.1	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.1	0.2	0.3	0.3	-0.4	0.2	0.2	0.1	0.1	0.2	0.3	0.1	0.2
11:00a	-0.3	0.2	0.1	0.0	0.3	0.1	0.2	0.1	0.1	0.0	0.3	0.3	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.3	0.2	0.2	-0.6	0.2	0.2	0.0	0.2	0.1	0.2	0.1	0.0
12:00p	-0.2	0.2	0.0	0.0	0.2	-0.1	0.0	-0.1	0.1	0.0	0.3	0.3	0.0	0.2	0.0	0.1	0.1	0.0	0.0	0.2	0.3	-0.1	-0.5	0.1	0.1	0.0	0.2	-0.1	0.2	0.0	0.2
1:00p	-0.2	0.1	0.0	0.0	0.2	-0.2	0.1	-0.3	-0.1	0.0	0.2	0.1	-0.2	0.2	0.0	0.1	0.1	-0.1	0.0	0.3	0.3	0.1	-0.6	0.0	0.1	-0.1	0.1	-0.1	0.2	0.0	0.0
2:00p	-0.3	0.0	-0.1	-0.4	0.2	-0.4	0.1	0.0	0.0	-0.3	0.2	0.1	-0.2	0.2	0.0	-0.1	0.1	-0.2	-0.1	0.3	0.3	-0.1	-0.3	0.0	0.1	0.0	0.1	-0.1	0.1	0.0	-0.2
3:00p	-0.2	0.1	0.0	-0.3	0.1	-0.1	0.0	-0.4	0.0	-0.3	0.2	0.2	-0.2	0.1	0.0	-0.2	0.2	-0.2	-0.1	0.2	0.3	-0.4	-0.4	-0.2	0.2	-0.3	0.0	-0.2	0.0	-0.2	-0.3
4:00p	-0.4	-0.1	0.0	-0.3	0.1	-0.4	0.1	-0.5	-0.1	-0.2	0.0	0.1	-0.2	0.1	-0.1	-0.1	0.2	-0.2	-0.1	0.2	0.3	-0.4	-0.7	-0.2	0.1	-0.2	-0.2	0.0	-0.1	-0.2	-0.2
5:00p	-0.5	0.0	0.0	-0.2	0.2	-0.1	-0.7	-0.5	-0.2	-0.5	0.0	0.1	-0.8	0.2	0.0	0.0	0.2	-0.3	-0.1	0.2	0.4	-0.3	-0.6	-0.1	0.2	-0.4	-0.2	-0.3	0.2	-0.1	-0.2
6:00p	-0.4	0.1	0.0	-0.2	0.1	-0.3	-0.5	-0.7	-0.2	-0.2	-0.2	0.1	-0.8	0.2	-0.2	0.1	0.3	-0.3	-0.2	0.3	0.3	-0.4	-0.7	0.1	0.2	-0.4	-0.2	-0.6	0.2	-0.1	-0.1
7:00p	-0.4	0.2	0.3	-0.2	0.1	-0.5	-0.2	-0.6	-0.3	-0.3	-0.2	0.2	-0.5	0.4	-0.1	0.2	0.2	-0.2	-0.1	0.3	0.3	-0.2	-1.0	0.1	0.2	-0.3	-0.2	-0.5	0.1	0.0	-0.2
8:00p	-0.3	0.2	0.1	-0.5	0.2	-0.5	-0.1	-0.5	-0.3	-0.2	-0.1	0.3	-0.4	0.3	-0.2	0.2	0.2	-0.1	-0.1	0.3	0.3	-0.3	-1.3	0.2	0.2	-0.3	-0.3	-0.6	0.2	0.1	-0.1
9:00p	-0.4	0.2	0.1	-0.7	0.3	-0.6	0.0	-0.8	-0.5	-0.3	-0.1	0.3	-0.2	0.2	-0.1	0.2	0.2	0.0	0.0	0.2	0.3	-0.5	-1.1	0.2	0.2	-0.2	-0.2	-0.7	0.1	0.1	-0.2
10:00p	-0.4	0.3	0.1	-0.5	0.2	-0.5	0.1	-0.4	-0.5	-0.1	-0.3	0.1	-0.4	0.3	-0.1	0.3	0.2	0.0	0.1	0.3	0.3	-0.3	-0.8	0.2	0.2	-0.1	-0.3	-0.6	0.2	0.1	-0.2
11:00p	-0.4	0.3	0.5	-0.4	0.2	-0.4	0.1	-0.4	-0.5	-0.2	0.0	0.3	-0.5	0.3	0.1	0.2	0.2	0.1	0.1	0.3	0.3	-0.4	-0.7	0.2	0.2	-0.1	-0.2	-0.5	0.3	0.1	-0.1
Max.	0.3	0.3	0.5	0.2	0.3	0.3	0.3	0.2	0.1	0.2	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.3	0.4	0.4	-0.3	0.2	0.3	0.3	0.2	0.3	0.3	0.3	0.2
Min.	-0.8	-0.3	-0.1	-0.7	-0.2	-0.6	-0.7	-0.8	-0.5	-0.6	-0.3	-0.1	-0.8	-0.3	-0.2	-0.2	0.1	-0.3	-0.2	0.1	0.2	-0.5	-1.3	-0.5	0.1	-0.4	-0.3	-0.7	-0.6	-0.2	-0.3
Avg.	-0.2	0.1	0.1	-0.1	0.1	-0.1	0.0	-0.1	-0.2	-0.2	0.0	0.2	-0.1	0.1	0.1	0.1	0.2	0.0	0.0	0.2	0.3	0.0	-0.7	0.0	0.2	0.0	0.0	-0.1	0.1	0.1	0.0

Average Delta Temperature Calculations: Crystal Falls Hydroelectric Project (Downstream Minus Upstream), Aug. 2007



APPENDIX H

Agency Comments to Draft Annual Report for 2002 Monitoring



STATE OF MICHIGAN

JENNIFER M. GRANHOLM
GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
LANSING

K. L. COOL
DIRECTOR

Refer to: 4202.2.76

January 3, 2003

Mr. Kent Premo
White Water Associates, Inc.
429 River Lane, P.O. Box 27
Amasa, MI 49903

Subject: City of Crystal Falls Hydroelectric Project (FERC No. 11402)
Comments on the 2002 Water Quality Monitoring Draft Report

Dear Mr. Premo:

The Michigan Department of Natural Resources (MDNR) is in receipt of your draft copy of the Water Quality Monitoring study dated December 13, 2002. In this report, results for the 2002 City of Crystal Falls Hydroelectric Project Water Quality Monitoring Plan were submitted. In addition, monitoring results were compared for the years 2000 through 2002.

Monitoring methods and results were in compliance with the Federal Energy Regulatory Commission (FERC) Order Approving Water Quality Monitoring Plan. Except for one instance explained by calibration error in 2001, the Crystal Falls Hydroelectric Project did not influence DO or water temperature beyond limits specified by the State of Michigan.

As a result of this compliance, White Water Associates, Inc. has asked for a reduced long-term monitoring schedule. Water quality monitoring is proposed on the frequency of once every five years with a reduction from June through September data collection to only mid-July through mid-August. It is further proposed that long term monitoring be conducted in the same manner as 2002.

MDNR is pleased with the three years of monitoring results. Because water quality violations could potentially occur at any time over the license period, MDNR agrees that is important to conduct periodic monitoring over the term of the license. MDNR concurs that long-term monitoring, beginning in 2007 and every five years thereafter, is appropriate. However, rather than limiting the monitoring to only mid-July through mid-August, MDNR would like to see monitoring include the entire two month low flow period of July and August. Two months of monitoring data during the low flow period will ensure detection of any water quality problems and provide resource protection. All monitoring and reporting protocols shall remain the same as conducted in 2002.

Thank you for the opportunity to comment. If you have any questions, please contact me.

Sincerely,

A handwritten signature in cursive script that reads "Jessica Mistak".

Jessica Mistak, Fisheries Biologist
Marquette Fisheries Station
484 Cherry Creek Rd
Marquette, MI 49855
906-249-1611 ext 308
mistakjl@michigan.gov

cc: Ms. Sharon Hanshue, MDNR
Ms. Janet Smith, USFS

APPENDIX I

Agency Comments to Draft Annual Report for 2007 Monitoring

Delivered-To: white-wa-kent.premo@white-water-associates.com
Date: Fri, 4 Jan 2008 15:13:20 -0500
X-Mailer: Groupwise 6.5
From: "Jessica Mistak" <mistakjl@michigan.gov>
Subject: Re: City of Crystal Falls Hydro Report (water quality)
To: "Premo, Kent" <kent.premo@white-water-associates.com>, "Yasenak, Tyler" <tyler_yasenak@fws.gov>
X-Antivirus: AVG for E-mail 7.5.516 [269.17.13/1206]

Kent,
The Michigan DNR has reviewed the Draft 2007 Water Quality Report for the City of Crystal Falls. Since no deviations were noted for either DO or temperature during the July and August study period, we have no additional comments.

Thank you for keeping us informed,
Jessica

Jessica Mistak, Senior Fisheries Biologist
DNR Marquette Fisheries Station
484 Cherry Creek Rd
Marquette, MI 49855
906-249-1611 ext. 308
FAX 906-249-3190

>>> Kent Premo <kent.premo@white-water-associates.com> 12/13/2007 11:37:29 AM >>>
Attached is a 57-page PDF (cf07_water_quality_report.pdf) of the draft 2007 water quality report for the City of Crystal Falls Hydroelectric Project (No. 11402-013) for your review and comment. Let me know if you wish to have a hard copy of the report and a CD-ROM including the report and raw data files and spreadsheets, the basis for graphs and tables presented here. Otherwise, I will plan to simply e-mail you the finished report upon its completion.

The report needs to be filed with FERC by February 15, 2008. Therefore, I'd like to have your comments by February 1 if possible.

Thanks very much for your consideration. Please reply to this message so I know you received it.

Best regards,

Kent Premo

Kent Premo
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Fax: (906) 822-7977
E-mail: kent.premo@white-water-associates.com
<http://www.white-water-associates.com>

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