

# **Baudette Estuary Dissolved Oxygen Impairment Verification And TMDL Development for AUID # 09030008-536 Final Report**

Mike Hirst  
Lake of the Woods  
Soil and Water Conservation District  
7/30/2011

## TABLE OF CONTENTS

<b>Grants Project Summary</b> .....	<b>3-6</b>
A. Grants Project Summary	
B. Executive Summary	
C. Goals	
D. Results	
E. Pictures	
F. Acronyms	
G. Partnerships	
H. Other Activities	
<b>Section I. Work Plan Review</b> .....	<b>7-12</b>
A. Work Plan Changes	
• Baudette River Monitoring Site Map	
B. Work Plan Review	
<b>Section II. Grant Results</b> .....	<b>13-24</b>
A. Measurements	
B. Deployed Sonde Data	
C. Open Water Season Data	
D. Storm Event Data	
• Storm Water Site Map	
E. Winter Monitoring Data	
F. 2010 Baudette Bay Transect Data	
• Baudette Estuary Transect Map	
G. Products Produced	
H. Participation and Outreach	
I. Long Term Results	
<b>Section III. Final Expenditures</b> .....	<b>25</b>
<b>Section IV. Appendices</b> .....	<b>26-29</b>
A. Acknowledgments	
B. Precipitation Data	
C. Rainy River Flow Data	
D. Update on Concerns Addressed from the Baudette River TMDL Report (2006)	
E. References	

## A. Grant Project Summary

Project title: Baudette Estuary Dissolved Oxygen Impairment Verification and TMDL Development  
Organization (Grantee): Lake of the Woods Soil and Water Conservation District  
Project start date: 6/16/2008 Project end date: 6/30/2011 Report submittal date: 7/30/2011  
Grantee contact name: Mike Hirst Title: Resource Technician  
Address: PO Box 217  
City: Baudette State: MN Zip: 56623  
Phone number: 218-634-1842 Fax: 218-634-1726 E-mail: [mike.hirst@mn.nacdn.net](mailto:mike.hirst@mn.nacdn.net)  
Basin (Red, Minnesota, St. Croix, etc.): Rainy Basin County: Lake of the Woods

### Project type (check one):

- Clean Water Partnership (CWP) Diagnostic
- CWP Implementation
- Total Maximum Daily Load (TMDL) Development
- 319 Implementation
- 319 Demonstration, Education, Research
- TMDL Implementation

## Grant Funding

Final grant amount: \$105,000 Final total project costs: \$95,176.70  
Matching funds: Final cash: \$0 Final in-kind: \$0 Final Loan: \$0  
Contract number: CFMS Contract No. B15226 MPCA project manager: Tim James

## For TMDL Development or TMDL Implementation Projects only

Impaired reach name(s): Baudette River, Estuary  
AUID or DNR Lake ID(s): 09030008-536  
Listed pollutant(s): Low Dissolved Oxygen  
303(d) List scheduled start date: 2008 Scheduled completion date: 2011

*AUID = Assessment Unit ID  
DNR = Minnesota Department of Natural Resources*

## B. Executive Summary of Project

The Baudette River is listed as impaired for low dissolved oxygen on federal Clean Water Act section 303(d) list. This list is commonly referred to as the Impaired Waters List or variously as the Total Maximum Daily Load (TMDL) List. The federal Clean Water Act and the United States Environmental Protection Agency's Water Quality Planning and Management Regulations require states to develop TMDLs for water bodies not meeting water quality standards. A water body can be a stream reach, aquifer, lake or wetland that has been assessed as a unit. A name and location on the National Hydrography Dataset define each Assessment Unit. For the Baudette TMDL, the assessment unit is the main stem of the river from its headwaters to the confluence with the Rainy River (AUID # 09030008-518,519). The Baudette is a subwatershed of the Rainy River/Baudette Watershed (HUC # 09030008-006).

A TMDL Report for the riverine portion of the Baudette has been drafted and was in the peer review process when the need to include the bay in the TMDL was identified. The existing report identifies and allocates loads for all stressors affecting the riverine portion of the Baudette River, including possible stressors directly affecting Baudette Bay. These stressors include: CBOD and nutrient loading from the Baudette storm water system, storm water and wastewater from the Canadian community of Rainy River and the background loads of the Baudette and Rainy Rivers. Other conditions influencing the resource include: fluctuating stage and flows of the Baudette and Rainy Rivers, lake levels of Lake of the Woods, and wind direction.

### C. Goals

- 1<sup>st</sup> Goal: Collect and analyze water quality data to verify a low dissolved oxygen impairment.
- 2<sup>nd</sup> Goal: Collect and analyze land use data which may lead to a low dissolved oxygen impairment.
- 3<sup>rd</sup> Goal: Based on the analysis of water quality data and land use data, complete either a delisting report or a TMDL Report for AIUD # 09030008-536.

### D. Results

- 1<sup>st</sup> Result: Data collected verified that there is a dissolved oxygen impairment during certain times of the year.
- 2<sup>nd</sup> Result: Land uses identified could not be linked to a low dissolved oxygen impairment. The resource is recognized as sensitive, even though there are limited anthropogenic impacts in the watershed.
- 3<sup>rd</sup> Result: Based on this analysis, a delisting request will be made for the AUID # 09030008-536. This delisting request will be made based on natural background conditions and further analysis that will be completed through the Intensive Watershed Monitoring Initiative to be conducted in 2017.

---

## E. Picture

Description/location:

Picture 1: Bridge at STORET site S000-063, taken on June 10, 2008.

Picture 2: Bridge at STORET site S000-946, taken on June 10, 2008.

Picture 3: Bridge at STORET site S004-622, taken on June 10, 2008.

Picture 4: River Watch Program sampling at site S004-622, taken on June 24, 2008.

Picture 5: Deployed sonde equipment prep (Matt Fischer, Mike Hirst, Bruce Paakh), taken on June 25, 2008.

Picture 6: Deployed sonde equipment installation at site S000-063 (Bruce Paakh, Matt Fischer), taken on June 25, 2008.

Picture 7: Monitoring at site S004-622 (Corryn Trask), taken on September 1, 2009.

Picture 8: Monitoring at site S000-063 (Mike Hirst), taken on March 13, 2009

---

## F. Acronyms

**BMP** – Best Management Practices

**CBOD** – Carbonaceous Biochemical Oxygen Demand

**CSAH** – County State Aid Highway

**DNR** – Department of Natural Resources

**DO** – Dissolved Oxygen

**EPA** – Environmental Protection Agency

**HWY** – Highway

**LOW** – Lake of the Woods

**MPCA** – Minnesota Pollution Control Agency

**NRCS** – Natural Resources Conservation Service

**QAPP** – Quality Assurance Project Plan

**RMB Laboratories** – Robert M. Borash Laboratories

**STORET** – EPA's STOrage – RETrieval Data Warehouse

**SWCD** – Soil and Water Conservation District

**TKN** – Total Kjeldahl Nitrogen

**TMDL** – Total Maximum Daily Load

**TP** – Total Phosphorous

**YSI** – Yellow Stone Instruments

---

## G. Partnerships

City of Baudette: City staff assisted with stormwater outfall data, locations and drainage area.

Lake of the Woods County Land and Water Planning Office: Assisted with use of pickup truck to transport DNR boat.

Lake of the Woods County: Use of vehicle.

Lake of the Woods School: In conjunction with the Baudette TMDL, a River Watch Program was established at Lake of the Woods School. Through this program, students monitor water quality in the Baudette watershed. Lake of the Woods SWCD has been a partner in getting this program established and has also assisted by teaching more about the watershed in the 10th grade chemistry classroom.

Minnesota Department of Natural Resources Fisheries Office in Baudette: Use of boat for 2 summer sampling seasons to access deployed YSI sondes.

Minnesota Department of Natural Resources Wildlife Office in Baudette: Use of snowmobile for 2 winters for winter sampling.

---

## **H. Other Activities:**

The City of Baudette has been updating stormwater outlet structures within the Baudette Bay.

The SWCD implements the MPCA Delegated Feedlot Program for Lake of the Woods County. Through this program the SWCD inspects feedlots and finds assistance for landowners if there is a pollution problem. The SWCD has partnered with 4 feedlot owners in the upper reaches of the watershed to minimize feedlot runoff.

The SWCD partnered with Lake of the Woods School and County to establish a River Watch Monitoring Program to monitor in the Baudette Watershed.

Lake of the Woods County Land and Water Planning Office enforces the Individual Septic Treatment System program, and works with landowners to stay in compliance with the state septic regulations.

The SWCD implements the Ag BMP Loan Program in partnership with Minnesota Department of Agriculture and Border State Bank. The program can assist landowners with low interest loans for best management practices including septic system upgrades.

The NRCS works with agricultural producers in the watershed to implement best management practices within the watershed. These BMP's include rotational grazing management plans that provide a good management strategy for livestock management in the watershed.

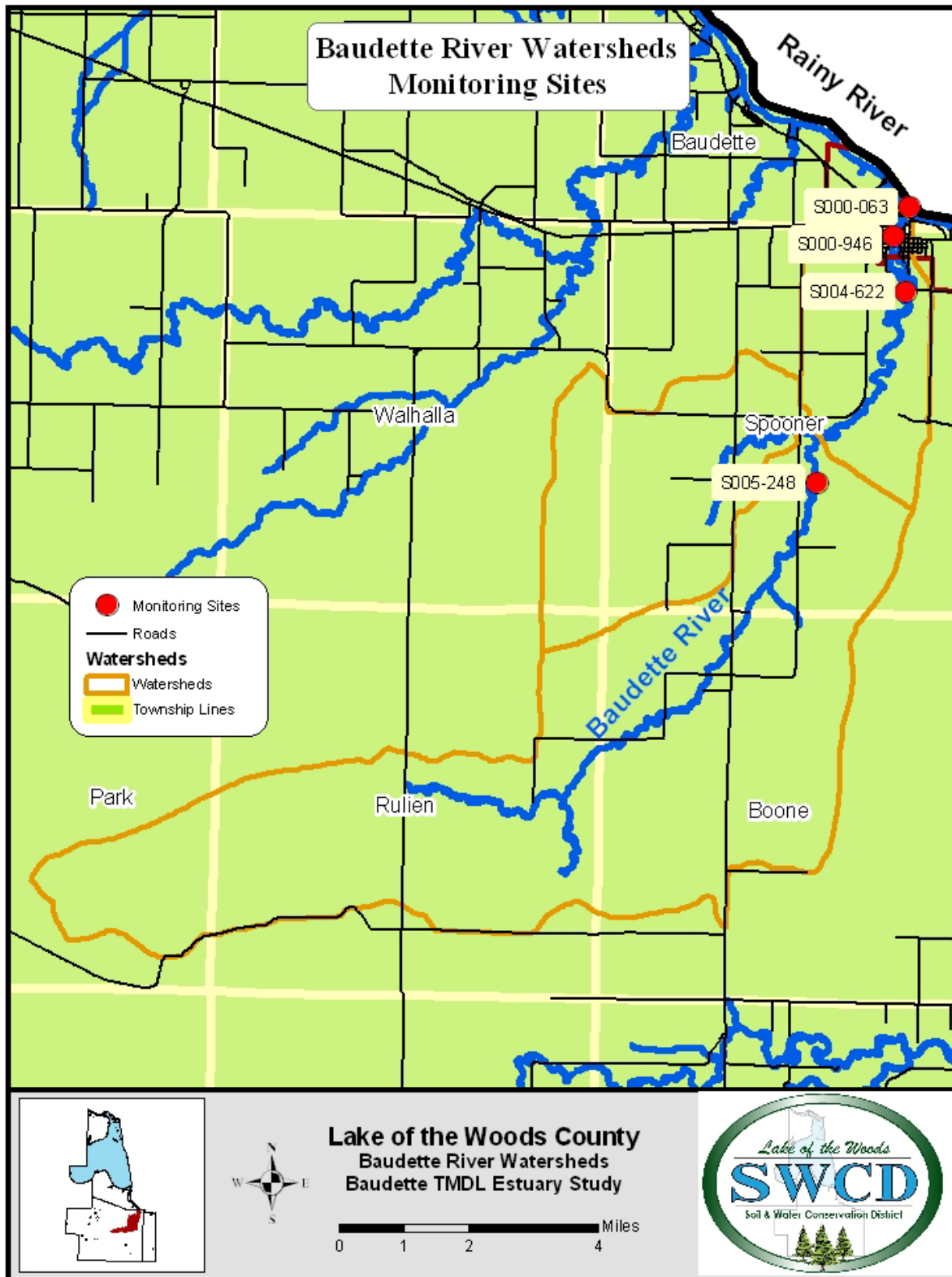
## Section I - Work Plan Review

### A. Work Plan Changes:

The Baudette Dissolved Oxygen Impairment Verification and TMDL Development had minor changes to the work plan. The minor changes included:

- 1) The proposed start date was scheduled to begin May 1, 2008, but the contract was not executed until June 13, 2008. Therefore, the work did not commence until June 16, 2008.
- 2) The MPCA Project Manager recommended that the sediment sampling be accomplished by taking dissolved oxygen transects. The transect monitoring would utilize a YSI Sonde optical DO Sensor to collect DO values at the surface water interface and the sediment water interface to determine the sediment oxygen depletion. This work plan change occurred on 5/13/2010.
  - a. Explanation: The current Baudette TMDL Contract between Lake of the Woods SWCD and the Minnesota Pollution Control Agency (6/16/2008 – 6/30/2011) had budgeted \$3,000 for a sediment oxygen depletion analysis. The MPCA Project Manager Tim James has proposed that instead of collecting samples to be analyzed by a laboratory, the SWCD could take 2 transects in the Baudette Bay with a dissolved oxygen probe in June through September of 2010. This new strategy was employed to better quantify the affects the sediment has on the oxygen depletion in the estuary.
  - b. SWCD Staff time / budget: Sampling occurred bimonthly, once in the morning and once in the afternoon at 2 transects June through September in 2010. There will be a total of 16 sampling events at 4 hours each (64 hours x \$50 an hour = \$3,200). There are funds in the existing budget available for lab expenditures to accommodate for this change in the work plan if it runs longer than estimated and exceeds previously budgeted amounts.
- 3) The Final TMDL Report outline in Objective 4, Sub-task 3 initially stated that the report would merge the Baudette Estuary data with the existing *Total Maximum Daily Load for Low Dissolved Oxygen from the Headwaters of the Baudette River to the Rainy River*. On 3/26/2011 the MPCA Project Manager stated that the final report created from the Baudette Estuary Study would not need to be merged with the previous Baudette River TMDL. The urgency of this data being merged is no longer needed due to the shift of focus to the Watershed Approach of MPCA. The Final Draft Report will reference the previous work and recommendations from the Baudette River TMDL Study, however a complete merger of the reports will not be necessary at this time. In 2017, the entire Lower Rainy Watershed will be assessed through the State of Minnesota's 10 year Intensive Watershed Monitoring Schedule.

Baudette River Watershed Monitoring Site Map:



## B. Work Plan Review:

- **Timeframe:** The project commenced in the spring on June 13, 2008 and was completed with the submission of a final report before July 30, 2011.

### Objective 1- Water Quality Data Collection

**Task A:** Dissolved Oxygen, CBOD, TKN and Total Phosphorus sampling will be conducted at selected locations in Baudette Bay, the Baudette main stem and Rainy River at representative water levels and flows to determine the stressors associated with the dissolved oxygen impairment. Surface water sampling must be conducted before 07:30. All water quality samples for this impairment verification and TMDL development study will be submitted to RMB Environmental Lab in Detroit Lakes for analysis.

Sub-task 1: Continuous sonde measurements of O<sub>2</sub>, temp, conductivity, pH, and turbidity at Hwy 11, and CSAH 35, Highway 72.

- Install sondes in 3 locations on the Baudette River, upstream of the confluence with the Rainy River for the monitoring period April 2008 through October 31, 2009. Sondes will be installed at the following Baudette River Crossings:
  - CSAH 35 (S004-622)
  - Highway 11 Bridge (S000-946)
  - International Bridge Highway 72 (S000-063)
- Service sondes and download data bimonthly
- MPCA provides training and assistance to SWCD staff for maintenance, calibration, and downloading associated with sondes
- MPCA will install and remove sondes

#### **Objective 1, Task A, Sub-task 1 summary of activities:**

**The data collected from these stations utilized two 6920 V2 YSI sondes at the 2 downstream locations and a 6600 EDS was utilized at the CSAH 35 bridge. The 6600 EDS sonde DO probe membrane had a couple of failures throughout the 2 year study. In addition, the 6600 EDS had the wrong software to run the turbidity probe so the majority of the turbidity data at this site is inaccurate. The pH probe on the International bridge was damaged in 2008 during the calibration and maintenance and was replaced 2 weeks later. The sondes were installed 6/25-26/08 removed 10/17/08, and installed 6/5/09 removed 10/19/09 at the three sites by MPCA staff. Downloads and calibrations were completed bimonthly by SWCD staff after training and assistance from MPCA staff.**

Sub-task 2: Water Monitoring (June 2008 through October 31, 2009)

- Frequency – Once per week
- Sites:
  - International Bridge, Hwy 72 (Rainy River) (S000-063)
  - Hwy 11 crossing (Baudette Bay) (S000-946)
  - CSAH 35 crossing (Baudette Bay) (S000-063)
  - Baudette main stem (County Road # 161 ) (S005-248)
- Field Parameters:
  - O<sub>2</sub>
  - Temp
  - Conductivity
  - pH
  - Turbidity
- Samples for Lab Analysis:
  - CBOD
  - TKN
  - Total Phosphorus
  - TSS

**Objective 1, Task A, Sub-task 2 summary of activities: This task was accomplished before 7:30 a.m. at all sites utilizing a 6820 YSI sonde, t-tube, and water sample collection for analysis. Samples were sent to RMB Laboratories for analysis.**

Sub-task 3: Storm event monitoring at river and estuary sites plus 6 City of Baudette storm water outfalls, for TSS, TP, TKN, and CBOD.(June 2008 through October 31, 2009)

- Frequency – Minimum 12 storm events greater than 0.25 inches precipitation
- Sites:
  - International Bridge, Hwy 72 (Rainy River) **(S000-063)**
  - Hwy 11 crossing (Baudette Bay) **(S000-946)**
  - CSAH 35 crossing (Baudette Bay) **(S000-063)**
  - Baudette main stem (County Road # 161 ) **(S005-248)**
  - 6 storm water outfalls (all Baudette outfalls to Baudette Bay)
- Field Parameters:
  - O<sub>2</sub>
  - Temp
  - Conductivity
  - pH
  - Turbidity
- Samples for Lab Analysis:
  - CBOD
  - TKN
  - Total Phosphorus
  - Chlorophyll-a
  - TSS

**Objective 1, Task A, Sub-task 3 summary of activities: Approximately 8 storm events were collected over the 1 ½ open water sampling seasons. The 2008 and 2009 sampling seasons were short on good storm events to adequately characterize the stormwater runoff. The other limiting factor was the contract was not completed until June 28 of 2008, thus the spring rain events of 2008 were not able to be collected. However there were more storm events collected in 2008 than in 2009. See appendix for precipitation information.**

Sub-task 4: Bi-weekly sonde monitoring November-March as ice conditions permit. (November 2008 through March 2009 and November 2009 through March 2010)

- Sonde measurements taken through the ice at the following site locations:
  1. CSAH 35 **(S004-622)**
  2. Highway 11 Bridge **(S000-946)**
  3. International Bridge Highway 72 **(S000-063)**

**Objective 1, Task A, Sub Task 4 summary of activities: Nine total monitoring events were conducted over the 2 year winter sampling season. Winter sampling was accomplished with the use of an ice auger and YSI 6820 sonde during daylight hours.**

Time Frame: June 2008 – March 30, 2010

Responsible Organization: Lake of the Woods SWCD, MPCA Hydrologist

**Task B: Sediment Sampling to determine CBOD level of sediments and its potential for internal nutrient loading. –This item was eliminated.**

- Frequency – one sample per site (monthly May – October)
- Sites – 3 to be determined in Baudette Bay (top 3-4 inches of sediment)
- Samples for Lab Analysis:
  - CBOD
  - TKN
  - Total Phosphorus
  - Sulfate/Sulfide

**Objective 1, Task B, summary of activities: This task was amended in the work plan, see below for amended Task B.**

Time Frame: June 2008 – October 31, 2008

Responsible Organization: Lake of the Woods SWCD

Person(s) Responsible: Resource Technician

**Task B-Amended: Dissolved Oxygen Probe Transect Data**

- Frequency – 2 transects in Baudette Bay (bimonthly June – September 2010)
- Sites – 2 transects of 4 sites located upstream of the Highway 11 bridge
- Field parameters:
  - O<sub>2</sub>
  - Temp

- Conductivity
- pH
- Turbidity

**Objective 1, Task B-Amended, summary of activities: In the summer of 2010, nine transect monitoring events were completed. Each event included two separate transects locations. Each transect consisted of four sites where both air/water and water/sediment interfaces were monitored for the YSI sonde parameters utilizing a 6920 V2 sonde.**

Time Frame: June 2010 – September 30, 2010  
 Responsible Organization: Lake of the Woods SWCD  
 Person(s) Responsible: Resource Technician

**Task C: Data Management and Report submission to the MPCA**

- Organize water quality data into a spreadsheet format suitable for entry into STORET.
- Work with MPCA project manager and data management staff to provide information on water quality or biological sampling as needed to get the monitoring data into STORET:
  - Provide information, such as project name, purpose, staff, and sampling procedures for project establishment in STORET, using the MPCA Project Establishment Form.
  - Provide information on all laboratories used for water sample analysis, using the MPCA Lab Establishment Form.
  - Provide information on monitoring station locations for station establishment(s) in STORET using the MPCA Station Establishment Form.

**Objective 1, Task C summary of activities: Reports were submitted punctually. Sites were established in the STORET. Data was reviewed and submitted to MPCA staff for STORET submission promptly.**

Time Frame: August 1, 2008 – October 31, 2010  
 Responsible Organization: Lake of the Woods SWCD  
 Person(s) Responsible: Resource Technician

**Objective 2:** GIS Mapping of the City of Baudette, including storm water outfalls, the storm shed of each outfall, the amount of impervious surface in each watershed, treatment methods and best management practices (BMPs). Data Layers and Maps Due January, 2010.

Task A: Develop the following data layers for the land surrounding Baudette Bay:

- Impervious surfaces
- Storm water outfalls and drainage areas
- Ditches
- Water courses
- Roads
- Parcels Identification numbers
- Parks
- Golf courses
- NPDES Permits

**Objective 2, Task A summary of activities: The mapping objective was completed in the summer of 2008 utilizing ArcGIS software and were submitted to the MPCA project manager.**

Time Frame: July, 2008 – January 2010  
 Responsible Organization: Lake of the Woods SWCD  
 Person(s) Responsible: Resource Technician

**Objective 3:** Evaluate all data to determine future direction of the project. Choose appropriate scenario for moving ahead. Evaluate and Analyze Data Due June 2010.

Scenario A: If the data show that the listing data no longer verifies a low Dissolved Oxygen impairment, then write the final report as either a delisting document, or a site specific standard request, using the appropriate MPCA methodology.

Scenario B: If the data show that the impairment is verified, then proceed with Objective 4.

**Objective 3, Task A summary of activities: Scenario A did not come to fruition. The data was evaluated and analyzed prior to June 2010. The impairment was verified and the work plan proceeded with Scenario B.**

**Objective 4:** Completion of semi-annual reports and either a delisting, or a site specific, or a TMDL Report

Sub-task 1: Prepare semi-annual reports

- August 1, 2008
- February 1, 2009
- August 1, 2009
- February 1, 2010
- August 1, 2010
- February 1, 2011

**Objective 4, Sub-task 1 summary of activities: Semi-annually reports were completed and sent to the MPCA project manager.**

Sub-task 2: Participate with MPCA in Public Outreach Program

**Objective 4, Sub-task 2 summary of activities: A Public meeting was held at the Baudette City Council in Baudette on 7/13/2009. Another meeting is scheduled in Baudette in August of 2011 after the final report is complete. The Lake of the Woods Comprehensive Local Water Management Planning Committee discussed the Baudette watershed and was given updates on the project as the Water Plan was being updated. The Water Plan meeting were held on 4/30/2009, 4/7/2010 and 11/30/2010. The Baudette Estuary TMDL Project has also been discussed during semiannual updates with the Lake of the Woods County and Lake of the Woods SWCD Boards during regularly scheduled meetings from 2008 through 2011.**

Sub-task 3: Draft Final TMDL Report merging Baudette Bay data into the existing *Total Maximum Daily Load for Low Dissolved Oxygen from the Headwaters of the Baudette River to the Rainy River, HUC: 09030008-006*

**Objective 4, Sub-task 3 summary of activities: The Final Report references the Baudette River TMDL but is a separate report and does not completely merge the 2 data sets.**

Time Frame: July 2009 – January 2009

Responsible Organization: Lake of the Woods SWCD

Person(s) Responsible: Lake of the Woods SWCD Resource Technician with assistance from MPCA Project Manager, MPCA Rainy River Basin Coordinator, MPCA Hydrologist, MPCA Modeler

**Objective 4 - Final TMDL Report Due July 30, 2011.**

## Section II - Grant Results

### A. Measurements taken through the Baudette Estuary Dissolved Oxygen TMDL Project Work Plan:

The main focus for this two-year study was to identify the possible stressors directly affecting the Baudette Bay. These stressors include: CBOD and nutrient loading from the Baudette storm water system, storm water and wastewater from the Canadian community of Rainy River and the background loads of the Baudette and Rainy Rivers. Other conditions influencing the resource include: fluctuating stage and flows of the Baudette and Rainy Rivers, lake levels of Lake of the Woods, and wind direction.

The work plan tasks were previously described in Section I of this report. Explanations were given for the methodology, data collected and various equipment utilized. The data collected followed sampling protocol established by the *Baudette River Estuary Dissolved Oxygen Impairment Verification and TMDL Development Project Quality Assurance Project Plan* (Fischer 2008).

Below are further details on the measurements taken through this work plan and a summary of results for each task.

For the overall project, the instruments used to collect the water quality data included:

- YSI 6600 EDS sonde
- YSI 6820 sonde
- Three YSI 6920 V2 sondes
- 100 cm and 60 cm transparency tubes
- Weighted tape measure for stage measurements
- Sampling device – simple bucket

### B. Deployed Sonde Data:

YSI sondes were deployed at three sites in the watershed. This data is the most comprehensive set of data during the study period. The three sites were: S000-063, S000-946, and S004-622. Site S000-063 was installed at the confluence of the Rainy River and the Baudette Bay. This site never experienced low dissolved oxygen readings over the course of the 2 year study. The other two sites (S000-946 and S004-622) were located upstream in the Baudette Estuary, and experienced numerous low dissolved oxygen readings.

Deployed YSI sondes collected data on temperature, conductivity, pH, dissolved oxygen, and turbidity every 15 minutes during the 2008 and 2009 open water seasons. The sondes at the three sites were downloaded and calibrated every 2 weeks. The equipment was deployed in the spring of the year and removed in the fall by MPCA staff.

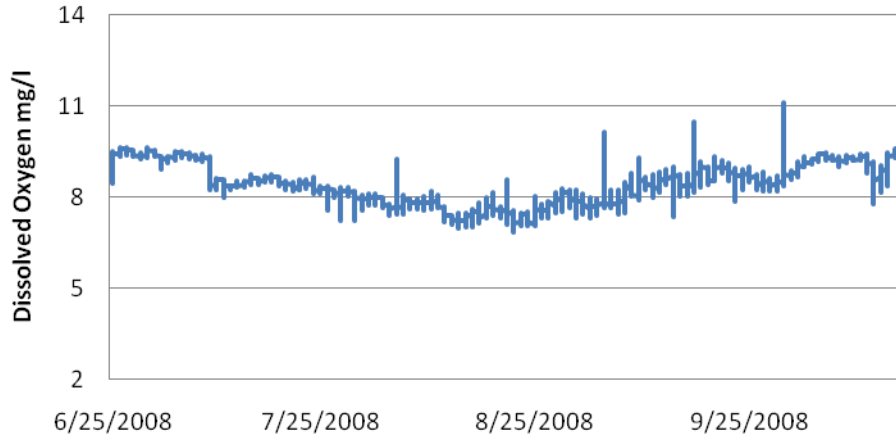
As this dataset contains the most comprehensive data, there may be some uncertainty to the deployed sonde data. These issues can be evaluated in detail during the delisting process. Below are some of factors that may have influenced the data:

1. The sondes at sites S000-063 and S000-946 had missing data from 09/07/2009 to 09/16/2009 due to data memory exceedances.
2. All sites were shaded by bridge decks due to installation locations. Site S000-946 was especially shaded from the sun.
3. Sondes were installed outside of the main river channels.
4. The sonde at site S004-622 had a dissolved oxygen membrane instead of an optical DO sensor.
5. The sonde at site S004-622 was tampered with and was found out of water for approximately a week.
6. The sonde at site S004-622 did not have the correct software installed to run the optical turbidity probe.

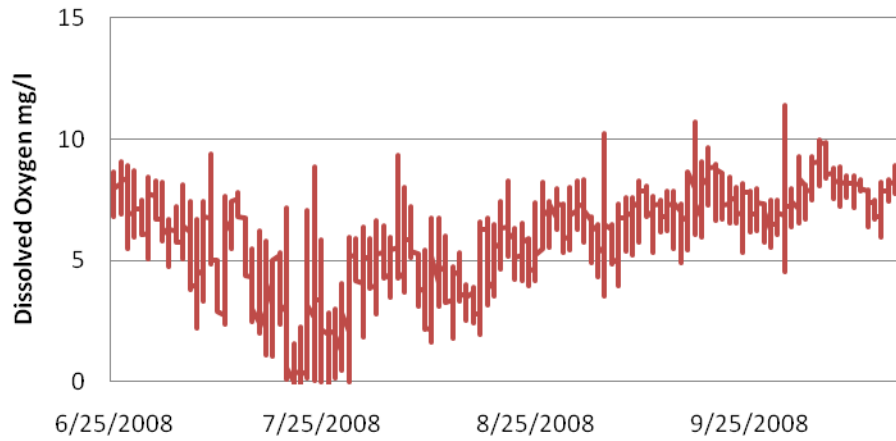
See a summary of the deployed sonde data below, followed by the yearly graphical data.

<b>Baudette Estuary 2008-2009 Data Summary (Deployed Data)</b>					
Site	Years of data	Number of samples	Number of exceedances <5 mg/l	Percent exceeded	Notes
S000-063	2008-2009	23,065	0	0.00%	Site located in the Rainy River
S000-946	2008-2009	23,058	4,491	19.48%	3,134 exceedances in 2008, & 1,357 exceedances in 2009
S004-622	2008-2009	22,841	11,020	48.25%	Issues occurred with this sonde due to DO membrane failures
<b>Total</b>		<b>68,964</b>	<b>15,511</b>	<b>20.92%</b>	

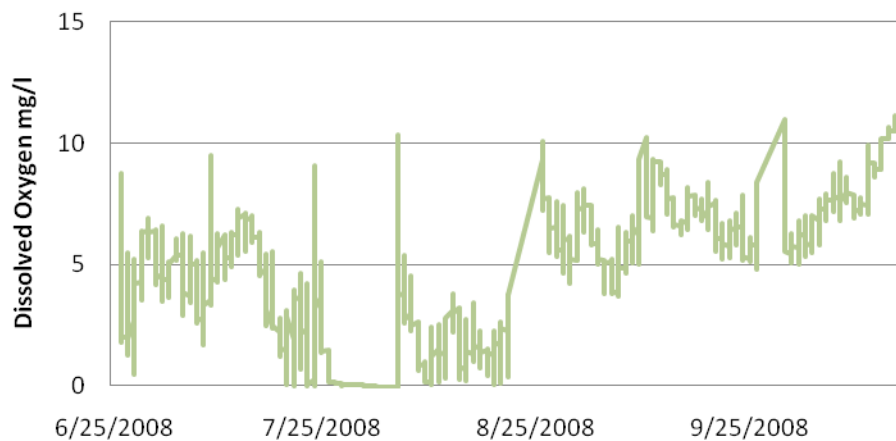
### 2008 Deployed Sonde at S000-063



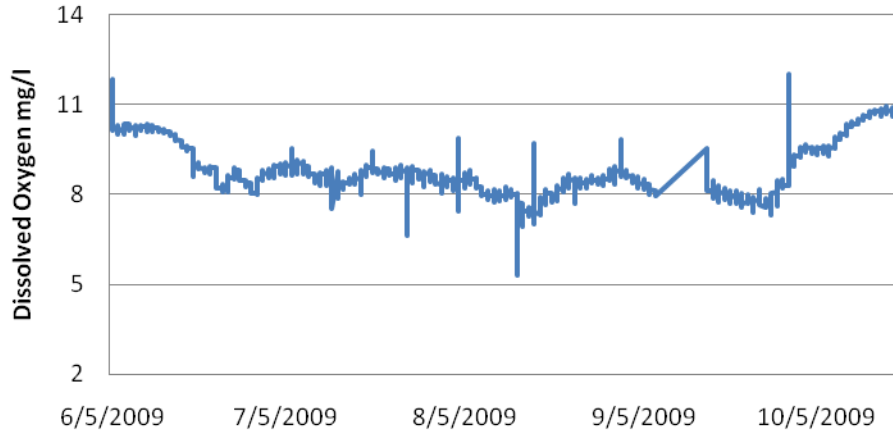
### 2008 Deployed Sonde at S000-946



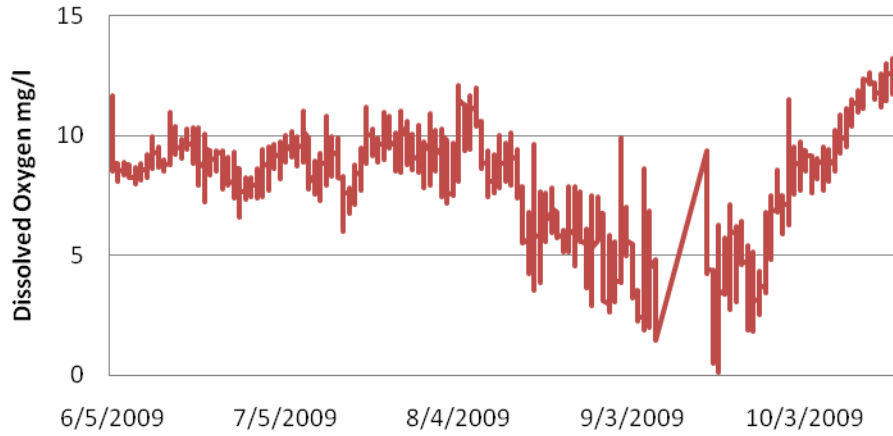
### 2008 Deployed Sonde at S004-622



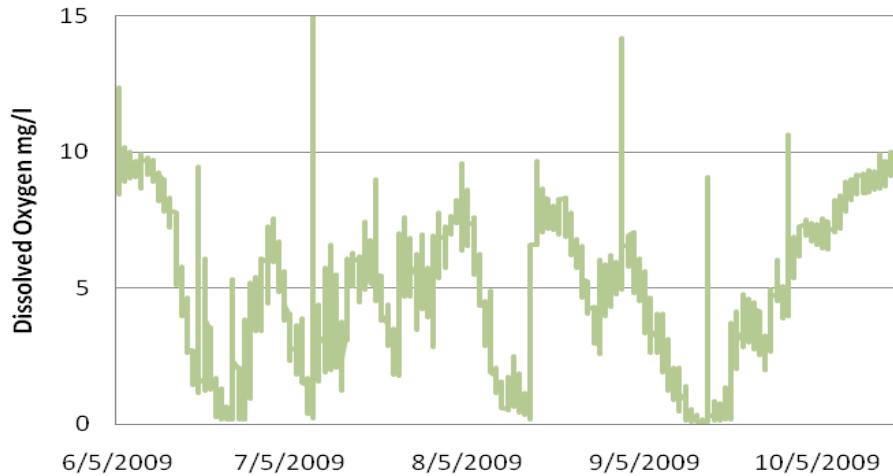
### 2009 Deployed Sonde at S000-063



### 2009 Deployed Sonde at S000-946



### 2009 Deployed Sonde at S004-622



**C. Open Water Season Data - collected before 7:30 a.m.:**

Routine monitoring data was collected before 7:30 a.m. at all bridge sites. This early morning sampling technique provides data with the lowest amount of dissolved oxygen in the water during a 24 hour period. The data collected during the open water seasons in 2008 and 2009 were very similar to the results collected in 2007 by the SWCD. The data collected included: temperature, conductivity, pH, dissolved oxygen, turbidity, transparency, stage, field observations and chemical analysis. Equipment maintenance and calibrations were completed and documented as required. Chemical analysis was completed by RMB Environmental Laboratories in Detroit Lakes, Minnesota.

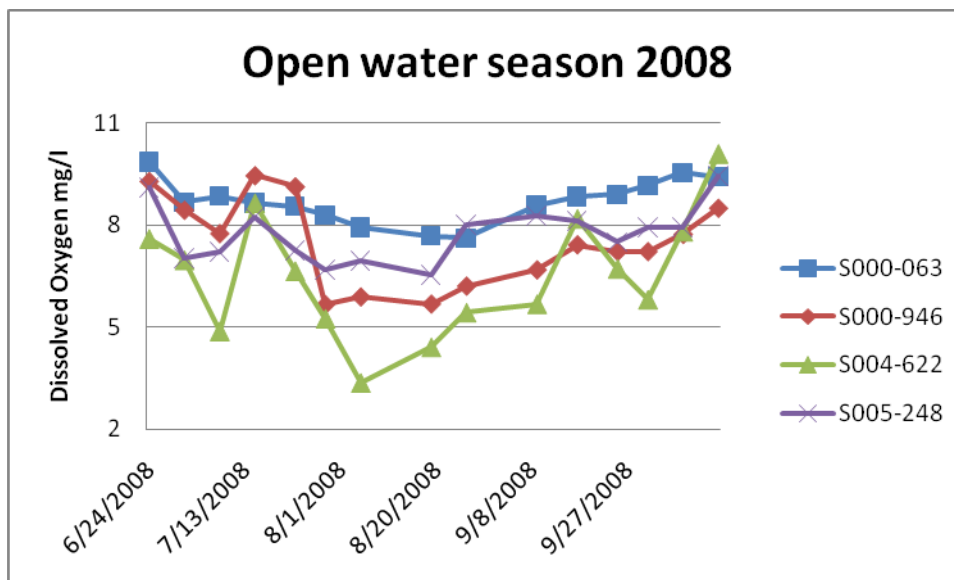
Chemical analysis included:

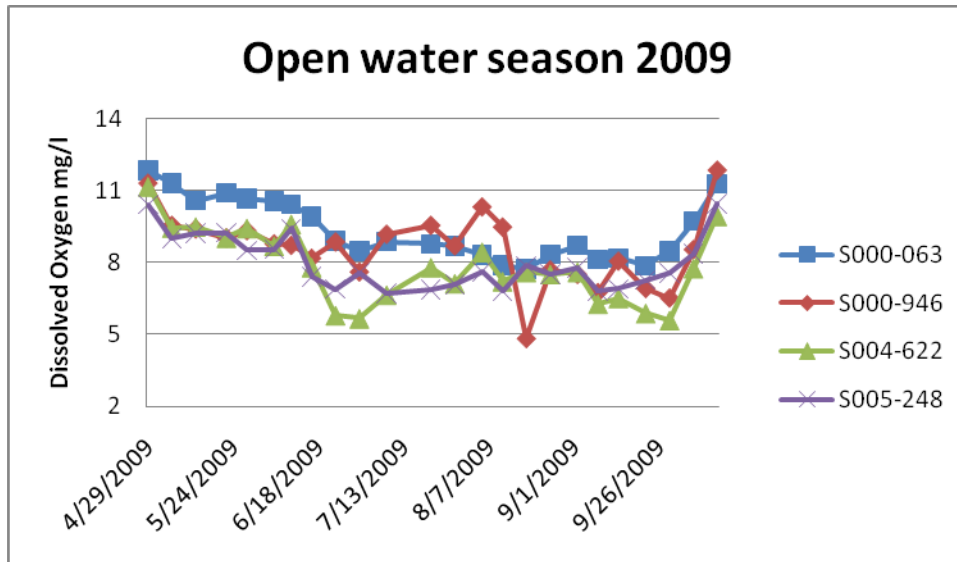
- chemical biological oxygen demand (CBOD)
- total kjeldahl nitrogen (TKN)
- total phosphorous (TP)
- total suspended solids (TSS)

The evident trend confirms that during the warmer parts of the summer when the flow is minimal, some locations will experience low levels of dissolved oxygen that fall below the state standard. Under these conditions, the upper portions of the estuary can act more like a wetland complex, where the buildup of decaying vegetation consumes oxygen. See precipitation and flow data in the appendix.

The Rainy River site, and the site in the upper reaches of the Baudette River (sites S000-063 and S005-248 respectively) never experienced low dissolved oxygen readings out of a total of 39 measurements each over a 2 year period (2008-2009). Sites within the estuary experienced some low dissolved oxygen readings. Site S000-946 had one low DO reading in August of 2009. Site S004-622 had low DO readings 3 times in late July / early August of 2008. This data does not include storm event data that was collected after 7:30 a.m.. See a summary of the data below, followed by the yearly graphical data.

<b>Baudette River 2008-2009 Data Summary</b> <b>(Open water season monitoring data without storm events before 7:30 am)</b>					
Site	Years of data	Number of samples	Number of exceedances <5 mg/l	Percent exceeded	Notes
S000-063	2008-2009	39	0	0.00%	Site located in the Rainy River
S000-946	2008-2009	39	1	2.56%	1 exceedance in Aug of 2009
S004-622	2008-2009	39	3	7.69%	3 exceedances in July/Aug of 2008
S005-248	2008-2009	39	0	0.00%	Site located in the Baudette River upstream of the Estuary
<b>Total</b>		<b>156</b>	<b>4</b>	<b>2.56%</b>	





#### D. Storm Event Data:

Storm event data was collected when precipitation events greater 0.25 inches occurred. The data collected included: temperature, conductivity, pH, dissolved oxygen, turbidity, transparency, stage, field observations and chemical analysis. Equipment maintenance and calibrations were completed and documented as required.

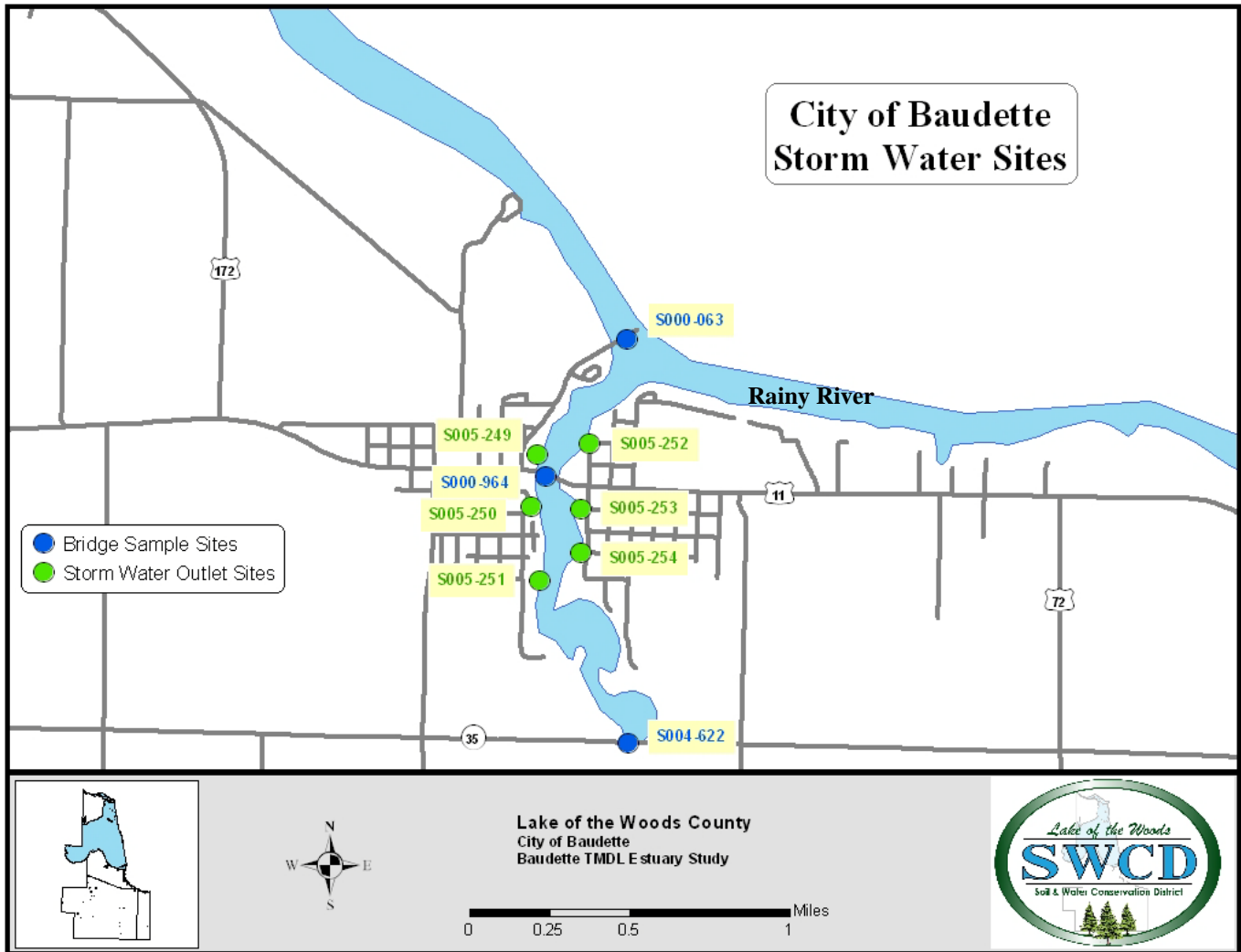
Chemical analysis was completed by RMB Environmental Laboratories in Detroit Lakes Minnesota.

Stormwater samples were collected from 6 stormwater outlets and at the 4 bridge sites. Stormwater analysis included:

- Chemical Biological Oxygen Demand (CBOD)
- Total Kjeldahl Nitrogen (TKN)
- Total Phosphorous (TP)
- Chlorophyll-a
- Total Suspended Solids (TSS)

A total of 8 quality storm events were collected in 2008 and 2009. There were 5 storm events collected during the 2008 open water sampling season, starting on June 16, 2008. During the 2009 monitoring season there was nearly 20% less rainfall compared to monthly norms (see Precipitation Data in the Appendix). This lower amount of precipitation combined with timing of the precipitation occurrences led to only 3 storm events captured during the 2009 monitoring season.

The storm event data illustrates the influx of nutrients to the watershed and estuary as peak flows enter the watershed and storm water outlets. The data reflects higher levels of TKN, TP, TSS and CBOD than the regular monitoring chemical analysis. Below is a map of the storm water outlet sites and the bridge sampling sites in Baudette.



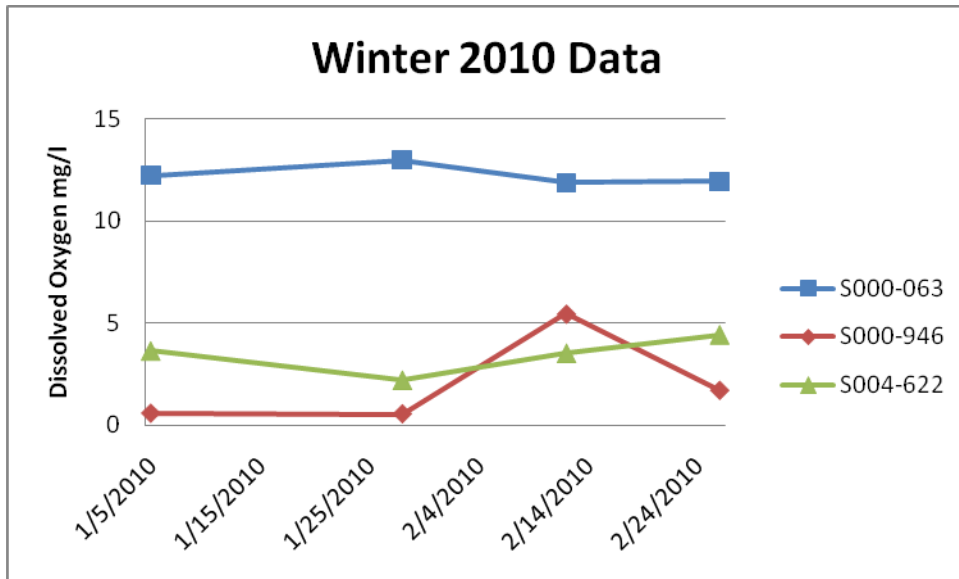
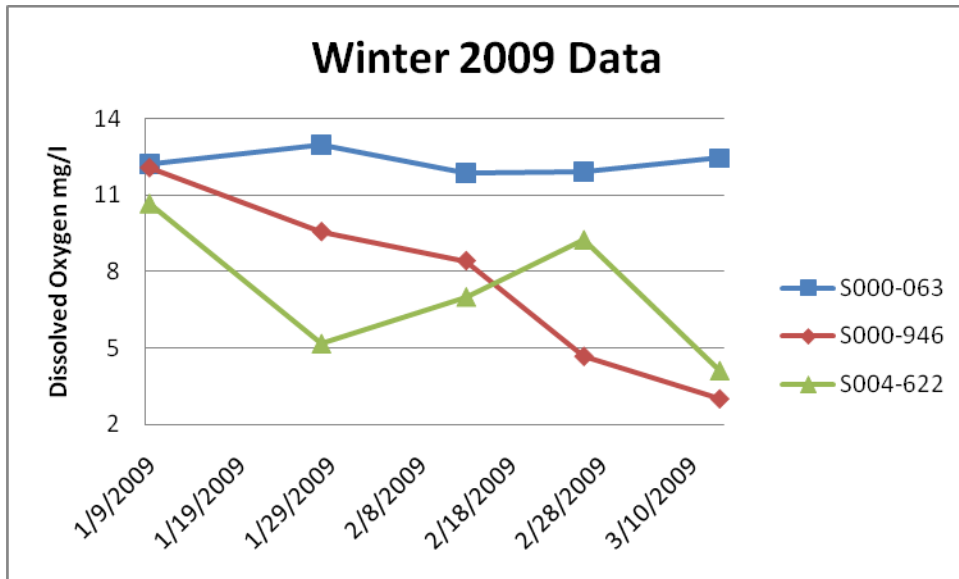
**E. Winter Monitoring Data:**

Winter monitoring data was collected starting after January 1<sup>st</sup> in both 2009 and 2010. Data was collected taking sonde parameters every two weeks until spring ice-out conditions. The winter monitoring sites included: the Rainy River site S000-063, the Highway 11 bridge site S000-946, and the CSAH 35 bridge site S004-622. In both 2009 and 2010 site S000-063, located on the Rainy River, did not display any low dissolved oxygen readings. However, at both site S000-946 and site S004-622, dissolved oxygen levels fell below 5 mg/l in March of 2009. These sites also remained below 5 mg/l through January and February of 2010.

The Baudette Bay has been known to have low dissolved oxygen occurrences throughout the years. Historically, through the last 30 years, retired MNDNR Fisheries Area Manager Mike Larson has said that the Baudette Bay will reach levels of low dissolved oxygen. The DNR Fisheries Office has not completed any specific studies on the Baudette Estuary, however knowing the angling reports, the assumption has been made that the dissolved oxygen levels have dropped below required levels for fish species (5 mg/l). He also stated that if it occurs, it will typically happens during low flow conditions. It has been known to happen late winter, in March, and also during July and August when there is little flow and high temperatures. The estuary acts like a wetland area that can experience diurnal swings in dissolved oxygen. Through the winter monitoring completed in the 2009 and 2010 seasons, it is evident that the 2009 year resembled this type of occurrence. However, in 2010 there were low flows in the fall and they continued through the winter. See the Rainy River flow data in the appendix for flow data comparisons. The winter of 2011, the bay was not monitored but there was constant northern tip-up fishing until ice out conditions from the highway 11 bridge to the mouth of the bay. These indicators provide evidence that the 2011 winter did not experience low dissolved oxygen impairment in the Baudette Bay. See a summary of the winter monitoring data below, followed by the yearly graphical data.

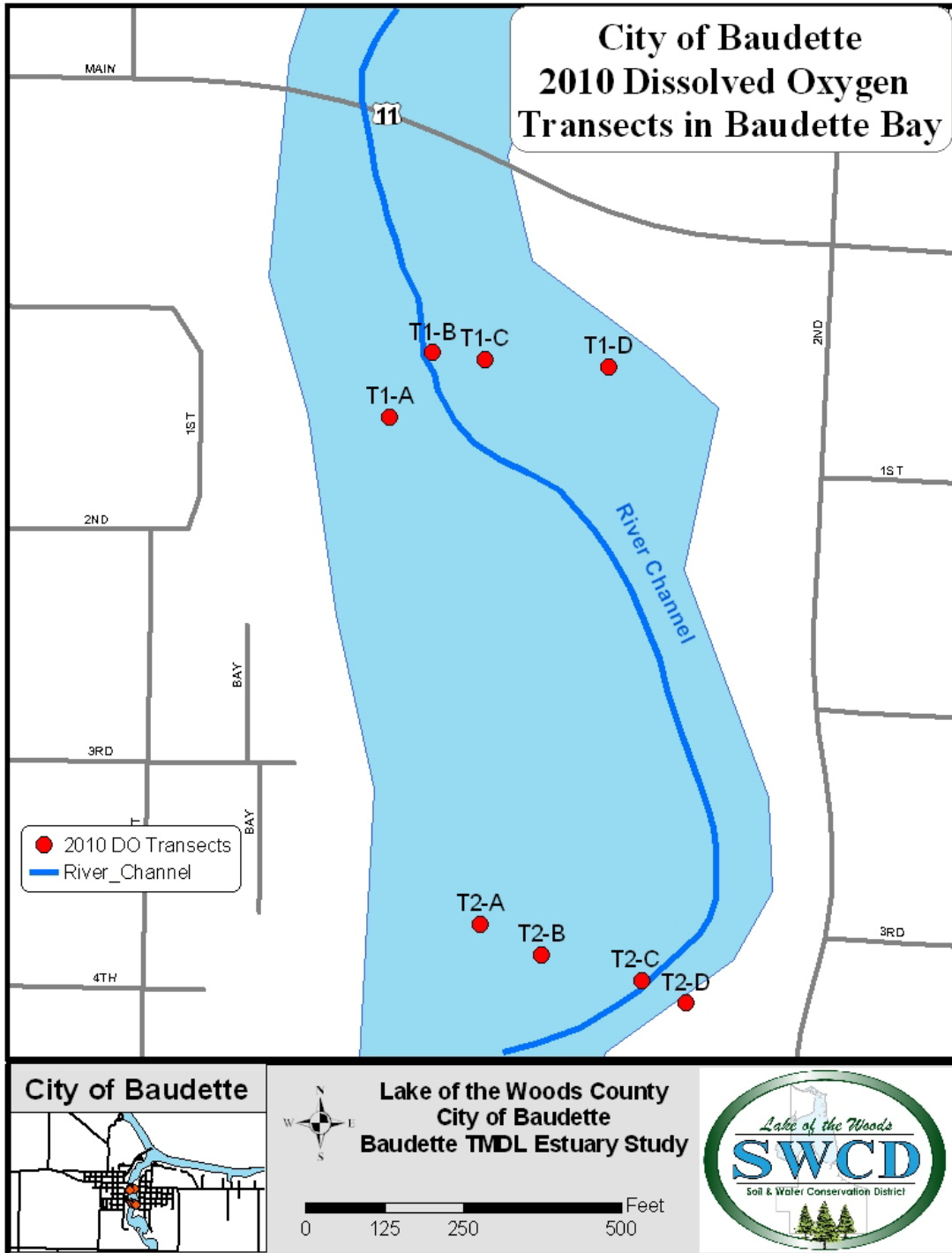
## Baudette Estuary 2009-2010 Data Summary (Winter Data)

Site	Years of data	Number of samples	Number of exceedances <5 mg/l	Percent exceeded	Notes
S000-063	2009-2010	9	0	0.00%	Site located in the Rainy River
S000-946	2009-2010	9	5	55.56%	2 exceedances in 2009 & 3 exceedances in 2010
S004-622	2009-2010	9	5	55.56%	1 exceedance in 2009 & 4 exceedances in 2010
<b>Total</b>		<b>27</b>	<b>10</b>	<b>37.04%</b>	



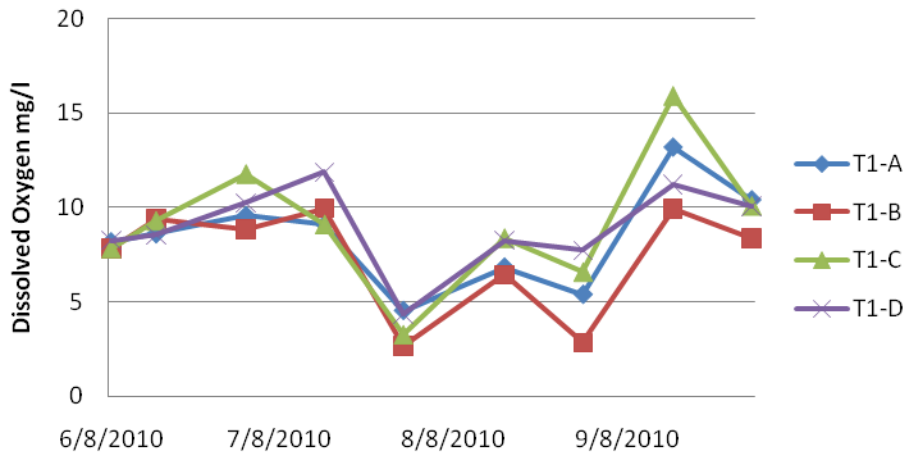
## F. 2010 Baudette Bay Transect Data:

The work plan was changed to include a more detailed look at oxygen levels in the estuary. Originally it was planned to analyze sediment core samples in the estuary. However, this task was altered to taking dissolved oxygen transects utilizing a YSI sonde to collect dissolved oxygen values at the surface water interface and below at the sediment/water interface. This information will be used to determine the oxygen depletion of the sediments by comparing and contrasting the measurements at the differing levels in the water column. DO transect data was collected bimonthly June through September in 2010 using a YSI sonde with an optical dissolved oxygen sensor. Nine transect monitoring events were completed. Each event included two separate transect locations. Each transect consisted of four sites where both air/water and water/sediment interfaces. See map below for transect locations.

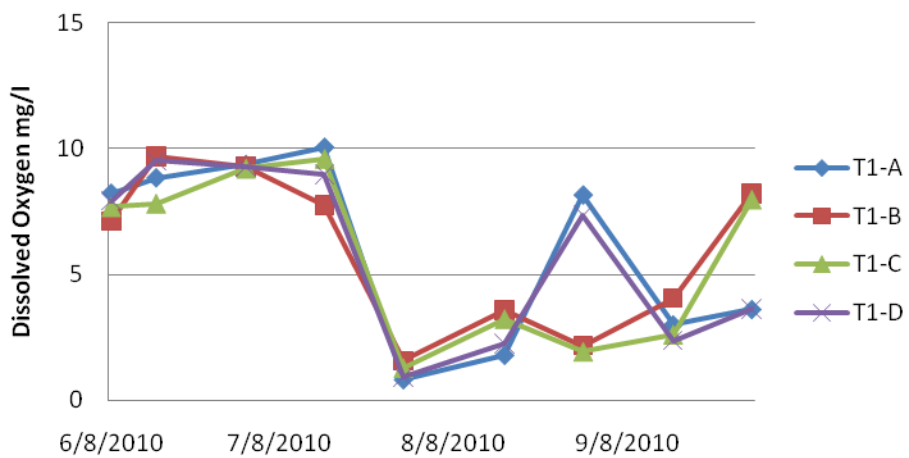


The data suggests that the dissolved oxygen levels at the surface of the water are significantly higher than at the sediment/water interface. These same results were experienced during the winter monitoring of 2010 when there was not extensive plant growth in the estuary. See a summary of the dissolved oxygen transect graphical data below.

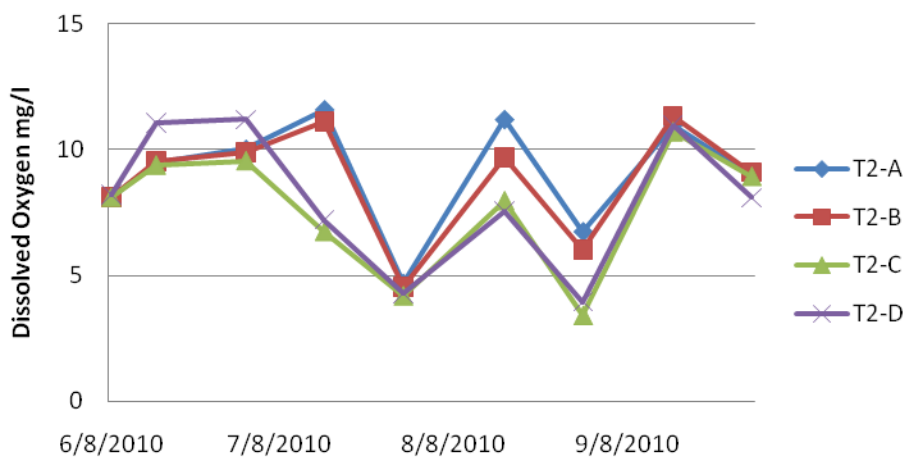
### 2010 DO Transect-1 Top of Water



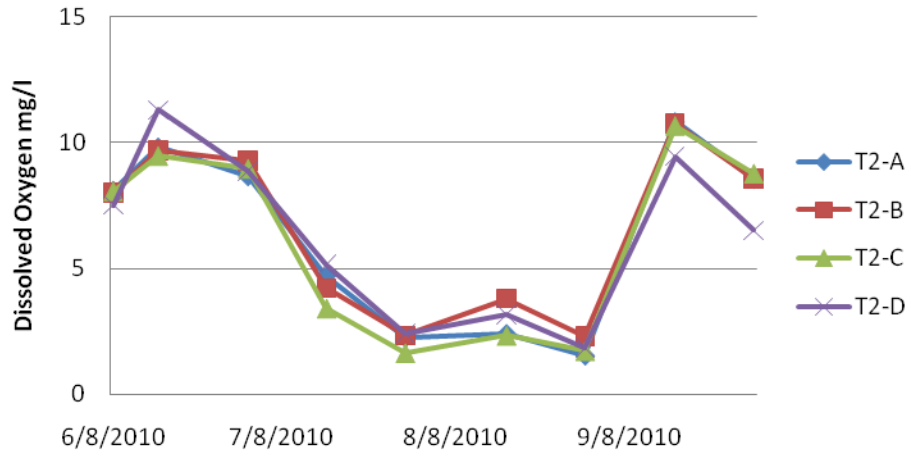
### 2010 DO Transect-1 Bottom of Water



### 2010 DO Transect-2 Top of Water



## 2010 DO Transect-2 Bottom of Water



## **G. Products produced through the Baudette Estuary Dissolved Oxygen TMDL Project Work Plan:**

**1. Reports:** The final report was completed on July 30, 2011. Semi-annual reports were completed on August 1 and February 1. The reports were submitted on the following dates:

- 8/1/2008
- 2/1/2009
- 8/1/2009
- 2/1/2010
- 8/1/2010
- 2/1/2011

**2. Billing Vouchers:** Quarterly billing vouchers were completed and submitted to the project manager, starting with the 2<sup>nd</sup> quarter of 2008 and ending on the 2<sup>nd</sup> quarter of 2011.

**3. Maps:** Maps were created for the Baudette Watershed. The maps created included: aerial photo, general soils, impervious surfaces, land administrative status, land use, minor watersheds, parcels, roads and waterways, monitoring sites, and wetlands.

**4. Public Meetings:** A public meeting was held in conjunction with a Baudette City Council Meeting on July 13, 2009. A powerpoint presentation was created and presented to the City Council Members and to the public to inform them of the project, project results and next steps. A final public meeting will be conducted in August 2011 to review the final report of the project.

**5. Data:** Data was collected during the open water sampling season in 2008, 2009 and 2010. Data was also collected in the winter through the ice in 2009 and 2010. Data sheets, photos, and calibration sheets were created for this time period. Monitoring data collected by the Lake of the Woods SWCD has been entered into STORET and has gone through the data review process.

All reports, billing vouchers, maps, presentations, data sheets, photos, and calibrations sheets are available upon request.

## **H. Public Participation & Outreach through the Baudette Estuary Dissolved Oxygen Impairment Verification and TMDL Development Project Work Plan:**

A public meeting was held in conjunction with a Baudette City Council Meeting on July 13, 2009. A powerpoint presentation was presented to the Baudette City Council members and to the public to inform them of the project, project results and next steps. The Lake of the Woods Comprehensive Local Water Management Planning Committee discussed the Baudette watershed and was given updates on the project as the Water Plan was being updated. The Water Plan meeting were held on 4/30/2009, 4/7/2010 and 11/30/2010. The Baudette Estuary TMDL Project has also been discussed during semiannual updates with the Lake of the Woods County and Lake of the Woods SWCD Boards during regularly scheduled meetings from 2008 through 2011. A final public meeting will be conducted in August 2011 to review the final report of the project at a Baudette City Council Meeting.

## **I. Long-term Results:**

The data from this study provides a better understanding of the Baudette River in relation to the Baudette Bay. Results from this study indicate that there is still an impairment of low dissolved oxygen in the Baudette Estuary. Based upon the data collected from this study and the characteristics of estuarine systems, the SWCD staff and MPCA project manager agree that the impairment for low dissolved oxygen is due to natural conditions. The next step for this waterbody is to technically review the data and commence the delisting review process.

## Section III - Final Expenditures

<b>Work Plan Tasks</b>	<b>unit cost (rate per hour, mileage, etc.)</b>	<b>unit type</b>	<b># units</b>	<b>Original Project Budget (includes 9/30/09 and 6/30/10 Amendments)</b>	<b>Final Project Balance</b>
<b>OBJECTIVE 1 - Water Quality Data Collection</b>					
<b>Task A - Surface Water</b>					
SWCD Resource Technician	\$50.00	hours	480	\$24,000.00	\$0.00
Field Intern	\$40.00	hours	100	\$4,000.00	\$0.00
Lab Analysis				\$14,376.70	\$0.00
<b>Total Task A</b>				<b>\$42,376.70</b>	<b>\$0.00</b>
<b>Task B - Sediment Sampling</b>					
SWCD Resource Technician	\$50.00	hours	80	\$4,000.00	\$0.00
Lab Analysis				\$1,000.00	\$1,000.00
<b>Total Task B</b>				<b>\$5,000.00</b>	<b>\$1,000.00</b>
<b>Task C - Data Management and Reporting</b>					
SWCD Resource Technician	\$50.00	hours	195	\$9,750.00	\$0.00
Field Intern	\$40.00	hours	50	\$2,000.00	\$0.00
<b>Total Task C</b>				<b>\$11,750.00</b>	<b>\$0.00</b>
<b>TOTAL OBJECTIVE 1</b>				<b>\$59,126.70</b>	<b>\$1,000.00</b>
<b>OBJECTIVE 2 - GIS Mapping</b>					
<b>Task A - Data Layers and Maps</b>					
SWCD Resource Technician	\$50.00	hours	144	\$7,200.00	\$0.00
Field Intern	\$40.00	hours	80	\$3,200.00	\$0.00
<b>TOTAL OBJECTIVE 2</b>				<b>\$10,400.00</b>	<b>\$0.00</b>
<b>OBJECTIVE 3 - EVALUATE AND ANALYZE DATA</b>					
SWCD Resource Technician	\$50.00	hours	264	\$13,200.00	\$0.00
<b>TOTAL OBJECTIVE 3</b>				<b>\$13,200.00</b>	<b>\$0.00</b>
<b>OBJECTIVE 4 - FINAL REPORT</b>					
<b>Task A - Produce final report</b>					
SWCD Resource Technician	\$50.00	hours	445	\$22,273.30	\$8,823.30
<b>TOTAL OBJECTIVE 4</b>				<b>\$22,273.30</b>	<b>\$8,823.30</b>
<b>ITEMIZED PROGRAM TASK BUDGET</b>					
<b>Total Objective 1</b>				<b>\$59,126.70</b>	<b>\$1,000.00</b>
<b>Total Objective 2</b>				<b>\$10,400.00</b>	<b>\$0.00</b>
<b>Total Objective 3</b>				<b>\$13,200.00</b>	<b>\$0.00</b>
<b>Total Objective 4</b>				<b>\$22,273.30</b>	<b>\$8,823.30</b>
<b>Project Grand Total</b>				<b>\$105,000.00</b>	<b>\$9,823.30</b>

## Section IV - Appendices

### A. Acknowledgements:

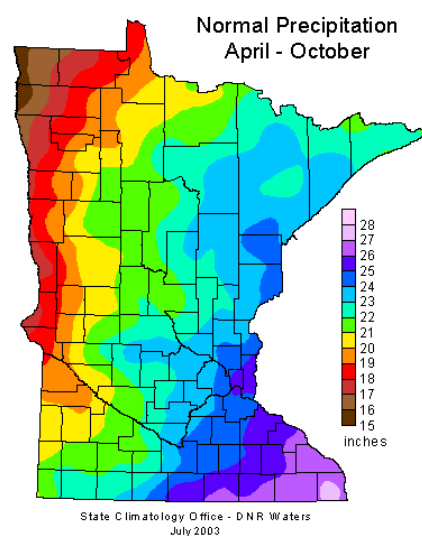
SWCD staff thanks Mike Larson, Phil Talmage, Tom Heinrich and Dennis Topp of MN DNR Fisheries office in Baudette for the use of their boat for deployed sonde installations and calibrations and Jeff Dittrich and Ted Dick of MN DNR Wildlife for the use of their snowmobile for winter monitoring. We also thank the many volunteers of the river watch program and the SWCD summer interns, Matt Fischer, Ashley Grundtner and Amber Thoreson.

### B. Precipitation Data:

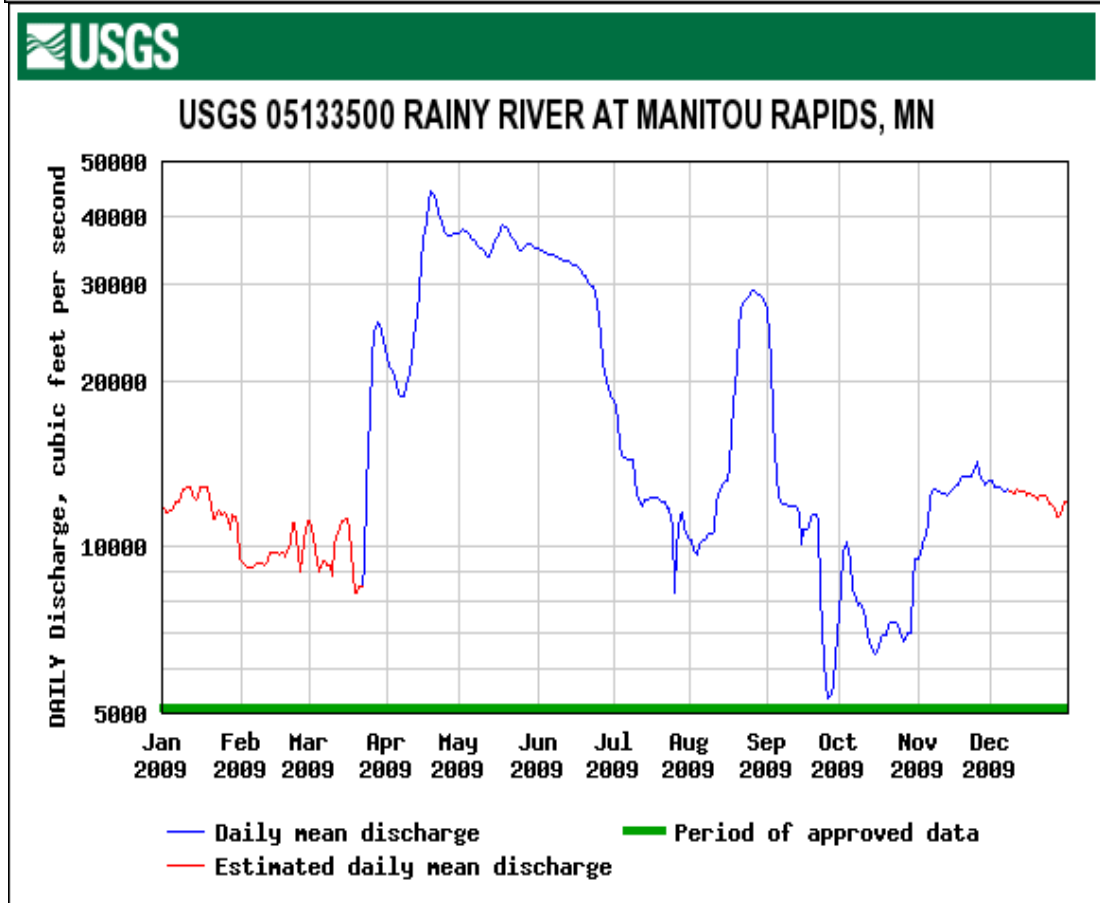
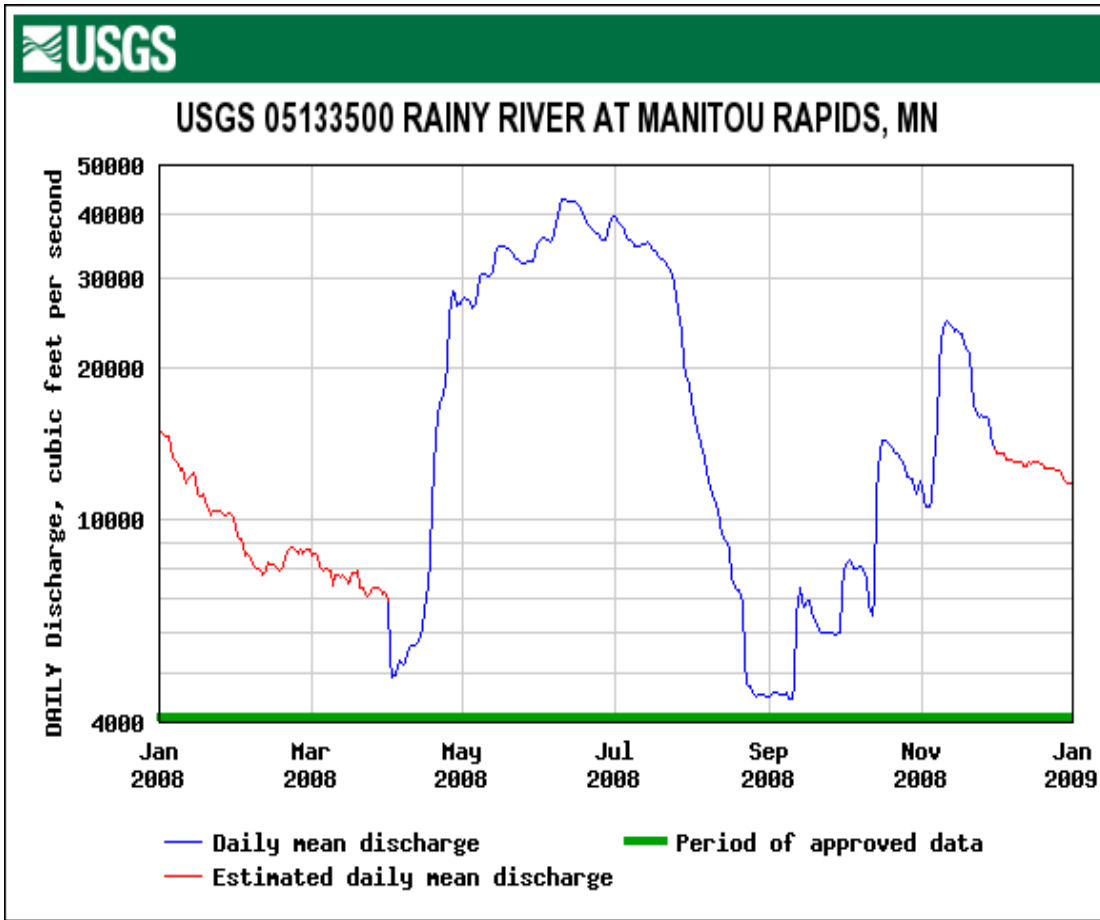
Monthly rainfall totals were minimal over the one and a half year open water season as designated in the table below. The contract was not completed until the end of June of 2008. The delay in the completion of the contract minimized the amount of storm events that were able to be monitored. There were 5 storm events collected in the shortened 2008 open water sampling season. In 2009 there was nearly 20% less total rainfall from the period of April through October when compared to the total monthly norms for rainfall during that same period. Therefore, there was less opportunity to sample storm events. In 2009 there were only 3 storm events captured during the monitoring season. Storm event monitoring was only scheduled for 2008 and 2009 seasons; however 2010 would have been a great year for storm events as there was nearly twice as much rain fall than in 2009 from April through October. The dissolved oxygen transects were taken in 2010.

Month	2008 Rainfall Amounts	2009 Rainfall Amounts	2010 Rainfall Amounts	Monthly Norms*
April	2.46	1.67	0.99	1.17
May	2.57	2.5	6.15	2.62
June	3.02	1.93	5.07	3.69
July	4.41	3.40	4.25	3.38
August	2.76	2.65	4.55	3.34
September	3.85	1.02	6.60	2.68
October	4.36	1.02	2.14	2.14
<b>Totals:</b>	<b>23.43</b>	<b>15.33</b>	<b>29.75</b>	<b>19.02</b>

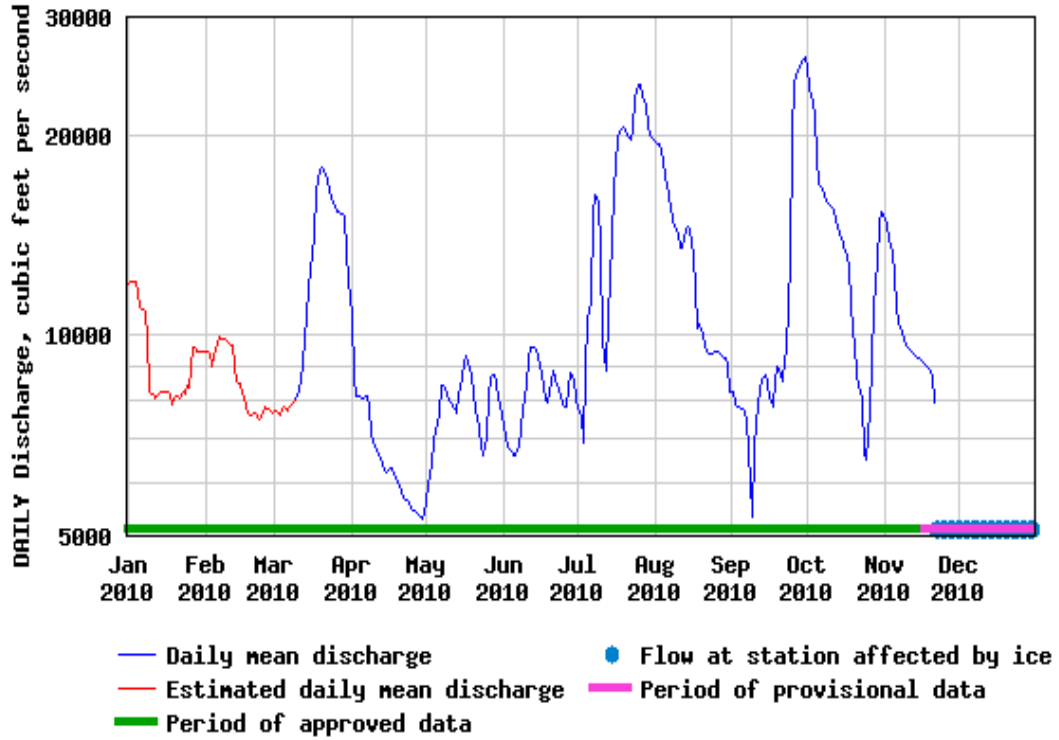
\*NOAA, Baudette Station. Data from 1971 - 2000 monthly norms.



C. Rainy River Flow Data:



### USGS 05133500 RAINY RIVER AT MANITOU RAPIDS, MN



#### **D. Update on Concerns Addressed from the Baudette River TMDL Report (2006):**

**Septic Systems:** The Land and Water Planning Office has continued efforts to upgrade septic systems in the watershed. Recently, the Land and Water Planning Office received state grant dollars to provide financial assistance to landowners for septic upgrades. In addition, the SWCD implements the AgBMP Loan program and has assisted landowners with low interest loans to upgrade their septic systems. In the last 5 years there have been an average approximately 4 septic upgrades per year, including upgrades in the Baudette watershed.

**Feedlots:** The SWCD has been actively working with all 11 feedlot owners in the watershed identified in the 2006 TMDL Report. Through implementing the Delegated Feedlot Program the SWCD has worked with the animal agricultural producers to minimize and eliminate the pollution potential of feedlot runoff. Six of the eleven feedlots are no longer in operation. Some operations were able to utilize the MPCA's Open Lot Agreement. The SWCD has assisted 4 of the feedlot owners with cost share projects to minimize feedlot runoff. Three of these projects are complete. Of the feedlot sites remaining in the watershed, all sites are either in compliance with the Minnesota State Statues or are actively installing corrective practices and BMPs.

#### **E. References:**

Fischer R. 2008. Baudette Estuary Dissolved Oxygen Impairment Verification and TMDL Development Project Quality Assurance Project Plan. Minnesota Pollution Control Agency.

Hirst M.W., Baratono N. & Magner J., 2006. The Total Maximum Daily Load for Low Dissolved Oxygen from the Headwaters of the Baudette River to the Rainy River, HUC: 09030008-006. Lake of the Woods Environmental Department, Lake of the Woods Soil and Water Conservation District, Minnesota Pollution Control Agency.