IRRB

THE

INTERNATIONAL RED RIVER BOARD

Seventeenth Annual

Progress Report

October 2016

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 Seventeenth 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 2014 Water Year (October 01, 2014 through September 30, 2015). In addition, this report describes the activities of the International Red River Board during the reporting period October 01, 2015 to September 30, 2016 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

Fall/Winter 2014/2015

Flows were "above normal" to "much above normal" into the winter freeze-up. The Antecedent Precipitation Index and soil moisture measurements indicated moisture conditions were below normal heading into the winter freeze-up. The API is a comparison of the precipitation from May to freeze-up of the current year to the historical record. Flows over the 2014/2015 winter period continued to be "above normal" to "much above normal" at Emerson.

In the US portion of the basin, stream flows for much of the Red River Basin were at near normal levels. In late winter, the U.S. Drought monitor was reporting abnormally dry conditions for the last six months for the U.S. portion of the basin.

Spring 2015

The spring freshet occurred a few weeks earlier than normal. Flooding did not occur on any Canadian tributaries. In the US portion of the basin, most streams did not reach minor flood stage as a deep frost layer, below normal soil moisture, and a much below normal snowpack led to below normal river levels in April (10-24th percentile) as no significant snow melt runoff developed.

The Red River peaked at Emerson on March 20th at a flow of 8500 cfs (240 m^3/s). This peak flow is well below flood stage and has been exceeded approximately in 80 % of the years in the historical record. In Winnipeg, the Red River peak on March 22nd at approximately 7.5 ft (James Avenue datum), approximately 1 ft below the walkway level and well below flood stage of 18.0 ft.

Very dry conditions were experienced throughout the basin during spring. After the spring freshet the river declined to just under 2000 cfs (57 m^3/s) at Emerson. The wildfire risk was very high in the basin. A few wild fires and dust storms occurred on the Canadian side of the border. Burning bans and other restrictions were put into place by the province and municipalities. Some irrigators on the intermittent tributaries in Canada had difficulty filling their off-channel reservoirs until rains in mid-May provided enough stream flow to complete reservoir filling. In mid-April smoke from multiple grass fires in North Dakota caused reduced visibility and led to the closure of I29 from Grand Forks to the Canadian border. Governor Jack Dalrymple declared a fire emergency on April 1st. A statewide burn ban was put into effect.

Significant rainfall in mid-May ended the drought conditions. The main stem quickly rose from "below normal" to "above normal" by the end of May. The peak flow as a result of the May rain was higher than the spring peak. The Red River in Winnipeg crested at 14.2 ft (James Avenue datum) on May 21st. The highest flow recorded at Emerson for the year was 18,900 cfs (535 m^3/s) on May 23rd (Figure 1). The Red River Floodway was not operated in 2015.

Summer 2015

In the US portion of the basin, April was followed by an active weather pattern that subsequently produced peaks at or above the spring levels for many stream gauges and led to overall conditions in the above normal range for most stream gauges this summer. The Red River at Grand Forks crested on June 5 at 22.97 ft. with a peak discharge of 14,800 cfs (420 m^3/s), which is the 56th highest peak for the 134 years of record.

After the flows on the main stem increased in response to the mid-May rains, the additional precipitation maintained flows in the "above normal" range throughout the summer.

Fall/Winter 2015

The Antecedent Precipitation Index (API) and soil moisture measurements indicated moisture conditions were below normal in the North Dakota portion of the basin and normal to above normal in the Manitoba portion of the basin heading into the winter freeze-up. The U.S. Drought Monitor identified portions of the Red River Basin as abnormally dry or short term (less than six months) moderate drought. Flows at Emerson were in the "normal" range in the fall of 2015.

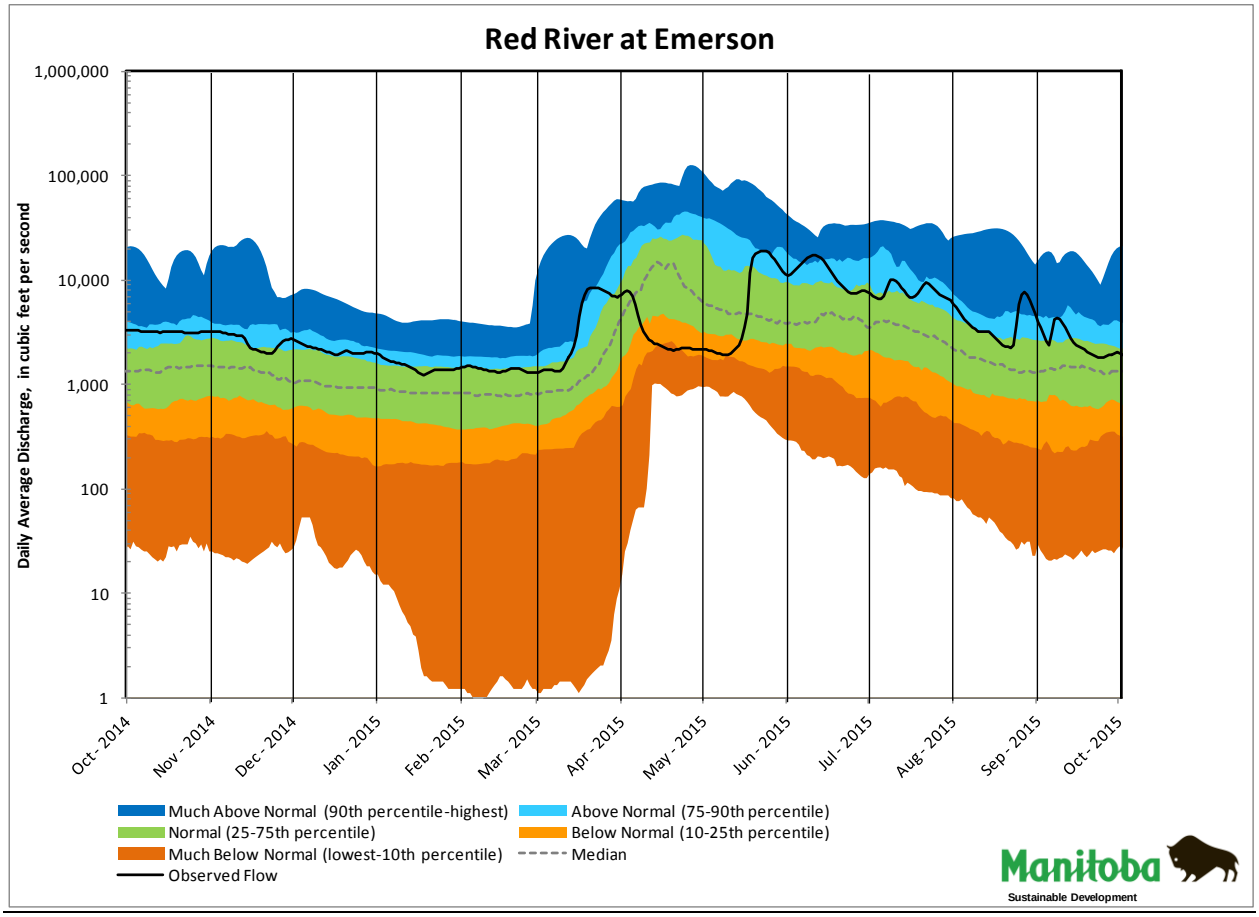

Figure 1. Average Daily Discharge in the Red River at Emerson from October 2014 through September 2015.

Water Quality

Several exceedances of the International Joint Commission (IJC) water quality objectives were observed at the international boundary during the 2014-2015 water year (October 1, 2014 - September 30, 2015). Dissolved oxygen generally remained well above the objective level of 5.0 mg/L. Exceedances of the International Joint Commission (IJC) water quality objectives, and concentrations approaching the objective level for total dissolved solids (TDS) were observed at the international boundary during the October 1, 2014 - September 30, 2015 time period. Total Dissolved Solids (TDS) remained at or above the objective of 500 mg/L for most of the 2014 water year, with the exception of during the flood stage. The highest observed value of TDS was 773.2 mg/L.

The chloride objective (100 mg/L) was not exceeded in any of the samples collected during the water year.

The sulphate objective (250 mg/L) was exceeded in 17% of the samples collected in the 2014-2015 water year with a maximum concentration of 336 mg/L.

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 2014-2015 water year, the *Escherichia coli* bacteria objective of 200 colonies per 100 ml was exceeded in 8% of the samples collected.

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, 2015 - September 30, 2016 which succeeds the 2015 water year. The key activities are highlighted below.

In 2015, 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 and implementation 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; and setting 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.

The IRRB held its summer bi-annual meeting on September 9-10, 2015 to address select issues in the basin, and the winter bi-annual meeting on January 21-22, 2016 for a more complete review of its responsibilities, activities, and accomplishments. The meetings addressed water quality monitoring and compliance with IJC objectives and established alert levels and IRRB work plan priorities. The latter included actions to develop and implement 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 (2015-2018)

The Board reviewed and updated its three-year work plan in September 2015. Current priorities include:

- Report 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, 2015 through September 30, 2018.

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 mandate presently includes the Poplar and Big Muddy River basins, previously the responsibility of the International Souris-Red Rivers Engineering Board. The Red River Basin is illustrated in Figure 2.

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

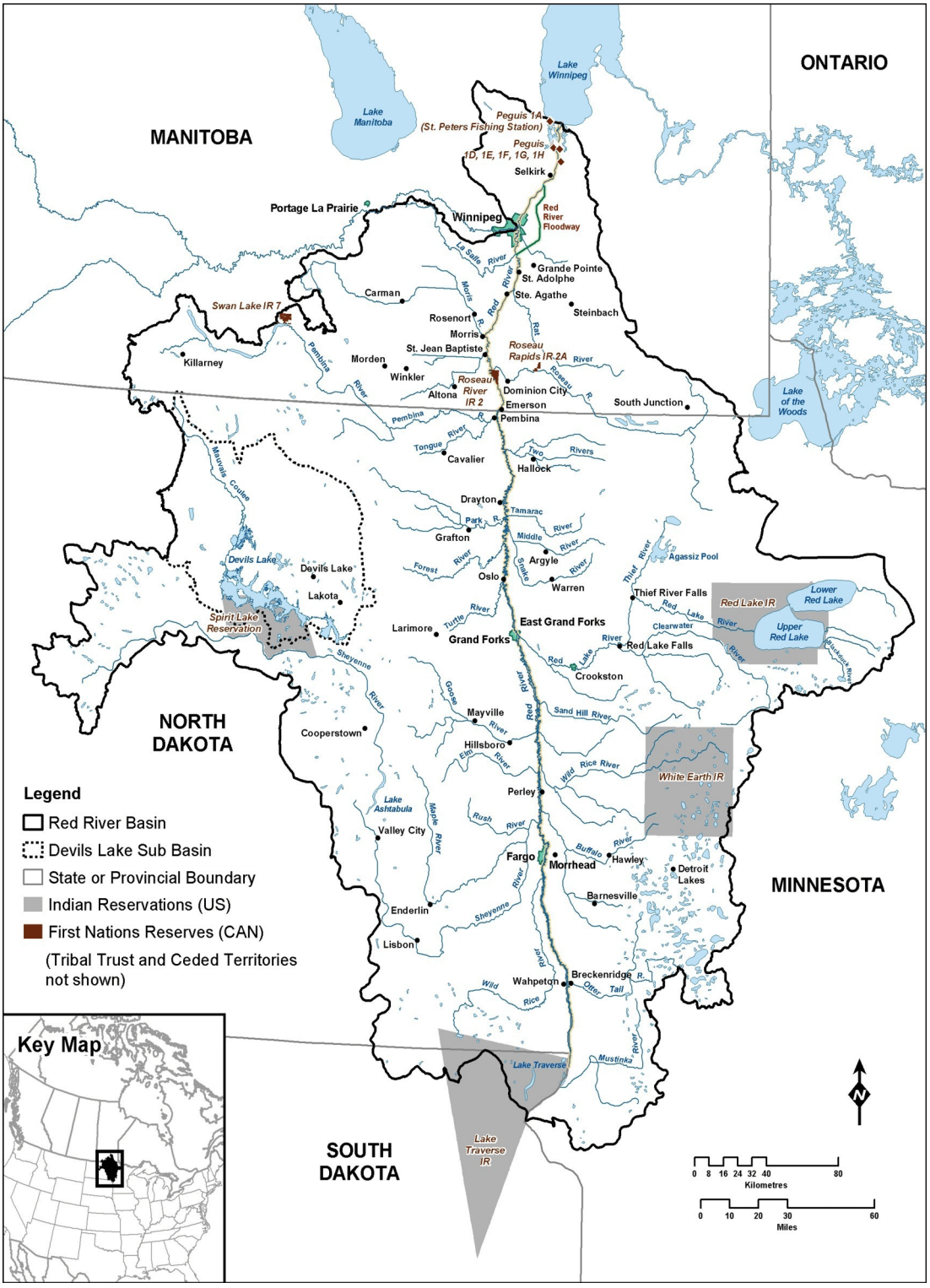

Figure 2: Red River and its Tributaries

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, many of the goals of a comprehensive watersheds approach are being achieved by the International Red River Board. 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. Scott Jutila, US Army Corps of Engineers; and Girma Sahlu, Environment and Climate Change Canada, provide secretarial and technical support to the Board.

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North Dakota

Vacant

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4.0 INTERNATIONAL RED RIVER BOARD ACTIVITIES

During the reporting period October 01, 2014 - September 30, 2015, 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 September 9-10, 2015 to address select issues in the basin, and the winter bi-annual meeting on January 21-22, 2016 for a more complete review of its responsibilities, activities, and accomplishments. The meetings addressed water quality monitoring and compliance with IJC objectives and established alert levels, and IRRB work plan priorities. The latter included actions to develop and implement 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 September 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 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 to the public that used to be held at the end of its Board meeting.

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 address 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 (see reports summarized in Chapter 5).

IRRB Member agencies also reported on 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.

In September 2011, Environment Canada announced its plans to reduce the water quality sampling program for the Red River at Emerson. The Board sent a letter to the IJC expressing its concern about the reduction to the water quality sampling program. At the Board meeting held on August 30, 2012 in Detroit Lakes, MN, Environment and Canada re-assured the Board its commitment to hire more staff and to re-instate the water quality sampling program on the Red River at the International Boundary.

4.03-2 Aquatic Ecosystem Committee – Water Quality and Ecosystem Health

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 "assure 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:

Megan Estep, United States Fish & Wildlife Service (co-chair)
Patricia Ramlal, Fisheries & Oceans Canada (co-chair)
Luther Aadland, Minnesota Department of Natural Resources
Todd Caspers, North Dakota Game and Fish Department
Eva Enders, Fisheries & Oceans Canada
Amanda Hillman, Minnesota Department of Natural Resources
Geoff Klein, Manitoba Sustainable Development
Aaron Larsen, North Dakota Department of Health
Jeff Long, Manitoba Sustainable Development
Candace Parks, Manitoba Sustainable Development
Doug Watkinson, Fisheries & Oceans Canada
Jamison Wendel, Minnesota Department of Natural Resources

The AEC holds monthly phone calls from January through May, which will resume in September, unless there is a need to meet sooner. The group's discussion centers on how current work being done in the basin could either be linked to ongoing programs or how the various programs could collaborate to get a better picture of the entire basin.

Based on discussions of the AEC the main issues of concern to the committee were those related to: (1) fish movement within the basin including in-stream flow needs (IFN); (2) aquatic invasive species (AIS); and (3) communication.

IFN and Fish Movement:

- Dam modifications/removal to increase connectivity with the Red River
- In North Dakota many of the Red tributaries have lower flows than those in Minnesota
- Because of the large size of the Red River near Winnipeg fish movement studies are difficult to do with the currently available methodology
- The group should work together to coordinate efforts on the study of the riverine fish community using electrofishing; i.e. Province of Manitoba and DFO
- Minnesota is actively stocking sturgeon; is there a role for the AEC?
- There is a new fish tagging study being in done in Canada in 2016-2021. Hydroacoustic tags will be used to track the movements of Channel Catfish, Lake Sturgeon, Bigmouth Buffalo and potentially Walleye and Sauger. This study will investigate long range movement and specific habitat use.

The AEC has submitted a telemetry proposal to the IWI that would link the work being done on the Canadian side of the border with the United States. It would be valuable to have more receivers to extend the range of information for both US and CAD jurisdictions. There is a need for funding for receivers to be placed in the

ND/MN portions of the watershed. It is also a terrific opportunity for researchers in the US to start a tagging study in conjunction with the Canadian study to broaden the receiver coverage and collect data. If the proposal is funded by the IWI Jamison Wendell (for MN) and Todd Caspers (for ND) will partner in the deployment of the receivers on the US portion of the basin.

A recent article, http://www.grandforksherald.com/outdoors/recreation/4061958-red-river-roundup-fishing#.V3Evr7qYIb8.email highlights some of the work currently being done.

Aquatic Invasive Species:

- Asian carp, Rusty Crayfish, Zebra Mussels and Quagga Mussels were noted to be of concern
- Discussion of detection methods for detection focussed on the use of eDNA; however the current state of the method is such that it is not practical for use in diffuse systems such as the Red; it is primarily directed at the aquarium trade, and bait buckets.
- A regional rapid response should be developed, but it is not clear who has the jurisdiction to design and implement such a plan; lessons can be learned from the Laurentian Great Lakes rapid response desk top activities.

Communication:

- The suggestion has been put forward that with so many jurisdictions working independently, and with possibly conflicting strategies, a proper work plan and communication needs to be established. In particular given the concerns regarding AIS there should be an integrated plan given the considerable effects, current and predicted, on the sustainable resources in the Red River Basin. Unless and until there is an integrated plan in place, there is no way to deal with AIS even if they are detected.

Other topics that the committee discussed or may address in the future could include:

- DFO will be doing mussel surveys this year if the flow in the Red is low enough; this data is needed now before the ZM exposure is more extensive; there is limited knowledge about the distribution and abundance of native mussels (including those at risk)
- ND and MN cooperate to do a fish population survey (targeting catfish mostly) on the Red every 5 years. Creel surveys are usually done in the same year as the fisheries surveys. (see link to the article in the Grand Forks Herald above)
- There is a need for the IFN/oxygen/temperature models to be developed for the Red.
- Need a better understanding of the cumulative impacts of rip-wrapping projects
- Has there been any hydrologic modelling in the US on the conservation reserve program?
- Protection of riparian zones and good area for land acquisition. It is easy to foresee increased population growth as a stressor that will see more development along the river. It would go a long way toward maintaining river function and productivity if the belt width of the river were prioritized and maintained in a natural state through land acquisitions and conservation easements. There might also be opportunities to develop off-channel water storage that would assist in mitigating a two-peaked hydrograph and diminish nutrient delivery to the Lake Winnipeg. Such storage would also provide irrigators with water that are now relying on in-channel dams.
- What biological studies should be included in this integrated approach and how can we approach the IWI funds? For example, basin wide issues on increased P load and how that relates to the hydrology of the basin; what are the drainage practices during high flows that could lead to connection
- Review the University of Minnesota assessment study on Asian Carp for its applicability to the Red River Basin (Chapman et al.; Jamison Wendel has been involved with this study).
- It was noted that while considering AIS that the water systems will become more dysfunctional and this needs to be considered a driver, as does the fragmentation of river systems.

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 Sustainable Development (co-chair)
Mike Ell, North Dakota State Department of Health
Rochelle Nustad, U.S. Geological Survey
Eric Steinhaus, U.S. Environmental Protection Agency
Sharon Reedyk, Agriculture and Agri-Food Canada
Jeff Lewis, Red River Basin Commission
Mike Vavricka, Minnesota Pollution Control Agency
Iris Griffin, Environment and Climate Change Canada
Rob Sip, Minnesota Department of Agriculture
Keith Weston, United States Department of Agriculture
Elaine Page, Manitoba Sustainable Development
Jason Vanrobaeys, Agriculture and Agri-Food Canada
Kristina Farmer, Environment and Climate Change Canada
Jim Noren, US Army Corps of Engineers (for Comprehensive Watershed Management Plan)

The Committee's last report to the IRRB was in January 2016. The committee met in May 2016 in Grand Forks and has had a number of conference calls regarding the Stressor Response project.

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

The 2014 RESPEC report (IWI funded) reviewing methods for developing water quality targets included a recommendation regarding developing nutrient objectives/targets for the Red River. The report recommended a two pronged approach for the development of water quality objectives/targets for nutrients at the US/Canada border. The report recommended developing water quality objectives/targets for the Red River through a stressor response approach and comparing these objectives/targets with targets developed for the Red River to meet water quality goals in Lake Winnipeg. In late 2014, RESPEC was contracted through IWI funding to develop the stressor response model and identify biological thresholds that could be used to establish water quality objectives/targets for nutrients. A major data gap (algae) which was identified in winter 2015 was filled through a cooperative effort by the Minnesota Pollution Control Agency, Manitoba Sustainable Development, Environment and Climate Change Canada, North Dakota Department of Health and the Buffalo-Red River Watershed Management District. RESPEC incorporated the additional information on algae and water chemistry into the project and has now completed both the draft and final reports on the stressor response model.

The final RESPEC report demonstrates that the algal community responded to the nutrient gradient that was observed along the international Red River. Free floating (phytoplankton) and attached (periphyton) algae quantity responded to the nutrient gradient, although the response of the periphyton community was repressed by total suspended solids (turbidity) in the river. Periphyton reached nuisance levels towards the mouth of the Red River where the highest concentrations of nutrients were observed. Periphyton quality also responded to the nutrient gradient and the response was not suppressed by total suspended solids (turbidity). Multivariate analyses were used to determine that both periphyton and phytoplankton responded significantly to varying nutrient concentrations. Nutrient targets for the Red River were then derived from these analyses with a recommendation of 0.15 mg/L total phosphorus and 1.15 mg/L total nitrogen water quality objective/target.

The final report will be shared with the International Red River Board at the September 2016 meeting. The committee is recommending that the report be accepted by the board and shared with the International Joint Commission. Next steps for the committee include reconciling the RESPEC nutrient targets for the Red River with the work done on Lake Winnipeg and exploring options for applying the RESPEC targets (for example, seasonally, not to exceed, annual average, normalizing for flow, etc.) in the Red River.

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 pursuing web-based delivery of information on water quality monitoring programs. The USGS and the IJC have made considerable progress mapping water quality stations across Canada and the US in the Red River watershed and linking to summarized data on the IJC web through the interactive maps.

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.

Other Updates

The US Army Corp continues to attend the Water Quality Committee meetings as part of the development of the Comprehensive Watershed Management Plan (CMP).

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 Committee on

Hydrology (COH) was asked to prepare a detailed proposal to establish the 'process' for undertaking development and implementation of apportionment procedures. The proposal is to identify the project elements, participating agencies, related capacity issues, and timelines.

At the January 2008 meeting, the Board approved the Committee on Hydrology's plan for the development and implementation of flow apportionment procedure for the Red River. The Committee noted the establishment of a process for the development and implementation 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 likely to be 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 International 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 really required at this time.

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. A report gathered information to support the development of instream flows 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. 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 at least a year's effort would be required by a person specializing in hydraulic modelling and GIS would be required to process the data to determine the feasibility of an instream flow study with the available data. If feasible, an Instream flow study of the Red River would be led by a Steering Committee with several Task groups and takes 3-5 years.

The Hydrology Committee's work on apportionment is continuing and focussing on two components: 1) quantifying Manitoba's low flow vulnerabilities (municipal and other licensed water use, ecosystem instream flow needs, wastewater assimilation, etc.), and 2) quantifying 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 Manitoba faces from Red River drought scenarios and how a drought contingency plan or minimum flow criteria for the Red River could reduce these risks.

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 recognizes current 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 [current] 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 Committee on Hydrology Committee (COH) 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 COH regarding the IRRB's role in identifying priority flood mitigation activities for the basin. In their letter, the Co-Chairs asked the COH 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 COH. The Co-Chairs have indicated that based on the discussion with the IJC, they would amend their direction to the COH.

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 COH 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 COH 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 to be 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?” and review the status of each of the IJC’s recommendations and identify the key items left undone. The report will determine if the Living with the Red recommendations are still relevant and if there is need to report on flood resiliency building in the future using a new template. The report is expected to be completed in 2016 and will be available on the Board website upon completion.

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. 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. Heavy infestations can kill native mussels, impact fish populations, interfere with recreation, and increase costs for industry, including power and water supply facilities.

Zebra mussels are adapted to lentic (lakes/reservoir) habitat. They can survive in riverine habitat, but they require an upstream source of healthy zebra mussel populations to continually supply free floating larvae – typically from an upstream reservoir or lake. Zebra mussels are typically spread overland from infected lakes via transient recreational boat traffic and transfers of boat docks or lifts.

There is little that can be done to address an existing infestation of zebra mussels. Natural resource agencies in the U.S. and Canada are focused on public awareness and education aimed at preventing transportation of mussels on boats, trailers, and docks. Actions include increased signage at infested lakes, watercraft inspections, and monitoring. In October 2013, Manitoba Sustainable Development (then Conservation and Water Stewardship) confirmed zebra mussels had been found in Manitoba waters. Mussels were found on the hull of a private boat, probably the source of infestation, and a dock at Winnipeg Beach and on some fishing boats dry docked at Gimli (Lake Winnipeg). Manitoba implemented a rapid-response protocol to address the issue which included:

- Ensuring staff were on site at Winnipeg Beach, Gimli and Hecla to provide information to watercraft owners and local residents to help identify zebra mussels, collect samples to determine the extent of infestation and advise on steps everyone can follow to help prevent the further spread of this aquatic invasive species. Watercraft inspection teams were available in the Winnipeg Beach and Gimli areas from October until Lake freeze-up.
- Deploying mobile decontamination units for aquatic invasive species where necessary. Teams' locations were changed depending on need and as new information was received.
- Engaging stakeholders to make them aware that zebra mussels have been found in Manitoba and what can be done to deal with the situation.
- Extending the watercraft inspection program to help collect data about this situation.

Zebra Mussel 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 hydro-electric 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.

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". All three phases of the study were conducted by the National Hydraulic Centre (NRC). 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". These LPRFTT reports from the three phases were then presented and subsequently accepted by the IJC. The reports, the 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 can be used as an analysis and visualization tool for hydraulic models.

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 5 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 meeting was organized by the Red River Basin Commission. 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
- 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 were provided
- 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
    - Analysis of additional temporary flood water 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, narrowing the focus on alternatives to be pursued, a summary of additional information that may be needed to determine the best overall solutions for the area, and 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.

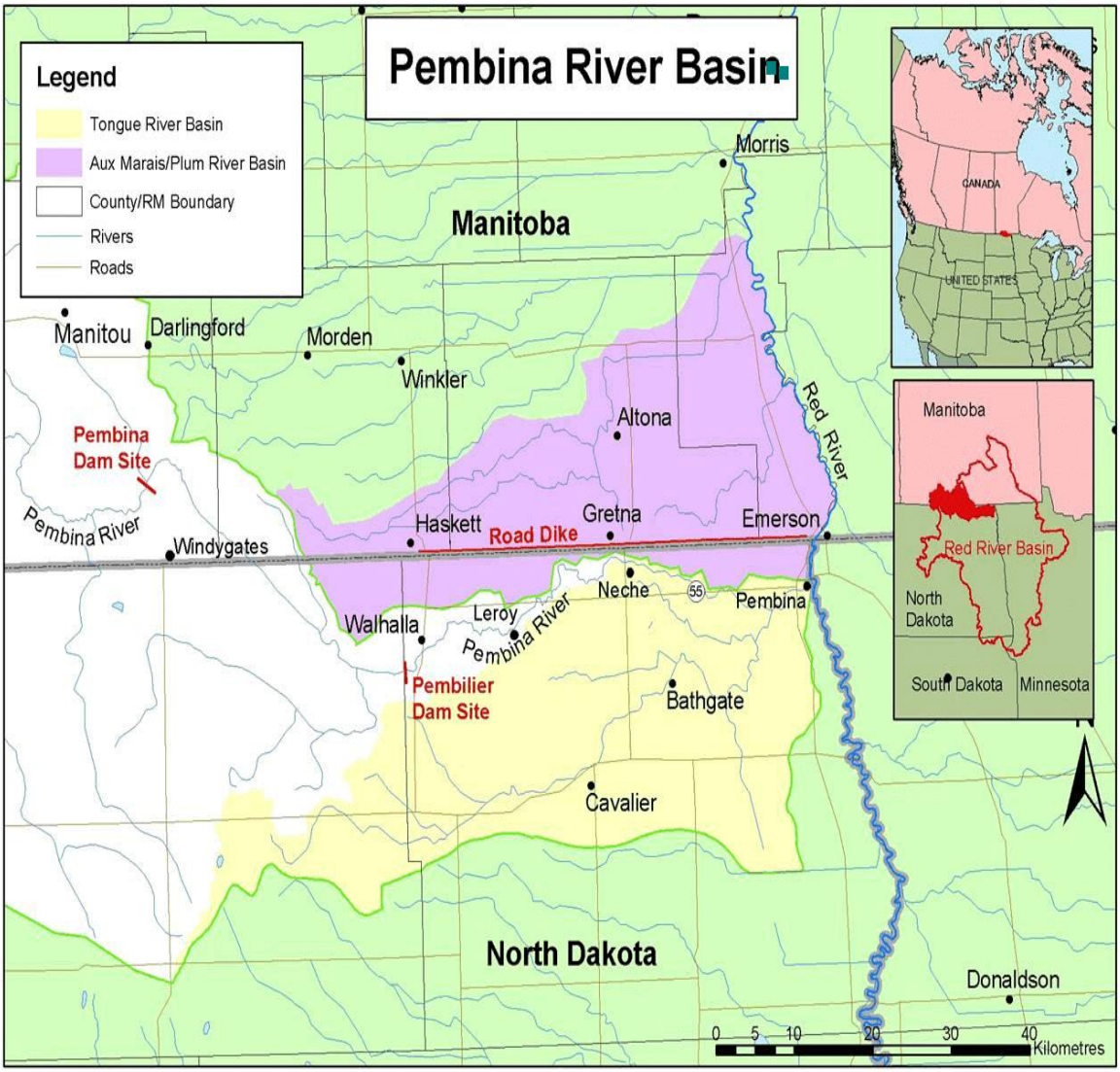


Figure 3: Pembina River Basin. The yellow and white areas comprise the Pembina River Basin.

4.07 Poplar River Basin

The Poplar River forms an international river basin shared by Saskatchewan and Montana. Although not geographically located within the Red River basin, the mandate of the IRRB includes the Poplar River, previously the responsibility of the International Souris-Red Rivers Engineering Board (ISRREB). This responsibility originates with the 1975 IJC instructions to the ISRREB to investigate equitable apportionment alternatives on the East Poplar River in consideration of the thermal power station and cooling reservoir that were being constructed by the Saskatchewan Power Corporation near Coronach, Saskatchewan. In 1976, the ISRREB recommended an apportionment formula to the IJC for the East Poplar River. Subsequently, in 1978, the IJC recommended an apportionment formula to the governments of Canada and the United States.

Environment and Climate Change Canada and the United States Geological Survey (USGS) have been collecting monthly water quality samples for nutrients, major ions and metals since July 1975. However, in 1977, the governments of Canada and the United States referred the issue of water quality to the IJC. The IJC Water Quality Task Force completed its report in 1981, which provided the basis for establishing flow-weighted objectives for numerous water quality parameters, including total dissolved solids (TDS) and boron. The International Air Pollution Advisory Board provided advice to the IJC regarding air pollution potential from the generating station. The Coronach Power Station began operation in 1981. Although Canada and Saskatchewan have not accepted the IJC apportionment formula and water quality objectives, both the formula and objectives have been followed by Saskatchewan throughout the intervening years.

Bilateral Monitoring Committee

The Poplar River Bilateral Monitoring Committee was established in 1980, and is composed of government representatives from Canada and the United States, Montana, and Saskatchewan, as well as one public ex-officio member from Canada and one from the United States. The Committee's main responsibility is to oversee monitoring programs designed to evaluate the potential for transboundary impacts from the generating station and its operations. The Committee's current mandate expires in 2017.

Under the Committee's purview, surface and ground water quality and quantity data, and air quality data are collected at or near the international boundary. These monitoring programs initially included a quarterly data exchange and an annual data review and report. In September 1991, the Committee agreed that the data exchange was no longer required and that an annual data review and report would suffice.

Compliance with Apportionment and Water Quality Objectives

The water quality report for boron and TDS for 2015 was derived from the daily specific conductance data collected on the East Poplar River at the international boundary. No exceedances of the water quality objectives of the East Poplar River were observed for the 2015 monitoring year.

Based on IJC recommendations, the United States was entitled to an on-demand release of 1,230 dam^3 (1000 acre-feet) from Cookson Reservoir in 2015. A volume of 2,200 dam^3 (1,780 acre-feet) was delivered between May 1 and May 31, 2015. In addition, daily flows during 2015 met or exceeded the minimum recommended by the IJC except for several periods during June, July and August when daily flows were below the recommended minimum flow due to summer period low flow conditions.

Starting August 2013, the Poplar River Annual Report will be posted on the IJC website under the International Red River Board using the following link:
http://www.ijc.org/en_/Poplar_Big_Muddy_Rivers_Basin

5.0 WATER QUALITY AT THE INTERNATIONAL BOUNDARY

The water quality of the Red River at the international boundary, as reported herein, is based on continuous monitoring and instantaneous grab samples obtained during the 2014-2015 water year (October 1, 2014 - September 30, 2015). The collected data, carefully scrutinized, are used to determine compliance with established IJC water quality objectives and alert levels at the international boundary and in meeting the provisions of the Boundary Waters Treaty of 1909. Detection of exceedances of the objectives and alert levels serves as a trigger mechanism for 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 the IJC has approved objectives, as well as the suite of pesticides, metals and toxic substances for which the IJC has approved alert levels, are discussed below along with streamflow and pH characteristics 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.

5.01 Water Quality Objectives

As described in Appendix B, the IJC established 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 IJC 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.

Dissolved Oxygen
Dissolved oxygen remained above the objective level of 5.0 mg/L throughout the reporting period. The lowest dissolved oxygen concentrations were detected in July, when water temperatures were highest.

Total Dissolved Solids
Total Dissolved Solids (*TDS*) remained at or above the objective of 500 mg/L for most of the reporting period, with the exception of during the flood stage (Figure 2). Exceedances were observed in 71% of the samples collected in the 2014-2015 water year. The highest observed value of 773.2 mg/L occurred in September 2015.

Chloride
The chloride objective (100 mg/L) was not exceeded in any of the samples collected during the 2014-2015 water year.

Sulphate
The sulphate objective (250 mg/L) was exceeded in 17% of the samples collected in the 2014-2015 water year. Exceedances were observed in the last week of November and beginning of December 2014 under partial ice conditions and then again in May, June and July 2015. These observed exceedances were coincident with a relatively higher flow event starting at the end of May, with exceedances detected in 3 out of 4 weeks in June and continuing into July. Operation of the Devils Lake Outlets started on April 23, 2015, 19 days earlier than in 2014, which may have also affected sulphate concentrations during this time period.

Bacteriological Characteristics

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 2014-2015 water year, the *Escherichia coli* bacteria objective of 200 colonies/100 ml was exceeded on one sampling date, with a total count of 325 colonies per 100 ml being observed.

Table 1. Exceedances of Objectives Levels, Red River at International Boundary October 1, 2014 to September 30, 2015

Parameter	Objective Level	Number of Samples	Exceedances		
			Number	% exceeding	Maximum value
Dissolved Oxygen	5 mg/L	42	0	0%	-
Total Dissolved Solids	500 mg/L	42	32	71%	773.2
Chloride	100 mg/L	42	0	0%	-
Sulphate	250 mg/L	42	11	17%	336
Escherichia coli	200 colonies /100 ml	12	0	8%	325

5.02 Alert Levels

Eleven of the pesticides and herbicides and three of the metals and toxic substances for which alert levels have been established were detected by Environment and Climate Change Canada (Water Quality Monitoring and Surveillance Division) during the reporting period (Table 2).

Pesticides and Herbicides

Based on a total of up to 12 water samples, 10 pesticides and/or herbicides and one metabolite (Desethyl Atrazine) with a total aggregate of 83 alerts (greater than detection concentration) were recorded during the October 1, 2014 - September 30, 2015 reporting period. Only one compound (Atrazine) was 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 and herbicides is expected. The detection of banned pesticides (legacy contaminants) is not unusual given the slow biodegradation rate of these chemicals.

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 continues to closely monitor 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 42 water samples were collected and analyzed for metals and toxic substances during the reporting period. The highest number of exceedances were detected for cadmium, manganese and iron, with exceedances exceedance rates of 100%, 93% and 90%, respectively. The maximum values were detected in June 2015, which corresponds to a high flow and higher particulate matter event. Iron and manganese are components in natural soils. Detection of higher levels of cadmium could indicate anthropogenic sources but cadmium also occurs naturally in surface waters.

Table 2. Exceedances of Alert Levels, Red River at International Boundary
October 1, 2014 to September 30, 2015

Table 2 Exceedances of Alert Levels, Red River at International Boundary October 1, 2014 to September 30, 2015						
Parameter	**Units**	**Alert Level**	**Number of Samples**	**Number of Exceedances (%)**	**Maximum Exceedance Value (Month)**	**Canadian Environmental Quality Guideline**
Metals (total):						
Cadmium	ug/L	Detect	42	**42 (100%)**	0.345 (Jun)	0. 074 ug/l[1,3]
Chromium	ug/L	50	42	0	--	NG
Iron	ug/L	300	42	**38 (90%)**	8860 (Jun)	300 ug/l[1]
Manganese	ug/L	50	42	**39 (93%)**	960 (Jun)	200 ug/L[2]
Selenium	ug/L	10	42	0	--	1 ug/l[1]
Zinc	ug/L	47	42	0	--	30 ug/l[1]
Toxic Substances:						
Arsenic	ug/L	10	42	0	--	5 ug/l[1]
Boron	ug/L	500	42	0	--	29 mg/l[1]
Total PCB	ng/L	Detect	0	--	--	NG
Pesticides:						
2,4-D	ng/L	Detect	12	**11 (92%)**	239 (Mar)	4000 ng/l[1]
Bromoxynil	ng/L	Detect	12	**8 (67%)**	123 (Jun)	5000 ng/l[1]
Clopyralid	ng/L	Detect	12	**10 (83%)**	78 (Sep)	NG[5]
Dicamba	ng/L	Detect	12	**3 (25%)**	14.4 (Sep)	10000 ng/l[1]
Imazamethabenz-methyl a	ng/L	Detect	5	0	--	NG
Imazamethabenz-methyl b	ng/L	Detect	5	0	--	NG
MCPA	ng/L	Detect	12	**8 (67%)**	191 (Jun)	2600 ng/l[1]
Mecoprop (MCPP)	ng/L	Detect	12	**6 (50%)**	23.4 (Jul)	NG
Picloram	ng/L	Detect	12	**9 (75%)**	19.8 (Nov)	29000 ng/l[1]
Aldrin	ng/L	Detect	5	0	--	NG
g-Benzenehexachloride	ng/L	Detect	11	0	--	NG
Pentachloroanisole	ng/L	Detect	5	0	--	NG
Atrazine	ng/L	Detect	11	**11 (100%)**	223 (Jun)	1800 ng/l[1]
Desethyl Atrazine	ng/L	Detect	11	**6 (55%)**	35.4 (Jun)	NG
Metolachlor	ng/L	Detect	11	**10 (91%)**	128 (Jun)	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]
Heptachlor Epoxide	ng/L	Detect	5	0	--	NG
Metribuzin	ng/L	Detect	11	**1 (9%)**	35.9 (Jun)	1000 ng/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

6.0 WATER QUALITY SURVEILLANCE PROGRAMS

As described in Chapter 5, data collected at Emerson, Manitoba, are used to determine compliance with established IJC water quality objectives at the international boundary. Chapter 6 contains basin-wide data and information contributed by IRRB member 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

Water Quality Surveillance

MPCA's Watershed Approach and WRAPS

A framework for protecting and restoring water quality in Minnesota's watersheds

MPCA's Watershed Approach and WRAPS

The watershed approach is a 10-year rotation for assessing waters of the state on the level of Minnesota's major watersheds (see map). This approach led to development of a process to identify and address threats to water quality in each major watershed. This process is called WRAPS or the Watershed Restoration and Protection Strategy.

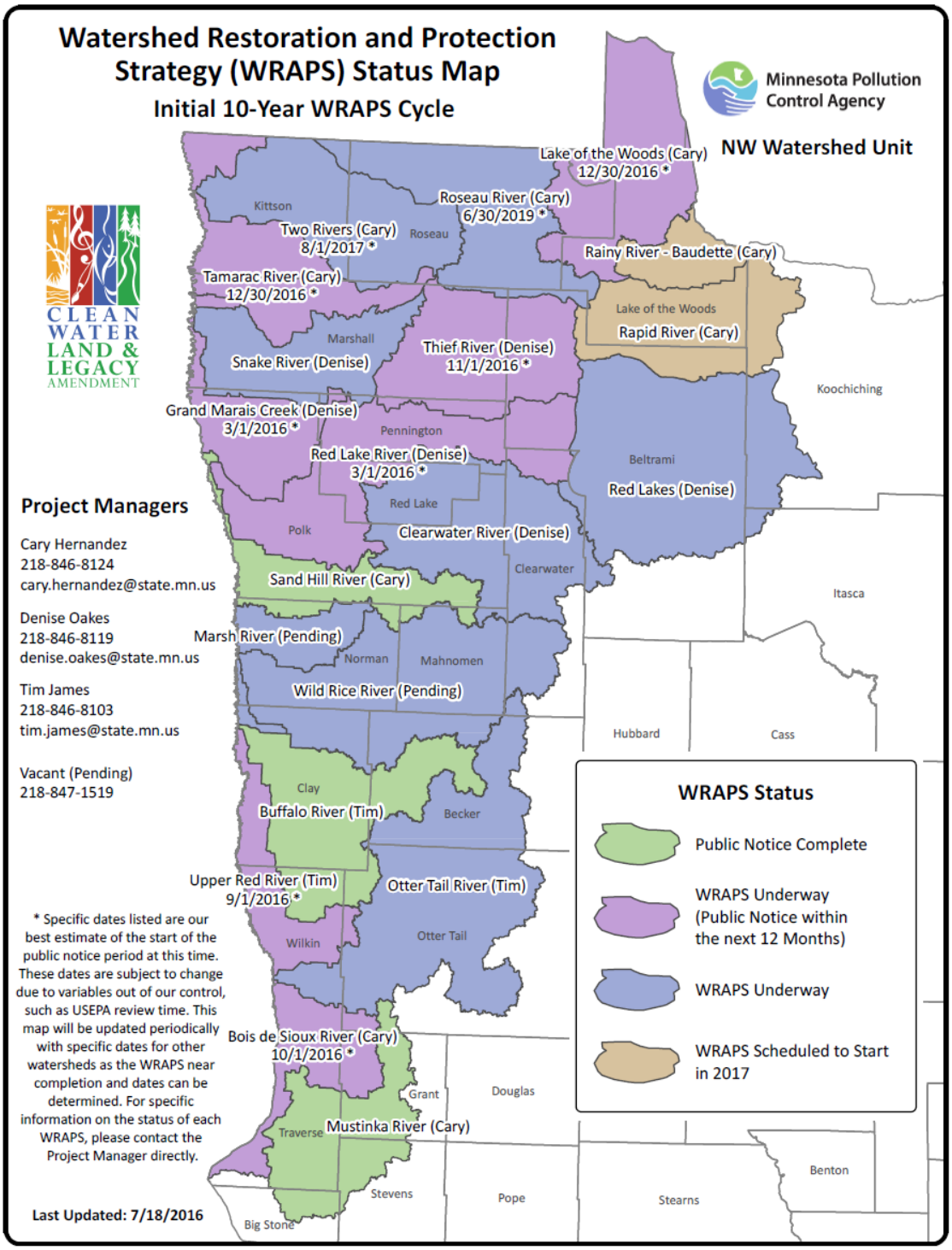
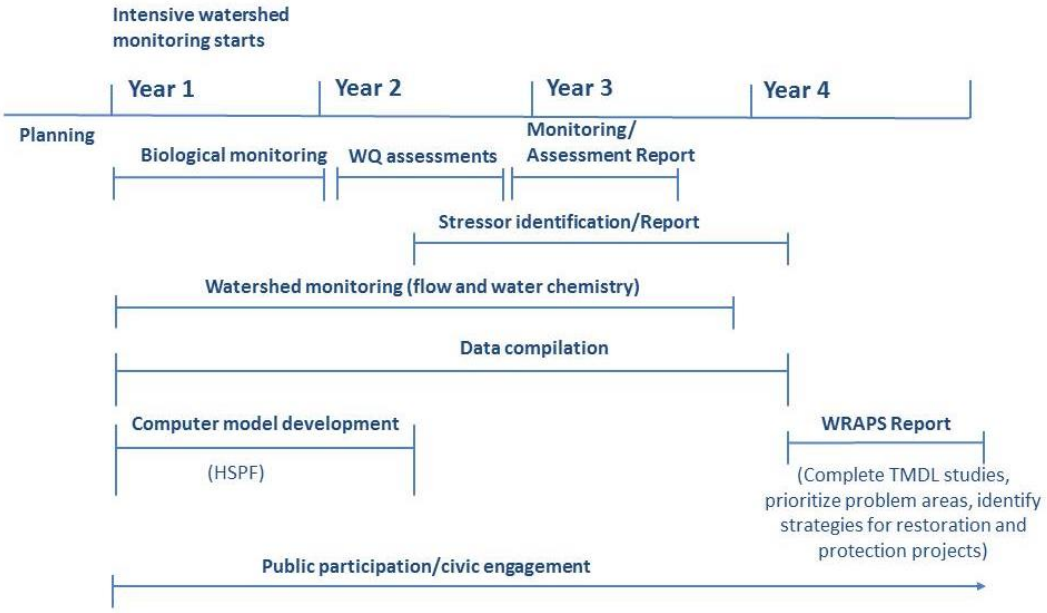


Figure 4 Watershed Restoration and Protection Strategy (Minnesota)

Major steps/phases of WRAPS

There are four main overlapping steps of the WRAPS process. The goal is to complete steps 1 through 3 within four years with step 4 beginning in year five.

The WRAPS Process at a glance



2016 Update on progress toward completing the Basin watersheds.

- Intensive Watershed Monitoring (IWM) has been started or completed in all but one watershed in the basin. The Otter Tail has started IWM in 2016.
- WRAPS are underway in all basin watersheds except the Otter Tail. Wraps for the Otter Tail should start in September or October this year, 2016.
- Stressor Identification which happens in the 3rd year of a WRAPS is completed in 11 watersheds (Buffalo, Red Lake River, Grand Marais, Sand Hill, Bois de Souix, Thief River, Upper Red, Mustinka, Lower Red (Tamarac), Lake of the Woods, and Two Rivers.
- TMDL's have been calculated and draft WRAPS reports have been completed and public noticed in 3 watersheds – Buffalo, Mustinka, Sand Hill. Additionally, TMDLs and WRAPS will be completed by late this year/early 2017 for these seven watersheds, Bois de Souix Red Lake River, Thief River, Lower Red (Tamarac), and Upper Red, Lake of the Woods and Two Rivers.

6.02 North Dakota

Ambient Water Quality Monitoring Program

Beginning January 1, 2013, the North Dakota Department of Health (department) began implementation of a revised ambient water quality monitoring program for rivers and streams in the state, including the Red River basin. This revised monitoring program is based on recommendations provided in a report published by the US Geological Survey's North Dakota Water Science Center (USGS) entitled "Evaluation of water-quality characteristics and sampling design for streams in North Dakota, 1970–2008" (http://pubs.usgs.gov/sir/2012/5216/).

In its report the USGS recommended a set of core monitoring sites representing 3 levels of sampling intensification. 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 5, Table 3). 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 23 sites with 12 level 2 sites located in the Red River basin (Figure 5, Table 4). 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 26 sites.

There are 12 level 3 sites located in the Red River basin (Figure 5, Table 5). These sites are only be 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 which is sampled by the department) and all the design level 3 sites. In the Red River basin the department samples 8 level 1 sites, while the USGS samples 8 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 6). 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 6). E. coli bacteria are only be 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 analysis of the total suspended sediment samples is conducted by the USGS Iowa Sediment Laboratory. All chemical analysis of samples is performed by the department's Laboratory Services Division.

Table 3 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 4 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 5 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 Coulee 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

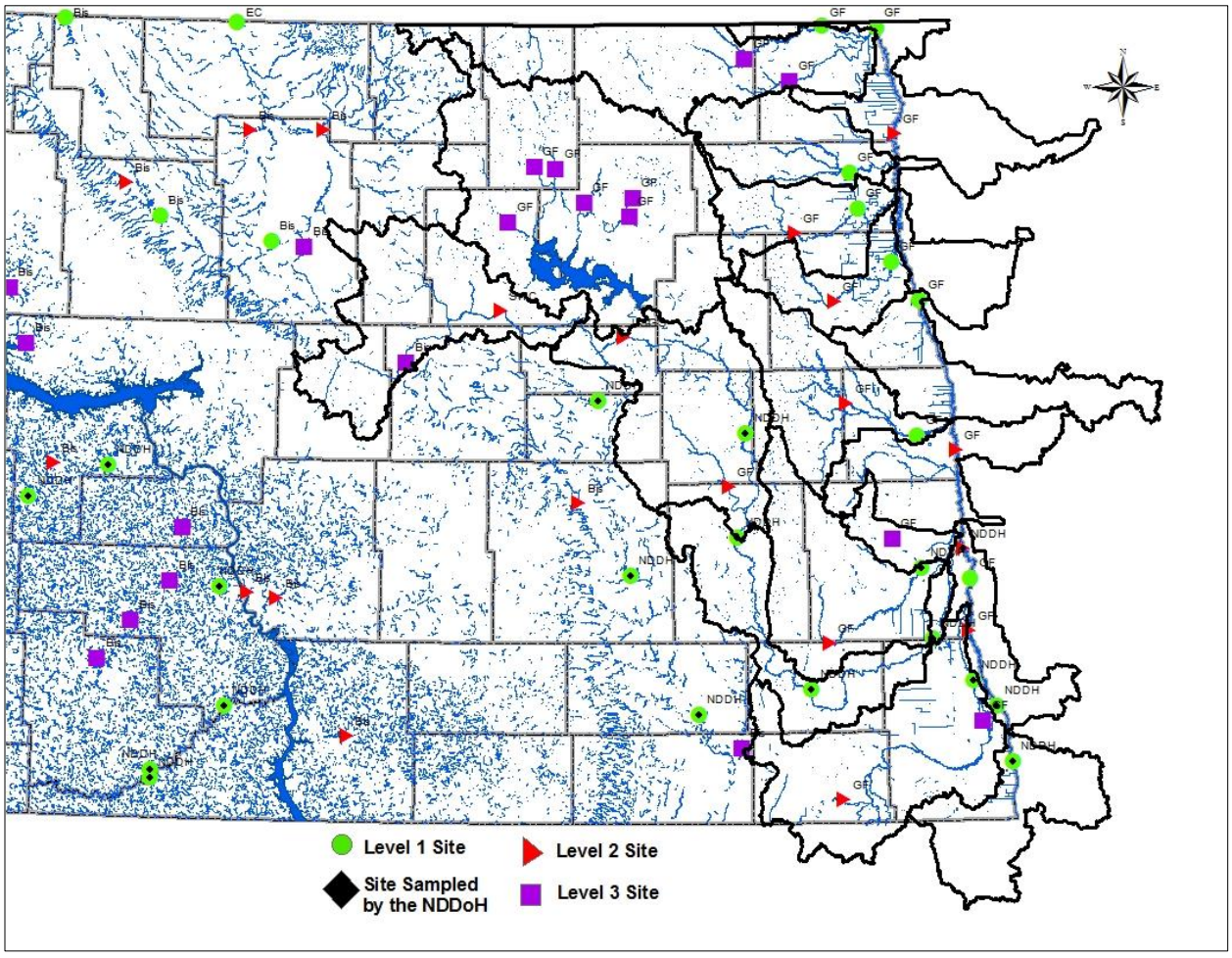


Figure 5 North Dakota Ambient Water Quality Monitoring Sites in the Red River Basin.

Table 6 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 2015 the department and the USGS cooperated with the North Dakota Department of Agriculture (NDDA) in a state pesticide monitoring program. Through this cooperative pesticide monitoring program, the department and the USGS collected pesticide samples 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 6 to 7 samples were collected at each site in 2015. In general, samples collected in the Red River basin were collected in late April, mid May, late May, mid-June, mid-late July, late August, and in mid-late October. A final report detailing the results of the 2015 monitoring program, including the results from samples collected in the Red River basin is available at https://www.nd.gov/ndda/files/resource/Pesticide%20Monitoring%20Report%202015.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 and downstream of the City of Winnipeg (Floodway control structure and Selkirk, respectively) (Figure 6). An additional site was monitored on the Red River at Emerson in July 2015 for comparison to data collected by Environment and Climate Change Canada. 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 7. In addition, benthic macroinvertebrates were collected from the Red River at Emerson and Selkirk in September 2015.

Manitoba Sustainable Development also conducts routine monitoring at eight sites on six tributary streams to the Red River (Figure 6). Samples are collected at minimum four times per year and analyzed for a wide range of variables including physical, 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 draft management strategies.

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. Dissolved oxygen concentrations were relatively high with an average concentration of 8.5 mg/L upstream of the City of Winnipeg and 8.9 mg/L downstream of the City of Winnipeg. Dissolved oxygen was sufficient for the protection of aquatic life during the reporting period as the lowest dissolved oxygen concentration was 5.1 mg/L in July 2015 upstream of the City of Winnipeg.

Densities of *Escherichia coli* (*E. coli*) bacteria downstream of the City of Winnipeg were somewhat higher than the previous reporting period. The geometric mean density downstream of the City of Winnipeg was 102 organisms / 100 mL, compared to 45 organisms / 100 mL in the previous reporting period. The geometric mean density of *E. coli* bacteria in the upstream reach was 8 organisms / 100 mL and comparable to the previous year (10 organisms / 100 mL). Densities of *E. coli* bacteria did not exceed the recreational water quality objective of 200 organisms / 100 mL (Manitoba Water Quality Standards, Objectives, and Guidelines, 2011) upstream of the City of Winnipeg. Meanwhile, the exceedance rate of the recreational water quality objective was 21 per cent downstream of the City of Winnipeg, compared with 7 per cent in the previous reporting period.

During this reporting period, eight samples were analyzed for routine pesticide screening upstream of the City of Winnipeg. Nine pesticides out of the 52 routinely monitored were detected, compared to eight in the previous reporting period. Glyphosate was the most commonly detected pesticide being detected six times. 2,4-D, AMPA and Dicamba were detected five times respectively. Atrazine and Triclopyr were detected twice while MCPA, Benomyl and Bromoxynil were each detected once.

Dicamba exceeded the irrigation guideline of 0.006 µg/L on five occasions during the open water season of 2015 with concentrations 1.5 to 18 times greater than the guideline. MCPA also exceeded the irrigation guideline (0.025 µg/L) on one occasion in June (0.373 µg/L). None of the detections of pesticides 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.
Eight pesticides out of the 52 monitored were detected downstream of the City of Winnipeg, versus seven detections in the previous reporting year. A total of eight samples were collected between April and October and analyzed for pesticides. Glyphosate and AMPA were the most commonly detected pesticides, detected in six of the eight samples. Dicamba and 2,4-D were detected in five samples and four samples, respectively.

Atrazine, MCPA, Bromoxynil, and Triclopyr were each detected on one occasion in the 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. Dicamba exceeded the irrigation guideline (0.006 µg/L) on five occasions during the open water season with concentrations 1.7 to 8 times greater than the guideline. MCPA also exceeded the irrigation guideline (0.025 µg/L) on one occasion in June 2015 (0.0261 µg/L).

Over this reporting period, six samples from each of the two Red River main stem stations were analysed for five estrogenic contaminants of emerging concern (17a-estradiol, 17a-ethinylestradiol, 17b-estradiol, estriol, and estrone). Most compounds were never detected, while estrone was detected once downstream of Winnipeg in December 2014 with a concentration of 0.0128 ng/L.

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 on a quarterly basis. 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 5.9 to 8.0 mg/L. Dissolved oxygen concentrations were usually above the Manitoba Water Quality Objective at the tributaries monitored in the reporting year with the following notable exceptions. Low dissolved oxygen concentrations were measured in the Seine, La Salle and Morris Rivers in January 2015 with concentrations of 0.5, 1.8, 2.3, and 2.8 mg/L in the Seine (Perimeter Highway), La Salle, Morris, and Seine Rivers (South East of Ste. Anne) respectively, below the minimum instantaneous Water Quality Objective of 3.0 mg/L.

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 in July 2015 for the Roseau River (and October 2014), the Rat River, the Boyne River, and the Seine (SE of Ste. Anne).

Two samples were analyzed for routine pesticides in the reporting period the Boyne River and the La Salle River (at La Salle) in October 2014 and July 2015. Pesticides detected included 2,4-D, AMPA, atrazine, bromoxynil, dicamba, ethalfluralin, glyphosate, malathion, MCPA, pentachlorophenol, and sethoxydim. MCPA exceeded the irrigation guideline (0.025 µg/L) in the Boyne River during July (0.072 µg/L). Dicamba also exceeded the irrigation guideline (0.006 µg/L) in the La Salle River on both sampling occasions.

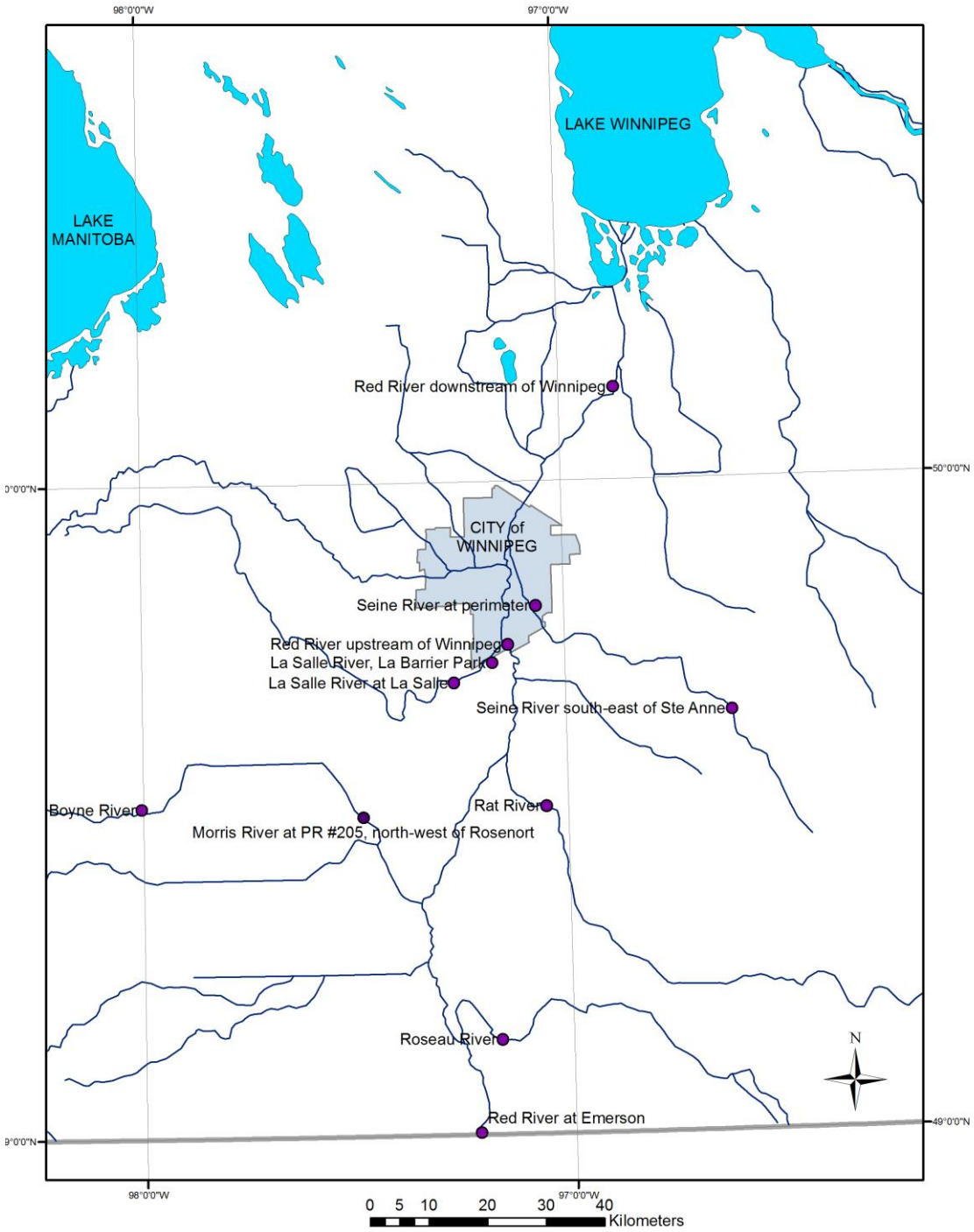


Figure 6. Location of water quality and benthic invertebrate sample sites in the Red River watershed (Manitoba)

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 in the current water year.

Table 7. Routine surface water quality analyses on water samples collected by Manitoba Sustainable Development from the Red River and tributaries within Manitoba, Canada.

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

Table 7. Continued….

Variables	Units
DIURON	µg/L
EPTAM	µg/L
ESCHERICHIA, COLI	CFU/100 mL
ETHALFLURALIN (EDGE)	µg/L
FENOXAPROP	µg/L
GAMMA-BENZENEHEXACHLORIDE (LINDANE)	µg/L
GLYPHOSATE (ROUNDUP)	µg/L
HARDNESS TOTAL CACO3	mg/L
IMAZAMETHABENZ-METHYL	µg/L
IRON TOTAL (FE)	mg/L
LEAD TOTAL	mg/L
LITHIUM TOTAL	mg/L
MAGNESIUM TOTAL	mg/L
MALATHION	µg/L
MANGANESE TOTAL (MN)	mg/L
MCPA	µg/L
MCPP (MECOPROP)	µg/L
METASULFURON-ME	µg/L
METHOXYCHLOR (P,P'-METHOXYCHLOR)_	µg/L
METRIBUZIN	µg/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	µg/L
PARATHION METHYL	µg/L
PENTACHLOROPHENOL	µg/L
PHEOPHYTIN A	µg/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)	µg/L
POTASSIUM TOTAL	mg/L
PROPANIL	µg/L
PROPOXUR	µg/L
QUIZALOFOP	µg/L
RUBIDIUM TOTAL	mg/L
SELENIUM TOTAL	mg/L
SETHOXYDIM	µg/L
SILICON TOTAL	mg/L
SILVER TOTAL	mg/L
SIMAZINE	µg/L
SODIUM TOTAL	mg/L

Table 7. Continued….

Variables	Units
SULPHATE DISSOLVED	mg/L
TELLURIUM TOTAL	mg/L
TERBUFOS	µg/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	µg/L
TRIALLATE (AVADEXBW)	µg/L
TRIBENURON	µg/L
TRICLOPYR	µg/L
TRIFLURALIN(TREFLAN)	µg/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 a contingency plan was developed by the former International Red River Pollution Board. 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 impact 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

The spills information covers the period from August 2, 2015 to August 2 2016. The time period was fairly normal for the number of spills compared to the long term record.

There were roughly 295 spills reported for MPCA Region III through the State Duty Officer. They are received by emergency response (ER) staff and responded to by ER staff or triaged by ER to the specific MPCA program that deals with that industry. Those spills were made up of the following:

- Residential heating oil spills, (a homeowners fuel tank spilled to their property either inside or just outside of their home). Impacts may include both surface and groundwater near the spill site.
- Reports of releases from process activities at American Crystal Sugar at East Grand Forks, Crookston and/or Moorhead. These incidents most commonly consist of high BOD process water/product which spills into the enclosed ditch/treatment system at the facility. The facilities have their own storm water systems, which are designed to prevent flow of product/spills off of their property.
- Pipeline releases. Most were releases of crude oil at a pump station or discovery of historic contamination at a facility or along the line.
- Vehicle fuel releases and spills from locomotives. These are commonly over-the-road incidents where the fuel line was compromised, leaking fuel to the roadway, ditch or RR ballast.
- There were numerous wastewater releases from Waste Water ponds (both treated and untreated waste water), mostly resulting from heavy rain events and equipment failures. Numbers of these incidents is not quantifiable under normal ER record keeping, but a conservative estimate would be perhaps 10 bypasses, accounting for 1000's of gallons of water, from wastewater facilities into Red River Basin surface waters per year.
- A number of feedlot basin bypass, overflow and/or liquid manure application incidents occurred. These occur on an infrequent and usually unpredictable basis, but can impact surface waters during heavy precipitation and/or snow melt events. They may contribute a high nutrient loaded discharge to the basin.
- No large scale incidents/discharges were reported in the Red River Basin during the time period listed however, there were other more numerous smaller incidents, including a discharge of several hundred gallons of diesel fuel into the Baudette River in Baudette in March. Responsible persons are required to complete cleanup of any and all spills that occur. The MPCA ER team provides oversight and insures that remediation takes place in compliance with MPCA cleanup goals.

Municipal and Industrial Wastewater

Seven municipal/industrial permits were issued in calendar year 2015, five of these were reissuances, two were new (Table 8).

Table 8 Municipal and Industrial Permits Issued in 2015 (Minnesota)

name	permit #	city name	major watershed name	permit action date	npdes	waste type
MNDOT SP 0301-60 TH10 & TH59 Road Construction	MNG790210	Detroit Lakes	Otter Tail River	7/1/15	NPDES/SDS	Industrial
Oslo WWTP	MN0024431	Oslo	Red River of the North - Grand Marais Creek	7/31/15	NPDES/SDS	Domestic
Summit Sand & Gravel	MNG490318	Barnesville	Buffalo River	4/13/15	NPDES/SDS	Industrial
Donnelly WWTP	MN0041319	Donnelly	Mustinka River	4/3/15	SDS	Domestic
Ogema WWTP	MNT049794	Ogema	Wild Rice River	9/9/15	SDS	Domestic
Frazee WWTP	MN0022021	Frazee	Otter Tail River	9/9/15	SDS	Domestic
Callaway WWTP	MNT022985	Callaway	Buffalo River	1/23/15	SDS	Domestic

In calendar year 2015 there were 29 unauthorized releases of wastewater at 12 facilities. Of the 29, 16 occurred at four industrial facilities and 13 occurred at eight municipal/domestic facilities. The table below (Table 9) summarizes the 29 releases, not all of which resulted in a surface water discharge:

Table 9 Releases from Domestic and Municipal Facilities in Minnesota

Permit #	Facility Name	major watershed name	report date	estimated amount
MN0001929	American Crystal Sugar - Crookston	Red Lake River	3/22/15	
MN0001929	American Crystal Sugar - Crookston	Red Lake River	4/13/15	1000 gallons
MN0001929	American Crystal Sugar - Crookston	Red Lake River	4/28/15	1000 gallons
MN0001929	American Crystal Sugar - Crookston	Red Lake River	7/22/15	432,000 gallons
MN0001937	American Crystal Sugar - East Grand Forks	Red Lake River	1/16/15	150 gallons
MN0001937	American Crystal Sugar - East Grand Forks	Red Lake River	1/18/15	1000 gal
MN0001937	American Crystal Sugar - East Grand Forks	Red Lake River	1/31/15	14,000 gallons

Table 9 continued...

MN0001937	American Crystal Sugar - East Grand Forks	Red Lake River	2/1/15	1000 gallons
MN0001937	American Crystal Sugar - East Grand Forks	Red Lake River	2/12/15	15000 gallons
MN0001937	American Crystal Sugar - East Grand Forks	Red Lake River	5/12/15	1000 gallons
MN0001937	American Crystal Sugar - East Grand Forks	Red Lake River	8/22/15	1000 gallons
MN0001945	American Crystal Sugar - Moorhead	Upper Red River of the North	7/24/15	
MN0052451	Argyle WWTP	Snake River - Red River Basin	3/10/15	50 gal pm
MN0041319	Donnelly WWTP	Mustinka River	4/16/15	100 gpm
MN0068357	Green Plains Otter Tail	Otter Tail River	8/21/15	100 gallons
MN0049069	Moorhead WWTP	Upper Red River of the North	3/12/15	unknown
MN0022225	Pelican Rapids WWTP	Otter Tail River	2/9/15	
MN0022225	Pelican Rapids WWTP	Otter Tail River	4/25/15	unknown
MN0022225	Pelican Rapids WWTP	Otter Tail River	7/12/15	200 - 250 gallons
MNG580162	Stephen WWTP	Red River of the North - Grand Marais Creek	3/9/15	160,000 - 180,000
MNG580162	Stephen WWTP	Red River of the North - Grand Marais Creek	3/10/15	unknown
MNG580162	Stephen WWTP	Red River of the North - Grand Marais Creek	7/5/15	Unknown
MNG580083	Warroad WWTP	Roseau River	7/16/15	100 gallon Per Minute
MNG580083	Warroad WWTP	Roseau River	8/6/15	100 gpm
MN0068357	Green Plains Otter Tail LLC	Otter Tail River	9/22/2015	1000 gallons
MN0001937	American Crystal Sugar - East Grand Forks	Red Lake River	10/9/2015	unknown
n/a	River View Mobile Home Park Detroit Lakes	Pelican river	11/5/2015	unknown to ground only
MN0001945	American Crystal Sugar - Moorhead	Upper Red River of the North	10/27/2015	unknown
MN0050628	Fergus Falls WWTP	Otter Tail River	12/14/2015	unknown

Manitoba

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.

The City of Winnipeg is in the process of upgrading their wastewater treatment facilities including to enhance nutrient removal. The City of Winnipeg's West End Water Pollution Control Centre has been upgraded to meet a 1 mg/L total phosphorus and a 15 mg/L total nitrogen limit. Construction is underway on the South End Water Pollution Control Centre with a scheduled completion date of December 31, 2016. The City has asked for an extension to July 31, 2018 which is currently being considered. A Master Plan for upgrading the North End Water Pollution Control Centre has been approved and the upgrades are to be completed by December 31, 2019. The City has also developed a master plan for the management of biosolids and is developing a plan for reducing the number of combined sewer overflows.

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. Similarly, in Manitoba, no intensive livestock proposals were proposed near the international border.

North Dakota

The North Dakota Pollutant Discharge Elimination System (NDPDES) program requires all permitted facilities (industrial and municipal) to report wastewater spills and by-passes. During this reporting period (October 1, 2013~~4~~ through September 30, 2014~~5~~), there were 8 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 which 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 150 facilities with a NDPDES Program permit in the Red River basin. Of these, there are 30 industrial wastewater permits and 120 domestic/municipal wastewater permits. A majority of the domestic/municipal wastewater permits are for small lagoon systems which 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 (termed 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 556 stormwater permits for construction activity and 112 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 147 AFOs permitted by the department in the Red River basin. Of these, there are 21 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, federal funds are appropriated by the U.S. Congress to EPA for NPS pollution management. These Section 319 funds are then made available to individual states based on an allocation formula. In North Dakota, approximately 80% of the annual Section 319 grant award is allocated to project sponsors (e.g., soil conservation districts, water resource boards, cities, state agencies, universities, nonprofit organizations) to implement a variety of NPS pollution education, assessment and abatement projects. Section 319 funds are awarded to the approved projects at a 60 percent federal/40 percent non-federal matching ratio.

Through the NPS Program, the department is currently cost-sharing several watershed projects in the Red River basin that are focused on nonpoint source pollution abatement. A map depicting the location of these projects in the Red River basin is provided in Figure 7. The following is a short summary of these projects.

- The Richland County SCD was awarded Section 319 funding in 2011 and 2014 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 best management practices (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 will be accomplished through one-on-one conservation planning; implementation of agricultural BMPs; septic system renovation; and public education.

- 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 will: 1) provide 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 will: 1) implement educational programs to heighten public awareness of NPS pollution impacts and solutions; and 2) develop working partnerships in the local community to ensure long term maintenance of efforts that protect water quality and the 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 project to cost share the implementation of BMPs. 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 will be accomplished by providing financial and technical assistance to producers to improve livestock management along the riparian corridor of Timber Coulee. Specific emphasis will be placed on improving manure management on three animal feeding operations and addressing livestock grazing in the riparian corridor. Practices to be 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 will also promote the implementation of water quality improvement practices throughout the Maple River Watershed. To achieve these goals, the project sponsors will initiate an extensive watershed-wide educational program and provide financial and technical assistance to implement BMPs that address failed septic systems and improve land management along Buffalo Creek. Emphasis will be 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 2008 and 2014 to support the implementation of the Red River Riparian Project. Outdoor Heritage Funds were also awarded to the project in 2014 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 the project's priority watersheds in the Red River Basin. The current priority watersheds include the Park River watershed and seven 12 digit hydrologic units along the Sheyenne River in Nelson County. Land owners will be provided riparian management planning assistance to identify and install BMPs that will 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 will include the general public and landowners as well as staff and supervisors from local communities, water resource districts, and soil conservation districts.

- The Grand Forks County SCD was awarded Section 319 funding in 2015 to support the implementation of the Upper Turtle River Watershed project. The primary goal for the project is to restore the recreational uses of the North and South Branches of the Turtle River in western Grand Forks County. As a secondary goal, the SCD will also initiate a county-wide educational program to increase producer understanding of the benefits of soil health management and the BMPs they can

adopt to improve soil health. The project goals will be accomplished by conducting a series of soil health workshops, tours and demonstrations as well as by providing financial and technical assistance to implement BMPs that reduce E. coli bacteria concentrations in the river. BMPs to be promoted and implemented may include manure management systems, cross fencing, livestock watering facilities, riparian buffers and cover crops. Emphasis will be placed on addressing management needs within the riparian corridors and on the priority cropland and rangeland acres in the watershed.

- The Wild Rice SCD received Section 319 funding in 2014 and 2016 to implement Phase II of 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. During Phase II, the project will focus 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 will be 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 that will be 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.

- The Walsh County Three Rivers SCD was awarded Section 319 funding for the Homme Dam watershed project in 2014. Outdoor Heritage Funds were also awarded to the project in 2015. The SCD is using the funding to promote and implement BMPs that will maintain the aquatic life and recreational uses of Homme Dam. To maintain the beneficial uses, the SCD's land management improvement efforts will focus on maintaining the chlorophyll-a concentrations in the reservoir through the reduction of total phosphorus concentrations in waters entering Homme Dam. The project will provide technical and financial support to implement BMPs that protect or enhance riparian areas as well as improve grazing and woodland management along the South Branch of the Park River, upstream from the reservoir. BMPs supported by the project will be targeted toward the priority areas closest to Homme Dam's inlet. Land use within these priority areas primarily consists of pastures and woodlands, with a mix of cropland. Practices that will be 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. To restore the beneficial uses, the SCD's land management improvement efforts will focus on the reduction of in-stream concentrations for E. coli bacteria, total nitrogen, total phosphorus and total suspended solids. These reductions will be achieved by providing technical and financial support for the implementation of BMPs that focus on manure management, riparian grazing, nutrient management, cover crops, and riparian buffers. Implementation of the BMPs will be targeted toward the highest priority sub-watersheds and areas of cropland and grazing land immediately adjacent to the 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 will use 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 will offer technical and financial assistance to agricultural producers for conservation planning and BMP installation as well as conduct information/education activities centered on reducing livestock impacts within the riparian corridor. Priority BMPs to be promoted

and installed include prescribed grazing systems, fencing, watering facilities, cover crops, septic systems and manure management systems.

- The Grand Forks County SCD was awarded Section 319 funding in 2016 to support the implementation of the English Coulee watershed project. The main goal for the project is to achieve an improving trend towards fully supporting but threatened status for 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 will offer technical and financial assistance to producers for riparian grazing management, fencing, tanks, pipeline, use exclusion, cover crops, and septic systems

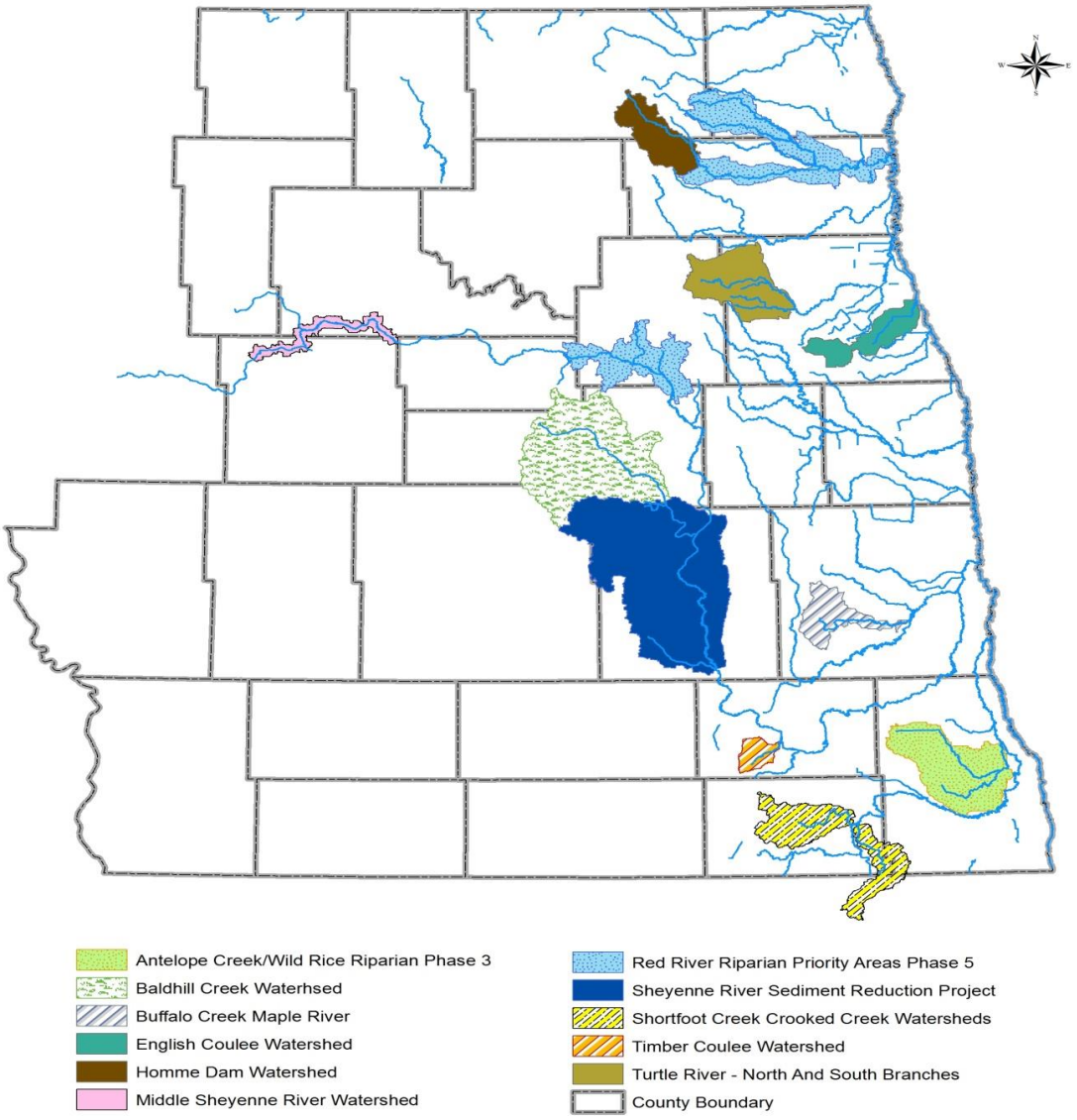


Figure 6 Watershed and Water Quality Assessment and Restoration Projects in the Red River Basin, North Dakota.

Pollution Abatement

Manitoba

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, habitat for aquatic life and wildlife, 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.

- Monitoring
    - Routine monitoring of physical, chemical and biological conditions on Lake Winnipeg from the *MV Namao* continued in cooperation with the Lake Winnipeg Research Consortium and others. Three scientific cruises on Lake Winnipeg were completed in 2015. Manitoba Sustainable Development led winter sampling efforts in early 2015 including collection of physical, chemical and biological samples by helicopter and snow machine on the north and south basins of Lake Winnipeg.
    - Manitoba Sustainable Development collaborated with Minnesota, North Dakota and the Canadian federal government on a first of its kind survey of water quality, algae and benthic invertebrates along the international Red River in the US and Canada. Manitoba Sustainable Development led sample collection efforts and implementation of new attached algae sampling techniques in Canada.
- 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 biosolids/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 immediately for 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. Existing wastewater treatment facilities discharging more than 820 kilograms of phosphorus per year (serving more than 2,000 people or equivalent due to industrial contributions) were required to meet a 1 mg/L phosphorus limit by January 1, 2016.

- Integrated Watershed Management Planning:

    - Work on integrated watershed management planning under *The Water Protection Act* continues in Manitoba. To date 25 plans have been initiated, of which 20 have been completed. Planning continues for five watersheds including the Cooks-Devils Creek, Boyne – Morris, and Roseau River. Integrated watershed management plans are compiled by local water planning authorities with stakeholder input and are to be 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 planning 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 knowledge of the watershed environment as well as initiatives to monitor, maintain, and improve environmental conditions in the watershed http://www.gov.mb.ca/waterstewardship/iwmp/index.html).

8.0 BIOLOGICAL MONITORING IN THE RED RIVER BASIN

8.01 Macorinvertebrates of the Red River in Manitoba

Biological Information

Benthic macroinvertebrates were collected at two locations on the Red River in September 2015: Emerson and Selkirk (Table 10). 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 glass jars with 70 % ethyl alcohol preservative. Macroinvertebrates were subsequently identified to the lowest possible taxonomic level, typically genus and species, by ALS Environmental, Winnipeg, MB.

Table 10. Geographic coordinates for the benthic macroinvertebrates sampling stations at Emerson and Selkirk on the Red River, Manitoba in September 2015.

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

In 2015 at Emerson, 73 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 635 organisms/m^2 (Table 11). At Emerson, the organisms in greatest abundance were from the order Trichoptera (Family Hydropsychidae), a relatively pollution-tolerant net spinning caddis fly larvae.

In the Red River at Selkirk, 270 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 2349 organisms/m^2 (Table 12). The organism of greatest abundance at Selkirk were classified as: Class Insecta, Order Diptera, Family Chironomidae, Genus Chironomus. The second most abundant type of organism was from the Class Annelida, Order Oligochaeta, Family Tubificidae.

Both reaches of the Red River had a similar species richness of benthic macroinvertebrates in 2015. The Red River near Selkirk had a higher number of total organisms due to a few subsamples that included a large number of Tubificidae worms and Chironomidae. Tubificidae are typically tolerant to organic pollutants.

Table 11. 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 2015.

Class	Order	Family	Genus	Species	Number per transect
Crustacea	Copepoda	Cyclopida			3
Insecta	Coleoptera	Elmidae	*Dubiraphia*		2
Insecta	Coleoptera	Elmidae	*Stenelmis*		3
Insecta	Diptera	Ceratopogonidae			1
Insecta	Diptera	Chironomidae	*Axarus*		2
Insecta	Diptera	Chironomidae	*Ceolotanypus*		1
Insecta	Diptera	Chironomidae	*Corynoneura*		1
Insecta	Diptera	Chironomidae	*Endochironomus*		1
Insecta	Diptera	Chironomidae	*Unidentified pupa*		3
Insecta	Ephemeroptera		*Unidentified*		1
Insecta	Ephemeroptera	Heptageniidae			1
Insecta	Ephemeroptera	Leptohyphidae	*Tricorythodes*		1
Insecta	Trichoptera	Hydorpsychidae	*Hydropsyche*		4
Insecta	Trichoptera	Hydorpsychidae	*Potamyia*		42
Insecta	Trichoptera	Hydorpsychidae	*Unidentified*		4
Insecta	Trichoptera	Leptoceridae	*Nectopsyche*		1
Pelecypoda	Veneroida	Pisiidae	*Unidentified*		2
			Total number of organisms		73
			Total number per square metre		635
			Total number of taxa		17

Table 12. Summary of macroinvertebrates collected per transect and calculated total per metre squared in pooled Ponar © dredge samples on the Red River at Selkirk, Manitoba in September 2015.

Class	Order	Family	Genus	Species	Number per Transect
Annelida	Unidentified				6
Annelida	Oligochaeta	Naididae	*Nais*		3
Annelida	Oligochaeta	Tubificidae	*Branchiura*	*sowerbyi*	4
Annelida	Oligochaeta	Tubificidae	*Unidentified*		72
Crustacea	Copepoda	Cyclopoida			2
Crustacea	Ostracoda				6
Gastropoda	Neotaenioglossa	Hydrobiidae	*Amnicola*	*limosa*	1
Gastropoda	Prosobranchia	Valvatidae	*Valvata*	*sincera*	2
Insecta	Diptera	Ceratopogonidae			2
Insecta	Diptera	Chironomidae	*Chironomus*		135
Insecta	Diptera	Chironomidae	*Cryptochironomus*		4
Insecta	Diptera	Chironomidae	*Procladius*		1
Insecta	Diptera	Chironomidae	*Unidentified pupa*		1
Insecta	Ephemeroptera	Ephemeridae	*Hexagenia*	*limbata*	1
Insecta	Ephemeroptera	Leptohyphidae	*Tricorythodes*		1
Nematoda	unidentified				2
Pelecypoda	Veneroida	Pisiidae	*Sphaerium*		1
Pelecypoda	Veneroida	Pisiidae	*unidentified*		27
			Total number of organisms		270
			Total number per square metre		2349
			Total number of taxa		18

Benthic Invertebrate Indices: Simpsons Eveness, 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.

$$\mathbf{D} = 1 - \sum_{i=1}^{s} (\mathbf{p}_i)^2$$

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 0.65 and 0.68 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

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

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 calculated for the two sites were 0.17 and 0.173 for Emerson and Selkirk respectively. The Evenness score for both sites was influenced by relatively large numbers of individuals from one or two taxa.

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 7 and Selkirk was 2. No samples included the pollution intolerant Order Plecoptera. Percent EPT is the total number of EPT individuals divided by the total number of individuals in the sample. Percent EPT was 74 percent for Emerson and 1 percent for Selkirk. The number of EPT individuals at Emerson was highly influenced by a large number of individuals from the Hydropsychidae family which is a group known to be relatively pollution tolerant. Excluding this group the modified EPT percent would be 5% for Emerson and 2% for Selkirk.

The Bray-Curtis Index compares the community composition of two sites where the co-efficient reaches a maximum of 1 for two sites that are entirely different and a minimum score of 0 for sites that possess identical composition (Legendre and Legendre, 1983). The calculated Bray-Curtis Dissimilarity Index was 0.92 indicating the sites community compositions were considerably different. Selkirk had a larger amount of Tubificidae worms, and Chironomidae. Selkirk had families that were not present at Emerson such as Naididae, Hydrobiidae, Vavatidae, and Ephemeridae. At Emerson there were several families present that were not found at Selkirk, including Heptageniidae, Leptoceridae, and Elmidae.

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.

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

Manitoba monitored eighteen recreational beaches within the south basin of Lake Winnipeg for levels of *Escherichia coli* during 2015 (Table 13). Sampling began at the end of May and continued weekly until the beginning of September. Two beaches were monitored twice per week. Bathing water samples near the shoreline were collected and analyzed for densities of *E. coli*.

While some beaches occasionally exceeded Manitoba's recreational water quality objective for fecal indicator bacteria, typically recreational water quality is excellent at Lake Winnipeg beaches. All beaches have "Clean Beaches" signage 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 2007 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 2015 beach monitoring program, Manitoba Sustainable Development continued to monitor beaches on Lake Winnipeg for the presence of algal blooms. On Lake Winnipeg, only West Grand Beach was posted with the first level of algae advisory indicating the number of blue-green algae cells exceeded the Manitoba recreational water quality objective of 100,000 cells per mL. The first level of algae advisory informs bathers that algae blooms have been observed at the beach and provides some additional advice regarding avoiding contact with the water when algae blooms are present. The second level of advisory or algae 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 2015 there were no beaches on Lake Winnipeg posted with second level algae advisory signs.

Table 13. Recreational beaches in Lake Winnipeg south basin monitored in 2015.

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

8.03 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 14). Presently, Bigmouth Buffalo (*Ictiobus cyprinellus)* and Chestnut Lamprey (*Ichthyomyzon castaneus*) are designated as Special Concern under *The Species at Risk Act*. In 2005, Lake Sturgeon (*Acipenser fulvescens)* was recommended for listing as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

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 hydro-electric 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 Manitoba's 2005 Angler Survey, Manitobans and visitors to the province fished a total of 2.6 million days, of which 10% were spent on the Red River, making it among the most heavily fished waterbodies in the province. It is estimated that anglers fishing the Red River contribute $15-20 million annually on goods and services directly/indirectly related to angling. Further economic information is available in the 2012 Travel Manitoba report "Economic Evaluation of Manitoba's Hunting and Fishing Industry".

The fishery attracts nonresidents 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.

The majority of angling effort occurs between the floodway gate structure at St. Norbert to the mouth of the river at Lake Winnipeg. Angling is especially concentrated from the dam at Lockport downstream to Netley Creek and within the City of Winnipeg. Ice fishing activity for Walleye has been expanding rapidly on the lower Red River and the southern portion of the south basin of Lake Winnipeg in recent years.

Manitoba Sustainable Development, Wildlife and Fisheries Branch has been collaborating with researchers from the University of Nebraska for 2011 through 2016 on a series of projects to understand and improve management of the 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 14,000 catfish have been tagged with externally visible orange Floy tags to date. In 2014 tagging activities extended to locations south of the City of Winnipeg, including the Red River at the International Boundary. In 2016, over 100 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.

Table 14. 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 other 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.

9.02 Devils Lake Sub-Basin

DEVILS LAKE UPDATE

Hydrology:

The water surface elevation on January 1, 2016 was 1450.0 msl. Spring and early summer precipitation has been above average throughout the Devils Lake and Upper Sheyenne River Basins. During these events, outlet operation has been reduced in an effort to allow the Sheyenne River greater capacity for storms flows. The apparent 2016 peak water elevation for Devils Lake occurred in late April at 1450.3 msl. This is an increase of 0.4 feet from the beginning of 2016. The apparent 2016 peak is about 1.7 feet lower than the 2015 peak and 4.0 feet below the modern day peak elevation that occurred in 2011. The lake elevation had dropped to about 1449.7 by the beginning of July. Substantial rain within the watershed caused an increase of the lake level to about 1450.1 msl on August 1. About 11 inches of rain had been recorded at the gage near the East Outlet from April 1 to August 1, 2016 (Table 15). Rainfall amounts varied throughout the watershed, with some areas receiving several inches more during that time frame.

Table 15 Devils Lake Elevation (2010-2015)

Date	Elevation (msl)	Area (acres)	Volume (acre-feet)
Jan. 16, 2010	1449.92	162,100	3.36 Million
June 27, 2010	1452.05	182,800	3.73 Million
Jan. 16, 2011	1451.62	178,600	3.66 Million
June 27, 2011	1454.30	208,500	4.19 Million
January 21, 2012	1453.3	197,000	4.00 Million
May 7, 2012	1453.6	200,057	4.03 Million
Jan. 1, 2013	1451.4	176,000	3.62 million
June 27, 2013	1454.0	204,852	4.11 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	165566	3.42 million

1. State Emergency Outlet Project Update:

Total outlet flows have ranged from 125 cfs to 500 cfs. The east outlet has not yet operated at full capacity because of water quality and channel capacity limitations in the Upper Sheyenne River. As of the end of June, pumping has removed about 50,699 acre-feet from the lake in 2016.

West Devils Lake Outlet:

The 2016 operation of this outlet started on April 18, at about half capacity. Discharge increased to full capacity, 250 cfs, near the beginning of May. Discharge was steadily around 220 cfs for all of June.

East Devils Lake Outlet:

The east end outlet started operation on May 2, discharging at about 138 cfs for much of May. The east outlet was shut down between May 25 and May 30, to provide greater capacity in the Upper Sheyenne River during periods of rain. Discharge continued at between 160 cfs and 222 cfs until June 18. The pumps were shut down from June 18 through June 20, due to high flows in the Upper Sheyenne River. Pumping resumed at a rate between 120 cfs and 300 cfs for the remainder of June. The following table (Table 16) summarizes the extent of discharge from the outlets for a portion of 2016.

Table 16 Summary of Extent of Discharge from the Outlets for a Portion of 2016

Month	Days Discharged		Average Discharge (cfs)		Monthly Volume (acre-feet)	
	West	East	West	East	West	East
April	13	0	99	0	3,353	0
May	31	24	246	138	15,128	8,490
June	30	27	221	177	13,175	10,553
July	29	24	204	108	12,535	6,621
August	31	28	152	116	9,374	7,150
Sept.						
Oct.						
Nov. 2016						
TOTAL					53,565	32,814

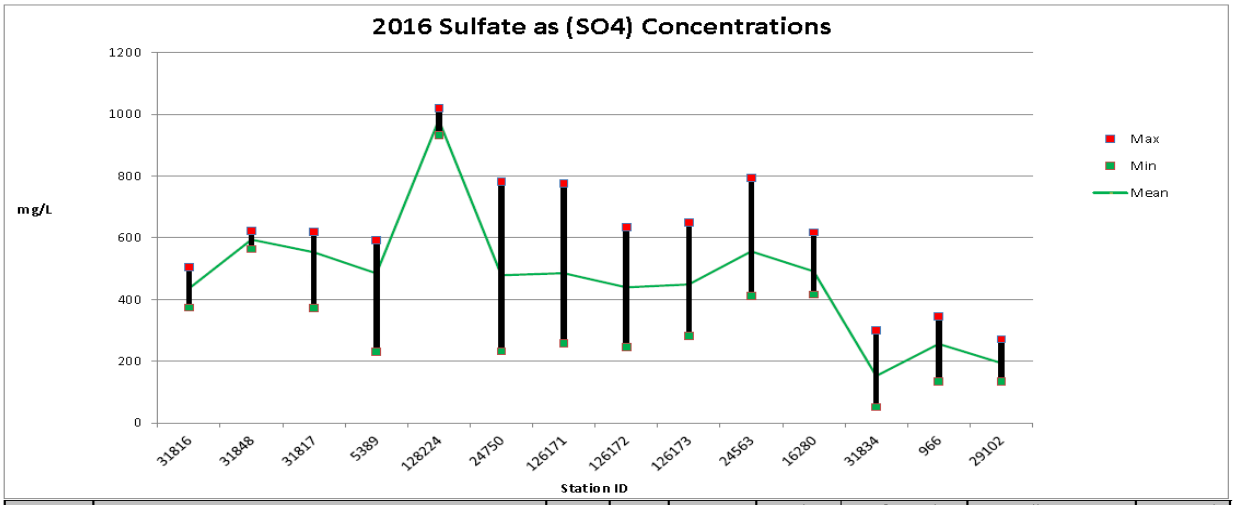
Summary of volume and inches of water removed from the lake since pumping was started in 2005 is shown in the following table (Table 17).

Table 17 Summary of Historic Volumes and Inches of Water Removed from Devils Lake

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	4.2
2011	46,911	2.7
2012	157,542	9.5
2013	141,783	10.0
2014	165,837	11.0
2015	171,234	12.0
2016		
TOTAL	775,514	51.5

Water Quality:

Water quality testing has been ongoing at several locations along the Sheyenne River and Red River. The range of sulfate concentrations measured at various locations, through July 5, 2016, are shown in the figure below (Figure 8).



StationID	Station Description	Max	Min	Mean	Median	# Of Samples	LastCollectionDate	LastResult
31816	Sheyenne River Near Flora	505	373	435.17	436	23	05-Jul-16	494
31848	Devils Lake State Outlet	622	563	593.40	592	20	01-Jul-16	622
31817	Sheyenne River Near Bremen	619	372	552.78	570	23	05-Jul-16	619
5389	Sheyenne River Near Warwick	592	231	483.85	524	13	05-Jul-16	569
128224	East End Outlet at County Road 4	1020	932	980.80	982	15	05-Jul-16	1020
24750	Sheyenne River Near Cooperstown	782	232	478.00	482	16	05-Jul-16	782
126171	Lake Ashtabula East Of Hannaford	776	258	484.50	479	8	05-Jul-16	776
126172	Lake Ashtabula At Sibley Crossing Bridge	634	246	438.88	450	8	05-Jul-16	550
126173	Lake Ashtabula Downstream Location At Ashtabula	650	281	448.13	421.5	8	05-Jul-16	564
24563	Sheyenne River Below Baldhill Dam	794	412	555.44	521	16	05-Jul-16	520
16280	Sheyenne River Near Horace	617	416	491.00	471	15	05-Jul-16	474
31834	Red River Near Harwood	299	50.6	151.40	127	9	29-Jun-16	82.3
966	Red River Near Halstad Mn	345	133	255.22	300	9	29-Jun-16	331
29102	Red River At Pembina	271	133	193.67	197	9	29-Jun-16	233

Figure 8 Range of Sulfate Concentrations Along the Sheyenne and Red River

Additional water quality information is available on the ND State Water Commission website and on the U.S. Geological Services website.

Mitigation:

The Upper Sheyenne River Joint Water Resource District met in Devils Lake on June 14, including a tour of the area on June 15. Many citizens of the region were present and provided input on their opinion of outlet operations. Citizens along the Sheyenne River noted that they are still experiencing erosion issues, but were generally accepting of the situation and mitigation efforts. Farmers with inundated land and the Devils Lake Basin Joint Water Resource District expressed their support for continued pumping while resort owners and other recreational interests would prefer to maintain the current lake level.

Devils Lake Outlet Management Advisory Committee

The committee met on May 3, 2016. The majority of the committee recommended a lake level target for the year of 1448 msl. If the water level of Devils Lake reaches 1448 msl in 2016, the committee will meet again to discuss operations. The historic water surface elevations are shown below in Figure 9 along with water surface elevations from 2010 -2015 (Figure 10).

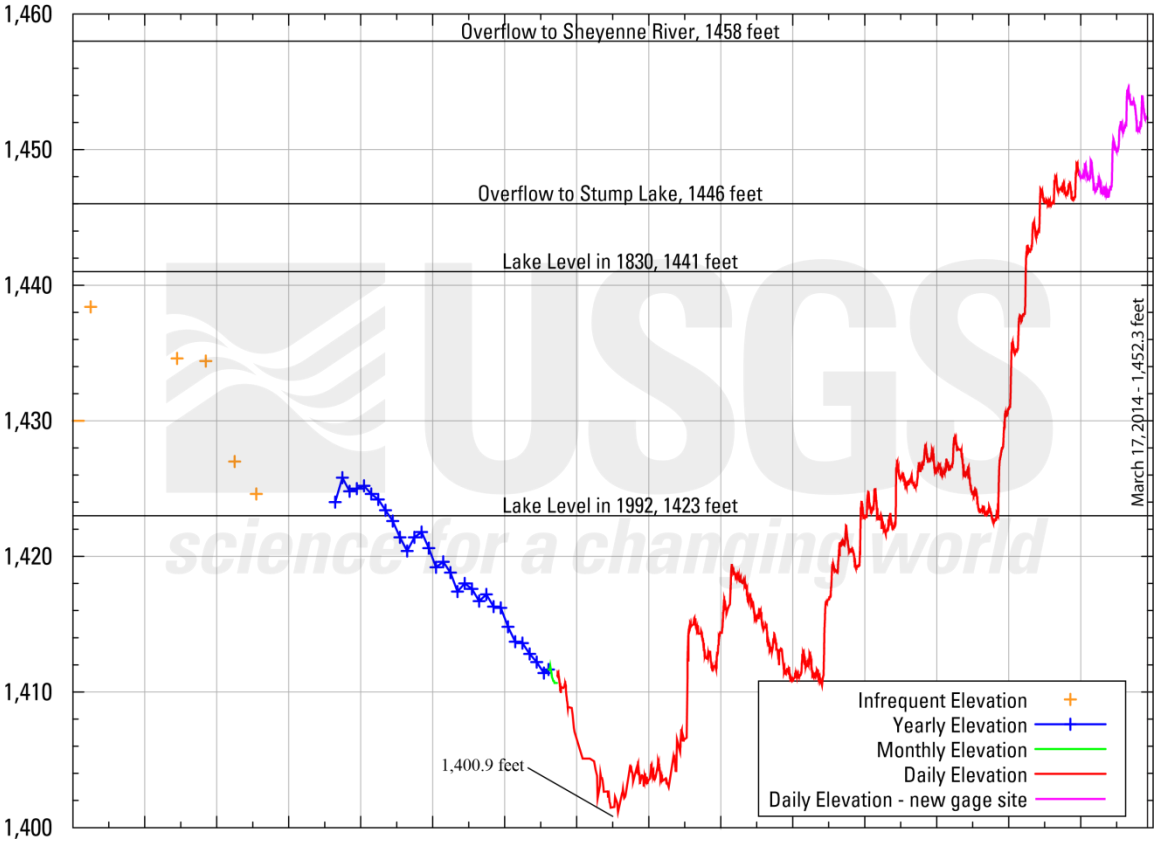


Figure 9 Devils Lake Historic Water Surface Elevations

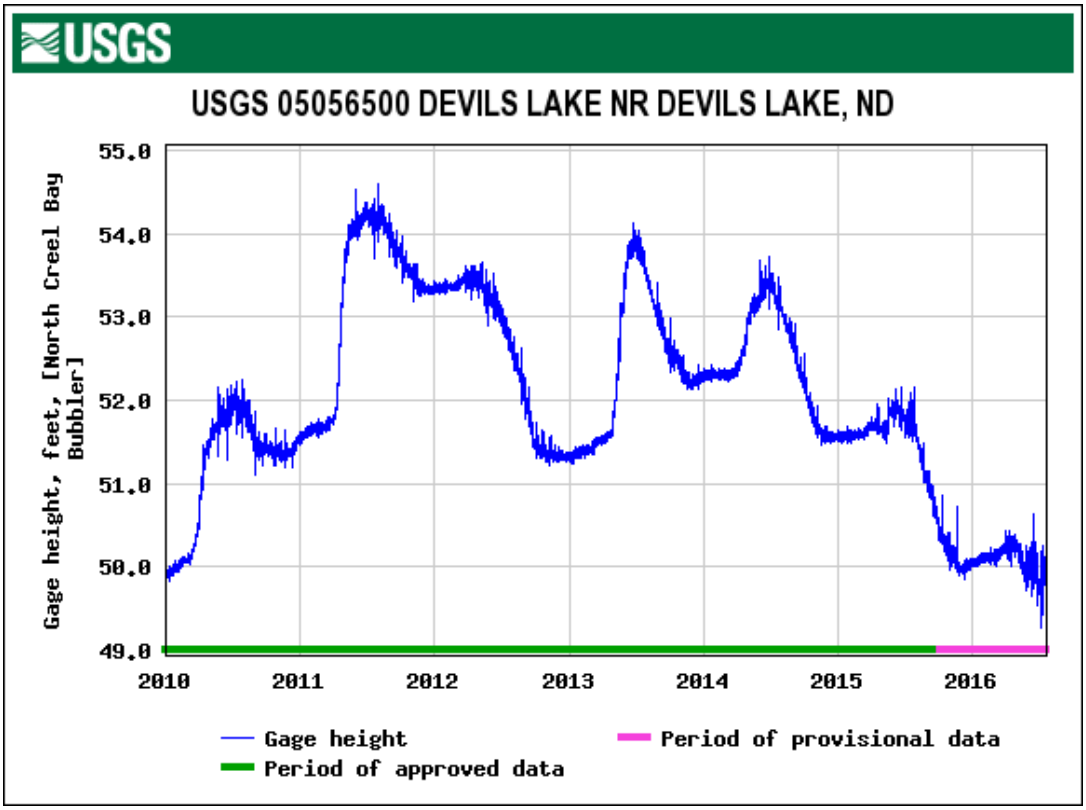


Figure 10 Devils Lake near Devils Lake Water Surface Elevations - 2010-2015

2. Red River Valley Water Supply Project – An extensive amount of engineering and environmental work had previously been completed using an approach to obtain a federal Record of Decision and federal implementation. Because the Secretary of Interior has not signed the Record of Decision, the Lake Agassiz Water Authority (LAWA) and Garrison Diversion Conservancy District (GDCD) had their consultants develop a proposed alternative route concept and project configuration for State and local implementation.

As part of this study to determine the feasibility of acquiring necessary amounts of Missouri River water for any future alignments, CH2M Hill conducted a hydrogeologic analysis and investigated the feasibility of a Bank Filtration System (BFS) design on the Missouri River. The study included a review of existing data, geophysical exploration, soil borings, aquifer pumping tests and conceptual design of an intake along with estimate of probable costs. Additional study was approved in January 2015.

The LAWA and GDCD proposed the following schedule for the project:

- Spring 2016: Complete conceptual design and cost estimate
- Winter 2016: Complete preliminary design and cost estimate
- End 2017: Complete final design an cost estimate
- 2018-2024: Phased bidding and construction

The draft budget to complete conceptual, preliminary, and final design is $66 million. The ND legislation appropriated $12.3 million for the RRVWSP for the 2015-17 biennium.

The status of items included in the conceptual design are:

- Missouri River Intake – Results of two previous studies indicated that only the Washburn area may support 122 cfs and recommended further study of up to four sites. Work includes well pumping tests to determine yield of horizontal collector wells at the sites and the recommended number and spacing of the horizontal collector wells at each site. The previous work was contracted through the SWC and CH2M Hill. The work in this task order was contracted through GDCD and CH2M Hill.
    - Status: All filed work has been completed. The final report is complete and was presented to the LAWA Technical Advisory Committee on January 22. Results suggest that the desired RRVWSP intake capacity of 122 cfs may be achievable through bank filtration intakes at multiple sites in the Washburn area. This would require 9 to 14 collector wells spread across four sites.
- Baldhill Creek Discharge – Utilizing the Baldhill Creek as a water conveyance to Lake Ashtabula could eliminate the need for 13 miles of pipeline and provide a savings of $40 million. Studies include creek capacity and the interaction of Baldhill Creek with groundwater aquifers and impacts, if any, to adjacent lands.
    - Status: Monitoring equipment has been installed for year 2016. A draft report was provided in early April. The draft report documented that the creek can contain the additional flow, but up to 15 cfs could be lost to infiltration and evaporation.
- Pipeline Alignment – The original RRVWSP alignment went from the McClusky Canal to Lake Ashtabula; however, the intake will now be moved to the Missouri River near Washburn. An alignment needs to be established from Washburn to Highway 200 connecting to the original alignment. Also, the original alignment needs to be refined to minimize permitting.
    - Status: A draft report with a proposed alignment and cost estimate was released in early March. The alignment has been reviewed by GDCD and LAWA and was submitted to the USCOE for jurisdictional determination.
- Hydraulic and Pump System Analysis – The intake site has moved from the McClusky Canal to the Missouri River near Washburn, including a new segment of pipeline connecting the two. This task order will build on existing data and expand and refine the hydraulic operational characteristics of the pump stations and control facilities required to successfully operate the RRVWSP. The specific goals will be to provide an updated hydraulic analysis of the entire project, a conceptual layout of pumping facilities and a conceptual level cost estimate of those pumping facilities.
    - Status: The team discussed a range of pumping flows, placement of a water treatment plant, closed system versus open system using break tank and hydraulic differences with each option. The draft report showing a conceptual design for the hydraulic structures and a cost estimate for the hydraulic structures was released in April 2016.
- Horizontal Collector Well Conceptual Design – The information collected from the Missouri River intake studies will be used to develop conceptual design and cost estimates.
    - Status: Four sites have been identified with potential hydrogeology. It is estimated that 9 to 14 collector wells would be required to achieve the desired capacity spread across the 4 sites. An additional 30 miles of pipe will be required to manifold the collector well sites together. Efforts have started to develop a conceptual design for each of the collector wells. The horizontal alignment for the piping to each collector well has been established, as have the initial pump sizes for each collector well. A draft report was to be released in mid-April 2016. No further work is recommended at this time for the collector wells. Continued work under this task order will be moving forward with a conventional intake conceptual design.
- Land Services – An alignment needs to established from Washburn to Highway 200 connecting to the original alignment. Documents for acquiring new easements will be prepared.
    - Status: The task order is being revised to reflect the implementation plan, and work is continuing.
- Needs Assessment – The original capacity of the RRVWSP was 122 cfs. Water uses in the LAWA service area will be asked to review their needs to determine if 122 cfs is an appropriate size. Furthermore, systems along the pipeline routes will be canvassed to see if there is a need to service those systems from the State project.

    - Status: A list of potential users has been generated, and letters sent to most of the systems requesting a meeting to discuss their potential participation in the project. Water usage and population projections have been generated in these areas. Many meetings have been held, with more planned.
- Water Treatment Plant Analysis – The federally proposed water treatment plant used pre-treatment, filtration, and disinfection processes located near the McClusky Canal. The State project will be using Missouri River water either through a horizontal collector well near Washburn or a conventional intake near Washburn. The location and level of treatment needs to be reviewed. A range of treatment processes will be developed to compliment the RRVWSP concept design and estimate.
    - Status: The Bismarck collector well data and results from the bank filtration study are being used to establish expected conditions in the source water. Overall treatment goals have been drafted that are consistent with the Boundary Waters Treaty for a biota water treatment plant. Alternative treatment processes are being developed to deal with a wide range of goals. Depending on the source water, processes included are 1) pre-sedimentation with no treatment, 2) pre-sedimentation with chlorination/dechlorination, 3) pre-sedimentation, chlorination/dechlorination with UV, and 4) filtration, sedimentation, chlorination/dechlorination and UV.
- Implementation Plan – The report will include project costs, operation and maintenance costs, construction schedule, review regulatory issues, and the discuss how to implement the project in phases.
    - Status: Ongoing

Preliminary Design

Engineering teams are ready to start the preliminary design phase. With a total cost of $10 million, the design is planned to be done in phases. The implementation plan will provide a road map to move forward with items that have to be completed first, which include permit phasing, design phasing, and construction phasing.

1. Pipeline alignment McClusky to the split – This pipeline segment from the McClusky Canal traversing east to the split is required for all options under the implementation plan. This segment has the highest priority of all segments. Preliminary design items, such as field wetland boundaries, determine trenchless construction boundaries, utility identification, location of valves and blowoffs, and horizontal and vertical layout of pipeline. Estimated cost is $2,800,000. Status: Initiated.
2. Missouri River Conventional Intake/COE Permit – The implementation plan identified using a conventional intake near Washburn as a viable option. Conventional intake plans and drawings will be generated and submitted to COE for approval. Work includes preliminary design of the intake and pump station, survey river bathymetric survey, environmental and geotechnical information, and permit application. Estimated cost is $1,000,000. Status: Inititated.
3. Financial Modeling – Financial impacts to the local users of the RRVWSP under various finding levels, project implementation scenarios and cost share scenarios will need to be evaluated. Financing strategies will be generated from these scenarios. The task order will assist GDCD in this effort. Estimated cost is $363,800. Status: Inititated.
4. Pipeline alignment Washburn to McClusky – Future Work
5. Pipeline alignment split to Baldhill Creek – Future Work
6. Municipal Advisor – A request for Proposal for a Municipal Advisor to provide financial advisory services for the RRVWSP is underway. The selected firm will work in collaboration with the financial modeling team. The firm selected will have a fiduciary responsibility to GDCD. Status: Underway.

3. Northwest Area Water Supply (NAWS)

Supplemental EIS

The Bureau of Reclamation (Reclamation) issued the Record of Decision for the Final Supplemental Impact Statement (SEIS) for the Northwest Area Water Supply on August 21, 2015. Reclamation received seven comment letters on the FSEIS, which along with point-by-point responses were included as an appendix to the Record of Decision. The Preferred Alternative includes a supply from the Missouri River (Lake Sakakawea) with an intake at Snake Creek Pumping Station along with a conventional treatment option for the Biota Water Treatment Plant near Max. This level of treatment includes five treatment processes versus two from the draft SEIS and the initial Environmental Assessment. Although all biota treatment options were considered sufficient by Reclamation, the conventional treatment option was chosen to address drinking water issues raised by the EPA.

Manitoba & Missouri Lawsuit

A Joint Motion for Entry of Case Management and Scheduling Order was submitted to the District of Columbia District Court December 22, 2015 and accepted with minor modifications December 23, 2015. The plaintiffs filed supplemental Complaints January 29, 2016 and the defendants lodged and served the Administrative Record February 5, 2016. A Motion to Modify Injunction Pendente Lite was filed by the State of North Dakota as intervenor defendant March 1, 2016. Oppositions by the Plaintiffs were filed April 4, 2016 and a reply was filed April 25, 2016 by the State. The Plaintiffs filed a Motion for Leave to sur-reply May 18th and an opposition to that motion was filed May 20th by the State of North Dakota. The Plaintiffs then filed a response to the opposition on May 25. The Motion for Leave was accepted by the Court on May 27th. The Motion for Modification to the Injunction was denied by the Court on June 14, 2016.

Motions for Summary Judgment were originally to be filed by the defendants on April 11, 2016, with combined cross-motions/opposition by the plaintiffs due May 13, 2016 and combined oppositions/replies by the defendants due June 17, 2016. However, the briefing schedule was delayed once due to a desire by the federal defendants for additional time for review and a medical issue for the plaintiff's legal counsel and then again for the same medical issue for the plaintiff's legal counsel. The defendants consented on both requests to delay the briefing but filed a joinder on the second request to ask the court to expedite the judgment filed June 3, 2016 with combined Opposition/Cross-Motion by the plaintiffs to be filed July 8, 2016 and combined Reply/Opposition by the defendants to be filed August 9, 2016 at which point the case will be fully briefed. This court typically takes four to six months to reach a verdict after the cases are fully briefed.

4. Watershed Detention Strategies – Distributed detention strategies have been completed in nearly all sub-basins in the Red River basin of ND. Studies for the remaining two sub-basins, the Park River and Pembina River watersheds, are expected to be completed in the summer of 2016. Potential temporary storage sites, for the purpose of flood damage reduction, were located within each sub-basin. Criteria used included the requirement that each site had a drainage area of at least 20 square miles, that it was capable of temporarily holding at least 3 inches of runoff, that off-channel sites be analyzed throughout the drainage area, and a combination of off-channel and on-channel sites analyzed in the upper portion of the tributaries.

The newly completed HEC-HMS hydrology models were used to develop hydrographs for various events and to compare the change in hydrograh if each potential site were in place. The volume of water removed from the flood hydrograph within each sub-basin was compared to the amount described in the Red River Basin Commission (RRBC) LTFS study, to determine if each sub-basin was capable of obtaining the storage described in that report.

A similar effort has been completed on the MN side of the Red River watershed.

To achieve the 20 percent reduction goal developed by the RRBC, it is estimated that retention projects in the basin need to temporarily store about 1.5 million acre-feet of water. Using the data provided in the detention studies, and detailed discussion with each individual member of the RRJWRD in ND and the RRWMB in MN, a list of potential projects has been prepared. The projects are in various stages of development; with some close to construction, some at various levels of study/design, and some just getting underway.

The local water boards are also working with the Corps of Engineers to develop a model to be able to provide a more accurate analysis of the impacts of potential flood water detention dams at the downstream end of each tributary and at several locations on the Red River mainstem. This will further define the required amount of storage required to meet the 20 percent peak flow reduction strategy described in the RRBC LTFS report. Possible impacts to the flood hydrograph on the Red River mainstem have already been determined for the southern portion of the watershed (to Halstad, MN).

5. 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.

The RRRA and its members have been aggressively pursuing federal dollars to off-set local costs for retention projects, and will serve as an advocate for local projects in the federal regulatory process. The U.S. Department of Agriculture has included the Red River Basin in the Prairie Grasslands Region Critical Conservation Area. This provides an opportunity for the RRRA to apply for funding through the Regional Conservation Partnership Program, which is included in the 2014 farm bill.

The Red River Watershed area in the U.S. received up to $50 million over 5 years in targeted funding to develop projects with the various farm practice programs that are available. The funds are to be used for projects to reduce flood damage, increase soil health, and improve water quality. Private landowners will be able to use existing programs for these purposes. It has been stated that the rules for these programs will be "flexible" in order to obtain some of the flood damage reduction goals. Practices that would slow down the water, providing flood damage reduction and water quality benefits have been prioritized by the RRRA.

In addition, the Secretary of Agricultural announced on January 14, 2015 that up to $12 million was included in funding for the Red River Basin of the North Flood Prevention Plan through the NRCS-Regional Conservation Partnership Program (RCPP), Figure 11. The Red River Retention Authority will be the lead partner for the projects. 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 20 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. The process for the study will identify any potentially feasible projects that would accomplish the goals set by the sponsors. Each study is expected to take about 2 ½ to 3 years to complete. The procedure, and information obtained, 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. While the main purpose of the projects is for flood damage reduction, water quality benefits may also be obtained.

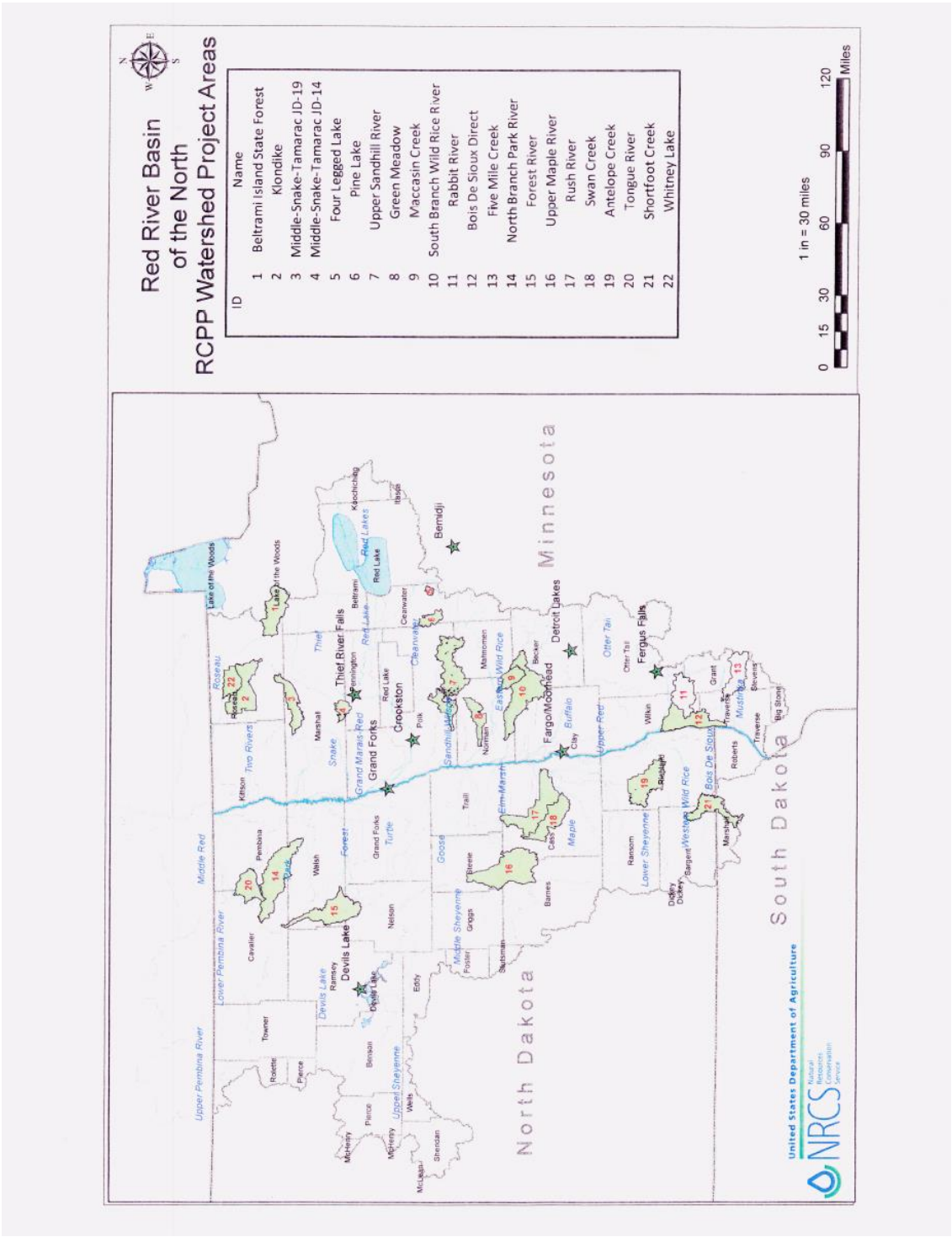


Figure 11 Red River Basin of the North RCPP Watershed Project Areas

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

Introduction

The Corps of Engineers has a long history of involvement in water resource issues in the Red River of the North basin. Current Corps activities in the basin include operating flood control and multipurpose reservoirs, conducting flood risk management and ecosystem restoration studies, constructing flood risk management and ecosystem restoration projects, conducting and participating in special studies and initiatives, regulating work in navigable waters and other waters of the United States, and providing emergency assistance and disaster response. The Corps cooperates and collaborates with other Federal and State agencies, local watershed districts, environmental groups, and local communities to address water resource problems and opportunities in the basin.

Current Construction Projects

Breckenridge, Minnesota, and Wahpeton, North Dakota

Wahpeton and Breckenridge are at the confluence of the Bois de Sioux and Otter Tail Rivers, the beginning of the Red River of the North. The flood risk management projects for these cities are treated as two separate, but dependent, projects.

The Breckenridge project consists of a high-flow diversion channel north of the Otter Tail River and two separable permanent levee reaches. The diversion channel was completed in June 2005 and operated for the first time in summer 2005. It has prevented nearly $164 million in combined damages (Breckenridge and Wahpeton) through 2015. Construction of the entire project is essentially complete. The total estimated cost for the Breckenridge project is $45.02 million.

The Wahpeton project, authorized under the Corps' Section 205 Continuing Authority, consists of a permanent levee system and flood easements. Construction of the Wahpeton project began in 2003 with interior flood control features. Levee construction was completed in 2012. A seepage cutoff for Stage 3b was completed in 2014 and the project is essentially complete. The local sponsor has begun working to remove levee encroachments in the zoo with completion expected in 2016. The total estimated cost for the Wahpeton project is $21.2 million.

Devils Lake Embankment, North Dakota

Devils Lake is subject to extreme variations in lake levels, depending on the climate change. Currently (December 28, 2015) the lake is at elevation 1450, down from its record elevation of 1454.3 in June of 2011. The embankment construction is complete to a minimum elevation of 1466, with minor drainage corrections to be completed. The current estimated cost for this work is $180.8 million.

Emergency Operations

During flood events in the Red River basin, the Corps' St. Paul District provides emergency assistance in support of the locally-led flood response. We become part of a large force made up of local, State and Federal responders as well as volunteers. In 2015 the Corps' St. Paul District's new Red River of the North Flood Area Manager, Mark Wilmes, worked with Rich Schueneman to become familiar with the basin and meet local and state officials in the Red River of the North basin.

North Dakota Environmental Infrastructure Program (Section 594)
The Corps is authorized to assist communities and rural areas in North Dakota under the North Dakota Environmental Infrastructure Program. The Corps provides design and construction assistance for wastewater treatment and related facilities; combined sewer overflow; water supply, storage, treatment, and related facilities. In fiscal year 2015 the Section 594 program received $2.25M in for the Cooperstown Water System Improvement Project, in which a Project Partnership Agreement (PPA) was executed in July 2015. Within the Red River Basin the cities of Kindred, Enderlin, and Leonard have requested support for water and wastewater improvements.

Roseau, Minnesota
A flood risk management project for the city of Roseau, Minnesota, was authorized in the Water Resources Development Act of 2007. The project includes a 4.5-mile long diversion channel, a Red River restriction structure and associated recreation features. The estimated project cost is $41.8 million. Construction is completed and the Corps is working with the City to obtain certification as providing a 100-year level of flood protection in accordance with the Federal Emergency Management Agency's national flood insurance program.

Studies

Fargo-Moorhead Metropolitan Area, North Dakota and Minnesota
The project was authorized in Section 7002 of the Water Resources Reform and Development Act of 2014. The Federal plan is the North Dakota 20,000 cubic feet per second (cfs) diversion with upstream staging. The plan includes a 30-mile long diversion channel, a 6-mile long connecting channel, 12 miles of tie-back embankments, 4 miles of overflow embankment, levee/floodwall features in Fargo and Moorhead, control structures on the Red and Wild Rice (North Dakota) rivers, gated diversion inlet structure, aqueducts on the Sheyenne and Maple Rivers, and ring levees around the communities of Comstock, Minnesota and Oxbow/Hickson/Bakke, North Dakota. The project is currently in the preconstruction engineering and design phase. Federal construction will begin upon receipt of a New Start and a construction appropriation. The project has been identified as an alternative financing and delivery demonstration project and will be implemented utilizing a public private partnership (P3) model. The P3 agreement was signed in July 2016. The first construction contract will be awarded in the fall of 2016.

Red River Basin-wide Watershed Study
The Corps began a basin-wide watershed study in June 2008. All phases of the study are expected to be complete in late 2017. The North Dakota Joint Water Resource District and the Minnesota Red River Watershed Management Board are the local sponsors for the study. HEC-HMS modeling was completed in 2014. The mainstem RAS model is in the final phases of development. The Red River Basin Commission published the long-term flood solutions report in December 2011, and published an update in 2015. The Red River Basin Decision Information Network website (www.rrbdin.org) continues to be updated, and LiDAR data, hydrologic and hydraulic models and other information have been linked to the site. The CWMP began in 2014 and is intended to provide an update to the Red River Basin Natural Resources Framework Plan. Six CWMP working groups have been formed and are developing goals, objectives, and recommendations for six focus areas: water quality; flood risk management and hydrology; fish, wildlife and ecosystem health; recreation; soil health; and water supply. The CWMP will be used to inform future local and Federal investment in the Red River basin. A draft CWMP was provided for review and discussion in early 2016. The CWMP will be completed in 2017. A retention model was initiated by the Corps in late 2015 for areas downstream of Halstad. The Lower Red Basin (LRB) retention modeling will be complete in 2017.

Programs

Silver Jackets

The North Dakota and Minnesota Silver Jackets teams recently completed a pilot project that developed an emergency action plan (EAP) guidebook template. This product will be used in another project to host three or four full day workshops around the Red River Valley to provide hands-on facilitation for communities and counties to begin development of their own flood emergency action plans. The EAP workshops will also include on-going support to communities that choose to develop EAP documents.
Another study in progress is the investigation of the placement of hydrologic instrumentation in the valley to improve flood forecasts, especially for spring snowmelt floods. A new Silver Jackets pilot project will update river gage datums to apply the latest advances in land surface surveying technology and provide consistency in reporting to reduce public confusion on river gage reports.

Planning Assistance to States

A HEC-RAS Unsteady Flow Model has been developed for the Red River from Halstad, Minnesota, to Pembina, North Dakota under the Section 22 Planning Assistance to States Program. The model has been calibrated and verified to the 2006 and 2009 floods. The North Dakota State Water Commission has developed a separate HEC-RAS Unsteady Flow Model of the 2006 flood on the Pembina River from Walhalla to Pembina. The two models are being combined. Other tributaries could be added as funds allow.

Project Modification Reviews: Section 408

Title 33 USC 408 (Section 408) authorizes the Secretary of the Army to grant permission to others to alter or modify an existing Corps project in certain circumstances. Proposals submitted for Section 408 review and approval undergo a rigorous engineering, policy and environmental review by the Corps and, if required, independent external peer review. Within the Red River Valley, major levee and floodwall alterations were approved at Pembina, North Dakota in 2014. Coordination with the Bois de Sioux Watershed District on a proposed retention project on the Mustinka River in Minnesota continue. Pre-review coordination regarding an alteration at Halstad Minnesota is also underway.

9.04 USGS Water Resource Investigations and Activities

Structural Equation Modeling of Phosphorus in the Red River Basin

With increased runoff in the past few decades, phosphorus loads have increased dramatically in the Red River of the North, especially with respect to Lake Winnipeg. There has been pressure from Canada and from Minnesota to reduce phosphorus loads – an expensive proposition, depending on the method and not always effective during spring runoff.

Using water-quality data with climate and land-use data throughout the basin, including the tile drainage database recently developed by the USGS, a structural equation model will be developed that explains as much of the phosphorus loading in terms of precipitation and land-use patterns as possible. Data from Sheyenne River (North Dakota) and Red Lake River (Minnesota) will be included in the structural equation model, either as potential variables, or the individual tributaries themselves could be modeled with an equation (or equations) and those equations put into the overall model. In addition, data sets such as annual fertilizers and livestock production will be used in the model. In doing this we will address some questions for future applications of structural equation models for water quality by examining whether we can have variables representing different time scales in the model, such as monthly phosphorus load and

annual fertilizer data. We may also include categorical variables, such as soil type. A major goal of this project is to attempt to separate the land-use and climate signals in the phosphorus concentrations and loads.

The States are under pressure to reduce phosphorus exports to Canada; however, if climate was found to be the major driver of the increased load, finding ways to significantly reduce the load would be challenging. We will also try to show how contributions from tile drainage, fertilizer, and livestock production (controllable sources) influence the phosphorus load and respond to climate fluctuations (to the extent that the best available data will allow this). This may point to some practices that could reduce the load. This study also supports the goals of the International Red River Board Water Quality Committee. The results of the study will be published in a peer-reviewed journal article. Some data may be available as supporting material and other data could be provided to MPCA.

Water-surface profile and discharge measurement data collection in the Red River of the North and its Tributaries near Fargo, North Dakota

As the Fargo-Moorhead diversion moves forward in the design phase, discharge and water-surface information is needed at locations where structures are being planned. For design planning on diversion structures on the Red and Wild Rice Rivers and the aqueduct/diversion structures on the Sheyenne and Maple Rivers, water surface elevations at a range of discharges are needed for calibration of HEC-RAS models for the reaches. The purpose of this project is to collect discharge and associated water level information through reaches on the Maple, Wild Rice, Sheyenne, and Red Rivers. One discharge measurement and multiple water surface elevations along each reach will be collected together during six to eight different flow conditions from low-flow up to bankfull conditions. At each of the 4 river reaches, a discharge measurement will be made at one selected site with either an ADCP or conventional measurement equipment. During the same day, water level measurements will either be made at selected sites throughout the reach, or continuously throughout the entire reach if possible by boat. Water-surface elevation data will be collected using RTK-GPS where possible and tied to USACOE benchmarks.

9.05 Manitoba Sustainable Development Water Retention Studies

Manitoba Sustainable Development, through its Water Science and Management Branch, is planning to develop water retention plans for watersheds across Manitoba in the coming years to support integrated watershed management plans. Many individuals and organizations see distributed storage projects as solutions to local watershed management goals including improving water quality and mitigating flooding and drought. When the cumulative impacts of many projects are combined, benefits can occur at the basin scale. This activity supports two initiatives. The first is Manitoba Sustainable Development's Watershed Planning and Programs' integrated watershed management planning process. The second is the larger basin-scale goal of the Red River Basin Commission to reduce flooding on the Red River through distributed storage projects.

The Branch is nearing completion of a pilot study that investigated the potential of distributed water retention in the Canadian portion of the Roseau River Watershed. The project started in summer 2015 and will be completed in fall 2016. The main goal is to identify surface water issues and to provide ideas for potential water retention opportunities in the watershed by:

- Providing general hydrology information of the watershed,

- Summarizing previous reports and plans to identify surface water issues such as water supply, excessive moisture and flooding, and water quality,

- Identifying potential water retention study sites and propose possible projects, and

- Evaluating the potential local and basin scale flow reductions the projects would achieve.

The results of the study were presented to the Project Management Team preparing the Roseau River Integrated Watershed Management Plan in September 2016. A draft report was circulated for review in September 2016 with the expectation of completing the study and final report in the fall of 2016. Based on the success of the Roseau River pilot study, future studies are being planned in the Red River Basin to coincide with Integrated Watershed Management Plans for Cooks-Devils Creek Watershed and the Boyne-La Salle River Watershed. These projects will be completed over the next 1 to 2 years.

9.06 Manitoba Infrastructure

The recently elected Conservative government has reaffirmed that flood mitigation is a high priority for the government. Specifically, the government has approved the $495 M lake Manitoba outlet which is a Federal/Provincially funded project. This project is one component for improving the City of Winnipeg's flood protection level. Engineering is currently underway on this project with a 2020 projected in service date. Flood protection in the Red River Valley is nearly complete (estimated 98% complete) with the implementation of the 2009, 2011 and 2014 Individual Flood protection initiatives(IFPI and community diking programs The 2009, 2011, 2014 programs flood protected 32 homes, 13 farms and 8 businesses in the Red River valley. On the Red River north of the City of Winnipeg, municipalities of East St Paul, West St Paul, St Clements and St. Andrews are receiving improved community flood protection.

With the Minister's acceptance of the recommendations of the Manitoba 2011 Flood Review Task Force Recommendations, the Provincial Flood Protection level will increase to the 1:200 year level or the flood of record. For the Red River Valley this means the 1997 plus 2 foot freeboard will be replaced with the 200 year flood plus freeboard. Communities of St. Agathe and St. Adolphe are being considered for this new flood standard.

In December of 2016, Manitoba Infrastructure, Hydrologic Forecasting and Water Management (HFWM) moved to 280 Broadway. A state of the art flood forecasting center was done in conjunction with the branch relocation. HFWM will be adopting the Deltaires Fuse flood forecasting platform which is compatible with the National Weather Service forecasting system. This will promote Manitoba and NWS collaboration on flood forecasting and data sharing.

Manitoba continues to collect LIDAR and river bathymetric surveys and anticipates enhancing the collection efforts with the 3 year Federal National Disaster Mitigation Program (NDMP) agreement. NDMP also has a flood plain mapping component.

Manitoba has also enhanced the meteorological network with the addition 19 new and 15 upgraded weather stations.

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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 which 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 their release has been authorized by the Commission.

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

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 objectives were adopted for the Red River at the international boundary by the IJC in 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.

Water quality alert levels, for a wide range of parameters, in addition to the five specific parameters noted above, were developed by a working group in 1985. These alert levels were approved by the predecessor International Red River Pollution Board 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 bioconcentrations 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 Water Stewardship – 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

Kristina Farmer - (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 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 Bismark, 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
Jeff Lewis	Red River Basin Commission	1120 28th Ave. N., Suite B Fargo, ND 58102	(701) 356-3183 (o) (763) 226-4016 (c)	jeff@redriverbasincommission.org
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
Scott Jutila	US Army Corps of Engineers	180 East Fifth Street, Suite 700 Saint Paul, Mn, 55101	(651) 290-5631	scott.a.jutila@usace.army.mil

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lnternational Red River Board
Aquatic Ecosystem Committee
Membership:

Name	Organization	Phone	E-mail
Mike Ell	NDHD/Bismarck	(701) 328-5214	mell@nd.gov
Wayne Berkas	USGS/Bismarck	(701) 250-7429	wrberkas@usgs.gov
Mike Vavricka	MPCA/Detroit Lakes	(218) 846-8137	michael.vavricka@state.mn.us
Lance Yohe	RRBC/Moorhead	(218) 291-0422	lancer2b2@corpcomm.net
Patricia Ramlal (Co-Chair)	Fisheries and Oceans Canada	(204) 983-8838	Patricia.Ramlal@dfo-mpo.gc.ca
Megan Estep (Co-Chair)	US FWS	303-236-4491	meg_estep@fws.gov
Nicole Armstrong	MB Conservations & Water Stewardship	(204) 945-3991	Nicole.Armstrong@gov.mb.ca

International Red River Board
Water Quality Committee
Membership:

Name	Organization	Phone	E-mail
Jim Ziegler, (Co-chair)	Minnesota Pollution Control Agency		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	
Eric Steinhaus	US EPA	(303) 312-6837	Steinhaus.Eric@epa.gov
Sharon Reedyk	Agriculture and Agri-Food Canada		
Lance Yohe	RRBC	701 371-8246	lance@redriverbasincommission.org
Jeff Lewis	RRBC	701-356-3183	jeff@redriverbasincommission.org
Mike Vavricka	MPCA/Detroit Lakes	(218) 846-8137	michael.vavricka@state.mn.us
Iris Griffin	Environment Canada	204-984-5694	iris.griffin@ec.gc.ca
Rob Sip	MN Dept. of Agriculture		
Keith Weston	US Dept. of Agriculture		
Elaine Page	MB Conservation & Water Stewardship		
Jim Noreen	US Army Corps of Engineers (CWMP)		

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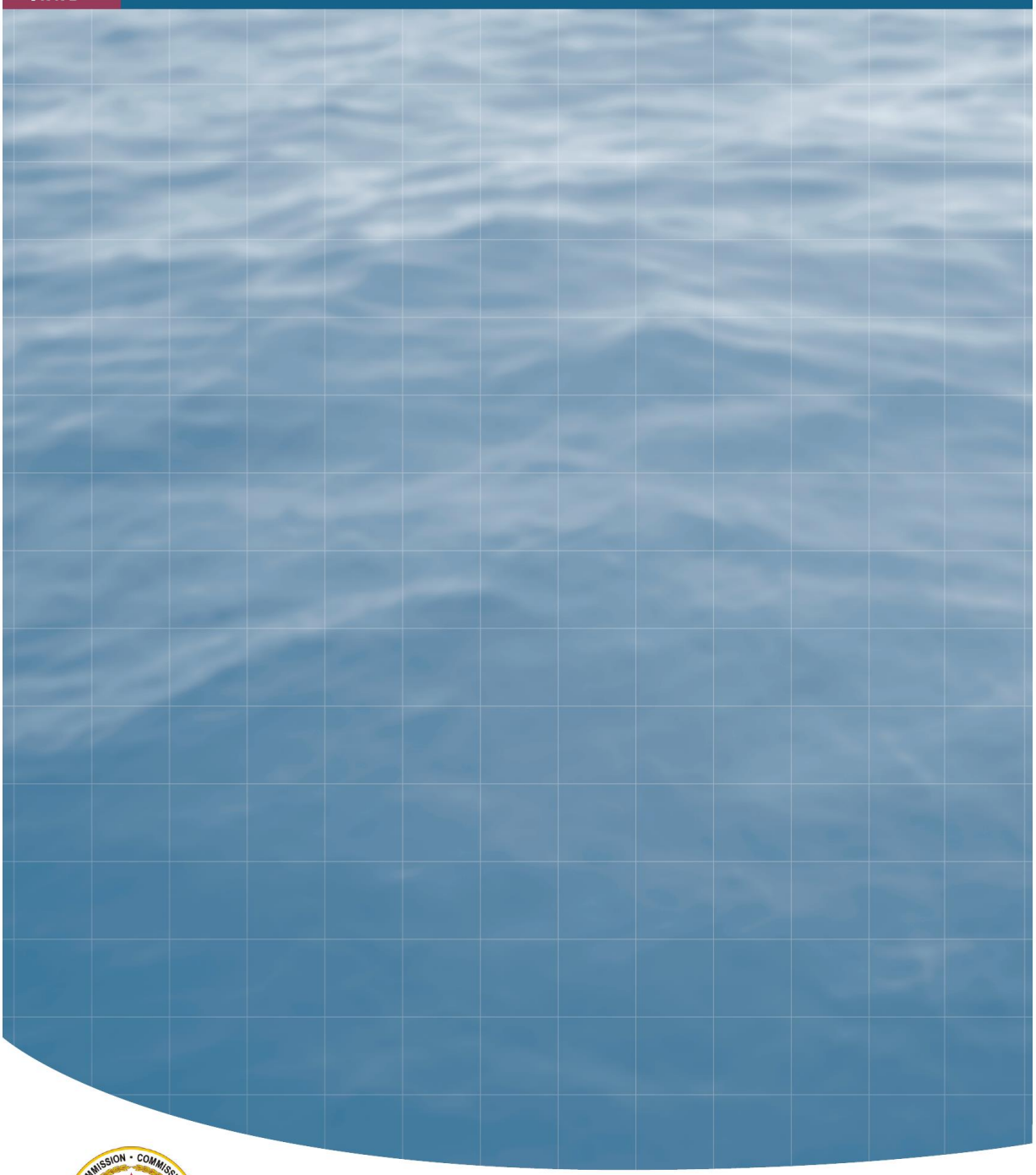


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