IRRB

THE

INTERNATIONAL RED RIVER BOARD

Nineteenth Annual

Progress Report

October 2018

INTERNATIONAL
RED RIVER BOARD

CONSEIL INTERNATIONAL
DE LA RIVIERE ROUGE

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Commissioners:

The International Red River Board is pleased to submit its Nineteenth Annual Progress Report to the International Joint Commission.

Respectfully submitted,

Mike Renouf
Co-Chair, Canadian Section

COL. Samuel L. Calkins
Co-Chair, United States Section

PREFACE

This report documents water quality trends and exceedances of objectives, effluent releases, and control measures for the Red River basin for the 2016 Water Year (October 01, 2016 through September 30, 2017). In addition, this report describes the activities of the International Red River Board during the reporting period October 01, 2017 to September 30, 2018 and identifies several current and future water quality and water quantity issues in the basin.

The units of measure presented in this report are those of the respective agencies contributing to this report.

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1.01 Water Quantity and Water Quality

Streamflow for calendar year 2018 on the Red River in Grand Forks, North Dakota, was in the normal range except for a short period in late April to early May 2018, when the flows reached the above normal category, because of snowmelt runoff. The graph below (Figure 1) shows the trend in flows from January 1, 2017 to August 12, 2018.

The Red River at Fargo crested on April 19 at 18.65 ft., with a peak discharge of 4,740 ft^3/s, (54th highest peak) for the 118 years of daily record. The exceedance probability for the spring peak was in the 0.20 to 0.10 range (5 - 10 year). The Red River at Grand Forks crested on April 24 at 34.99 ft. with a peak discharge of 28,000 ft^3/s (43rd highest peak) for the 136 years of peak flow record. The exceedance probability for the peak was in the 0.50 to 0.20 range (2 – 5 year).

Spring runoff into Devils Lake was insignificant and did not cause an appreciable rise in lake level. The peak water level at Devils Lake occurred on July 4, at an elevation of 50.21 ft. The current water level (August 13, 2018) is around 49.20 ft. Withdrawals from Devils Lake began on May 24 from the East End Outlet (165 ft^3/s, increasing to 230 ft^3/s on June 6) and on May 9 from the West End Outlet (125 ft^3/s, increasing to 250 ft^3/s on May 22).

In Manitoba in fall 2016/winter 2017, the Antecedent Precipitation Index (API) and soil moisture measurements indicated moisture conditions were normal to above normal throughout the Red River Basin heading into freeze up. The API reflects the soil moisture, or the amount of May to October precipitation that is within the soil and is yet to contribute for runoff. During the winter of 2017, there was well above (150 % – 200 %) to extremely above (>200 %) normal winter snowfall in the Red River Valley. Frost depths were near normal. The February 2017 Outlook published by the Manitoba Hydrologic Forecasting Center estimated that the peak flow at Emerson could reach the level seen in the 2011 flood under unfavorable conditions, and the 2010 flood under normal conditions.

Above freezing temperatures in late February caused much of the snow in the southern basin to melt, producing minor flooding at some locations. This greatly reduced the snow pack in the southern portion of the Red River Basin where the greatest accumulation of precipitation had occurred. The peak flow at Emerson during this event was approximately 15,150 cfs (429.0 cms). Due, in part, to this early melt event, the flood outlook was significantly reduced prior to the spring melt.

Streamflow for much of the Red River were at “normal” to “much above normal” levels (50 to >90 percentile) for the 2016/2017 winter. Flows at Emerson were in the “much above normal” range in the winter of 2016/2017 and early into spring 2017 (Figure 1).

Spring 2017

Significant runoff in the northern Red River and Devils Lake basins did not occur until the end of March and into early April. Some locations in the northern basin reached major flood stage in April. The Red River at Grand Forks crested on February 27th at 29.57 ft (provisional) with an estimated daily discharge 18,000 cfs (510 cms), in the interquartile range (72nd highest peak) for the 113 years of record. The discharge was estimated as the peak flow was impacted by backwater from ice. The exceedance probability for the peak was in the 0.20 to 0.50 range. Emerson peaked April 2nd at a flow of approximately 36,200 cfs (1025 cms). This corresponds to an approximately 1 in 4-year event.

Water levels peaked in Winnipeg on April 1st shortly after Red River Floodway operations began. The peak water level at the James Avenue Pumping Station was 19.53 ft (227.72 m). The Red River Floodway operated for 28 days from March 31 to April 27. The peak natural flow at James Avenue in Winnipeg would have occurred on the evening of April 7th, and calculated to be approximately 92,000 cfs (2600 cms). This peak flow would have resulted in a James Avenue level of 27.37 ft (230.11 m). In combination with operation of the Portage Diversion and Shellmouth Reservoir, operation of the floodway reduced the flood crest in the City of Winnipeg by 8.99 feet (2.74 m) at the peak natural flow.

Summer 2017

April peaks were followed by a generally dry weather pattern that resulted in flows in the main stem steadily receding but remaining in the normal range for the summer months (Figure 1).

Portions of the basin experienced some degree of dryness or drought conditions over the summer months. The Canadian and US Drought monitors registered abnormally dry to moderate drought conditions. While drier than normal, drought conditions were not as severe as those in northwest Montana, southern Saskatchewan, or western North Dakota.
Moderate impacts to crops were reported. However, drought impacts in the Red River Basin were fairly minor. August and September rains benefitted some crops.

Fall 2017

Late summer rains resulted in flows rising to above normal for the month of October. The Antecedent Precipitation Index (API) and soil moisture measurements indicated moisture conditions were generally normal, with some below normal conditions in the eastern and northern portions of the basin heading into freeze up. The API is a comparison of the precipitation from May to freeze-up of the current year to the historical record. The 2017 API was generally below normal in the northern portion of the basin and normal in the southern portion of the basin.

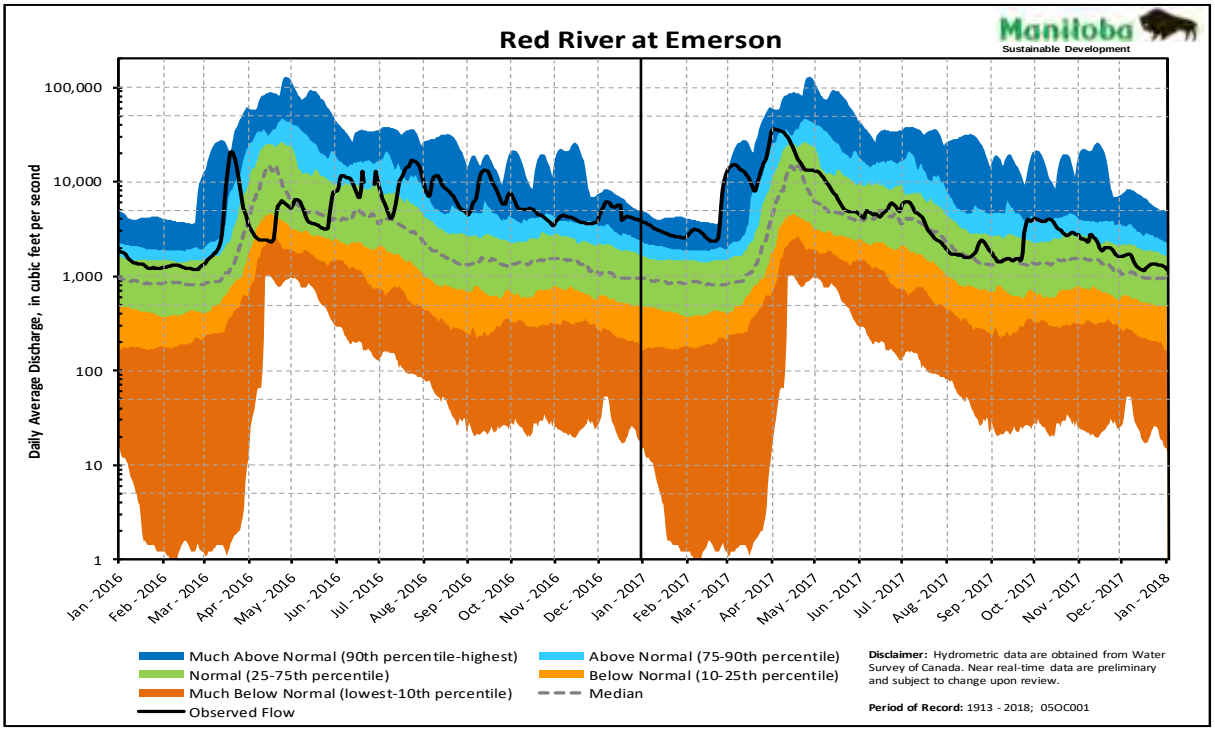

Figure 1. Average daily discharge in the Red River at Emerson for 2016 and 2017.

Water Quality

There are five water quality objectives established by the governments of Canada and the United States, herein called multi-national water quality objectives, for the Red River at the International Boundary. These parameters are - Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Chloride (Cl), Sulphate (SO_4), and E. coli. Exceedances of the water quality objectives, and concentrations approaching the objective level for total dissolved solids (TDS) were observed at the international boundary during the October 1, 2016 - September 30, 2017 time period. Total Dissolved Solids (TDS) remained at or above the objective of 500 mg/L for most of the 2017 water year (85 %). The highest observed value of TDS was 1.124 mg/L on December 19th.

Furthermore, the Sulphate objective (250 mg/L) was exceeded in 49% of the samples collected during the same period. The highest recorded value was 469 mg/L on December 19th.

The bacteriological characteristics of the Red River are assessed on the basis of observed *Escherichia coli* bacteria for which an IJC objective (200 colonies per 100 ml) has been defined. The presence of *Escherichia coli* in water is an indicator of impacts via human and/or animal wastes. During the 2016-2017 water year, the *Escherichia coli* bacteria objective of 200 colonies per 100 ml was not exceeded with a maximum count of 130 colonies per 100 ml measured in July 2017.

1.02 International Red River Board Activities

As noted in the Preface, this report also describes the activities of the International Red River Board (IRRB) for the period October 01, 2017 - September 30, 2018, which succeeds the 2017 water year. The key activities are highlighted below.
In 2018, the IRRB further revised its 3-year work plan to reflect the status of its activities, and to affirm

consistency with the International Watersheds Initiative and the IJC Directive to the IRRB. The work plan priorities include a continued effort to expand the existing scientific knowledge of aquatic ecosystem dynamics and current conditions. Key IRRB activities also include: development of apportionment/flow targets at the International Boundary including instream flow needs (IFN); continuation of the development of Comprehensive Flood Mitigation Strategy (CFMS) as per the terms of reference of the Committee on Hydrology; LiDAR mapping and hydraulic modeling of the Lower Pembina River Basin which has been completed and submitted to the IJC with recommendations; and development of nutrient objectives for the Red River at the International Boundary. An IWI proposal prepared by the Water Quality Committee (WQC) titled, "Red River Stress Response Modelling – Phase 1 Data Identification and Computational Model" was approved by the Board and received IJC funding through the International Watersheds Initiative. In addition, the Aquatic Ecosystems Committee (AEC) is conducting a three-year Fish Telemetry study with funding support from the IJC/ IWI.

The IRRB held its summer bi-annual meeting on August 30-31, 2017 to address select issues in the basin, and the winter bi-annual meeting on January 25-26, 2018 for a more complete review of its responsibilities, activities, and accomplishments. The meetings addressed water quality monitoring and compliance with the multi-national water quality objectives and established alert levels and IRRB work plan priorities. The latter included actions to develop water quantity apportionment procedures / instream flow needs (IFN), prioritized flood mitigation plans, and biological monitoring and nutrient management strategies for the basin.

1.03 International Red River Board Three-Year Work Plan (2018-2021)

The Board reviewed and updated its three-year work plan in August 2018. Current priorities include:

- Reporting on Water Quality Objectives,
- Comprehensive Flood Mitigation Strategy,
- Water Quantity Apportionment & Instream Flow Needs (IFN),
- Next Steps to Address the Lower Pembina Flooding Issues,
- Strategies to Develop Nutrient Management Objectives,
- Outreach and Engagement, and
- IWI funded Projects.

The current three-year work plan covers the period from October 1, 2018 through September 30, 2021.

2.0 INTRODUCTION

In April 2000, the International Joint Commission (IJC) formally merged its International Red River Pollution Board and International Souris-Red Rivers Engineering Board consolidating the water quality and water quantity responsibilities of the former boards, to form the International Red River Board (IRRB). This consolidation formalized the already emerging cooperative efforts of the former boards toward an integrated approach to transboundary water issues in the basin. Further, in its November 2000 report *Living with the Red*, the IJC recommended that the governments assign certain flood-related tasks to the IJC for implementation by its IRRB. In June 2001, Canada and the United States formally approved a new expanded directive for the IRRB. The directive is included in Appendix A.

In April 2003, the IJC requested further discussion with the IRRB on how to achieve a more ecosystem approach and a capacity to respond to the range of environmental and water-related challenges of the 21st century. In April 2004, the IJC adopted guiding principles aimed at broadening the partnership efforts of its international boards with other watershed entities for a more inclusive approach. The IJC refers to this effort as the International Watersheds Initiative. The various water management organizations in the Red River Basin appear receptive to the Initiative while at the same time recognizing the independent, impartial and objective role of the IJC and its boards in providing advice to governments. In June 2005, the IJC recommended that the governments of Canada and the United States confirm their support for the Initiative. The Red River basin is one of three pilot watersheds recommended by the IJC for implementation of the Initiative and for funding support.

In brief, the IRRB is responsible for assisting the IJC in avoiding and resolving transboundary disputes regarding the waters and aquatic ecosystems of the Red River and its tributaries and aquifers. This is accomplished through the application of best available science and knowledge of the aquatic ecosystems of the basin and an awareness of the needs, expectations and capabilities of residents of the basin. The geographic scope of the Board's mandate is the Red River basin, excluding the Assiniboine and Souris Rivers. The Poplar and Big Muddy basins were removed after consultation with the IJC. The Red River Basin is illustrated in Figure 2.

This report is the nineteenth IRRB annual progress report to the IJC.

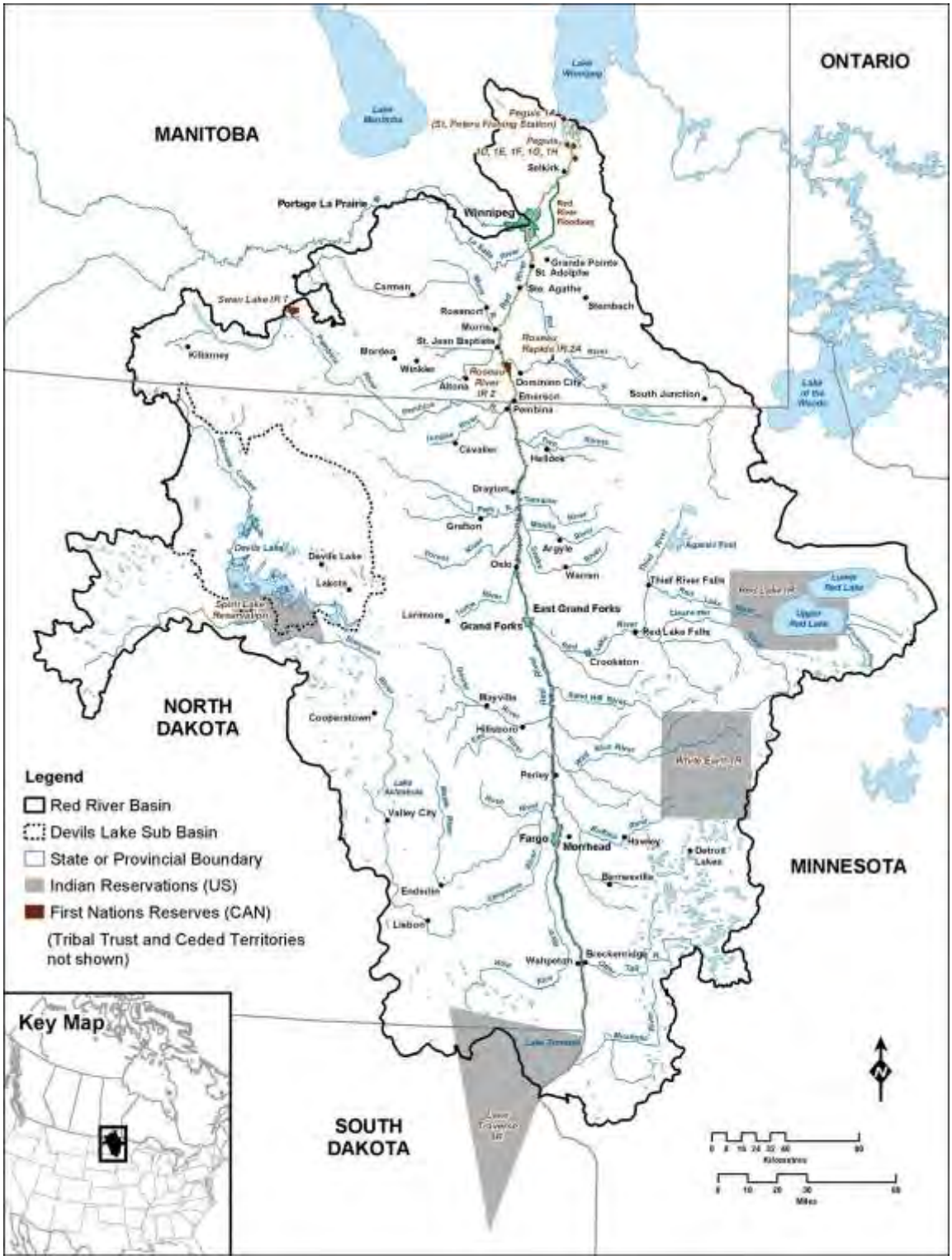

Figure 2: Red River and its Tributaries

3.0 INTERNATIONAL RED RIVER BOARD MEMBERSHIP

In its 1997 report *The IJC and the 21st Century,* the IJC proposed comprehensive international watershed boards as an improved mechanism for avoiding and resolving transboundary disputes. The intent was to broaden the scope of information upon which decisions relating to water and air are being made.

Through the continued integration of its water quality and water quantity responsibilities, and through efforts to increase stakeholder involvement, the International Red River Board is achieving many of the goals of a comprehensive watersheds approach. To facilitate these objectives, Board membership has been expanded to include non-government participation.

COL Samuel Calkins, U.S. Army Corps of Engineers; and Mike Renouf, Environment and Climate Change Canada, are the current Co-Chairs of the Board, respectively. Rebecca Seal-Soileau, US Army Corps of Engineers; and Girma Sahlu, Environment and Climate Change Canada, provide secretarial and technical support to the Board.

United States

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Minnesota Pollution Control Agency

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4.0 INTERNATIONAL RED RIVER BOARD ACTIVITIES

During the reporting period October 01, 2017 - September 30, 2018, the International Red River Board met with the IJC at the fall and spring semi-annual meetings at which Board priorities, activities and funding requirements were discussed. The Commissioners were apprised of basin developments and their potential transboundary implications.

4.01 Interim and Annual Board Meetings

The IRRB held its summer bi-annual meeting on August 30-31, 2017 to address select issues in the basin, and the winter bi-annual meeting on January 25-26, 2018 for a more complete review of its responsibilities, activities, and accomplishments. The meetings addressed water quality monitoring and compliance with the multi-national objectives and established alert levels, and IRRB work plan priorities. The latter included actions to develop water quantity apportionment procedures, instream flow needs, prioritized flood mitigation plans, and biological monitoring and nutrient management strategies for the Red River Basin.

Except for half-day executive sessions during the August and January bi-annual meeting, both meetings were open to the public in a spirit of information sharing and collaboration. This was undertaken in recognition that there are many local, regional, state/provincial, federal and natural resource management entities operating in the basin with which connective links would be mutually beneficial. In addition to inviting presentations from interested groups, the public audience was invited to share its views. The Board initiated its first public session in conjunction with the Red River Basin Commission (RRBC) Annual Conference in January 2015. RRBC provided a session in its conference agenda for IRRB Co-Chairs and IJC Commissioners to answer questions and receive input from conference attendees. IRRB will continue to coordinate with RRBC for future public meetings. This would allow the IRRB to reach a larger public audience than it would during its regular open house that used to be held at the end of its meetings.

4.02 IJC International Watersheds Initiative (IWI)

In 2004, the IJC adopted guiding principles aimed at broadening the partnership efforts of its international boards with other watershed entities for a more inclusive approach. The IJC refers to this effort as the 'International Watersheds Initiative'. The aim of the Initiative is to enhance the capabilities of existing IJC international boards while at the same time, strengthening cooperation among the various local entities. Building this capability includes[1]:

- employing a broader, systemic perspective of the watershed;
- expanding outreach and cooperation among organizations with local water-related interests and responsibilities;
- promoting the development of a common vision for the watershed;
- developing a better hydrologic understanding of the water-related resources; and
- creating the conditions for the resolution of specific watershed-related issues.

There are many government, non-government, academic, private; and other entities with resource management responsibilities and interests in the Red River basin. Many have expressed support for a watershed approach. The present IRRB membership and Committee structures provide a linkage to key segments of this community with potential to expand the linkages as integrative approaches evolve.

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[1] *A Discussion Paper on the International Watersheds Initiative: Second Report to the governments of Canada and the United States under the Reference of November 19, 1998 with respect to International Watershed Boards, June 2005.*

In its June 2005 report to the governments of Canada and the United States[1], the IJC recommended that the governments confirm their support for the Initiative and that funds be made available commensurate with board work plans. The Red River watershed is one of five pilot watersheds recommended by the IJC for implementation of the Initiative and for funding support.

4.03 Improving the Information Base to Address Transboundary Issues

The IRRB monitors water quality at the international boundary; maintains awareness of development activities basin-wide; provides a forum for the identification and resolution of water-related transboundary issues; recommends strategies for water quality, water quantity, and ecosystem health objectives, and monitors flood preparedness and mitigation activities.

To effectively address this mandate a focused effort through the application of best available science and knowledge of the hydrology and aquatic ecosystems of the basin is required. Hence, in 2001 the Board established two committees, a Committee on Hydrology (COH) and the Aquatic Ecosystem Committee (AEC) under which access to expertise could be consolidated with the capacity to undertake specific investigations and tasks.

The COH was re-established in 2006-2007 with a broader agency representation and new members. Specific activities assigned to the committees include establishing natural flow and water usage databases, evaluating current water quality monitoring and reporting protocols, developing biological monitoring strategies, and developing recommendations on an inter-jurisdictional drainage policy for the basin. These efforts are characterized by strengthened coordination with key water-oriented organizations in the watershed; and improved partnerships to develop a knowledge base and a shared understanding of water issues. Most frequently, the interests, objectives, and activities of the Committees intersect. Cross-membership also contributes to an integration of effort. Furthermore, the Board established the Water Quality Committee (WQC) in 2011 to report on water quality and nutrient management issues in the Red River Basin.

4.03-1 Water Quality Monitoring at the International Boundary and Red River Basin

During the reporting period, Environment and Climate Change Canada continued to provide water quality monitoring at the international boundary and reported on the status of compliance with established IJC water quality objectives. This was augmented with reports on the presence of pesticides, herbicides and other chemical constituents for which alert levels have been established (reports summarized in Chapter 5).

IRRB also received information from agencies monitoring the status of water quality surveillance and water pollution control in their respective portions of the basin. The scope of this work and its significant contribution to the information base is described in Chapters 6 and 7.

4.03-2 Aquatic Ecosystem Committee

In 2003, the Aquatic Ecosystem Committee (AEC) prepared a conceptual framework to monitor the long-term aquatic ecosystem health of the watershed and an action plan outlining specific activities and resource requirements. The framework and action plan were endorsed by the Board and form the basis of the IRRB work plan. The overarching aquatic ecosystem health goal for the watershed, as articulated by the AEC, is to "assist in assuring that water resources of the Red River of the North basin support and maintain a balanced community of organisms with species composition, diversity and functional organization comparable to the natural habitats within the basin without regard to political boundaries".

In January of 2016, the AEC was expanded to include several new members at the state, provincial and federal level. The committee members are:

Canadian Co-Chair: Patricia Ramlal, Fisheries & Oceans Canada
US Co-Chair currently vacant

Current Committee members are:

Luther Aadland (MN)
Todd Caspers (ND)
Eva Enders (CAD)
Amanda Hillman (MN)
Jessica Howell (ND)
Geoff Klein (MB)
Aaron Larson (ND)
Jeff Long (MB)
Patricia Ramlal (CAD)
Doug Watkinson (CAD)
Jamison Wendel (MN)

The AEC holds monthly phone calls except during the spring/summer field season. The group's discussion centers on how current work being done in the basin, could be linked either to ongoing programs or how the various programs could collaborate to get a better picture of the entire basin.

The AEC continues to flag the main issues of concern to the committee as those related to: (1) fish movement within the basin including instream flow needs (IFN); (2) aquatic invasive species (AIS); and (3) communication.

Currently the AEC is without a US co-chair.

Fish Telemetry Study in the Red River Basin conducted by the AEC

Brief Project Summary:

- A large scale hydro-acoustic telemetry study is currently conducted in the Red River and the adjunct Lake Winnipeg Basin to study habitat use and movement of a number of fish species including Lake Sturgeon (*Acipenser fulvescens*), Bigmouth Buffalo (*Ictiobus cyprinellus*), Channel Catfish (*Ictalurus punctatus*), Walleye (*Sander vitreus*), and Common Carp (*Cyprinus carpio*).

- The obtained information on habitat use and fish movement is crucial for Instream Flow Needs predictions and will provide previously unknown aspects of the lives of fishes in the Red River such as where certain fish spawn and when fish move to and from spawning grounds or overwintering areas. Additionally, we will better understand the population structure and movement of fish between the United States (US) and Canada in the Red River Basin.

Project Description:

- This study is part of a larger six-year project entitled "Effects of nutrients and aquatic invasive species on the local fish community in the Lake Winnipeg Basin" analyzing fish movement and habitat use in the Lake Winnipeg Basin in relation to Aquatic Invasive Species and other anthropogenic changes (e.g., climate change, nutrient loads, Instream Flow Needs). Currently 247 receivers have been deployed on the Canadian site of the border to detected tagged fish and 530 fish have been tagged.

- The funds provided by International Watershed Initiative (IWI) of the International Joint Commission (IJC) have been used to extend this fish movement study into the US portion of the Red River by expanding the receiver array by 14 stations into US and tagging an additional 50 fish in the US. Channel Catfish and Bigmouth Buffalo were tagged.

- The choice of study species is in response to requests and interests of different governmental agencies and non-governmental organizations. Including, Fisheries and Oceans Canada (DFO) Species-at-Risk, Fisheries Protection, and Aquatic Invasive Species programs, Manitoba Sustainable Development, the Lake Winnipeg Foundation, Ducks Unlimited Canada, and the States of Minnesota and North Dakota. The study is also likely to be of interest to the US Army Corps of Engineers in the frame of the Fargo Floodway Project. The acquired Habitat Use data will serve the International Red River Board (IRRB) part of IJC to make recommendations for water apportionment in the Red River by answering questions on Instream Flow Needs for fish movement and habitat. In addition, the habitat data will support DFO, Environment & Climate Change Canada, and the Province of Manitoba as baseline data before the full establishment of Zebra Mussel. The acquired data will also be useful to the understanding of the development of the Fargo Floodway and of the river connectivity particular in regards to fish passage over the weir in Drayton, ND.

- The deliverables of the project are:
  (1) Findings on fish movement, distribution, riverine habitat use, and diurnal shifts in habitat use to infer feeding ecology for the different fish species;
  (2) Analysis of fish detections in relation to abiotic and biotic variables (e.g., nutrients, temperature, depth, aquatic invasive species, fish passage, Instream Flow Needs);
  (3) Data serving Instream Flow Needs recommendations for the Red River.

Cost Estimate:

- The proposal requested:
  (1) In 2016-17, $50K that was used to purchase receivers and transmitters.
  (2) In 2017-18, $25K was used to support the salary of a data manager to coordinate fish tagging, receiver downloads and habitat survey.

(3) In 2018-19, $25K will be used to support the salary of a data manager to assist in the data analysis.

- The proposal is consistent with the International Red River Board (IRRB)'s existing mandate to establish Instream Flow Needs Recommendations for the Red River as outlined in work plan. The IRRB Committee on Hydrology (COH) has requested fish habitat use and movement data to establish recommendation on minimum flow criteria.
- In addition, the IRRB Aquatic Ecosystem Committee has added and prioritized the "Red River Telemetry Study" in the work plan.
- Results from the study will be communicated in annual reports (first, mid-term, and final reports) and distributed to all collaborators and stakeholders. In particular, federal, state, and provincial client sectors and the Committee on Hydrology of the International Red River Board as well as interested non-governmental organizations will be informed. This is an ongoing activity. Furthermore, the scientific findings will be published in the primary literature. Findings will also be presented at IRRB Annual Meeting and/or the Red River Basin Commission's annual conference. In January of 2018, Dr. Eva Enders gave a well- received presentation at the annual conference.

- In the annual reports, AEC will report on basic findings of the study such as:
  - Habitat use,
  - Fish movement,
  - Fish distribution, and
  - Discuss their implications for Instream Flow Needs in the Red River.

- Furthermore, the XY position data with date and time information (detections) is the basic unit of data collected in this study. Millions of detections may be collected based on the movement patterns observed and number of fish tagged. This data will be used to provide descriptive statistics as well as develop models that allow us to infer from the data available and make predictions about fish movement. It should be noted that the deliverables could be provided to the IFN Committee as preliminary results arrive. Selecting species in modelling IFN processes, such as Weighted Usable Area (WUA), is often based on expert opinion and/or extremely opportunistic sampling evidence. Even early empirical evidence provides a substantial support to species selection for the IFN study.
- Once the project is completed, the data from this project will be made available on the open-access DFO Scientific Data and Products website to be widely accessible. Project meta-data will be managed and archived according to DFO's Management Policy for Scientific Data Framework.
- Furthermore, an executive summary style write-up for the IJC activities annual report and a "Lessons Learned" write-up discussing whether the project met projected deadlines as well as reflections upon how the project process could have been improved will be provided.

Future Work Plan:

The Aquatic Ecosystem Committee proposed a three-year work plan to the IRRB that met with their approval. We will be applying for IWI funds to support some of these activities. The three components of that plan are as follows:

- Continuation of the Fish Movement Study: The large-scale hydro acoustic telemetry study is currently conducted in the Red River and the adjunct Lake Winnipeg Basin to study habitat use and movement of a number of fish species.

- Aquatic Invasive Species: Evaluation of current and projected AIS in the Red River.

- Habitat Evaluation in the Red River: Survey the riverine habitat in the Red River by conducting velocity and depth measurements along transects positioned at every hydro acoustic receiver site in the Red River using an ADCP (Acoustic Doppler Current Profiler). In addition, depth and substrate will be assessed using a Bio Sonics MX Aquatic Habitat Echo sounder throughout the entire the length of the Red River. This study would be conducted by both countries (US and Canada) and would require approx. four weeks of fieldwork and two months of data analysis. This work complements the fish movement study and the IFN study by the COH. Possibly add surveys of some of the tributaries, with ADCP if depths are deep enough, or with alternate survey equipment appropriate to the depths being surveyed. NOTE: This study has been postponed until fiscal 2020/21 due to the heavy workload of the participants.

4.03-3 Water Quality Committee - Nutrient Management Strategy for the Red River Watershed

The formation of the Water Quality Committee was approved at the September 2011 International Red River Board meeting. The Committee is developing a Nutrient Management Strategy as endorsed by the Board.

The Water Quality Committee currently consists of the following members:

Jim Ziegler, Minnesota Pollution Control Agency (co-chair)
Nicole Armstrong, Manitoba Conservation and Water Stewardship (co-chair)
Mike Ell, North Dakota State Department of Health
Leah Thvedt, Red River Basin Commission
Rochelle Nustad, U.S. Geological Survey
Eric Steinhaus, U.S. Environmental Protection Agency
Mike Vavricka, Minnesota Pollution Control Agency
Iris Griffin, Environment Canada
Rob Sip, Red River Watershed Management Board
Keith Weston, Red River Retention Authority
Brian Parker, Manitoba Sustainable Development
Glenn Benoy, IJC
Jason Vanrobaeys, Agriculture and Agri-Foods Canada
Dave Jones, Natural Resources Conservation Service
Michelle Harland, Environment and Climate Change Canada
Paul Klawunn, Environment Canada

The Committee's last report to the IRRB was January 25 and 26, 2018. The committee has not met since then.

Component One - Develop Nutrient Management Study
Complete

Component Two - Develop a Shared Understanding of Jurisdictions' Nutrient Regulatory Frameworks and Identify Current Nutrient Reduction Actions, Activities and Plans for the Red River Watershed

Complete. The matrix and regulatory framework distributed previously will be updated as required.

Component Three - Recommend and Implement Nutrient Load Allocation and/or Water Quality Targets for Nutrients

<u>International Watersheds Initiative Project – Review of Methods for Developing Water Quality Targets</u>

The final report for this work was submitted by RESPEC in March 2013 and approved by the Water Quality Committee in May 2013. The report was distributed to and approved by the IRRB in July 2013. It is posted on the IRRB website at: http://ijc.org/boards/irrb/files/2012/06/Approaches-to-Setting-Nutrient-Targets-in-the-Red-River-of-the-North-FINAL.pdf

Water Quality Modeling

No committee work has been done on this since the last report. Individual jurisdictions have the information they need to begin to utilize the SPARROW model.

International Watersheds Initiative Proposal – Development of a Stressor-Response model for the Red River

This work has been completed and presented to the IRRB in August 2017. The Water Quality Committee (WQC) addressed additional questions from the Board in January 2018. The WQC will request approval of the Board for this work at the Board's fall 2018 meeting.

Component Four – Monitor and Report on Progress towards Meeting Water Quality Targets and Nutrient Load Allocations

Work to assess the comparability of existing water quality monitoring programs and data throughout the watershed is underway and the committee is exploring options for web-based delivery of information on water quality monitoring programs.

This work is ongoing.

Component Five - Facilitate ongoing technical, scientific and methodological dialogue and information sharing

This work is ongoing.

Component Six - Adapt the nutrient management strategy based on progress and ongoing evaluation.

This work is ongoing.

4.03-4 Water Quantity Apportionment

As indicated by the historic streamflow records, water supply in the Red River basin is highly variable seasonally, annually, and over longer time periods. Recent forecasts of water demand based on population and economic growth projections further test the adequacy and reliability of these supplies. Scientific opinion with respect to climate change provides added caution regarding future hydrologic trends and the prospect of greater instability in water supply in the region.

The factors noted above and projected increases in water use causing larger departures from the natural regime to occur, prompt action to set flow targets at the international boundary. The IRRB considers it prudent to consider establishment of such targets before they are needed. In July 2006, the Hydrology Committee was asked to prepare a detailed proposal to establish the 'process' for undertaking development and implementation of apportionment procedures. The proposal was to identify the project elements, participating agencies, related capacity issues, and timelines.

At the January 2008 meeting, the Board approved the Hydrology Committee's plan for the development of flow apportionment procedure for the Red River. The Committee noted the establishment of a process for the development of water quantity apportionment requires an understanding of the natural flow regime on the Red River. Any acceptance of an apportionment procedure will require agreement on the method of computing the natural flow in the Red River Basin and understanding water uses in the Basin. The development of a flow apportionment procedure is a multi-year process and will require involvement of many partners. Major issues will be differences in water laws between the jurisdictions and consideration of instream flows. To support the development of a flow apportionment procedure three reports have been prepared under the IJC International Watershed Initiative.

The first report, Dr. Rob de Loe's, University of Guelph, reviewed apportionment governance procedures relevant to the Red River Basin, and recommended an appropriate model. Dr. de Loe's completed report titled, "Sharing the Waters of the Red River Basin: A Review of options for Transboundary Water Governance" was approved by the IRRB at the September 2009 meeting.

The study was based on an extensive review of two main sources of information: (1) documents and reports relating to water management in the Red River Basin, and (2) the literature of transboundary water management. Two overseas and two Canada/US case studies were analyzed in detail, with the goal of revealing insights into real-world problems and solutions of transboundary water governance. The overseas case studies were the Orange-Senqu River Basin in southern Africa and the Murray-Darling Basin, in Australia, The two Canada/US case studies were the St. Mary-Milk Rivers and the Souris River Basins. The study recommended an apportionment model and approach to transboundary water governance in the Red River Basin that includes the following major elements:

1. A prior appropriation to meet critical human and environmental needs.
2. Rules to apportion remaining natural flows between Canada and the United States based on the principle of equitable sharing.
3. Rules regarding waters that originate in the respective countries' portion of the basin but do not cross the boundary. This model represents a balanced approach that takes account of local circumstances (e.g., the role of the *Boundary Waters Treaty of 1909*, existing management relationships, climatic conditions and the nature of water uses).

The second report, by R. Halliday & Associates, entitled "Determination of Natural Flow for Apportionment

of the Red River identified a process for the development and implementation of water quantity apportionment procedures. The report covered the following areas:

- Define and review various methodologies that may be used to determine natural flow.
- Discuss these methods in the context of the Red River basin and recommend a specific method or methods.
- Review the data requirements of the selected method/methods and compare the requirements to the existing databases.
- Identify key data deficiencies and indicate how these could be resolved.
- Identify potential problem areas, such as, availability of structures to deliver minimum flows, different water rights appropriation procedures between jurisdictions and information availability.
- Review specific calculation procedures pertaining to international tributaries and recommend an approach.
- Review considerations related to equitable apportionment.

The Project Depletion Method was recommended given the availability of an adequate hydrometric network and a robust system of water permits or licenses in the Basin. Information is provided on how the calculation can be accomplished and several information gaps were identified in the areas of hydrometric and meteorological networks; water allocation; water use: evaporation and apportionment.

The report notes that there are a number of matters that must be resolved before natural flow can be calculated and before an apportionment arrangement can be executed. None of them is incapable of being resolved with good will among the parties. However, as water consumption in the Red River Basin is relatively low compared to that in other apportioned basins in the interior plains, it may be preferable to explore whether an international drought contingency plan may be a productive task to pursue rather than considering a traditional apportionment agreement. As an alternative, careful consideration of minimum flow criteria for the Red River could provide additional insights. Such criteria could well be the only element of an apportionment arrangement that is required at this time.

The third report gathered information to support the development of instream flow needs. A report entitled "Information Available for an Instream Flows Analysis of the Red River for Water Apportionment Purposes" was prepared by William G. Franzin for the Board. The development and implementation of water quantity apportionment procedures for the Red River Basin requires an understanding of the aquatic ecosystem to assist in identifying instream flow requirements for the Red River. Information was gathered with respect to the following five major riverine areas of hydrology; geomorphology; biology; connectivity; and water quality; variables. Because of the large amount of detailed hydrological, hydraulic and modeling data, a person specializing in hydraulic modelling would require at least a year's effort, and GIS would be required, to process the data to determine the feasibility of an instream flow study with the available data.

The Hydrology Committee's work on apportionment and international drought contingency planning is continuing and focussing on two components: 1) quantifying water usage and low flow vulnerabilities (municipal and other licensed water use, ecosystem instream flow needs, wastewater assimilation, etc.), and 2) quantifying low flow frequencies and the ability of U.S. reservoirs to deliver water during a drought to satisfy U.S. water demand and a potential low flow criteria at the border. The result of the study will be a better understanding of the risks the Basin faces from various Red River Drought scenarios and how a drought contingency plan or minimum flow criteria for the Red River could reduce these risks.

In January 2017, the Hydrology Committee presented work the committee has been undertaking internally to develop a fish habitat model from Emerson, MB to Morris, MB. The purpose of this model development is to have a tool to assess habitat availability for various fish species at various low flows. The committee

continues to work on the model development and refinement, is determining the next steps in the model application to support low flow and drought planning.

The Hydrology Committee has updated its work plan with projects focused on obtaining more information of water usage and low flow frequencies. Two potential projects to be completed in the next two to three years include "Red River Low-Flow Frequency Analysis for Evaluation of Future Instream Flow Needs" and "Water Use in the Red River of the North Basin, United States and Canada, 1985-2015".

4.04 Comprehensive Flood Mitigation Strategy

In its report *Living with the Red*, the IJC noted that there is no single solution to reduce, mitigate and prevent harm from future flooding, and that comprehensive, integrated, binational approaches must be pursued and implemented. The report follows with a list of recommendations to include," Governments immediately take steps, on a binational basis, to begin development of a comprehensive flood damage reduction plan for the Red River basin".

In 2003, at the request of the IJC, the IRRB completed a basin-wide survey and analysis of actions taken by governments at all levels in implementing the recommendations contained in *Living with the Red*. The final survey report titled *Flood Preparedness and Mitigation in the Red River Basin - October 2003*, indicated that while considerable progress had been made in increasing preparedness for major floods and in mitigating potential harm from future floods, there was a need for continued and concerted effort to address those IJC recommendations entailing multiple objectives and inter-jurisdictional cooperation. Further to this report, the IRRB indicated that a comprehensive flood mitigation plan as proposed by the IJC in January 2003 would provide an appropriate mechanism to mobilize the multi-jurisdictional co-operation necessary to assure cohesion on flood management and long-term resiliency in the basin.

In 2005, the document titled *Comprehensive Flood Mitigation Plan* (CFMP) was prepared by the IJC in consultation with the Red River Basin Commission (RRBC) and the IRRB, and advice regarding preferred options for advancing the document to the political level was sought from senior officials in the three jurisdictions (North Dakota, Minnesota, and Manitoba). The proposed CFMP is intended to build on the Memorandum of Understanding for Flood and Drought Mitigation on the Red River that was signed by the governors of North Dakota, Minnesota and South Dakota and the Premier of Manitoba in April 2004. Further, the Plan recognized efforts led by the RRBC to develop a Natural Resources Framework Plan (NRFP). The CFMP would contribute to and become an integral part of the NRFP.

Support for the CFMP was discussed further at the IRRB annual meeting in July 2006. It was concluded that while members do not all have the same interpretation of the priorities for flood mitigation in the basin or on follow-up approach, the components under a CFMP, or Flood Mitigation Strategy as the suggested name-change, need to be determined. Integral to this task is a documentation of the accomplishments and the positive benefits that have accrued to the basin and communities. The latter represents an important communications document reflecting the actions and achievement of many agencies, including the IJC and IRRB. This undertaking would also provide insight into how the IRRB and others might support or influence continued preparedness and mitigation activities in the basin.

As agreed at the 2006 annual meeting, the IRRB Co-Chairs prepared a Terms-of-Reference for the Hydrology Committee to develop a detailed project proposal that outlines the scope of work required to document the flood mitigation accomplishments to date and to identify the remaining mitigation priorities for the basin. The individual and collective capacity of participating agencies, and options to engage Committee members, IRRB members, and/or independent consultants, to complete the task is to be

explored.

The IRRB Co-Chairs reviewed the March 2007 letter they had sent to the Hydrology Committee regarding the IRRB's role in identifying priority flood mitigation activities for the basin. In their letter, the Co-Chairs asked the Hydrology Committee to continue providing a current inventory of improvements and deficiencies based on agency knowledge. The same letter was also discussed with the IJC Commissioners at the April 2007 meeting. Based on the discussion, the Commissioners clarified their position on the Comprehensive Flood Mitigation Strategy (CFMS), previously known as the Comprehensive Flood Mitigation Plan (CFMP), and it was agreed that the IRRB should continue with the development of the CFMS as per the terms of reference provided to the Hydrology Committee. The Co-Chairs have indicated that based on the discussion with the IJC, they would amend their direction to the Hydrology Committee.

Since the 1997 Red River Flood, there has been a legacy of accomplishments in the areas of cooperation between jurisdictions, improvements in predictive tools, public involvement and changes in legislation and development of data dissemination tools. However, there are still challenges in improving the predictive tools, maintaining and improving databases, data collection and data dissemination, maintaining flood protection infrastructure and continued review of flood protection policy and legislation.

Based on these accomplishments and challenges the Board felt it was time to update the IJC report "Living with the Red". The Hydrology Committee was instructed to develop a project proposal under the IWI initiative for the publication of a document entitled "How Are We Living with The Red?" In 2008, the IJC approved funding for this project and the Hydrology Committee contracted Halliday & Associates to assess flood preparedness, mitigation and to identify gaps and tasks yet to be undertaken. The intent of the document is to inform the public of accomplishments and challenges regarding flood mitigation in the basin and to supplement IRRB information available via the IJC International Red River web page. The completed project was presented to the Board at its meeting on September 16, 2009 in Gimli, Manitoba.

The study found much has been accomplished, yet some unresolved issues remain. While the communities of the Red River basin are unquestionably more flood resilient than in 1997, it will still take considerable effort to achieve the level of integration and cohesion on flood management that the IJC envisaged. Adoption of binational measures, however, will still be needed before the long-term resiliency of the basin can be assured. Some of the key achievements can be summarized under headings of policy, legislation and institutions; preparedness; mitigation; and environment as follows:

Policies, Legislation and Institutions

- Improvements in policy and legislation have been made in all jurisdictions.
- In 2008 Canada introduced its first national flood mitigation strategy. That strategy includes a number of priority actions, including an avenue for federal contributions to mitigation measures.
- Changes in data policies by the Canadian federal government and by the Manitoba government have led to much improved access to data.
- Manitoba has introduced a new designated flood area regulation. The associated elevation and inspection requirements for new structures will reduce future flood damages.
- Activities of the United States Army Corps of Engineers are aimed at a more integrated basin-wide consideration of mitigation projects.
- Both North Dakota and Minnesota have implemented new state building codes that include flood-proofing measures.
- Key institutional developments include the formation of the IJC's International Red River Basin

Board, the Red River Basin Commission and the International Water Institute.

Preparedness

- All communities in the basin now have up-to date emergency response plans.
- Significant improvements have been made to flood forecasting in both Canada and the United States.

Mitigation

- Many structural measures aimed at protecting both rural and urban floodplain residents have been completed or are at advanced stages of development.
- Major levees such as those for Grand Forks and East Grand Forks are essentially complete.
- The increased capacity of the expanded Red River Floodway at Winnipeg is now available. Channel expansion was complete in 2009 and all project components were completed by 2014.
- Flood protection measures for many other communities, large and small, are in place and thousands of rural residences have been moved, raised or diked.
- Several agencies are collaborating with the Red River Basin Commission, U.S. Army Corps of Engineers, and the International Water Institute on the development of complex hydrology and hydraulic models for the basin.

Environment

- Measures have been introduced to avoid contamination of wells and to remove hazardous chemicals from the floodplain, or improve the storage facilities for chemicals.
- Programs are underway aimed at establishing riparian conservation reserves and developing a greenway on the Red River.

There are some causes for concern nonetheless. The less successful recommendations are those that involve multiple agencies and, perhaps, multiple objectives. These sorts of tasks could be deemed more difficult and could naturally be expected to take longer. It may be that public expectations for structural measures supersede all other post-flood pressures and that those expectations need to be met before proceeding with "softer" projects. As well, some structural measures in the upper basin have been delayed by other priorities and because of permitting issues.

In the summer of 2016, the Hydrology Committee was awarded funding through the IWI initiative to provide another update on the recommendations made in “Living with the Red”. The Hydrology Committee contracted Halliday & Associates to undertake the update of “How Are We Living With the Red?” review the status of each of the IJC’s recommendations, and identify the key items left undone. The contracted work has been completed and the Board has accepted the final report titled “Twenty Years Later: Flood Mitigation in the Red River Basin” (dated March 31, 2017) for posting publicly on the Board’s website.

The “Twenty Years Later: Flood Mitigation in the Red River Basin” report concludes that in the almost 20 years since the 1997 flood some matters that were extremely important at the time have been resolved while others can be addressed by today’s vastly superior technology. Continued consideration of all the IJC recommendations from “Living with the Red” is no longer the best approach. Instead, the IJC and its International Red River Board can continue to monitor a small sub-set of the original recommendations. Based on Living with the Red update recommendations, the Comprehensive Watershed Management Plan, and Red River Basin Commission’ Long Term Flood Solutions planned update the Hydrology Committee will provide recommendations to the Board for flood mitigation monitoring in the future. The Hydrology Committee will ensure the Board stays engaged about future plans and activities of the Red River Basin

Commission as they update the Long Term Flooding Solutions document.

4.05 Invasive Species – Zebra Mussels

Zebra mussels, a non-native invasive species, were discovered in the Red River basin for the first time in September 2009. The mussels were found in Pelican Lake in Otter Tail County, Minnesota, which is on the Otter Tail River, which in turn drains into the Red River. Zebra mussels were found in the Red River at Wahpeton North Dakota/Breckinridge Minnesota in 2010.

Native to Eastern Europe and Western Russia, zebra mussels were first discovered in the Great Lakes in 1988. They entered the Upper Mississippi River system from Lake Michigan via the Illinois River (Chicago Sanitary and Shipping Canal) and spread upriver into Minnesota and Wisconsin via recreation and commercial boat traffic. Invasions can kill native mussels, impact fish populations and their habitats, interfere with recreational activities such as boating and beach-going, increase taxes and costs for industry, including power and water supply facilities, and compromise drinking water infrastructure and tourism opportunities.

Zebra mussels are adapted to lentic (lakes/reservoir) habitat. They can survive in riverine habitat, but it is generally understood that they require an upstream source of healthy zebra mussel populations to supply free-floating larvae – typically from an upstream reservoir or lake. Zebra mussels are spread overland from invaded water bodies via transient recreational watercraft traffic and transfers of boat docks or lifts or other water related gear. Other vectors such as floatplanes and off-road vehicles all pose concern for spreading aquatic invasive species.
Preventing an introduction is key, as there is little that can be done to address an existing invasion of aquatic invasive species such as zebra mussels. Natural resource agencies in the U.S. and Canada are focused on public awareness and education aimed at preventing transportation of aquatic invasive species on watercraft, trailers, and docks. Actions include increased communication targeting water user-groups signage at invaded lakes, watercraft inspections, and monitoring.

In October 2013, the Government of Manitoba confirmed zebra mussels in the south basin of Lake Winnipeg. Zebra mussel veligers were detected in the Manitoba portion of the Red River for the first time in early June 2015 at Emerson and a second sampling location at Selkirk. Zebra mussel adults and veligers were subsequently found in the U.S.A. portion of the Red River. In early May 2015, adult Zebra Mussels were reported from a dock located in an offshoot of the Red River near Selkirk Park. This was the first detection of adult Zebra Mussels in the northern portion of the Red River.

Although the eradication of zebra mussels in four harbours in Lake Winnipeg in May and June 2014 was successful, a reproducing offshore population of Zebra Mussels was identified in the south basin of the lake in mid-summer 2014. By the end of the 2015 open water season Zebra Mussels were re-invading the treated harbours and expanding their range within the south basin.
In 2015, Zebra Mussel veligers were found throughout the length of the Manitoba portion of the Red River as well the first detection of zebra mussel veligers was found in the north basin of Lake Winnipeg. In the fall of 2015 zebra mussel veligers were found in Cedar Lake, Manitoba, located immediately upstream from Lake Winnipeg's north basin on the Saskatchewan River system.

In 2017, a single, suspect adult zebra mussel was found on a retrieved substrate sampler used for early detection monitoring in Singush Lake located in Duck Mountain Provincial Park in southwestern Manitoba. Preventative measures were implemented to contain the spread of the potential zebra mussels by closing the lake to all day-use boaters and only allowing watercraft access to Singush Lake cottagers with the condition that their watercraft could not be launched in any other water body for the 2017 open water season.

Monitoring continues on Singush Lake to determine the presence or absence of zebra mussels thus the lake may remain closed to day-use boaters for up to 3 to 5 years. These control measures remain in place for the 2018 open water season.

In December 2017, Riding Mountain National Park closed Whirlpool Lake to all use after a laboratory confirmation positive for zebra mussel eDNA (Environmental DNA) was detected in that lake. To date, no physical specimens of zebra mussels have been found. The lake is being actively managed through winter drainage in attempts to freeze / suffocate any potential zebra mussels within the lake.

Although zebra mussel are the most notable aquatic invasive species, the Government of Manitoba is working to prevent the spread of species such as spiny water flea, black algae, rusty crayfish, flowering rush and invasive giant reed which are either established or newer invaders to the province. In addition, it is critical for Manitoba to continue efforts to prevent the introduction of new invasive threats such as invasive carp, quagga mussels or Eurasian watermilfoil, which are in close proximity to Manitoba.

Overall, the Government of Manitoba has increased its efforts to prevent introductions and continue to work to contain the spread of aquatic invasive species such as zebra mussels, spiny water flea, and black algae. In 2017 watercraft inspection stations were operating, both at key highway locations designed to intercept watercraft exiting aquatic-invasive-species- invaded water bodies, and at high risk boat launches. In addition, Manitoba developed provincial aquatic invasive species legislation under The Water Protection Act, collaborated on the development of federal aquatic invasive species legislation under the federal Fisheries Act (both the federal and provincial legislation came into force in 2015), and increased communication initiatives targeting the main vectors of spread such as boaters, water-related aircraft, and off-road vehicles.

Increased monitoring of water bodies in Manitoba continues. Provincial monitoring within Lake Winnipeg is ongoing to determine the range and rate of spread of this species and in surrounding water bodies for early detection purposes.

4.06 Lower Pembina River Flooding

The IRRB at its January 2008 meeting established the Lower Pembina River Flooding Task Team (LPRFTT). The mandate of this Task Team was to develop a science-based solution(s) to mitigate flooding in the lower Pembina River Basin (Figure 3).

A significant milestone for the IRRB was the completion of the Lower Pembina River Flooding Task Team (LPRFTT) Report. The LPRFTT has overseen the completion of a three- phased International Watersheds Initiatives (IWI) study report entitled, “Simulation of Flood Scenarios on the Lower Pembina River Flood Plains with the TELEMAC 2D Hydrodynamic Model”. The National Hydraulic Centre (NRC) conducted all three phases of the study. Based on the results of the modelling effort, the LPRFTT developed a document titled, “An exploratory analysis of mitigation measures for the lower Pembina River basin”. The three phases of LPRFTT reports were presented to, and subsequently accepted by, the IJC. The reports, model, and animations have also been made public.

The National Research Council’s (NRC) Canadian Hydraulics Centre provided a March 1, 2013 webinar showing how Blue Kenue™, an advanced data preparation, analysis, and visualization tool for hydraulic modellers, uses direct import of model results from TELEMAC, ADCIRC and HydroSim, and can provide fully geo-referenced data and animated views in multiple dimensions (1D, Polar, 2D, 3D and spherical).

One of the recommendations provided by the IJC to Governments was to establish a Task Team to work

towards a binational solution to help manage the flooding issues in the Pembina Basin. Based on this recommendation, the Governor of ND and the Premier of Manitoba have each assigned five members and have created the Pembina River Task Team. IRRB Co-chairs have also been included as members of the Task Team in addition to the 10 Task Team members. The first meeting was held on 15 October 2013 in Fargo, ND. The Red River Basin Commission organized the meeting. Lance Yohe, Executive Director of the RRBC, was the meeting facilitator (Jeff Lewis has since become Executive Director of the RRBC and will be the main facilitator for the Task Team). Topics of discussion included:

    - Summary of past reports/plans/studies, data, modeling, and transboundary committees;
    - Purpose and charge of the committee;
    - Role of participants;
    - Starting points that Manitoba and North Dakota agree on for what the committee will move forward on;
    - Presentation on the Telemac 2D model prepared under the leadership of the Lower Pembina River Basin Task Team from 2008-2012; and
    - Primary discussion of possible solutions.
- The second meeting of the Task Team was held on March 24, 2014 in Fargo, ND. Discussion included:
    - Purpose, charge, roles, and starting points;
    - Additional study needs;
    - Effects of possible raise of HW #18 near Neche;
    - Impact of 2 large openings through border road/dike for larger floods;
    - Opinions on various alternatives; and
    - Some economic information on various options was also presented.
- A conference call was held on June 13, 2014 to provide further information on the following:
    - Preliminary economic analysis of some alternatives;
    - Agreement on the need for the following additional modeling:
        - Impact of raising HW #18 in Neche area;
            - Additional culvert capacity required to prevent change in flood conditions
        - Analysis of 50-year and 100-year flood for the alternative where two large openings are made through the road/dike; and
        - Analysis of additional temporary floodwater storage near the study area.

Several members of the Task Team were able to tour the study area during an August 26, 2014 tour of the area that was hosted by the IRRB and IJC members. An IWI Project Proposal Form was completed to request funding for the National Hydraulics Centre to complete the modeling of the 3 items described during the June 13, 2014 conference call (as listed above), with the TELEMAC 2D Hydrodynamic Model.

Work started on the model development after funding was approved during the latter part of 2014. The modellers held bi-weekly conference calls to update the status of the study, starting near the middle of January 2015 and continuing to the middle of March 2015. The final report was completed by the end of March 2015.

Technical representatives of the Task Team were involved in a June 8, 2015 conference call to discuss results of the Phase 4 model. Much of the discussion concerned the Highway #18 analysis. Some additional detail on the results was requested for that portion of the study. This information was provided through the National Hydraulics Centre shortly after that time. There was also a request to determine the impacts in the area if the culverts were longer than had been analyzed. An additional phase of modelling (Phase 5) was undertaken in response with the support of IWI funding.

Representatives of the Task Team have already been developing a draft report to: summarize the issues,

itemize progress made based on points of agreement, narrow the focus on alternatives to be pursued, provide a summary of additional information that may be needed to determine the best overall solutions for the area, and draft a description on how to proceed towards that solution.

The Task Team's last meeting was held September 21, 2015. The work of the task team was delayed in 2016 as jurisdictions awaited the outcome of a lawsuit in the Canadian Federal Court. Results of the Phase 5 Telemac 2D Study were presented to the IRRB at their September 7 and 8, 2016 meeting. A public meeting was held on March 15, 2017 in Gretna, Manitoba to discuss the conclusions of the modeling. Hossein Babaei, National Research Council, said that they had been requested to determine the amount of culverts required to prevent any change in flood conditions if the portion of U.S. Highway #18 was raised to prevent overtopping in the segment starting from the border crossing near Gretna and extending south about 2 ½ miles south to Pembina County Highway #55. Various frequency events were used for the analysis. Les Noehre of the North Dakota Department of Transportation attended the meeting along with three representatives of the IRRB. A similar meeting was held the same day with the RM of Rhineland Council.

After the judge ruled that the Canadian Federal Court did not have jurisdiction to hear the lawsuit, in June 2017 the Red River Basin Commission sent letters to ND Governor Burgum and Manitoba Premier Selinger, requesting notification of interest in re-engaging the Lower Pembina River Flooding Task Team. An official response has not been received to that request.

The National Hydraulics Centre is developing a Pembina Interactive Visualization Tool to assist in viewing flood inundation areas for various scenarios modeled with the TELEMAC 2D model for the Lower Pembina River area. Ten different scenarios are proposed to be shown: existing conditions, natural conditions, a scenario with two large openings in the border dike, and seven different floodway scenarios. Each scenario will be shown with the 10-year, 50-year, and 100-year flood events. The split screen allows comparison of flood conditions for various scenarios. The window can also be slid across the screen to compare the conditions at specific points. The animation will also show the entire flood event. The process is currently underway to transfer the application to the IJC website.

Border Dike Lawsuit

An application for leave to appeal was submitted to the Supreme Court of Canada in August 2017. The applicants are requesting to appeal the Canadian Federal Court and the Canadian Federal Court of Appeal concerning the determination that the Federal Courts do not have any jurisdiction to hear the issues concerning the border dike located near the Lower Pembina River. In December 2017, the Supreme Court of Canada dismissed the leave application for appeal of the Federal judge decision concerning whether the border dike lawsuit could be heard in Federal court. The remaining legal issue concerns the liability of costs for the court case.

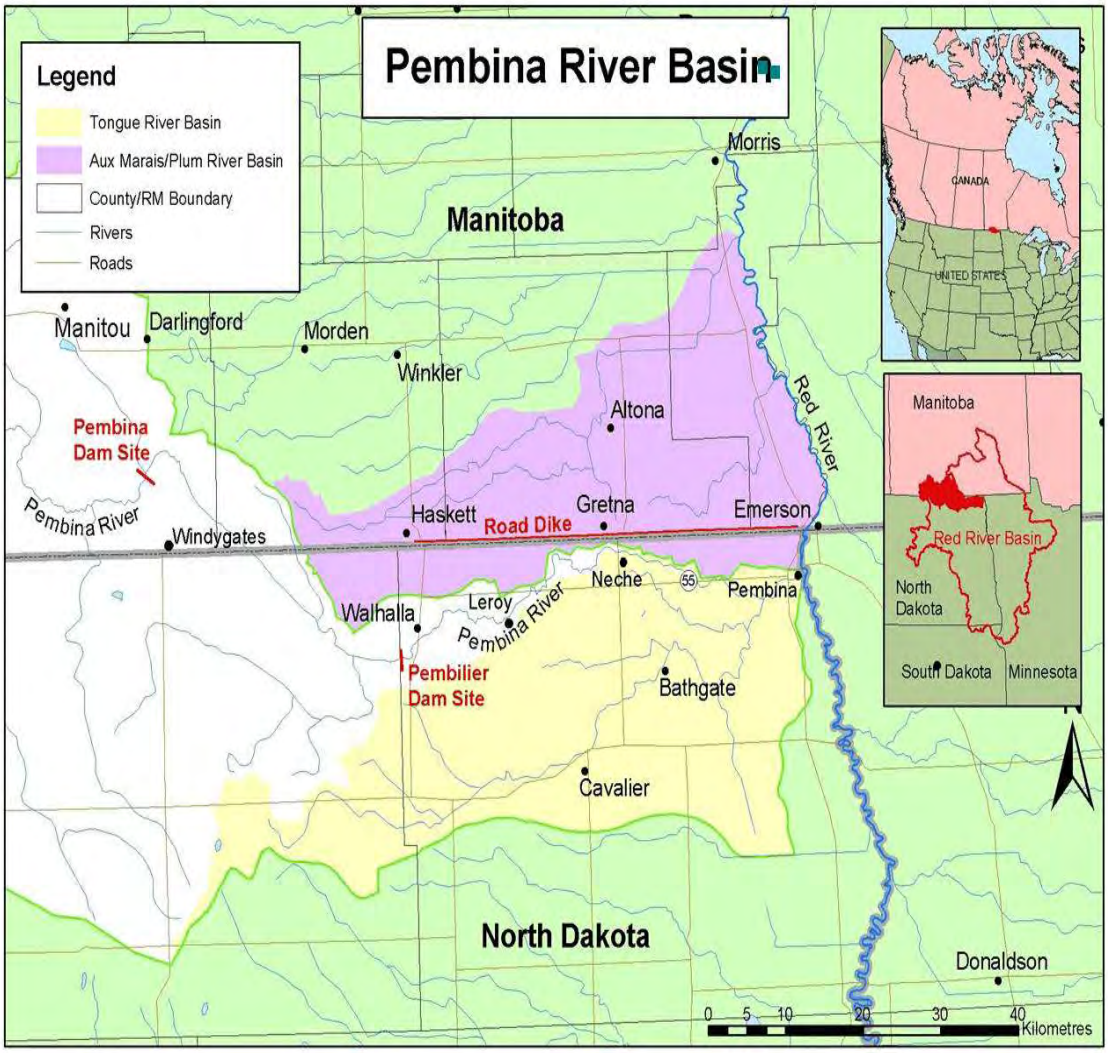


Figure 3: Pembina River Basin. The yellow and white areas comprise the Pembina River Basin.

5.0 WATER QUALITY AT THE INTERNATIONAL BOUNDARY

The water quality of the Red River at the Canada-US boundary, as reported herein, is based on continuous monitoring and instantaneous grab samples obtained during the 2016-2017 water year (October 1, 2016 - September 30, 2017). The collected data are used to determine compliance with the binational water quality objectives and alert levels at the boundary. Detection of exceedances of the objectives and alert levels serves as a trigger mechanism for the Board to report to the IJC and for the IJC to report to governments and may lead agencies to take appropriate action to prevent or to mitigate potential problems, and to minimize the potential for reoccurrence. Environment and Climate Change Canada provides this monitoring service for the IRRB and maintains a permanent water quality and water quantity data collection site at Emerson, Manitoba.

The five parameters for which governments have approved objectives, as well as the suite of pesticides, metals and toxic substances, which the Board uses as alert levels, are discussed below along with streamflow and pH for a corresponding time period. Water quality characteristics at other locations throughout the basin are referenced in subsequent chapters of this report to provide a more complete spatial representation of water quality and aquatic ecosystem conditions in the Red River basin. During the reporting period, the observed pH and temperature values for the Red River remained within the normal range with a maximum temperature of 25.3^{o}C recorded in August.

5.01 Binational Water Quality Objectives for the Red River at the International Boundary

As described in Appendix B, the IJC reports on objectives for a limited number of water quality variables for the Red River at the international boundary. These variables are dissolved oxygen, total dissolved solids, chloride, sulphate, and *Escherichia coli* bacteria. The IRRB is responsible for monitoring and reporting on compliance with these objectives.

As described below and summarized in Table 1, some exceedances of the binational water quality objectives, and concentrations approaching the objective level for some parameters were observed during the reporting period. However, no intervention or action by the IRRB or participating agencies was required other than reporting to the IJC.

Dissolved Oxygen

Observed levels did not fall below the objective of 5.0 mg/L during the 2016-2017 water year. The lowest concentration was measured in the summer. Minimums often occur when discharge increases following significant summer rains.

Total Dissolved Solids

Total Dissolved Solids (*TDS*) remained at or above the objective (500 mg/L) for most of the reporting period, with the exception of the spring. This pattern has been consistent over the last number of years, with higher flows resulting in additional dilution. Exceedances were observed in 85% of the samples collected in the 2016-2017 water year. The highest observed value of 1,124 mg/L occurred on Dec. 19, 2016.

Chloride

The *chloride* objective (100 mg/L) was not exceeded during this reporting period. The maximum chloride concentration was 98 mg/L on Dec. 5, 2016.

Sulphate

The *sulphate* objective (250 mg/L) was exceeded in 49% of the samples collected in the 2016-2017 water year. Sporadic exceedances were observed from October through December 2016, consistently in May 2017 and the latter half of June and July 2017. Exceedances were detected again at the close of the water year for most of September 2017.

Devils Lake is a known source of sulphate to the Red River. Operation of the Devils Lake outlets ceased midway through November 2016, and commenced in May 2017 for the remainder of the water year.

E. coli

The bacteriological characteristics of the Red River are assessed based on observed *Escherichia coli* bacteria for which an IJC objective (200 colonies per 100 ml) has been defined. The presence of *Escherichia coli* in water is an indicator of impacts via human and/or animal wastes. During the 2016-2017 water year, the *Escherichia coli* bacteria objective of 200 colonies/100 ml was not exceeded, with a maximum count of 130 colonies per 100 ml being observed in July 2017.

Table 1. Exceedances of Objectives Levels, Red River at International Boundary October 1, 2016 to September 30, 2017

Parameter	Objective	Exceedances		Exceedance Value
		Number (total # samples)	% samples exceeding	Maximum (Date)
Dissolved Oxygen	>5 mg/L	0 (47)	0	6.81 (Jul 11)**
Total Dissolved Solids	500 mg/L	40 (47)	85	1124 (Dec 19)
Chloride	100 mg/L	0 (47)	0	98 (Dec 5)
Sulphate	250 mg/L	23 (47)	49	469 (Dec 19)
E. coli	<200 colonies /100 ml	0 (11)	0	130 (Jul 4)

**Dissolved Oxygen objective is a minimum criterion and value reported is lowest recorded.

5.02 Alert Levels

The former International Red River Pollution Board established alert levels for suites of pesticides, metals and toxic substances in 1986. For pesticides, the alert level is described as "not detectable in water", while specific metals have concentration values for alert levels. The following table details the number of "alerts" detected by Environment and Climate Change Canada (Water Quality Monitoring and Surveillance Division) during the reporting period (Table 2).

Pesticides

Based on a total of up to 11 water samples, twenty-one (21) pesticides and metabolites with alert levels (greater than detection concentration) were recorded during the October 1, 2016 - September 30, 2017 reporting period. Five (5) compounds (Atrazine, 2, 4-D, Clopyralid, Picloram, Desethyl Atrazine) were detected in all samples analyzed. The detection levels for all compounds were all below the Canadian Guidelines for the Protection of Aquatic Life. Given that the Red River basin is an agriculturally dominated region, the presence of pesticides is expected. The detection of banned pesticides (legacy contaminants) is not unusual given the slow bio-degradation rate of these chemicals. None of the legacy pesticides were detected in this water year.

Environment and Climate Change Canada recently added additional pesticide analyses to assess current use pesticide concentrations during open water conditions (May to October). These include neonicotinoids, sulfonylurea and carbamate pesticides. In 2016-17, detections included three of eight neonicotinoid insecticides, six of 19 sulfonylurea herbicides and one of seven carbamate fungicides. These results are summarized in Table 3.

The IRRB recognizes that there is limited scientific information available to assess the implications of long-term exposure to low concentrations of pesticides and herbicides by aquatic organisms and humans. The IRRB closely monitors trends in these concentrations and their frequency of detection with the intention to update its assessment as new scientific information becomes available.

Metals

A total of 46 water samples were collected and analyzed for metals and toxic substances during the reporting period. The highest numbers of exceedances were detected for cadmium, manganese and iron, with exceedances exceedance rates of 100%. The maximum values for cadmium and manganese were detected in April 2017, while the maximum concentration for iron was detected in June. Higher metals concentrations tend to correspond to higher flow and higher particulate matter events. Iron and manganese are components in natural soils; however, the detection of higher levels of cadmium suggests anthropogenic sources.

Table 2 Exceedances of Alert Levels, Red River at International Boundary October 1, 2016 to September 30, 2017

Parameter	Units	Alert Level	Number of Samples	Number of Exceedances (%)	Maximum Value (Month)	Canadian Environmental Quality Guideline
Metals:						
Cadmium	ug/L	Detect	46	**46 (100%)**	0.696 (Apr 18)	0. 074 ug/l[1,3]
Chromium	ug/L	50	46	0	8.7 (Jun 26)	NG
Iron Total	ug/L	300	46	**46 (100%)**	8600 (Jun 26)	300 ug/l[1]
Manganese Total	ug/L	50	46	**46 (100%)**	1450 (Apr 18)	200 ug/L[2]
Selenium	ug/L	10	46	0	1.9 (Jul 11)	1 ug/l[1]
Zinc	ug/L	47	46	**1 (2%)**	51.3 (Apr 18)	30 ug/l[1]
Toxic Substances:						
Arsenic (total)	ug/L	10	46	0	8.5 (Aug 14)	5 ug/l[1]
Boron (total)	ug/L	500	46	0	159 (Aug 22)	29 mg/l[1]
Total PCB (Not tested)	ng/L	Detect	0	--	--	NG
Pesticides:						
2,4-D	ng/L	Detect	11	**11 (100%)**	96 (Mar 2)	4000 ng/l[1]
Bromoxynil	ng/L	Detect	11	**9 (82%)**	40 (Jul 4)	5000 ng/l[1]
Clopyralid	ng/L	Detect	11	**11 (100%)**	351 (Jul 4)	NG[5]
Dicamba	ng/L	Detect	11	**5 (45%)**	408 (Jul 4)	10000 ng/l[1]
Imazamethabenz-methyl (A)	ng/L	Detect	11	**2 (18%)**	5.8 (Oct 4)	NG
MCPA	ng/L	Detect	11	**10 (91%)**	115 (Jul 4)	2600 ng/l[1]
Mecoprop (MCPP)	ng/L	Detect	11	**9 (82%)**	5.8 (Jul 4)	NG
Picloram	ng/L	Detect	11	**11 (100%)**	169 (Jul 4)	29000 ng/l[1]
g-Benzenehexachloride	ng/L	Detect	11	**1 (9%)**	2.75 (Jul 4)	NG
Atrazine	ng/L	Detect	11	**11 (100%)**	488 (Ju1 4)	1800 ng/l[1]
Desethyl Atrazine	ng/L	Detect	11	**9 (82%)**	72 (Aug 1)	NG
Metolachlor	ng/L	Detect	11	**11 (100%)**	447 (Jul 4)	7800 ng/l[1]
P,P-DDE	ng/L	Detect	11	0	--	NG
Alpha-Endosulfan	ng/L	Detect	11	0	--	3 ng/l[1,4]
Beta-Endosulfan	ng/L	Detect	11	0	--	3 ng/l[1,4]
Metribuzin	ng/L	Detect	11	0	--	1000 ng/l[1]
Simazine D-ethyl	ng/L	Detect	11	**2 (18%)**	23 (Feb 1)	NG
Endosulfan sulfate	ng/L	Detect	11	0	--	NG
Mirex	ng/L	Detect	11	0	--	NG
p,p'-DDT	ng/L	Detect	11	0	--	1 ng/L
Penta chlorobenzene	ng/L	Detect	11	0	--	6.0 ug/l[1]

Notes:
1. Canadian Water Quality Guidelines for the Protection of Aquatic Life (http://st-ts. ccme. ca/)
2. Canadian Water Quality Guidelines for the Protection of Agriculture (http://st-ts. ccme. ca/)
3. Guideline value corrected for minimum value for hardness (mg/L $CaCO_3$) in the reporting period (http://st-ts. ccme. ca/?lang=en&factsheet=93)
4. Guideline value is for technical grade Endosulfan, which is a mixture of the two biologically active isomers (α and β)
5. NG = No guideline established

Table 3 Detections of Current Use Pesticides, Red River at International Boundary October 1, 2016 to September 30, 2017

Parameter	Units	Number of Samples	Detections (%)	Maximum Value (Date)	Canadian Environmental Quality Guideline[1,2]
Carbamates (Fungicides)					
Metalaxyl	*(ng/L)*	4	100	7.9 (July 4)	NG
Neonicotinoids (Insecticides)					
Imidacloprid	*(ng/L)*	4	75	14.2 (July 4)	NG
Clothianidin	*(ng/L)*	4	100	37.2(July 4)	NG
Thiomethoxam	*(ng/L)*	4	100	38.3 (July 4)	NG
Sulfonyl Ureas (Herbicides)					
Acifluorfen	*(ng/L)*	5	40	7.8 (July 4)	NG
Chlorsulfuron	*(ng/L)*	5	20	1.3 (July 4)	NG
Diuron	*(ng/L)*	5	60	13 (July 4)	NG
Fomesafen	*(ng/L)*	5	100	521 (July 4)	NG
Flumetsulam	*(ng/L)*	5	60	11(July 4)	NG
Thifensulfuron	*(ng/L)*	5	20	2.1 (July 4)	NG

Notes:

1. Canadian Water Quality Guidelines for the Protection of Aquatic Life (http://st-ts. ccme. ca/)
2. Canadian Water Quality Guidelines for the Protection of Agriculture (http://st-ts. ccme. ca/)
3. NG = No guideline established

6.0 WATER QUALITY SURVEILLANCE PROGRAMS

As described in Chapter 5, data collected at Emerson, Manitoba, are used to determine compliance with established Binational Water Quality Objectives at the international boundary. Chapter 6 contains basin-wide data and information contributed by federal, state and provincial agencies to provide a more complete spatial representation of water quality and aquatic ecosystem health conditions in the Red River basin.

U.S. Water Quality Standards Program

In the United States, the statutory basis for the current Water Quality Standards (WQS) program is the Clean Water Act. Under Section 303 of this Act, the Environmental Protection Agency (EPA) issued a Water Quality Standards Regulation (40 CFR Part 131). This regulation specifies the requirements and procedures for developing, reviewing, revising, and approving WQS by the States and Tribal Nations. EPA has approved WQS programs for the States of North Dakota, South Dakota, and Minnesota. No tribal programs in the Red River basin have yet been approved.

WQS define the water quality goals for a water body or portion thereof, by designating the use or uses to be made of the water, and implementation criteria for protecting each of those uses or areas. Additionally, a WQS program must include an anti-degradation policy to protect water quality that is already better than State standards. Designated uses for water bodies may include:

- Aquatic life - protection of fish and other aquatic organisms;
- Recreation - swimming, wading, boating, and incidental contact;
- Drinking water - protection for downstream public water supply intakes;
- Miscellaneous - industrial or agricultural uses, tribal religious uses, etc.

Water quality standards are designed to protect the beneficial uses associated with the standards. Based on the assessment of the water quality data and other relevant information compared to the standards for a given pollutant or water quality characteristic, the use may be:

- Fully supported
- Partially supported
- Threatened
- Not supported

6.01 Minnesota

This information in this report is from July 1, 2017 to June 30, 2018

Watershed Restoration and Protection Projects

There are 17 major tributaries to the Red River in Minnesota. The Minnesota Pollution Control Agency is developing watershed restoration and protection plans for each of these watersheds. Each project consists of monitoring, stressor identification, modeling, public participation/input and a TMDL. The WRAPs have been completed on four watersheds, two are on public notice, reports are being developed for five and fieldwork is underway in six watersheds.

Bois De Sioux River WRAPS 2010	On Public Notice
Buffalo River WRAPS 2009	Complete
Clearwater River WRAPS 2014	In Progress
Mustinka River WRAPS 2010	Complete
Otter Tail River WRAPS 2016	In Progress
Red Lake River WRAPS 2012	Reports in Development
Red R. - Grand Marais Creek WRAPS 2012	In Progress
Red R. - Marsh River WRAPS 2014	In Progress
Red R. - Sandhill River WRAPS 2011	Complete
Red R. - Tamarack River WRAPS 2008	Reports in Development
Roseau River WRAPS 2015	In Progress
Snake River (Red R. Basin) WRAPS 2013	Reports in Development
Thief River WRAPS 2011	On Public Notice
Two Rivers WRAPS 2013	Reports in Development
Upper Red River WRAPS 2008	Complete
Upper/Lower Red Lake WRAPS 2014	Reports in Development
Wild Rice River WRAPS 2014	In Progress

Work has been completed on the Red River main stem, the report is expected to be released in late 2018 or early 2019.

Total Maximum Daily Loads

Watershed wide TMDL's have been completed in four watersheds with the exception of several specific reaches were more data is required to complete the TMDL for those reaches.

Upper Red	Complete
Buffalo River	Complete
Mustinka	Complete
Sandhill	Complete

6.02 North Dakota

Ambient Water Quality Monitoring Program

In 2012, the USGS North Dakota Water Science Center completed an analysis of the state's ambient water quality monitoring network, including the North Dakota Department of Health's (NDDoH) fixed station ambient monitoring network and the ND State Water Commission's (SWC's) High/Low flow network. In addition to evaluating trends, providing loading estimates and providing a spatial comparison of sites, the report, entitled "Evaluation of Water-Quality Characteristics and Sampling Design for Streams in North Dakota, 1970-2008" (http://pubs.usgs.gov/sir/2012/5216/), provided recommendations for a revised water quality monitoring network for rivers and streams in the state. These recommendations were made to ensure adequate coverage, both spatially and temporally, which is necessary to estimate trends, estimate loads and provide for general water quality characterization in rivers and streams across the state.

Beginning on January 1, 2013 and based on the recommendations provided in the USGS report, the NDDoH, in cooperation with the USGS and the SWC, implemented a revised ambient water quality-monitoring network for rivers and streams. The highest level of sites, design level 1, consist of a network of 32 basin integrator sites located across the state with 16 level 1 sites located in the Red River basin (Figure 4, Table 4). These sites are sampled 8 times per year, twice in April, once each in May, June, July, August, and October, and one time in the winter (January) under ice. The next level, design level 2, consists of 25 sites with 12 level 2 sites located in the Red River basin (Figure 4, Table 5). These sites are sampled 6 times per year, once each in April, May, June, August and October and once under ice during the winter (January). The lowest level of sites, design level 3, consists of 25 sites. There are 12 level 3 sites located in the Red River basin (Figure 4, Table 6). These sites are only being sampled 4 times per year, once each in April, June, August and October. Under the current design, the USGS samples all of the design level 2 sites (with the exception of the Red River at Harwood that is sampled by the department) and all the design level 3 sites. In the Red River basin, the department samples 8 level one sites, while the USGS samples eight sites.

At all level 1, 2 and 3 sites field measurements are taken for temperature, dissolved oxygen, pH and specific conductance. Sampling and analysis at all level 1, 2 and 3 sites consist of general chemistry, dissolved trace elements, and total and dissolved nutrients (Table 7). In addition to these water quality parameters, total organic carbon (TOC), dissolved organic carbon (DOC), total suspended solids (TSS), and E. coli bacteria are sampled and analyzed for at all level 1 sites (Table 7). E. coli bacteria are only sampled during the recreation season (May-September). In addition to sampling for these analytes, the Red River at Fargo, the Red River at Grand Forks, and the Red River at Pembina are sampled for total suspended sediment. The USGS Iowa Sediment Laboratory conducts the analysis of the total suspended sediment samples. The department's Laboratory Services Division performs all chemical analysis of samples.

Table 4. Level 1 North Dakota Ambient Water Quality Monitoring Sites in the Red River Basin.

USGS Site ID	NDDoH Site ID	Site Name	Latitude	Longitude	Design Level	Responsible Agency
05051300	385055	Bois de Sioux River near Doran, MN	46.1522	-96.5789	1	NDDH
05051510	380083	Red River at Brushville, MN	46.3695	-96.6568	1	NDDH
05053000	380031	Wild Rice River near Abercrombie, ND	46.4680	-96.7837	1	NDDH
05054000	385414	Red River at Fargo, ND	46.8611	-96.7837	1	USGS-GF
05057000	380009	Sheyenne River near Cooperstown, ND	47.4328	-98.0276	1	NDDH
05058000	380153	Sheyenne River below Baldhill Dam, ND	47.0339	-98.0837	1	NDDH
05058700	385168	Sheyenne River at Lisbon, ND	46.4469	-97.6793	1	NDDH
05059000	385001	Sheyenne River near Kindred, ND	46.6316	-97.0006	1	NDDH
05060100	384155	Maple River below Mapleton, ND	46.9052	-97.0526	1	NDDH
05066500	380156	Goose River at Hillsboro, ND	47.4094	-97.0612	1	USGS-GF
05082500	384156	Red River at Grand Forks, ND	47.9275	-97.0281	1	USGS-GF
05083000	380037	Turtle River at Manvel, ND	48.0786	-97.1845	1	USGS-GF
05085000	380039	Forest River at Minto, ND	48.2858	-97.3681	1	USGS-GF
05090000	380157	Park River at Grafton, ND	48.4247	-97.4120	1	USGS-GF
05100000	380158	Pembina River at Neche, ND	48.9897	-97.5570	1	USGS-GF
05102490	384157	Red River at Pembina, ND	48.9769	-97.2376	1	USGS-GF

Table 5. Level 2 North Dakota Ambient Water Quality Monitoring Sites in the Red River Basin.

USGS Site ID	NDDoH Site ID	Site Name	Latitude	Longitude	Design Level	Responsible Agency
05051522	NA	Red River at Hickson, ND	46.6597	-96.7959	2	USGS-GF
05051600	385573	Wild Rice River near Rutland, ND	46.0222	-97.5115	2	USGS-GF
05054200	385040	Red River at Harwood, ND	46.9770	-96.8203	2	NDDH
05055300	385505	Sheyenne R above DL Outlet nr Flora, ND	47.9078	-99.4162	2	SWC
05056000	385345	Sheyenne River near Warwick, ND	47.8056	-98.7162	2	USGS-GF
05057200	384126	Baldhill Creek near Dazey, ND	47.2292	-98.1248	2	USGS-GF
05059700	385351	Maple River near Enderlin, ND	46.6216	-97.5740	2	USGS-GF
05064500	NA	Red River at Halstad, MN	47.3519	-96.8437	2	USGS-GF
05065500	NA	Goose River nr Portland, ND	47.5389	-97.4556	2	USGS-GF
05082625	385370	Turtle River at State Park near Arvilla, ND	47.9319	-97.5145	2	USGS-GF
05084000	NA	Forest River near Fordville, ND	48.1972	-97.7306	2	USGS-GF
05092000	380004	Red River at Drayton, ND	48.5722	-97.1476	2	USGS-GF

Table 6. Level 3 North Dakota Ambient Water Quality Monitoring Sites in the Red River Basin.

USGS Site ID	NDDoH Site ID	Site Name	Latitude	Longitude	Design Level	Responsible Agency
05052500	385232	Antelope Creek at Dwight, ND	46.3113	-96.7345	3	USGS-GF
05054500	380135	Sheyenne River above Harvey, ND	47.7028	-99.9490	3	USGS-Bis
05056060	385089	Mauvais Coulée Trib #3 nr Cando, ND	48.4575	-99.2243	3	USGS-GF
05056100	380207	Mauvais Coulee nr Cando	48.4481	-99.1026	3	USGS-GF
05056200	385092	Edmore Coulee nr Edmore	48.3367	-98.6604	3	USGS-GF
05056215	385093	Edmore Coulee Trib nr Webster	48.2664	-98.6809	3	USGS-GF
05056239	385091	Starkweather Coulee nr Webster, ND	48.3206	-98.9407	3	USGS-GF
05056340	380213	Little Coulee nr Leeds, ND	48.2433	-99.3729	3	USGS-GF
05060500	385302	Rush River at Amenia, ND	47.0166	-97.2143	3	USGS-GF
05099400	385287	Little South Pembina near Walhalla, ND	48.8653	-98.0059	3	USGS-GF
05101000	381279	Tongue River at Akra, ND	48.7783	-97.7468	3	USGS-GF

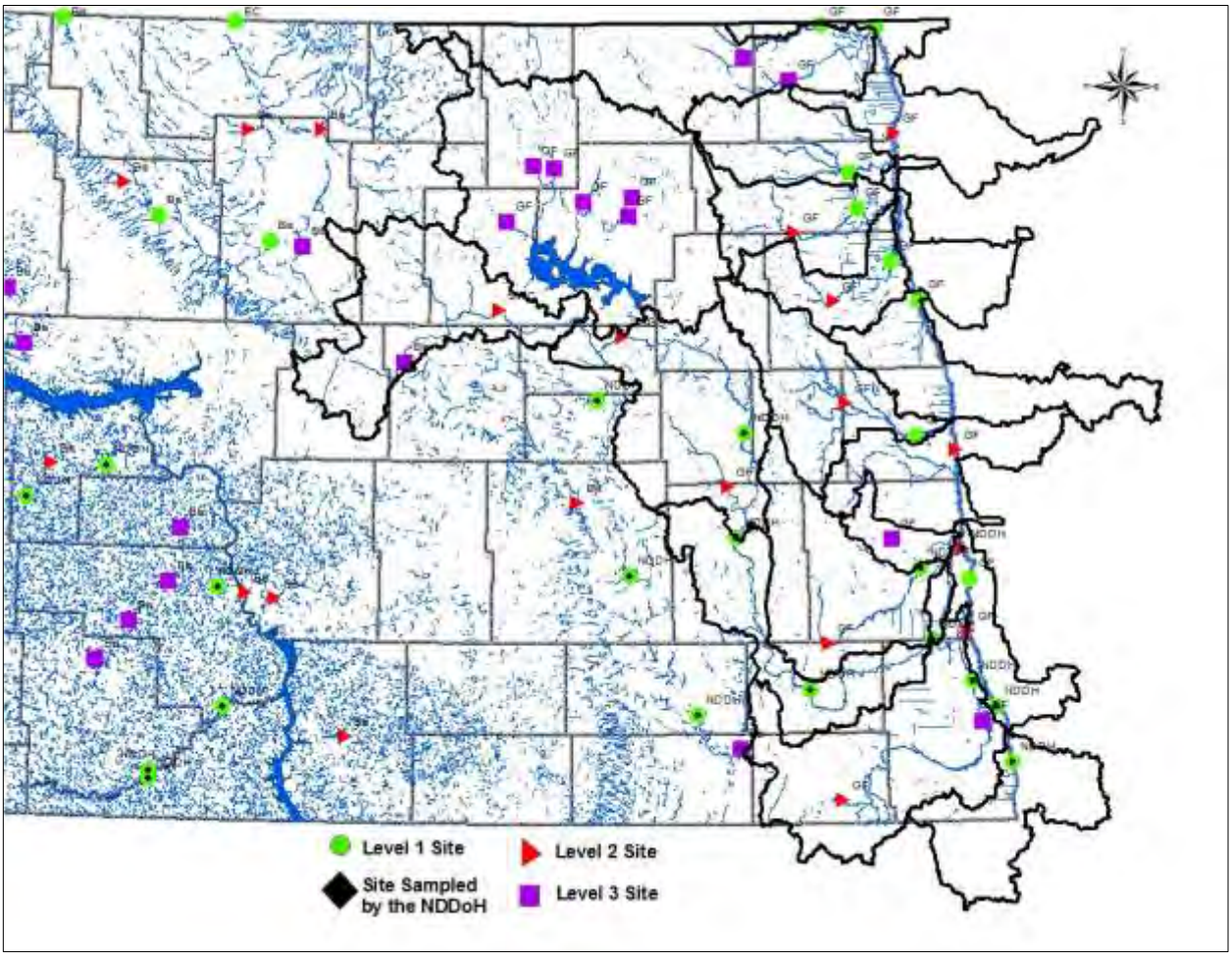


Figure 4. North Dakota Ambient Water Quality Monitoring Sites in the Red River Basin.

Table 7. North Dakota Ambient Water Quality Monitoring Parameters

Field Measurements	Laboratory Analysis			
	General Chemistry	Trace Elements	Nutrients	Biological
Temperature	Sodium[1,2]	Aluminum[1,2]	Ammonia (Total) [2]	E. coli[3]
pH	Magnesium[1,2]	Antimony[1,2]	Nitrate-nitrite (Total) [2]	
Dissolved Oxygen	Potassium[1,2]	Arsenic[1,2]	Total Kjeldahl Nitrogen[2]	
Specific Conductance	Calcium[1,2]	Barium[1,2]	Total Nitrogen[2]	
	Manganese[1,2]	Beryllium[1,2]	Total Phosphorus[2]	
	Iron[1,2]	Boron[1,2]	Total Organic Carbon[3]	
	Chloride[1,2]	Cadmium[1,2]	Ammonia (Dissolved) [2]	
	Fluoride[1,2]	Chromium[1,2]	Nitrate-nitrite (Dissolved) [2]	
	Sulfate[1,2]	Copper[1,2]	Total Kjeldahl Nitrogen (Dissolved) [2]	
	Carbonate[2]	Lead[1,2]	Total Nitrogen (Dissolved) [2]	
	Bicarbonate[2]	Nickel[1,2]	Total Phosphorus (Dissolved) [2]	
	Hydroxide[2]	Silica[1,2]	Dissolved Organic Carbon[3]	
	Alkalinity[2]	Silver[1,2]		
	Hardness[2]	Selenium[1,2]		
	Total Dissolved Solids[3]	Thallium[1,2]		
	Total Suspended Solids[1]	Zinc[1,2]		

[1]Analyzed as dissolved.
[2]Sampled and analyzed at level 1, 2 and 3 sites.
[3]Sampled and analyzed at level 1 sites.

North Dakota Department of Agriculture Pesticide Monitoring Program

As a compliment to North Dakota's revised ambient water quality monitoring program, in 2017 the department and the USGS cooperated with the North Dakota Department of Agriculture (NDDA) in a state pesticide-monitoring program. The goals of the 2017 monitoring program were to: 1) determine the occurrence and concentration of pesticides in North Dakota rivers and streams; 2) identify trends in pesticide contamination to guide regulatory activities; 3) determine whether any pesticides may be present at concentrations that could adversely affect human health, aquatic life, or wildlife dependent on aquatic life; and 4) evaluate levels of certain neonicotinoid insecticides in North Dakota's rivers and streams.

Through this cooperative pesticide monitoring program, the department and the USGS collected pesticide samples April through August and in October at all of the level 1 water quality monitoring sites in the state, while the NDDA provided sample analysis through a contract with Montana State University's Agriculture

Experiment Station Analytical Laboratory. Through this program, six (6) samples were collected at each site in 2017. A final report detailing the results of the 2017 monitoring program, including the results from samples collected in the Red River basin is available at https://www.nd.gov/ndda/sites/default/files/resource/2017%20SW%20Report.pdf.

6.03 Manitoba

Surface Water Quality Monitoring

During the water year, Manitoba Sustainable Development continued to monitor water quality on a monthly basis at two sites on the Red River within Manitoba. These sites are located upstream of the City of Winnipeg at the Floodway control structure at St. Norbert and downstream of the City of Winnipeg at Selkirk (Figure 5. Additionally, joint federal/provincial samples are collected at Emerson and Selkirk for quality control/quality assurance purposes to ensure the long-term consistency among federal and provincial datasets. Variables measured include physical parameters, general chemistry, suspended sediment, bacteria, industrial organics, pharmaceuticals, trace elements, nutrients, and agricultural chemicals. Long-term variables monitored by Manitoba Sustainable Development are shown in Table 8. Benthic macroinvertebrates were also collected from the Red River at Emerson and Selkirk in September 2017.

Manitoba Sustainable Development also conducts routine monitoring at seven sites on six tributary streams to the Red River (Figure 5). Samples are collected at minimum four times per year and analyzed for a wide range of variables including physical parameters, general chemistry, suspended sediment, bacteria, industrial organics, trace elements, nutrients, and agricultural chemicals. Long-term monitoring allows Manitoba Sustainable Development to identify potential sources of pollution on the Red River and develop management strategies to address water quality issues.

Red River – Main Stem

During this reporting period, water quality in the Manitoba reach of the Red River main stem remained similar to previous years. Overall, dissolved oxygen concentrations in the Red River were sufficient to support aquatic life and were relatively high with an average concentration of 9.0 mg/L upstream of the City of Winnipeg at St. Norbert and 9.4 mg/L downstream of the City of Winnipeg at Selkirk. The lowest dissolved oxygen concentrations were sufficient for the protection of aquatic life and occurred in July and August 2017 (6.6–6.8 mg/L) at sites upstream and downstream of the City of Winnipeg.

Densities of *Escherichia coli* (*E. coli*) bacteria downstream of the City of Winnipeg were lower than the previous reporting period. The geometric mean density downstream of the City of Winnipeg was 68 organisms / 100 mL (an outlier measurement was removed), compared to 291 organisms / 100 mL in the previous reporting period. The geometric mean density of *E. coli* bacteria in the upstream reach at St. Norbert was consistent with the previous reporting year with 16 organisms / 100 mL. Densities of *E. coli* bacteria exceeded the recreational water quality objective of 200 organisms / 100 mL (Manitoba Water Quality Standards, Objectives, and Guidelines, 2011) upstream of the City of Winnipeg on only one occasion in September 2017 at St. Norbert (210 organisms / 100 mL). Meanwhile, *E. coli* densities did not exceed the recreational water quality objective in samples downstream of the City of Winnipeg during the current reporting period (after removal of the outlier), representing a considerable improvement when compared to the previous reporting period where 43 per cent of samples exceeded the recreational water quality objectives.

During this reporting period, twelve samples were analyzed for routine pesticide screening upstream of the City of Winnipeg at St. Norbert. Overall, nine of the 52 routinely monitored pesticides were detected (17 per cent rate of detection) in the Red River at St. Norbert, which was consistent with the previous reporting period.

Glyphosate was the most commonly detected pesticide with ten detections (83 per cent rate of detection). Dicamba, 2, 4-D and AMPA were detected on nine, five and four occasions, respectively. Atrazine and Triclopyr were detected twice, while Atrazine Desethyl, Imazamethabenz-methyl and MCPA were each detected once. Dicamba exceeded the irrigation guideline of 0.006 µg/L in October and December 2016, as well as February to May and July to September 2017, with concentrations ranging from 0.0556 to 0.516 µg/L or nearly 10 to 100 fold greater than the irrigation guideline. None of the pesticides detections upstream of Winnipeg exceeded water quality guidelines (where available) for the protection of surface water used as sources of drinking water supply, protection of aquatic life, or livestock uses.

A total of eleven samples were also collected from downstream of the City of Winnipeg at Selkirk during the reporting period and analyzed for pesticides. Seven pesticides out of the 52 monitored were detected downstream of the City of Winnipeg at Selkirk (13 per cent rate of detection), versus eleven detections at this site in the previous reporting year. Glyphosate and Dicamba were the most commonly detected pesticides in the Red River at this site, detected in eight of the eleven samples. AMPA was also frequently detected, with seven of the eleven samples measuring detectable concentrations during the 2016-2017 reporting period. 2,4-D and Atrazine were each detected five and three times, respectively, while Triclopyr and MCPA were each detected once during the current reporting period. None of the detections of pesticides downstream of Winnipeg exceeded water quality guidelines (where available) for the protection of surface water used as sources of drinking water supply or livestock uses. Similar to the Red River at St. Norbert site, Dicamba exceeded the irrigation guideline (0.006 µg/L) on several occasions. These exceedances occurred during the October 2016, December 2016 and March to September 2017 sampling periods with concentrations ranging from 0.0062 to 0.45 µg/L or up to 75 times greater than the irrigation guideline.

Over this reporting period, one sample from each of the two Red River main stem stations was also analysed for five estrogenic compounds of emerging concern (17a-estradiol, 17a-ethinylestradiol, 17b-estradiol, estriol, and estrone). However, all five compounds were below the analytical limit of detection.

Red River - Tributary Streams

During this reporting period, seven sampling stations on six tributary rivers (Boyne, Rat, Roseau, Morris, La Salle and two sites on the Seine Rivers) were sampled between four and eight times. Additional sampling occurred on some tributaries corresponding with the spring melt in 2017. Most water quality parameters in these tributaries to the Red River main stem remained comparable to past years. Average dissolved oxygen concentrations were similar to the previous reporting period, ranging from 8.8 to 10 mg/L. In most cases, dissolved oxygen concentrations were sufficient to support aquatic life and usually above the Manitoba Water Quality Objective in the Red River tributaries.

Densities of *E. coli* bacteria in several Red River tributaries occasionally exceeded the Manitoba Water Quality Objective for recreation of 200 organisms / 100 mL. Exceedances occurred during October 2016 in the Morris River (530 organisms / 100 mL), and during July 2017 at two locations in the Seine River (249 organisms / 100 mL at Perimeter and 320 organisms / 100 mL at Ste. Anne).

Two samples each from two tributary rivers were analyzed for routine pesticides in the reporting period, the Boyne River and the La Salle River (at La Barriere Park) in October 2016 and July 2017. Pesticides detected in both rivers included AMPA, Dicamba, and Glyphosate. MCPA was also detected in the Boyne River, while 2, 4-D and Triclopyr were detected in the La Salle River. The concentration of Dicamba exceeded the irrigation guideline of 0.006 µg/L in July 2017 in both the La Salle and Boyne rivers.

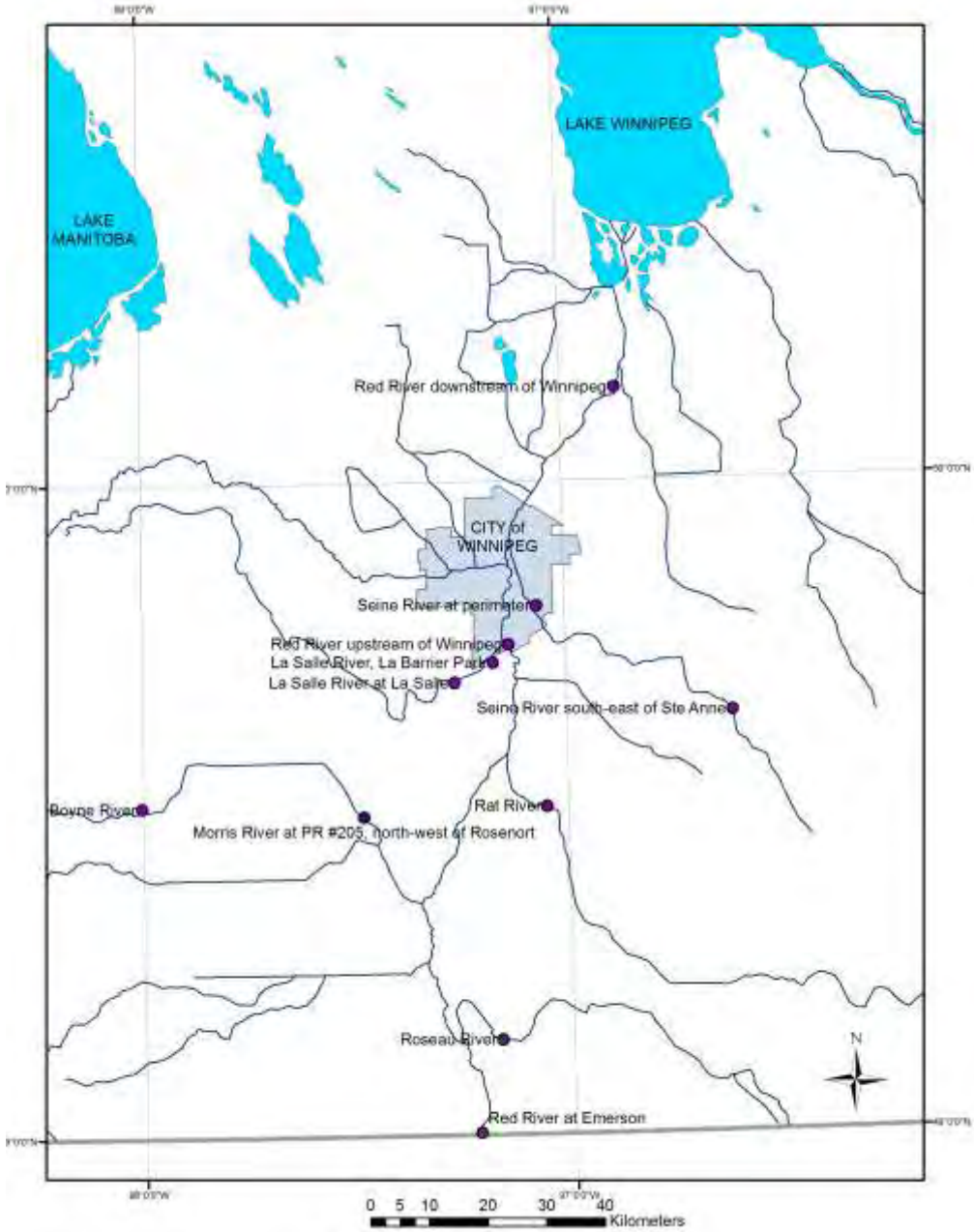


Figure 5 Location of water quality and benthic invertebrate sampling sites in the Red River watershed (Manitoba). Note: The La Salle River at La Salle is only sampled when the La Salle River at La Barrier Park is flooded and was not sampled during the current reporting period.

Table 8. Routine surface water quality monitoring variables sampled by Manitoba Sustainable Development on the Red River and tributaries within Manitoba, Canada.

Variables	Units
2,4-DB	ug/L
2,4-D	ug/L
2,4-DP	ug/L
ALACHLOR	ug/L
ALKALINITY CO3	mg/L
ALKALINITY OH	mg/L
ALKALINITY TOTAL CACO3	mg/L
ALKALINITY TOTAL HCO3	mg/L
ALUMINUM DISSOLVED	mg/L
ALUMINUM TOTAL	mg/L
AMMONIA DISSOLVED	mg/L
AMPA(AMINOMETHYLPHOSPHONIC ACID)	ug/L
ANTIMONY TOTAL	mg/L
ARSENIC TOTAL	mg/L
ATRAZINE DESETHYL	ug/L
ATRAZINE	ug/L
AZINPHOS METHYL	ug/L
BARIUM TOTAL	mg/L
BENOMYL	ug/L
BERYLLIUM TOTAL	mg/L
BISMUTH TOTAL	mg/L
BORON TOTAL	mg/L
BROMACIL	ug/L
BROMOXYNIL	ug/L
CADMIUM TOTAL	mg/L
CALCIUM TOTAL	mg/L
CARBOFURAN	ug/L
CARBON TOTAL INORGANIC	mg/L
CARBON TOTAL ORGANIC (TOC)	mg/L
CARBON TOTAL	mg/L
CARBOXIN (CARBATHIN)	ug/L
CESIUM TOTAL	mg/L
CHLORDANE-CIS	ug/L
CHLORDANE-TRANS	ug/L
CHLORIDE DISSOLVED	mg/L
CHLOROPHYLL A	ug/L
CHLORPYRIFOS-ETHYL (DURSBAN)	ug/L
CHROMIUM HEXAVALENT DISSOLVED	mg/L
CHROMIUM TOTAL (CR)	mg/L
COBALT TOTAL	mg/L
COLOUR TRUE	CU
CONDUCTIVITY (AT 25C)	uS/cm
COPPER TOTAL (CU)	mg/L
CYANAZINE	ug/L
DELTAMETHRIN	ug/L
DIAZINON	ug/L
DICAMBA (BANVEL)	ug/L
DICHLOROPROP(2,4-DP)	ug/L
DICLOFOP-METHYL	ug/L
DIMETHOATE (CYGON)	ug/L
DINOSEB	ug/L

Table 8. Continued….

Variables	Units
DIURON	ug/L
EPTAM	ug/L
ESCHERICHIA, COLI	CFU/100 mL
ETHALFLURALIN (EDGE)	ug/L
FENOXAPROP	ug/L
GAMMA-BENZENEHEXACHLORIDE (LINDANE)	ug/L
GLYPHOSATE (ROUNDUP)	ug/L
HARDNESS TOTAL CACO3	mg/L
IMAZAMETHABENZ-METHYL	ug/L
IRON TOTAL (FE)	mg/L
LEAD TOTAL	mg/L
LITHIUM TOTAL	mg/L
MAGNESIUM TOTAL	mg/L
MALATHION	ug/L
MANGANESE TOTAL (MN)	mg/L
MCPA	ug/L
MCPP (MECOPROP)	ug/L
METASULFURON-ME	ug/L
METHOXYCHLOR (P,P'-METHOXYCHLOR)_	ug/L
METRIBUZIN	ug/L
MOLYBDENUM TOTAL	mg/L
NICKEL TOTAL	mg/L
NITROGEN DISSOLVED NO3 & NO2	mg/L
NITROGEN TOTAL KJELDAHL (TKN)	mg/L
OXYGEN BIOCHEMICAL DEMAND	mg/L
OXYGEN DISSOLVED	mg/L
PARATHION ETHYL	ug/L
PARATHION METHYL	ug/L
PENTACHLOROPHENOL	ug/L
PHEOPHYTIN A	ug/L
PHOSPHOROUS-ACID HYDROLYZABLE	mg/L
PHOSPHOROUS-TOTAL-ORTHO	mg/L
PHOSPHORUS DISSOLVED ORTHO	mg/L
PHOSPHORUS PARTICULATE	mg/L
PHOSPHORUS TOTAL (METALS SCAN)	mg/L
PHOSPHORUS TOTAL (P)	mg/L
PHOSPHORUS TOTAL DISSOLVED	mg/L
PHOSPHORUS TOTAL INORGANIC	mg/L
pH	pH units
PICLORAM (TORDON)	ug/L
POTASSIUM TOTAL	mg/L
PROPANIL	ug/L
PROPOXUR	ug/L
QUIZALOFOP	ug/L
RUBIDIUM TOTAL	mg/L
SELENIUM TOTAL	mg/L
SETHOXYDIM	ug/L
SILICON TOTAL	mg/L
SILVER TOTAL	mg/L
SIMAZINE	ug/L
SODIUM TOTAL	mg/L

Table 8. Continued….

Variables	Units
SULPHATE DISSOLVED	mg/L
TELLURIUM TOTAL	mg/L
TERBUFOS	ug/L
THALLIUM TOTAL	mg/L
THIFENSULFURON-ME	ng/L
THORIUM TOTAL	mg/L
TIN TOTAL	mg/L
TITANIUM TOTAL	mg/L
TOTAL DISSOLVED SOLIDS	mg/L @180C
TOTAL SUSPENDED SOLIDS	mg/L
TRALKOXYDIM	ug/L
TRIALLATE (AVADEXBW)	ug/L
TRIBENURON	ug/L
TRICLOPYR	ug/L
TRIFLURALIN(TREFLAN)	ug/L
TUNGSTEN TOTAL	mg/L
TURBIDITY	NTU
URANIUM TOTAL	mg/L
VANADIUM TOTAL	mg/L
ZINC TOTAL (ZN)	mg/L
ZIRCONIUM TOTAL	mg/L

7.0 WATER POLLUTION CONTROL

7.01 Contingency Plan

In January 1981, the former International Red River Pollution Board developed a contingency plan. The purpose of the plan, which has been adopted by the IRRB, is to ensure that positive coordinated action is taken to minimize public health hazards and environmental damage in the event of a spill. This plan does not supersede any local or national contingency plans in existence but rather serves to coordinate these activities. The plan becomes effective wherever the discharge of a pollutant within the Red River basin has the potential to adversely affect the Red River. The plan also becomes effective at any time when exceedances of either water quality objectives or alert levels as described in Chapter 5 are observed at the international boundary. A current list of contacts and telephone numbers associated with the contingency plan is included in Appendix C.

7.02 Spills and Releases

Minnesota

Red River Basin Spills

There were 40 spills/releases, two of which were from wastewater treatment plants. Many of the remaining spills/releases were petroleum spills. The remaining were a variety of materials. There is little or no information on the amount spilled or released, nor is there any information about whether any contamination reached surface water, so any impacts to surface waters is unknown.

Cargill Oilseeds - Barnesville	Closed or Completed
American Crystal Sugar - East Grand Forks	Closed or Completed
Green Plains Otter Tail LLC	Closed or Completed
Bongards' Creameries - Perham	Closed or Completed
American Crystal Sugar - Crookston	Closed or Completed
Bongards' Creameries - Perham	Closed or Completed
Ada WWTP	Open
Zip Trip #65	Closed or Completed
Barnesville WWTP	Open
American Crystal Sugar - Crookston	Closed or Completed
American Crystal Sugar - Crookston	Open
Fergus Falls Landfill Facility	Closed or Completed
Thief River Falls WWTP	Open
Otter Tail Power Co - Hoot Lake Plant	Closed or Completed
BNSF Dilworth Yard	Closed or Completed
Bagley Coop Association	Closed or Completed
MDA - Roseau - Northern Resources	Closed or Completed
American Crystal Sugar - Crookston	Open
American Crystal Sugar - Crookston	Open
American Crystal Sugar - Crookston	Open
American Crystal Sugar - Crookston	Open

American Crystal Sugar - Moorhead	Open
Thief River Falls WWTP	Open
Municipal Service Center	Open
American Crystal Sugar - Crookston	Open
Kleven Residence	Closed or Completed
Oasis Market	Closed or Completed
American Crystal Sugar - Crookston	Closed or Completed
American Crystal Sugar - East Grand Forks	Closed or Completed
Pump 24 C-store	Closed or Completed
American Crystal Sugar - Crookston	Open
Enbridge Energy - Clearbrook Terminal	Closed or Completed
Pelican Rapids WWTP	Closed or Completed
Red Lake Falls WWTP	Open
Arctic Cat Inc	Open
Polk County Landfill	Closed or Completed
Enbridge Energy - Clearbrook Terminal	Open
American Crystal Sugar - Moorhead	Closed or Completed
American Crystal Sugar - Crookston	Closed or Completed
American Crystal Sugar - Crookston	Open

Municipal and Industrial Wastewater

There were seven WWTP and twenty-seven industrial NPDES/SDS permits issued.

WWTPs permitted include:

Climax
Cormorant Park Place Estates
Detroit Lakes
East Grand Forks
Fergus Falls
Glyndon

Industrial facilities permitted include:

Aggregate Industries Inc
Anderson Brothers Construction Co
Anderson Contracting Inc
Beltrami County Highway Dept
Bemidji Bituminous Inc
Bongards' Creameries - Perham
Border States Paving/Marvin/Gordon Pits
Central Specialties Inc
Clay County Highway Dept
Donarski Brothers Inc
Earthwork Services Inc

FM Asphalt LLC
Forterra Concrete Products
J&S Gravel Inc
Knife River Central Minnesota
Knife River Corporation
Mark Sand & Gravel Acquisition Co
MNDNR - St Paul
Northern Improvement Co
Northstar Materials Inc dba Knife River Materials
Ottertail Aggregate Inc
Rogge Excavating Inc
Schenkey Inc
Stoney Creek Sand & Gravel
Strata Corp
Wells Concrete Products

Manitoba

Pollution Sources

Three municipalities with populations greater than 1,000 discharge treated effluents directly to the Red River within Manitoba. The Town of Morris discharges for a short period of time each spring and fall, while the City of Winnipeg's South End and North End Water Pollution Control Centres and the Town of Selkirk discharge continuously. Volumes and quality of effluent have not changed significantly from previous years. In addition to the two major wastewater treatment facilities within the City of Winnipeg, discharges also occur from 79 combined sewer outfalls and 90 major land drainage outfalls. Most tributary streams also receive treated wastewater effluents from nearby communities.

Notification Regarding Intensive Livestock Operations

During the reporting period, Manitoba was not notified of any intensive livestock operations proposing to locate near the international border on the North Dakota or Minnesota side. In Manitoba, no intensive livestock proposals were proposed near the international border between October 2016 and September 2017.

Pollution Abatement

Manitoba Water Quality Standards, Objectives, and Guidelines are applicable to streams within the Red River basin. Water uses protected in the Red River basin include domestic water supply source, protection of aquatic life, industrial uses, irrigation, livestock watering, and water-related recreation.

Treated municipal effluents discharged to the Red River and tributary streams in Manitoba are licensed under The Environment Act (Manitoba). Disinfection with ultraviolet light technology has been installed and is operational at the City of Winnipeg's South and North End Water Pollution Control Centres. In August 2004, the City of Winnipeg introduced a web-based system to inform the public whenever there is likely to be a sewer overflow into the Red or Assiniboine Rivers (http://winnipeg.ca/waterandwaste/sewage/overflow/previous24.stm).

Manitoba continues to work to understand sources of nutrients to Lake Winnipeg, to monitor the impacts

of excess nutrients and to reduce nutrient loading to achieve a 50 % reduction in phosphorus in Lake Winnipeg. Specific targets and timelines for phosphorus and nitrogen concentrations for the north and south basin of the lake and nutrient loads from major tributaries are currently being developed in partnership with neighbouring jurisdictions.

The Sustainable Watersheds Act received royal assent on June 4, 2018 in Manitoba. The Act introduces a streamlined approach to drainage including stronger enforcement powers for illegal drainage, provisions to enable offset requirements for loss of significant wetlands, and changes to The Conservation Districts Act to shift to watershed-based boundaries. The Act also enables the development of nutrient targets and establishes reporting requirements, supports mandate commitments to implement watershed-based planning for drainage and water resource management and also provides a foundation to implement a province-wide ecological goods and service program called Growing Outcomes in Watersheds or GROW.

GROW is a homegrown approach to ecological goods and services programming that was based on the Alternate Land Use Services (ALUS) model. GROW will create ecological goods and services on the agricultural landscape and encourage beneficial management practices like water retention, grassland restoration, wetland restoration or improved riparian area management by incenting farmers to create new environmental improvements on the landscape. The expected outcomes of GROW are reduced flooding, improved water quality, improved on-farm management of nutrients, enhanced resiliency to the impacts of climate change, improved biodiversity, enhanced carbon storage, enhanced sustainable food production and improved groundwater quality and recharge. The Manitoba government consulted with Manitobans on GROW from August to October 2017 and continues to develop GROW based on what we heard throughout this consultation process.

In addition, Manitoba continues to implement a series of key water protection initiatives aimed at reducing nutrient loading to waterways including regulations restricting nutrient applications to land, requirements for advanced wastewater treatment to remove nutrients and improving surface water retention and management through integrated watershed management planning:

- Nutrient Management Regulation:
    - Manitoba is continuing to implement the Nutrient Management Regulation (http://www.gov.mb.ca/waterstewardship/wqmz/index.html). The Nutrient Management Regulation addresses the application of nutrients to land from all sources, including livestock manure, inorganic fertilizer, cosmetic fertilizers, and bio solids/sludge.
    - Under the Nutrient Management Regulation, nutrients (regardless of the source) cannot be applied to land between November 10th and April 10th.
- Wastewater Treatment:
    - The Manitoba Water Quality Standards, Objectives and Guidelines Regulation (http://www.gov.mb.ca/waterstewardship/water_quality/quality/website_notice_mwqsog_2011.html) includes province-wide standards for phosphorus in wastewater effluent (1 mg/L) and, where site-specific conditions warrant, nitrogen (15 mg/L). Under the province-wide nutrient standards, a 1 mg/L phosphorus limit applies to all new, expanding or modified wastewater treatment facilities. Small wastewater treatment facilities discharging more than 820 kilograms of phosphorus per year (serving less than 2,000 people or equivalent) have the option of implementing a demonstrated nutrient reduction strategy (for example, a constructed wetland, effluent irrigation, etc.) or the 1 mg/L phosphorus

limit. Some facilities in Manitoba have received an extension for implementing the 1 mg/L phosphorus standard through an approved phosphorus compliance plan that

- Integrated Watershed Management Planning:
    - Work on integrated watershed management planning under The Water Protection Act continues in Manitoba. To date 27 plans have been initiated, of which 22 have been completed. One watershed plan was completed in 2017-18 for the Cooks-Devils Creek Watershed. Planning continues for five watersheds including two in the Red River, the Boyne-Morris River and Roseau River watersheds.
    - Integrated watershed management plans are compiled by local water planning authorities with stakeholder input. Plans are implemented, monitored and updated regularly (every ten years) by these authorities. Water planning authorities are designated under The Water Protection Act and the development of integrated watershed management plans is guided by specifications in the Act. Manitoba provides financial, planning and technical assistance throughout the process. The integrated watershed management plans include a report on current science and traditional knowledge of the watershed as well as actions to monitor, maintain, and improve environmental conditions in the watershed (http://www.gov.mb.ca/waterstewardship/iwmp/index.html).

North Dakota

The North Dakota Pollutant Discharge Elimination System (NDPDES) program requires all permitted facilities (industrial and municipal) to report wastewater spills and bypasses. During this reporting period (October 1, 2016 through September 30, 2017), there were 11 releases reported to the department in the Red River basin in North Dakota. The releases were related to pipe break/mechanical failure and lift station problems (overflows/bypasses) due to localized flooding and excessive precipitation. The facilities followed the reporting requirements of their permit. The spills/releases were followed up by department staff and all actions were resolved. Formal enforcement was required for one facility based on the findings of the department.

7.03 Pollution Abatement and Advisories

Point Source Control Program

The department regulates the release of wastewater and stormwater from point sources into waters of the state through permits issued through the NDPDES Program. Permitted municipal and industrial point source dischargers must meet technology or water quality based effluent limits. In addition, all major municipal and industrial permittees must monitor their discharge for Whole Effluent Toxicity (WET) on a regular basis.

Toxic pollutants in wastewater discharges are regulated through the industrial pre-treatment program that is administered by the NDPDES Program. The cities of Grand Forks, Fargo, and West Fargo all have approved pre-treatment programs within the Red River basin in North Dakota.

There are presently 151 facilities with a NDPDES Program permit in the Red River basin. Of these, there are 36 industrial wastewater permits and 115 domestic/municipal wastewater permits. A majority of the domestic/municipal wastewater permits are for small lagoon systems that typically discharge 2-3 times a year for a period of a few days to a few weeks.

Stormwater

The NDPDES Program permits stormwater discharges from industrial sites, construction sites and larger municipalities or Municipal Separate Storm Sewer Systems (MS4s). The cities of Grand Forks, Fargo, West Fargo and their urbanized area continue to implement their MS4 permits within the Red River basin in North Dakota.

A majority of the construction stormwater permitting in North Dakota is now in the western part of the state. There are approximately 803 stormwater permits for construction activity and 118 industrial stormwater permits in the Red River basin in North Dakota.

Animal Feeding Operations (AFOs)

The NDPDES Program continues to regulate animal feeding operations (AFOs) in the North Dakota. All large (>1000 animal units) permitted confined animal feeding operations (CAFOs) are inspected annually; whereas medium and small AFOs are inspected on an as-needed basis. There are 142 AFOs permitted by the department in the Red River basin. Of these, there are 24 designated as large CAFOs.

Nonpoint Source Pollution Management Program

The Division of Water Quality is responsible for administering the Clean Water Act Section 319 Nonpoint Source Pollution Management Program (NPS Program) in North Dakota. Section 319 of the Clean Water Act and guidance provided by EPA defines the scope of the NPS Program, while the department administers the program with input from the North Dakota Nonpoint Source Pollution Task Force (Task Force). The Task Force is comprised of representatives from state and federal natural resource agencies, commodity/producer groups and private wildlife/natural resource organizations.

Each year, the U.S. Congress for nonpoint source pollution (NPS pollution) management appropriates Section 319 funds to EPA. The amount of Section 319 funding available to each state is based on an allocation formula and variable from year to year. In North Dakota, approximately 80% (i.e., $3,000,000) of the annual Section 319 grant award is allocated to various organizations (e.g., soil conservation districts, water resource boards, state agencies, universities, and non-profit organizations) to implement

NPS pollution education, assessment and/or abatement projects. The balance of funds awarded to the state are used to support staff and laboratory services. Section 319 funds awarded to the state and approved projects require a 40 percent non-federal match.

Through the NPS Program, the department is currently supporting several watershed projects in the Red River basin that are focused on nonpoint source pollution abatement. In most cases, these projects are addressing NPS pollution associated with agricultural activities. A map depicting the location of these projects is provided in Figure 6. Best management practices (BMP) implemented by the watershed projects since 2010 are listed in Table 9. The following is a summary of the active watershed projects in the Red River Valley.

- The Richland County SCD was awarded Section 319 funding in 2011, 2014, 2015 and 2018 to support the implementation of the Antelope Creek Watershed and Wild Rice Riparian Corridor project. The SCD was also awarded Outdoor Heritage Funds in 2014 to supplement the Section 319 funds committed for the implementation of BMPs. The Outdoor Heritage Funds are state funds generated through oil tax revenues. The primary goal of the project is to restore the recreational uses of the impaired reaches of Antelope Creek and the Wild Rice River in Richland County. As a secondary goal, the project will protect and enhance aquatic life uses of Antelope Creek and the Wild Rice River through targeted implementation of BMPs within or immediately adjacent to the riparian corridor. These goals are being accomplished through one-on-one conservation planning; implementation of agricultural BMPs; septic system renovation; and public education. Through these efforts, the project has reported declining E. coli bacteria concentrations in some stream reaches of the Wild Rice River in the project area. For one of these reaches, E. coli concentrations are now being maintained below state water quality standards criteria, indicating recreational uses have been fully restored. The water quality improvements in this reach are described in an Environmental Protection Agency (EPA) "Success Story." The web address for the EPA Success Story is https://www.epa.gov/sites/production/files/2015-11/documents/nd_wildrice.pdf.

- The Barnes County SCD received Section 319 funding in 2010 and 2014 to implement the Barnes County Sheyenne River Watershed Project. Outdoor Heritage Funds were also allocated to the project in 2013 and 2015 to support the installation of BMPs identified in the project implementation plan. The goal of the project is to restore and maintain the recreational and aquatic life uses of the Sheyenne River and its tributaries in Barnes County. To meet this goal, the SCD is providing technical and financial assistance to install BMPs that improve manure management; restore degraded riparian areas; replace failed septic systems and control erosion on cropland and rangeland. Additionally, to strengthen local support for the project, the SCD is: 1) implementing educational programs to heighten public awareness of NPS pollution impacts and solutions; and 2) developing working partnerships in the local community to ensure long-term maintenance of efforts to protect water quality and other natural resources in the watershed.

- The Ransom County SCD was awarded Section 319 funding in 2015 to support the implementation of the Timber Coulee Watershed project. Outdoor Heritage Funds were also allocated to the SCD to cost share the implementation of BMPs throughout the county, including Timber Coulee Watershed. The primary goal of the project is to restore the recreational uses of Timber Coulee, which is a tributary to the Sheyenne River near Lisbon ND. This is being accomplished by providing financial and technical assistance to producers to improve livestock management along the riparian corridor of Timber Coulee. Specific emphasis is being placed on improving manure management on three animal feeding operations and addressing livestock grazing in the riparian corridor. Practices being promoted and installed include cover crops; cross fencing, vegetative buffers, watering facilities, prescribed grazing and manure management

systems.

- The Cass County SCD was awarded Section 319 funding for the Buffalo Creek Watershed project in 2014. The primary goal of the project is to restore the recreational uses of Buffalo Creek, which is a tributary to Maple River in Cass County. As a secondary goal, the project is also promoting the implementation of water quality improvement practices throughout the Maple River Watershed. To achieve these goals, the project sponsors have initiated an extensive watershed-wide educational program and is providing financial and technical assistance to implement BMPs that address failed septic systems and improve land management along Buffalo Creek. Emphasis is being placed on installing BMPs in priority cropland areas and along riparian corridors. Practices that may be installed include septic systems, cross-fencing, off-site watering facilities, nutrient management, water wells, cover crops, riparian buffers and grass waterways.

- The Red River Regional Council was allocated Section 319 funding in 2014 and 2018 to support the implementation of the Red River Riparian Project. Outdoor Heritage Funds were also awarded to the project in 2014 and 2017 to support the installation of BMPs identified in the project implementation plan. The goal of the project is to provide financial and technical assistance to land owners to restore degraded riparian areas within priority watersheds in the Red River Basin. Current priority watersheds include the Forest, Goose, Lower Pembina, Middle Sheyenne, Park and Turtle River watersheds. Landowners are being provided riparian management planning assistance to identify and install BMPs that restore and protect the proper functioning condition of the riparian corridor. Proposed practices include BMPs such as prescribed grazing, exclusion fencing, tree plantings, bank stabilization practices, vegetative buffers, and off-site watering facilities. The project also conducts public outreach events annually to disseminate information on riparian management and restoration techniques. The target audience for the educational efforts includes the public and landowners as well as staff and supervisors from local communities, water resource districts, and soil conservation districts.

- The Wild Rice SCD received Section 319 funding in 2014, 2016 and 2018 to implement the Wild Rice River Restoration and Riparian project. The project was also allocated Outdoor Heritage funds in 2014 to support BMPs implemented in the project area. The project is focusing on the watersheds for Shortfoot and Crooked Creek as well as the riparian corridor along the main stem of the Wild Rice River in Sargent County. The goal of the project is to improve aquatic life use in the Wild Rice River, Shortfoot Creek and Crooked Creek. This is being accomplished by providing financial and technical assistance to agricultural producers to implement BMPs that reduce livestock impacts, restore riparian habitat and improve the buffering capabilities of riparian areas and adjacent lands. Practices being promoted and installed include manure management systems (i.e., diversions, dikes, holding ponds; etc.) cross fencing, off-site watering facilities, cover crops, riparian easements, grassed waterways, filter strips, and tree plantings. Because of these efforts, the project sponsors have reported declining trends in E. coli bacteria concentrations for one stream reach located in the Shortfoot Creek watershed.

- The Walsh County Three Rivers SCD was initially awarded Section 319 funding for the Homme Dam watershed project in 2014. That project area was expanded in 2018 to include the entire Park River watershed upstream of Grafton. Additional Section 319 funding was awarded in 2018 to support efforts in the expanded project area. Outdoor Heritage Funds were also awarded to the project in 2015. The goal for the expanded project area is to improve the recreational and aquatic life uses of the Park River and Homme Dam reservoir. E. coli bacteria, phosphorus and nitrogen are the primary NPS pollutants being addressed by the project. To achieve the long-term goal,

technical and financial assistance is being provided to agricultural producers to implement BMPs that protect or enhance riparian areas as well as improve grazing and woodland management along the Park River, upstream and downstream from Homme Dam reservoir. Practices being promoted and implemented include fencing, off-site watering facilities, water wells, cover crops, grassed waterways, riparian tree plantings; grass buffers/filters and windbreaks.

- The Griggs County SCD was awarded Section 319 funding for the Baldhill Creek watershed project in 2014. The project was also allocated Outdoor Heritage Funds in 2014. The SCD is using the funding to implement BMPs that will restore the recreational and aquatic life uses of the Baldhill Creek. The SCD's land management improvement efforts are focused on the reduction of in-stream concentrations for E. coli bacteria, total nitrogen, total phosphorus and total suspended solids. These reductions are being achieved by providing technical and financial support for the implementation of BMPs that improve manure management, riparian grazing, nutrient management, cover crops, and riparian buffers. Implementation of the BMPs is generally targeted toward the highest priority sub-watersheds as well as areas of cropland and grazing land immediately adjacent to the creek. With the project nearing completion, data indicates a declining trend in nitrogen and phosphorus average annual concentrations in one reach of the Baldhill Creek.

- The Wells County SCD was awarded Section 319 funding for the Middle Sheyenne River watershed project in 2016. The project area includes a one-mile corridor along both sides of the Sheyenne River from Harvey Dam downstream to the Eddy County line. The SCD is using the 319 funding to implement BMPs that restore the recreational and aquatic life uses of the Middle Sheyenne River. To achieve the goal, the SCD is offering technical and financial assistance to agricultural producers for conservation planning and BMP installation. The project is also conducting information/education activities focused on practices that reduce livestock impacts within the riparian corridor. Priority BMPs being promoted and installed include prescribed grazing systems, fencing, watering facilities, cover crops, septic systems and manure management systems.

Table 9. BMPs implemented with Section 319 funding in the watershed projects located in the Red River Valley: January 2010 - June 2018.

BMP Category/BMP Type	Amount Applied
Cropland	
Cover Crops	18,435 acres
Erosion Control	
Critical Area Plantings	41 acres
Grazing Manangement	
Livestock Fencing	228,192 linear feet
Pasture/Hayland Planting	1,657 acres
Pipelines	37,057 linear feet
Pond	1 pond
Prescribed Grazing	683 acres
Range Planting	137 acres
Rural Water Hookup	3 hookups
Spring Developments	3 developments
Trough and Tanks	36 tanks
Wells (livestock watering only)	10 wells
Solar Pumps	3 pumps
Livestock Manure Management Systems	
Full Containment Manure Management System	10 systems *
Perimeter Fencing	12,690 linear feet
Pipelines	100 linear feet
Portable Windbreaks	6,696 linear feet
Waste Utilization	2,020 tons
Watering Facility (tank, pipeline & well)	2 systems
Miscellaneous Practices	
Septic System Renovations	137 systems
Well Decommissioning	69 wells
Riparian Area Management	
Evergreen Revetments	250 linear feet
Riparian Easements (Cropland)	475 acres
Riparian Forest Buffer	2.22 acres
Riparian Herbaceous Cover	291 acres
Strembank and Shoreline Stabilization	6,563 linear feet
Tree Hand Plants	1,795 trees
Tree Planting (scalp plant & site prep)	1,020 feet
Tree/Shrub Establishment	9,630 feet
Upland Tree Planting	
Tree/Shrub Establishment	24,030 feet
Windbreak/Shelterbelt	2,720 feet
Vegetative Buffers	
Grassed Waterway	1 acres
Filter Strip	81 acres

**Includes eight systems implemented with Section 319 funds allocated to the statewide manure management programs administered by the ND Stockmen's Association and ND Department of Agriculture.*

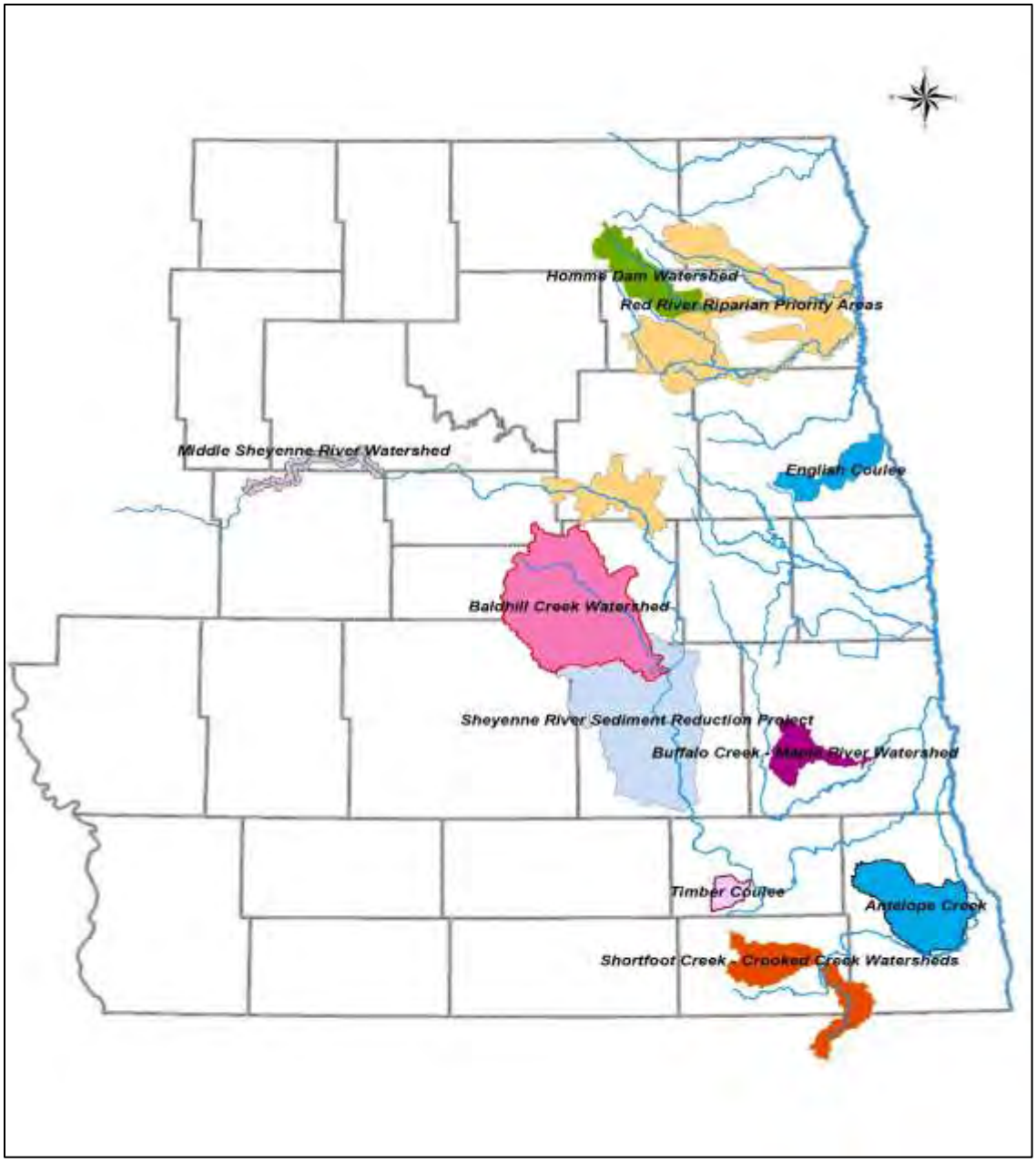


Figure 6. Watershed and Water Quality Assessment and Restoration Projects in the Red River Basin, North Dakota.

- The Grand Forks County SCD was awarded Section 319 funding in 2014 and 2016 to support the implementation of the English Coulee watershed project. The main goal for the project is to achieve an improving trend in the recreational and aquatic life uses of English Coulee. A secondary goal of the project is to educate the public on the relationship between healthy soils and water quality through education and BMP demonstrations. To accomplish these goals, the SCD is offering technical and financial assistance to producers for riparian grazing management, fencing, tanks, pipeline, use exclusion, cover crops, and septic systems.

In addition to the watershed projects, the NPS Program also provides Section 319 financial support to

several educational projects conducting outreach efforts in the Red River Valley. In general, these educational projects are disseminating information on NPS pollution impacts as well as the solutions to those impacts. The target audiences for these educational events range from K-12 students to the public at large. However, given the extent of the agricultural industry in the state, agricultural producers are typically the primary target audience for most NPS Program educational efforts. Table 10 lists the specific educational projects currently active in the Red River Valley.

Table 10. Educational projects supported by the NPS Program in the Red River Valley

Section 319 Funded Education Project	Section 319 Funded Education Project
Statewide ECO ED Program	Envirothon Program
Ranchers Mentoring and Outreach Program	Eastern ND Soil Salinity Demonstration
Project WET	Prairie Waters Education & Research Center
Riparian Ecological Site Description Development	The Regional Environmental Education Series (TREES)
Nutrient Management Education & Support Program	

A third category of projects supported by the NPS Program includes projects that are providing technical support to other NPS projects or focusing on a specific priority resource concern. Collectively, these projects are identified as "support projects." The support projects are generally statewide or regional in scale. To date, three support projects have been awarded Section 319 funding through the NPS Program. While the scope of these projects extends beyond the Red River Valley, they have implemented BMPs in the Red River Valley. Summaries of the support projects currently funded by the NPS Program are as follows:

- The ND Department of Agriculture has been awarded Section 319 funding in 2010-2016 to support the Livestock Pollution Prevention Program (LP3). The goal of the program is to deliver a statewide program that will reduce water quality impairments associated with concentrated livestock feeding areas. This is being accomplished by providing planning assistance to livestock producers to design and install manure management systems. Some of the practices being installed include diversions, dikes, fencing, holding ponds, vegetative buffers, and settling basins. Since 2010, the LP3 has provided financial and technical assistance to implement seven full containment livestock manure management systems in the Red River Valley.

- Section 319 funds were awarded to the Stockmen's Association in 2010, 2011, 2013, 2016 and 2017 to support the ND Stockmen's Association Environmental Services Program. The program goal is to deliver a statewide program that addresses water quality impairments associated with concentrated livestock feeding areas. To meet this goal, financial and technical assistance is provided to livestock producers to design and install full containment manure management systems. Assistance is also being provided to develop manure utilization plans for each feeding system. Practices that may be installed include diversions, dikes, fencing, holding ponds, vegetative buffers, and settling basins. The Environmental Services Program assisted with the implementation of one full containment manure management system in the Red River Valley in 2017.

- Pheasants Forever, Inc. was awarded Section 319 funding in 2017 to implement the Precision Ag Business Planning Support Program. The goal of the program is to utilize precision Ag business planning technology, delivered through Profit Zone Manager (PZM) or an equivalent Return on Investment Platform, to improve water quality and wildlife habitat while maximizing farm profits

and minimizing risks for participating producers. This is being accomplished by providing technical assistance to producers to utilize PZM or an alternative to evaluate their fields and identify areas of low or negative profits. Using this information, project staff coordinate with local SCD and/or NRCS staff to assist producers in determining alternative uses for the revenue negative acres. The management objective for the targeted acres is to implement practices that will improve producer profits; eliminate unnecessary nutrient and/or pesticide inputs; protect the soil resource; and reduce potential water quality impacts. Typically, the management adjustments on the revenue negative acres include enrollment in the Conservation Reserve Program or, for more short-term practices, planting annual cover crops, perennial forage crops or native grasses. Counties in the Red River Valley where the program is being implemented include Ransom and Sargent counties.

8.0 BIOLOGICAL MONITORING IN THE RED RIVER BASIN

8.01 Macroinvertebrates of the Red River in Manitoba

Benthic macroinvertebrates were collected at two locations on the Red River in September 2017: Emerson and Selkirk (Table 11). At each location, one transect of five dredge grab samples were collected with a petit Ponar dredge. Starting at the east bank, samples were collected at five equidistant sample sites across the width of the river. Each Ponar dredge covered an area of 0.023 m^2. For each transect, 0.115 m^2 of sediment was collected. The dredge samples were washed through 500 µm Nitex nylon nets. River water was used to remove organisms and sediment from the nylon net into a 500-µm mesh sieve. Remaining sediment and all organisms were then placed in labelled 500 mL jars with 70 % ethyl alcohol preservative. ALS Environmental in Winnipeg, Manitoba subsequently identified Macroinvertebrates to the lowest possible taxonomic level, typically genus and species. Data were screened for terrestrial species that were removed from the data subsequently reported.

Table 11. Geographic coordinates for the benthic macroinvertebrates sampling stations at Emerson and Selkirk on the Red River, Manitoba in September 2016.

Transect	Latitude	Longitude
Emerson	49°00'13.6"	97°13'16.2"
Selkirk	50°08'55.7"	96°51'24.8"

In 2017 at Emerson, 113 organisms were collected. To calculate organisms per square metre, the number of organisms at each transect was multiplied by a factor of 8.70, yielding 983 organisms/m^2 (Table 12). For the reporting period at Emerson in 2017, the organisms in greatest abundance were from the Order Diptera (Family Chironomidae).

In the Red River at Selkirk, 315 organisms were collected. To calculate organisms per square metre, the number of organisms at each transect was multiplied by a factor of 8.70, yielding 2741 organisms/m^2 (Table 13). Similar to the Emerson site, the organism of greatest abundance at Selkirk was from the Class Insecta, Order Diptera, Family Chironomidae. The second most abundant type of organism was from the Class Pelecypoda, Order Veneroida, Family Pisidae. Both reaches of the Red River had a similar species richness of benthic macroinvertebrates in 2017. The Red River near Selkirk had a higher number of total organisms due to a few subsamples that included a large number of Chironomidae and Tubificidae species, which are typically tolerant to organic pollutants.

Table 12. Summary of macroinvertebrates collected per transect and calculated total per metre squared in pooled Ponar © dredge samples from the Red River at Emerson, Manitoba in September 2017.

Class	Order	Family	Genus	Species	Number per transect
ANNELIDA	OLIGOCHAETA	TUBIFICIDAE	*unidentified*	*with hair setae*	5
ANNELIDA	OLIGOCHAETA	TUBIFICIDAE	*unidentified*	*without hair setae*	1
CRUSTACEA	COPEPODA	CALANOIDA			1
CRUSTACEA	OSTRACODA				1
INSECTA	COLEOPTERA		*unidentified*	*damaged*	1
INSECTA	COLLEMBOLA	ISOTOMIDAE	*Isotomurus*	*sp.*	1
INSECTA	DIPTERA	CERATOPOGONIDAE	*Ceratopogon*	*sp.*	36
INSECTA	DIPTERA	CHIRONOMIDAE	*Ablabesmyia*	*sp.*	1
INSECTA	DIPTERA	CHIRONOMIDAE	*Chironomus*	*sp.*	29
INSECTA	DIPTERA	CHIRONOMIDAE	*Cryptotendipes*	*sp.*	2
INSECTA	DIPTERA	CHIRONOMIDAE	*Harnischia*	*sp.*	1
INSECTA	DIPTERA	CHIRONOMIDAE	*Polypedilum*	*sp.*	5
INSECTA	DIPTERA	CHIRONOMIDAE	*Procladius*	*sp.*	5
INSECTA	DIPTERA	CHIRONOMIDAE	*Stenochironomus*	*sp.*	1
INSECTA	DIPTERA	CHIRONOMIDAE	*Tanytarsus*	*sp.*	1
INSECTA	DIPTERA	CHIRONOMIDAE	*unidentified pupa*		4
INSECTA	EPHEMEROPTERA	EPHEMERIDAE	*Ephemera*	*sp.*	2
INSECTA	EPHEMEROPTERA	LEPTOHYPHIDAE	*Tricorythodes*	*sp.*	1
INSECTA	HEMIPTERA	CORIXIDAE	*Callicorixa*	*audeni*	1
INSECTA	HEMIPTERA	CORIXIDAE	*Sigara*	*lineata*	5
INSECTA	HEMIPTERA	CORIXIDAE	*unidentified nymph*		4
INSECTA	TRICHOPTERA	HYDROPSYCHIDAE	*Potamyia*	*sp.*	1
INSECTA	TRICHOPTERA	LEPTOCERIDAE	*Nectopsyche*	*sp.*	1
INSECTA			*unidentified damaged*		1
NEMATODA			*unidentified*		1
PELECYPODA	VENEROIDA	PISIIDAE	*unidentified*	*too young to ID*	1
				Total number of organisms	**113**
				Total number per square meter	**983**
				Total number of taxa	**26**

Table 13 Summary of macroinvertebrates collected per transect and calculated total per metre squared in pooled Ponar © dredge samples from the Red River at Selkirk, Manitoba in September 2017

Class	Order	Family	Genus	Species	Number per transect
ANNELIDA	OLIGOCHAETA	TUBIFICIDAE	*Unidentified*	*With hair setae*	20
ANNELIDA	OLIGOCHAETA	TUBIFICIDAE	*Unidentified*	*Without hair setae*	37
CRUSTACEA	CLADOCERA				1
CRUSTACEA	COPEPODA	CYCLOPOIDA			1
CRUSTACEA	OSTRACODA				2
INSECTA	DIPTERA	CERATOPOGONIDAE			1
INSECTA	DIPTERA	CHIRONOMIDAE	*Chironomus*	*sp.*	148
INSECTA	DIPTERA	CHIRONOMIDAE	*Polypedilum*	*sp.*	2
INSECTA	DIPTERA	CHIRONOMIDAE	*Procladius*	*sp.*	9
INSECTA	HEMIPTERA	CORIXIDAE	*Dasycorixa*	*sp.*	1
INSECTA	HEMIPTERA	CORIXIDAE	*Sigara*	*sp.*	1
INSECTA	HEMIPTERA	CORIXIDAE	*Unidentified nymph*		2
INSECTA	TRICHOPTERA	LEPTOCERIDAE	*Oecetis*	*sp.*	2
NEMATODA			*Unidentified*		1
PELECYPODA	VENEROIDA	PISIIDAE	*Damaged*		16
PELECYPODA	VENEROIDA	PISIIDAE	*Sphaerium*	*sp.*	4
PELECYPODA	VENEROIDA	PISIIDAE	*Unidentified*	*Too young to ID*	67
				Total number of organisms	**315**
				Total number per square meter	**2741**
				Total number of taxa	**17**

8.2 Benthic Invertebrate Indices: Simpsons Evenness, EPT taxa, and Bray-Curtis Dissimilarity Index.

Simpsons Diversity Index (D) (Krebs, 1994) places little weight on rare taxa and more weight on common species and is calculated.

$$D = 1 - \sum_{i=1}^{s} (p_i)^2$$

Where S total number of species in the community (richness), pi proportion of S made up of the ith species. D ranges from zero to one, indicating a low level of diversity. Calculated Diversity scores for Emerson and Selkirk were 0.83 and 0.71 respectively.

Simpsons equitability or Evenness (E) indicates if taxa are evenly represented within a given sample. Evenness varies from a score of zero to one. A score of one represents a sample in which all the taxa are equally abundant (Smith and Wilson 1996). Evenness is calculated by

$$E_D = \frac{D}{D_{max}} = \frac{1}{\sum_{i=1}^{s} p_i^2} \times \frac{1}{S}$$

where:
E = evenness
Pi = the proportion of the ith taxon at the station
S = the total number of taxa at the station

Simpsons Evenness scores were 0.21 and 0.2 for the Red River at Emerson and Selkirk respectively. Relatively large numbers of individuals from relatively few taxa influenced the Evenness score for both sites.

The EPT Index is named for three orders of aquatic insects that are common in the benthic macroinvertebrate community including pollution intolerant Ephemeroptera (mayflies), Plecoptera (stoneflies), and generally pollution tolerant order Trichoptera (caddisflies). EPT taxa richness will decrease with decreasing water quality. The EPT score is the sum of the number of species from within these groups. The EPT score for Emerson was four and Selkirk was one. No individuals from the pollution intolerant Order Plecoptera were found at Emerson or Selkirk. Percent EPT is the total number of EPT individuals divided by the total number of individuals in the sample. Percent EPT was 4 percent for Emerson and 0.63 percent for Selkirk. Overall, very low numbers of EPT individuals were observed at either sites during the 2016-2017 report period.

The Bray-Curtis Index compares the community composition of two sites where the co-efficient reaches a maximum of one for two sites that are entirely different and a minimum score of zero for sites that possess identical composition (Legendre and Legendre, 1983). The calculated Bray-Curtis Dissimilarity Index was 0.76 indicating that community compositions were considerably different between sites. In particular, there was a much greater diversity of taxonomic families observed at Emerson compared to Selkirk (28 and 17 respectively), whereas, overall abundance of organisms was much greater at Selkirk compared to Emerson (315 and 115 organisms collected respectively). Overall, 13 taxonomic groups were observed at both sites, while 15 groups and 4 groups were only observed at Emerson and Selkirk, respectively (Tables 12 and 13).

References:

Krebs, C.J. 1994 Ecology: The Experimental Analysis of Distribution and Abundance, 4th Ed. Harper Collins, New York. P. 705-706.

Legendre, L., and P. Legendre. 1983. Numerical ecology. Elsevier, Amsterdam.

Smith, B. and J. Wilson. 1996. A consumer's guide to evenness indices. - Oikos. 76: 70-82.

8.3 *Escherichia coli* and Algal Bloom Monitoring in Lake Winnipeg

Manitoba monitored nineteen recreational beaches within the south basin of Lake Winnipeg for levels of *Escherichia coli* during 2017 (Table 14). Sampling began at the beginning of June and continued weekly until the beginning of September. Two beaches were monitored twice per week.

While some beaches occasionally exceeded Manitoba's recreational water quality guideline for fecal indicator bacteria, typically recreational water quality is excellent at Lake Winnipeg beaches. All beaches have a blue coloured "Clean Beaches" sign that provides information to bathers about *E. coli* and identifies precautions on how the bathing public can reduce risk of exposure to pathogens. For beaches that had *E. coli* densities above the guideline and that have a history of elevated densities, additional yellow coloured 'Beach Advisory' signs were posted. Results of DNA ribotyping from 2002 to 2006 indicated that approximately 34 per cent of *E. coli* from all samples could be attributed to shorebirds and geese, while less than 5 per cent of the samples could be attributed to human sources. Thirty seven per cent of the *E. coli* samples could not be matched to a particular animal source.

As part of the 2017 beach monitoring program, Manitoba Sustainable Development continued to monitor beaches on Lake Winnipeg for the presence of algal blooms. On Lake Winnipeg, Grindstone Beach, Black's Point Beach, Gull Harbour Beach, East Grand Beach, Hillside Beach, Lester Beach, Sunset Beach, and Victoria Beach were posted with first level algal advisories indicating the number of blue-green algae cells exceeded the Manitoba recreational water quality objective of 100,000 cells per mL. The first level algal advisory informs bathers that algal blooms have been observed at the beach and provides some additional advice regarding avoiding contact with the water when algal blooms are present. The second level algal toxin advisory is posted when the concentration of microcystin exceeds the Manitoba recreational water quality objective of 20 µg/L. The advisory indicates that drinking, swimming or other contact with the water is not recommended. In 2017, there were no beaches on Lake Winnipeg posted with second level algal advisory signs.

Table 14. Recreational beaches in Lake Winnipeg south basin monitored in 2017.

Locations	*Escherichia coli* in bathing water
Victoria Beach (2 sites)	Weekly
Albert Beach	Weekly
Hillside Beach	Weekly
Lester Beach	Weekly
East Grand Beach	Weekly
West Grand Beach	Twice a Week
Patricia Beach	Weekly
Sunset Beach	Weekly
Gull Harbour	Weekly
Black's Point	Weekly
Grindstone Beach	Weekly
Sandy Bar Beach	Weekly
Hnausa Campground Beach	Weekly
Spruce Sands Beach	Weekly
Gimli Beach	Twice a Week
Sandy Hook Beach	Weekly
Winnipeg Beach	Weekly
Matlock Beach	Weekly

8.4 Fisheries of the Red River in Manitoba

Biological Information

A total of 67 fish species have been recorded in the Manitoba portion of the Red River (Table 15). Presently, Bigmouth Buffalo (*Ictiobus cyprinellus)* and Chestnut Lamprey (*Ichthyomyzon castaneus*) are designated as Special Concern under *The Species at Risk Act.* In 2005, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recommended Lake Sturgeon (Acipenser fulvescens) for listing as Endangered.

Known aquatic invasive species that have been introduced in the Manitoba portion of the Red River include the Common Carp (*Cyprinus carpio),* White Bass (*Morone chrysops)*, Rainbow Smelt (*Osmerus mordax)* and Asian Carp Tapeworm (*Bothriocephalus acheilognathi)*. Other introductions into the Manitoba portion of the Red River include feral Goldfish (*Carassius auratus),* Smallmouth Bass *(Micropterus dolomieu)* and Largemouth Bass *(Micropterus salmoides).*

Zebra Mussel (*Dreissena polymorpha*) veligers were detected in the Manitoba portion of the Red River for the first time in samples collected on June 9th, 2015 at Emerson and a second sampling location at Selkirk. Zebra Mussel veligers were subsequently found in the U.S.A. portion of the Red River. In early May 2015, adult Zebra Mussels were reported from a dock located in an offshoot of the Red River near Selkirk Park. This was the first detection of adult Zebra Mussels in the entirety of the Red River.

Although the eradication of Zebra Mussels in four harbours in Lake Winnipeg in May and June 2014 was successful, a reproducing offshore population of Zebra Mussels was identified in the south basin of the lake in mid-summer 2014. By the end of the 2014 open water season Zebra Mussels had re-infested the treated harbours and had expanded their range within the south basin. In 2015, Zebra Mussel veligers were found throughout the length of the Manitoba portion of the Red River and the channel region and the north basin of Lake Winnipeg. Zebra Mussel veligers were also found in Cedar Lake, Manitoba, a hydroelectric

impoundment located immediately upstream from Lake Winnipeg on the Saskatchewan River system. Manitoba has increased its efforts to minimize the spread of Zebra Mussels from Lake Winnipeg and the Red River to other water bodies by operating more watercraft inspection stations, developing legislation and increasing communication initiatives. Monitoring within Lake Winnipeg is ongoing to determine the range and rate of spread of this species.

Recreational Angling - Value

The Manitoba portion of the Red River is internationally known for the high quality of angling the fishery supports. Based on a 2010 Angler Survey, Manitobans and visitors to the province fished a total of 2 million days, of which 11% were spent on the Red River, and 8% on Lake Winnipeg, making these the most heavily fished water bodies in the province. It is estimated that anglers fishing the Red River and Lake Winnipeg contributed approximately $70M towards the overall economic value of angling in Manitoba ($407M annually based on the 2012 Travel Manitoba report "Economic Evaluation of Manitoba's Hunting and Fishing Industry"). A partial winter creel survey was conducted on Lake Winnipeg in winter 2017 and confirmed the continuing and rapid expansion of angling on the south basin of Lake Winnipeg. Between January 23 and February 23, 2017, more than 66,000 angler visits to the lake were reported.

The Red River fishery attracts non-residents primarily to trophy Walleye and Channel Catfish angling opportunities. Furthermore, the diverse fish species composition appeals to residents of all ages. From an angling perspective, the fishery is managed to: 1) ensure sustainability of the recreational fishery for future generations, 2) encourage angler participation and development of the recreational fishing potential of the river, and 3) maximize economic returns to angling interests who rely on the fishery for their livelihood. A commercial net fishery targeting primarily Walleye and Lake Whitefish has operated on Lake Winnipeg since the late 1800s.

The majority of angling effort occurs between the floodway gate structure at St. Norbert and the north end of the south basin of Lake Winnipeg. Angling is especially concentrated from the dam at Lockport downstream to Netley Creek, within the City of Winnipeg and along the southern shore of the south basin.

Manitoba Sustainable Development, Wildlife and Fisheries Branch has been collaborating with researchers from the University of Nebraska from 2011 through 2018, and more recently the Canadian Department of Fisheries and Oceans on a series of projects to understand and improve management of the internationally valuable Red River Channel Catfish fishery. Demographic information is being collected and stable isotope evaluation of the food web is being conducted to facilitate description of energy flow through to catfish. The ongoing catfish-tagging program, which began in the Lockport area in August of 2012, will estimate population size, mortality, and physical extent of the population. More than 15,000 catfish have been tagged with externally visible orange Floy tags to date. In 2016, 120 catfish were implanted with radio transmitters and an array of receivers were located through the south basin of Lake Winnipeg and the Red and Assiniboine rivers to determine individual movement patterns.

Initial results show Channel Catfish mortality rates are low in Manitoba at 11%, probably due to restrictive angling regulations, and to date, little interest in catfish from the commercial fishery, but higher in the US portion of the Red River (22%). Further, movement appears to be size dependent, with a number of large catfish moving southwards into US waters, with minimal return movement observed to date, while mostly smaller catfish moved from the Red River into Lake Winnipeg. Individual catfish moved as far as 703-river km (from Selkirk, Manitoba to Near Harwood, North Dakota). Study proponents recommended broader, watershed scale management of the Channel Catfish fishery.

In recent years, additional species have been equipped with radio transmitters to take advantage of the

established monitoring network, including Bigmouth Buffalo, Walleye and Lake Sturgeon.

Table 15 Fish species of the Red River in Manitoba.

Common Name	Genus	Species	Presence	Common Name	Genus	Species	Presence
Banded Killifish	*Fundulus*	*diaphanus*	Rare	Largemouth Bass +	*Micropterus*	*salmoides*	Uncommon
Bigmouth Buffalo *	*Ictiobus*	*cyprinellus*	Common	Logperch	*Percina*	*caprodes*	Common
Bigmouth Shiner	*Notropis*	*Dorsalis*	Unknown	Longnose Dace	*Rhinichthys*	*cataractae*	Unknown
Black Bullhead	*Ameiurus*	*Melas*	Common	Longnose Sucker	*Catostomus*	*catostomus*	Common
Black Crappie	*Pomoxis*	*nigromaculatus*	Common	Mimic Shiner	*Notropis*	*volucellus*	Unknown
Blackchin Shiner	*Notropis*	*heterodon*	Unknown	Mooneye	*Hiodon*	*tergisus*	Rare
Blacknose Shiner	*Notropis*	*heterolepis*	Unknown	Ninespine Stickleback	*Pungitius*	*pungitius*	Common
Blackside Darter	*Percina*	*Maculate*	Unknown	Northern Pike	*Esox*	*lucius*	Common
Bluntnose Minnow	*Pimephales*	*Notatus*	Unknown	Pearl Dace	*Margariscus*	*margarita*	Unknown
Brassy Minnow	*Hybognathus*	*hankinsoni*	Unknown	Quillback	*Carpiodes*	*cyprinus*	Uncommon
Brook Stickleback	*Culaea*	*inconstans*	Common	Rainbow Smelt +	*Osmerus*	*mordax*	Uncommon
Brown Bullhead	*Ameiurus*	*nebulosus*	Common	River Darter	*Percina*	*shumardi*	Common
Burbot	*Lota*	*Lota*	Common	River Shiner	*Notropis*	*blennius*	Unknown
Central Mudminnow	*Umbra*	*Limi*	Common	Rock Bass	*Ambloplites*	*rupestris*	Common
Channel Catfish	*Ictalurus*	*punctatus*	Common	Rosyface Shiner	*Notropis*	*rubellus*	Unknown
Chestnut Lamprey *	*Ichthyomyzon*	*castaneus*	Unknown	Sand Shiner	*Notropis*	*stramineus*	Uncommon
Cisco	*Coregonus*	*Artedi*	Common	Sauger	*Sander*	*canadensis*	Common
Common Carp +	*Cyprinus*	*Carpio*	Common	Shorthead Redhorse	*Moxostoma*	*macrolepidotum*	Common
Common Shiner	*Luxilus*	*Cornutus*	Rare	Silver Chub	*Macrhybopsis*	*storeriana*	Common
Creek Chub	*Semotilus*	*atromaculatus*	Unknown	Silver Lamprey	*Ichthyomyzon*	*unicuspis*	Unknown
Emerald Shiner	*Notropis*	*atherinoides*	Abundant	Silver Redhorse	*Moxostoma*	*anisurum*	Common
Fathead Minnow	*Pimephales*	*Promelas*	Common	Smallmouth Bass +	*Micropterus*	*dolomieu*	Unknown
Flathead Chub	*Platygobio*	*Gracilis*	Unknown	Spotfin Shiner	*Cyprinella*	*spiloptera*	Unknown
Freshwater Drum	*Aplodinotus*	*grunniens*	Abundant	Spottail Shiner	*Notropis*	*hudsonius*	Common
Golden Redhorse	*Moxostoma*	*erythrurum*	Rare	Stonecat	*Noturus*	*flavus*	Unknown
Golden Shiner	*Notemigonus*	*crysoleucas*	Unknown	Tadpole Madtom	*Noturus*	*gyrinus*	Common
Goldeye	*Hiodon*	*Alosoides*	Common	Troutperch	*Percopsis*	*omiscomaycus*	Common
Goldfish +	*Carassius*	*Auratus*	Unknown	Walleye	*Sander*	*vitreus*	Common
Hornyhead Chub	*Nocomis*	*biguttatus*	Unknown	Western Blacknose Dace	*Rhinichthys*	*obtusus*	Unknown
Iowa Darter	*Etheostoma*	*Exile*	Common	White Bass +	*Morone*	*chrysops*	Common
Johnny Darter	*Etheostoma*	*Nigrum*	Common	White Crappie	*Pomoxis*	*annularis*	Unknown
Lake Chub	*Couesius*	*plumbeus*	Rare	White Sucker	*Catostomus*	*commersoni*	Common
Lake Whitefish	*Coregonus*	*clupeaformis*	Uncommon	Yellow Perch	*Perca*	*flavescens*	Common
Lake Sturgeon *	*Acipenser*	*fulvescens*	Rare				

Note: * = indicates species at risk, + = indicates introduced species

9.0 ADDITIONAL ACTIVITIES IN THE RED RIVER BASIN

As outlined in Appendix A – International Red River Board Directive, the duties of the Board include maintaining an awareness of agencies in the basin, of developments and conditions that may affect water levels and flows, water quality and ecosystem health of the Red River and its transboundary tributaries, and activities that contribute to a better understanding of the aquatic ecosystems. Chapter 9 provides an overview of a number of relevant activities and developments in the basin.

9.01 Garrison Diversion Project - Dakota Water Resources Act

The Dakota Water Resources Act (DWRA) of December 2000 amended authorizing legislation for the Garrison Diversion Project. The legislation outlines a program to meet Indian and non-Indian water supply needs in North Dakota and authorizes water uses including municipal, rural and industrial, fish and wildlife, recreation, irrigation, flood control, stream flow augmentation, and ground water recharge.

Red River Valley Water Supply Project

The Garrison Diversion Conservancy District (GDCD) is the project's state sponsor, while the Lake Agassiz Water Authority (LAWA) represents the local users. The project is designed to provide a supplemental water supply during times of water scarcity to central and eastern North Dakota. The project, as envisioned by the GDCD, will also supply additional water to support industrial development as well as provide an environmental benefit by augmenting natural stream flows (Figure 7).

Thirty-five cities and water systems have committed to help fund the development portion of the project (Figure 8). A capacity of about 159 cfs would be needed to service these interests. The current estimated cost of the project ranges from $947 million to $1.174 billion, for 150 cfs and 180 cfs project capacity.

Legislative Mandate

HB 1020, passed during the 2017 ND Legislative session, directs the ND State Water Commission (ND SWC) to provide, in the form of a grant, up to $30 million, of which $17 million is for the completion of the planning and permitting process and $13 million is to initiate construction of phase one prioritized project features to the Garrison Diversion Conservancy District for the Red River Valley Water Supply Project, for the biennium beginning July 1, 2017 and ending June 30, 2019. The bill also established the following requirements for this funding.

1. Any funding received for the completion of the planning and permitting process of the Red River valley water supply (RRVWS) project must result in the following accomplishments:
    a. The completed RRVWS project plan document that will be the basis and justification for project construction and must include alternative selection, water supply needs, projected project costs, easement acquisitions, environmental regulation compliance to include the Boundary Waters Treaty of 1909, and an implementation schedule;
    b. Acquisition of all state and federal permits required for the construction of any project features intended to be constructed with funding provided during the 2017-19 biennium;
    c. A signed Bureau of Reclamation water service contract agreeing to a minimum of one hundred sixty-five cubic feet per second over a minimum of forty years or equivalent to ensure an adequate water source for the project's needs;
    d. Prioritized project features for phase one construction; and
    e. A recommendation for funding options for all phases of the RRVWS project.

2. Any funding received to initiate construction of phase one prioritized project features identified in subsection 1 may be spent and construction of phase one may begin only after the budget section receives and approves certification from the state water commission and the state engineer that all items listed in subsection 1 have been accomplished.
3. Quarterly progress reports on the RRWVS project from the Garrison Diversion Conservancy District to the water topics overview committee of the legislative management, during the 2017-18 interim.

At their August 23, 2017 meeting, the ND SWC approved transferring $17 million to the Garrison Conservancy District for the purpose of planning and permitting the Red River Water Supply Project.

Figure 7: Proposed Route

Figure 8: 35 Water Systems Shown That Have Signed Development Agreements

Design/Construction:
The conceptual plan was completed and is summarized in a September 2016 report.

The draft preliminary design was released in October 2017.

Phased final design is underway. Priority items for the phased final design and construction are the discharge structure, trenchless crossings, and portions of the intake.

Other priorities for 2017 to 2019 include: exercise existing options, acquire remaining easement options, acquire state and federal permits, secure water source, complete the final design of strategic lengths of the pipeline for construction, complete final design for the Missouri River intake and discharge structures, and start construction of key components.

The first segment of pipeline to be designed and prepared for construction is a 28-mile length located on the Missouri River side of the divide. The phased design of the trenchless crossings will also be located within this 28-mile section.

The majority of the remaining project work is planned to be bid and constructed from 2019 to 2027. Major components of the design and construction include: Pipeline alignment McClusky to the split; Missouri River Conventional Intake/COE Permit; Financial Modeling; Pipeline alignment Washburn to McClusky; Pipeline alignment split to Baldhill Creek; Main Pumping Station, Pre-Treatment, Break Tank, Control Valve Structure, Hydraulics and Tansient – Preliminary Engineering; Aerial Photography and LIDAR Services; StateMod Water Supply Model; Pipeline Extensions; and Discharge Structure Design.

The scheduled design and construction would require approximately $180 million to be approved for the 2019-21 biennium.

Northwest Area Water Supply (NAWS)

An August 2015 Record of Decision (ROD) addressed invasive species and inter-basin water transfer concerns. The ROD identified the use of Missouri River water with subsequent advanced water treatment before it crosses the basin divide. This water treatment will provide flexibility in addressing long-term Safe Drinking Water Act standards to provide a safe and reliable drinking water supply to this region, while providing additional benefits for biota treatment.

Manitoba & Missouri Lawsuit

Summary judgement was granted to North Dakota on August 10, 2017. Both plaintiffs filed appeals in October and initial filings were due November 27, 2017. The court issued a briefing schedule January 3, 2018 with appellant's briefs due February 12, 2018, appellee's briefs due March 14, 2018, and appellant's reply briefs due March 28, 2018. A joint motion was filed and approved by the court to hold the case in abeyance for 90 days to allow settlement negotiations between appellant Manitoba and the appellees. Another joint motion was filed and approved by the Court to extend the abeyance further to allow further discussions. A joint motion by North Dakota, Department of Interior, and Province of Manitoba moving to dismiss Manitoba's appeal was filed June 22nd, 2018 and granted by the Circuit Court the following week. The State of Missouri filed their appeal brief June 22, 2018 based solely on the issue of their standing in the case. No arguments were made on the merits of their opposition to the project. North Dakota's brief and that of the Department of Interior are due August 3. Missouri's reply brief is due August 17. Oral arguments are anticipated in the winter of 2018-2019.

Biota Water Treatment Plant Design

A pre-design meeting for the Biota WTP was held May 23, 2017 at Reclamation's office in Bismarck with the intent of establishing the guidelines for the design to ensure compliance with the Final SEIS and ROD. Multiple treatment technologies were examined. Discussions were held with legal counsel for the State of ND and the Department of Interior regarding the flexibility of design allowed by the environmental documents. It was determined that there was little flexibility allowed by the Record of Decision, so design is proceeding on a conventional water treatment plant utilizing dissolved air floatation as the sedimentation process and dual media filtration followed by ultraviolet radiation disinfection and chemical disinfection with chlorine converted to chloramine to maintain a pipeline disinfectant residual. The decision has been made to construct the Biota WTP in phases to free up funding for other critical project components and add to the plant later as demand warrants it. The estimated cost of this design is roughly $4.9 million. As this is a federal facility, it is 100 percent eligible for federal reimbursement for design, construction, and operations and maintenance. Two value engineering studies are also required; one after the basis of design is established and one closer to the 60 percent design level. The first value engineering session was during the week of July 30, 2018.

Minot Water Treatment Facility

NAWS Contract 7-1B

NAWS Contract 7-1B was awarded by the State Water Commission at its February 8, 2018 meeting to PKG Contracting and generally consists of construction of a new primary treatment building at the Minot water treatment facility to replace the aging softening basins, chemical storage and feed systems, a new laboratory, break room, and IT facilities. Work on this project is currently underway. The substantial completion date for this contract is December 20, 2019.

NAWS Contract 2-24-2

Bids were opened for NAWS Contract 2-2A-2 on June 20, 2018. Four bids were received, with the apparent low bid of $515,695 by PKG Contracting, Inc. All bids received were in accordance with the advertisement for bids and no anomalies were found.

This contract includes approximately 700 feet of pipe, a new vault pad, 95 feet of casing, relocating the existing vault, and associated valving and tie-ins to the existing infrastructure (Figure 9). The contract was awarded to PKG Contracting, Inc. The substantial completion date for this project is October 31, 2018.

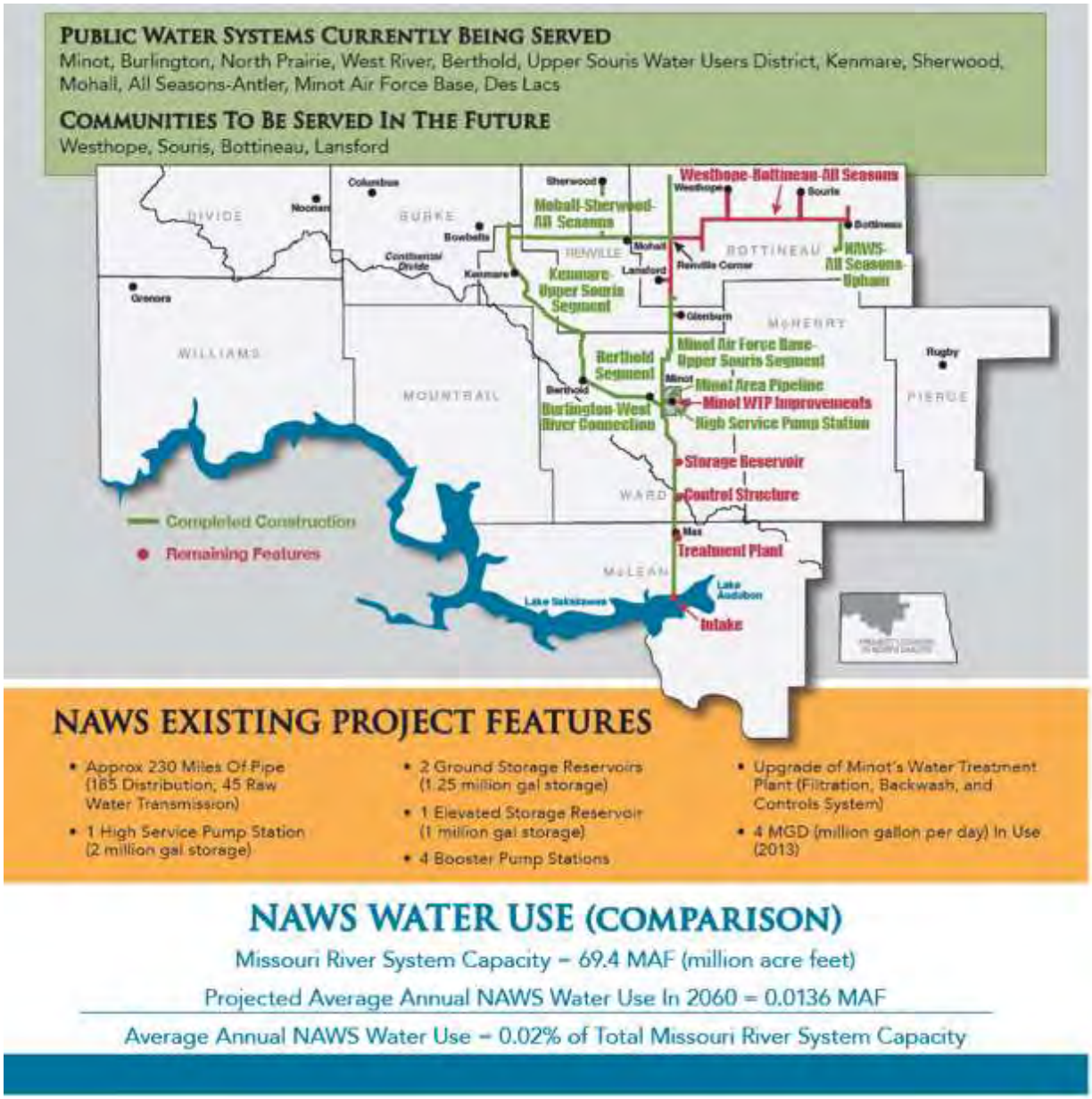


Figure 9: Northwest Area Water Supply (NAWS) Project

Red River Retention Authority

The Red River Retention Authority (RRRA), formed in 2010, is comprised of members of the Red River Joint Water Resource District, a North Dakota political subdivision, and the Red River Watershed Management Board, a Minnesota political subdivision. The primary objective of the Red River Retention Authority is to ensure joint, comprehensive, and strategic coordination of retention projects in the Red River of the North watershed and facilitating implementation and construction of temporary retention in the Red River Watershed for the purpose of flood damage reduction. Several entities are involved as partners in this process.

The main goal of the RRRA is to reduce the severe flood damage within the Red River watershed. While the majority of the benefit from an individual project will be in the sub-watershed where it is located, a combination of several detention projects would also be expected to reduce peak flows on the Red River mainstem.

Regional Conservation Partnership Program (RCPP):

The Secretary of Agricultural announced on January 14, 2015 that up to $12 million was included in the 2014 farm bill for the Red River Basin of the North Flood Prevention Plan through the NRCS-Regional Conservation Partnership Program (RCPP). The Red River Retention Authority will be the lead partner for the projects (Figure 10). These funds will be used to plan PL-566 like projects to achieve the main goal of reducing flood damages. They will be leveraged with state and local funds.

There are now 19 potential watershed protection studies approved by the RRRA that will be pursued. A local cooperation agreement has now been signed, for each of these studies, between the Natural Resource Conservation Service (NRCS) and the local sponsors. Public meetings have been held for each study area. Problems within the watersheds have been identified and a "purpose and need" statement has been developed for the majority of the studies. The task teams for many of the study areas have identified potentially feasible projects that would accomplish the goals set by the sponsors. Further analysis will be required for each potential project to determine if they have a B/C ratio of at least 1 to be eligible for federal cost share for construction. An extension has been approved for the completion of some of these studies, now scheduled for completion in the fall of 2019.

The procedure, and information obtained, for the study would be adequate to pursue any necessary permits for the identified projects. Additional federal funding may eventually be requested to construct any projects found to be feasible. Other projects may be able to proceed without federal cost share for construction.

While the main purpose of the projects is for flood damage reduction, water quality benefits may also be obtained.

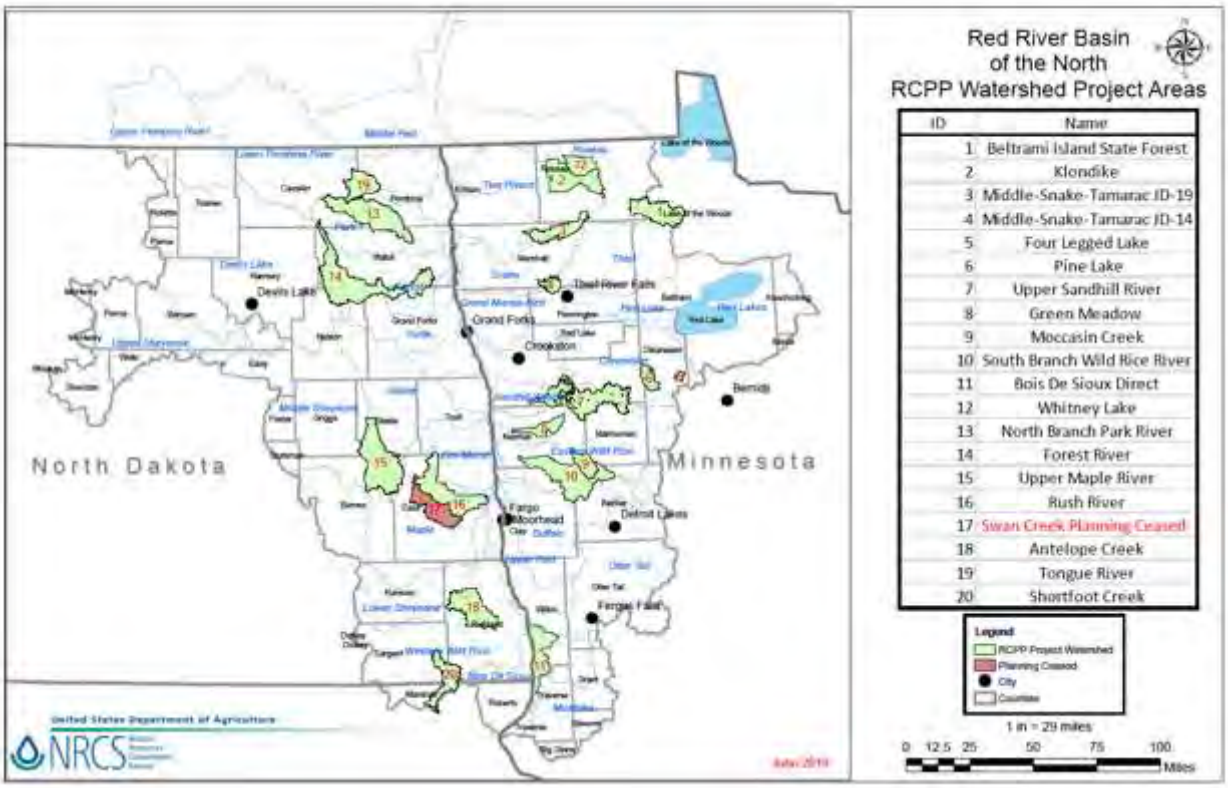


Figure 10: Red River Basin – Red River Conservation Partnership Program

9.02 Devils Lake Sub-Basin

The water elevation of Devils Lake was 1449.7 on January 1, 2018. The water elevation experienced very little rise from the spring runoff and has been slowly declining since late May. Spring and early summer precipitation has been near normal. The July 24th National Weather Service Forecast indicated there is a 50 percent chance of the lake dropping to 1448.2 msl by the end of November. The highest water level currently experienced in 2018 was about 1450.2 msl on July 4. The water elevation for Devils Lake was 1448.9 msl on August 2, 2018; about 1.6 feet lower than the lake level one prior to that date (Table 16).

Table 16 Devils Lake Water Levels 2011-2018

Date	Elevation (msl)	Area (acres)	Volume (acre-feet)
June 27, 2011	1454.30	208,500	4.19 Million
Jan. 1, 2014	1452.3	185,000	3.77 million
June 29, 2014	1453.5	198,881	4.01 million
Jan. 1, 2015	1451.6	178,100	3.65 million
June 9, 2015	1452.0	182,244	3.72 million
January 1, 2016	1450.0	163,000	3.38 million
April 25, 2016	1450.3	165,566	3.42 million
January 1, 2017	1450.1	163,025	3.39 million
May 4, 2017	1451.7	179,138	3.67 million
January 1, 2018	1449.7	160,191	3.32 million
May 2018	1449.9	161,954	3.36 million
June 1, 2018	1449.7	160,191	3.32 million
July 4, 2018	1450.2	164,652	3.41 million
August 2, 2018	1448.9	153,417	3.20 million

State Emergency Outlets Project Update:

The west end outlet started operation on May 9, discharging at 125 cfs. It was shut down from May 15 to May 18 for a planned electrical preventive maintenance service. The west end outlet was at full capacity (250 cfs) on May 22. It continued operating at full capacity until June 21 when an electrical conduit was damaged on a construction site unrelated to the outlet. The resulting power interruption led to failure of a transformer at the Josephine pump station. This forced the west end outlet to operate at a reduced capacity (about 165 cfs) for several weeks. The final repairs were made during the week of July 16 while the outlet was shut down to perform seasonal canal maintenance. Operation of the west outlet returned to 250 cfs discharge on July 21.

Repair of the erosion on the downstream end of the east outlet terminal structure was completed on May 22. Discharge started on May 24, at 150 cfs. The east end outlet discharge varied between 80 cfs and 250 cfs throughout June and July, with an average of about 160 cfs. Operation of the east outlet was stopped on August 2 because of erosion damage at the outfall to the Tolna Coulee. It resumed operation on August 22,

The flow volumes from the east outlet have been managed, to mix with the discharge from the west outlet, to prevent exceedances of downstream water quality limitations. The following table (Table 17) summarizes the extent of discharge from the outlets through June 2018:

Table 17 Summary of Extent of Discharge from the Outlets in 2018

Month	Days Discharged		Average Discharge (cfs)		Monthly Volume (acre-feet)	
	West	East	West	East	West	East
May	22	10	119	40	7,337	2,472
June	30	30	229	200	13,633	11,904
July	29	31	199	135	12, 245	8,271
August						
Sept.						
Oct.						
Nov. 2017						
TOTAL					**33, 215**	**22, 647**

The following (Table 18) is a summary of the volume and inches of water removed from the lake since pumping was started in 2005 (based on the volume at the peak yearly elevation).

Table 18 Summary of the Volume and Inches of Water Removed Since 2005 (since pumping started)

Year	Volume Removed (acre-ft.)	Inches Removed (inches)
2005	38	0.0
2006	0	0.0
2007	298	0.02
2008	1,241	0.1
2009	27,653	2.0
2010	62,977	4.1
2011	46,911	2.7
2012	157,542	9.5
2013	141,783	8.3
2014	165,837	10.6
2015	171,234	11.3
2016	136,096	9.9
2017	131,872	9.5
2018		
TOTAL	**1,043,482**	**68.0**

Water Quality:

Samples are collected from 20 sites ranging from the Sheyenne River above the West Outlet discharge location, throughout the Sheyenne and Red Rivers, to the final sample location near Pembina. These samples are collaboratively collected by staff from the SWC, Garrison Diversion Conservancy District, and the USGS. The ND Department of Health Chemistry Lab tests the samples, and the results are used to adaptively manage the outlet operations within their permitted parameters. Water quality limitations have not been exceeded in the Upper Sheyenne River in 2018.

The June 2018 range of discharge, sulfate concentrations, and conductance at the outlets and at some locations on the Sheyenne River, are shown below (Figure 11).

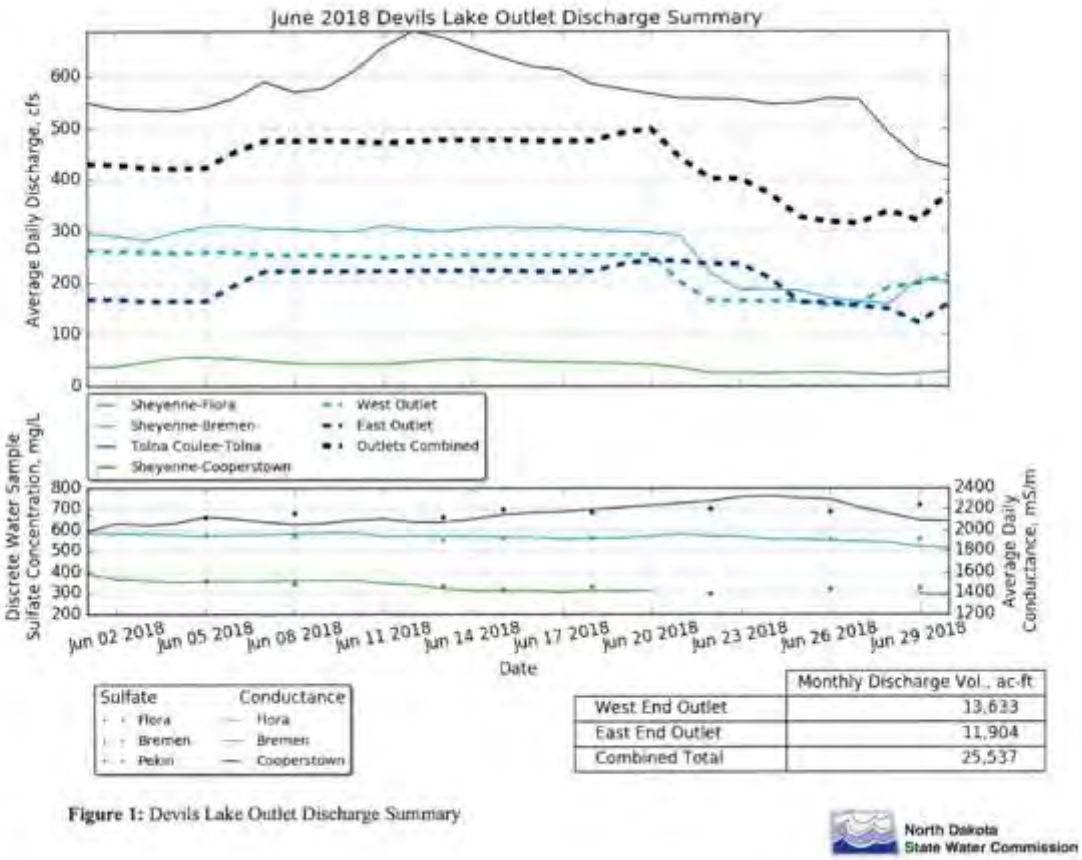


Figure 11 Range of Discharge and Sulphate Concentrations at Selected Locations in the Sheyenne River

Additional water quality information is available on the ND State Water Commission website and on the U.S. Geological Services website. Water surface elevations for Devils Lake are shown in Figures12 &13.

Devils Lake Outlet Management Advisory Committee:

The Devils Lake Outlet Management Advisory Committee met on April 18, 2018 in Carrington, North Dakota. Concerns of downstream water quality and quantity were discussed. This was balanced by upstream concerns that a lot of cropland is still under water. There was also discussion on what water elevation constitutes and emergency. Minutes indicate that the majority of members had agreed at the 2017 meeting to set a long-term goal of drawing the lake down to 1448 msl before operating parameters are re-evaluated by the Committee. Meeting minutes and the 2018 PowerPoint presentation are available on the State Water Commission website under Basins/Devils Lake/Outlets/Tolna Structure.

Figure 12 Devils Lake Historic Water Surface Elevations

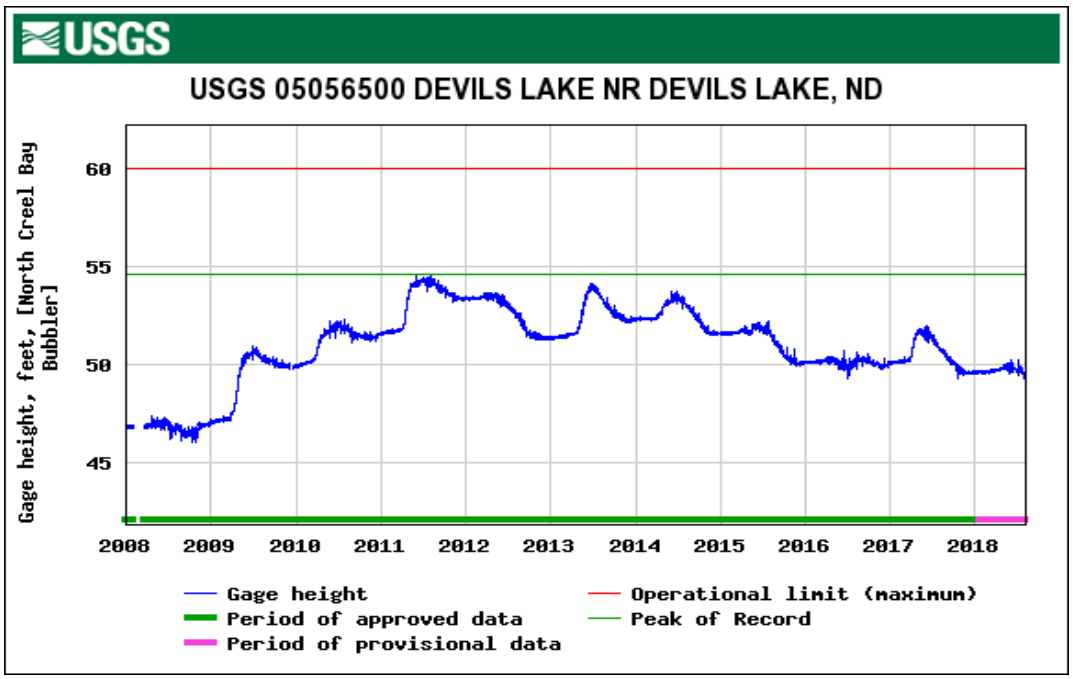


Figure 13 Devils Lake near Devils Lake Water Surface Elevations - 2008-2018

9.03 U.S. Army Corps of Engineers Flood Control Activities

Introduction

The U.S. Army Corps of Engineers (Corps) St. Paul District has a long history of involvement in water resource issues in the Red River of the North basin. The St. Paul District operates reservoirs for flood control, recreation, and environmental purposes.

The Corps works with other federal and state agencies, municipalities, local watershed districts, environmental groups, and local communities to address water resource problems and opportunities in the basin. The Corps also regulates work in navigable waters and other waters of the United States through the Omaha and St. Paul Districts for North Dakota and Minnesota respectively.

Currently, Corps activities in the basin include conducting flood risk management and ecosystem restoration studies, constructing flood risk management and ecosystem restoration projects, and providing emergency assistance and disaster response.

Current Construction Projects

Fargo-Moorhead Metropolitan Area Flood Risk Management Project
Fargo, North Dakota; Moorhead, Minnesota

The project was authorized in the Water Resources Reform and Development Act of 2014 and funded to begin construction in 2016. It includes building a 20,000 cubic feet per second diversion to the west of Fargo with upstream staging and storage. Once construction is complete, the diversion would operate for events larger than a 20-year flood event. The project will provide permanent flood protection to a metropolitan area of 230,000 people.

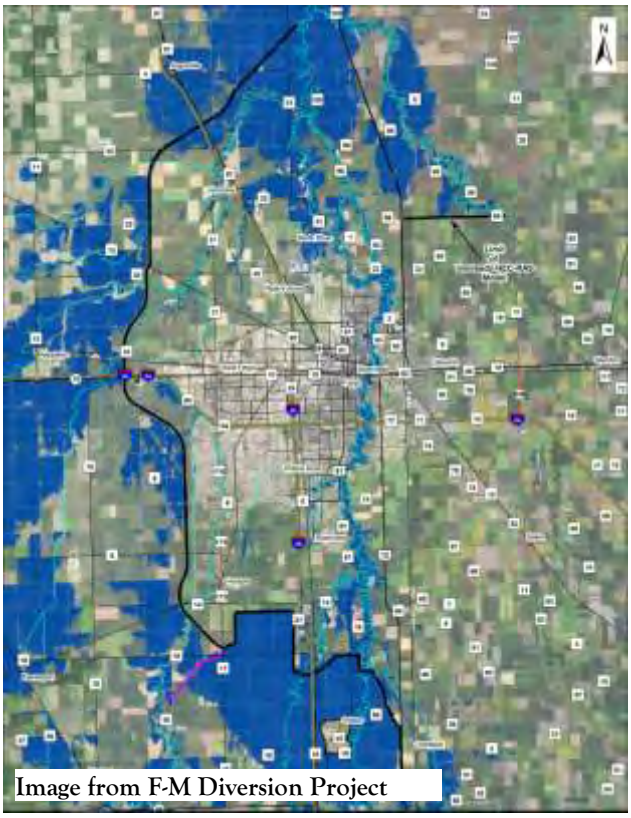


Image from F-M Diversion Project

The project is being implemented using a split delivery plan. Under this plan, the local sponsor constructs the diversion channel using a public-private partnership, and the Corps constructs the Southern Embankment or "dam" portion of the project. Federal construction began in the spring of 2017 with the diversion inlet structure. The sponsors issued a request for proposals in December 2016 for their portion of the project, and discussions were initiated with the three shortlisted teams.

Construction of the diversion inlet structure and negotiations for the diversion channel were suspended after a federal judge issued a temporary injunction on the project in September 2017. A revised plan, called "Plan B," was developed as a result of a Governors' Task Force. Environmental documentation for Plan B is under development and public review will begin in late summer 2018.

Drayton Dam Fish Passage Mitigation Project
Drayton, North Dakota

This aquatic ecosystem restoration project will provide fish passage and eliminate dangerous hydraulic conditions at Drayton Dam while maintaining the pool for water supply and bank stability. Construction plans involve replacing the existing dam and creating rock riffles. The project is being considered for implementation as mitigation for the Fargo-Moorhead Metropolitan Area Flood Risk Management Project. Construction is currently unscheduled.

Sand Hill River Fish Passage Project
Fertile, Minnesota

Between 1955 and 1958, the Corps completed a flood control project that straightened 18 miles of the Sand Hill River and installed four concrete drop structures. Although the project reduced the flood profile along the lower portion of the river, the drop structures left the river impassable for spawning fish and isolated the upper portion of the watershed.


Image from Houston Engineering,

Recently, at the request of the Sand Hill River Watershed District, the St. Paul District addressed fish passage on the Sand Hill River by completing a Section 1135 ecosystem restoration project. The four drop structures were replaced with rock slopes that allow fish migration. Construction was completed in the fall of 2017.

Devils Lake Embankment Project
Devils Lake, North Dakota

Devils Lake is a terminal lake in Devils Lake Basin, meaning water leaves Devils Lake through evapotranspiration or when its elevation is high enough to overflow the basin's boundary. Because Devils Lake typically does not have a natural outlet, it is subject to extreme variations in lake levels depending on changes in climate.

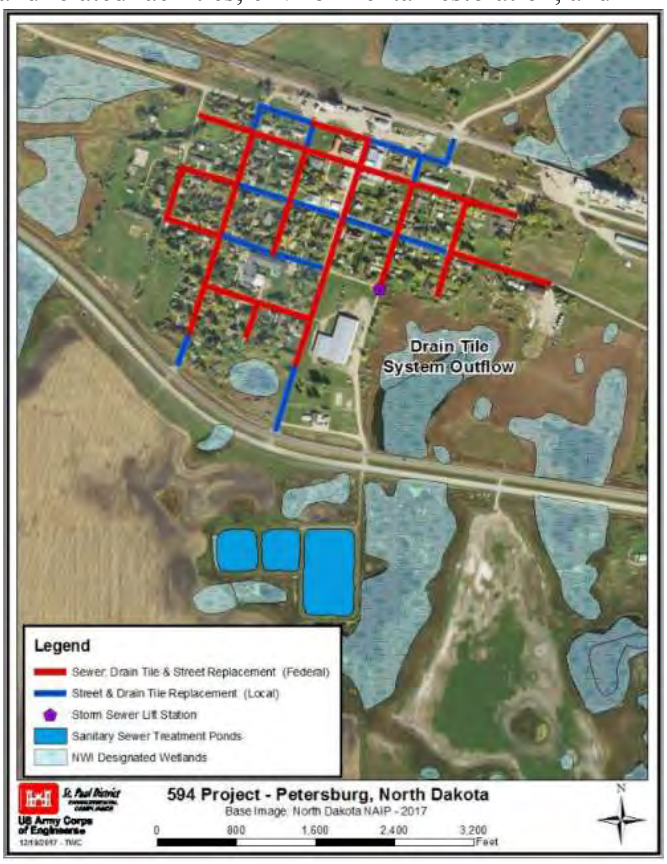

Image from

As of August 15, 2018, the lake is at elevation 1449.15 feet, down from its record elevation of 1454.30 feet in June 2011. The embankment construction is complete to a minimum elevation of 1466.00. The project was transitioned to the City of Devils Lake, North Dakota, on July 17, 2018.

North Dakota Environmental Infrastructure Program (Section 594)

The Corps is authorized to assist communities and rural areas in North Dakota under this program. The Corps provides design and construction assistance for wastewater treatment and related facilities; combined sewer overflow; water supply, storage, treatment, and related facilities; environmental restoration; and surface water resource protection and development.

Section 594 of the Water Resources Development Act of 1999, Public Law 106-53, as amended, authorizes the following sanitary sewer systems where the non-federal sponsor performs the work.



City of Petersburg Sanitary Sewer Service Replacement Project

The 1950s era sewer has significant deterioration, and the city could not afford the rehabilitation alone. Removing the current sanitary sewer could cause potential flooding. The city requested assistance from the Corps, which selected the city as the non-federal sponsor. New pipes, a lift station, and a drain tile system will be installed. In fiscal year 2017, the Section 594 program received $2,765,000 for this project. Construction of this project is ongoing.

Current Studies

Red River Basin-wide Feasibility Study

The study began in June 2008. The North Dakota Joint Water Resource District and the Minnesota Red River Watershed Management Board are the local sponsors. Products of the study include planning, data collection, hydrologic and hydraulic modeling, and development of a comprehensive watershed management plan (CWMP). The Corps, the Red River Basin Commission (RRBC), and local stakeholders and experts, including representatives from both the U.S and Canada, cooperatively developed the CWMP.

Building on the RRBC's 2005 Natural Resources Framework Plan, the CWMP contains recommendations for action in flood risk management and hydrology, aquatic and riparian ecosystem restoration, water quality, water supply and drought management, recreation, and soil health. The Corps, the RRBC, and federal, state, and local stakeholders can implement these actions.

The RRBC provided a letter of support in June 2017 for the federally implementable actions, which include de-authorization of two existing Corps channel projects. All elements of the basin-wide study will be completed in 2018.

Lower Otter Tail River Restoration Project
Breckenridge, Minnesota

Under the authority of Section 1135 of the Water Resources Development Act of 1986, the Corps is able to study and implement ecosystem restoration projects at existing Corps projects. In this case, the Corps constructed a flood control project in the 1950s that straightened and enlarged a portion of the Lower Otter Tail River between Orwell Dam and the city of Breckenridge, Minnesota. This reach of the Lower Otter Tail River is characterized by unstable banks, excessive sediment loading, and degraded in-stream and riparian habitats.

The St. Paul District and the Buffalo-Red River Watershed District (BRRWD) are currently completing a feasibility study on improving these environmental conditions of the Lower Otter Tail River while maintaining the originally authorized purpose of protecting adjacent lands from flood damages. Potential alternatives include constructing rock riffle structures to create diversified river pools and reconnecting river meanders that were cut off.

The Corps and the BRRWD should complete the feasibility study in 2019, which will identify a plan for achieving the project goals. Construction would likely begin no early than 2020, subject to availability of federal and local funds. The maximum federal contribution is limited to $10 million.

Upper Red River Watershed Wetland Restoration Prioritization Study
Minnesota

The Corps and the Minnesota Board of Water and Soil Resources are partnering to develop a comprehensive water resources plan which will identity and prioritize wetland restoration opportunities in the Upper Red River Watershed within Minnesota. The study is being conducted under the authority of Section 22 of the Water Resources Development Act of 1974 (Planning Assistance to States and Tribes).

The watershed faces significant natural resources challenges, including major losses of historic wetlands and stream alterations that have contributed to increased flooding, water quality impairments, and loss of habitat. Stakeholders have increased interest in conservation and regulatory decisions that consider the condition and needs of the watershed.

Using a stakeholder informed, geospatial approach, the study will develop a plan for prioritizing wetland restoration projects in the watershed. A series of stakeholder meetings are being planned for 2019 or 2020. A final plan is anticipated to be completed in 2020.

Ongoing Programs

Silver Jackets

The Corps has worked with the U.S. National Weather Service, the U.S. Geological Survey, and others on the placement of soil moisture and temperature instrument packages around the basin to provide detailed hydrologic parameters to improve spring flood forecasts. There is a project to update river gage datum to the current standard (NAVD 1988) and provide consistent elevations for the river stages across the basin.

Emergency Operations

During flood events in the Red River basin, the St. Paul District provides emergency assistance in support of the locally led flood response. The St. Paul District becomes part of a large force made up of local, state, and federal responders as well as volunteers.

9.04 USGS Water Resource Investigations and Activities

Streamflow for calendar year 2018 on the Red River in Grand Forks, North Dakota, was in the normal range except for a short period in late April to early May 2018, when the flows reached the above normal category, a result of snowmelt runoff. The graph below shows the trend in flows from January 1, 2017 to August 12, 2018.

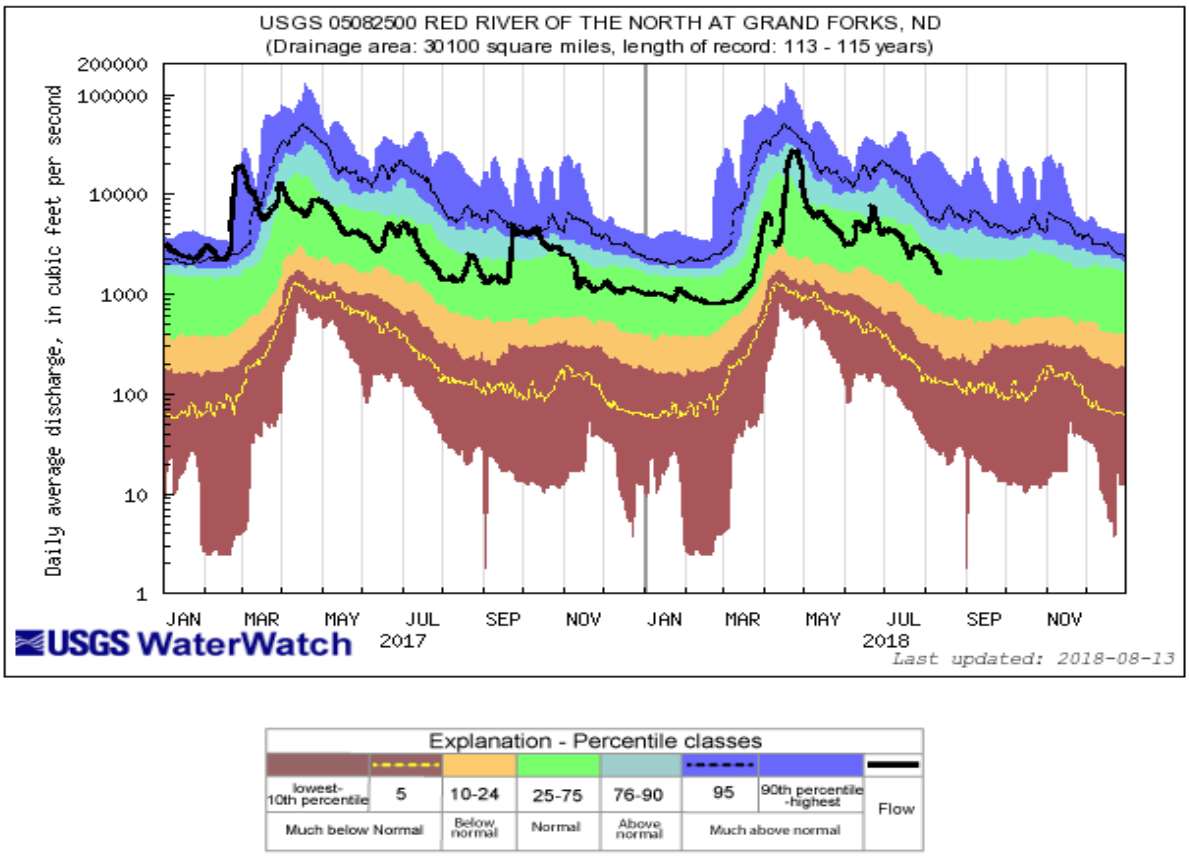


Figure 14 Red River Flows at Grand Forks

The Red River at Fargo crested on April 19 at 18.65 ft., with a peak discharge of 4,740 ft^3/s, (54th highest peak) for the 118 years of daily record. The exceedance probability for the spring peak was in the 0.20 to 0.10 range (5 - 10 year). The Red River at Grand Forks crested on April 24 at 34.99 ft. with a peak discharge of 28,000 ft^3/s (43rd highest peak) for the 136 years of peak flow record. The exceedance probability for the peak was in the 0.50 to 0.20 range (2 – 5 year). Spring runoff into Devils Lake was insignificant and did not cause an appreciable rise in lake level. The peak water level at Devils Lake occurred on July 4, at an elevation of 50.21 ft. The current water level (August 13, 2018) is around 49.20 ft. Withdrawals from Devils Lake began on May 24 from the East End Outlet (165 ft^3/s, increasing to 230 ft^3/s on June 6) and on May 9 from the West End Outlet (125 ft^3/s, increasing to 250 ft^3/s on May 22). The water level trend for Devils Lake can be seen in the graph shown below (Figure 15).

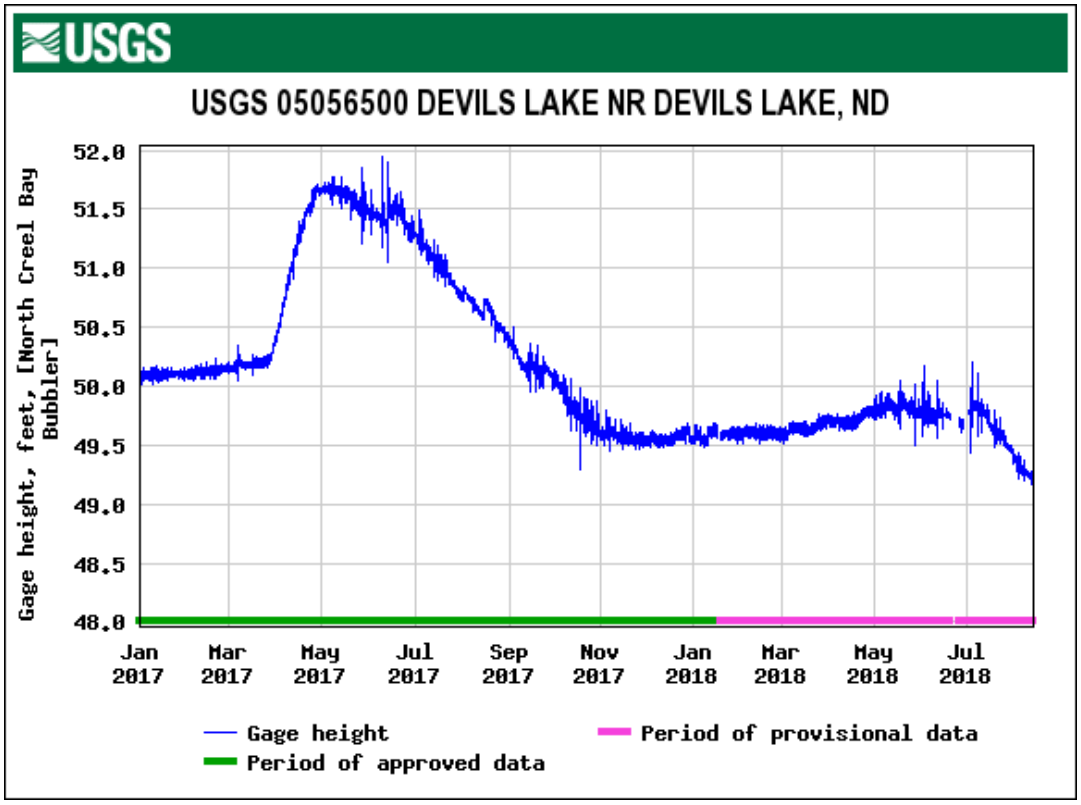


Figure 15 Devils Lake – Water Levels Trend

In the Red River Basin, the USGS Dakota Water Science Center works in cooperation with the U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, International Joint Commission, Manitoba Provincial Government, National Weather Service, North-Central River Forecast Center, Minnesota Department of Natural Resources, North Dakota State Water Commission, North Dakota Department of Health; U.S. Bureau of Indian Affairs, several water resource boards and districts; and other Federal, State and local water resources managers. Data and information shared among the agencies and offices helps in flood mitigation, water regulation, and water resource planning.

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APPENDIX A

DIRECTIVES TO THE INTERNATIONAL RED RIVER BOARD

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DIRECTIVE TO THE INTERNATIONAL RED RIVER BOARD

1. Pursuant to the Boundary Waters Treaty of 1909, responsibilities have been conferred on the Commission under a 1948 Reference from the governments of Canada and the United States with respect to the use and apportionment of the waters along, across, or in the vicinity of the international boundary from the eastern boundary of the Milk River drainage basin on the west up to and including the drainage basin of the Red River on the east, and under the May 1969 authorization from the governments to establish continuous supervision over the quality of the waters crossing the boundary in the Red River and to recommend amendments or additions to the objectives when considered warranted by the International Joint Commission.

2. This directive replaces previous directives and instructions provided by the International Joint Commission to the International Souris-Red Rivers Engineering Board, and in the February 8, 1995 Directive to the International Red River Pollution Board. This Directive consolidates the functions of those two former boards into one board, to be known as the International Red River Board (Board).

3. The Board's mandate is to assist the Commission in preventing and resolving transboundary disputes regarding the waters and aquatic ecosystem of the Red River and its tributaries and aquifers. This will be accomplished through the application of best available science and knowledge of the aquatic ecosystem of the basin and an awareness of the needs, expectations and capabilities of residents of the Red River basin.

4. The geographical scope of the Board's mandate shall be the Red River basin, excluding the Assiniboine and Souris Rivers. The Board's activities shall focus on those factors that affect the Red River's water quality, water quantity, levels and aquatic ecological integrity.

5. The Board's duties shall be to:

   A. Maintain an awareness of basin-wide development activities and conditions that may affect water levels and flows, water quality and the ecosystem health of the Red River and its transboundary tributaries and inform the Commission about transboundary issues.

   B. Provide a continuing forum for the identification, discussion and resolution of existing and water-related issues relevant to the Red River basin.

   C. Recommend appropriate strategies to the Commission concerning water quality, quantity and aquatic ecosystem health objectives in the basin.

   D. Maintain continuing surveillance and perform inspections, evaluations and assessments, as necessary, to determine compliance with objectives agreed to by governments for water quality, levels and quantity in the Red River basin.

   E. Encourage the appropriate regulatory and enforcement agencies to take steps to ensure that agreed objectives are met.

   F. Encourage the appropriate authorities, such as resource and emergency planning agencies, to establish and maintain contingency plans, including early warning procedures, for appropriate reporting and action on accidental discharges or spills, floods and droughts.

G. Monitor and report on flood preparedness and mitigation activities in the Red River basin and their potential effects on the transboundary aquatic ecosystems, and encourage and facilitate the development and maintenance of flood-related data information systems and flood forecasting and hydrodynamic models. In carrying out this responsibility, the Board shall:

   i. Monitor progress by the governments (federal, state, provincial, municipal) in implementing the recommendations of the Commission's report on the Red River basin flooding, and in maintaining and advancing the work of the Task Force's legacy projects, and to this end provide opportunities for the public to comment on the adequacy of such progress.

   ii. Encourage governments to develop and promote a culture of flood preparedness in the Red River valley.

   iii. Encourage government efforts to develop and implement a long-term strategy for flood mitigation emergency preparedness.

   iv. Encourage the sharing of accurate and timely transboundary information to support the development of improved flood forecasting techniques and procedures for early flood warnings and to improve communication of flood forecasts.

   v. Provide through the activities of the Board a forum for the exchange of best practices and for other flood-related information on preparedness, mitigation, response and recovery to assist in transboundary problem solving.

   vi. Promote the application of innovative technologies for supporting flood modeling and mapping.

   vii. Monitor the adequacy of data and information collection networks (meteorological, hydrometric, water quality) for flood preparedness, forecasting and mitigation, within the larger context of overall water management needs in the basin.

   viii. Monitor potential transboundary effects of flood mitigation and other works in the basin, and encourage cooperative studies necessary to examine these effects.

   ix. Encourage governments to integrate floodplain management activities in watershed and basin management.

   x. Interact with all levels of government to help decision-makers become aware of transboundary flood-related and associated water management issues.

   xi. Assist in facilitating a consultative process for resolution of the lower Pembina River Flooding issue.

H. Involve the public in the work of the Board, facilitate provision of timely and 'pertinent information within the basin in the most appropriate manner', including electronic information networks; and conduct an annual public meeting in the Red River basin.

I. Provide an annual report to the Commission, plus other reports as the Commission may request or the Board may feel appropriate in keeping with this Directive.

J. Maintain an awareness of the activities of other agencies and institutions, in the Red River basin.

6. The Board shall continue to report on the non-Red River geographic areas under the responsibility of the former International Souris-Red Rivers Engineering Board, including the Popular and Big Muddy basins, but excluding the Souris River basin until the Commission determines otherwise.

7. The Board shall have an equal number of members from each country. The Commission shall normally appoint each member for a three-year term. Members may serve for more than one term. Members shall act in their personal and professional capacity, and not as representatives of their countries, agencies or institutions. The Commission shall appoint one member from each country to serve as co-chairs of the Board. An alternate member may not act as a co-chair.

8. At the request of any members, the Commission may appoint an alternate member to act in the place of such member whenever the said member, for any reason, is not available to perform such duties as are required of the member.
9. The co-chairs of the Board shall be responsible for maintaining proper liaison between the Board and the Commission, and among the Board members. Chairs shall ensure that all members of the Board are informed of all instructions, inquiries, and authorizations received from the Commission and also activities undertaken by or on behalf of the Board, progress made, and any developments affecting such progress.

10. Each chair, after consulting the members of the Board, may appoint a secretary. Under the general supervision of the chair(s), the secretary (ies) shall carry out such duties as are assigned by the chairs or the Board as a whole.

11. The Board may establish such committees and working groups as may be required to discharge its responsibilities effectively. The Commission shall be kept informed of the duties and composition of any committee of working group. Unless other arrangements are made, members of the Board, committees or working groups will make their own arrangements for reimbursement of necessary expenditures.

12. The Commission should also be informed of the Board's plans and progress and of any developments or cost impediments, actual or anticipated, which are likely to affect carrying out the Board's responsibilities.

13. The Commission shall be informed, in advance, of plans for any public meetings or public involvement in the Board deliberations. The Board shall report in a timely manner, to the Commission on these meetings, including representations made to the board.

14. The Board shall provide the text of media releases and other public information materials to the Secretaries of the Commission for review by the Commission's Public Information Officers, prior to their release.

15. Reports, including annual reports and correspondence of the Board shall, normally, remain privileged and be available only to the Commission and to members of the Board and its committees until the Commission has authorized their release.

16. If, in the opinion of the Board or of any member, any instruction, directive, or authorization received from the Commission lacks clarity or precision, the matter shall be referred promptly to the Commission for appropriate action.

17. In the event of any unresolved disagreement among the members of the Board, the Board shall refer the matter forthwith to the Commission for decision.

18. The Commission may amend existing instructions or issue new instruction to the Board at any time.

APPENDIX B

B.1 WATER QUALITY OBJECTIVES

B.2 WATER QUALITY ALERT LEVELS

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B.1 WATER QUALITY OBJECTIVES

On October 1, 1964, the Governments of Canada and the United States submitted a reference to the IJC requesting an investigation of pollution in the waters crossing the International Boundary in the Red River pursuant to the provisions of Article IV of the Boundary Waters Treaty of 1909. Following receipt of the reference, the Commission established the International Red River Water Pollution Board on December 2, 1964, and appointed technical experts to the Board from both countries. The Commission provided detailed instructions to the Board in the form of a directive that asked that all relevant water quality information be examined, pollution sources identified and remedial measures determined. The International Red River Water Pollution Board conducted investigations from 1965 to 1966 and submitted a report to IJC in October 1967. The purpose of the water quality objectives and alert levels is to restore and maintain the chemical, physical, and biological integrity of the waters of the Red River. Five specific binational water quality objectives were adopted for the Red River at the international boundary in 1969.

The IJC conducted public hearings on April 11, 1968 and reported to the Governments on their findings, recommendations and conclusions. The key recommendation was that WQOs, as defined in the IJC report, be accepted by Governments. In letters dated May 13 and 14, 1967, the Governments informed the Commission that the recommendations contained in the Commission's report to Governments were accepted and approved. The two Governments specifically authorized the Commission to establish continuous supervision over the quality of waters in the Red River crossing the International Boundary and to recommend amendments or additions to the objectives when warranted by the Commission. IJC recommended the establishment of WQOs for a limited number of variables at the boundary on April 11, 1968 and governments on May 4, 1969 approved the recommendation. Shortly after, the Commission established the International Red River Pollution Board on June 10, 1969.

Water quality objectives are used when necessary to secure government commitment to pollution abatement action. Compliance with the objectives is the primary means by which the International Red River Board identifies major water quality issues to the IJC.

The term “exceedance” is used to describe a situation where an objective is not met. A situation is classified as an exceedance if an individual instantaneous sample, obtained from the continuous auto- monitor, or through a grab sample, is equal to or greater than the corresponding water quality objective (except for dissolved oxygen, which must be observed to be equal to or less than the objective). The five specific parameters and corresponding objective are listed below.

E. Coli	200 colonies/100 ml
Chloride	100 mg/L
Sulphate	250 mg/L
Total Dissolved Solids	500 mg/L
Dissolved Oxygen	5 mg/L

B.2 WATER QUALITY ALERT LEVELS

Water quality alert levels are used to complement water quality objectives. If exceeded, alert levels will trigger investigative action on the part of the IRRB or its representatives. The exceedance is addressed in terms of its magnitude, implications to water uses and possible resolutions. On the basis of alert level exceedances and subsequent investigations, the IRRB may advance proposals for additional objectives.

A working group developed water quality alert levels, for a wide range of parameters, in addition to the five specific parameters noted above, in 1985. The predecessor International Red River Pollution Board approved these alert levels in January 1986. The alert levels that are currently in effect are listed in the following table. Further, the table provides a comparison of alert levels with the North Dakota and Minnesota Water Quality Standards, and with the Manitoba Water Quality Objectives as of 1990. The table has not been updated to reflect recent state and provincial revisions. The IRRB Aquatic Ecosystem Committee established by the IRRB in June 2001 will be reviewing the issue of objectives and alert levels with respect to monitoring requirements, analytical methodologies, and reporting protocols.

COMPARISON OF WATER QUALITY ALERT LEVEL STANDARDS AND OBJECTIVES - August 20, 1990

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
Fecal Coliform	200/100 ml geometric mean 10% of samples not to exceed 2,000 based on a minimum of 5 samples in a 30 day period from Mar. 1 – Oct. 31. HH*	200 fecal coliforms per 100 ml. This standard shall apply only during the recreation season, May 1 to September 30. HH	100/100 ml. At least 90% of samples in any consecutive 30 day period should have a fecal coliform density of less than 100 per 100 ml. HH	200/100 ml geometric mean with 10% of samples not to exceed 400 based on min. 5 samples – 30 day period – May 1 – Oct. 31 and for the balance of year not to exceed 1000/100 ml. Current IJC objective.	Minnesota and North Dakota based on primary body contact recreation.
Chloride	100 mg/l (total) ID	100 mg/l (total) ID	100 mg/l (soluble) ID	100 mg/l (dissolved) Current IJC Objective	All agencies based on industrial consumption.
Sulfate	250 mg/l (total) DW	250 mg/l (total) DW	250 mg/l (dissolved) DW	250 mg/l (total) Current IJC Objective	All agencies based on domestic consumption.
TDS	500 mg/l DW	None	500 mg/l DW	500 mg/l Current IJC Objective	All agencies, excluding North Dakota based on domestic consumption.
Dissolved Oxygen	5 mg/l (minimum)	5 mg/l (minimum)	47% saturation or more.	5 mg/l (minimum) Current IJC Objective	All agencies for the protection of aquatic life.
Chemical Characteristics					

- DW – Drinking Water
- HH – Human Health
- AL – Aquatic Life
- ID – Industrial Consumption
- IR - Irrigation

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
pH	6.5 - 9.0 AL	7.0 - 9.0 AL	6.5 – 9.0 AL	6.5 - 9.0	All agencies based on protection of aquatic life.
Dissolved Gas					
Ammonia-N	.04 mg/l as N unionized (warm water) Al	Unionized as N (dissolved). Calculation from standards. See page 8-10. AL	Variable, ranging from 0.0184 to 0.050 mg/l ammonia as NH_3.*		Minnesota and North Dakota for the protection of aquatic life.
Metals (Total)					
Aluminum	Total 125 µg/l AL	None	None	None	Minnesota for the protection of aquatic life.
Cadmium	Total The chronic standard shall not exceed: e [0.7852 {ln (total hardness mg/l)} – 3.49]. For hardness values greater than 400 mg/l, 400 mg/l shall be used in the calculation of the standard. Cadmium standards in µg/l at various hardness values: 50 mg/l hardness = 0.66 µg/l, 100 mg/l hardness = 1.1 µg/l, 200 mg/l hardness = 2.0 µg/l AL	Total The one-hour average, concentration in µg/l cannot exceed the numerical value given by e [1.128{ln(hardness as mg/l)} –3.828] more than once every 3 years on the average. AL The four day average concentration in µg/l cannot exceed the numerical value given by e [.7852{ln(hardness as mg/l)} –3.490] more than once every 3 years on the average.	e [0.7852 {ln(hardness as mg/l)} –3.49], where hardness is expressed in mg/l $CaCO_3$ and the resultant objective is expressed in µg/l. (e.g.) 50 mg/l $CaCO_3$ = 0.66 µg/l, 100 mg/l $CaCO_3$ = 1.1µg/l, 200 mg/l $CaCO_3$ = 2.0 µg/l. AL	Less than detection.	Minnesota and Manitoba for the protection of aquatic life and wildlife.
Chromium	None	Total 50 µg/l DW	e [0.8190 {ln (hardness)} +1.561], where hardness is expressed in mg/l $CaCO_3$ and the resultant objectives	50 µg/l	North Dakota based on domestic consumption.

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
			is expressed in µg/l. (e.g.) 50 mg/l $CaCO_3$ = 120 µg/l, 100 mg/l $CaCO_3$ = 210 µg/l, 200 mg/l $CaCO_3$ = 370 µg/l.		
Chromium, Trivalent	Total The chronic standard shall not exceed: exp. [0.819{ln (total hardness mg/l}+ 1.561]. For hardness values greater than 400 mg/l, 400 mg/l shall be used in the calculation of the standard. Chromium +3 standards in µg/l at various hardness values: 50 mg/l hardness = 117 µg/l, 100 mg/l hardness = 207 µg/l, 200 mg/l hardness = 365 µg/l. AL	None	e [0.8190 {ln (hardness)} +1.561], where hardness is expressed in mg/l $CaCO_3$ and the resultant objectives is expressed in µg/l. (e.g.) 50 mg/l $CaCO_3$ = 120 µg/l, 100 mg/l $CaCO_3$ = 210 µg/l, 200 mg/l $CaCO_3$ = 370 µg/l.. AL	None	Manitoba and Minnesota for the protection of aquatic life.
Chromium, Hexavalent	Total The chronic standard is 11 µg/l AL	None	11 µg/l AL	None	Manitoba and Minnesota for the protection of aquatic life.

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
Copper	Total The chronic standard shall not exceed: exp. [0.62 {ln (total hardness mg/l}) -0.57]. For hardness values greater than 400 mg/l, 400 mg/l shall be used in the calculation of the standard. Copper standards in µg/l at various harness values: 50 mg/l hardness = 6.4 µg/l, 100 mg/l hardness = 9.8 µg/l, 200 mg/l hardness = 15 µg/l . AL	Total The one-hour average concentration in µg/l cannot exceed the numerical value given by e[.9422{1n (hardness as mg/l})-1.464] more than once every 3 years on the average. The four-day average concentration in µg/l cannot exceed the numerical value given by e [8545{ln (hardness as mg/l)} –1.465] more than once every 3 years on the average. AL	e[0.8545{ln(hardness)}-1.465], where hardness is expressed in mg/l $CaCO_3$ and the resultant objective is expressed in µg/l. (e.g.) 50 mg/l $CaCO_3$ = 6.5 µg/l., 100 mg/l $CaCO_3$ = 12 µg/l, 200 mg/l $CaCO_3$ = 21 µg/l.		Minnesota and Manitoba for the protection of aquatic life.
Iron	300 µg/l DW	None	300 µg/l DW	300 µg/l	Minnesota, Manitoba based on domestic consumption.
Lead	Total The chronic standard shall not exceed: exp. [1.273{ln (total hardness mg/l)}-4.705]. For hardness values greater than 400 mg/l, 400 mg/l shall be used in the calculation of the standard. Lead standards in µg/l at various hardness values: 50 mg/l hardness = 1.3 µg/l 100 mg/l hardness = 3.2 µg/l 200 mg/l hardness = 7.7 µg/l AL	Total The one-hour average concentration in µg/l cannot exceed the numerical value given by e [1.266{In (hardness as mg/l) - 1.416] more than once every 3 years on the average. The four-day average concentration in µg/l cannot exceed the numerical value given by e (1.266{ln (hardness as mg/l) - 4.661) more than once every 3 years on the average. AL	e [1.273{ln (hardness)} - 4.705], where hardness is expressed in µg/l $CaCO_3$ and the resultant objective is expressed in µg/l. (e.g.) 50 mg/l $CaCO_3$ = 1.3 µg/l, 100 mg/l $CaCO_3$ = 3.2 µg/l, 200 mg/l $CaCO_3$ = 7.7 µg/l,		Manitoba, Minnesota and North Dakota for the protection of aquatic life and wildlife.
Manganese	50 µg/l DW	None	50 µg/l DW	50 µg/l	Minnesota and Manitoba based on domestic consumption.
Mercury	Total	Total	Acid soluble mercury	Less than detection in water.	Minnesota, North Dakota and Manitoba for

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
	0.0069 µg/l AL	Acute 2.4 µg/l Chronic 0.012 µg/l AL	0.006 µg/l	0.5 micrograms per gram in fish fillets.	protection of aquatic life, animal life and humans as a result of bio concentrations in tissue in the food chain.
Nickel	Total The chronic standard (CS) shall not exceed the human health-based criterion of 88 µg/l. For waters with total hardness values less than 50 mg/l, the CS shall not exceed: exp. [0.846{ln(total hardness mg/l)} + 1.1645]. AL and HH	None	e [0.76{ln(hardness)} None +1.06], where hardness is expressed in mg/l) $CaCO_3$ and the resultant objective is expressed in µg/l (e.g.) 50 mg/l $CaCO_3$ = 56 µg/l, 100 mg/l $CaCO_3$ = 96 µg/l, 200 mg/l $CaCO_3$ = 160 µg/l, AL	None	Minnesota for the protection of aquatic life and human health. Manitoba for the protection of aquatic life.
Selenium	Total 5 µg/l AL	10 µg/l DW	10 µg/l DW	10 µg/l	Manitoba and North Dakota based on domestic consumption. Minnesota for the protection of aquatic life.
Silver	Total The chronic standard shall not exceed 1.0 µg/l. AL	The one-hour average concentration in µg/l cannot exceed the numerical value given by e [1.72{ln(hardness)} as mg/l)}-6.52] more than once every three years on the average. AL	0.1 µg/l AL	None	Manitoba, Minnesota and North Dakota for protection of aquatic life.
Zinc	Total The chronic standard shall not exceed: exp. [0.8473{ln(total hardness mg/l)} + 0.7615], For hardness values greater than 400 mg/l, 400 mg/l shall	Total The one-hour average concentration in µg/l cannot exceed the numerical value given by e [.8473{ln(hardness as	47 µg/l AL	47 µg/l	Minnesota, North Dakota and Manitoba for the protection of aquatic life.

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
	be used in the calculation of the standard. Zinc standards in µg/l at various hardness values: 50 mg/l hardness = 59 µg/l 100 mg/l hardness = 106 µg/l 200 mg/l hardness = 191 µg/l AL	mg/l)} +.8604] more than one every 3 years on the average. The four-day average concentration in µg/l cannot exceed the numerical value given by e [.8473 {ln(hardness as mg/l})+.7614] more than once every 3 years on the average. AL			
Nutrients					
Nitrates (N)	Total 10 mg/l DW	Dissolved 1.0 mg/l DW	Total 10 mg/l DW	Total 10 mg/l	Minnesota and Manitoba based on domestic consumption.
Toxic Substances					
Arsenic	Total 50 µg/l DW and AL	Total 50 µg/l DW	Acid soluble arsenic 50 µg/l DW	Total 10 µg/l (under review)	Minnesota based on domestic consumption and for protection of aquatic life.
Boron	500 µg/l IR	750 µg/l IR	500 µg/l IR	Total 500 µg/l	Minnesota, Manitoba based on irrigation water.
Chlorine	Total residual 6 µg/l	None	None	None	Minnesota for protection of aquatic life.
Cyanide	Free cyanide 5.2 µg/l AL	Total 5 µg/l AL	Free cyanide 5.2 µg/l cyanide AL	Total 5 µg/l	Minnesota and North Dakota for protection of aquatic life.
Dioxin	None	None	None	Not detectable in any media analyzing to parts per trillion.	Task Force

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
PCBs	Total 0.000029 µg/l AL and HH	Total Acute 2.0 µg/l Chronic 0.014 µg/l AL	.014 µg/l AL	Not detectable in water, in fish total PCBs not exceeding 2 micrograms per gram in fillets.	Body burden: Manitoba, North Dakota and Minnesota for protection of aquatic life, animal life and human life.
Phenolics	None	None	1 µg/l DW	10 µg/l	North Dakota to protect against taste and odor in water and fish.
Phenol	123 µg/l AL	Total 10 µg/l DW	1.0 µg/l 2.0 AL	None	North Dakota to protect against taste and odor in water and fish.
Pentachlorophenol	The chronic standard shall not exceed: exp.[1.005{pH} – 5 .290]. Pentachlorophenol standards in µg/l at, various pH values: pH 7.0 = 5.7 µg/l, pH 7.5 = 9.5 µg/l, pH 8.0 = 16 µg/l. AL	Acute 20.0 µg/l Chronic 13.0 µg/l AL	0.06 mg/l DW	None	Minnesota and North Dakota for the protection of aquatic life. Manitoba based on domestic consumption.
Pesticides and Volatile Hydrocarbons	Acenapthene 12 µg/l Acrylonitrile 0.38 µg/l Anthracene 0.029 µg/l Benzene 6.9 µg/l Bromoform 128 µg/l Carbon Tetrachloride 1.9 µg/l Chlordane 0.00029 µg/l Chlorobenzene 10 µg/l Chloroform 55 µg/l Chlorpyrifos 0.041 µg/l	Aldrin (total) Acute 3.0 µg/l Chlordane (total) Acute 2.4 µg/l Chronic 0.0043 µg/l Dieldrin (total) Acute 2.5 µg/l Chronic .002 µg/l Endosulfan (total) Acute .22 µg/l Chronic .06 µg/l	Aldicarb 0.009 mg/l Aldrin + Dieldrin 0.0007 mg/l Atrazine 0.06 mg/l Azinphos-methyl 0.02 mg/l Bendiocarb 0.04 mg/l	Not detectable in water**	All agencies for the protection of aquatic life, animal life domestic consumption and human health.

** Limits in fish tissue are being researched by the Task Force.
Tissue samples have been collected by North Dakota and Manitoba.

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
	DDT 0.0017 µg/l 1,2-Dichloroethane 3.8 µg/l Dieldrin 0.000026 µg/l Di-2-Ethylhexyl phthalate 1.9 µg/l Di-n-Octyl phthalate 30 µg/l Endosulfan 0.15 µg/l Endrin 0.016 µg/l Ethylbenzene 68 µg/l Fluoranthene 4.1 µg/l Heptachlor 0.00039 µg/l Heptachlor epoxide 0.00048 µg/l Hexachlorobenzene 0.00022 µg/l Lindane 0.032 µg/l Methylene chloride 46 µg/l Parathion 0.013 µg/l Phenanthrene 2.1 µg/l 1,1,2,2-Tetrachloroethane 1.54 µg/l Tetrachloroethylene 3.8 µg/l 1,1,1-Trichloroethane 263µg/l 1,1,2-Trichloroethylene25µg/l 2,4,6-Trichlorophenol 2.0µg/l Toluene 253 µg/l Toxaphene 0.0013 µg/l Vinyl Chloride 0.15 µg/l Xylene(total m, p and o) 166 µg/l	(continued) Endrin (total) Acute .18 µg/l Chronic .0023 µg/l Heptachlor (total) Acute .52 µg/l Chronic .004 µg/l Lindane (Hexachlorocyclohexane) Acute 2.0 µg/l Chronic .06 µg/l Toxaphene (total) Acute .73 µg/l Chronic .0002 µg/l AL	Benzene 0.005 mg/l Benzo (a) pyrene 0.00001 mg/l Bromoxynil 0.005 mg/l Carbaryl 0.09 mg/l Carbofuran 0.09 mg/l Carbon tetrachloride 0.005 mg/l Chlordane 0.0043 µg/l Chlorpyrifos 0.09 mg/l Cyanazine 0.01 mg/l Diazinon 0.02 mg/l Dicamba 0.12 mg/l 1,2-Dichlorobenzene 0.2 mg/l 1,4-Dichlorobenzene 0.005 mg/l DDT and metabolites 0.001 µg/l 1,2-Dichloroethane 0.005 mg/l Dichloromethane 0.05 mg/l 2,4-Dichlorophenol 0.9 mg/l 2,4-D – 0.9 mg/l (continued) Diclofop-methyl 0.009 mg/l		

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
			Dieldrin – 0.0019 µg/l Dimethoate – 0.02 mg/l Diquat – 0.07 mg/l Diuron – 0.15 mg/l Endosulfan – 0.056 µg/l Endrin – 0.0023 µg/l Glyphosate – 0.18 mg/l Heptachlor and heptachlor epoxides – 0.0038 µg/l Hexachlorobutadiene 0.1 µg/l Lindane – 0.080 µg/l Malathion – 0.19 mg/l Methoxychlor – 0.9 mg/l Metribuzin – 0.08 mg/l Monochlorobenzene 0.08 mg/l Nitrilotriacetic acid 0.05 mg/l Paraquat – 0.01 mg/l Parathion – 0.05 mg/l Phthalic acid esters: Dibutylphthalate–4.0 µg/l Dii-(2-ethylhexyl) phthalate 0.6 µg/l other phthalates –0.2 µg/l Phorate – 0.002 mg/l Picloram – 0.19 mg/l Polychlorinated biphenyls 0.014 µg/l Simazine – 0.01 mg/l Temephos – 0.28 mg/l Terbufos – 0.001 mg/l (continued) 2,3,4,6-Tetrachlorophenol 0.1mg/l Toxaphene – 0.013 µg/l Triallate – 0.23 mg/l Trichloroethylene		

Parameter	Minnesota Standards	North Dakota Standards	Manitoba Objectives	Red River Pollution Board Objectives	Origin/ Rational
			0.05 mg/l 2,4,6-Trichlorophenol 0.005 mg/l 2,4,5-T – 0.28 mg/l Trifluralin – 0.045 mg/l Trihalomethanes 0.35 mg/l DW and AL		
Oil and Grease	500 µg/l HH	No visible film or sheen upon the waters.	Free from oil and grease residues which cause a visible film or sheen upon the waters or any discolouration of the surface of adjoining shorelines, or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines.	No visible sheen on the surface.	All agencies based on aesthetics, taste and odor in water and fish, and bathing.

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APPENDIX C

WATER POLLUTION CONTROL CONTINGENCY

PLAN LIST OF CONTACTS

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Notification List
For D.O. Depletions, Non-toxic, Oil, and Toxic Spills

United States:

Minnesota Pollution Control Agency – Detroit Lakes, MN

Jim Ziegler - (218) 856-0730 (office) State Duty officer
(218) 846-0719 Fax
1-800-422-0798 (24-hr) State Duty officer

Minnesota Department of Natural Resources – Bemidji, MN (Fisheries)

Marilyn Danks - (651) 259-5087 (office – primary contact Central Office St. Paul)
Henry Drewes - (218) 308 -2633 (office – secondary contact Bemidji office)
1-800- 422-0798 (24-hr National Response Center)

North Dakota Health Department – Bismarck, ND

David Glatt - (701) 328-5210 (office)
Mike Ell - (701) 328 -5214 (office)
(701) 328-5200 fax
1-800-472-2121 (24-hr in-state-ask for REACT Officer)
(701) 328-9921 (24-hr out-of-state - ask for REACT Officer)

Environmental Protection Agency – Denver, CO

Bert Garcia - (303) 312-6670 office
Eric Steinhaus - (303) 312 -8637 (office-alternate contact)
(303) 312-7206 fax
1-800-424- 8802 (24-hr National Response Center)

Canada:

Manitoba Sustainable Development – Winnipeg, MB

Spills - (204) 944-4888 (24-hr telephone service emergency number)

Exceedance - Nicole Armstrong – nicole.armstrong@gov.mb.ca

Environment and Climate Change Canada – Winnipeg, MB

Ute Holweger - (204) 983 – 9832 (office)
(204) 984 – 6683 (fax)
(204) 294 – 5128 (cell)

Environment and Climate Change Canada – Regina, SK

Girma Sahlu - (306) 780 – 6425 (office)
(306) 780 - 6466 (fax)

APPENDIX D

HYDROLOGY COMMITTEE, AQUATIC ECOSYSTEM COMMITTEE, AND WATER QUALITY COMMITTEE MEMBERSHIP LIST

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International Red River Board
Hydrology Committee Membership:

NAME	AGENCY	ADDRESS	PHONE #	E-MAIL
Mark Lee	Manitoba Sustainable Development	200 Saulteaux Cres. Winnipeg, MB R3J 3W3	(204) 945-5606 (o) (204) 391-1623 (c)	mark.lee@gov.mb.ca
Stella Fedeniuk	Agriculture and Agri-Food Canada	2701 Grand Valley Road, P.O. Box 1000A R.R. #3 Brandon, MB R7A 5Y3	(204) 578-6637	Stella.Fedeniuk@agr.gc.ca
Dr. Haitham Ghamry	Fisheries and Oceans Canada	501 University Crescent Winnipeg, Manitoba R3T 2N6	(204) 983-5206	Haitham.Ghamry@dfo-mpo.gc.ca
Bruce Davison	National Hydrological Services Environment and Climate Change Canada	11 Innovation Blvd Saskatoon, Saskatchewan S7N 3H5	(306) 975-5788	bruce.davison@canada.ca
Steven M. Robinson	U. S. Geological Survey	821 East Interstate Avenue Bismarck, ND 58503	(701) 250-7404 (o) (701) 595-9153 (c)	smrobins@usgs.gov
Bob White	North Dakota State Water Commission	900 E Boulevard Avenue Bismarck, ND 58505	(701) 328-2756	bwhite@nd.gov
Dan Thul	Minnesota Dept of Natural Resources	2532 Hanna Ave. Box, 9 Bemidji, MN 56601	(218) 308-2463	dan.thul@state.mn.us
Randy Gjestvang	North Dakota State Water Commission	1120 28th Avenue N., Suite C Fargo, ND 58102	(701) 282-2318 (o) (701) 390-3578 (c)	rgjestvang@nd.gov
Rebecca Seal-Soileau	US Army Corps of Engineers	180 East Fifth Street, Suite 700 Saint Paul, MN, 55101	(651) 290-5631	Rebecca.s.soileau@usace.army.mil

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International Red River Board
Aquatic Ecosystem Committee Membership:

Name	Organization	Phone	Email
Patricia Ramlal	Fisheries and Oceans Canada	204-983-5173	Patricia.Ramlal@dfo-mpo.gc.ca
Maureen Gallagher	US Fish and Wildlife Service	303-236-4304	maureen_gallagher@fws.gov
Luther Aadland	Minnesota Department of Natural Resources	218-739-7576 ext. 235	luther.aadland@state.mn.us
Todd Caspers	North Dakota Game and Fish Department	701-739-6869	tcaspers@nd.gov
Eva Enders	Fisheries and Oceans Canada	204-984-4653	Eva.Enders@dfo-mpo.gc.ca
Amanda Hillman	Minnesota Department of Natural Resources	218-739-7576 ext. 276	amanda.hillman@state.mn.us
Geoff Klein	Manitoba Sustainable Development, Fisheries Branch	204-945-5206	Geoff.Klein@gov.mb.ca
Aaron Larsen	North Dakota Department of Health, Environmental Health Section	701-328-5230	allarsen@nd.gov
Jeff Long	Manitoba Sustainable Development, Fisheries Branch	204 945-7801	Jeff.Long@gov.mb.ca
Doug Watkinson	Fisheries and Oceans Canada	204-983-3610	Doug.Watkinson@dfo-mpo.gc.ca
Jamieson Wendel	Minnesota Department of Natural Resources	218-846-8340	jamison.wendel@state.mn.us

International Red River Board
Water Quality Committee
Membership:

Name	Organization	Phone	E-mail
Jim Ziegler, (Co-chair)	Minnesota Pollution Control Agency	(218) 846-8102	Jim.Ziegler@state.mn.us
Nicole Armstrong, (Co-Chair)	Manitoba Conservation and Water Stewardship	(204) 945-3991	nicole.armstrong@gov.mb.ca
Mike Ell	North Dakota State Department of Health	(701) 328-5214	mell@nd.gov
Mike Vavricka	MPCA/Detroit Lakes	(218) 846-8137	michael.vavricka@state.mn.us
Leah Thvedt	RRBC/Moorhead	(218) 291-0422	leah@redriverbasincommission.org
Rochelle Nustad	USGS	(701) 231-9747	ranustad@usgs.gov
Eric Steinhaus	US EPA	(303) 312-6837	Steinhaus.Eric@epa.gov
Sharon Reedyk	Agriculture and Agri-Food Canada	(708) 495-5965	Sharon.Reedyk@AGR.GC.CA
Mike Vavricka	MPCA/Detroit Lakes	(218) 846-8137	michael.vavricka@state.mn.us
Iris Griffin	Environment Canada	(204) 984-5694	iris.griffin@canada.ca
Rob Sip	MN Dept. of Agriculture	(218) 784-9501	rob.sip@rrwmb.org
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Wills Goill	Natural Resources Conservation Service		
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