Dickinson Conservation District

102 North Hooper Street
Kingsford, MI 49802

Phone: 906-774-8441
Fax: 906-774-0177

ORIGINAL

December 24, 2010

P-2712-000

Federal Energy Regulatory Commission
Attn: Secretary
Mail Code: DHAC, PJ-12.3
888 First Street, NE
Washington, DC 20426

Dear Sir or Madam;

Attached is the 2010 Report for the Sturgeon Falls Hydro Project Water Quality Monitoring Study (Temperature and Dissolved Oxygen) conducted by the Dickinson Conservation District for the City of Norway (MI) to fulfill the requirements of their FERC License's Water Quality Certification's Conditions. The study included hourly water temperature and dissolved oxygen monitoring at three locations respective to the Sturgeon Falls Project from May 1 through Sept 30, 2010. Measurements were taken with three submersible, portable continuous reading instruments (Manta2 Multiprobes). As per the agreed upon Monitoring Plan, three locations were targeted for sampling: (1) the tailrace of the Sturgeon Falls Project; (2) the Sturgeon River at or near Highway 2, and (3) the Menominee River at or near Hwy 8. Per the Monitoring Plan, the following data items are included in this report : a) daily min, max and average Temp and DO for each site; b) all raw data; c) an explanation of any data gaps; d) presentation of any Temp or DO values that exceed of violate the water quality standards; e) a summary of quality assurance data. The above data items are found in Appendix C & D of the report.

In the period May 1 through Sept 30, 2010, the Temperature values for the Sturgeon Falls Project tail race met or exceeded the water quality standards as set forth by the MDEQ in the Project's FERC Licenses Conditions document, with the exception of two brief periods of elevated water temperatures. Those periods were: between the week between May 23 - June 2 and on the day of Sept 1. In these same periods, temperatures at the two upstream locations were also above the target values of 70F (May) and 74F (Sept), allowing the Sturgeon Falls Project to remain in compliance by comparison.

In the period May 1- Sept 30, 2010, all the Dissolved Oxygen values for the Sturgeon Falls Project tail race met or exceeded the water quality standards.

This report should reach you within the three month deadline following the end of the monitoring period, or by December 31, 2010. If you have any questions regarding the report or would like to receive the report in electronic form, feel free to contact me at the above address or by email: ann.hruska@mi.nacdnet.net.

Sincerely,

Ann E. Hruska

Ann E. Hruska, Project Manager
Dickinson Conservation District,
For the City of Norway

P-2720-000

Water Quality Monitoring Study: Temperature and Dissolved Oxygen

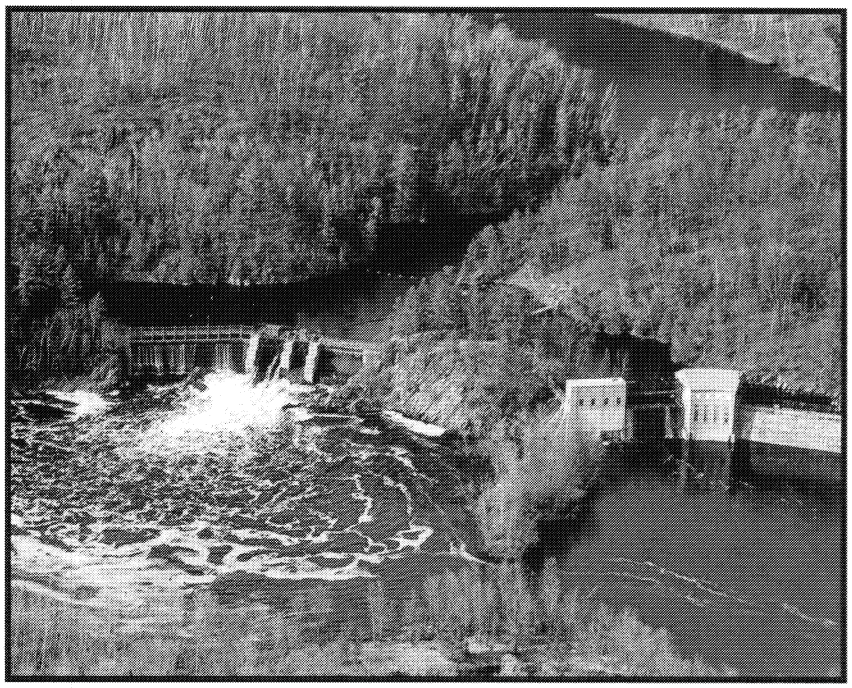
For the Period

May 1 - Oct 1, 2010

At three sites relative to the

Sturgeon Falls Hydro Project

Conducted for the City of Norway to fulfill the requirements of their FERC License



Study conducted by:
Dickinson Conservation District
102 N. Hooper Street Kingsford, MI 48902 (906) 774-8441
Ann Hruska, Project Manager

City of Norway
P.O. Box 99 (906) 563-8015
Norway, MI 49870
Ray Anderson, City Manager / Joe Pickart, Department of Power & Light

Water Quality Monitoring Study: Temperature and Dissolved Oxygen

For the Period

May 1 - Oct 1, 2010

At three sites relative to the

Sturgeon Falls Hydro Project

Conducted for the City of Norway to fulfill the requirements of their FERC License

Study conducted by:

Dickinson Conservation District

102 N. Hooper Street Kingsford, MI 48902

(906) 774-8441

Ann Hruska, Project Manager

Table of Contents

Background

On July 24, 2002, The Michigan Department of Environmental Quality (MDEQ) granted Water Quality Certification under section 401 of the Federal Clean Water Act to the City of Norway, Michigan for the Sturgeon Falls Hydroelectric Project with a set of twelve conditions. This report reflects water quality monitoring data collected to verify compliance with the Water Quality Certification's Condition (2) (Sturgeon Falls Water Quality Limitations) and a portion of Condition (3) (Water Quality Monitoring and Reporting) (Appendix A). Informally stated, the specific study contracted and reported on here includes hourly water temperature and dissolved oxygen monitoring in three locations respective to the Sturgeon Falls Project from May 1- Sept 30, 2010. The purpose of the study is to verify that the Sturgeon Falls Project does not alter the temperature and dissolved oxygen levels in the waters below the Project to levels beyond those specified by the MDEQ to maintain the biological health of the river ecosystem. Since the Sturgeon Falls Project is near the confluence of the Sturgeon and Menominee Rivers, upstream locations in both rivers act as the "controls" to provide comparative data out of the influence of the project.

The water quality monitoring was conducted by the Dickinson Conservation District, under contract by the City of Norway, owner and licensee of the Sturgeon Falls Hydroelectric Project. Specifics on the City's plan for implementation of the above Conditions are detailed in Section 2 of their *Water Quality Monitoring and Fish Tissue Plan*: *Temperature and Dissolved Oxygen Monitoring (The Plan)* prepared for the City by Mead & Hunt and approved by the MDEQ to satisfy the FERC license requirements. (Relevant sections may be found in Appendix A.)

Temperature and Dissolved Oxygen Monitoring

A. Monitoring Schedule

Temperature and dissolved oxygen (DO) monitoring are to be conducted from May 1 through September 30 in the year 2010, and from May 1 through Sept 30 at 5-year intervals thereafter for the duration of the term of the current FERC license.

- Three submersible, portable continuous recording instruments were deployed on April 26, 2010 and removed from the three different monitoring stations on October 1, 2010 to satisfy the 2010 monitoring cycle. The specific instruments purchased new by the City of Norway in February 2010, were Manta2 Multiprobes, which house both Dissolved Oxygen and Temperature sensors in one unit. A product and spec sheet for these units is included in Appendix B. The instruments (data loggers) were purchased from Eureka Environmental Engineering (www.eurekaenvironmental.com)
- Data was downloaded to a PC at 2 week intervals, with a couple exceptions.
- Individual units were always returned to the same monitoring site.

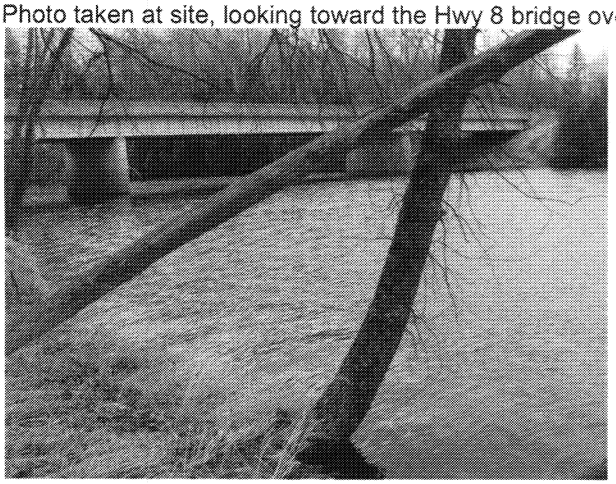
B. Monitoring Locations

The temperature and DO monitoring was conducted at representative locations upstream and downstream of the Sturgeon Falls Project according the locations targeted in the Water Quality Monitoring and Fish Tissue Plan. The targeted monitoring locations included: 1) the Menominee River at or near Highway 8 (upstream of project), 2) the Sturgeon River at or near Highway 2 (upstream of project), and 3) the tailrace of the Sturgeon Falls Project (downstream of project). The specific locations were chosen to consider vandalism avoidance, accessibility, and for depth consistency as much as possible. An aerial photo portraying the three monitoring locations is included in Appendix B. The following narrative further describes the three sites:

1) **The Menominee River at or Near Hwy 8**: About 100' U/S of the bridge, MI side, accessed by the utility road to a pump house for golf course water extraction from the river, west side of Hwy 8. The unit was chained to a tree about 20' U/S of the water extraction pipe. This location avoided the illicit activity under bridge and provided the greatest depth in close proximity to the shore of any of the sites. The logger was secured with a 15' piece of chain around a tree overhanging the water. The bottom substrate at this site was sand with scattered large cobble and woody debris.

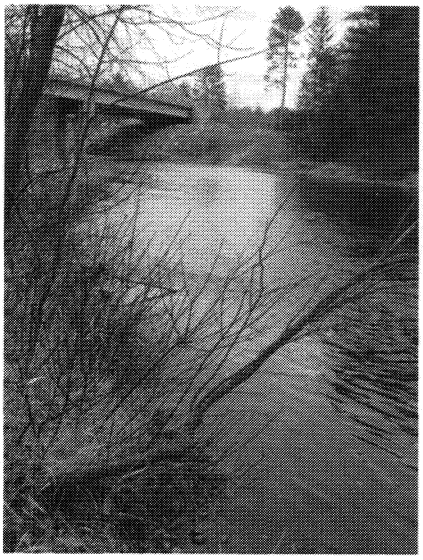
   The manufacturer's identification number for the Manta2 unit at this site was:
   #4100337- we called it or #7- Hwy 8.
   Water depth 4/23: 30", water depth at logger location 10/1: 42".
   GPS Location N45.75740 W087.92126 Elevation: 847'

   Photo taken at site, looking toward the Hwy 8 bridge over the Menominee River.



2) **The Sturgeon River at or near US 2**: About 230' D/S of the US 2 Bridge over the Sturgeon River, west bank, accessed by a utility road at SW corner of bridge. The unit was anchored to a USGS gauging station base and extended into the river with 30' of chain. More chain was used in this location than site 1 because the 2010 spring water depth in this section of the Sturgeon was so low that the unit had to be placed further out into the river to obtain even 12" of water depth. The bottom substrate at this location was small cobble and gravel.

   The manufacturer's identification number for the Manta2 unit at this site was:
   #4100339 – we called it #9-US 2
   Water depth 4/23: 16" 10/1-35"
   GPS Location N45.77621 W 087.82805 868 ft elev.



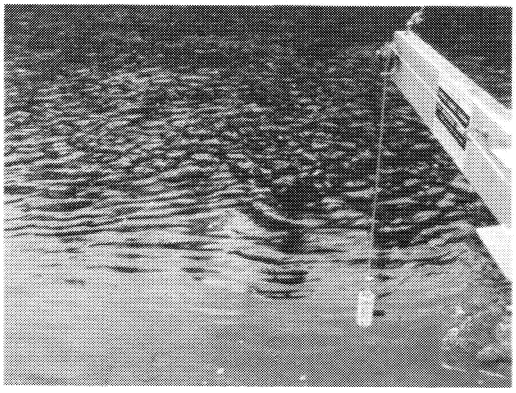
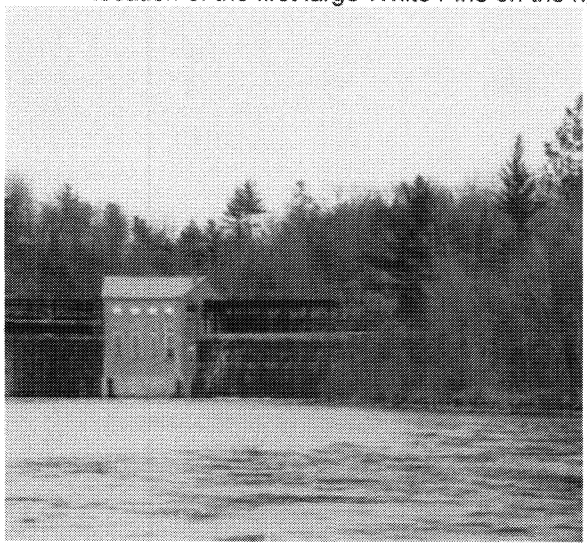


Photo taken at site, looking upstream to the US 2 Bridge (L) and from the gauging station.

3) **The tailrace of the Sturgeon Falls Project**: The monitoring site was about 300 ft below the dam (180 ft downstream of the Canoe Put In) on the east (MI) side of the river. The unit was chained to a tree and extended about 20 ft out into water, where is was partly anchored in the fork of a fallen tree. The bottom substrate was large cobble and large woody debris.
The manufacturer's identification number for the Manta2 unit:

4100338 or # 8 or Power Dam
Depth 4/26: 27" 10/1- 36"
GPS Location N45.74039 W087.86317 elev. 828

Photo taken looking upstream toward the dam and the monitoring site, which is near the location of the first large White Pine on the right below the dam.



C. Quality Assurance Plan

Quality Assurance was accomplished by means of bi-weekly data collection, regular instrument and sensor maintenance, component repair/replacement as needed, and routine calibration.

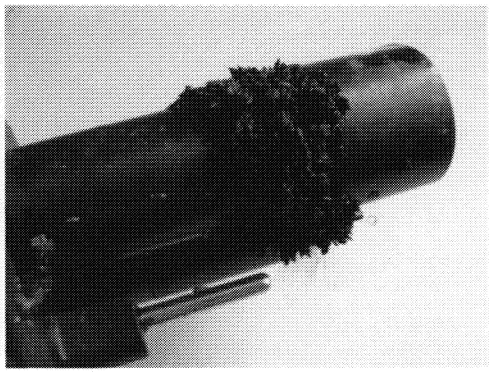
1. Data Collection Schedule:

According to discussions with the Manufacturer, the data loggers could easily record three months of data as configured. We opted to download data bi-weekly. We thought it important to capture data more frequently in case of instrument failure or ambient conditions that might impact their function. Data included in each download report included: DO mg/l, DO % Saturation, Temperature (Degrees Centigrade), % Cable Power. Temperature was later converted to Fahrenheit for direct comparison to MDEQ standards. DO% Saturation facilitated calibration. %Cable Power gave us an indication of battery strength and in some cases identified the reason for failure to capture data. Data was downloaded on the following dates: 5/19, 6/1, 6/16, 6/30, 7/6, 7/12, 7/26, 8/9, 8/23, 9/6, 9/15, and 10/1.

2. Regular instrument maintenance included:

a) Cleaning the data loggers and sensors:
Cleaning involved removal of the instrument from the water to gently scrub off collected algae, other biota (zebra mussels, macroivertebrates) and iron filings on a bi-weekly basis prior to data downloads. It was important to remove debris prior to battery replacement and sensor cleaning and calibration, so as not to contaminate the unit's O-ring seals. Maintenance needs proved variable during the summer, and the units experienced a rapid escalation of biofouling and iron filing fouling as the summer advanced into the warmth and higher water level of mid- late summer. The Power Dam site showed the highest degree of biofouling and iron filing collection throughout the summer. The iron filings often appeared to impede the circulator operation, which was included as a partner to the Clark type DO sensor for instances where water was not flowing freely around the sensor. Given the river flows where these units were deployed, this should not have been an issue.

b) Clark DO Sensor Maintenance:
The Clark-type dissolved-oxygen sensor comprises a gold cathode and silver anode immersed in a potassium-chloride electrolyte; the electrolyte is retained by a thin, oxygen-permeable membrane. If a voltage of roughly 0.8 V is imposed between the cathode and anode, any oxygen gas at the cathode is ionized, giving up electrons in the process. Those electrons are an electrical current through the electrolyte, between the cathode and anode, the magnitude of which is related to the amount of oxygen present in the air or water outside the membrane. The sensor output is corrected for the temperature characteristics of the membrane, and for the temperature characteristics of oxygen saturation in water. Because the Clark sensor consumes oxygen, you must usually have a circulator to prevent oxygen starvation at the outer surface of the membrane. Clark sensor maintenance involves replacing the membrane after cleaning the sensor and refilling its electrolyte. Care was taken to exclude bubbles in the electrolyte, and to install the membrane tautly with no wrinkles or holes, as per manufacturers' instructions (Section E6 of the Manta2 Operator's Manual). A maintenance kit was purchased from the manufacturer which included the membranes and electrolyte solution. There was no specific guidance on when the membranes would need replacement. We originally anticipated this to occur monthly, but adapted our regime to bi-weekly as membrane fouling became more apparent in the middle of summer. Membrane replacement coincided with all calibration events after 5/19.

Pictured above: The Power Dam Unit with a 2 week accumulation of biofouling and iron filings in mid- June. This level of fouling was only experienced in early-mid summer and had a rather swift onset, likely due to the unusually warm water temps.

c) Lubrication of seals: O-ring seals on the External Battery Pack and the Sensor Guard were lubricated with silicone-based lubricant/sealant supplied as part of the Maintenance Kit purchased from the Manufacturer. Lubrication occurred after every cleaning/download episode.

d) Battery replacement: Six double A (AA) batteries in an External Battery Pack are used to power the data loggers for their remote sensing deployment (away from a computer). We consulted the Eureka Environmental support staff about the projected battery life in the units we had purchased. Battery life was described to us as six weeks or more, dependent on deployment conditions, so once again we had to adapt our maintenance regime based on what we learned as the summer progressed. Batteries were checked after 1 month of logger deployment and it appeared that battery usage was not uniform across the three units. After mid- July we decided to install fresh batteries at every download event to eliminate loss of data while trying to keep track of battery power. Over the course of the summer, we discovered that data collection proceeded reliably until cable power fell below 4.0%.

Batteries were changed/checked as recorded below:

Hwy 8	US 2	Power Dam
6/1; 6/30; 7/26; 8/9; 8/23; 9/6 (Checked, still high); 9/15	6/16 (tested OK 6/1); 7/6; 7/26; 8/9; 8/23; 9/6 (Checked, still high); 9/15	6/1; 7/12; 7/26; 8/9; 8/23; 9/6 (Checked, still high); 9/15

e) Component replacement in the event of instrument malfunction: The "US 2" Manta2 logger was returned to the manufacturer for repair of the External Battery Pack connector. The unit failed to reinitiate logging operations after the data download of 8/20. The logger was sent to the manufacturer for repair (overnight FedEx) and returned to the water on 8/23. One of the data logger connection cords also malfunctioned at the beginning of the summer and was replaced. Due to late September damage to two of the data loggers from being bounced around in high water events, it would be our recommendation to return all three units to the manufacturer for refurbishing before their next deployment and within the 2 year warranty.

3. **Sensor calibration**: Sensor calibration is discussed in Section E of the Operation Handbook.
   a) **Temperature Sensor Calibration**
   (Section E5 Temperature: Manta2 Manual December 2008):
   "The Temperature sensor is an electrical resistor (thermistor) whose resistance changes predictably with temperature. The sensor is protected by a stainless-steel tube. Thermistors are very stable with time, and so do not require calibration." The accuracy of the temperature sensor on the Manta 2 is +/- 0.1 $^{\circ}$C. See Product Spec Sheet (Appendix B).

   To provide additional Quality Control, we purchased an NIST certified digital thermometer to

record the water temperature throughout the monitoring period at each site on the event of a data download. The thermometer has a 95% confidence rating and accuracy of +/- 1°C. See attached Certificate of Calibration.

A comparison of Manta2 vs their corresponding Digital Thermometer readings is presented in Appendix C. Considering a precision of 0.1 (and rounding Manta2 to nearest 0.1) the mean variance between the two temperature readings is 0.2°C for all three sites. We thought this acceptable evidence of the Manta2 temperature sensor accuracy throughout the course of the monitoring effort.

b) **Dissolved Oxygen**: Calibration of the DO sensor took place with each membrane change, which took place on the escalating schedule described under DO Sensor maintenance, response to the degree of biofouling of the sensor. Sensors were calibrated according to oral instructions from the Eureka Service representative for the air-saturated water method, which varied slightly from the instructions found in section E7 of the Manta2 Manual. Clark DO sensors require only one calibration point, in our case the calibration standard was considered to be 100% air saturated water.

A calibration log is recorded on each Manta2 unit. The data file Cal.log records every calibration the instrument accepted and includes the time and date of calibration, the parameter calibrated, the reading before calibration, and the reading after calibration was accepted. This data cannot be altered within Manta2. Also included in the Calibration Record is each calibration's Sensor Response Factor (SRF). According to mfr: An SRF of 80-120% is typical, though the sensor should perform within specifications with an SRF of 50-150%. SRF values in all cases were within this range. However, evaluation of the calibration values and data led us to conclude that there were obvious calibration errors that affected the DO values acquired by all three Manta 2 units. A software design engineer was consulted to help correct the error. Please see the discussion following the DO Calibration logs in Appendix C and graphs comparing the Raw versus Corrected DO data in Appendix D.

Specifications: Dissolved Oxygen Clark Sensor- (mg/l) Range 0-20 mg/l – Accuracy +/- 0.2 mg/l

D. Reporting of Data

a) Temperature Data

Raw data tables for hourly temperatures collected by the Manta2 data loggers at the US 2 Sturgeon River, Hwy 8 Menominee River, and Power Dam tail race can be found in Appendix D. The worksheets containing this data are labeled: "Raw Data US2"; "Raw Data Hwy 8", and "Raw Data Power Dam".

Daily minimum, maximum, and average temperature tables for all three monitoring sites are found in Appendix D. The tables are located on worksheets labeled "US 2 Avg_Min_Max"; "Hwy 8 Avg_Min_Max"; and "Power Dam Avg_Min_Max".

Graphs of the average daily temperatures in °F for the three sites vs the not to exceed temp are portrayed for the five month monitoring period in Appendix D. The comparative graph is located on the worksheet labeled "Temp Graphs" and is probably the easiest way to view the data.

Gaps in data are exhibited and explained in three worksheets labeled "Data Gaps US 2", "Data Gaps Hwy 8", and "Data Gaps Power Dam."

b) Dissolved Oxygen Data

Raw data for hourly dissolved oxygen levels in mg/l and % Saturation collected by the Manta2 data loggers at the US 2 Sturgeon River, Hwy 8 Menominee River, and Power Dam tail race can be found in Appendix D. DO data is combined with Temperature, Circulator Status, Cable Power_V (Battery strength), Sensor Response Factor (SRF)%, DO mg/l Corrected, and DO %

Sat Corrected. The worksheets containing this data are labeled: "Raw Data US2"; "Raw Data Hwy 8", and "Raw Data Power Dam".

Daily minimum, maximum, and average dissolved oxygen values (corrected values, see discussion in Appendix C) are found in Appendix D. The tables are located on worksheets labeled "US 2 Avg_Min_Max"; "Hwy 8 Avg_Min_Max"; and "Power Dam Avg_Min_Max".

A minimum of 5 mg/l DO is required for achievement of water quality standards as set forth in the FERC licensing agreement.

A graph of the comparing the average daily DO values for the three sites over the course of five months are portrayed on the worksheet labeled "DO Graphs" in Appendix D, and is probably the easiest way to view this data.

Gaps in data are exhibited and explained in three worksheets labeled "Data Gaps US 2", "Data Gaps Hwy 8", and "Data Gaps Power Dam."

E. Summary and Discussion of Data

In the period May 1 through September 30, 2010, the **Temperature** values for the Sturgeon Falls Project tail race met or exceeded the water quality standards as set forth by the MDEQ (now MDNRE) in the Project's FERC License Conditions document, with the exception of two brief periods of elevated water temperatures, the first being between 5/23 and 6/1/2010. In this brief period, temperatures at both the US 2 and Hwy 8 sites were also above the May target of < 70° F allowing the Sturgeon Falls Project to remain in compliance by comparison. Supplemental temperature data taken by the calibration thermometer were actually employed for the Power Dam location in the month of May to indicate this trend in lieu of Manta2 data (unfortunately the logger sensor failed to activate). This period of warm water temperatures was the likely product of a very dry spring (3.29" rainfall between Jan 1 and May 31), resultant low water depths, and a week of average maximum temps of 81 F and minimums of 49 F. It was difficult to find a 12" water depth in the US 2 location when the units were first deployed. Rainfalls in early June alleviated the low water conditions and set the water quality in a more positive direction. The second period above water quality standards was on Sept 1st, when once again all three locations registered average daily temps above the Sept target of <74°F. They were reflecting a late August trend of above normal daily highs (86.5 F), preceding a cooler period starting Sept 2nd. Sept also saw high rainfall totals (8.54") and flood flow conditions. With the exception of the exceptionally warm spring water temperatures, the trends in all three locations follow a typical trend toward warmer mid-summer temperatures and cooler spring and fall temperatures mirrored by the Water Quality Standard temperatures.

Overall, the Power Dam (downstream of Sturgeon Falls Project in the Menominee River) monitoring location showed the greatest similarity to readings at the Hwy 8 (Menominee River upstream of Project) location. Both sites have similar flows and depths. The US 2 site on the Sturgeon River (upstream of the Sturgeon Falls Project) showed more volatility in temperature readings and were generally below the readings of the other two locations once the June rains allowed water levels to rise. In the Temperature Graph, close inspection indicates that an additive effect is seen at the Sturgeon Falls Project that would likely have been seen had there been no dam there, since the Sturgeon River enters the Menominee River above the Sturgeon Falls Project, i.e. the cooler water of the Sturgeon River depresses the temperature of the Menominee River by a degree or two compared to the upstream location at Hwy 8.

In the period May 1 through September 30, 2010, the **Dissolved Oxygen** values for the Sturgeon Falls tail race met or exceeded the water quality standards as set for the by the MDEQ in the Projects' FERC License Conditions Document (all reading above 5 mg/l). Once again, the DO readings below the Power Dam portray an additive effect of the two upstream contributing waterbodies, with very few exceptions its DO values being intermediate between the Hwy 8 and US 2 values, as would be expected per its relative location.