

Flood Risk Management and Hydrology

Appendix A



Red River of the North Watershed
June 2017



US Army Corps
of Engineers 
St. Paul District



This page is intentionally left blank.

FLOOD RISK MANAGEMENT AND HYDROLOGY WORKING GROUP REPORT

EXECUTIVE SUMMARY

Flooding is a significant issue in the Red River Basin. Due to its geomorphology and hydrology, flooding is a major concern for residents in the basin; frequent flood events impact urban and rural infrastructure and agricultural production. The flat north-south river valley and the extremely limited topography throughout the basin exacerbate the flooding problems in the area.

The primary source of information for this Flood Risk Management and Hydrology Working Group Report is the September 2011 Red River Basin Commission's Long Term Flood Solutions for the Red River Basin (RRBLTFS) report, and the January 2015 "Long Term Flood Solutions for the Red River Basin Progress Report." The September 2011 Red River Basin Commission's Long Term Flood Solutions for the Red River Basin report and its periodic updates should be referred to when considering the flood risk management and hydrology aspects of this Comprehensive Watershed Management Plan. The parties will continue to work towards the goal of a more flood resilient Red River Basin.

This page is intentionally left blank.

FLOOD RISK MANAGEMENT AND HYDROLOGY WORKING GROUP REPORT

Table of Contents

1	Introduction	1
1.1	Framework	1
1.2	Red River of the North Watershed	1
1.3	Working Group Process	3
1.4	Flood Risk Management and Hydrology Working Group Composition	3
2	Background	3
2.1	Existing Information	3
2.2	Watershed Conditions	4
2.2.1	History of Flooding	4
2.2.2	Climate Change	4
2.3	Drainage	4
2.4	Jurisdictional Considerations	5
2.4.1	Congressional Districts	5
2.4.2	Tribal Nations	5
2.4.3	International Joint Commission	6
2.4.4	Red River Basin Commission	7
2.4.5	International Water Institute	7
2.4.6	Red River Retention Authority	8
2.4.7	Minnesota Red River Watershed Management Board	8
2.4.8	North Dakota Red River Joint Water Resource District	8
2.4.9	Province of Manitoba	8
2.4.10	Other Stakeholders	8
2.5	International Red River Board Mandate	9
3	Problems and Opportunities	11
3.1	Problems	11

3.2	Opportunities.....	12
4	Future Conditions.....	12
5	Goals and Objectives.....	12
6	Strategies	15
7	Actions	16
7.1	U.S. Department of Agriculture Regional Conservation Partnership Program Update.....	16
8	Recommendations	17
9	References	18

List of Figures

Figure A-1: Red River of the North.....	2
---	---

List of Tables

Table A-1: Basin Objectives.....	14
----------------------------------	----

List of Attachments

<i>Attachment A-1:</i>	<i>Red River Basin Commission's Long Term Flood Solutions for the Red River Basin Report – excerpt of main section of September 2011 report</i>
<i>Attachment A-2:</i>	<i>Long Term Flood Solutions for the Red River Basin, Progress Report – January 2015</i>
<i>Attachment A-3:</i>	<i>Red River Basin Commission Halstad Upstream Retention Study</i>
<i>Attachment A-4:</i>	<i>Basin Technical and Scientific Advisory Committee (BTSAC): Impacts of Subsurface Agricultural Drainage on Watershed Peak Flows – Briefing Paper #1</i>
<i>Attachment A-5:</i>	<i>Basin Technical and Scientific Advisory Committee (BTSAC): Water Management Options for Subsurface Drainage – Briefing Paper #2</i>

FLOOD RISK MANAGEMENT AND HYDROLOGY WORKING GROUP REPORT

1 INTRODUCTION

The U.S. Army Corps of Engineers (Corps) St. Paul District, in partnership with the North Dakota Red River Joint St. Paul District Water Resource District (RRJWRD), the Minnesota Red River Watershed Management Board (RRWMB) and the Red River Basin Commission (RRBC) has developed a Comprehensive Watershed Management Plan (CWMP)—a deliverable under the Corps’ specifically-authorized Red River Basin Feasibility Study (Feasibility Study)—for the Red River of the North Basin (also known as Red River Basin and RRB). This Flood Risk Management and Hydrology working group report is an appendix to the overall CWMP.

1.1 Framework

The Red River Basin CWMP framework is based upon the vision, goals and objectives outlined in the RRBC’s Red River Basin Natural Resources Framework Plan (NRFP) and supporting inventory reports. These reports, completed in 2005, were developed with extensive stakeholder input and regional participation and using the best available data in the watershed. The CWMP builds upon this effort with a focus on six major resource areas:

1. Flood Risk Management and Hydrology
2. Fish, Wildlife and Ecosystem Health
3. Water Quality
4. Water Supply
5. Recreation
6. Soil Health

This working group report summarizes the Flood Risk Management and Hydrology focus area.

1.2 Red River of the North Watershed

The Red River of the North Basin is an international, multi-jurisdictional watershed of 45,000 square miles, with 80 percent of the basin lying in the United States and 20 percent in Manitoba, Canada (Figure A-1). Eighteen Minnesota counties, twenty-two North Dakota counties, two South Dakota and one Canadian province lie wholly or partially in the basin. The economic impact of the basin, from both urban-generated activity and a vibrant agricultural economy, is significant. This basin is home to more than half a million people and serves as a jobs, education and medical hub, in addition to a world-renowned agricultural producer.

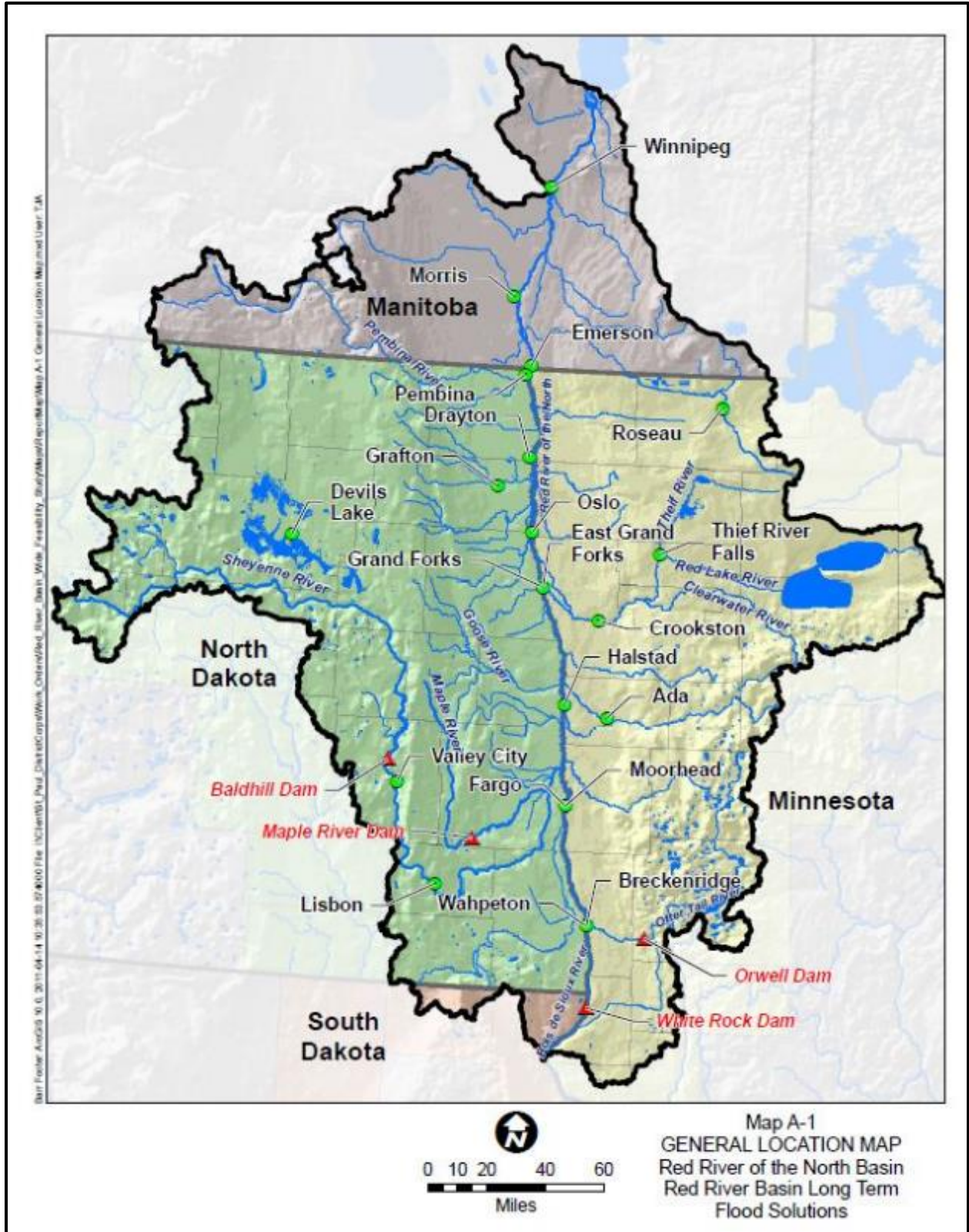


Figure A-1: Red River of the North

1.3 Working Group Process

Six working groups corresponding to each of the six CWMP resource areas were formed. The six CWMP groups worked closely with the existing RRBC's NRRFP working groups. A subject matter expert from the Corps was identified for each working group to serve as the secretary. The secretary role has the primary responsibility for writing the report. Each coordinating committee also included a facilitator or chair, in addition to subject matter experts from other agencies or stakeholder groups.

Each of the six resource areas collaborated with existing NRRFP working groups to perform iterations of the Corps' 6-step planning process and develop recommendations for each area. The collaboration and integration of the CWMP working groups and the RRBC's NRRFP working groups were done to economize efforts, leverage local resources, ensure collaborative stakeholder involvement, generate a broad set of solutions for multiple stakeholders and ultimately lead to comprehensive long-term recommendations and actionable solutions for the basin.

Over the course of two years, the working groups held various meetings to work through the 6-step planning process described in *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (1983) and the *Planning Guidance Notebook ER 1105-2-100* (April 2000). The six steps in the iterative plan formulation process are:

1. Specify the water and related land resources problems and opportunities of the study area;
2. Inventory and forecast existing conditions;
3. Formulate alternative plans;
4. Evaluate alternative plans;
5. Compare alternative plans; and
6. Select the recommended plan.

1.4 Flood Risk Management and Hydrology Working Group Composition

A variety of stakeholders representing local, state and other federal agencies, as well as varied jurisdictional representation from North Dakota, Minnesota and Manitoba were included on each working group. A list of agencies involved with the Flood Risk Management and Hydrology working group is provided below.

- City of Grand Forks, ND
- Minnesota Department of Natural Resources
- International Water Institute
- National Oceanic and Atmospheric Administration (National Weather Service)
- North Dakota State Water Commission
- Red River Basin Commission
- Red River Retention Authority
- Red River Watershed Management Board
- U.S. Army Corps of Engineers

2 BACKGROUND

2.1 Existing Information

The primary source of information for this Flood Risk Management and Hydrology Working Group Report is the September 2011 Red River Basin Commission's Long Term Flood Solutions for the Red

River Basin (RRBLTFS) report, and the January 2015 “Long Term Flood Solutions for the Red River Basin Progress Report.” The RRBLTFS report was prepared using a planning process similar to the Corps’ 6-step planning process: identifying problems, opportunities, data gaps, goals, objectives, strategies and actions related to flood risk management in the Red River of the North Basin. The Corps actively participated in the RRBLTFS report development.

Since the RRBLTFS report has been formally adopted by the RRBC, it serves as the de facto Flood Risk Management and Hydrology working group report for this CWMP. The main body of the September 2011 RRBLTFS report (Attachment A-) and the January 2015 progress report (Attachment A-) are attached to this Flood Risk Management and Hydrology working group appendix. The complete RRBLTFS report and other pertinent documents may be found in the Resources section of the Red River Basin Commission website: <http://www.redriverbasincommission.org>

2.2 Watershed Conditions

2.2.1 History of Flooding

The spring flood of 1997 that decimated the metropolitan center of Grand Forks-East Grand Forks and gravely threatened areas throughout the basin introduced a decade of flooding. From 2000 to 2013, the basin experienced damaging flooding in all but two years, including major floods in 2006, 2009, 2010 and 2011. Since 1997, most sites along the main stem Red River have seen levels of flooding at or close to 100-year levels, some in more than one flood event. And tributary areas have experienced up to 500-year flood levels during the past decade.

2.2.2 Climate Change

The Corps’ 2015 regional climate change assessment report for the Red River Basin summarizes observed and projected climate and hydrological patterns cited in literature and reports. Increased annual precipitation and larger precipitation events are projected in the basin. This may impact flood events in the area if intense storms cause increased runoff or flash floods. Flood risk management projects, both structural and nonstructural, may help reduce flood damages. Area hydrologic, hydraulic and climate information is further detailed in Appendix B of the RRBLTFS report and can be found at the website listed above.

2.3 Drainage

In the NRFP, objectives related to drainage were included in the report. The NRFP drainage goal is to “Manage urban and agricultural drainage systems to enhance productivity, while minimizing impact to others”; and the NRFP objectives are to manage drainage systems to protect agricultural land and minimize environmental impacts; to design and improve drainage systems with consideration of local, sub-watershed and main stem effects; and to design and implement urban and rural storm water strategies that minimize environmental impacts.

The CWMP does not include a separate working group appendix for drainage; however, it is an issue that impacts other resource areas and is significant in the basin. The Red River Retention Authority Basin Technical and Scientific Advisory Committee (BTSAC) developed two briefing papers on drainage in 2011 and 2012. The reports included the status and trends of agricultural drainage in the basin, a literature review, summary of hydrologic effects of subsurface drainage and descriptions of recommendations and preferred drainage management options.

Drainage systems and practices are part of a complex web of land use changes that affect hydrology downstream at the field, watershed and basin scale. Many landscape-scale changes have occurred in addition to agricultural drainage that can increase or decrease downstream flood flows including drained or restored lakes and wetlands, urbanization, on and off channel dams, channelization, and road and field crossing culverts. Agricultural drainage is essential to the Red River Basin's agricultural industry and is a key component of the Basin's infrastructure and economy. The impact of subsurface drainage on flooding is complex and should not be generalized; timing and volume of runoff are key variables. The cumulative impacts of drainage on peak flows are unclear; additional analysis was recommended. The BTSAC preferred subsurface drainage management options include controlled subsurface drainage and water storage trading. It must be noted that there are many complex water management policy issues involved with implementing the BTSAC preferred drainage management options including the balance of public and private cost, risk, benefit and equity.

Red River Retention Authority BTSAC briefing papers on drainage are included as Attachment A- and Attachment A- to this appendix.

2.4 Jurisdictional Considerations

The hydrologic system of the Red River Basin is complex. It is influenced by many natural and human forces. To deal with this system, dozens of government agencies and organizations have evolved with management responsibilities or interests in various aspects of its water and land resources. These resources are managed and controlled through myriad federal, provincial, state and local laws, regulations, rules and ordinances. In addition, there are a number of binational, interstate and international arrangements as well as committees and working groups that oversee and coordinate many aspects of basin water management.

In addition to the individual jurisdictional influences of the States of North Dakota, Minnesota and South Dakota and the province of Manitoba, two groups are highly influential in matters concerning the Red River of the North Basin: the RRBC and the International Joint Commission (IJC). Water resource management in the Red River Basin is an international effort. The hydrologic system of the basin is complex, and the multi-jurisdictional approaches to addressing resources in the basin are numerous.

2.4.1 Congressional Districts

On the Canadian side, the study area is located in the province of Manitoba. The study area is located in the At Large Congressional District of North Dakota. In Minnesota, the study area is located in the Seventh Congressional District. A small portion of South Dakota At Large Congressional District is at the far southern tip of the basin.

2.4.2 Tribal Nations

Tribal coordination was done with assistance from the RRBC. Participation in the working groups was open for signup at the 2014 conference, and notification was extended more broadly, including to tribes. The RRBC members include a tribal/First Nations representative who had equal opportunity to participate in the CWMP and will be given the opportunity to review the recommendations. In addition, related to the Flood Risk Management and Hydrology recommended actions and for the Fargo Moorhead Flood Risk Reduction Project, the Corps coordinated with tribal chairpersons and the Tribal Historic Preservation Office of the following tribes: Sisseton Wahpeton, White Earth, Leech Lake, Yankton Sioux, Bois Forte, Turtle Mountain, Upper Sioux, Lower Sioux, Spirit Lake, Red Lake, Fort Peck, Three Affiliated Tribes, Northern Cheyenne and Standing Rock. As a result of this coordination a

programmatic agreement was developed for the project and a traditional cultural properties study was developed and completed for Fargo-Moorhead Metropolitan Flood Risk Management Project.

2.4.3 International Joint Commission

The IJC is an international organization created by the Boundary Waters Treaty, signed by Canada and the United States in 1909. The IJC prevents and resolves disputes between the United States of America and Canada under the 1909 Boundary Waters Treaty and pursues the common good of both countries as an independent and objective advisor to the two governments. In particular, the Commission rules upon applications for approval of projects affecting boundary or trans boundary waters and may regulate the operation of these projects; it assists the two countries in the protection of the trans boundary environment, including the implementation of the Great Lakes Water Quality Agreement and the improvement of trans boundary air quality; and it alerts the governments to emerging issues along the boundary that may give rise to bilateral disputes. Canada and the United States each appoint three of the six IJC commissioners, including one chair from each country. The two chairs serve concurrently. The commissioners are appointed by the highest level of government in each country, but once appointed they do not represent the national governments; they operate at arm's length. The commissioners traditionally work by consensus to find solutions that are in the best interest of both countries. The commissioners are supported by U.S. and Canadian section offices in Washington, D.C., and Ottawa, Ontario. The IJC has established more than 20 boards and task forces to help meet its responsibilities along the Canada-U.S. boundary. Board and task force members are drawn equally from both countries and are expected to work in their professional capacities, not as representatives of an organization or region.

The IJC has a number of sub-boards as follows:

2.4.3.1 International Souris-Red Rivers Engineering Board

In response to a request from the governments of Canada and the United States in January 1948, the IJC established the International Souris-Red Rivers Engineering Board to report on the use and apportionment of the waters within the Souris, Red, Poplar and Big Muddy river basins and to develop plans of mutual advantage for these waters. The Board has been involved in numerous issues over the years. With respect to the Red River, these include flooding and diking problems, Garrison Diversion, Pembina River water supply and flooding and Roseau River water management. The Board has reported routinely on water use and development activities that could have trans boundary impacts.

2.4.3.2 International Red River Pollution Board:

In 1964, the IJC was requested by the governments to study and report on the extent and causes of pollution of the Red River at the boundary and to recommend remedial measures. Governments adopted the water quality objectives recommended by the Commission in April 1968 and agreed that a water quality supervision board be established. The International Red River Pollution Board was established by the Commission in June 1969 and has provided continuous surveillance of the water quality of the Red River at the international boundary. The Board also partnered with state, provincial and local governments to improve water quality and has monitored the health of the Red River ecosystem.

2.4.3.3 International Red River Basin Task Force

Recognizing the devastating effects of the 1997 Red River flood on both sides of the border and the need for cross-border cooperation in addressing flood-related issues, the governments of Canada and the United States on June 12, 1997 asked the IJC to examine and report on the causes and effects of damaging floods in the Red River Basin, and to make recommendations on means to reduce, mitigate

and prevent harm from future flooding in the basin. The task force's work was completed with the completion of the IJC's final report of November 2000 "Living With the Red – A Report to the Governments of Canada and the United States on Reducing Flood Impacts in the Red River Basin."

2.4.3.4 International Red River Board

To ensure a more ecosystemic approach to transboundary water issues and to achieve operational efficiencies in the conduct of IJC responsibilities, the IJC combined the ongoing activities and membership of the International Souris-Red Rivers Engineering Board and the International Red River Pollution Board into the International Red River Board (IRRB). The mandate of the IRRB is outlined in its directive of February 7, 2001 from the IJC.

2.4.4 Red River Basin Commission

The RRBC was formed in 2002 to initiate a grass roots effort to address land and water issues in a basin-wide context. The RRBC was formed as a result of a merger between the Red River Basin Board, the International Coalition and the Red River Water Resources Council.

The RRBC is a chartered not-for-profit corporation under the provisions of Manitoba, North Dakota, Minnesota and South Dakota law. It maintains offices in Moorhead, Minnesota and Winnipeg, Manitoba and is dedicated to innovation in the management of the Red River Basin's water resources.

The RRBC is made up of a 41-member Board of Directors, comprised of mainly representatives of local government, including the cities, counties, rural municipalities, watershed boards, water resource districts and joint powers boards, as well as First Nations representation, a water supply cooperative, a lake improvement association, environmental groups and four at-large members. The governors of North Dakota and Minnesota and the premier of the province of Manitoba have also appointed members to the board.

The RRBC adopted a vision, a mission statement and a set of Guiding Principles that are based on input provided by basin residents and used to guide its future activities. Although general in nature, these documents provided the foundation to develop reasonably specific goals and objectives for water management in the basin. These goals and objectives, along with the mission statement and the Guiding Principles, will provide a framework for the board to conduct business in the future.

RRBC VISION: A Red River Basin where residents, organizations and governments work together to achieve basin-wide commitment to comprehensive integrated water stewardship and management.

RRBC MISSION: To create a comprehensive integrated basin-wide vision, to build consensus and commitment to the vision and to speak with a unified voice for the Red River Basin.

In 2005 the RRBC completed a Red River Basin Natural Resources Framework Plan, which is a guide for a basin-wide approach to integrated resource management using multi-jurisdictional decision making and cooperation. The NRFP outlines thirteen basin-wide goals and associated objectives that address integrated resource management, soil conservation, water quality, sustainability, agricultural productivity, flood forecasting, flood risk reduction and recovery, data management, fish, wildlife and recreation, and stakeholder participation.

2.4.5 International Water Institute

The International Water Institute (IWI) is a 501(c)(3) organization governed by an international board of directors. The IWI was formed following the 1997 Red River of the North flood to facilitate research, public education, training and information dissemination related to flood damage reduction and water resource protection and enhancement in the Red River Basin.

2.4.6 Red River Retention Authority

The Red River Retention Authority is comprised of representatives from the RRJWRD (North Dakota) and the RRWMB (Minnesota). 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 retention in the Red River Valley.

2.4.7 Minnesota Red River Watershed Management Board

Eight watershed districts within the Red River Valley form the Minnesota RRWMB including the Joe River, Two Rivers, Roseau River, Middle-Snake-Tamarac Rivers, Red Lake, Sand Hill River, Wild Rice and Bois de Sioux. The RRWMB was created by an act of the Minnesota Legislature in 1976 to provide an organization with a basin-wide perspective concerning flooding. Historically, the activities of the RRWMB have centered on flood control. The RRWMB actively promotes a basin-wide perspective for water management within Minnesota.

2.4.8 North Dakota Red River Joint Water Resource District

The RRJWRD is a joint board under North Dakota law comprised of 14 individual water resource districts in the Red River Basin. The RRJWRD provides for a coordinated and cooperative approach to water management and provides critical funding to member districts for the purpose of developing and financing water retention projects. The member districts include these fourteen counties: Barnes, Grand Forks, Maple River, Nelson, North Cass, Pembina, Ransom, Richland, Rush River, Sargent, Southeast Cass, Steele, Trail and Walsh.

2.4.9 Province of Manitoba

The province of Manitoba is a Canadian prairie province. The province, with an area of 649,950 square kilometers (250,900 square miles), has a largely continental climate with thousands of lakes and many rivers. Agriculture, mostly concentrated in the fertile southern and western parts of the province, is vital to the province's economy; other major industries are transportation, manufacturing, mining, forestry, energy and tourism. Manitoba's capital and largest city, Winnipeg, is Canada's eighth-largest census metropolitan area and home to 60 percent of the population of the province with a population of 663,617 (2011 census). Canada's provinces are an integral layer of the nation's governmental system. Under Canada's Constitution, provincial governments have many key powers and jurisdictions, such as the provision of fundamental social service, control over civil and property rights and power over local government.

2.4.10 Other Stakeholders

Additional stakeholders include local and regional government units, other state and federal agencies, landowners, the public and any other interested parties. A partial list includes:

- AAE Tech Services Inc.
- Agriculture and Agri-Food Canada
- Cardno JFNew
- City of Grand Forks, North Dakota
- City of Winnipeg, Water and Waste Department
- Conservation & Water Stewardship—Fisheries Division
- Emmons & Olivier Resources, Inc.
- Environment Canada

- International Institute for Sustainable Development
- International Water Institute
- Manitoba Agriculture, Food and Rural Development
- Manitoba Conservation and Water Stewardship
- Manitoba local government
- Minnesota Board of Water and Soil Resources
- Minnesota Department of Agriculture
- Minnesota Department of Natural Resources
- Minnesota Pollution Control Agency
- Moorhead Public Service, Water Division
- National Oceanic and Atmospheric Administration —National Weather Service
- Natural Resources Conservation Service (U.S. Department of Agriculture)
- North Dakota Department of Health
- North Dakota Game and Fish Department
- North Dakota Parks and Recreation Department
- North Dakota State University
- North Dakota State Water Commission
- Pembina Valley Water Cooperative Inc.
- Red River Basin Commission
- Red River Basin, Long-Range Planning
- Red River Joint Water Resources District (North Dakota)
- Red River Retention Authority
- Red River Watershed Management Board (Minnesota)
- River Keepers
- Rivers West
- Seine-Rat River Conservation District
- The Nature Conservancy
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- U.S. Geographical Survey
- University of Manitoba
- University of Minnesota Extension and Northwest Regional Sustainable Development Partnership
- University of Minnesota Regional Partnership
- URS Corporation
- U.S. Fish and Wildlife Service

2.5 International Red River Board Mandate

The following is an excerpt from the directive that was assigned to the IRRB from the IJC.

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 trans boundary 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 trans boundary tributaries and inform the Commission about trans boundary issues.
 - b. Provide a continuing forum for the identification, discussion and resolution of existing and emerging 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 trans boundary aquatic ecosystem, and encourage and facilitate the development and maintenance of flood-related data

and 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 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 and emergency preparedness.
- iv. Encourage the sharing of accurate and timely trans boundary 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 trans boundary 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 trans boundary 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 trans boundary flood-related and associated water management issues.
- xi. Assist in facilitating a consultative process for resolution of the lower Pembina River flooding issue.

3 PROBLEMS AND OPPORTUNITIES

The RRBLTFS report enumerates a number of problems and opportunities, which are listed below:

3.1 Problems

- Incomplete flood-forecasting tools
- Larger magnitude floods
- Non-uniform level of protection

- Incomplete data and modeling
- Multi-jurisdictional basin
- Non-uniform floodplain management practices.

3.2 Opportunities

- Improve flood-forecasting tools
- Develop a basin-wide standard for flood risk management
- Improve available data and models
- Instill cooperative management of the basin
- Develop a basin-wide standard for floodplain management.
- Decrease the damages from flooding to urban areas, critical infrastructure, small cities, rural residences and farmsteads, agricultural cropland, and critical transportation systems and emergency services

4 FUTURE CONDITIONS

Components of the RRBLTFS report are intended to be developed and implemented over the next 50 years. It is important to understand the assumptions under which this plan was developed. The following describe basic assumptions about several issue areas in the Red River Basin that are key to plan development.

1. Agriculture will continue to be the dominant land use throughout the basin. Adequate surface drainage has been and will continue to be integral to maintaining productivity of cropland. Sub-surface drainage is likely to become increasingly popular.
2. Current development trends will continue into the foreseeable future. The major urban centers and communities will continue in their present locations. The major metropolitan areas will continue to grow. Future development will occur in compliance with floodplain management regulations.
3. Floods will continue into the future. Floods larger than historically experienced can be expected to occur.
4. Flood damage reduction will need to be implemented in the basin based primarily on the identified needs of the basin residents and their willingness to provide or seek the funding necessary to implement the measures that they believe are appropriate, effective and justified. State and federal agencies will support the implementation of the various measures based on their policies, regulations and availability of funding.
5. Flood damage reduction is just one issue that affects the sustainability of the region. Other key resource issues need to be considered as this plan is developed and implemented, including droughts, water supply, water quality, recreation and other natural resource areas.

5 GOALS AND OBJECTIVES

Two sets of active principles and/or goals and objectives currently being used in the basin include the RRBB/RRBC's Guiding Principles and the RRBC's Red River Basin Natural Resources Framework Plan. Both address flooding and flood damage reduction as part of broader water and land management principles and goals/objectives.

The stated goals of the Guiding Principles related to flood risk management and hydrology are:

- To minimize flood damage, water will be retained where practical in agreement with local, watershed and basin water management plans.
- All approaches to managing floods and minimizing flood damage will be evaluated for their possible impact on the economy, community and environment.
- Land subject to flooding should be developed only according to planning guidelines that prevent human suffering and property damage, limit public costs and liabilities and address the impact on the environment.

The stated goal of the NRRFP related to flood risk management and hydrology is:

- Reduce the risk of flood damages for people, property and the environment in the main stem floodplain and in tributary waters.

The Flood Risk Management and Hydrology working group restated these goals as a single goal:

- A more flood resilient Red River Basin.

This goal includes three objectives:

- Reduce risk of flood damages for people, property and the environment in the main stem floodplain and in tributary waters.
- Improve flood forecasting, mitigation, response and recovery.
- Use non-structural measures to move beyond minimum standards for flood risk management.

Along with these generic goals, the basin has more specific flood risk management objectives as shown in Table A-1.

Table A-1: Basin Objectives

Area Protected	Estimated Recurrence Interval
Major urban/metropolitan areas (1) (2) (4)	500 years or greater
Critical infrastructure (1) (2)	500 years or greater
Cities/municipalities (1) (2)	200 years or greater
Rural residences & farmsteads (1) (2)	100 years or greater
Agricultural cropland: summer flood	10 years or greater
Transportation (2) (3); critical transportation system and emergency service links	200 years or greater
<p>Notes</p> <p>(1) Protection for urban areas, critical infrastructure, cities, rural residences and farmsteads should all have appropriate freeboard (i.e., contingency or risk and uncertainty allowance) with any projects designed to provide the specified level of protection.</p> <p>(2) If a flood of record has occurred, which exceeds the specified level of protection goal, the flood of record should be used in place of the specified level of protection goal.</p> <p>(3) The critical transportation systems should be maintained passable during a flood of the described level of protection to assure safe and reliable transportation and provision of emergency services. The transportation system should not increase flooding problems either upstream or downstream.</p> <p>(4) Includes Fargo-Moorhead, Grand Forks-East Grand Forks and Winnipeg.</p>	

As a result of the RRBLTFS report goals, objectives and recommendations and specifically the 20 percent flow reduction modeling effort, the RRBC completed the “Red River Basin Commission Halstad Upstream Retention Study” (HUR) (Attachment A-).

Since the development of the basin-wide flow reduction strategy, outlined in the RRBLTFS report, additional tools have been made available in evaluating potential impoundment locations. The IWI led the Red River Basin mapping initiative to collect a consistent dataset of high resolution LiDAR topography data across the United States portion of the Red River basin. Completion of this effort quickly led to the development of a consistent set of synthetic hydrologic models for tributaries above Halstad, MN in December 2011, with hydrologic models for remaining tributaries in the United States portion completed in 2013. In addition to the enhanced hydrologic modeling capabilities, a detailed hydraulic model of the Red River main stem was developed to aid in ongoing analysis of flood control alternatives for the communities of Fargo, ND and Moorhead, MN. This model allows for a detailed assessment of proposed projects that wasn’t previously available. Development of this hydraulic model began in 2009 and has since been evolving and improved as the Fargo Moorhead Metro Flood Risk Management project progresses.

The new tributary hydrologic models were used by local water resource districts (North Dakota) and watershed districts (Minnesota) to identify potential impoundment locations throughout the United States portion of the Red River Basin. Generally, these planning efforts have indicated that distributed detention can be used to alleviate local flooding concerns while providing enough storage to meet RRBLTFS report tributary volume and peak flow reduction goals. The RRBC's HUR study utilizes tributary detention planning efforts to evaluate the cumulative regional impact along the Red River main stem above Halstad, MN. This effort was funded through the Fargo-Moorhead Diversion Authority.

The initial step of the HUR study was to develop a consistent method for assessing distributed detention with the project area. This led to development of the Standardized Melt Progression Event, which takes into account how the melt pattern progresses across the landscape during a typical spring snowmelt event. Runoff depths were used consistent with 100-year, 10-day runoff depths used for hydrologic model development.

After development of the Standardized Melt Progression Event, tributary hydrologic models and the Red River main stem hydraulic model were used to evaluate distributed detention above Halstad, MN. The modeling approach used the most recent set of hydrologic models from tributary detention planning efforts to develop synthetic inflow hydrographs for the Red River main stem hydraulic model. Impoundment locations identified by local water resource districts (North Dakota) and watershed districts (Minnesota) were used to evaluate impacts along the Red River main stem. This modeling approach also provides a framework for policy makers to evaluate relative benefits associated with individual detention projects and if desired, allocate funding based on a performance-based assessment.

This effort was completed for the Red River Basin upstream of Halstad, MN. Results indicate that the basin-wide flow reduction strategy appears to be attainable. Several other considerations should be addressed as distributed detention is further evaluated. In 2015, the "Lower Red Basin (United States portion) Retention Study," was proposed as a draft scope of work for the Corps. This is the second phase of work begun under the HUR study, completed as [Ph2-NF task 19](#). The work would provide a consistent framework to evaluate distributed detention for the remainder of the United States portion of the Red River Basin.

6 STRATEGIES

During the development of the RRBLTFS report, the following strategies were developed to address the stated objectives:

- **Basin-wide retention strategies**
 - Strategically located storage to help reduce peak flows on the main stem while mitigating local flooding on the tributaries,
 - Increased water storage at existing reservoirs,
 - Development of a prioritization process for retention projects,
 - Streamlining of the water retention project permitting process, and
 - Analysis of aged dams and restoration potential for increased flood control capacity.
- **Nonstructural strategies**
 - Mitigating existing development and protecting future growth to a higher standard,
 - Identification of barriers to increased participation in the community rating system,
 - Education and outreach of floodplain information to residents.
 - Local floodplain ordinances should be updated, and

- New development in areas of high risk areas adjacent should not be permitted.
- **Structural strategies**
 - Fargo-Moorhead, the most populous metropolitan city in the United States portion of the basin, is at severe risk of significant damage and requires immediate permanent protection measures.
- **Strategies to develop further information and tools**
 - Advanced collaboration and facilitation of the multijurisdictional issues,
 - Creative alternatives for federal agency participation across jurisdictions,
 - Expansion of these efforts to Manitoba and South Dakota,
 - Improved flood forecasting measures, and
 - The development of a consistent and seamless stream gage system.

7 ACTIONS

Actions to address the issue of flood risk management in the Red River Basin were enumerated in the 2011 RRBLTFS report. The RRBC, the States of North Dakota and Minnesota and the Canadian province of Manitoba have been making progress toward the above-stated goals through the actions defined the RRBLTFS report.

Attachment A- to this appendix, *Long Term Flood Solutions for the Red River Basin Progress Report*, published in January 2015, outlines the progress that was made toward the flood risk management goals between 2011 and 2014.

Key items among the accomplishments towards the flood risk management goals include levee improvements at the main stem communities of Wahpeton-Breckenridge and Oxbow-Hickson-Bakke; the Minnesota communities of Georgetown, Perley, Hendrum, Olso, Pembina, Ada, Alvarado, Crookston and Roseau; the North Dakota communities of Argusville, and Devils Lake; progress towards improved protection at Fargo-Moorhead; and proposals for improvements at Halstad, Grafton, Lisbon and Valley City.

Progress that has been made towards the hydraulic and hydrologic modeling goals include the development of HEC-HMS models for all of the U.S. border sub-basins of the Red River and completing a main-stem HEC-RAS model. Studies to identify the potential for retention in the U.S. sub-basins have been completed. Work is underway to combine the HEC-RAS, HEC-HMS and retention information to evaluate the relative effectiveness of retention projects in accomplishing the peak reduction goal.

7.1 U.S. Department of Agriculture Regional Conservation Partnership Program Update

As was briefly introduced in the RRBLTFS report's January 2015 progress report, the Red River Retention Authority (RRRA) under the direction of the Minnesota (RRWMB) and the North Dakota RRJWRD are proceeding with planning work under a U.S. Department of Agriculture grant program called Regional Conservation Partnership Program. The \$12 million grant issued to the RRRA has been allocated to 19 different planning subwatersheds, 8 in North Dakota and 11 in Minnesota. These planning projects are following the guidance documents of the Natural Resources Conservation Service PL566 program. Once the planning processes are complete it is anticipated that the RRRA will seek construction dollars

through NRCS if projects are designed that have a positive cost/benefit ration using the federal guidelines in PL566.

8 RECOMMENDATIONS

The September 2011 Red River Basin Commission’s Long Term Flood Solutions for the Red River Basin report and its periodic updates should be referred to when considering the flood risk management and hydrology aspects of this Comprehensive Watershed Management Plan. The parties will continue to work towards the goals and actions enumerated in the RRBLTFS report and its periodic progress reports.

It should be noted that Corps implementation of any of the actions described in the RRBLTFS report would be subject to the standard Corps planning process and must be economically justified for federal investment.

The RRBLTFS report contains specific recommendations for action for local, state and federal officials on the following topics.

1. First and foremost, the **two most critical areas of the basin must be addressed as soon as possible:**
 - a. **Fargo-Moorhead**, as the most populous metropolitan city in the United State portion of the basin, is at severe risk of significant damage and requires immediate permanent protection measures. State and federal funding to continue the local projects identified to date, should be continued to completion. Beyond this local protection, progress towards the proposed diversion should be advanced beginning with agreement between Minnesota and North Dakota on non-federal cost share formula. Retention should complement the diversion.
 - b. **Devils Lake, ND** requires immediate measures as well to mitigate a potential natural overflow its rising waters to head off major water quality and quantity adverse impacts throughout a large portion of the basin. Current efforts must be brought to completion. Progress and timelines should be conveyed to the public. A comprehensive model with real-time data to determine the effects of releases of Devils Lake water should be considered.
2. **Floodplain management** is a cornerstone of the solutions in the basin and includes the following:
 - a. **Nonstructural strategies** must be advanced that addresses mitigating existing development and protecting future growth to a higher standard, identification of barriers to increased participation in the community rating system, and education and outreach of floodplain information to residents. Local floodplain ordinances should be updated, and new development in areas of high risk areas adjacent to the main stem Red River and its tributaries should not be permitted.
 - b. The **levels of protection** must be raised for an integrated approach for urban areas, critical infrastructure, small cities, rural residences and farmsteads, agricultural cropland, and critical transportation systems and emergency services. Funding for identified local protection projects consistent with these levels of protection should be cost-shared among state and local partners. A multipurpose drainage strategy should be developed for agricultural land. Road elevations must be considered as well as funding strategy for county and township road repairs.
 - c. **Retention strategies** that are developed must be funded and implemented, including strategically located storage to help reduce peak flows on the main stem while mitigating local flooding on the tributaries, federal funding participation, a review of existing reservoirs for increased water storage, the development of a prioritization process for retention

- projects, streamlining of the water retention project permitting process, updating and expansion of various modeling efforts throughout the basin, and an analysis of aged dams and restoration potential for increased flood control capacity.
3. **The development of further information and tools** is necessary for basin leaders including advanced collaboration and facilitation of the multijurisdictional issues, creative alternatives for federal agency participation across jurisdictions, expansion of these efforts to Manitoba and South Dakota, improved flood forecasting measures and the development of a consistent a seamless stream gage system. This plan shall remain active with an annual progress report from the Red River Basin Commission.

These recommendations require dedicated local, state and federal participation in funding and commitment to implement in order to be successful.

9 REFERENCES

See Attached.

Attachment A-1: Red River Basin Commission's Long Term Flood
Solutions for the Red River Basin Report – excerpt of main section of
September 2011 report

This page is intentionally left blank.

Attachment A-2: Long Term Flood Solutions for the Red River Basin,
Progress Report – January 2015

This page is intentionally left blank.

Attachment A-3: Red River Basin Commission Halstad Upstream
Retention Study

This page is intentionally left blank.

Attachment A-4: Basin Technical and Scientific Advisory Committee
(BTSAC): Impacts of Subsurface Agricultural Drainage on Watershed
Peak Flows – Briefing Paper #1

This page is intentionally left blank.

Attachment A-5: Basin Technical and Scientific Advisory Committee
(BTSAC): Water Management Options for Subsurface Drainage –
Briefing Paper #2

This page is intentionally left blank.