RECLAMATION

Managing Water in the West

Northwest Area Water Supply Project

North Dakota

Final Supplemental Environmental Impact Statement

U.S. Department of the Interior
Bureau of Reclamation

April 2015

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Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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List of Acronyms and Abbreviations

ac-ft	acre-feet
ac-ft/yr	acre-feet per year
AADNC	Aboriginal Affairs and Northern Development Canada
AEES	Advanced Engineering and Environmental Services, Inc.
AG	agricultural
AIS	aquatic invasive species
ALD Report	*Appraisal-Level Engineering Design Report*
AOP	Annual Operating Plan
APE	area of potential effects
ASWUD	All Seasons Water Users District
BEA	Bureau of Economic Analysis
bgy	billion gallons per year
BKD	bacterial kidney disease
BMP	best management practice
CCV	channel catfish virus
CEQ	Council on Environmental Quality
cfs	cubic feet per second
CMA	Census Metropolitan Area
CMIP3	Coupled Model Intercomparison Project Phase 3
CMIP5	Coupled Model Intercomparison Project Phase 5
Corps	U.S. Army Corps of Engineers
DAF	dissolved air flotation
DBPs	disinfection byproducts
DNR	Department of Natural Resources
DRM	Daily Routing Model
EA	Environmental Assessment
EIS	Environmental Impact Statement

EPA	U.S. Environmental Protection Agency
EPRINC	Energy Policy Research Foundation, Inc.
ERM	enteric redmouth disease
FONSI	Finding of No Significant Impact
FWP	Federal Writers Project
GAP	Gap Analysis Program
gdp	gross domestic product
GIS	geographic information system
gpc/d	gallons per capita per day
IHA	Indicators of Hydrologic Alteration
IPNV	infectious pancreatic necrosis virus
ISAV	infectious salmon anemia virus
ISRB	International Souris River Board
ISU	Iowa State University
ITAs	Indian Trust Assets
kAF	thousand acre-feet
kcfs	thousand cubic feet per second
LSWG	Lake Superior Working Group
MAF	million acre-feet
Master Water Control Manual	*Missouri River Mainstem Reservoir System Master Water Control Manual* (Corps 2006)
MBTA	Migratory Bird Treaty Act
mgd	million gallons per day
mg/L	milligrams per liter
Missouri River System	Missouri River Mainstem Reservoir System
MnDNR	Minnesota Department of Natural Resources
MR&I	Municipal, Rural, and Industrial
msl	mean sea level
MT	metric tons
MWh	million megawatt-hours

NCRWC	North Central Rural Water Consortium
NDAC	North Dakota Administrative Code
NDDH	North Dakota Department of Health
NDGFD	North Dakota Game and Fish Department
NDPR	North Dakota Parks and Recreation Department
NED	National Economic Development
Needs Assessment	*Water Needs Assessment Technical Report* (Reclamation 2012a)
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPDWRs	National Primary Drinking Water Regulations
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
NWI	National Wetland Inventory
NWR	national wildlife refuge
OM&R	operation, maintenance, and replacement
OSE	Office of the State Engineer
PAB	palustrine aquatic bed
PEM	palustrine emergent
Project	Northwest Area Water Supply Project
PSS	palustrine scrub-shrub
PUB	palustrine unconsolidated bottom
PUS	palustrine unconsolidated shore
Reclamation	Bureau of Reclamation
RIMS II	Regional Input-Output Modeling System
ROD	Record of Decision
RV	recreational vehicle
SCPP	Snake Creek Pumping Plant

SDWA	Safe Drinking Water Act
SEIS	Supplemental Environmental Impact Statement
Service	U.S. Fish and Wildlife Service
SHPO	State Historic Preservation Office
SHSND	State Historical Society of North Dakota
SWC	North Dakota State Water Commission
TDS	total dissolved solids
THPO	Tribal Historic Preservation Office
TMDL	total maximum daily load
Transbasin Technical Report	Transbasin Effects Analysis Technical Report
USDA	U.S. Department of Agriculture
USDOI	U.S. Department of the Interior
USGS	U.S. Geological Survey
USWUD	Upper Souris Water Users District
UV	ultraviolet
VHSV	viral hemorrhagic septicemia virus
Water Supply and Flood Control Agreement	1989 Agreement between the Governments of Canada and the United States for Water Supply and Flood Control in the Souris River Basin, as amended in 2000
WCRP	World Climate Research Program
WMA	wildlife management area
WNS	white-nose syndrome
WPA	waterfowl production areas
WTP	water treatment plant
WWCRA	West-Wide Climate Risk Assessment

Northwest Area Water Supply Project
Final Supplemental Environmental Impact Statement
North Dakota
Burke, Bottineau, Divide, McHenry, McLean, Mountrail, Pierce, Renville, Ward, and Williams counties, North Dakota

Prepared by the U.S. Department of the Interior, Bureau of Reclamation

Cooperating Agencies:

- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- City of Minot, North Dakota
- North Dakota State Water Commission
- Garrison Diversion Conservancy District

Abstract:

The Department of the Interior, Bureau of Reclamation proposes to construct a project to provide drinking water to local communities and rural water systems in northwestern North Dakota. The project would be designed to supply bulk water to serve the municipal, rural, and industrial water needs through 2060. The proposed action would include the construction of components needed to provide reliable, high-quality drinking water to existing infrastructure for distribution to water users in the service area.

This Final Supplemental Environmental Impact Statement supplements the 2008 Final Environmental Impact Statement on Water Treatment prepared by Reclamation. It has been prepared pursuant to the National Environmental Policy Act to analyze and disclose the effects of the proposed action on environmental and human resources. Four action alternatives and a No Action Alternative are evaluated. The Missouri River and Groundwater Alternative is the preferred alternative. This alternative includes an intake at Lake Sakakawea, within Reclamation’s Snake Creek Pumping Plant, and a Biota Water Treatment Plant in Max, North Dakota. Biota treatment, using conventional treatment processes, is included as a means of reducing the Project-related risk of transferring aquatic invasive species from the Missouri River basin to the Hudson Bay basin.

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Chapter One – Project Purpose and Need

Introduction

The U.S. Department of Interior, Bureau of Reclamation (Reclamation) has prepared this Supplemental Environmental Impact Statement (SEIS) in compliance with the National Environmental Policy Act of 1969 (NEPA) for the Northwest Area Water Supply Project (Project), located in northwestern North Dakota. This SEIS supplements the Environmental Impact Statement (EIS) Reclamation completed on water treatment for the Project in 2008 (Reclamation 2008), in addition to re-examining and updating all prior NEPA analyses that have been completed in connection with the proposed Project.

MR&I uses include domestic, industrial, commercial, institutional, and non-irrigation agricultural uses.

The Project was authorized by the Garrison Diversion Reformulation Act of 1986 and the Dakota Water Resources Act of 2000 as part of the Municipal, Rural, and Industrial (MR&I) Grant Program. It is intended to address long-standing water supply and water quality problems experienced by residents of northwestern North Dakota and to provide adequate, high-quality water to serve the projected population growth in the Project Area through 2060. The Project Area is defined as the 10-county region where bulk water service potentially could be distributed. A bulk water distribution system supplies water to communities and rural water systems, not individual water users; the term "bulk" does not refer to the size of the system. The local communities and rural water systems participating in the Project are shown in Table 1-1. The Project Area (Figure 1-1) spans portions of the Missouri River basin and the Hudson Bay basin. Figure 1-2 shows the Project Area in greater detail.

Project Area:
The 10-county area in northwestern North Dakota where bulk water service could be provided.

The planning, design, and construction of the Project is a cooperative effort between Reclamation and the State of North Dakota. Reclamation is providing technical and financial assistance for the planning and construction of this Project. The North Dakota State Water Commission (SWC) is the Project sponsor and has worked extensively with the communities and rural water systems involved to develop a plan that would meet their water needs.

Table 1-1 Project Members

Rural Water Associations and Districts					
All Seasons Water Users District			North Central Rural Water Consortium		
West River Water & Sewer District			Upper Souris Water Users		
Cities and Municipal Areas					
Berthold	Bottineau	Burlington	Grenora	Kenmare	Minot
Mohall	Rugby	Sherwood	Souris	Westhope	

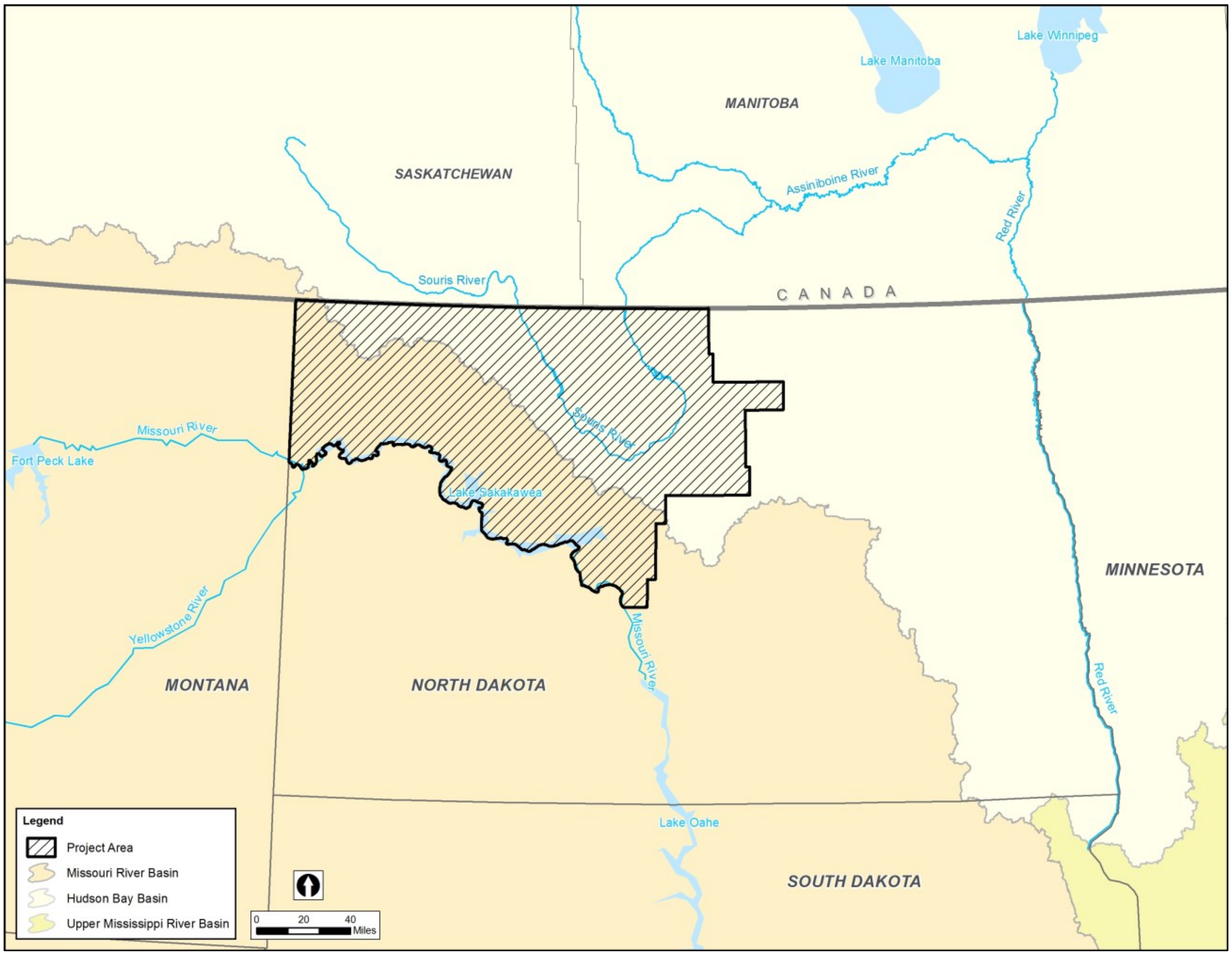

Figure 1-1 Regional Overview

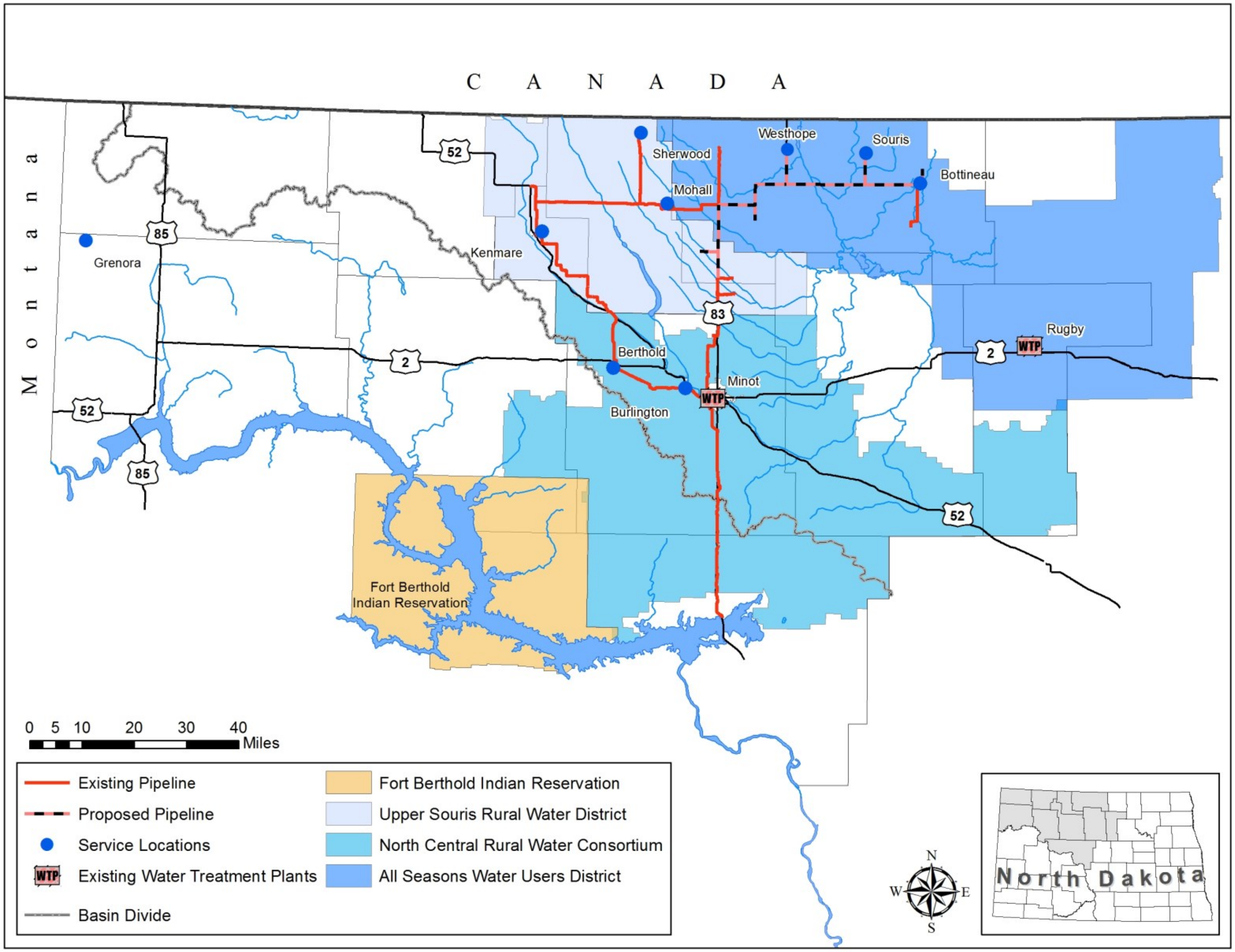

Figure 1-2 Project Area

Background

AUTHORIZATIONS:

* **1944 Flood Control Act**
(78 Public Law 235, 58 Statute 59)

* **1965 Garrison Diversion Unit**
(89 Public Law 108, 79 Statute 433)

* **1986 Garrison Diversion Reformulation Act**
(99 Public Law 100 Statute 418)

* **2000 Dakota Water Resources Act**
(106 Public Law 554, 114 Statute 2763)

The Garrison Diversion Unit's MR&I grant program was authorized by the U.S. Congress on May 12, 1986, through the Garrison Diversion Unit Reformulation Act of 1986. This act authorized the appropriation of $200 million of federal funds for the planning and construction of water supply facilities throughout North Dakota. The MR&I program was established to treat and deliver drinking water throughout North Dakota and has supplied funding to approximately 130 communities and rural water projects throughout the state. Federal funds provided through this grant program are cost-shared with state and local funds at a ratio of 75 percent federal funds and 25 percent matching funds. The Dakota Water Resources Act of 2000 authorized an additional $200 million (indexed) for the state MR&I grant program.

The authorizing legislation (1986 and 2000) contemplated movement of Missouri River water into the Hudson Bay basin and included language on compliance with the 1909 Boundary Waters Treaty established between the United States and Canada. Section 1(h) of the Dakota Water Resources Act states: "Prior to the construction of any water systems authorized under this Act to deliver Missouri River water into the Hudson Bay basin, the Secretary, in consultation with the Secretary of State and the Administrator of the Environmental Protection Agency, must determine that adequate treatment can be provided to meet the requirements of the Treaty…." It goes on to state that all costs of water treatment and related facilities attributable to meeting the requirements of the treaty (construction, operation, maintenance, and replacement) are non-reimbursable, or federal, costs. This means that all costs associated with compliance with the Boundary Waters Treaty are to be funded by the federal government.

An Environmental Assessment (EA) (SWC et al. 2001) and Finding of No Significant Impact (FONSI) were completed for the Project in 2001 (Reclamation 2001). During this initial planning phase of the Project, several communities and three rural water systems signed up as participants, and the Project was designed to meet the future (2010) water needs of those communities and rural water systems. Three of these communities (Rugby, Grenora, and Wildrose) were to receive Project funding to upgrade their existing water treatment plants (WTPs) rather than receive Project water from the bulk distribution system. The water system improvements for the community of Rugby have been completed. The communities of Wildrose, Columbus, and Noonan have since connected to the Western Area Water Supply Project and are receiving water supply from this other regional water supply project rather than the Northwest Area Water Supply Project. The community of Grenora is currently deciding whether to connect to the Western Area Water Supply Project or to complete upgrades to their existing WTP as originally planned in the 2001 EA. Should the city of Grenora choose to make future WTP improvements using federal funds provided by the Project, additional NEPA analyses would be completed as necessary for the proposed improvements.

Construction of certain Project components began in April 2002. In October 2002, the Province of Manitoba, Canada, filed a legal challenge in the U.S. District Court for the District of Columbia claiming that the EA on the Project was inadequate under NEPA (*Government of the Province of Manitoba vs. Ken Salazar, Secretary, U.S. Department of the Interior et al.*). A court order issued in February 2005 remanded the case to Reclamation for completion of certain additional environmental analysis. A second court order issued in April of that year allowed construction to proceed on Project features that would not predetermine a future decision on water treatment to reduce the risk of transferring invasive species.

Construction of certain Project components continued between 2002 and 2012 on the 45 miles of main transmission pipeline from Lake Sakakawea to the City of Minot, along with several segments of the bulk distribution pipeline and associated facilities. Other Project features completed include a high service pump station and storage reservoir in Minot. All components constructed to date have been built in compliance with the environmental commitments included in the FONSI (Reclamation 2001). A summary of the construction activities for previously constructed components is included in Appendix A.

The City of Minot has been temporarily serving water to several communities and rural water systems from the city's groundwater wells. This water supply is provided by the City through temporary water service contracts that will expire in 2018 or sooner, depending on the reliability of the water source.

In March 2006, Reclamation initiated an EIS focused on different water treatment methods to reduce the risk of transferring potentially invasive species from Lake Sakakawea, the then-proposed water source for the Project. The analysis focused on environmental impacts that could occur due to pipeline leaks and failure of the water treatment systems. The Final EIS was published in December 2008 (Reclamation 2008; documents are available electronically at http://www.usbr.gov/gp/dkao/). Reclamation signed a Record of Decision (ROD) in January 2009, selecting an alternative using chlorination and ultraviolet radiation to disinfect and inactivate organisms that may be in the water before it would be delivered into the Hudson Bay basin. Final treatment to drinking water standards would occur at the existing Minot WTP (Reclamation 2009).

In February 2009, the Department of Justice notified the court that Reclamation had completed the Final EIS and ROD. Shortly thereafter, the Province of Manitoba filed a supplemental complaint contending that the Final EIS was insufficient. Additionally, the State of Missouri filed a complaint against the Department of the Interior and the U.S. Army Corps of Engineers (Corps) in the same U.S. District Court. The State of Missouri alleged that Reclamation's Final EIS was insufficient and that the Corps failed to complete a separate NEPA analysis for the Project. The court consolidated the Missouri suit with the Manitoba suit. In March 2010, the court issued an order remanding the case to Reclamation for further environmental review with respect to two specific issues: (1) cumulative impacts of water withdrawals on Lake Sakakawea and the Missouri River; and (2) consequences of transferring potentially invasive species into the Hudson Bay basin. The 2005 injunction was modified by the court in 2013, stating the court "will not permit new pipeline construction or new pipeline construction contracts."

The Purpose and Need statements below have been modified since the publication of the Notice of Intent in the Federal Register (Volume 75, Number 155: 48986–48988) in order to clarify the Project objectives. The Needs statement was refined to allow for an expansive consideration of alternatives, as well as to further explain the underlying Project need. The modifications do not make any substantive changes and do not change any alternatives.[1]

Purpose of the Proposed Action

The purpose of the proposed action (i.e., the Project) is to provide a reliable, high-quality water supply to communities and rural water systems in northwestern North Dakota for MR&I uses; the Project is sized to serve projected population growth to the year 2060. The water provided by the Project would need to meet the primary drinking water standards established by the Safe Drinking Water Act.

Primary drinking water standards protect public health by limiting the levels of contaminants in drinking water.
Secondary drinking water standards are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water.

Need for the Proposed Action

The Project is needed because the existing water supplies are not of sufficient quality or quantity to reliably meet current needs or projected growth in the Project Area during the 50-year planning period. Reclamation commonly uses a 50-year planning horizon to estimate overall needs in water distribution systems. This timeframe is based on the life expectancy of common water project facilities.

Communities within the Project Area are supplied by groundwater, and supplies are currently constrained by water quality that does not meet primary or secondary drinking water standards (refer to Appendix B for additional details). The most severe problem is that the City of Kenmare's water source contains arsenic levels that exceed the primary drinking water standards, forcing the community to make decisions on how to supply community members with safe drinking water. Other water sources for communities and rural water systems throughout the Project Area have elevated levels of total dissolved solids (TDS), as well as iron, manganese, sodium, sulfate, and other contaminants. Since 2008, the City of Minot has been providing water from the city's groundwater wells to Berthold, Burlington, Deering, Kenmare, Mohall, and the North Central Rural Water Consortium to alleviate some of the area's most severe problems. For example, Berthold's groundwater from the Fort Union aquifer was found to be unsuitable as a public supply due to high levels of sodium and TDS. This interim water supply is provided by the City of Minot through temporary water service contracts that are scheduled to expire in 2018, although the contracts may end sooner because groundwater in the Minot and Sundre aquifers is being withdrawn at a level that exceeds the sustainable rate. (Groundwater is being withdrawn more rapidly than it is being replenished, and groundwater levels are declining.)

Some communities also have insufficient quantities of water supply available to meet current and/or anticipated future demand. Mohall, for example, historically had water shortages during periods of peak water need. In other communities, the quantity of water is adequate to meet the present needs, but is not adequate to meet estimated future needs. A population-based water

[1] The purpose statement as it appeared in the Notice of Intent stated: "The purpose of the proposed action is to provide a reliable source of high-quality treated water to northwestern North Dakota for MR&I uses."

demand model was used to project water needs, based on data from the U.S. Census and water user surveys circulated to each of the Project members to solicit information regarding the future water needs of their communities. In 2010, the water use was approximately 7.91 million gallons per day (mgd). By the end of the planning period in 2060, the projected average daily water need would be approximately 10.40 mgd, an increase of 2.49 mgd (Reclamation 2012a). As documented in the *Water Needs Assessment Technical Report* (Reclamation 2012a), communities throughout the Project Area would experience water quality or quantity issues.

Proposed Action

The proposed action is to construct a project to provide drinking water to local communities and rural water systems in northwestern North Dakota, including the City of Minot. The Project would supply bulk water to specific delivery points, and each community or rural water system would be responsible for connecting to the distribution line and delivering the water through their own water system to the end users.

Scope of the SEIS

The NEPA implementing regulations (40 CFR 1502.9) direct federal lead agencies to prepare a supplement to an EIS if:

(i) The agency makes substantial changes in the proposed action that are relevant to environmental concerns; or

(ii) There are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts.

Reclamation has conducted new analysis to comply with the court's order to take a hard look at the cumulative impacts of water withdrawal on the water levels of Lake Sakakawea and the Missouri River and the consequences of biota transfer into the Hudson Bay basin, including impacts in Canada. Reclamation has undertaken an evaluation of the potential impacts from the Project to the Canadian environment consistent with the court's Order.

In addition, this SEIS updates the estimated future Project water needs and examines a full range of reasonable alternatives to meet this future need. Other analyses presented in the prior EA and EIS were updated, and the potential effects of global climate change are evaluated.

Four action alternatives are evaluated, as are the consequences of no action (i.e., not completing the Project). The impacts of components that already have been constructed are discussed in Appendix A. As described in Appendix A, the majority of impacts were temporary and are not revisited in this SEIS. Permanent impacts realized during this construction are considered in the cumulative effects analysis as appropriate. This SEIS focuses on the impacts of Project operations and constructing new facilities.

This SEIS considers direct, indirect, and cumulative effects. Direct effects are caused by the action and occur at the same time and place. Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (40 CFR Section 1508.8). Cumulative impacts result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR Section 1508.7). The projects included in the cumulative impact analysis were developed through the scoping process and coordination with the Cooperating Agency team.

A cumulative action was identified in the Souris River basin. The cumulative effects of the Mouse (Souris) River Enhanced Flood Protection Project are considered and discussed in the "Wetlands and Riparian" and "Historic Properties" sections. A preliminary plan has been developed to serve as a guiding document to help reduce the risk of flood damages from river flows comparable to those seen during the 2011 flood. The geographic scope is the Mouse River Valley in North Dakota, from Burlington to Velva and Mouse River Park. The preliminary alignment plan includes flood risk reduction features such as levees, concrete floodwalls, transportation closure structures, river closure structures, high-flow diversion control structures, bridge modifications, channel realignments, overbank excavation, pump stations, interior drainage modifications, floodplain buyouts, and erosion protection measures such as riprap. Additional features include roadway raises and realignments, as well as modifications to municipal utilities. Almost 90 percent, or 21.6 miles, of the total alignment consists of levees. Floodwalls and 30 transportation closure structures (for both roadways and railroads) comprise the remaining 2.8 miles of the alignment. The estimated time frame for planning, engineering, environmental, and regulatory steps for the entire project is 5 years or longer. Preliminary results suggest that there may be some impacts from this flood protection project on wetlands and on some cultural, historic, and archeological resources. Therefore, the reasonably foreseeable cumulative effects of the Project and this flood protection project are evaluated in this SEIS.

Analysis of future depletions from the Missouri River Mainstem Reservoir System is included in Appendix D, and the cumulative effects of those depletions are discussed in the appropriate resource sections in Chapter 4. Cumulative effects associated with aquatic invasive species are analyzed in the *Transbasin Effects Analysis Technical Report* included in Appendix E and discussed in Chapter 4.

Summary of Concerns and Issues

Reclamation conducted scoping for the SEIS to identify public and agency concerns; clearly define the environmental issues and alternatives to be examined in the SEIS, including the elimination of non-significant issues; identify related issues that originate from separate legislation, regulation, or Executive Order (e.g., historic preservation or endangered species concerns); and identify any state and local agency requirements that must be addressed. The public scoping period began with the publication of a Notice of Intent to prepare an SEIS in the Federal Register in August 2010. Verbal comments were received at public scoping meetings held at four locations in North Dakota (Bottineau, Minot, New Town, and Bismarck) during September 2010; and written comments also were submitted by agencies, tribes, organizations, and the general public.

Issues and concerns identified during the scoping period are summarized in a Scoping Report, which is available to the public on the Project website (www.usbr.gov/gp/dkao). The issues and concerns evaluated, along with their location in the SEIS, are included in Table 1-2.

Table 1-2 Issues and Resources Addressed in the SEIS

Issue/Resource	Location in SEIS	Summary
Project Purpose and Need	Chapter 1 – Project Purpose and Need Chapter 2 – Alternatives Appendix B – Community/Water Systems Data	The purpose and need are described, along with the Project Area. The need for the Project is further described in the Water Needs Assessment Technical Report (Reclamation 2012a) and Appendix B. Chapter 2 also discusses the results of the Water Needs Assessment Technical Report.
Proposed Alternatives	Chapter 2 – Alternatives Appendix C – Alternatives Formulation Appendix B – Community/Water Systems Data Appendix J – Draft Appraisal-Level Design Engineering Report	Reclamation has considered new water supplies and treatment options in the development of this SEIS. These are described in Chapter 2 and examined in Chapter 4.
Cumulative Impacts	Chapter 4 – Environmental Impacts	Cumulative impacts are addressed in Chapter 4, using quantitative measures when possible.
Missouri River Depletions	Chapter 4 – Environmental Impacts Appendix D – Missouri River Basin Depletions	An updated estimate of Missouri River depletions has been undertaken, addressing the cumulative effects of water withdrawals on the river (Chapter 4).
Aquatic Invasive Species	Chapter 4 – Environmental Impacts Appendix E – Transbasin Effects Analysis Technical Report	The SEIS takes a fresh, hard look at the potential for and consequences of transferring non-native aquatic species into the Hudson Bay basin. The SEIS also discusses how adaptive management could be used to address future uncertainties and change related to this issue.
Climate Change	Chapter 4 – Environmental Impacts	The potential effects of climate change on the Project are addressed in Chapter 4.
Environmental Evaluation of Resources	Chapter 3 – Affected Environment Chapter 4 – Environmental Impacts Appendix E – Transbasin Effects Analysis Technical Report Appendix G – Biological Resources Appendix H – Socioeconomic Resources	The SEIS describes the affected environment (Chapter 3) and environmental impacts (Chapter 4) for the following issues and resources: climate change; water resources (including surface water and groundwater); fisheries and aquatic invertebrates; aquatic invasive species; vegetation; wetlands; wildlife; protected species; paleontological resources; land use, recreation and farmland; historic properties and Indian Trust Assets; socioeconomics; and environmental justice.

Other Issues

NEPA regulations call for identifying, at an early stage in the NEPA process, the significant environmental issues deserving of detailed study and de-emphasizing insignificant issues, thus narrowing the scope of the EIS analysis (40 CFR 1501.1[d]). During the initial stages of preparing this SEIS, Reclamation conducted preliminary analyses on several issues that were not identified during public scoping (aesthetics, air quality, earth resources, noise, public services and utilities, and transportation); as well as a preliminary analysis on greenhouse gas emissions generated by the proposed action, which was identified as a concern during public scoping. The results of these preliminary analyses found that the effects of the alternatives on these resources would be insignificant. Most Project effects on these resources would be temporary (lasting only during construction) and would not result in a significant impact. For example, the Project would not notably alter the landscape or affect landscapes of unusual or high scenic quality, would occur in the vicinity of other sources of noise (e.g., roads) and therefore would not substantially change the noise environment, and would not disrupt traffic or transportation. Therefore, Reclamation has determined that the magnitude and duration of Project effects on these resources would not be significant, and they are not considered further in this SEIS. Additional detail regarding the preliminary analyses for these resources is included in Appendix I.

Purpose of the Final SEIS

Reclamation has prepared this Final SEIS in response to substantive comments on the Draft SEIS related to environmental issues. Comments were received from reviewing state and federal agencies, organizations, and interested and potentially affected members of the public. Some changes were incorporated into the Final SEIS in response to comments on the Draft SEIS, but these revisions do not fundamentally change the impact analysis or the results presented in the SEIS. The primary changes from the Draft SEIS include:

- Following the release of the Draft SEIS, downscaled hydrologic projections for the U.S. portion of the Souris River became available, along with updated hydrologic projections for the Missouri River. Additional information has been added to the Climate Change section of Chapter 4.
- Information on the status, range, and potential impacts on the northern long-eared bat, rufa red knot, Dakota skipper, and gray wolf has been added to the Federally Protected Species sections of Chapters 3 and 4 in response to changes in their status under the Endangered Species Act.
- In response to concerns raised by the U.S. Environmental Protection Agency, Reclamation changed the Biota WTP option included in the preferred alternative to the Conventional Treatment option. This change is intended to ensure compliance with the Safe Drinking Water Act regulations on disinfection byproducts. This option also provides increased flexibility and ensures that the Project would be able to modify treatment processes as needed to comply with future Safe Drinking Water Act regulations.
- In response to questions raised by the Province of Manitoba, information was added to the Aquatic Invasive Species section of Chapter 4 to further explain the reasons for performing a qualitative vs. quantitative risk analysis. Text in the Aquatic Invasive Species section of Chapter 4 also was modified to clarify the potential economic impacts that could result from introductions of aquatic invasive species.
- The *Transbasin Effects Analysis Plan of Study* (Reclamation 2011e) and the independently prepared *Peer Review of the Draft Transbasin Effects Analysis Technical Report* (Atkins 2012) have been added as supporting documents to the Final SEIS.
- Reclamation prepared a biological assessment in compliance with the Endangered Species Act, which is included as Appendix L.
- Appendix K includes all comment letters received on the Draft SEIS and Reclamation's responses to these comments.
- Appendix M provides further explanation of the missing and incomplete information and the relevance to evaluating reasonably foreseeable significant adverse impacts on the human environment (40 CFR 1502.22).

Final SEIS Organization

The Final SEIS is organized in the same manner as the Draft SEIS. Chapter 1 introduces the Project, describes its background and the SEIS process, and establishes the purpose and need for the Project. Chapter 2 describes the four action alternatives and the No Action Alternative. It also identifies the preferred alternative. Chapter 3 describes the environmental resources that would be affected by the alternatives. Chapter 4 analyzes impacts of the proposed alternatives. Chapter 5 describes consultation and coordination activities and the applicable laws, regulations, and executive orders.

SEIS Process

Reclamation is the lead federal agency under NEPA and is responsible for the preparation of the SEIS and for ensuring compliance with NEPA, the National Historic Preservation Act, and other federal laws. Cooperating Agencies assisting in the preparation of the SEIS include the Corps, U.S. Environmental Protection Agency, SWC, City of Minot, and the Garrison Diversion Conservancy District. The U.S. Fish and Wildlife Service was invited to participate on the team but declined; however, it does participate as a member of the Impact Mitigation Assessment team in reviewing construction plans prior to construction. The Standing Rock Sioux Tribe and the Three Affiliated Tribes were also invited to participate as Cooperating Agency members, but no response was received. The formation and activities of the Cooperating Agency team are further discussed in Chapter 5.

This SEIS analyzes and discloses the environmental impacts of the Project alternatives and has been prepared in compliance with NEPA, the Council on Environmental Quality's Regulations for Implementing NEPA (40 CFR 1500), and Reclamation's *NEPA Handbook* (Reclamation 2012b). The Final SEIS is being made available to the public prior to a final decision on implementation of the proposed action.

Record of Decision

In accordance with NEPA requirements, there will be a minimum 30-day period between the availability of the Final SEIS and the issuance of a ROD. Comments on the Final SEIS may be offered to Reclamation for consideration during this time. Following this 30-day period, Reclamation's Great Plains Regional Director will determine the appropriate final action and issue a ROD. Significant comments received and issues raised on the Final SEIS will be identified. The selected alternative and the alternatives considered in the Final SEIS will be disclosed. Alternative(s) considered environmentally preferable also will be identified. Factors considered with respect to the alternatives and how these considerations entered into the decision will be discussed. Reclamation will include environmental commitments, means to avoid or minimize environmental harm, and any monitoring or enforcement activities to ensure that environmental commitments will be met, if an action alternative is selected. This will complete the NEPA process.

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Chapter Two – Alternatives

Introduction

This chapter describes the range of reasonable alternatives developed to meet the Project's purpose and need (Chapter 1), as well as the No Action Alternative, which is the future (through 2060) without any further Reclamation funding for the Project. A no action alternative is required to be considered under NEPA (40 CFR 1502.14[d]) as a basis for comparison of the alternatives. In addition to the No Action Alternative, four action alternatives have been evaluated in detail, considering potential environmental effects, as well as technical and economic considerations such as reliability and cost.

The four action alternatives are designed to provide reliable, high-quality water supply to communities and rural water systems in northwestern North Dakota for municipal, rural, and industrial (MR&I) uses. As discussed in Chapter 1, the Project Area spans portions of the Souris River basin and the Missouri River basin (Figure 1-1). To develop the action alternatives, water sources within each basin were considered as possible sources for the Project. The action alternatives whose principal water sources are within the Souris River basin are referred to as *inbasin alternatives*. The action alternatives designed with the principal water source within the Missouri River basin (Lake Sakakawea) are referred to as *Missouri River alternatives*.

In addition to describing the No Action Alternative and the four action alternatives, this chapter also describes the process used to develop the alternatives. Through this process, a broad range of possible water sources, water storage and transmission methods, and water treatment options were assembled into conceptual alternatives. These conceptual alternatives were further refined into a full range of reasonable alternatives. Also described are alternatives that were considered but eliminated from further detailed evaluation and the reasons for doing so. The chapter concludes with a description of the preferred alternative.

Alternatives evaluated in detail in this SEIS are:

- **No Action Alternative –** The No Action Alternative describes the future as it would occur without additional Reclamation funding for the Project, based on the best available data. This alternative includes any reasonably foreseeable federal, state, tribal, and local water supply projects that may be constructed in the Project Area through 2060.
- **Inbasin Alternatives**
  - **Groundwater with Recharge** – This inbasin alternative would use the existing Minot and Sundre aquifer wellfields as the primary sources of water for the Project. The Souris River would be used to provide artificial recharge to the aquifers. The groundwater would be conveyed to and treated at the Minot Water Treatment Plant (WTP) and distributed to the Project members through the bulk distribution system.
  - **Groundwater with Recharge and the Souris River** – This inbasin alternative would use existing Minot and Sundre aquifer wellfields as the primary sources of water, with

the Souris River providing artificial recharge to the aquifers, as well as providing a direct supply of water to the Minot WTP during certain periods. Groundwater would be conveyed to the Minot WTP, blended with Souris River water when available, and treated and distributed to Project members through the bulk distribution system.

- **Missouri River Alternatives**
  - **Missouri River and Conjunctive Use –** This Missouri River alternative would withdraw water from Lake Sakakawea, convey it to the Minot WTP, and blend it with Souris River water and groundwater from the Minot and Sundre aquifers. Following treatment at the Minot WTP, water would be distributed to Project members through the bulk distribution system. This alternative includes two options for a new intake and pump station at Lake Sakakawea and five options for a Biota WTP in Max, North Dakota.
  - **Missouri River and Groundwater** – This Missouri River alternative would also withdraw water from Lake Sakakawea as the primary water supply. Water would be conveyed to the Minot WTP and blended with groundwater from the Minot and Sundre aquifers. No water would be withdrawn from the Souris River. Following treatment at the Minot WTP, water would be distributed to Project members through the bulk distribution system. This alternative includes the same two options for a new intake and pump station at Lake Sakakawea and five options for a Biota WTP as the Missouri River and Conjunctive Use Alternative.

Definitions of Key Terms

The alternatives presented in this SEIS were developed in the *Appraisal-Level Design Report* (Appendix J), which includes the design and cost estimate details. Key terms used throughout that report and this SEIS are defined below.

- <u>Component</u> – A facility designed for the Project (i.e., pipeline, intake, pump station, reservoir, treatment facility) that forms an alternative when combined with other components.
- <u>Option</u> – An alternate way of implementing a component (e.g., biota water treatment or intake).
- <u>Action alternative</u> – A combination of components and options that together are designed to meet the purpose and need of the Project.
- <u>Conjunctive use</u> – Combining more than two sources (e.g., surface water and groundwater) to optimize supply and demand for the Project.
- <u>Intake</u> – A facility that collects surface water from a surface water source, such as a river or lake.
- <u>Recharge basin</u> – A facility designed to infiltrate water into the ground to recharge an aquifer.
- <u>Best management practices (BMPs)</u> – Methods that are commonly used in projects of this nature to avoid or reduce effects while an action is being implemented.
- <u>Main transmission pipeline</u> – The buried pipeline between Lake Sakakawea and the Minot WTP.

- Bulk distribution system – A series of buried pipelines, pump stations, and reservoirs that would distribute water from Minot WTP to communities and rural water systems that are members of the Project.
- Project member – Communities and rural water systems that would receive water from the Project.

Alternatives Development Process

The development of Project alternatives was completed in a multistep process, described here and in more detail in Appendix C. The basic steps in this process included preparing a needs assessment, alternative concept development and analysis, and engineering design of the alternatives, both at a conceptual level (10%) and appraisal level (30%).

Needs Assessment

A needs assessment was completed as part of the initial NEPA analysis for the Project (SWC et al. 2001). As part of updating information, Reclamation completed the *Water Needs Assessment Technical Report* (Needs Assessment) (Reclamation 2012a) as one of the very first steps in developing the Project alternatives for this SEIS. The Needs Assessment was completed to assess how growth trends in northwestern North Dakota may be affecting population and water use habits of Project members, and to determine projected water needs within the Project Area through the 2060 planning horizon. A 50-year planning horizon is commonly used by Reclamation when estimating overall needs in water distribution systems, based on the life expectancy of common water project facilities. The Needs Assessment concluded that communities and rural water systems need a water supply to replace existing supplies that are experiencing both water quality and water quantity problems. The report showed that the Project Area has a current water use of approximately 7.9 million gallons per day (mgd) and that the need in the Project Area could increase to approximately 10.4 mgd on a daily average by the year 2060.

To clearly assess the water needs, several sources of information were used. These sources include the North Dakota State Water Commission's (SWC's) spatial and tabular datasets, U.S. Census Bureau's spatial and tabular datasets, other publicly available reports and databases, and a water user survey sent out to communities and rural water systems within the Project Area. The Needs Assessment provides additional information and data used in developing the report and is a supporting document for the SEIS.

Geographic information system (GIS) spatial data were used to assist in projecting future populations. These projections were used to determine the amount of water needed in 2060 (Reclamation 2012a). The SWC maintains a spatial dataset of service areas for the rural water districts of North Dakota. These spatial data were updated based on information provided by the Project members to accurately depict their respective service areas.

Publicly available reports and databases were also used to gather existing information on Project members: the City of Minot's Comprehensive Plan, the City of Bottineau's *Water Supply and Treatment Facility Plan Report* (Advanced Engineering and Environmental Services, Inc. 2001), and the Office of the State Engineer's (OSE's) permit database (Reclamation 2012a). Data accessed from the Internet were useful in digitizing utility service areas for the City of Minot, the All Seasons Water Users District (ASWUD), and the North Central Rural Water Consortium (NCRWC).

A water user survey was developed to solicit data (Reclamation 2012a), including current and future (through 2060) water needs, water sources and future availability of these sources, exceedance of drinking water quality standards, and water contaminants in these sources. The completed surveys were useful in determining areas that are currently or will be served by existing public water supply systems. The information gathered through these sources of information are presented in Appendix B and summarized below for each Project member.

Secondary Standards of Concern (EPA 2013a)
TDS – 500 mg/L
Iron – 0.5 mg/L
Manganese – 0.05 mg/L
Sulfate – 250 mg/L
Copper – 1.0 mg/L

The following describes existing conditions and what is expected to occur in each community and rural water system participating in the Project through 2060. Based on information from the water user survey and Needs Assessment (Reclamation 2012a), there are water quantity and quality issues associated with Project members' current water sources. Water quality in many of the current water sources exceeds the threshold for various constituents under the U.S. Environmental Protection Agency (EPA) secondary standards. Secondary standards are a set of non-mandatory water quality standards recommended by the EPA for primarily aesthetic considerations such as taste, color, and odor. According to the EPA (2013a), if contaminants are present in levels above the recommended levels, people may stop using water from their public supplies. Several of the communities are experiencing water quality in excess of the secondary standards established by the EPA; the secondary standards of concern within the Project Area and the EPA-established threshold are presented in the text box above.

All Seasons Water Users District had a 2010 water demand of 250,000 gallons per day (gpd), which is projected to increase to 750,000 gpd by 2060. This increase is mainly due to annexation of additional connections not currently included in its service area and the expansion of service within its existing service area to customers who have not been connected to the system. ASWUD currently relies on local groundwater aquifers in the immediate vicinity of its service area, including Antler Creek, Shell Valley, and an unnamed aquifer. These aquifers may or may not be able to supply additional water to ASWUD for future expansion; the district would need to conduct hydrogeologic investigations to determine whether additional capacity can be developed from its existing wellfields in these aquifers to meet increasing needs. ASWUD has experienced water quality issues for some time throughout its service area. Water quality data are limited, but indications are that water in these aquifers has elevated iron, manganese, sodium, color, and in some cases, has been shown to exceed the secondary standard threshold (500 milligrams per liter [mg/L]) for total dissolved solids (TDS). ASWUD's current water treatment system includes chemical treatment, aeration, and greensand filtration.

The City of Berthold had a 2010 water use of approximately 30,000 gpd, which is projected to increase to 35,000 gpd by 2060 primarily due to population growth within the city. Prior to 2009, the City of Berthold used groundwater from the Fort Union aquifer, but the aquifer was determined to not be suitable for public supply due to high sodium and TDS levels. Historically, the aquifer has seen extreme levels of TDS—up to almost five times more than the secondary standard recommended by the EPA. Since 2008, the City has been meeting its water needs by purchasing water from the City of Minot. The City of Berthold indicated that it is depending on the Project to meet its future needs.

The City of Bottineau had a 2010 water use of approximately 220,000 gpd, which is projected to increase to 229,000 gpd by 2060. Bottineau is currently using groundwater from the Willow Creek aquifer as its water supply source. Testing has shown that the aquifer exhibits elevated levels of TDS, sodium, uranium, and sulfate, which have exceeded water quality standards. The city has a chemical addition and filtration treatment facility that does not consistently provide enough treatment to meet all secondary drinking water standards. The City of Bottineau has indicated that without the Project it would need to develop additional sources to meet its water needs in 2060, and that treatment upgrades to accommodate additional quantities of water and to meet all water quality standards would be necessary (Advanced Engineering and Environmental Services, Inc. 2001).

The City of Burlington currently receives water from the City of Minot (limited to its annual daily average use, by contract) and uses groundwater from the Burlington aquifer to meet peak demands. In 2010, Burlington used approximately 30,000 gpd from its source, and that use is projected to increase to 85,000 gpd by 2060. The increase in water use is mainly due to population growth within the city, as well as the planned annexation of 25 residential lots. If additional water were available from the glaciofluvial aquifers in the area, the City of Burlington has sufficient capacity in its existing wellfield for additional quantities of water if needed for future use. However, water quality data for the local source show that sulfate, TDS, and manganese concentrations are elevated above secondary water quality standards, and current treatment capability would be required in the future to serve the increased water needs for the community if it is required to use its current water source.

The City of Kenmare currently receives municipal water from the City of Minot. According to its water user's survey, Kenmare had a water use of approximately 30,000 gpd in 2010, which is projected to increase to 70,000 gpd by 2060—mainly due to expected expansion of the system associated with growth adjacent to the city's boundaries. The City had to abandon its groundwater source, the Columbus aquifer, due to noncompliance with the Arsenic Rule, the EPA's standard for arsenic in drinking water. Without the City of Minot supplying water to the City of Kenmare, it would face elevated levels of TDS and sodium (above water quality standards) along with arsenic, a constituent regulated by a primary drinking water standard. Additional capacity could potentially be developed from the Columbus aquifer, but water quality is poor. In the absence of additional treatment, Kenmare would face water quality issues, including the need to comply with the legally enforceable primary standard for arsenic.

The City of Minot's service area includes the city's municipal boundary, outlying areas, and Minot Air Force Base. Water use in 2010 was approximately 5.28 mgd, which is projected to increase to 7.0 mgd by 2060 mainly due to population growth (an increase of approximately 7,500) in and around the city. Minot's response to the water user survey indicated that the municipal service area will be expanded to serve a new subdivision in the northwest portion of the city, which includes approximately 400 acres of planned mixed commercial and residential development with a projected water demand of 0.5 mgd beginning in 2012.

The major glaciofluvial aquifers in Minot's vicinity include the Minot and Sundre aquifers, which are the current water sources for the city. The Minot aquifer has been used as a source of public water supply by the city for the past 95 years, in conjunction with the Sundre aquifer and the Souris River. Although Minot holds a permit to withdraw water from the Souris River, the river is no longer used as a regular source to meet municipal demands due to treatment difficulties and unreliability of the river (quantity and quality). In 1994, the SWC estimated the sustainable yield of the Minot aquifer at 2.0 mgd; however, the continuing downward trend in aquifer levels during the period when withdrawals averaged 2.0 mgd indicates that the portion of the aquifer near the Minot wellfield cannot sustain this level of withdrawal or support additional withdrawals. Investigations have been conducted by the SWC and U.S. Geological Survey, but the sustainable yield of the Sundre aquifer is undetermined. The continuing downward trend of the water level during the period when withdrawals averaged 3.1 mgd indicates that the aquifer cannot sustain this level of withdrawal or support additional withdrawals. Both of the aquifers in the vicinity of Minot experience some water quality problems, including iron, manganese, sodium, sulfate, and TDS levels that exceed secondary drinking water standards. The future availability of aquifer water for the City of Minot is very uncertain both in terms of quantity and quality.

<u>The City of Mohall</u> used approximately 80,000 gpd in 2010, which is projected to increase to 126,000 mgd in 2060. Mohall currently receives some water (limited to its annual daily average by contract) from the City of Minot and uses groundwater from the Mohall or Cut Bank Creek aquifers to meet peak demands. The aquifer sources have a low probability of providing additional groundwater supplies; they historically had water shortages during periods of peak water need. Mohall confirmed in its water user survey response that the quantity of its existing aquifer source is very limited. Water quality data from 1994 and 2008 indicate that after treatment Mohall's water quality generally meets applicable standards. TDS concentrations are typically below the water quality standards in the vicinity of the City's wells, but in other parts of the aquifer, TDS concentrations above water quality standards (340 to 838 mg/L) have been recorded. Future water needs in Mohall could not be met without the supply from the City of Minot, and additional investigations would be required to determine whether the Mohall aquifer could sustain additional withdrawals or if another source would be needed. The current water treatment process appears to be sufficient to meet water quality standards, although well and treatment capacities are not adequate to meet the projected water needs through 2060.

<u>The North Central Rural Water Consortium</u>, for population and water demand projection purposes, includes the North Prairie Rural Water District and the West River Water and Sewer District service areas, but does not include the Central Plains Rural Water District. Water use in 2010 was approximately 1.45 mgd and is projected to increase to 1.58 mgd in 2060. The existing source of water used by the NCRWC in the Project Area is provided by the City of Minot and the North Prairie Rural Water Association. However, if that water were not available, their sources would include the Sundre and Voltaire aquifers.

The Sundre aquifer has TDS levels of 1,100 to 2,000 mg/L in addition to elevated levels of magnesium and sulfate. Aquifer levels are generally in decline in the vicinity of the City of Minot, and the potential to develop additional groundwater supplies from the Sundre aquifer is low. TDS levels in the Voltaire aquifer range from 500 to 2,000 mg/L, and the aquifer also has high concentrations of iron, manganese, sodium, and sulfates. The potential to develop additional quantities of groundwater from the Voltaire aquifer is low, and the aquifer is considered fully allocated. The North Prairie Rural Water District has unused capacity in its wellfields, so groundwater production from existing facilities could possibly be increased, or additional wells could be installed, but due to poor water quality and limited treatment capability, they may not be able to meet all standards.

The City of Rugby had approximately 210,000 gpd of water use in 2010, which is projected to increase to 266,000 gpd by the year 2060. The city's current water source is the Pleasant Lake aquifer. The Project has completed upgrades to Rugby's water treatment plant, and no additional infrastructure needs are anticipated at this time.

The City of Sherwood had approximately 10,000 gpd of water use in 2010, and despite the projected decline in population in the city, use is projected to increase to 12,000 gpd by 2060. The Cut Bank Creek aquifer is the source of water for Sherwood. The city receives some water (limited to its annual daily average) from the City of Minot and meets peak demands using groundwater obtained from its existing wells. There is a low probability of the city obtaining additional water from the local aquifer, which has a limited capacity and water quality limitations that include concentrations of TDS, manganese, and sodium above water quality standards. Additional investigations would be required to determine whether the local aquifer could sustain additional withdrawals or if another source would be needed and additional treatment would be needed to meet all standards.

The City of Souris water use in 2010 was approximately 10,000 gpd, which is projected to decline to 5,000 gpd by 2060. An unnamed aquifer is its current source of water and is characterized by high levels of iron, manganese, sulfate, and TDS that are in excess of water quality standards. Data indicate that additional treatment would be needed to meet all standards.

The Upper Souris Water Users District (USWUD) includes the communities of Bowbells, Carpio, Donnybrook, Glenburn, Lansford, Kenmare, Mohall, Sherwood, and Tolley, as well as other rural users. In 2010, the system's water use was 130,000 gpd and it is projected to decline to 119,000 gpd by 2060. Existing water sources for the USWUD include the Columbus and Glenburn aquifers. The Columbus aquifer is characterized by high TDS concentrations (1,800 mg/L), and the aquifer also has elevated concentrations of iron, salinity, manganese, arsenic, lead, and copper. TDS in the Glenburn aquifer is also high (95 percent of samples are above 1,000 mg/L) along with elevated salinity, iron, manganese, arsenic, lead, and copper concentrations. Additional treatment capabilities would be required to meet all standards.

The City of Westhope used approximately 60,000 gpd of water in 2010, and use is projected to decline to 10,000 gpd by 2060. The source of water for Westhope is the Souris Valley aquifer, and emergency water service is provided to Westhope by the ASWUD. The Souris Valley aquifer is highly allocated, and water quality issues include levels of dissolved manganese, TDS (greater than 1,000 mg/L), and sodium that exceed water quality standards.

An analysis of the data gathered resulted in an estimated overall monthly average Project 2060 need of 10.4 mgd, as discussed in the Needs Assessment (Reclamation 2012a). Table 2-1 identifies the projected water needs of each of the communities in the Project Area. Since some local communities are currently receiving interim water from the City of Minot, the values in the table reflect their use from their other sources of water. All the communities' needs that are being met by the City of Minot are included in the City of Minot's projected water demand.

A peaking factor was also investigated and determined to be 2.6 times the projected need for the Project (Reclamation 2012a), which then results in a 2060 peak day demand of approximately

27 mgd (26.3 mgd for the bulk distribution system and 0.7 mgd for the cities of Rugby and Grenora).

The Needs Assessment estimated that the Project population is projected to increase to approximately 82,400 people in 2060. The 2010 average water use was approximately 7.9 mgd, which is expected to increase to approximately 10.4 mgd in 2060. The increase of 2.5 mgd is mainly due to the addition of substantial rural populations who are not currently being served to rural water systems or are being annexed into communities, as well as the population growth in the more urban areas (Reclamation 2012a).

Table 2-1 Current and Estimated Future Water Needs of Project Participants (mgd)

Service Area	2010 Water Use	Projected 2060 Water Need	Change in Demand (2010 – 2060)
All Seasons Water Users District (ASWUD)	0.3	0.789	0.488
City of Berthold	0.03	0.035	0.01
City of Bottineau	0.22	0.229	0.01
City of Burlington	0.03	0.085	0.05
City of Grenora	0.02	0.012	-0.008
City of Kenmare	0.03	0.07	0.04
City of Minot	5.28	7.009	1.73
City of Mohall	0.08	0.126	0.05
North Central Rural Water Consortium (NCRWC) [a]	1.45	1.587	0.14
City of Rugby	0.21	0.266	0.06
City of Sherwood	0.01	0.012	0.002
City of Souris	0.01	0.005	-0.005
Upper Souris Water Users District (USWUD)	0.13	0.119	-0.01
City of Westhope	0.06	0.01	-0.05
Total	**7.9**	**10.4**	**2.5**

Note:

[a] For population and water demand projections, the NCRWC includes the North Prairie Rural Water District and the West River Water and Sewer District service areas.

Alternatives Concept Development and Analysis

The next step in the alternatives development process was to document the availability and quality of potential water sources that could individually or collectively meet the Project need. The options considered for water sources included groundwater, artificial aquifer recharge, aquifer storage and recovery, treated municipal wastewater, water conservation, and surface water. The information gathered and analyzed during this portion of the process is documented in Appendix C. The purpose of the initial investigations was to evaluate and describe the following:

- Availability and quality of groundwater in the Project Area.
- Feasibility of aquifer recharge and aquifer storage and recovery in the Project Area.
- Availability of treated municipal wastewater to offset Project water demand.
- Potential for conservation to reduce future water demand for Project members (described further in the “Water Conservation” section below).
- Availability and quality of Souris River water.
- Availability and quality of Missouri River water.

As explained in Appendix C, 14 options for meeting the Project purpose and need were developed. The options included water sources and combinations of water sources.

Three sources of water were identified as large enough to serve as potentially suitable sources to meet the future Project water needs. These sources include the Souris River, Minot and Sundre aquifers, and the Missouri River. Aquifer recharge was also carried forward for additional review to determine whether it could be a feasible option. Following are brief descriptions of these water sources and the analyses that were completed to determine the amount of water available for potential use by the Project.

Souris River – The initial analysis concluded that the river cannot be relied upon as a consistent source of water for the Project. The river is dynamic, with extreme low and high flows occurring throughout the period of record and with a high level of variability. The dynamic flows within the river contribute to variability in water quality, and it was recommended that further investigation would be needed to determine the level of treatment required to meet EPA’s current drinking water standards. Based on this evaluation, the Souris River was eliminated from consideration as a sole source of water supply for the Project but was carried forward for further review in conjunctive use options where it would provide aquifer recharge or supplement another water source.

Sundre and Minot Aquifers – Using a one-dimensional groundwater model, the initial analysis showed that the Sundre and Minot aquifers in the vicinity of Minot could be considered further as a potential water source for the Project. The City of Minot has been relying on these sources for its current drinking water system for a long time. The water levels in both aquifers are declining at the current use rate; therefore, it is reasonable to assume that the rate of decline would increase in the future with increased withdrawals for Project purposes. Water quality in these aquifers is sufficient for a public water supply as demonstrated by past use; however, some secondary drinking water standards would not be achieved in the future without the implementation of advanced water treatment technologies.

Missouri River – The initial assessment focused on the impounded portion of the Missouri River watershed above Garrison Dam at Lake Sakakawea because of its proximity to population centers in the Project Area. The Missouri River Mainstem Reservoir System (Missouri River System) contains a large amount of water and/or storage capacity. Project withdrawals from the Missouri River (approximately 10.1 mgd) would be relatively small compared to the daily discharge from Garrison Dam (approximately 0.07 percent). Based on evaluation of water quality data, water quality does not exceed primary or secondary drinking water standards, so water could easily be treated for drinking water purposes. This analysis concluded that ample quantities of water would be available from Lake Sakakawea to meet peak Project water needs and that this water is of sufficient quality that it can feasibly be treated to meet drinking water standards.

To determine which of the 14 options should be carried forward for additional analysis, several factors were developed, including the ability to meet current and future Project demand, water quality, potential for transfer of invasive species, implementation timeframe, socioeconomic impacts, regulatory requirements, technical feasibility, siting of components, risk management, cost and affordability, and integration with existing facilities. After the application of these factors, four conceptual alternatives were identified and carried forward to the conceptual design phase.

Water Conservation

An assessment was conducted to estimate water conservation measures that could be implemented by Project members to reduce overall Project water need. The evaluation considered potential water conservation measures, reasonable and achievable water reduction activities, and cost estimates for implementing the measures and activities.

Gallons per capita per day (gpc/d) = Average amount of water a person uses per day in gallons

Project Members Water Use = 126 gpc/d
National Average Water Use = 171 gpc/d

According to the U.S. Geological Survey (2011), the national average water use is 171 gallons per capita per day (gpc/d). In the Minot service area and for all Project members, per capita use is 119 and 126 gpc/d, respectively. Several factors contribute to the low water use in the Project Area: restrictions on lawn watering, managing water system losses, limited outdoor water use, and federal mandates for use of water-efficient plumbing fixtures. Therefore, the assessment determined that water conservation opportunities are limited because water use is already much lower than the national average, and many common conservation measures are already being used throughout the Project Area (Reclamation 2012a).

North Dakota water systems information was also reviewed, and it was determined that during the past 10 to 15 years, water conservation savings were between 5.0 and 37.3 gpc/d, or between 4.3 and 33.2 percent. These statewide savings were achieved through many direct actions: improving water metering service connections, monitoring water use, repairing and replacing pipelines, and providing effective management of water systems, as well as regulatory requirements for use of water-efficient plumbing fixtures. It is reasonable to assume that Project members are already using these same standard water system management practices and therefore have achieved a similar level of savings as demonstrated by the numbers (Reclamation 2012a). Using approximations, a total water conservation savings for Project members was estimated at approximately 754,000 gpd, or an average savings of nearly 7.3 percent through 2060.

Due to the limited opportunities for additional water conservation because of current low water use by the Project members, the estimated future Project water demand was not reduced by potential conservation savings. However, it is anticipated the Project members would continue to implement water conservation measures and that conservation could be used to offset uncertainties associated with projecting water needs during the 50-year planning horizon (2010 – 2060).

Engineering Design

The developed alternatives were designed to determine whether they are feasible and practicable and to provide a cost basis for comparison. The design of the action alternatives was completed in two phases—conceptual level (10%) and appraisal level (30%).

Conceptual-level designs were completed to determine which alternatives may be feasible based on the 10% design level and should be carried forward for further development. The conceptual design included identification of components for each alternative, investigation into the water quality of the source water and the types of treatment necessary to meet drinking water standards, and estimates of the costs associated with each alternative.

Based on the findings, Reclamation identified four alternatives to be evaluated at the appraisal level. Detailed descriptions of the alternatives, designs, drawings, and cost estimates are included in Appendix J. In addition, the appraisal-level design process included a more detailed analysis of the availability of flows from the Souris River to be used for aquifer recharge and as a direct water supply source (Appendix A within Appendix J). Detailed information regarding the analysis of the groundwater and aquifer recharge components is also included in the appraisal-level designs. A groundwater model was used to determine (1) the amount of Souris River water that would be needed to recharge the Minot and Sundre aquifers to maintain sufficient groundwater levels in order to meet the Project need; and (2) the water quality that could be expected under those conditions. Additional information is included in Appendix A within Appendix J.

This analysis concluded that the Souris River could be used as a water source based on this level of planning and design; however, it also confirmed that the Souris River flows are highly variable and potentially unreliable. The feasibility of using the Souris River would need further analysis during more advanced design phases. The appraisal-level design phase evaluates functionality and associated costs of alternatives. At this level of design, facility locations are represented as a general location of components. Advanced engineering phases (i.e., feasibility design and final design) would refine this information and ultimately determine the final location of the components. If significant changes occur during future design that are outside the scope of the SEIS analyses, additional NEPA evaluation would be completed as necessary.

Alternatives Evaluated in the SEIS

The alternatives evaluated in the SEIS include the No Action Alternative and four action alternatives that cover a full range of reasonable alternatives for implementing the Project. A no action alternative is always included in an EIS and is the basis for which all other alternatives are compared (40 CFR Section 1502.14[d]). All of the action alternatives propose to use either inbasin or imported water to meet the estimated needs of the Project participants. The inbasin water sources include the Minot and Sundre aquifers and the Souris River; the imported water source is the Missouri River System, specifically Lake Sakakawea.

NO ACTION – The future (through 2060) without further Reclamation funding for Project construction.

INBASIN ALTERNATIVES

Groundwater with Recharge – would use groundwater as the source of water to meet the Project need and includes recharging that groundwater using the Souris River.

Groundwater with Recharge and the Souris River – would use a combination of groundwater and water directly from the Souris River to meet the Project need. Recharging of the groundwater with water from the Souris River is included as well.

MISSOURI RIVER ALTERNATIVES

Missouri River and Conjunctive Use – would combine three sources of water to meet the Project need: the Missouri River, Souris River, and groundwater.

Missouri River and Groundwater – would combine two sources of water to meet the Project need: the Missouri River and groundwater.

Construction of the statewide North Dakota MR&I Program is administered through a cooperative agreement between the Garrison Diversion Conservancy District and Reclamation that lays out the responsibilities of the parties. The Project sponsor (system owner such as the SWC) is responsible for following standard construction practices; procurement regulations; and all applicable local, state, or federal laws. Reclamation provides oversight, and is the lead federal agency for National Historic Preservation Act and NEPA requirements. Reclamation ensures that all construction projects include the requirements and commitments made under those laws. Each of the action alternatives described in the SEIS includes BMPs (described in Appendix F). The BMPs will be followed during construction of the components described under each of the action alternatives.

Each of the four action alternatives would provide a bulk water supply to municipalities and rural water systems. Distribution of this water would be the responsibility of the rural water systems or municipalities.

Previously Constructed Project Components

As described in Chapter 1 (Project Background section), Project construction took place from 2002 to 2013, as permitted by court orders and amendment to the existing injunction. Several components of the Project have been completed (described in Appendix A). Components that have been constructed include improvements to Minot WTP and significant portions of the main transmission pipeline, as well as a significant portion of the bulk distribution system. Because they are already constructed, these components are included in each of the alternatives evaluated in the SEIS, including the No Action Alternative. However, it should be noted that not all of the constructed components would be utilized under each alternative. The use and purpose of these components are described in further detail in each of the alternative descriptions.

The main transmission pipeline is substantially complete and was intended to deliver water from an intake on Lake Sakakawea to Minot WTP. The buried pipeline is approximately 43 miles long and runs parallel to Highway 83. The pipe is between 30 and 36 inches in diameter, and was constructed using standard engineering practices and following the environmental commitments identified in the previous NEPA evaluations. Two short segments of this transmission pipeline are not constructed: at the proposed Biota WTP location in Max and at the location of a proposed storage reservoir (Appendix C within Appendix J).

Previous evaluations of the proposed Project also addressed concerns of a pipeline breach after the water would have been delivered via the buried transmission pipeline from the Missouri River basin into the Hudson Bay basin. The evaluations completed are documented in two reports: *Northwest Area Water Supply Project Biota Transfer Control Measures* (Houston Engineering et al. 1998) and *Northwest Area Water Supply Project Biota Transfer Control Measures Update* (Houston Engineering and Montgomery Watson 2001). These reports describe additional safeguards included in design and construction of the main transmission pipeline and associated features to reduce the risk of a Project-related transfer of aquatic invasive species (AIS) into the Hudson Bay basin. These safeguards include isolation valves installed in strategic locations along the pipeline to minimize the volume of water released into the Hudson Bay basin in the event of a pipeline breach. Further, where the pipeline crosses a coulee or drainage, the joints are welded or constructed with restrained joint fittings and encased in concrete (Houston Engineering et al. 2001). The pipeline was constructed to meet State Health Department guidelines for domestic water supply systems buried at a depth of 7 to 7.5 feet. These safeguards were installed during the construction of the main transmission pipeline. The State of North Dakota also conducted rigorous testing of the pipeline following installation, with each segment exceeding the requirements defined for the *Northwest Area Water Supply Project Biota Transfer Control Measures* (Houston Engineering et al. 1998).

The bulk distribution system (Figure 2-2) includes pipeline, pump stations, and storage reservoirs that together distribute water from the Minot WTP to Project members. This bulk distribution system is the same for each of the action alternatives. Approximately 184 miles of bulk distribution pipeline have been constructed; this includes several different pipe sizes ranging from 6 inches to 36 inches in diameter (details in Appendix A).

Also completed in the bulk distribution system were three aboveground storage reservoirs: a 500,000-gallon reservoir near Burlington, a 750,000-gallon reservoir near Berthold, and a 1-million-gallon reservoir near Kenmare. Storage reservoirs provide both emergency and operational storage within the water system to ensure a reliable source of water for Project members. Water storage in an MR&I system allows for the shutdown of pumping and/or treatment facilities for maintenance or repair, or in the event of a power loss. The storage also allows for the system to meet demands throughout normal day-to-day operations.

Pump stations in the bulk distribution system pump water through the pipelines for distribution. They operate by applying pressure to overcome elevation differences and therefore move water through the pipeline. Four pump stations have been constructed: three near Berthold and one near Kenmare. Each pump station consists of an underground concrete structure that houses pumps, with a hatch and/or manhole aboveground that allows entry for maintenance purposes.

Minot WTP was constructed in 1952; capacity was expanded in 1962. The WTP was designed for a capacity of 18 mgd, with two similar treatment trains. The purpose of the Minot WTP is to treat water to meet the rules and regulations implemented under the Safe Drinking Water Act (SDWA) prior to distribution to end users. Improvements completed at the WTP include upgrading the filtration system to 27-mgd capacity; however, the WTP is still limited to 18 mgd through the clarification process.

In 2009, a high service pump station and associated reservoir were constructed in the immediate vicinity of Minot WTP. The pump station is used to deliver water to the City of Minot and other Project members on an interim basis through the completed portion of the bulk distribution system.

In the past, the City of Minot used surface water from the Souris River and groundwater from the Sundre and Minot aquifers as water sources. With the exception of the flood in 2011, the Minot WTP has used groundwater exclusively since 2000. The use of groundwater is due to two main factors: (1) decreased flows in the Souris River make it a less reliable water supply; and (2) groundwater water chemistry is more consistent than that of the Souris River, increasing its treatability. Although the City of Minot has not been using its surface water source for several years, the plant has the capability to treat raw water from the Souris River via a pump station and river intake.

The community of Rugby is not physically connected to the bulk distribution system, but upgrades to Rugby's WTP were completed as part of the Project. Improvements included upgrades to the WTP to increase capacity from 620 gpm (0.89 mgd) to 1,240 gpm (1.78 mgd). No further upgrades are planned as part of the Project.

Alternative Components

The four action alternatives evaluated in the SEIS combine Project components that were assembled and designed into alternatives to the meet the Project's purpose and need. Table 2-2 lists each of the water supply components developed for this Project and identifies which components are included in each of the alternatives. As stated previously, these components were designed at an appraisal-level (30% design); the location of these proposed components would be refined during more advanced engineering phases. The locations of components identified on figures within the SEIS and Appendix J are a general location point for the purposes of design and impact analyses. Standard construction practices and the BMPs identified in Appendix F would be implemented to ensure that locations selected during final design would minimize or avoid impacts associated with them. A description of each proposed component for the action alternatives is included in the following sections.

Table 2-2 Components of the Action Alternatives

Component	Status	Alternatives			
		Groundwater with Recharge	Groundwater with Recharge and Souris River	Missouri River and Conjunctive Use	Missouri River and Groundwater
Recharge Facility – Minot Aquifer (intake structure and feeder lines, sediment settling facility, recharge basin, recharge wells)	Proposed	•	•		
Recharge Facility – Sundre Aquifer (intake structure and feeder lines, sediment settling facility, recharge basin, recharge wells)	Proposed	•	•		
Peaking Well Facilities	Proposed	•	•		
Upgraded Collector Lines	Proposed	•	•		
Intake and Pump Station at Lake Sakakawea	Proposed			•	•
Biota WTP and Pump Station	Proposed			•	•
South Prairie Storage Reservoir	Proposed			•	•
Transmission Pipeline[a] (buried)	Existing	○	○	•	•
Bulk Distribution Pipelines (buried)	Existing & proposed	•	•	•	•
Minot WTP Upgrades[b]	Existing & proposed	•	•	•	•
High Service Pump Station and Reservoir at Minot WTP	Existing	•	•	•	•
Storage Reservoirs (near Burlington, Berthold, and Kenmare)	Existing	•	•	•	•
Storage Reservoirs (near Lansford and Bottineau)	Proposed	•	•	•	•
Pump Stations (near Berthold and south of Kenmare)	Existing	•	•	•	•
Pump Stations (near Lansford, Mohall, Tolley, Renville County Corner Stations, and Bottineau [2 units])	Proposed	•	•	•	•
Rugby Water Treatment Facility Upgrades	Existing	•	•	•	•

Notes:

[a] Unfilled bullets indicate that the component is included in the alternative but would not be put to beneficial use.

[b] Each of the alternatives requires upgrades to Minot WTP, both to increase capacity and to meet drinking water standards, but the upgrades would be somewhat different under each.

No Action Alternative

The Council on Environmental Quality's NEPA Regulations (40 CFR 1502.14[d]) require the alternatives analysis in an EIS to "include the alternative of no action." The purpose of the No Action Alternative is to provide an appropriate base against which all other alternatives are compared. No Action is not the same as the existing conditions because future actions may occur regardless of whether any of the action alternatives is chosen in the SEIS. The No Action Alternative is defined as the future (through 2060) without any further Reclamation funding for the Project and includes reasonably foreseeable conditions that would occur. Other activities located in the Project Area that are likely to occur have also been considered under No Action to the extent that information is available.

As detailed in Appendix B, most Project members have indicated that they do not have alternative water supplies and are relying on the Project to supply their future needs. Some communities have insufficient water supplies to meet demands through 2060, some have water quality issues, and some have both. Many would be required to implement treatment and/or system upgrades to provide sufficient, high-quality water. At least five communities or rural water systems would face water shortages in their service areas, and many of the Project members would have water that would not meet the secondary drinking water standards in the absence of additional treatment. Because most members have not been planning for a future without the Project, few specific details are available regarding what the Project members would do. This analysis does not attempt to speculate whether the Project members would attempt to obtain funding from other sources or otherwise construct infrastructure improvements to address water quality and water supply issues.

The City of Kenmare would likely exceed the primary (legally enforceable) standard for arsenic and would be forced to seek additional treatment capabilities or other water sources. To address this issue, the City of Kenmare previously evaluated two alternatives in addition to participation in this Project. An iron-manganese removal system was considered, but while it would remove arsenic to a satisfactory level, it would not address color, turbidity, and sodium issues, and cost would be $1.4 million. A reverse osmosis system also was investigated, and while it would satisfactorily remove arsenic and address color, turbidity, and sodium issues, this approach would cost $2.6 million (Ackerman, pers. comm., 2013). The City of Kenmare indicated that it does not have the funds available to develop such a treatment plant and has expressed concerns that the skill level required to operate such a water treatment plant is above what the City of Kenmare could reasonably afford to attain, given the extremely high demand for skilled labor within the region (Ness 2011).

Due to limitations on the amount of groundwater available, it is assumed that the City of Minot would not renew interim water contracts set to expire in 2018 or sooner with Berthold, Burlington, Deering, Kenmare, Mohall, the NCRWC, and Sherwood. They would be required to find a different source of water or develop additional treatment capabilities if exceedances of secondary water quality standards, and in the case of Kenmare, primary water standards, were to be corrected. In addition to the water quality problems faced, some communities would also be likely to experience water shortages.

Groundwater with Recharge Alternative

Figures 2-1 and 2-2 depict the Groundwater with Recharge Alternative. This alternative would provide artificial recharge to the Minot and Sundre aquifers with water from the Souris River. The water would then be conveyed to two separate recharge facilities. Water would be withdrawn from the Minot and Sundre aquifers using the City of Minot's existing wellfields, which would be conveyed to the upgraded Minot WTP through upgraded collector lines. Groundwater would be treated to meet primary SDWA standards and, following treatment, would be distributed to Project members through the bulk distribution system. The communities of Rugby and Grenora would not be connected to the bulk distribution system.

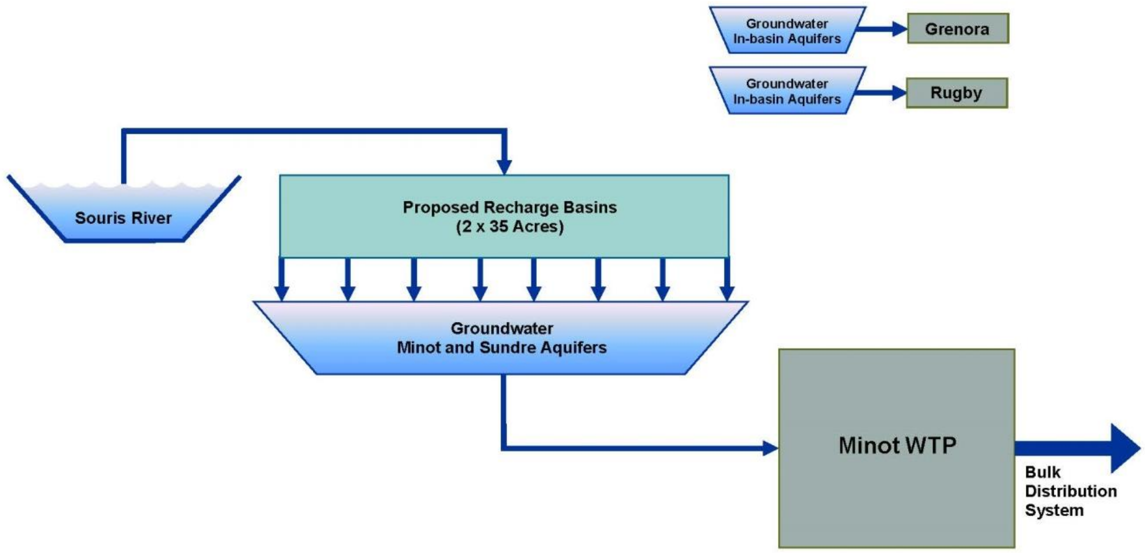

Figure 2-1 Schematic Diagram of the Groundwater with Recharge Alternative

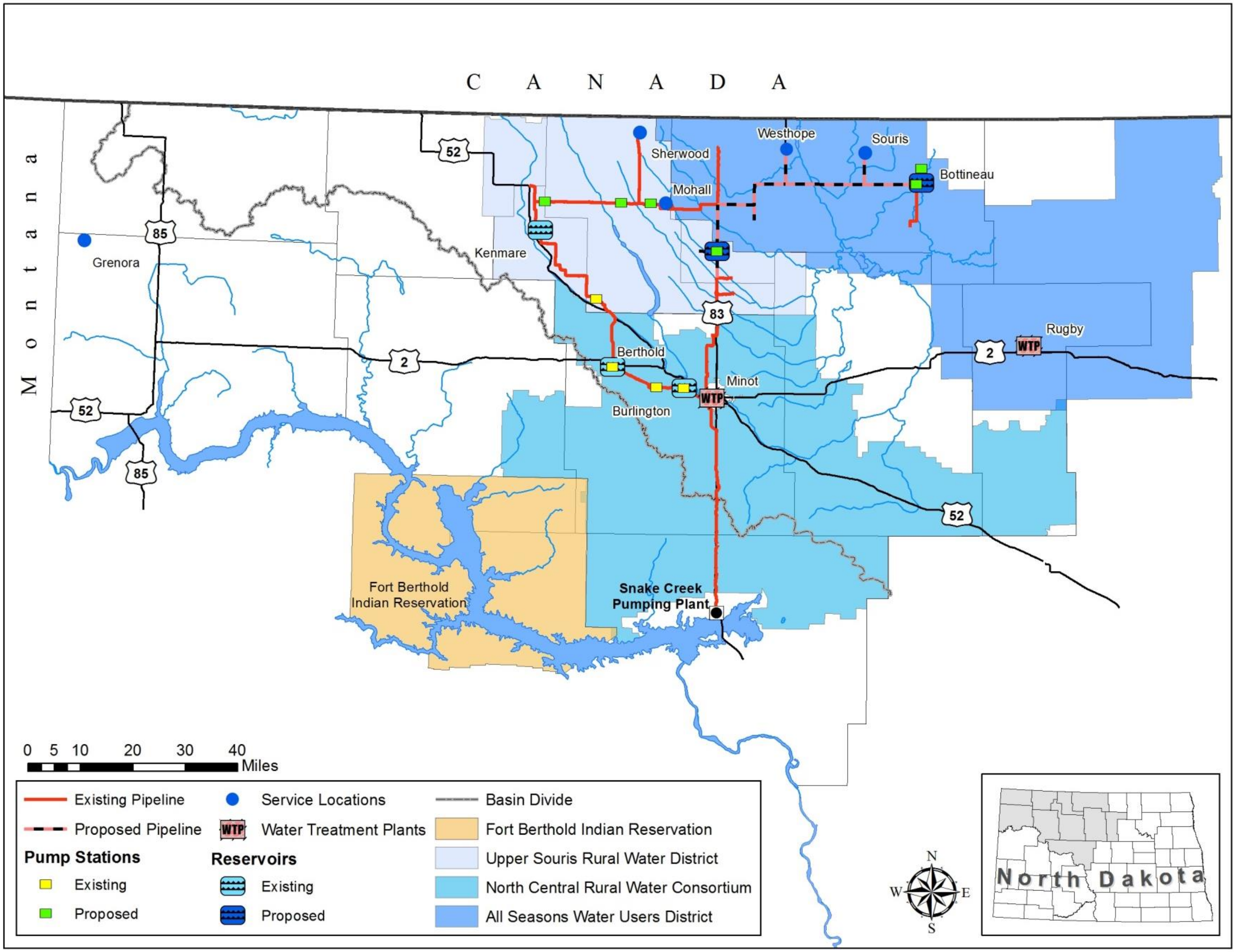

Figure 2-2 Inbasin Alternatives

Components

Each of the alternatives is made up of several components. Table 2-3 shows all of the components included in the Groundwater with Recharge Alternative and indicates whether they are existing or proposed under this alternative. Design details for the proposed components are included in Appendix J; Appendix A provides more information about the existing components.

Table 2-3 Groundwater with Recharge Alternative Components

Component	Status
Recharge Facilities – Minot Aquifer (intake structure and feeder lines, sediment settling facility, recharge basin, recharge wells)	Proposed
Recharge Facilities – Sundre Aquifer (intake structure and feeder lines, sediment settling facility, recharge basin, recharge wells)	Proposed
Groundwater Collection Facilities (existing groundwater wells, 6 peaking Wells, Collector Lines)	Existing & proposed
Main Transmission Pipeline	Existing
Minot WTP Upgrades	Existing & proposed
High Service Pump Station and Reservoir at Minot WTP	Existing
Bulk Distribution Pipelines	Existing & proposed
Storage Reservoirs (near Burlington, Berthold, and Kenmare)	Existing
Storage Reservoirs (near Lansford and Bottineau)	Proposed
Pump Stations (near Berthold and south of Kenmare)	Existing
Pump Stations (near Lansford, Mohall, Tolley, Renville County Corner, Bottineau [2 units])	Proposed
Rugby Water Treatment Facility Upgrades	Existing

Recharge Facilities

The proposed recharge facilities include intake structures, feeder lines, sediment settling basins, recharge basins, and recharge wells. Water would be collected from the Souris River using two separate intake structures on the Souris River (Figure 2-3) and transported to the recharge basins through feeder lines (36-inch-diameter buried pipelines). The water would enter a sediment settling facility where particles present in the water would settle out and be removed. The water would then enter the recharge basins, which are large rectangular basins constructed to infiltrate water into the groundwater. Recharge wells would be located in the bottom of the recharge basin that allow water to enter the aquifer and supplement the groundwater (detail in Appendix J). Table 2-4 shows the estimated construction and permanent footprints (surface impact) for each of the recharge facilities.

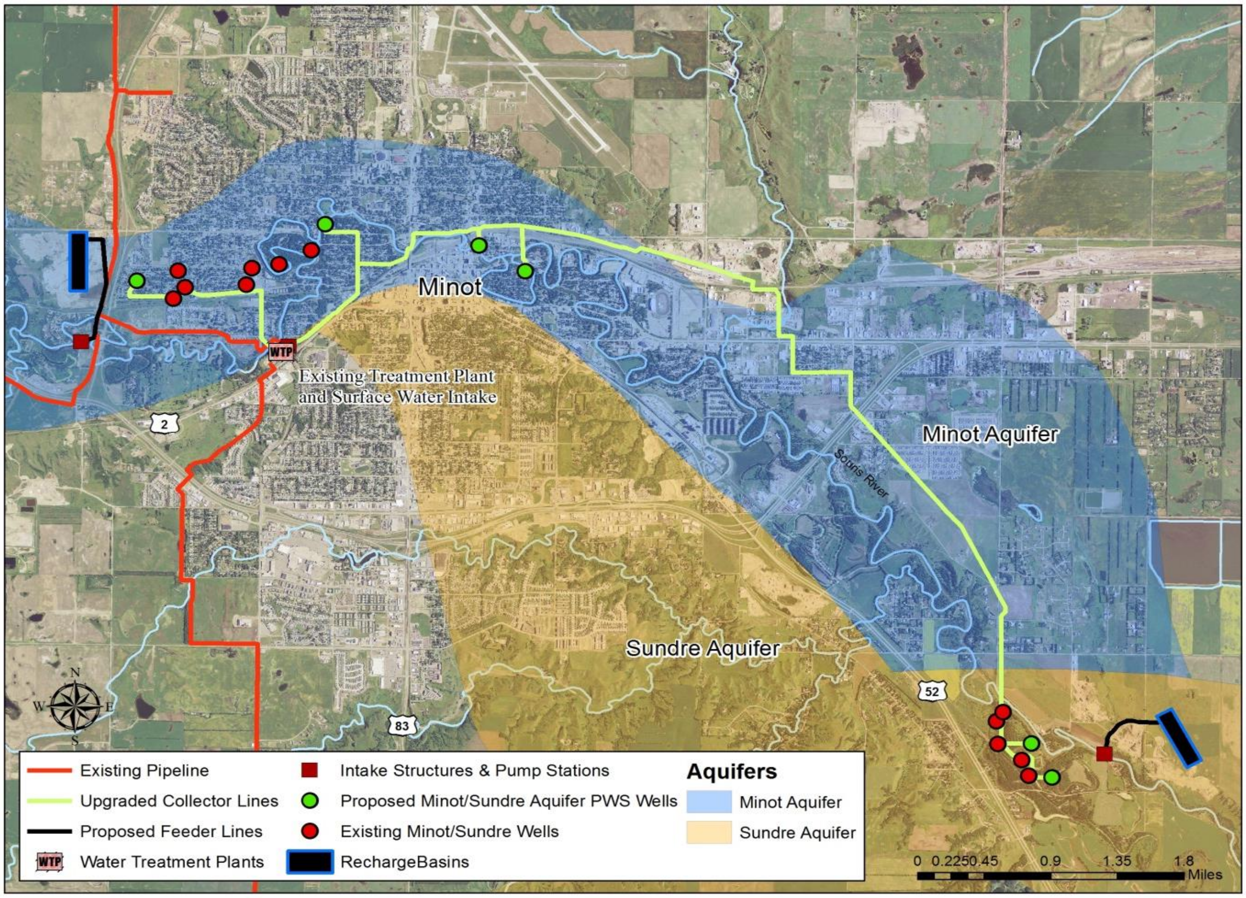

Figure 2-3 Inbasin Alternatives Components in the Vicinity of the City of Minot

Table 2-4 Footprint of Recharge Facility Components

Component	Footprint (acres)	
	Construction	Permanent
Recharge Facilities – Minot Aquifer		
Intake Structure	1	1
Feeder Lines	12	0
Sediment Settling Facility and Recharge Basins	35	35
Recharge Wells (4)	1	1
Collector Lines	7	0
Recharge Facilities – Sundre Aquifer		
Intake Structure	1	1
Feeder Lines	7	0
Sediment Settling Facility and Recharge Basins	35	35
Recharge Wells (2)	1	1
Collector Lines	7	0

Groundwater Collection Facilities

The Groundwater with Recharge Alternative would use the City of Minot's existing wellfield to withdraw groundwater from both the Sundre and Minot aquifers. However, the capacity of the wellfield is not large enough to meet the future water demands. Six new wells would be drilled: four in the Minot aquifer and two in the Sundre aquifer (Figure 2-3). The existing collector pipelines that transport water from the wellfield to the Minot WTP are not large enough to transport the 26.3 mgd needed for peak demand (through the bulk distribution system) and would be supplemented with additional lines that would generally run parallel to the existing lines and also extend to connect to the six proposed peaking wells.

Minot WTP

As described in the Previously Constructed Project Components section of this chapter, Minot WTP treatment capacity is limited to 18 mgd. The addition of a softening and recarbonation process train would increase the capacity from 18 to 27 mgd. Figure 2-4 shows the upgrades proposed for the WTP under this alternative. The darker symbols represent the proposed upgrades, and the lighter symbols indicate existing features within the WTP. Design details for these improvements are included in Appendix J.

An ultraviolet (UV) disinfection system would also be included under this alternative. EPA's Long Term 2 Enhanced Surface Water Treatment Rule requires a source water assessment to test for *Cryptosporidium*. Since the source water assessment has not been completed for this Project, the additional safeguards were included in the design upgrades; however, they may not be necessary once the testing has been completed.

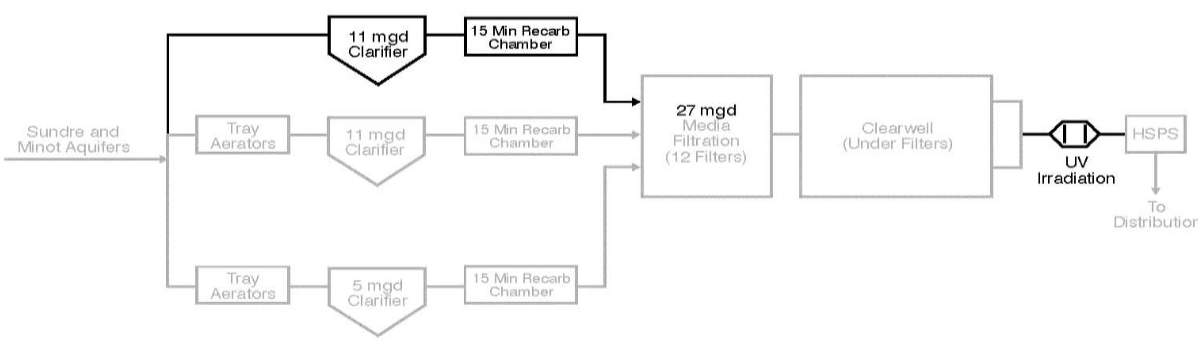

Figure 2-4 Groundwater with Recharge Alternative – Minot WTP Upgrades

Note: HSPS = high service pump station

The purpose of the Minot WTP is to treat the water for drinking water purposes; the plant is designed to meet the EPA's primary SDWA standards. However, due to the quality of the groundwater used for this alternative, some secondary standards would not be achieved through the proposed treatment process. An advanced treatment process such as reverse osmosis would be required to meet all secondary standards, but this was found to be cost prohibitive during the conceptual design phase of the alternative development process. This alternative therefore would have a finished water quality that does not meet all of the EPA's secondary standards, and the Project members would continue to have aesthetic issues (taste, odor, and color).

Bulk Distribution System

A significant portion of the bulk distribution system has been completed, as described in the Previously Constructed Components section of this chapter. The proposed portions of the bulk distribution system would include the remaining pipeline segments, storage reservoirs, and pump stations (Figure 2-1).

Approximately 58 miles of buried pipeline between 6 and 16 inches in diameter would be constructed. Table 2-5 lists the pipeline segments with their proposed length and estimated footprint. The permanent footprint for the pipeline segments would be essentially zero because the pipeline would be buried, and standard engineering practices and BMPs would be implemented during construction so there would not be a permanent ground disturbance. Each pipeline segment would be constructed according to standard engineering practices. Design details for the bulk distribution pipelines are included in Appendix J.

Table 2-5 Bulk Distribution System Pipelines

Description	Length (feet)	Footprint (acres)[a]	
		Construction	Permanent
Glenburn to Renville Corner	90,700	234	0
Westhope and ASWUD System III	104,500	267	0
Souris and ASWUD System I	112,300	556	0

Note:
[a] Estimated acres.

In addition to the installed pump stations, six pump stations are proposed to complete the delivery of water through the bulk distribution pipelines for each of the action alternatives. The proposed pump station locations are shown in Figure 2-2, and the estimated footprints associated with each are listed in Table 2-6. Each of these proposed pump stations would be constructed according to standard engineering practices; design details are included in Appendix J.

Table 2-6 Bulk Distribution System Pump Stations

Description	Footprint (acres)	
	Construction	Permanent
Lansford Pump Station	0	0
Mohall, Tolley, & Renville County Corner Pump Stations	3	1
Bottineau Pump Stations (2)	2	1

Table 2-7 lists the two proposed aboveground storage reservoirs within the bulk distribution system. These reservoirs would provide necessary normal and emergency storage along the distribution system. Each of these proposed storage reservoirs would be constructed according to standard engineering practices (design details in Appendix J).

Table 2-7 Bulk Distribution Storage Reservoirs

Description	Capacity (gallons)	Footprint	
		Construction	Permanent
Lansford Reservoir	4,000,000	3	2
Bottineau Reservoir	2,000,000	2	1

Operations

An analysis to determine the manner in which this alternative might be operated by the Project sponsor was conducted to evaluate impacts on affected resources and to estimate the costs of operations. Actual operations of the alternative would depend on actual conditions and would be further refined during more detailed engineering design. In defining this alternative's operations, the following assumptions were developed:

- Water would be withdrawn from the Souris River for artificial recharge when available from March through August, at a rate equal to the river flow or maximum rate of 56 mgd (87 cubic feet per second) up to a maximum annual allocation of 4.5 billion gallons per year.
- No water would be withdrawn from the Souris River from September through February, due to lack of availability.
- The Minot and Sundre aquifers would be recharged at a rate of up to 56 mgd.
- Water from the Minot and Sundre aquifers would be withdrawn at rates equal to the Project demand.
- An additional surface water permit for the Souris River may need to be obtained.

The amount of water that would be withdrawn from the Souris River for the Groundwater with Recharge Alternative was based on the operational assumptions above. Figure 2-5 shows the amount of groundwater withdrawn each month of an example normal year to meet future Project needs. Figure 2-6 shows the amount of water withdrawn from the Souris River to provide artificial recharge to the aquifers.

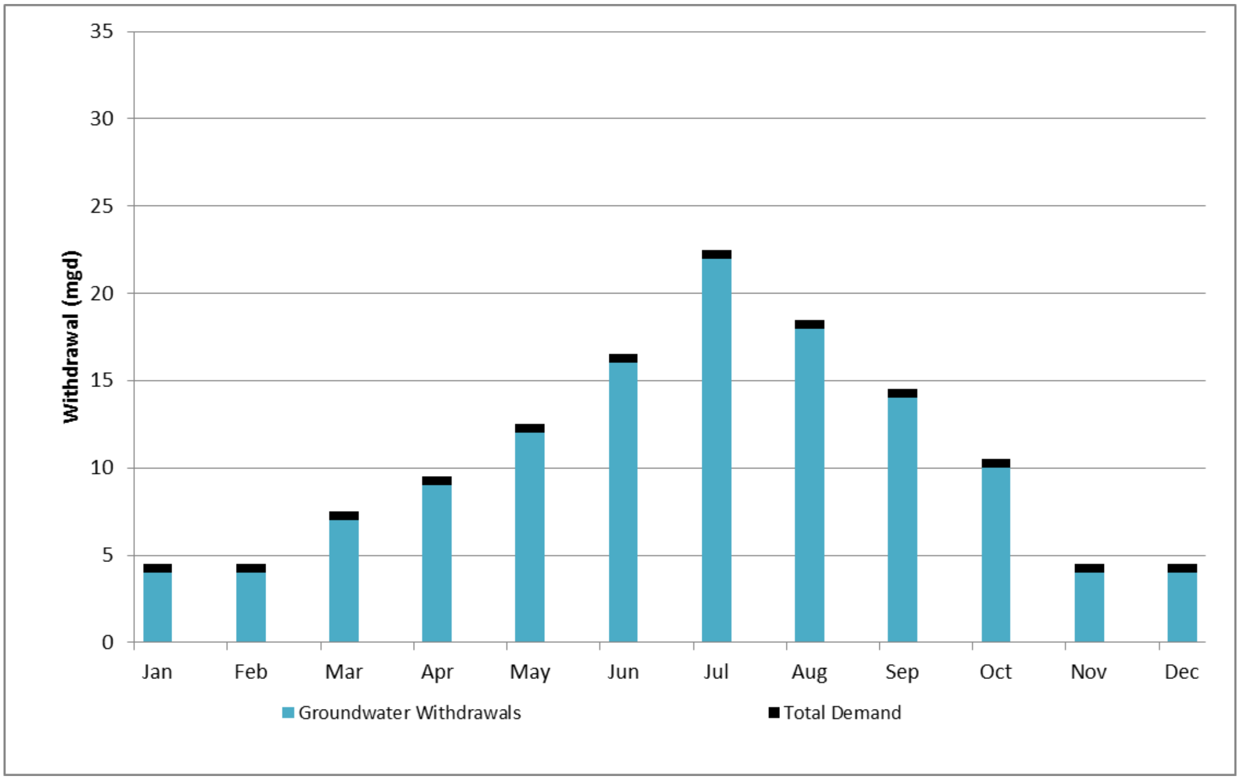

Figure 2-5 **Monthly Average Water Withdrawals from the Minot and Sundre Aquifers under the Groundwater with Recharge Alternative**

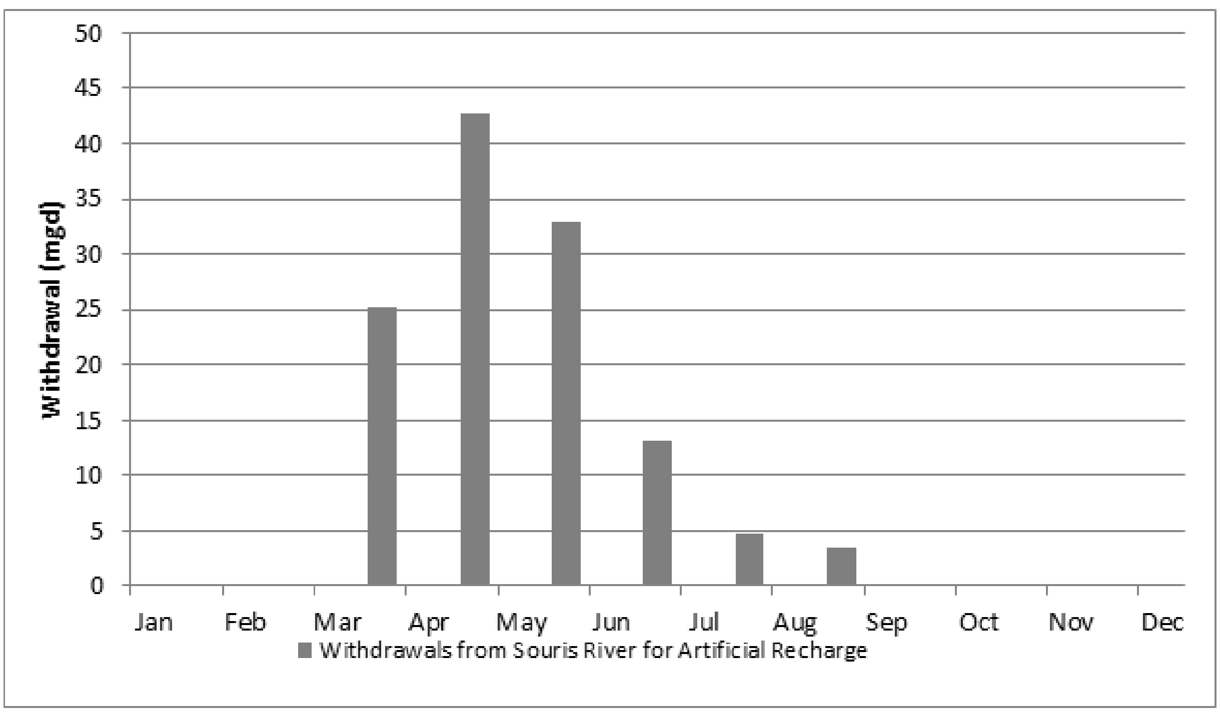

Figure 2-6 **Souris River Water Withdrawn and Recharged to the Minot and Sundre Aquifers under the Groundwater with Recharge Alternative**

Estimated Costs

Cost estimates were developed for construction and operation, maintenance, and replacement (OM&R) of this alternative (Appendix F of Appendix J). Table 2-8 shows actual costs for the previously constructed components and cost estimates for the proposed components. The estimated construction cost is approximately $216.6 million, and it would cost approximately $8.8 million per year for OM&R. These estimates are associated with the 30% design and should only be used to compare the alternatives.

Table 2-8 Construction and OM&R Costs of the Groundwater with Recharge Alternative

Component	Construction Cost	Annual OM&R Cost
Completed		
Transmission Pipeline (buried)	$30,940,000	$773,500
Existing Groundwater Wells	NA [a]	$630,420
Bulk Distribution Pipelines, Pump Stations, and Storage Reservoirs	$39,588,547	$1,003,956
Minot WTP	$24,000,000	$4,000,000
High Service Pump Station and Reservoir at Minot WTP	$14,075,578	$422,267
Rugby Water Treatment Facility Upgrades [b]	$1,795,000	
Subtotal (Actual Cost Expended)	**$110,399,125**	**$6,830,143**
Proposed		
Recharge Facilities – Minot and Sundre Aquifers	$47,735,000	$641,000
Groundwater Collection Facilities	$8,417,000	$339,000
Minot WTP Upgrades [c]	$11,470,000	
Bulk Distribution Pipelines and Pump Stations and Storage Reservoirs	$38,546,000	$993,000
Subtotal (Cost to Complete)	**$106,168,000**	**$1,973,000**
Alternative Total [d]	**$216,600,000**	**$8,803,000**

Notes:

[a] NA = Not applicable as a Project cost.

[b] OM&R costs of the Rugby WTP are not a Project cost.

[c] Estimated OM&R costs for Minot WTP upgrades are included in the “Completed” section, above.

[d] Alternative total is rounded.

Groundwater with Recharge and the Souris River Alternative

The Groundwater with Recharge and the Souris River Alternative is presented in Figures 2-1 and 2-7. This alternative includes the same components as the previously described Groundwater with Recharge Alternative plus an existing intake on the Souris River. This alternative would provide supplemental recharge to the Minot and Sundre aquifers with water from the Souris River and would also use the Souris River as a direct water source to the Minot WTP when river flows are sufficient to do so.

Water from the Souris River would be conveyed to two separate recharge facilities to provide artificial recharge to the Minot and Sundre aquifers. Groundwater from the Minot and Sundre aquifers would be withdrawn using the existing wellfields and would be conveyed to the upgraded Minot WTP through upgraded collector lines. Water would also be withdrawn directly from the river for water supply purposes, using the City of Minot's existing intake when flows are sufficient. The water from each source would be combined and treated to meet primary SDWA requirements. Following treatment, drinking water would be distributed to Project members through the bulk distribution system. The communities of Rugby and Grenora would not be connected to the bulk distribution system.

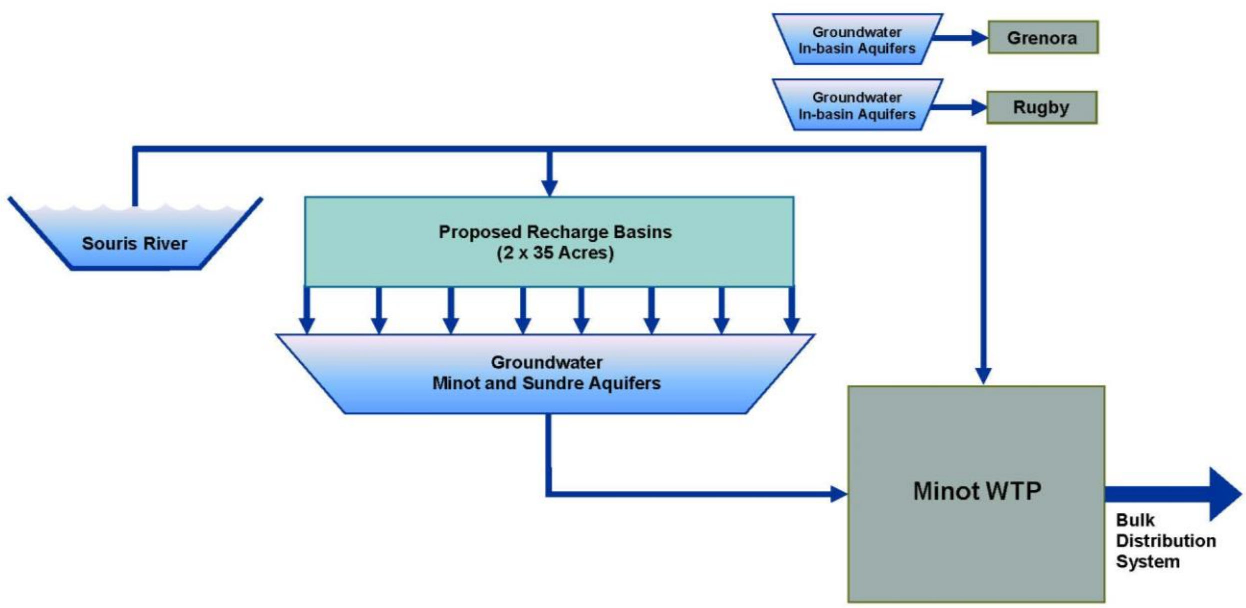

Figure 2-7 Schematic Diagram of the Groundwater with Recharge and the Souris River Alternative

Components

The components included in the Groundwater with Recharge and the Souris River Alternative are shown in Table 2-9. The components for this alternative are exactly the same as those described in the Groundwater with Recharge Alternative; however, this alternative also uses an existing feature, the Souris River intake at the Minot WTP.

Recharge Facilities

As described for the Groundwater with Recharge Alternative, the proposed recharge facilities include intake structures, feeder lines, sediment settling basins, recharge basins, and recharge wells. Design details for this component are included in Appendix J.

Table 2-9 Groundwater with Recharge and the Souris River Components

Component	Status
Recharge Facilities – Minot Aquifer (intake structure and feeder lines, sediment settling facility, recharge basin, recharge wells)	Proposed
Recharge Facilities – Sundre Aquifer (intake structure and feeder lines, sediment settling facility, recharge basin, recharge wells)	Proposed
Groundwater Collection Facilities (existing groundwater wells, 6 peaking wells, collector lines)	Existing & proposed
Main Transmission Pipeline	Existing
Souris River Intake at Minot WTP	Existing
Minot WTP Upgrades	Existing & proposed
High Service Pump Station and Reservoir at Minot WTP	Existing
Bulk Distribution Pipelines	Existing & proposed
Storage Reservoirs (near Burlington, Berthold, and Kenmare)	Existing
Storage Reservoirs (near Lansford and Bottineau)	Proposed
Pump Stations (near Berthold and south of Kenmare)	Existing
Pump Stations (near Lansford, Mohall, Tolley, Renville County Corner, Bottineau [2 units])	Proposed
Rugby Water Treatment Facility Upgrades	Existing

Souris River Intake at the Minot WTP

This alternative includes the use of the Souris River as a direct water supply when river flows are available to do so. River flows would be withdrawn using the City of Minot's existing intake at the Minot WTP. This component was not constructed for the Project and therefore is not included in the "Previously Constructed Project Components" section of this chapter. Costs of constructing it are also not included in the alternative cost estimates.

Groundwater Collection Facilities

As described for the Groundwater with Recharge Alternative, the proposed groundwater collection facilities include the construction of six new groundwater wells to meet peak day demands as well as upgraded collector lines. Design details are included in Appendix J.

Minot WTP

The upgrades to the existing Minot WTP facility for this alternative are slightly different than those proposed for the Groundwater with Recharge Alternative. The capacity increase of the WTP from 18 to 27 mgd is the same as for the Groundwater with Recharge Alternative. A UV disinfection system would be added to the treatment process under this alternative because it uses surface water. EPA's Long Term 2 Enhanced Surface Water Treatment Rule requires a source water assessment to test for *Cryptosporidium.* Since the source water assessment has not been completed for this Project, additional safeguards were included in the WTP upgrades. However, once the source water assessment has been completed, this UV disinfection system may not be necessary.

Since this alternative also includes the use of Souris River water directly and because the Souris River is known to have fluctuating water quality, both seasonally and on a daily basis, a separate 4-mgd pretreatment basin is included to reduce the effects on the other water treatment processes for this alternative. Figure 2-8 shows the proposed upgrades to the Minot WTP for this alternative. The darker symbols on the figure represent the proposed upgrades, and the lighter colored symbols indicate existing features of the WTP. Design details for this component are included in Appendix J.

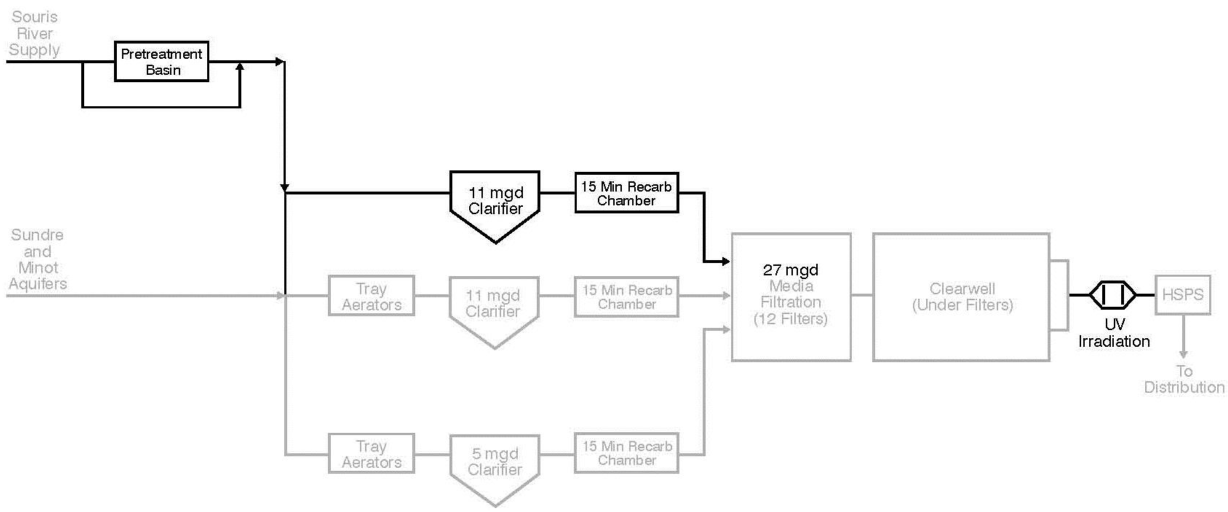

Figure 2-8 Groundwater with Recharge and the Souris River Alternative – Minot WTP Upgrades

Note: HSPS = high service pump station

Again, the purpose of the Minot WTP is to treat the water for drinking water purposes; the plant is designed to meet the EPA's primary SDWA standards. However, due to the quality of the groundwater used for this alternative, some secondary standards would not be met through the proposed treatment process. An advanced treatment process such as reverse osmosis would be required to meet all secondary standards but was found to be cost prohibitive during the conceptual design phase. This alternative, therefore, would have a finished water quality that does not meet all of the EPA's secondary standards, and the Project members would continue to have aesthetic issues (taste, odor, and color).

Bulk Distribution System

The bulk distribution system is the same for each of the alternatives and would include the remaining pipeline segments, storage reservoirs, and pump stations (Figure 2-1). Pieces of this component would be constructed according to standard engineering practices (design details in Appendix J).

Operations

An analysis to determine the manner in which the Groundwater with Recharge and the Souris River Alternative might be operated by the Project sponsor was conducted to evaluate impacts on affected resources and to estimate the costs of operations. Actual operations would depend on actual conditions and would be further refined during more detailed engineering design. In defining the operations for this alternative, the following assumptions were developed:

- Water would be withdrawn from the Souris River for artificial recharge when available in March through August, at a rate equal to the river flow or maximum rate of 56 mgd (87 cubic feet per second) up to a maximum annual allocation of 4.5 billion gallons per year.
- No water would be withdrawn from the Souris River from September through February due to lack of availability.
- The Minot and Sundre aquifers would be recharged at a rate of up to 56 mgd.
- When available, Souris River water would be delivered directly to the Minot WTP in March through August at a rate equal to the monthly average Project demand minus 1 mgd, up to 5.75 mgd.
- Water would be withdrawn from Minot and Sundre aquifers at rates equal to the Project demand (less direct delivery at a minimum rate of 1.0 mgd).
- An additional surface water permit for the Souris River may need to be obtained.

The amount of water withdrawn from the Souris River for the Groundwater with Recharge and the Souris River Alternative would be based on the operational assumptions above. Figure 2-9 shows the amount of groundwater and Souris River water withdrawn each month of an example normal-flow year to meet Project needs. It illustrates the amount of demand met from groundwater versus demand met from the Souris River directly. Figure 2-10 shows the amount of water withdrawn from the Souris River to provide artificial recharge to the Minot and Sundre aquifers during an example normal-flow year.

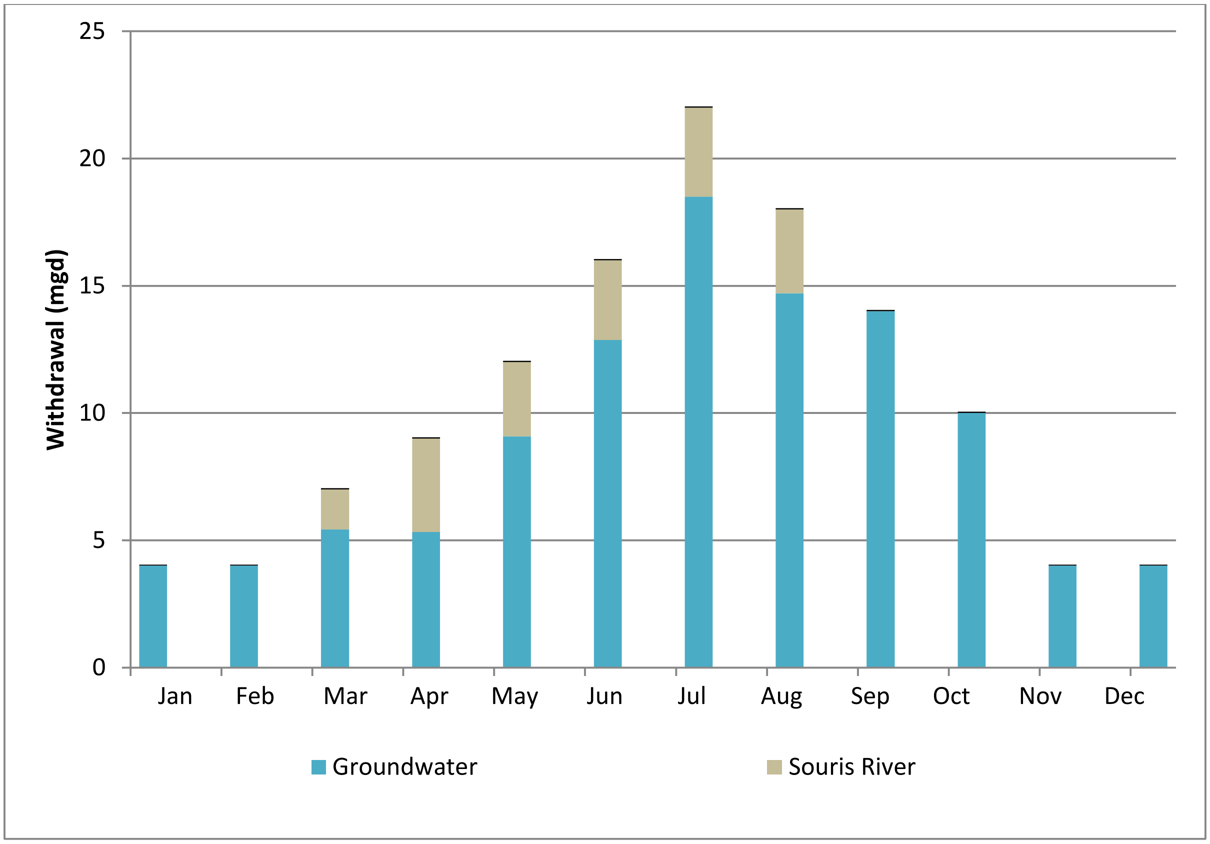

Figure 2-9 Monthly Average Water Withdrawals from the Groundwater and Souris River for the Groundwater with Recharge and the Souris River Alternative

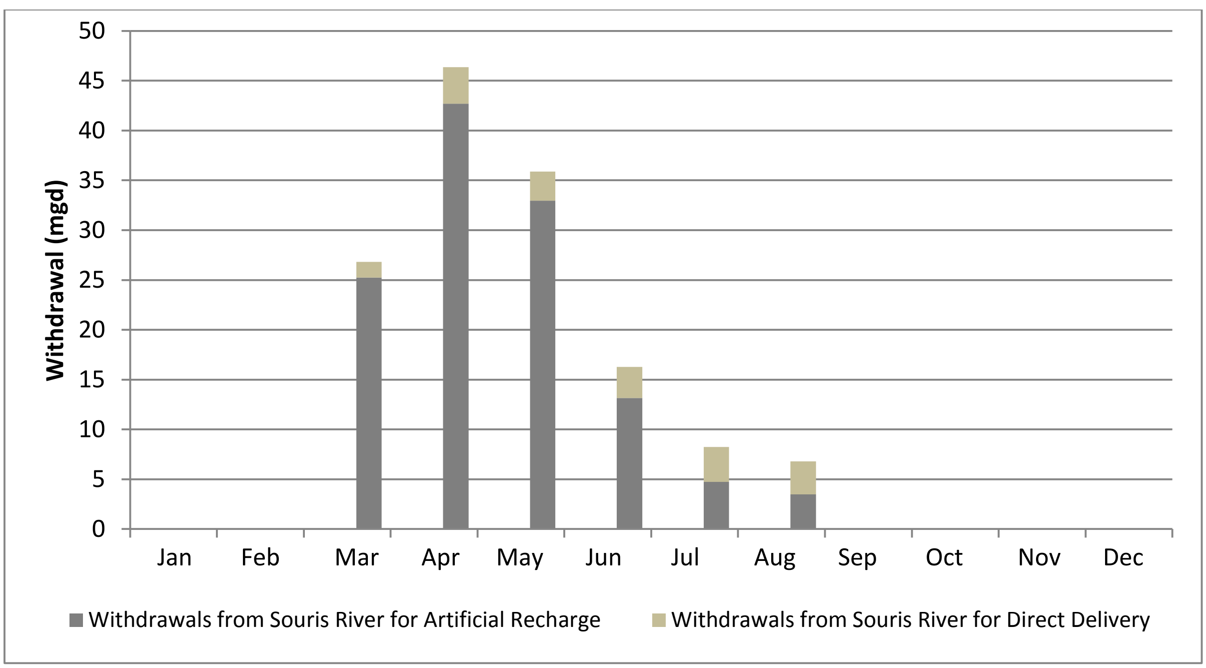

Figure 2-10 Groundwater with Recharge and the Souris River Alternative – Withdrawals from the Souris River for Artificial Recharge and Direct Supply

Estimated Costs

Cost estimates were completed for construction and OM&R (Appendix F of Appendix J). Table 2-10 shows actual costs for the previously constructed components and cost estimates for the proposed components. This alternative has a construction cost of approximately $217.1 million and would cost approximately $8.8 million per year for OM&R. These costs are associated with the 30% design level and should only be used for comparison of the alternatives.

Table 2-10 Construction and OM&R Costs of the Groundwater with Recharge and the Souris River Alternative

Component	Construction Cost	Annual OM&R Cost
Completed		
Transmission Pipeline (buried)	$30,940,000	$773,500
Existing Groundwater Wells	NA [a]	$630,420
Bulk Distribution Pipelines, Pump Stations, and Storage Reservoirs	$39,588,547	$1,003,956
Minot WTP and Souris River Intake	$24,000,000	$4,020,000
High Service Pump Station and Reservoir at Minot WTP	$14,075,578	$422,267
Rugby Water Treatment Facility Upgrades [b]	$1,795,000	
Subtotal (Actual Cost Expended)	**$110,399,125**	**$6,850,143**
Proposed		
Recharge Facilities – Minot and Sundre Aquifers	$47,735,000	$641,000
Groundwater Collection Facilities	$7,115,000	$339,000
Minot WTP Upgrades [c]	$13,336,000	
Bulk Distribution Pipelines and Pump Stations and Storage Reservoirs	$38,546,000	$993,000
Subtotal (Cost to Complete)	**$106,732,000**	**$1,973,000**
Alternative Total [d]	**$217,100,000**	**$8,823,000**

Notes:

[a] NA = Not applicable as a Project cost.

[b] OM&R costs of the Rugby WTP are not a Project cost.

[c] Estimated OM&R costs for Minot WTP upgrades are included in the "Completed" section above.

[d] Alternative total is rounded.

Missouri River and Conjunctive Use Alternative

Figures 2-11 and 2-12 depict the Missouri River and Conjunctive Use Alternative. This alternative uses water from the Missouri River, withdrawn from Lake Sakakawea. Water would be conveyed to the Minot WTP and blended with Souris River water and groundwater from the Minot and Sundre aquifers. Following treatment at the Minot WTP, water would be distributed to Project members through the bulk distribution system. Water would be treated to meet primary and secondary SDWA requirements. The communities of Rugby and Grenora would not be connected to the bulk distribution system. Each of the Missouri River alternatives includes two options for a new intake and pump station at Lake Sakakawea and five options for a Biota WTP in Max, North Dakota. The purpose of the Biota WTP is to reduce the risk of a Project-related transfer of AIS into the Hudson Bay basin, whereas the Minot WTP is needed to treat the water to SDWA standards.

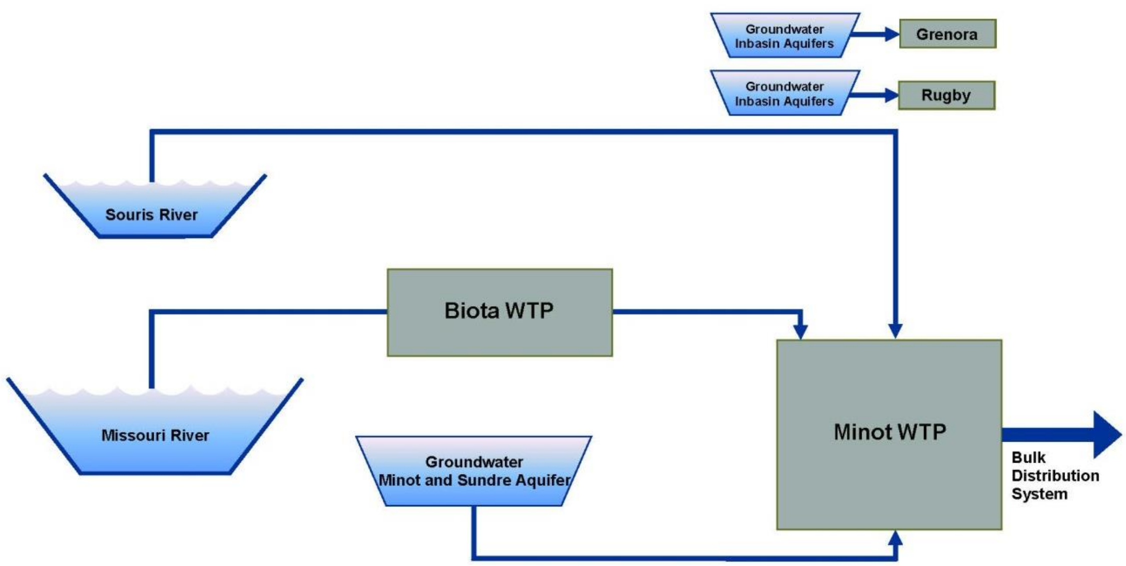

Figure 2-11 Schematic Diagram of the Missouri River and Conjunctive Use Alternative

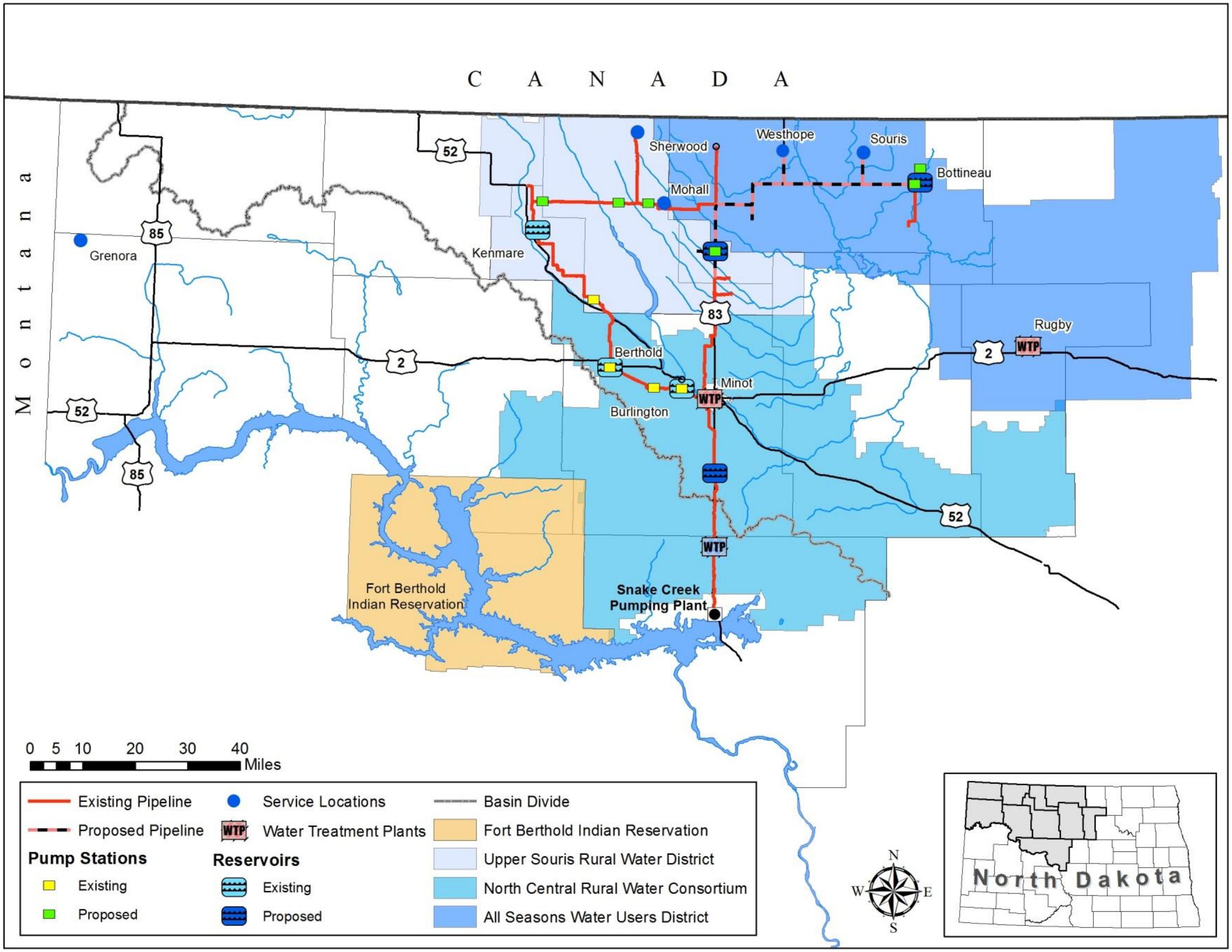

Figure 2-12 Missouri River Alternatives

Components

Table 2-11 shows the components included in the Missouri River and Conjunctive Use Alternative and indicates whether they are existing or proposed. For details regarding the existing components, refer to Appendix A and Appendix J.

Table 2-11 Missouri River and Conjunctive Use Components

Component	Status
Intake and Pump Station at Lake Sakakawea	Proposed
Biota WTP and Pump Station	Proposed
South Prairie Storage Reservoir	Proposed
Transmission Pipeline (buried)	Existing
Bulk Distribution Pipelines (buried)	Existing & proposed
Minot WTP Upgrades	Existing & proposed
Souris River Intake at Minot WTP	Existing
High Service Pump Station and Reservoir at Minot WTP	Existing
Storage Reservoirs (near Burlington, Berthold, and Kenmare)	Existing
Storage Reservoirs (near Lansford and Bottineau)	Proposed
Pump Stations (near Berthold and south of Kenmare)	Existing
Pump Stations (near Lansford, Mohall, Tolley, Renville County Corner Stations, and Bottineau [2 units])	Proposed
Rugby Water Treatment Facility Upgrades	Existing

Intake and Pump Station at Lake Sakakawea

Two options were considered and evaluated for the intake and pump station at Lake Sakakawea: (1) modifications to the Snake Creek Pumping Plant (SCPP); and (2) a new intake adjacent to the SCPP. These two options are described in detail in the Lake Sakakawea Intake Options section of this chapter; design details are included in Appendix J.

Biota WTP and Pump Station

Five options were considered and evaluated for the Biota WTP component. These options include the following: Chlorination, Chlorination/UV Inactivation, Enhanced Chlorination/UV Inactivation, Conventional Treatment, and Microfiltration. These options are described in detail in the Biota WTP section of this chapter and further in Appendix J.

South Prairie Storage Reservoir

The South Prairie Storage Reservoir would be situated on the transmission pipeline between the Biota WTP and the Minot WTP (Figure 2-11). The purpose of this 3-million-gallon aboveground storage reservoir would be to provide operational and emergency storage for the Project. Water to fill the reservoir would be supplied from the Biota WTP booster station, and the reservoir would feed the north section of the transmission pipeline to Minot WTP by gravity. Design details of this component are included in Appendix J.

Main Transmission Pipeline

The main transmission pipeline (Figure 2-11) is described in the Previously Constructed Project Components section. This alternative would also include completion of the short portions of the existing pipeline in the vicinity of the proposed South Prairie Storage Reservoir and the proposed Biota WTP.

Minot WTP

Minot WTP upgrades would be similar to those described for the Groundwater with Recharge Alternative. Upgrades would increase the treatment capacity from 18 to 27 mgd, and a static mixer would be added to provide adequate blending of the different source waters prior to treatment. Figure 2-13 shows the Minot WTP proposed upgrades for this alternative. Proposed upgrades are designated by the dark symbols in the figure. Additional details regarding these improvements are presented in Appendix J.

As in the other alternatives, a UV disinfection system would be included because a Souris River source water assessment for *Cryptosporidium* has not been completed as required by EPA's Long Term 2 Enhanced Surface Water Treatment Rule.

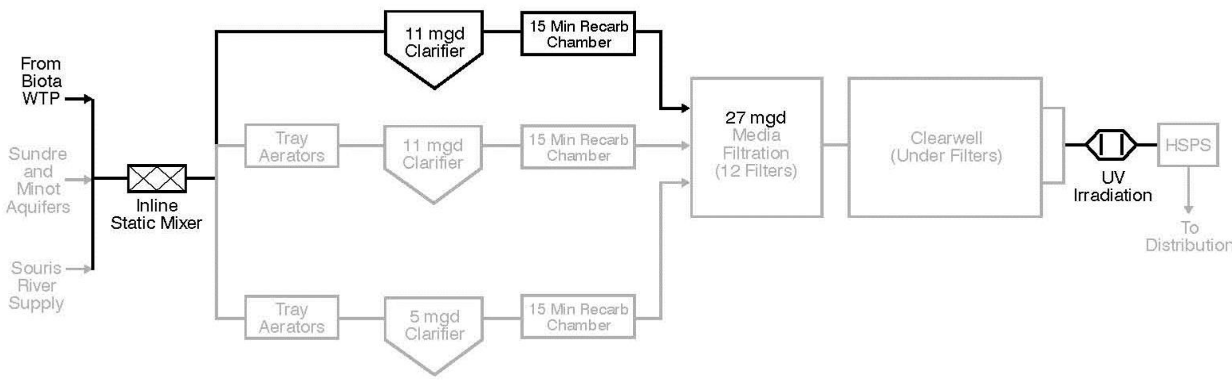

Figure 2-13 Missouri River and Conjunctive Use Alternative – Minot WTP Upgrades

Note: HSPS = high service pump station

Bulk Distribution System

The bulk distribution system is the same for each alternative, as previously explained and shown in Figure 2-12. Pieces of this component would be constructed according to standard engineering practices, and the design details are included in Appendix J.

Operations

An analysis to determine the manner in which this alternative would be operated was conducted to evaluate impacts on affected resources and estimate costs of operations. Actual operations would depend on actual conditions and would be further refined during more detailed engineering design. The following assumptions were used in defining how the Missouri River and Conjunctive Use Alternative would be operated:

- Up to 5.75 mgd would be withdrawn from the Souris River for direct delivery from March through August at a rate of half the demand whenever the flow was more than twice the monthly average demand.
- No withdrawals from the Souris River would take place when the flow was less than twice the monthly average demand.
- No Souris River withdrawals would take place from September through February due to lack of availability.
- Water would be withdrawn from the Minot and Sundre aquifers at a minimum rate of 1.0 mgd on a daily average up to 2.6 mgd during peak use (June, July, and August).
- At least 2 mgd of water would be withdrawn from the Missouri River at rates equal to the Project demand (less direct delivery from the Souris River and Minot and Sundre aquifers).
- An additional surface water permit for the Souris River may need to be obtained.

The amount of water that would be withdrawn from the Souris River for the Missouri River and Conjunctive Use Alternative was based on the operational assumptions above. Figure 2-14 shows the amount of water withdrawn from the different source waters each month of an example normal-flow year to meet Project demand.

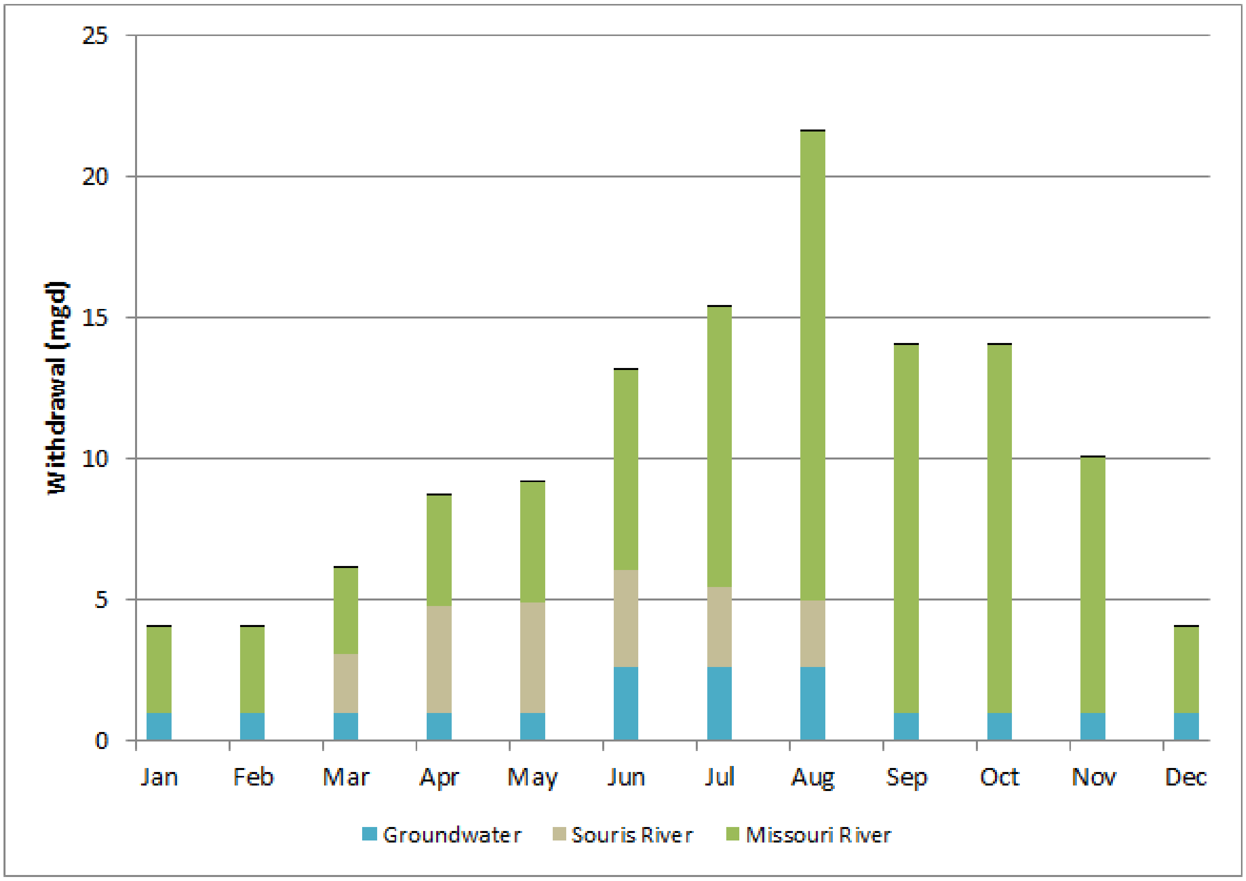

Figure 2-14 Missouri River and Conjunctive Use Alternative Operations

Estimated Costs

Cost estimates were completed for construction and OM&R (Appendix F of Appendix J). Table 2-12 shows actual construction costs for the completed components and cost estimates for the proposed components. The Missouri River and Conjunctive Use Alternative has a construction cost range from approximately $205.7 to $276.7 million, depending on the options for the intake and the Biota WTP. Annual OM&R costs would range from approximately $9.5 to $10.8 million. These costs are associated with the 30%design level and should only be used for comparison of the alternatives.

Table 2-12 Total Costs for Missouri River and Conjunctive Use Alternative

Component	Construction Cost	Annual OM&R Cost
Completed		
Transmission Pipeline (buried)	$ 30,940,000	$ 773,500
Bulk Distribution Pipelines, Pump Stations, and Storage Reservoirs	$ 39,588,547	$ 1,003,956
Existing Groundwater Wells	NA [a]	$ 85,620
Minot WTP Upgrades and Souris River Intake	$ 24,000,000	$ 4,020,000
High Service Pump Station and Reservoir at Minot WTP	$ 14,075,578	$ 422,267
Rugby Water Treatment Facility Upgrades [b]	$ 1,795,000	
Total Completed	**$ 110,399,125**	**$ 6,305,343**
Proposed		
Minot WTP Upgrades [c]	$ 11,640,000	*
Bulk Distribution Pipelines and Pump Stations and Storage Reservoirs	$ 38,546,000	$ 993,000
South Prairie Reservoir	$ 3,023,000	$ 41,000
Intake and Pump Station at Lake Sakakawea (2 options)		
Modify SCPP	*$ 13,835,000*	*$ 986,000*
Adjacent to SCPP	*$ 22,525,000*	*$ 1,061,000*
Biota WTP and Pump Station (5 options)		
Chlorination	*$ 28,300,000*	*$ 1,200,000*
Chlorination/UV	*$ 29,800,000*	*$ 1,500,000*
Enhanced Chlorination/UV	*$ 47,800,000*	*$ 1,800,000*
Conventional Treatment	*$ 66,700,000*	*$ 2,300,000*
Microfiltration	*$ 90,600,000*	*$ 2,400,000*
Total Proposed	**$95,344,000 - $166,334,000**	**$3,220,000 - $4,495,000**
Overall Total [d]	**$205,700,000 - $276,700,000**	**$9,500,000 - $10,800,000**

Notes:

a NA = Not applicable as a Project cost.

b OM&R costs of the Rugby WTP are not a Project cost.

c Estimated OM&R costs for Minot WTP upgrades are included in the “Completed” section, above.

d Alternative total is rounded.

Missouri River and Groundwater Alternative

Figures 2-12 and 2-15 depict the Missouri River and Groundwater Alternative. This alternative uses water from the Missouri River (withdrawn from Lake Sakakawea), which would be conveyed to the Minot WTP and blended with groundwater from the Minot and Sundre aquifers. Following treatment at the Minot WTP to meet primary and secondary SDWA requirements, water would be distributed to Project members through the bulk distribution system.

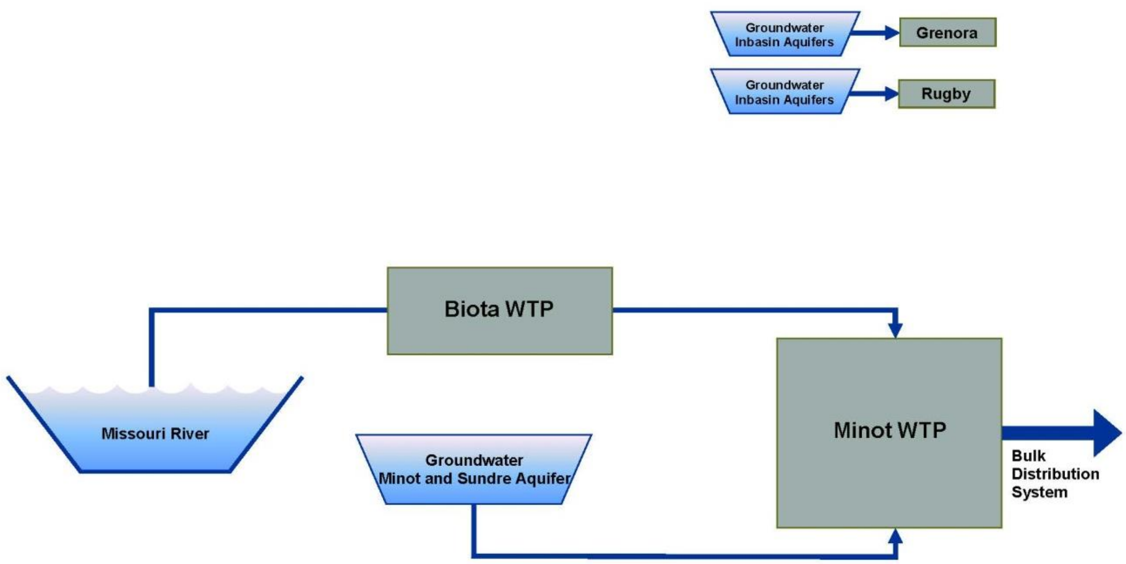

Figure 2-15   Schematic Diagram of the Missouri River and Groundwater Alternative

The components of this alternative are very similar to the Missouri River and Conjunctive Use Alternative. The options for a new intake and pump station at Lake Sakakawea are the same. The five options for a Biota WTP are the same. Completion of the main transmission pipeline and the water storage provided by the South Prairie Storage Reservoir are also included. Upgrades at the Minot WTP are slightly different and these are described below. The same distribution system proposed in the other alternatives would be used to distribute the water.

Components

Table 2-13 lists the components included in the Missouri River and Groundwater Alternative and identifies whether they existing or proposed. For details of the existing components, refer to Appendix A and Appendix J.

Table 2-13 Missouri River and Groundwater Alternative Components

Component	Status
Biota WTP and Pump Station	Proposed
South Prairie Storage Reservoir	Proposed
Transmission Pipeline (buried)	Existing
Bulk Distribution Pipelines (buried)	Existing & proposed
Minot WTP Upgrades	Existing & Proposed
High Service Pump Station and Reservoir at Minot WTP	Existing
Storage Reservoirs (near Burlington, Berthold, and Kenmare)	Existing
Storage Reservoirs (near Lansford and Bottineau)	Proposed
Pump Stations (near Berthold and south of Kenmare)	Existing
Pump Stations (near Lansford, Mohall, Tolley, Renville County Corner Stations, and Bottineau [2 units])	Proposed
Rugby Water Treatment Facility Upgrades	Existing
Groundwater Collection Facilities	Existing

Minot WTP

Minot WTP upgrades proposed in this alternative would be similar to those of both the Groundwater with Recharge Alternative and the Missouri River and Conjunctive Use Alternative. The processes currently used at the Minot WTP would not change substantially. The capacity would be increased from 18 to 27 mgd, and a static mixer would be added to provide adequate blending of the source waters prior to treatment. The proposed upgrades are shown in Figure 2-16. The dark symbols represent the proposed upgrades, while the lighter symbols represent existing treatment processes within the WTP.

As in the other alternatives, a UV disinfection system would be included because a source water assessment for *Cryptosporidium* has not been completed as required by EPA's Long Term 2 Enhanced Surface Water Treatment Rule. Design details are included in Appendix J.

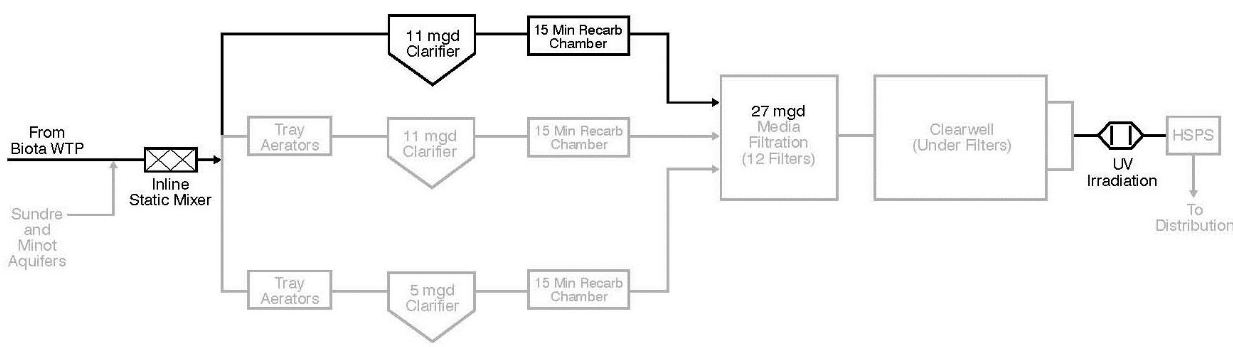

Figure 2-16 Missouri River and Groundwater Alternative – Minot WTP Upgrades

Note: HSPS = high service pump station

Operations

An analysis to determine the manner in which this alternative would be operated was conducted to evaluate impacts on affected resources and estimate costs of operations, actual operations of the alternative would depend on actual conditions and be further refined during more detailed engineering design. In order to define how the Missouri River and Groundwater Alternative would be operated the following assumptions were made:

- No withdrawals from the Souris River would occur under this alternative.
- Water would be withdrawn from the Minot and Sundre aquifers at a minimum rate of 1.0 mgd on a daily average and up to 2.6 mgd during peak use (June, July and August).
- Water would be withdrawn from the Missouri River at rates equal to the Project demand less direct delivery from the Minot and Sundre aquifers.

The amount of water that would be taken from each of the water sources was based on the operation assumptions listed above. Figure 2-17 illustrates how the Missouri River and Groundwater Alternative would be operated during an example normal-flow year, showing the amount of Missouri River water that would be used, compared to groundwater from the Minot and Sundre aquifers.

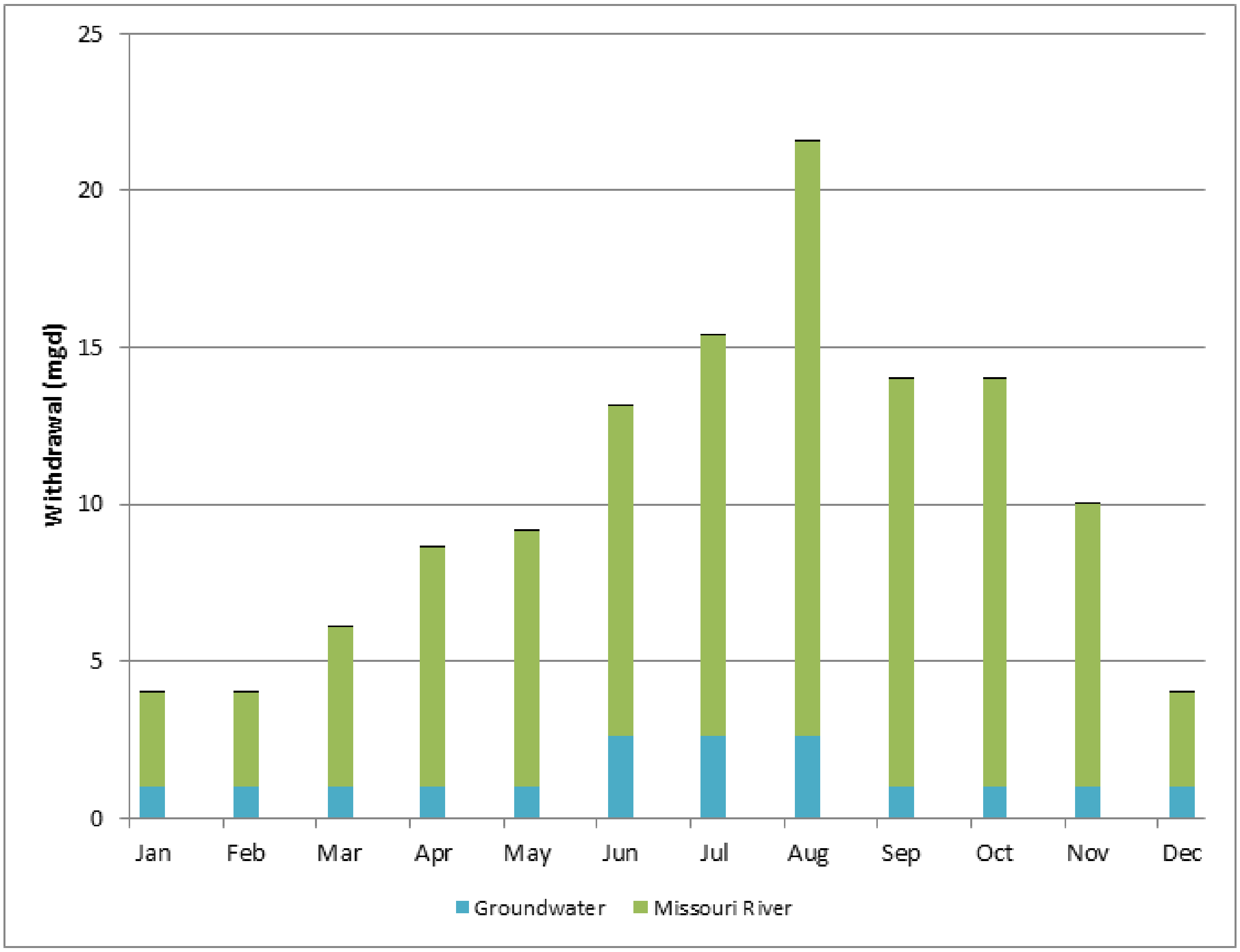

Figure 2-17 Missouri River and Groundwater Alternative Operations

Estimated Costs

Cost estimates were completed for construction and OM&R of this alternative (Appendix F of Appendix J). Table 2-14 shows the completed costs for previously constructed components (actual expenditures) and cost estimates for proposed components. The Missouri River and Groundwater Alternative construction costs range from approximately $205.6 to $276.8 million, depending on the options for the intake and the Biota WTP. Estimated OM&R costs range from approximately $9.6 to $10.9 million per year. These costs are associated with the 30% design level and should only be used to compare alternatives.

Table 2-14 Missouri River and Groundwater Alternative Construction and OM&R Costs

Component	Construction Cost	Annual OM&R Cost
Completed		
Transmission Pipeline (buried)	$30,940,000	$773,500
Bulk Distribution Pipelines, Pump Stations, and Storage Reservoirs	$39,588,547	$1,003,956
Existing Groundwater Wells	NA [a]	$85,620
Minot WTP	$24,000,000	$4,000,000
High Service Pump Station and Reservoir at Minot WTP	$14,075,578	$422,267
Rugby Water Treatment Facility Upgrades [b]	$1,795,000	NA
Total Completed	**$110,399,125**	**$6,285,343**
Proposed		
Minot WTP Upgrades [c]	$11,375,000	
Bulk Distribution Pipelines and Pump Stations and Storage Reservoirs	$38,546,000	$993,000
South Prairie Reservoir	$3,023,000	$41,000
Intake and Pump Station at Lake Sakakawea (2 options)		
Modify SCPP	*$13,910,000*	*$1,099,000*
Adjacent to SCPP	*$22,900,000*	*$1,207,000*
Biota WTP and Pump Station (5 options)		
Chlorination	*$28,300,000*	*$1,200,000*
Chlorination/UV	*$29,800,000*	*$1,500,000*
Enhanced Chlorination/UV	*$47,800,000*	*$1,800,000*
Conventional Treatment	*$66,700,000*	*$2,300,000*
Microfiltration	*$90,600,000*	*$2,400,000*
Total Proposed	**$95,150,000 – $166,440,000**	**$3,333,000 – $4,641,000**
Overall Total [d]	**$205,600,000 – $276,800,000**	**$9,600,000 – $10,900,000**

Notes:

[a] NA = Not applicable as a Project cost.

[b] OM&R costs of the Rugby WTP are not a Project cost.

[c] Estimated OM&R costs for Minot WTP upgrades are included in the "Completed" section above.

[d] Alternative total is rounded to the nearest $100,000.

Missouri River Alternative Options

Lake Sakakawea Intake Options

Each of the Missouri River alternatives would require an intake structure and pump station to collect water from Lake Sakakawea and convey it to the Minot WTP for Project use. As previously mentioned, two intake options were evaluated; each was designed to meet the peak day demand. The intake options include the following:

- Modifications at the SCPP
- Adjacent to the SCPP

Modifications at the SCPP

The SCPP is located on the north shore of Lake Sakakawea immediately adjacent to U.S. Highway 83 and is owned and operated by Reclamation (Figure 2-11). The facility pumps water from Lake Sakakawea to Audubon Lake to serve the McClusky Canal and other features of the Garrison Diversion Unit. The SCPP's location and the fact that it is equipped with redundant pumping units make it suitable for modification to house and operate pumping equipment for the Project. An agreement between Reclamation and the Project sponsor would be necessary for the use of this federal facility for Project purposes.

Modifications to the SCPP would include complete removal of one of the three existing pumping units, revising the floor plan, and installing pumps and piping appurtenances specific to Project purposes (Appendix C of Appendix J). The discharge pipe would exit the building within the existing SCPP discharge pipe and run below the bridge and up the slope to the top of the forebay, then turn north and run parallel to the access road and between the access road and the railroad (Figure 2-18).

Figure 2-18 Modifications at the SCPP Intake Option

Costs associated with this intake option are presented in Table 2-15 for each of the two Missouri River alternatives; these costs were developed based on an appraisal-level design. The methods and sources of information used in developing the construction and OM&R costs estimates are provided in Appendix F of Appendix J.

Table 2-15 Cost Estimates for Modifications at the SCPP Intake and Pump Station

<table>
<tr><th rowspan="2">Description</th><th colspan="2">Missouri River and Conjunctive Use</th><th colspan="2">Missouri River and Groundwater</th></tr>
<tr><th>Construction Cost</th><th>Annual OM&R Cost</th><th>Construction Cost</th><th>Annual OM&R Cost</th></tr>
<tr><td>Demolition and Removal</td><td>$2,409,000</td><td rowspan="4">$971,000</td><td>$2,409,000</td><td rowspan="4">$1,084,000</td></tr>
<tr><td>Site Work and Buildings</td><td>$7,726,000</td><td>$7,726,000</td></tr>
<tr><td>Pumping Units</td><td>$2,023,000</td><td>$2,098,000</td></tr>
<tr><td>Flow Meter, Generator, Surge Tank</td><td>$1,094,000</td><td>$1,094,000</td></tr>
<tr><td>36-inch Pipeline Connection</td><td>$583,000</td><td>$15,000</td><td>$583,000</td><td>$15,000</td></tr>
<tr><td>Total</td><td>$13,835,000</td><td>$986,000</td><td>$13,910,000</td><td>$1,099,000</td></tr>
</table>

Note: Costs in the table are rounded.

Adjacent to the SCPP

This option involves a new intake and pump station structure located immediately north of the SCPP (Figure 2-19). The intake screen would be located in the lake just west of the SCPP forebay, at a location where the intake could be graded to provide a minimum of 5 to 6 feet of submergence and at an elevation of 1,770 feet mean sea level. The intake screen structure would be connected to the pump station via a pipeline. The pump station building would include the pumps, surge tank, discharge line, control room, electrical room, and generator room (Appendix C in Appendix J). Two power poles and a power transformer would be added at the intake site.

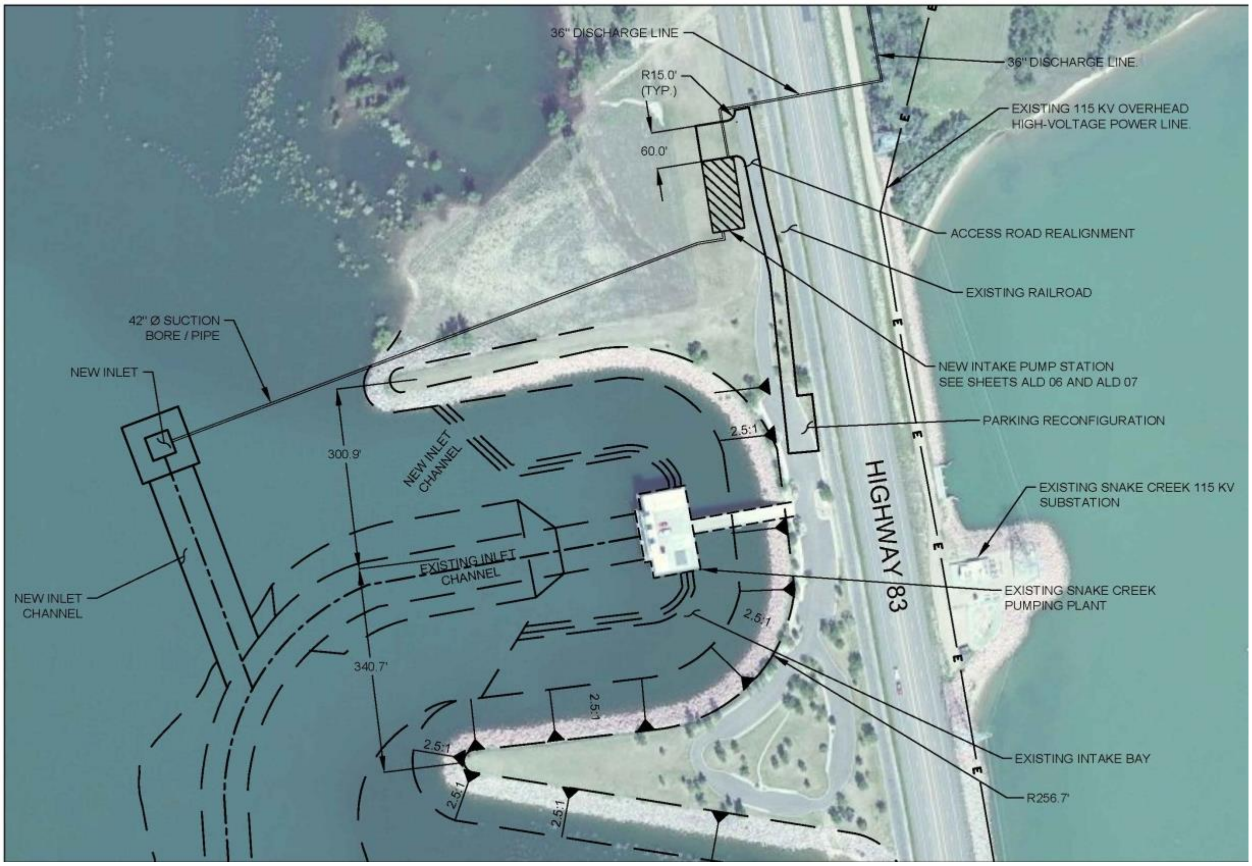

Figure 2-19 Adjacent to the SCPP Intake Option

Evaluations of costs associated with this option are presented in Table 2-16. Like the other intake option, these costs were developed during the appraisal-level design. The methods and sources of information used in developing the construction and OM&R cost estimates are provided in Appendix F of Appendix J.

Table 2-16 Adjacent to SCPP Intake Option Construction and OM&R Cost Estimates

Description	Missouri River and Conjunctive Use		Missouri River and Groundwater	
	Construction Cost	Annual OM&R Cost	Construction Cost	Annual OM&R Cost
Site Work and Buildings	$14,356,000	$1,049,000	$14,356,000	$1,195,000
Pumping Units	$1,929,000		$2,304,000	
Flow Meter, Surge Tank, Electrical	$2,390,000		$2,390,000	
Cofferdam	$3,364,000		$3,364,000	
36-inch Pipeline Connection	$486,000	$12,000	$486,000	$12,000
Total	**$22,525,000**	**$1,061,000**	**$22,900,000**	**$1,207,000**

Note: Costs in the table are rounded.

Biota WTP Options

The U.S. government has not developed water treatment standards, rules, or regulations specifically for use in reducing the risk of an introduction of an invasive species through interbasin water transfers. However, the United States, in its Secretarial Determination, as required under the Dakota Water Resources Act of 2000, has committed to disinfect water to inactivate 3 logs of *Giardia* and 4 logs of virus prior to water entering the Hudson Bay basin.

Five Biota WTP options were evaluated for the Missouri River alternatives to reduce the risk of a Project-related transfer of AIS into the Hudson Bay basin. The options were designed to provide a range of treatment methods, starting with disinfection and incrementally adding water treatment technologies to target different types of pathogens and biota, and increasing the level of protection with each option. The Biota WTP options were designed at the appraisal level, consistent with other components proposed in the action alternatives. The methods and sources of information used in developing the designs and cost estimates are provided in Appendix J. At this level of design, the estimated costs should only be used for comparison of the alternatives. The Biota WTP options include:

- Chlorination Treatment
- Chlorination/UV Inactivation Treatment
- Enhanced Chlorination/UV Inactivation Treatment
- Conventional Treatment
- Microfiltration Treatment

The proposed Biota WTP facility would be located on a 41-acre site in Max (Figure 2-20), and each option has been designed for the Project's peak day demand. All options would convey treated water to the existing Minot WTP in the buried transmission pipeline, which was constructed with additional safeguards (described in the Previously Constructed Project Components section) to reduce the risk of a Project-related transfer of AIS into the Hudson Bay basin. The annual OM&R estimates include labor, chemical costs, and energy requirements (Appendix J).

Giardia, viruses, and *Cryptosporidium* have been used as surrogates for the selected AIS to quantify the level of inactivation that would be attained for each treatment process. Quantities are measured using "log inactivation," which is a measure of the percent of biota that are inactivated and/or removed as a result of a treatment process. For example, 2-log, 3-log, 4-log, and 5-log inactivation corresponds to 99 percent, 99.9 percent, 99.99 percent, and 99.999 percent inactivation/removal, respectively. *Myxobolus cerebralis* (whirling disease) is a fish pathogen that is resistant to certain types of water treatment technologies. The potential to treat for this type of biota is evaluated for each option.

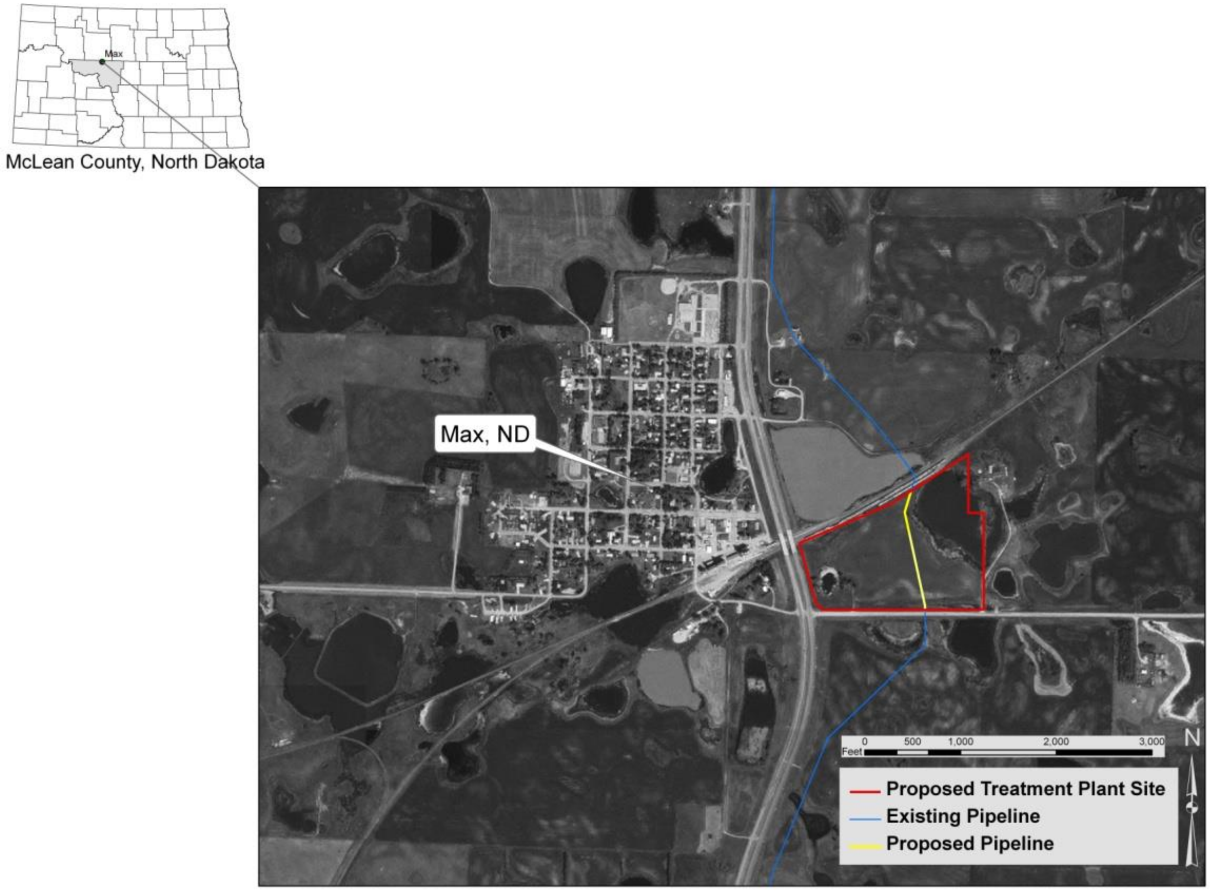

Figure 2-20 Proposed Biota WTP Site in Max, North Dakota

Chlorination Treatment Option

The Chlorination Treatment Option has been carried forward from previous NEPA analysis for the Project. The previous analysis has been reviewed and updated to ensure that its design is consistent with the other Biota WTP options. This option would include chemical disinfection of the raw water using free chlorine followed by ammonia addition to form chloramines. "Chloramines" are a disinfection residual maintained in the transmission pipeline that help to control biofilm and provide additional disinfection inside the pipe.

Figure 2-21 shows the main treatment processes included in the Chlorination Treatment Option. Water would enter the Biota WTP and be treated with free chlorine. The design of this option includes sufficient levels of contact time between the Biota WTP and the basin divide to achieve disinfection. Design details for this option are included in Appendix J.

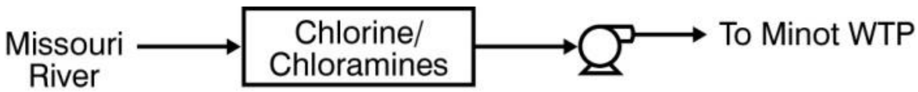

Figure 2-21 Chlorination Process Flow Diagram

The Chlorination Treatment Option would provide 3-log inactivation of *Giardia* and greater than 4-log inactivation of viruses. A disinfection study was completed to determine the effectiveness of chlorine and chloramines for the Project; details of the study methods and results are presented in the *Northwest Area Water Supply Project Chloramine Challenge Study – Final Report* (Houston Engineering et al. 1995). This option would not provide protection against organisms that are resistant to chlorine disinfectants, such as *Cryptosporidium*, before the water is conveyed in the buried transmission pipeline into the Hudson Bay basin. Treatment for these types of organisms would be provided at the Minot WTP. *Myxobolus cerebralis* has been used in the past for comparison to other types of species that may be resistant to certain types of treatment. Table 2-17 shows the log inactivation credits this option would achieve on a variety of target species of biota. Since this option does not include removal of biota, the waste stream at Minot WTP would be contained and disposed of in the Missouri River basin or an approved inbasin landfill.

Table 2-17 Chlorination Treatment Option Log-Inactivation

Target Biota	Chlorine	Chloramination (Transmission Pipeline)	Total Log-Inactivation
Giardia	2.7	0.3	3
Viruses	> 4	0.5	> 4
Cryptosporidium	0	0	0
Myxobolus cerebralis[a]	0	0	0

Note:
[a] Log inactivation for *Myxobolus cerebralis* was based on Hedrick et al. 2008. Inactivation with chlorine was assumed to be zero as chlorine doses employed by Hedrick et al. far exceeded those used in development of this option.
Source: Table IV.B-2. EPA, National Primary Drinking Water Regulations: Long Term 2 Enhanced Surface Water Treatment Rule, 40 Code of Federal Regulations Parts 9, 141, and 142, January 5, 2006

Estimated costs associated with the Biota WTP and pump station for this option are presented in Table 2-18. The estimated total construction cost for the chlorination treatment is $28.3 million, and the annual OM&R cost is estimated at $1.2 million.

Table 2-18 Chlorination Treatment Option Cost Estimates

Description	Construction Cost Estimate	Annual OM&R Cost Estimate
Site Work and Buildings	$16,450,617	$1,200,000
Process Equipment	$10,090,325	
Pumping Units	$1,800,163	
Total	**$28,300,000**	**$1,200,000**

Note: Values in the table are rounded.

This option has the potential to form disinfection byproducts (DBPs), which may be formed when naturally occurring organic matter (precursors) in water reacts with chemicals added for disinfection during the water treatment process. SDWA regulations have been established for DBPs. Once formed, DBPs such as trihalomethanes and haloacetic acids are small molecules and therefore difficult to remove.

The potential formation of DBPs was investigated during the alternatives formulation process. Under the proposed Missouri River alternatives, raw water would be transported in a buried transmission pipeline for approximately 15 miles to a proposed Biota WTP where treatment would occur; then the treated water would be conveyed approximately 30 miles in another segment of the buried transmission pipeline to the Minot WTP. The Biota WTP options include disinfection and therefore would have the potential to form DBPs in the main transmission pipeline if the precursors were not removed prior to disinfection at the Biota WTP. To address this concern, a study was completed to characterize the potential DBP formation for the Project (Montgomery Watson Harza and Houston Engineering 2007). This study determined that a free chlorine contact time of 60 minutes could be used without excessive DBP formation. Based on this study, Reclamation has determined that none of the Biota WTP options would exceed established regulations for DBPs at the appraisal-level design stage.

For this Biota WTP option, as a means of responding to potential future changes in the environment, Reclamation would prepare an adaptive management plan. Development of this plan is described in the "Adaptive Management" section of Chapter 4. This plan would develop and implement a strategy to optimize the treatment processes at the Biota WTP to ensure that the finished water quality meets the locational running annual averages for trihalomethanes and haloacetic acids five at all compliance locations served by the Project. This adaptive management plan process would be extended to all future National Primary Drinking Water Regulations (NPDWRs) to ensure compliance.

Chlorination/UV Inactivation Treatment Option

The Chlorination/UV Inactivation Treatment Option includes UV irradiation followed by chlorine disinfection and conversion to chloramines. Irradiation with UV would be used to inactivate chlorine-resistant biota such as *Cryptosporidium* and *Myxobolus cerebralis*. Figure 2-22 shows the main treatment processes included in this option.

Figure 2-22 Chlorination/UV Inactivation Treatment Option

This option would be designed to provide 3-log inactivation of *Giardia* and 4-log inactivation of viruses (Table 2-19). As described in the Chlorination Treatment Option, chemical disinfection alone does not provide protection against organisms, such as *Cryptosporidium*, that are resistant to disinfectants like chlorine. This option would also include UV disinfection designed to achieve 3-log inactivation of *Cryptosporidium* and other similar types of organisms. Design details are included in Appendix J. Since this option does not include removal of biota, the waste stream at Minot WTP would be contained and disposed of in the Missouri River basin or an approved inbasin landfill.

Table 2-19 Chlorination/UV Treatment Option Log-Inactivation

Target Biota	UV Irradiation	Chlorine	Chloramination (Transmission Pipeline)	Total Log-Inactivation
Giardia	3.0	0.63	0.30	> 3
Viruses	0.5	> 4	0.5	> 4
Cryptosporidium	3.0	0	0	3.0
Myxobolus cerebralis [a]	> 4	0	0	> 4

Note:
[a] UV log-inactivation for *Myxobolus cerebralis* was based on Hedrick et al. 2008. Inactivation with chlorine was assumed to be zero as chlorine doses employed by Hedrick et al. far exceeded those used in development of this option.

A summary of the estimated costs associated with this option are presented in Table 2-20. Methods and sources of information used in developing the construction and OM&R cost estimates are provided in Appendix J. The total construction cost is approximately $29.8 million, and the annual OM&R cost is estimated at $1.5 million.

Table 2-20 Chlorination/UV Inactivation Treatment Option Cost Estimates

Description	Construction Cost Estimate	Annual OM&R Cost Estimate
Site Work and Buildings	$14,466,553	$1,500,000
Process Equipment	$13,733,527	
Pumping	$1,606,406	
Total	**$29,800,000**	**$1,500,000**

Note: Values in the table are rounded.

As discussed in the previous option, DBPs can form when disinfection occurs prior to the removal of precursors through filtration. This Biota WTP option does not include filtration; therefore, DBP formation could be a potential concern for the Project.

For this Biota WTP option, as a means of responding to potential future changes in the environment, Reclamation would prepare an adaptive management plan. Development of this plan is described in the Adaptive Management section of Chapter 4. This plan would develop and implement a strategy to optimize the treatment processes at the Biota WTP to ensure that the finished water quality meets the locational running annual averages for trihalomethanes and haloacetic acids five at all compliance locations served by the Project. This adaptive management plan process would be extended to all future NPDWRs to ensure compliance.

Enhanced Chlorination/UV Inactivation Treatment Option

The Enhanced Chlorination/UV Inactivation Treatment Option includes pressure filtration, followed by UV irradiation, chlorine disinfection, and conversion to chloramines. These processes are the same as described for the previous two options, with pressure filtration being added to reduce the Project-related risk of transfer of AIS into the Hudson Bay basin. Figure 2-23 shows each of the treatment processes included.

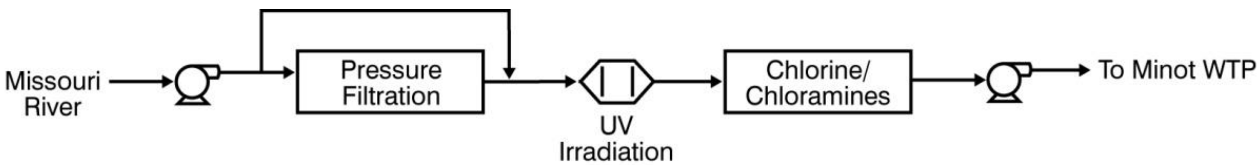

Figure 2-23 Enhanced Chlorination/UV Inactivation Treatment Option

This option would provide coagulation, followed by pressure filtration, which has been included as an enhancement to the chlorination/UV inactivation process. Pressure filtration would provide a physical barrier to remove particles from the Missouri River water. This is particularly important during any unexpected high-turbidity events, when turbidities are above 10 nephelometric turbidity units (NTUs). Turbidities up to 10 NTUs have been shown not to affect the UV dose-response of separately added microorganisms (Reclamation 2007a; EPA 2006). This option would include monitoring of the raw water turbidity and would operate the pressure filtration system when source water turbidity exceeded 7 NTUs as a safety factor. When raw water turbidities are below the 7-NTU threshold, the option was designed to allow the raw water to bypass the pressure filtration system and go directly through the UV irradiation and remaining processes included in the option. A pilot-scale water treatment study completed in 2007 showed that turbidity levels in the Missouri River during the test period never exceeded a sustained 10 NTU (Montgomery Watson Harza and Houston Engineering 2007). The pressure filtration process would provide an additional level of treatment by reducing turbidity and providing a physical barrier. The coagulant added prior to filtration (Appendix J) has been included to ensure that the filtration system would effectively reduce turbidity levels.

In addition to the log-inactivation provided by the disinfection and UV, the pressure filter would provide biota removal of *Giardia* (1-log) and *Cryptosporidium* (1-log), when operated. The pressure filters also would provide an operational benefit to the UV irradiation system by enhancing the water quality (i.e., lower turbidity and higher UV transmittance). The log inactivation that would be achieved for this option is summarized in Table 2-21. Since this option does not include removal of biota at all times, the waste stream at Minot WTP would be contained and disposed of in the Missouri River basin or an approved inbasin landfill.

Table 2-21 Enhanced Chlorination/UV Treatment Option Log-Inactivation and/or Removal

Target Biota	Pressure Filtration [a]	UV Irradiation	Chlorine	Chloramination (Transmission Pipeline)	Total Log-Inactivation
Giardia	1 [b]	3.0	0.63	0.3	> 3
Viruses	0	0.5	> 4	0.5	> 4
Cryptosporidium	1 [b]	3.0	0	0	> 3
Myxobolus cerebralis [c]	1 [b]	> 4	0	0	> 4

Notes:

[a] Log-inactivation values from *California Surface Water Treatment Alternative Filtration Technology Demonstration Report*, June 2001, and includes a 1-log safety factor from the inactivation values demonstrated from the pilot testing as recommended by the California Department of Health Services.

[b] When the pressure filter is in operation and achieving finished water turbidity comparable to conventional filtration, and as documented in a pilot study completed prior to design.

[c] UV log-inactivation *for Myxobolus cerebralis* was based on Hedrick et al. 2008. Inactivation with chlorine was assumed to be zero as chlorine doses employed by Hedrick et al. far exceeded those used in development of this option. Pressure filtration log-removal for *Myxobolus cerebralis* was based on comparison of particle size with *Cryptosporidium* oocysts.

Source: Table IV.B-2. EPA, National Primary Drinking Water Regulations: LT2ESWTR, 40 Code of Federal Regulations Parts 9, 141, and 142, January 5, 2006

A summary of the estimated costs associated with the option are presented in Table 2-22. Methods and sources of information used in developing the construction and OM&R cost estimates are provided in Appendix J. For purposes of estimating OM&R costs, the pressure filtration system and related pump station was conservatively estimated to operate approximately 30 percent of the time. The total estimated construction cost is approximately $47.8 million, and the annual OM&R costs are estimated at approximately $1.8 million.

Table 2-22 Enhanced Chlorination/UV Inactivation Treatment Option Cost Estimates

Description	Construction Cost Estimate	Annual OM&R Cost Estimate
Site Work and Buildings	$18,428,603	$1,800,000
Process Equipment	$26,334,083	
Pumping Units	$3,007,132	
Total	**$47,800,000**	**$1,800,000**

Note: Values in the table are rounded.

This Biota WTP option includes filtration; however, since the pressure filters operate only under certain water quality conditions, the concern regarding the potential formation of DBPs is relevant to this option, as in the two previous options.

Under this Biota WTP option, as a means of responding to potential changes in the environment in the future, Reclamation would prepare an adaptive management plan. Development of this plan is described in the Adaptive Management section of Chapter 4. This plan would develop and implement a strategy to optimize the treatment processes at the Biota WTP to ensure that the finished water meets the locational running annual averages for trihalomethanes and haloacetic acids five at all compliance locations served by the Project. This adaptive management plan process would be extended to all future NPDWRs to ensure compliance.

Conventional Treatment Option

"Conventional treatment" is defined as a series of processes, including coagulation, flocculation, sedimentation, and filtration, resulting in substantial particulate removal (40 CFR 141.2).

The Conventional Treatment Option was evaluated in the previous EIS for the Project (Reclamation 2008) and was re-evaluated for the SEIS. This option includes coagulation and flocculation, followed by sedimentation (clarification) via dissolved air flotation (DAF). "Sedimentation" is defined as a process for removal of solids before filtration by gravity or separation (40 CFR 141.2). The DAF process removes particles through floatation and therefore is considered a type of sedimentation. The clarified water would then be filtered through dual media filters, treated with UV irradiation, and chemically disinfected with chlorine, followed by conversion to chloramines. UV disinfection has been shown to be effective against protozoa including *Cryptosporidium* and *Giardia*, and *Myxobolus cerebralis* (Hedrick et al. 2007, 2008). Figure 2-24 shows the process flow diagram for this option. Design details for each of these processes are described in the report *Water Treatment Plant for Biota Removal and Inactivation Appraisal Level Design & Cost Estimates* (Reclamation 2007b) and supplemented in Appendix J.

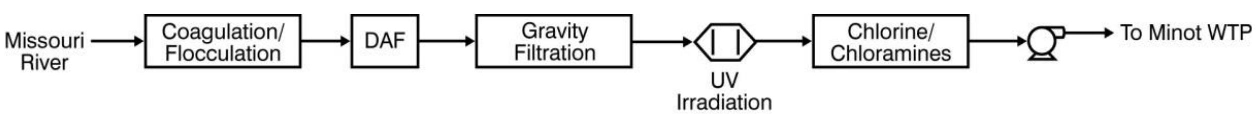

Figure 2-24 Conventional Treatment Option

The DAF process provides the pretreatment step by floating small particles instead of settling them by gravity as in gravity sedimentation. This process has proven to be effective by using minute air bubbles to float light flocculant that is skimmed off and removed, leaving clearer water underneath. It is categorized as a "high rate clarification process" by the Ten States Standards (Great Lakes – Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers 2007) and has been shown to provide effective clarification at higher loading rates than traditional sedimentation (Reclamation 2007b). The media filtration step uses a combination of silica sand below anthracite coal to remove particles as well as biological components, and also increases the effectiveness of both UV disinfection and chlorine/chloramines at inactivating organisms.

The Conventional Treatment Option was designed to inactivate and remove biota within the raw water from a Missouri River source. Therefore, the disposal of waste streams from Minot WTP would not be required. Table 2-23 shows the log removal (DAF and media filtration) and inactivation (UV, chlorine, and chloramination) for each of the treatment processes.

Table 2-23 Conventional Treatment Option Log-Inactivation and Removal Credits

Target Biota	DAF and Media Filtration	UV Irradiation	Chlorine	Chloramination (Transmission Pipeline)	Total Log-Inactivation
Giardia	2.5	3	0.63	0.3	> 3
Viruses	2	0.5	> 4	0.5	> 4
Cryptosporidium	2.5	3	0	0	> 3
Myxobolus cerebralis [a]	2.5	> 4	0	0	> 4

Note:

[a] UV log-inactivation for *Myxobolus cerebralis* was based on Hedrick et al. 2008. DAF and media filtration log-removal for *Myxobolus cerebralis* was based on comparison of particle size with *Cryptosporidium* oocysts. Inactivation with chlorine was assumed to be zero as chlorine doses employed by Hedrick et al. far exceeded those used in development of this option.

The cost estimate for this option was developed in the same manner as the other Biota WTP options, and the costs are summarized in Table 2-24. The estimates previously developed by Reclamation (Reclamation 2007b) were updated to reflect current construction costs. The result is a total construction cost estimate of approximately $66.7 million and an OM&R cost of approximately $2.3 million per year.

Table 2-24 Conventional Treatment Option Cost Estimates

Description	Construction Cost Estimate	Annual OM&R Cost Estimate
Site Work and Buildings	$21,669,398	$2,300,000
Process Equipment	$37,169,356	
Pumping	$7,875,611	
Total	**$66,700,000**	**$2,300,000**

Note: Values in the table are rounded.

The potential concerns associated with the formation of DBPs for this Biota WTP option are much lower because the option includes filtration prior to disinfection. This Biota WTP option also provides flexibility for adaptations in the treatment processes to address these and other concerns related to compliance with the SDWA now and into the future. For this option, Reclamation would prepare an adaptive management plan. Development of this plan is described in the Adaptive Management section of Chapter 4. This plan would develop and implement a strategy to optimize the treatment processes at the Biota WTP to ensure that the finished water meets the locational running annual averages for trihalomethanes and haloacetic acids five at all compliance locations served by the Project. This adaptive management plan process would be extended to all future NPDWRs to ensure compliance.

Microfiltration Treatment Option

The Microfiltration Treatment Option was also evaluated in the previous EIS for the Project (Reclamation 2008) and was re-evaluated for the SEIS. This option includes the same basic concepts as the Conventional Treatment Option; however, it includes a more effective type of filtration called "microfiltration." Microfiltration can remove smaller particles from the water than the media filtration included in the Conventional Treatment Option. This option includes coagulation to form pin-floc (pretreatment), and microfiltration using membranes, along with UV disinfection and chlorine/chloramines disinfection, as shown in Figure 2-25.

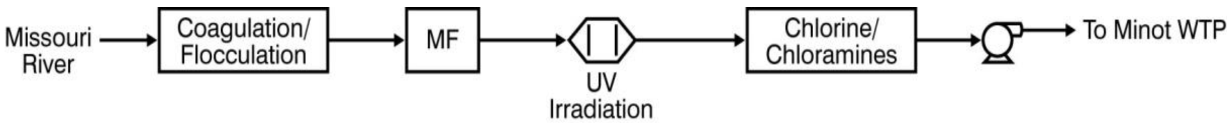

Figure 2-25 Microfiltration Treatment Option

The coagulation/flocculation process includes the addition of chemicals by slow mixing to form a floc around particles, which then can be readily removed by the membranes. The microfiltration system has two distinct stages where the backwash wastewater from the first stage is feed water for the second stage. This reduces backwash waste and increases the recovery of the system (Reclamation 2007a). Microfiltration is proven to be very successful in removing turbidity, with typical product water of less than 0.1 NTU. The process also results in a consistent treated water quality that is basically independent of raw water quality in most situations (American Water Works Association 2005), which improves the effectiveness of the disinfection/UV process.

Table 2-25 includes the log-inactivation and removal credits assumed for each of the treatment processes included in this option. The UV disinfection system provides inactivation of protozoa including *Cryptosporidium*, *Giardia*, and *Myxobolus cerebralis* (Hedrick et al. 2007, 2008). Followed by the addition of free-chlorine for increased disinfection for *Giardia*, bacteria, and viruses, the final step would be the conversion of the free chlorine to chloramines for a pipeline residual (Reclamation 2007). This option is designed to provide inactivation and removal of biota in the raw water from the Missouri River. Therefore, the disposal of waste streams from Minot WTP will not be required.

Table 2-25 Microfiltration Treatment Option Log-Inactivation and/or Removal Credits

Target Biota	Microfiltration	UV Irradiation	Chlorine	Chloramination (Transmission Pipeline)	Total Log-Inactivation
Giardia	4	3	0.63	0.3	> 3
Viruses	0.5	0.5	> 4	0.5	> 4
Cryptosporidium	4	3	0	0	> 3
Myxobolus cerebralis [a]	4	> 4	0	0	> 4

Note:

[a] UV log-inactivation for *Myxobolus cerebralis* was based on Hedrick et al. 2008. Microfiltration log-removal for *Myxobolus cerebralis* based on comparison of particle size with *Cryptosporidium* oocysts. Inactivation with chlorine was assumed to be zero as chlorine doses employed by Hedrick et al. far exceeded those used in development of this option.

Source: Table IV.B-2. EPA, National Primary Drinking Water Regulations: LT2ESWTR, 40 Code of Federal Regulations Parts 9, 141, and 142, January 5, 2006

The cost estimate for this option was developed in the same manner as the Conventional Treatment Option and is shown in Table 2-26. This estimate was originally developed in the report, *Water Treatment Plant for Biota Removal and Inactivation Appraisal Level Design & Cost Estimates* (Reclamation 2007b), and was updated to reflect current construction costs as detailed in Appendix J. The total estimated construction cost of this option is $90.6 million, with annual OM&R costs of approximately $2.4 million.

Table 2-26 Microfiltration Treatment Option Cost Estimates

Description	Construction Cost Estimate	Annual OM&R Cost Estimate
Site Work and Buildings	$22,097,856	$2,400,000
Process Equipment	$60,640,844	
Pumping	$7,875,611	
Total	**$90,600,000**	**$2,400,000**

Note: Values in the table are rounded.

As discussed in the Conventional Treatment Option, the potential for formation of DBPs for this option are much lower because the option includes filtration prior to disinfection. This Biota WTP option also provides flexibility for adaptations in the treatment processes to address these and other concerns related to compliance with the SDWA now and into the future. For this option, Reclamation would prepare an adaptive management plan. Development of this plan is described in the Adaptive Management section of Chapter 4. This plan would develop and implement a strategy to optimize the treatment processes at the Biota WTP to ensure that the finished water meets the locational running annual averages for trihalomethanes and haloacetic acids five at all compliance locations served by the Project. This adaptive management plan process would be extended to all future NPDWRs to ensure compliance.

Summary of Biota WTP Options

Each of the options includes a combination of treatment processes that reduces the potential risk of a Project-related transfer of AIS into the Hudson Bay basin. The Biota WTP options represent a full range of available water treatment technologies. They are listed in the order of their relative treatment inactivation/removal capability, with the Chlorination Treatment Option providing the lowest level of biota treatment and the Microfiltration Treatment Option providing the highest level of biota treatment prior to the water being conveyed in the buried transmission pipeline to the Minot WTP, which is located in the Hudson Bay basin. As would be expected, the cost of biota treatment increases with increased inactivation and removal efficiency. Table 2-27 provides a matrix showing the treatment processes included with each Biota WTP option being considered. Chapter 4 includes a detailed description and discussion of the risks and consequences associated with AIS.

Table 2-27 Proposed Biota Treatment Options and Treatment Processes Matrix

Treatment Processes (within the Missouri River Basin)	Proposed Biota Treatment Options				
	Chlorination	Chlorination/ UV Inactivation	Enhanced Chlorination / UV Inactivation	Conventional Treatment	Microfiltration
Pre-Treatment			X	X	X
Media Filtration (approx. 5.0 microns)			X	X	
Membrane Filtration (approx. 0.1 micron)					X
UV Disinfection		X	X	X	X
Chemical Disinfection (chlorine/chloramines)	X	X	X	X	X

Relative Treatment Standards

The U.S. government has not developed water treatment standards, rules, or regulations specifically for use in reducing the risk of an introduction of an invasive species through interbasin water transfers. However, extensive research has gone into the development of standards, rules, and regulations for treating drinking water to reduce risks of transmitting pathogens to humans. The SDWA sets forth the treatment measures that must be taken to effectively reduce the risk for transmission of human health diseases through drinking water systems. The EPA is responsible for developing regulations designed to comply with the SDWA and ensure that public water supplies used for human consumption provide for adequate treatment to reduce the risks of disease transmission to humans to an acceptable level.

Therefore, the SDWA and the associated research provide the best available information to compare treatment capabilities. The SDWA regulates *Giardia*, *Cryptosporidium,* and viruses as human health pathogens for drinking water systems. In the absence of interbasin water transfer treatment standards, the SDWA and the (NPDWRs can be used as a basis of comparison to evaluate treatment efficiency. The SDWA and NPDWRs set reduction standards, including the requirements of 3-log (99.9 percent) removal/inactivation of *Giardia* and 4-log (99.99 percent) removal/inactivation of viruses.

To address concerns of other disinfection-resistant protozoa such as *Cryptosporidium,* the Long Term 2 Enhanced Surface Water Treatment Rule was established by EPA and requires up to 2.5 logs (99.68 percent) of additional reduction (removal/inactivation), depending upon the levels of *Cryptosporidium* found in the source water, using bin classifications. “Bin classifications” are categories assigned to a drinking water treatment plant based on the *Cryptosporidium* data collected from the source water for 2 years and calculating an annual mean concentration. Based upon these concentrations, drinking water systems are classified as bin 1, 2, 3 or 4. Bin 1 classification requires no additional treatment, and bins 2, 3, and 4 would require 1.0, 2.0, and 2.5 logs of reduction/inactivation for *Cryptosporidium*, respectively (Table 2-28). The source water testing for the EPA’s Long Term 2 Enhanced Surface Water Treatment Rule has not been completed for drinking water systems in this area; therefore, Missouri River *Cryptosporidium* data are not available. The best available information suggests that the Missouri River water would be categorized as bin 1 based on the nature of the watershed, requiring the lowest level of reduction under the EPA rule. Nonetheless, UV disinfection was designed for 3-log inactivation (bin 4) for *Cryptosporidium* and *Giardia* as an additional risk reduction method in the Missouri River alternatives.

In addition, DBPs and cynobacterial toxins could be of concern to the Project, which is responsible for providing a safe and reliable source of water that meets SDWA requirements. As previously explained, DBPs can be formed when raw water is disinfected prior to filtration. Algae blooms could increase in the raw water as a result of potential increased temperatures due to climate change. When disinfection occurs, toxins can be released into the water; these toxins are difficult to remove once released from the organism. The Conventional Treatment and Microfiltration Biota WTP options, which include continuous filtration, would address both of those concerns from a drinking water perspective.

Table 2-28 Comparison of Biota Inactivation/Removal Effectiveness and Construction Costs

Biota Treatment Option	Viruses	*Cryptosporidium*	*Giardia*	*Myxobolus cerebralis*	Construction Costs	Annual OM&R Costs
Chlorination	> 4	0	3	0	$28,300,000	$1,200,000
Chlorination/ UV Inactivation	> 4	3	> 3	> 4	$29,800,000	$1,500,000
Enhanced Chlorination/ UV Inactivation	> 4	> 3	> 3	> 4	$47,800,000	$1,800,000
Conventional Treatment	> 4	> 3	> 3	> 4	$66,700,000	$2,300,000
Microfiltration	> 4	> 3	> 3	> 4	$90,600,000	$2,400,000

Note: Values in the table are rounded.

Summary of Construction and OM&R Costs

These cost estimates should only be used for comparative purposes when evaluating the differences between alternatives.

This section describes costs of the proposed alternatives and contains the best available current information on the costs of the action alternatives for the purpose of analysis and comparison. Table 2-29 includes estimates of construction costs, along with the estimated OM&R costs of each alternative evaluated. Annual OM&R costs include all facilities, not only those required for the expanded capacity. Detailed construction cost estimates for all alternatives are included in Appendix F of Appendix J. These cost estimates should only be used to compare alternatives. All alternative estimates were developed using the same assumptions and unit prices, so these are directly comparable from a cost standpoint. The upper portion of the table shows completed components, and these costs are the same for each alternative.

Table 2-29 Summary of Construction Cost Estimates by Alternative

Component	Alternatives			
	Groundwater with Recharge	**Groundwater with Recharge and Souris River**	**Missouri River and Conjunctive Use**	**Missouri River and Groundwater**
Completed				
Transmission Pipeline (buried)	$30,940,000 [a]	$30,940,000 [a]	$30,940,000	$30,940,000
Bulk Distribution Pipelines and Pump Stations	$36,609,696	$36,609,696	$36,609,696	$36,609,696
Minot WTP Upgrades	$24,000,000	$24,000,000	$24,000,000	$24,000,000
High Service Pump Station and Reservoir at Minot WTP	$14,075,578	$14,075,578	$14,075,578	$14,075,578
Storage Reservoirs	$2,978,851	$2,978,851	$2,978,851	$2,978,851
Rugby Water Treatment Facility Upgrades	$1,795,000	$1,795,000	$1,795,000	$1,795,000
Proposed				
Recharge Facilities – Minot and Sundre Aquifers	$47,735,000	$47,735,000		
Groundwater Collection Facilities	$8,417,000	$7,115,000		
Minot WTP Upgrades	$11,470,000	$13,336,000	$11,640,000	$11,375,000
Bulk Distribution Pipelines and Pump Stations and Storage Reservoirs	$38,546,000	$38,546,000	$41,569,000	$41,569,000
Intake and Pump Station at Lake Sakakawea (2 options)				
Modify SCPP			*$13,835,000*	*$13,910,000*
Adjacent to SCPP			*$22,525,000*	*$22,900,000*
Biota WTP and Pump Station (5 options)				
Chlorination			*$28,300,000*	*$28,300,000*
Chlorination/UV			*$29,800,000*	*$29,800,000*
Enhanced Chlorination/UV			*$47,800,000*	*$47,800,000*
Conventional Treatment			*$66,700,000*	*$66,700,000*
Microfiltration			*$90,600,000*	*$90,600,000*
Total Completed	**$110,399,125**	**$110,399,125**	**$110,399,125**	**$110,399,125**
Total Proposed	**$106,168,000**	**$106,732,000**	**$95,344,000 – $166,334,000**	**$95,150,000 – $166,440,000**
Overall Total	**$216,600,000**	**$217,100,000**	**$205,700,000 – $276,700,000**	**$205,600,000 – $276,800,000**

Notes:

[a] Main transmission pipeline costs have been incurred; however, under the inbasin alternatives, no beneficial use for this pipeline has been identified.

Values in the table are rounded.

Table 2-30 Summary of OM&R Cost Estimates by Alternative

Component	Alternatives			
	Groundwater with Recharge	**Groundwater with Recharge and Souris River**	**Missouri River and Conjunctive Use**	**Missouri River and Groundwater**
Completed				
Existing Components	$6,830,143	$6,850,143	$6,305,343	$6,285,343
Proposed				
Recharge Facilities – Minot and Sundre Aquifers	$641,000	$641,000		
Groundwater Collection Facilities	$339,000	$339,000		
Minot WTP Upgrades [a]				
Bulk Distribution Pipelines and Pump Stations and Storage Reservoirs	$993,000	$993,000	$1,034,000	$1,034,000
Intake and Pump Station at Lake Sakakawea (2 options)				
Modify SCPP			*$986,000*	*$1,099,000*
Adjacent to SCPP			*$1,061,000*	*$1,207,000*
Biota WTP and Pump Station (5 options)				
Chlorination			*$1,200,000*	*$1,200,000*
Chlorination/UV			*$1,500,000*	*$1,500,000*
Enhanced Chlorination/UV			*$1,800,000*	*$1,800,000*
Conventional Treatment			*$2,300,000*	*$2,300,000*
Microfiltration			*$2,400,000*	*$2,400,000*
Total Completed	**$6,830,143**	**$6,850,143**	**$6,305,343**	**$6,285,343**
Total Proposed	**$1,973,000**	**$1,973,000**	**$3,220,000 – $4,495,000**	**$3,333,000 – $4,641,000**
Overall Total	**$8,803,000**	**$8,823,000**	**$9,500,000 – $10,800,000**	**$9,600,000 – $10,900,000**

Notes:

[a] Estimated OM&R costs for Minot WTP upgrades are included in the Minot WTP estimate in Table 2-29.

Values in the table are rounded.

Alternatives Considered but Eliminated

According to NEPA, an EIS must consider a full range of alternatives that includes all reasonable alternatives. An EIS must "rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated. Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint and use common sense, rather than simply desirable from the standpoint of the applicant." (Federal Register 46[55])

During the SEIS scoping process, the public commented that Reclamation should explore reasonable alternatives using water sources other than the Missouri River, such as developing existing groundwater sources, use of the reverse osmosis treatment process, and integrated groundwater supplies. As discussed in the Alternatives Development Process section of this chapter, a rigorous analysis was conducted to identify different ways to meet the purpose and need of the Project, including potential treatment technologies and water sources. Those components and/or options that were considered but eliminated during the alternatives development process are briefly described below. Details of this process are included in Appendix C.

In preparing the SEIS, Reclamation reviewed previous analyses for the proposed Project. This review included the *Northwest Area Water Supply Project Final Environmental Assessment* (SWC et al. 2001) as well as the previous *Northwest Area Water Supply Project Final Environmental Impact Statement on Water Treatment* (Reclamation 2008) that this SEIS is supplementing. During this review, Reclamation determined that the Basic Treatment Option (pretreatment, chlorination, and UV inactivation) should not be carried forward for consideration because it provided limited improvements in treatment effectiveness with a substantial increase in capital cost (Reclamation 2008) in comparison to the Biota WTP options chosen for evaluation.

Also, the Final Environmental Assessment (SWC et al. 2001) evaluated intake options at both Lake Sakakawea and Audubon Lake, but a decision on the intake location was deferred pending additional engineering and water quality investigations. Audubon Lake is a subimpoundment of Lake Sakakawea that was formed by construction of the Snake Creek embankment. The contributing watershed of Audubon Lake is very small, and water levels are controlled almost entirely by operation of the SCPP, which delivers water from Lake Sakakawea to Audubon Lake. Thus, Missouri River depletions would be the same using Audubon Lake or Lake Sakakawea as a water source for the Project. Due to evaporation and limited outflow, concentrations of most water quality constituents are higher in Audubon Lake than in Lake Sakakawea. As a result, higher treatment costs and slightly higher potential to form DBPs would be expected with Audubon Lake water than with water from Lake Sakakawea. Therefore, an intake in Audubon Lake for the alternatives that would use Missouri River water was considered but eliminated.

During the alternative development process of this SEIS, several sources of water were initially considered, including the use of inbasin bedrock aquifers, aquifer storage and recovery, and wastewater treatment. The use of inbasin bedrock aquifers was eliminated due to excessive depth, poor water quality, potential impacts on nearby wells, and inadequate quantity. Aquifer storage and recovery was not carried forward for further analysis because it is not a proven technology for glaciofluvial and bedrock aquifers in North Dakota. Extensive investigations that were outside the scope of this EIS would be required to determine feasibility, technical considerations, and costs. Reusing the City of Minot's treated wastewater for outdoor water use to offset a portion of the Project's potable water demand, and thus reduce the overall demand on the system, was evaluated but is not considered feasible at this time due to a combination of factors. These include the high cost of treatment facility upgrades and developing a distribution system, low rates of outdoor water use, and a customer base that could not use appreciable quantities of the available reuse water. The potential to reuse treated wastewater from other communities and rural water systems within the Project Area was not evaluated due to their relatively small size and limited quantity of wastewater.

Several other initial components of the Missouri River alternatives considered during the conceptual design phase were not carried forward into the appraisal-level design phase due to high costs and feasibility, including an intake and pump station located on Lake Sakakawea northwest of Fort Berthold and east of New Town and a 73-mile transmission line from Lake Sakakawea northwest of Fort Berthold Indian Reservation to Minot, of which 59 miles represent a new extension to the intake site that branches off the existing transmission line. These were eliminated because of the cost of the long transmission line extension to the intake site. Additionally, implementing these components would require moving the Biota WTP to a new location southwest of the Basin Divide, requiring the evaluation and acquisition of a new site. The use of reverse osmosis at the Minot WTP to treat the water to meet secondary standards also was eliminated during the 10% design because the cost-benefit ratio for using this technology was very low.

Although included in the Appraisal-Level Design Report (Appendix J), the optional intake located on the south shore of Lake Sakakawea considered for the Missouri River alternatives was not carried forward for analysis in the SEIS due to the need to evaluate and acquire a new site and construct a costly and lengthy extension of the transmission pipeline. This option would also have required running the pipeline across either Lake Sakakawea or Lake Audubon because the U.S. Army Corps of Engineers indicated that construction of a buried, pressurized pipeline would not be allowed in the causeway between the two lakes. Costs would be greater for this option than for other intake options; it could have schedule implications and potentially could result in greater environmental impacts.

Identification of the Preferred Alternative

Reclamation has chosen to identify a preferred alternative in this SEIS. According to *Reclamation's NEPA Handbook* (Reclamation 2012b), in identifying a preferred alternative, Reclamation should consider:

- If an alternative exists which has consensus of the affected community, is reasonable and practicable, meets the purpose and need for action, and is within Reclamation's statutory authority to implement, Reclamation should designate it as the preferred alternative.
- The preferred alternative should be an alternative that completes the action and that best meets the purpose and need for the action as defined in the SEIS.

Reclamation chose a matrix evaluation method that has been established to evaluate several factors and compare the alternatives to determine the best recommendation for the Project. Reclamation compared all alternatives in terms of how each addressed the purpose and need (i.e., reliability), environmental impacts and non-environmental issues identified during the SEIS process, and the estimated construction and OM&R costs. Appendix C provides the detailed rationale for Reclamation's identification of the preferred alternative. Based on this information, the preferred alternative for the Project has been identified as the Missouri River and Groundwater Alternative.

In the Draft SEIS, the preferred alternative included the Modifications to the Snake Creek Pumping Plant as the intake option and Chlorination with UV Inactivation as the Biota WTP option. EPA submitted comments outlining potential concerns related to drinking water regulations associated with the Chlorination with UV Inactivation Option. In response to the concerns and following further consideration of the potential to form DBPs, Reclamation has identified the Conventional Treatment Option as the preferred Biota WTP option for the preferred alternative. The identification of this Biota WTP option is based on the Project's ability to comply with SDWA regulations and does not reflect the level of treatment necessary to address the concerns relative to the Project-related risk of AIS transfer. Other options proposed for the Biota WTP would be sufficient to reduce the Project-related risk for AIS transfer, as stated in the Draft SEIS. The estimated costs for the preferred alternative are shown in Table 2-31.

Table 2-31 Preferred Alternative Cost Estimate

Features	Construction Cost Estimate [a]	Annual OM&R Cost Estimate [a]
Existing Components	$110,399,125	$6,285,343
Minot WTP Upgrades [b]	$11,375,000	
Bulk Distribution System	$38,546,000	$993,000
South Prairie Storage Reservoir	$3,023,000	$41,000
Intake and Pump Station at Lake Sakakawea inside SCPP	$13,900,000	$1,099,000
Biota WTP and Pump Station Conventional Treatment	$66,700,000	$2,300,000
Cost to Complete	**$133.6 Million**	**$4.4 Million**
Total Cost	**$244 Million**	**$10.7 Million**

Notes:
[a] All estimated costs in the table are rounded.
[b] Estimated OM&R costs are included in the existing components.

With an estimated total construction cost of $244 million and an annual OM&R cost of approximately $10.7 million, the Missouri River and Groundwater Alternative would provide a reliable source of high-quality water to the Project Area that would be able to meet the Project purpose and need through 2060. The preferred alternative would provide Project members with drinking water that meets both primary and secondary standards. This alternative would not require additional water permits, would not affect the Souris River or the J. Clark Salyer National Wildlife Refuge, and would have minimal effects on the Missouri River and related resources.

The risk of a Project-related transfer and establishment of AIS would be much smaller than the risk of transfer and establishment through existing non-Project pathways. To reduce the risk of a Project-related transfer of AIS into the Hudson Bay basin, this alternative would include the Conventional Treatment Biota WTP option, which provides protection against the organisms of concern and includes a physical barrier for removal. The Conventional Treatment option also provides flexibility for the Project sponsor and Reclamation to adapt operations as needed to comply with SDWA regulations.

When coupled with proposed BMPs and environmental commitments described in Appendix F, the Missouri River and Groundwater Alternative would have fewer environmental effects than other alternatives that meet the Project purpose and need. Reclamation has committed to implement adaptive management planning regarding concerns related to AIS and the treatment efficacy of the Conventional Treatment Biota WTP. Through adaptive management, treatment processes can be optimized to address unforeseen changes in water quality in the future. Adaptive management would not result in reductions to the finished water quality as defined by the parameters of the Conventional Treatment Biota WTP option (shown in Table 2-23) or cause a change to the Biota WTP’s ability to meet conventional treatment as defined in 40 CFR 141.2. Reclamation would coordinate with the Project sponsor, EPA, and others, as appropriate, in development of an adaptive management framework for the operation and maintenance of the Conventional Treatment Biota WTP following a decision in the NEPA process. Reclamation’s role in adaptive management would be related to maintaining compliance with the Boundary Waters Treaty, and the Project sponsor would be responsible for SDWA compliance and other drinking water concerns.

Chapter Three – Affected Environment

Introduction

Affected Environment: The geographic area containing resources that could be affected by Project implementation. The affected environment varies by resource.

The affected environment is the geographic area containing resources that could be affected by new construction required to implement the Project alternatives. (Impacts of existing Project components already have occurred and are described in Appendix A, along with the environmental commitments that have been implemented.) The affected environment is not the same for all resources. For resources that would be affected primarily by construction activities (e.g., vegetation and agricultural resources), the affected environment typically would be limited to the construction corridor (assumed to be ½ mile on either side of proposed pipeline segments and facilities such as pump stations, storage reservoirs, and intake sites). The affected environment for other resources would be broader. For example, impacts on socioeconomic resources potentially would extend to communities throughout the Project Area, and the potential impacts from aquatic invasive species (AIS) could extend into Canada. The affected environment for each of the resources considered in this analysis, listed in Table 3-1, is defined for each resource in the discussions below. The description of resources begins with an overview of the ecoregions in the Project Area, followed by resource-specific discussions. Common and scientific names of plant, fish, and animal species used in this SEIS are listed in Appendix G.

Table 3-1 Resources and Issues Evaluated

• Water Resources	• Vegetation	• Indian Trust Assets
• Fisheries and Aquatic Invertebrates	• Wetlands and Riparian Areas	• Socioeconomics
• Aquatic Invasive Species	• Common Wildlife	• Environmental Justice
• Paleontological Resources	• Federally Protected Species	
• Land Use	• Historic Properties	

Ecoregions

The Project Area covers parts of three ecoregions: Northwestern Glaciated Plains, Northern Glaciated Plains, and Northwestern Great Plains (Figure 3-1).[1] Ecoregions are areas defined by environmental conditions and natural features. They denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. These resources include hydrology, geology, wildlife, land use, climate, soils, and vegetation. Ecoregions are relevant in natural resource management and decision making because each ecoregion's quality and integrity reflects its specific environmental resources. Ecoregions also reflect biodiversity as

[1] These ecoregions are based on Omernik (1987), as refined (EPA 2005).

defined by the Council on Environmental Quality (CEQ 1993). Ecoregions in the potentially affected environment in Canada (e.g., along the Souris River and adjacent to Lake Winnipeg) and along the Missouri River downstream of Lake Sakakawea are not described here because potential effects in these areas would be limited to aquatic resources, and these are discussed below under Aquatic Invasive Species and Fisheries and Aquatic Invertebrates, respectively.

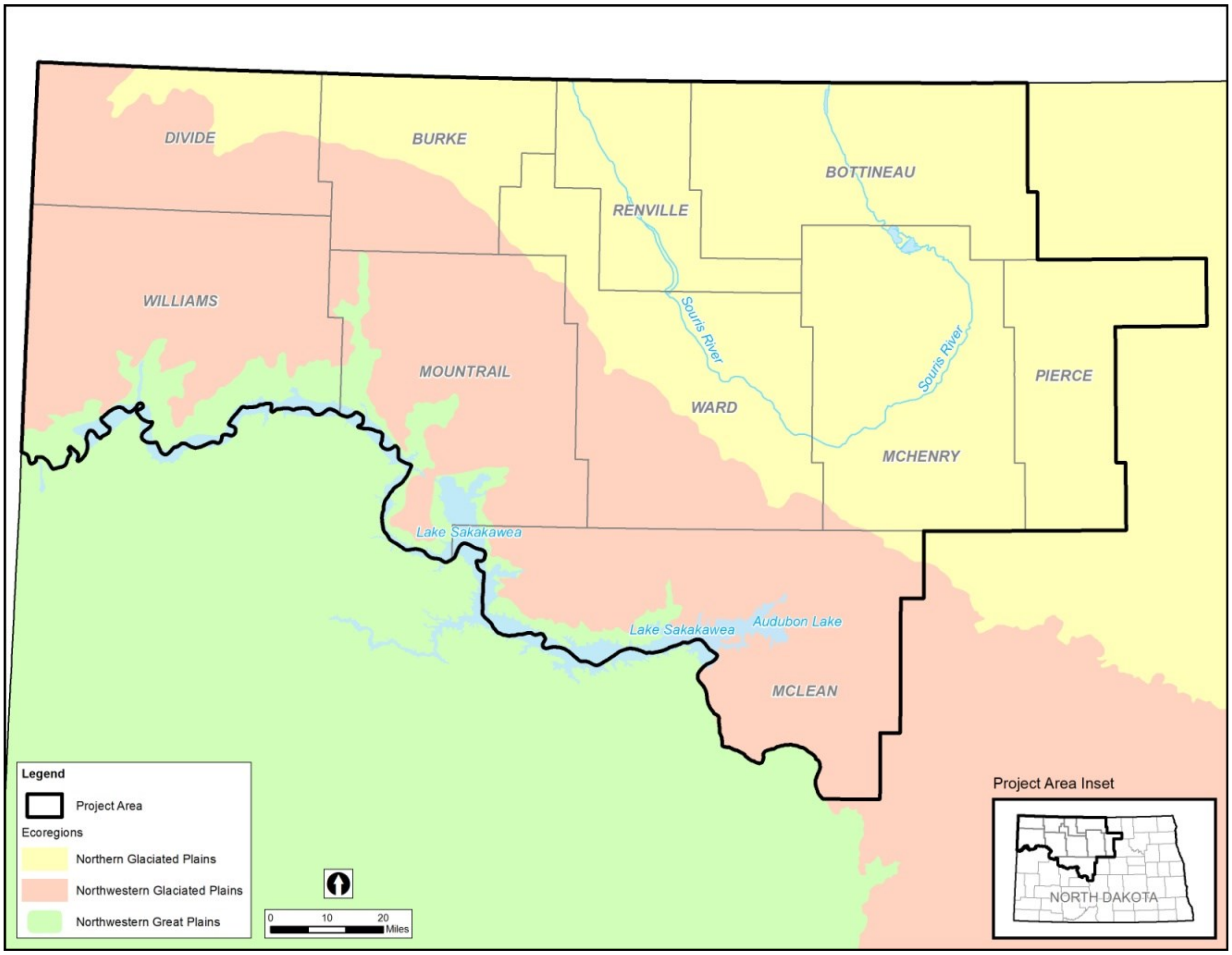

Figure 3-1 Ecoregions in the Project Area

The Northwestern Glaciated Plains ecoregion is a transitional region between the generally more level, moist, cultivated Northern Glaciated Plains to the east and the generally more irregular, drier, less cultivated Northwestern Great Plains to the west and southwest. The western and southwestern boundary of this ecoregion roughly coincides with the limits of continental glaciations, which occurred about 10,000 years ago. A moderately high concentration of semi-permanent and seasonal wetlands occurs across this ecoregion; these are referred to locally as "prairie potholes."

The Northern Glaciated Plains ecoregion is characterized by a flat to gently rolling landscape composed of glacial till. The sub-humid conditions foster transitional grasslands containing tallgrass and shortgrass prairie.

The Northwestern Great Plains ecoregion is characterized by a rolling plain with scattered buttes. The underlying substrate is composed of shale and sandstone. This ecoregion encompasses the Missouri Plateau. Although the native grasslands largely have been replaced by agriculture, native stands persist in areas with broken topography.

Climate

Due to its location in the geographic center of North America, the Project Area has a typical continental climate characterized by large annual, daily, and day-to-day temperature changes; light to moderate precipitation which tends to be irregular in time and coverage; low relative humidity; plentiful sunshine; and nearly continuous air movement (USGS Northern Prairie Wildlife Research Center 2006). Representative climate data for Minot are presented in Table 3-2.

Table 3-2 Representative Climate Data for Minot (1981 – 2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg. Max. Temp.(ºF)	20.9	25.4	37.1	54.9	66.7	75.1	81.5	81.2	69.7	55.0	36.9	23.6	52.5
Avg. Min. Temp. (ºF)	3.5	8.6	19.4	31.8	43.0	52.7	57.9	55.7	45.9	33.8	19.9	7.2	31.7
Avg. Total Precipitation (in.)	0.51	0.40	0.84	1.14	2.50	3.58	2.43	2.04	1.46	1.16	0.75	0.38	17.19
Avg. Total Snowfall (in.)	10.8	5.0	7.0	4.8	0.5	0.0	0.0	0.0	0.1	2.1	8.2	7.6	46.1

Source: National Weather Service Weather Forecast Office 2011

Water Resources

The affected environment for water resources includes the major features in the Hudson Bay and Missouri River basins that could be affected by the proposed alternatives, as follows:

- Hudson Bay basin
  - Souris River (also referred to as the Mouse River by North Dakota statute)
  - Minot and Sundre aquifers
- Missouri River basin
  - Missouri River
  - Lake Sakakawea
  - Audubon Lake

Water resources data, including the data describing the quality and quantity of the major groundwater and surface water features in both the Missouri River and Hudson Bay basins, were collected through extensive literature and database reviews, in addition to interviews with staff from the North Dakota State Water Commission (SWC).

Hudson Bay Basin Surface Waters and Aquifers

Souris River

The Souris River originates in Saskatchewan, Canada and flows for 435 miles to its confluence at the Assiniboine River in Manitoba, Canada, draining a total area of approximately 23,600 square miles (Figure 3-2). The river flows southeast from its source, crossing into the United States near Sherwood, North Dakota. It flows through the town of Burlington upstream of Minot, as well as the town of Sawyer. It reaches its southernmost point at Velva, North Dakota before looping to the north and crossing back into Manitoba, Canada.

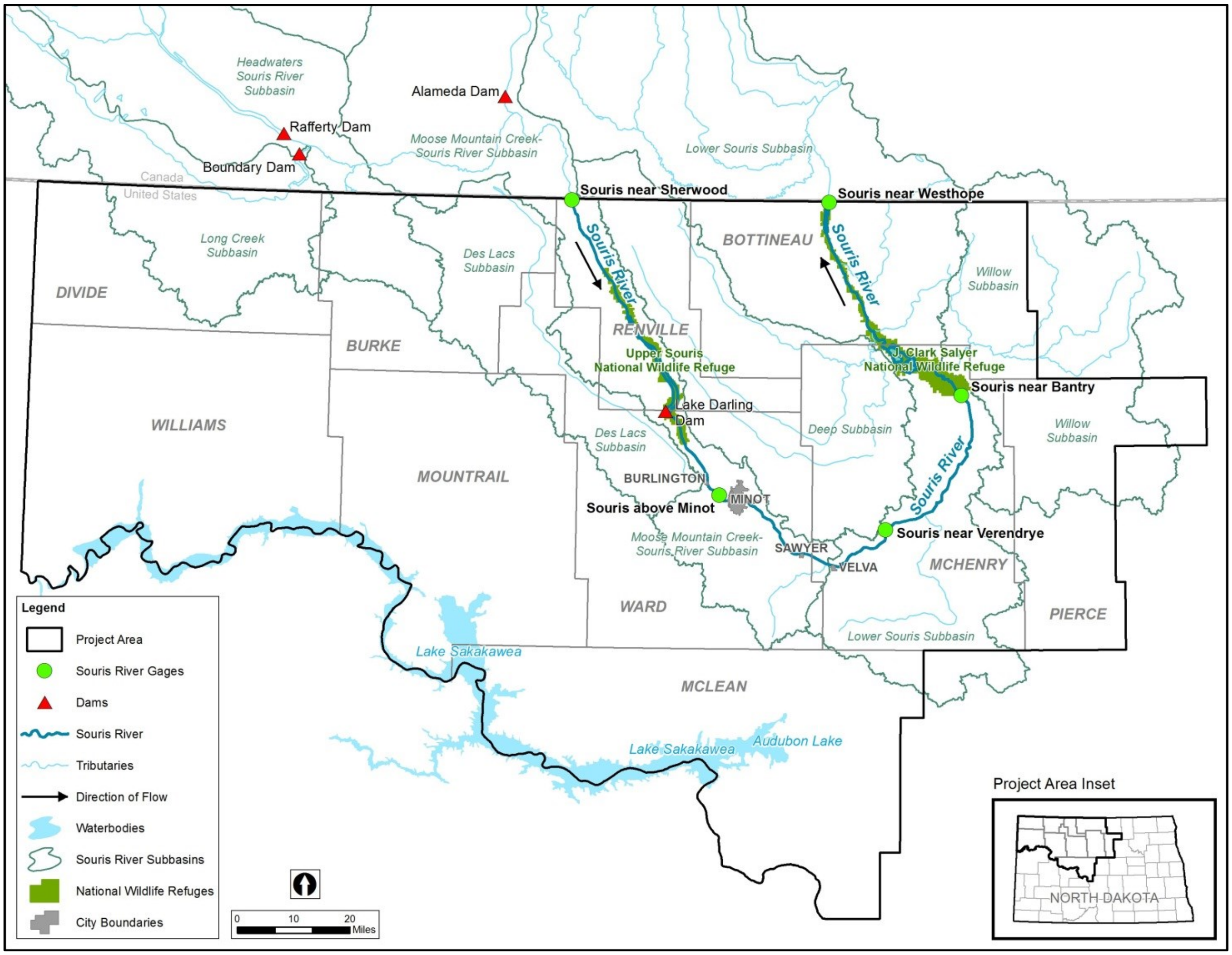

Figure 3-2 Souris River in the Project Area

Transboundary Water Management

The International Souris River Board (ISRB) of the International Joint Commission is responsible for Souris River transboundary water management through mandates for flow apportionment and flood control. The 1989 Agreement between the Governments of Canada and the United States for Water Supply and Flood Control in the Souris River Basin, as amended in 2000 (Water Supply and Flood Control Agreement) authorizes Canada to store or divert up to 60 percent of the Souris River flow for water supply and flood control before it reaches the international border (ISRB 2000). Canada's ability to divert and store Souris River water is based on the Rafferty-Alameda Project. This project was developed between 1988 and 1995 as a multipurpose project to provide water for the area, including the Shand Power Station near Estevan, and flood protection for residents downstream in Saskatchewan and North Dakota, including the City of Minot. It also ensures that a more reliable water source is available for municipal, domestic, irrigation, and recreational use in the Saskatchewan portion of the Souris River basin. The project consists of the Rafferty Reservoir on the Souris River near Estevan and the Alameda Reservoir on Moose Mountain Creek near Oxbow. In regard to flows into the United States, the Water Supply and Flood Control Agreement specifies the following:

- The annual flow of the Souris River from Saskatchewan into North Dakota shall be at least 50 percent of flow that would have occurred naturally. In wet years, annual flow of the Souris River may be only 40 percent to account for evaporation from the reservoirs in Saskatchewan and to account for the flood control benefits to North Dakota.
- There shall be a minimum flow of the Souris River of 4 cubic feet per second (cfs) flowing from Saskatchewan to North Dakota. The minimum flow may fall below 4 cfs if it would have occurred naturally without the Boundary, Rafferty, and Alameda reservoirs.
- The timing of the flows of the Souris River from Saskatchewan to North Dakota should be close to natural conditions or for the most beneficial use of North Dakota, which could include holding back flows to reduce flooding, or until they would be more useful.

Souris River Water Use

Within the Project Area in North Dakota, the Souris River flows through the Upper Souris National Wildlife Refuge (NWR), Lake Darling Dam, and the J. Clark Salyer NWR downstream of Minot before crossing back into Canada (Figure 3-2).

The Upper Souris NWR was established in 1935 as a refuge and breeding ground for migratory birds and wildlife. The 32,000-acre refuge extends 30 miles along the upper Souris River and includes the 10,000-acre Lake Darling, which stores water for downstream marshes and wildlife habitat during droughts. The refuge has an established water right to use about 10,822 acre-feet per year (ac-ft/yr) (or about 15.1 cfs if used continuously throughout the year) (Table 3-3). In the 1980s, 4 feet of flood storage was added to Lake Darling, which has a maximum capacity of 158,600 ac-ft and a normal spring flood storage capacity of 59,600 ac-ft (Barr Engineering et al. 2012). Gated spillways were also added to allow for better control of flows through the dam. The reservoir is operated for multiple purposes, including flood control, recreation, and irrigation, and is coordinated with the operations of the three upstream dams in Saskatchewan and the downstream J. Clark Salyer NWR. Example management objectives for Lake Darling, proposed for operating year 2002, include:

1) *Store water in Lake Darling by June 1 for future Refuge management uses.*
2) *Select releases that will not exceed the maximum allowable flows under the International Operating Plan while keeping downstream flooding to a minimum, if possible.*
3) *Alert the State Water Commission and other U.S. Board members if runoff is less than a 1 in 10 year event and if water apportionment releases do not arrive at the border pursuant to the natural hydrograph as required by the International Agreement language.*

4) *Coordinate with the State Water Commission to fulfill senior water right holder requests.*

5) *Coordinate and cooperate with the Corps of Engineers to operate Refuge gates to pass and/or store flood flows coming into Lake Darling pursuant to the International Agreement Operating Plan if the predicted runoff is equal or greater than the 1 in 10 year event.* (Service 2002a)

Table 3-3 Summary of Water Right Quantities on the Souris River in North Dakota

Use	Perfected	Conditionally Approved	Withheld, Deferred	Total
Water Permits above Minot[a] (ac-ft/yr)				
Municipal & Industrial	6,700	2,423.8	—	9,123.8
Irrigation and Stock	2,451.1	354	39	2,844.1
Fish and Wildlife	103	—	10,719	10,822
Total	9,254.1	2,777.8	10,758	22,789.9
Water Permits below Minot[a] (ac-ft/yr)				
Municipal & Industrial	678.9	115.9	—	794.8
Irrigation and Stock	299.3	10,160.1	12,826	23,285.4
Fish and Wildlife	—	1726	30,858	32,584
Recreation	—	29.3	—	—
Total	978.2	12,031.3	43,684	56,693.5

Notes:

ac-ft/yr = acre-feet per year

[a] Surface water permits within 1 mile of the Souris River (there were 5–10 additional permits within 3 miles, but it could not be ascertained whether they withdrew directly from the Souris River).

Source: SWC 2013a

The 58,700-acre J. Clark Salyer NWR is located along approximately 45 miles of the Souris River between Bantry and Westhope, just south of the Canadian border (Figure 3-2). The refuge consists of multiple dams, reservoirs, and facilities, with the primary objective of maintaining habitat for waterfowl and shorebirds (Service 2013a). Example objectives described for 2002 including managing water levels in the nine refuge pools at various levels to achieve habitat and revegetation goals (Service 2002a).

The refuge has a water right to use 30,839 ac-ft/yr, but the right is described as withheld or deferred because it has not yet been perfected. A "perfected right" means a water right acquired in accordance with state law, and the right has been exercised by the actual diversion of a specific quantity of water that has been used for a specific purpose. The water rights of the Service and the Eaton Irrigation Project would be senior to the majority of water rights held by the City of Minot (SWC 2014).

Other water use from the Souris River includes about 3,371 ac-ft above Minot and 20,805 ac-ft below Minot for non-fish and wildlife use, which primarily consists of diversions for agriculture

(Table 3-3). The City of Minot has a municipal water right to use 1,454 ac-ft from the Souris River, and an additional 252 ac-ft are allocated to the City for irrigation purposes.

The Water Supply and Flood Control Agreement requires that a 20-cfs minimum flow is maintained during the 5-month period from June through October at Westhope where the Souris River enters Canada. In some years, water has been released from Lake Darling and the J. Clark Salyer NWR to help meet the minimum flow requirement (Service 2002a; White, pers. comm., 2012).

USGS Gage Data

Five U.S. Geological Survey (USGS) gages are located on the Souris River in the Project Area (Figure 3-2). The gage above Minot provides records back to 1903, and the other gages provide records beginning in the 1930s (Table 3-4). The period of record is over 80 years in most cases, which allows for the variability in the record to be well represented. Most of the data are considered to have good accuracy, aside from those during the winter when the Souris River tends to freeze.

Souris River Flow Regime

The Souris River originates in the northern Great Plains and is characterized by highly variable flows. Very high flows can occur in the spring when rain falls on melting snowpack, and very low flows can occur during the winter when the ground is frozen and most precipitation falls as snow. Streamflow of the Souris River from snowmelt and spring rains peaks in April and declines over the summer, fall, and winter. Figure 3-3 is a simple representation of the median flow by month at Minot for the period of record (1903 to 2011). Median flows are less than 20 cfs from about mid-September until the following March when the spring melt and rainfall begins (USGS 2013a). The median flow is the flow where half of the flows are greater and half of the flows are less (also referred to as the "50-percent exceedance flow," which indicates that flows are higher than that flow 50 percent of the time), and are presented because they are more representative of typical conditions than average flows. Mean (average) flows are strongly affected by infrequent large-magnitude floods, which increase the average values relative to typical flows. For example, Table 3-4 shows both the annual mean flow (statistical average) and the annual median flow, which is much lower than the annual mean. This indicates that the annual flood flows skew the average value to be much larger than the median value.

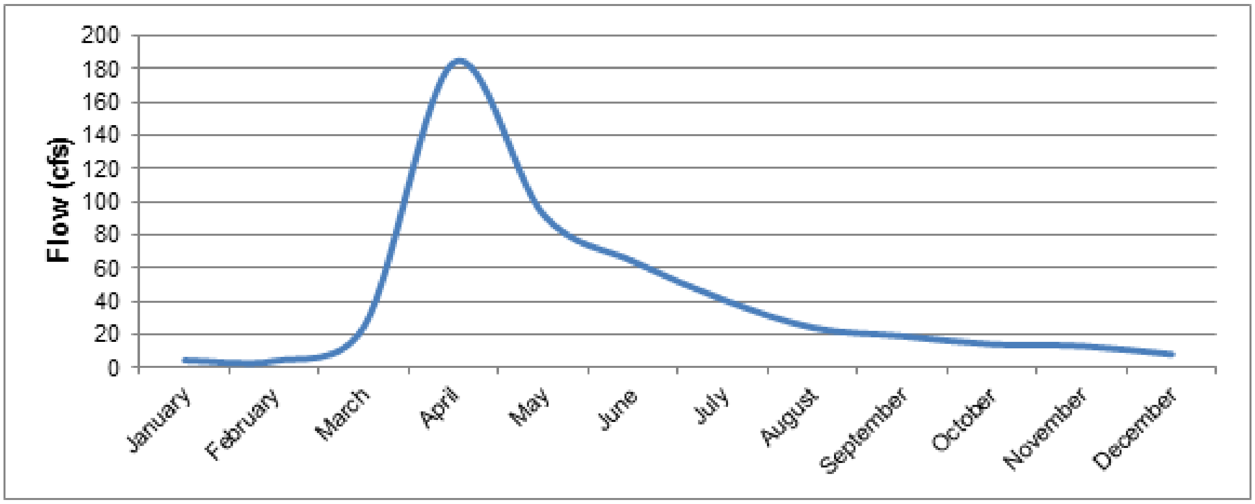

Figure 3-3 Souris River Monthly Median Flows for the USGS Gage above Minot (1903 to 2011)

Data Source: USGS gage 05117500 (USGS 2013a)

Table 3-4 Summary Statistics for Five USGS Streamflow Gages on the Souris River, North Dakota

USGS Gage Name	Gage Number	Drainage Area (mi^2)	Contributing Area (mi^2)	Non-Contributing Area (mi^2)	Annual Mean Flow (cfs) 1929 – 2012	Annual Median Flow (cfs) 1929 – 2012	Period of Record	Record Accuracy [a]
Souris River near Sherwood, ND	05114000	8,940	3,040	5,900	147	6.9	March 1930 to present	Good except when daily flows were estimated, which are poor quality
Souris River above Minot, ND	05117500	10,600	3,900	6,700	176	21	May 1903 to present (moved from Minot in 1934)	Good except when daily flows were estimated, which are poor quality
Souris River near Verendrye, ND	05120000	11,300	4,400	6,900	228	39	April 1937 to present	Good except when daily flows were estimated, which are poor quality
Souris River near Bantry, ND	05122000	12,300	4,700	7,600	258	52	March 1937 to present	Good except when daily flows were estimated, which are poor quality
Souris River near Westhope, ND	05124000	16,900	6,600	10,300	326	28	July to October 1929 April 1930 to present	Good except when daily flows were estimated, which are poor quality

Notes:

cfs = cubic feet per second; mi^2 = square miles

[a] U.S. Geological Survey stream record accuracy rating definitions: “Excellent” means that about 95 percent of the daily discharges are within 5 percent of the true value; “good” is within 10 percent; and “fair” is within 15 percent. Records that do not meet any of these criteria are rated “poor.”

Source: USGS 2012a

While Figure 3-3 portrays typical flows for the Souris River over the period of record, Figure 3-4 is a "box and whisker" plot that not only shows the same median monthly flows depicted in Figure 3-3 (as black horizontal bars in the middle of each month's box) but also includes a box showing the range of flows exceeded 25 to 75 percent of the time, and whiskers extending to the low flow that is exceeded 95 percent of the time (the bottom end of the whisker) and to the high flow that is exceeded 5 percent of the time (the top end of the whisker). The overall seasonal pattern of flows, as well as the extreme variability of flows from year to year, are highlighted in this type of graph, particularly since the vertical axis is a logarithmic scale (it increases from 0.1 to 1 to 10 to 100 to 1,000). A very wide range of flows is shown on this scale, which is needed since flows in some months range from near zero up through thousands of cfs. For example, over the period of record (1903 to 2011), about half of the recorded flows for the month of May were between approximately 15 and 425 cfs based on the area within the box in Figure 3-4. However, there is a wide spread in the extremes for this month shown by the whiskers; about the same number of flows were below 1 cfs and above about 2,700 cfs.

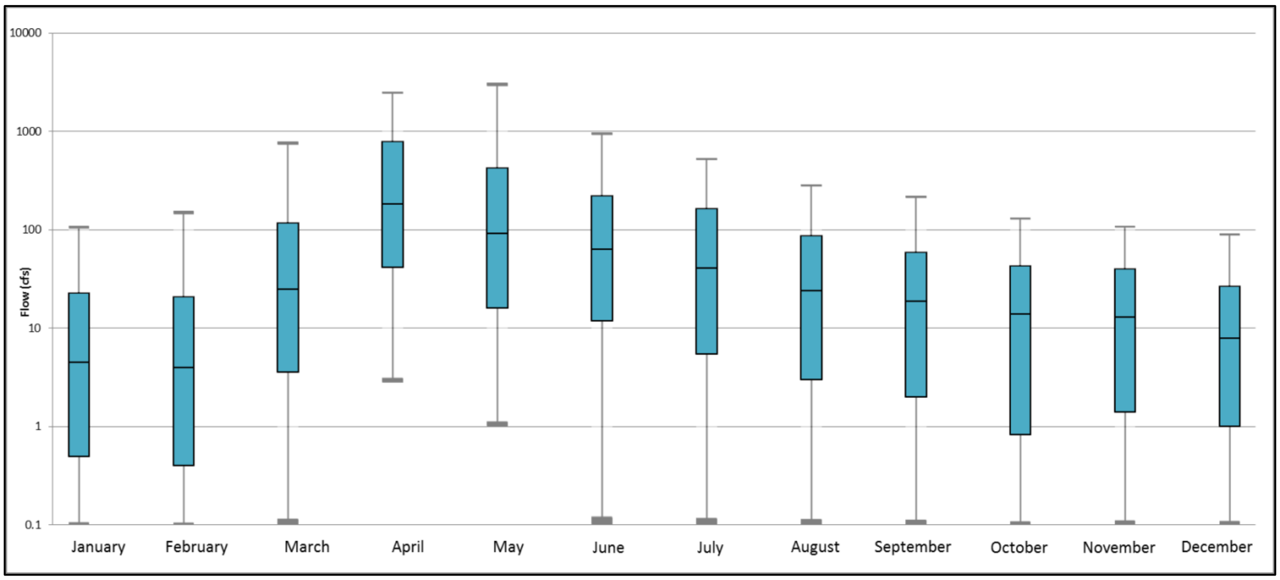

Figure 3-4 Box Plots of Monthly Streamflows for the Souris River above Minot (1903 – 2011)

Data Source: USGS gage 05117500 (USGS 2013a)

The variability of the Souris River may also be portrayed using the daily flows, which illustrate the range of flows that has occurred each day over the period of record. Figure 3-5 illustrates daily flows displayed in color bands representing ranges in the percent of time that flows are experienced. The flow (discharge) is also presented using a logarithmic scale on this graph so flows ranging from 0.1 cfs to over 20,000 cfs can be represented. The green band represents the same range of flows (75- to 50-percent exceedance) as the boxes in Figure 3-4 and is considered the "normal" flow condition. The yellow and red bands represent the "below-normal" and "dry" conditions, respectively, while the light blue and dark blue bands indicate the "above-normal" and "wet" conditions. Figure 3-5 also includes flow data from the year 1987 (black line) as an example to demonstrate that each individual year can also be variable; there is no "typical year." Starting in January 1987 and moving through the year, flows started out in the median range, although they were close to being higher than normal (in the upper portion of the green band). They then varied between median and higher-than-normal flows in March (green and blue bands), generally decreased to normal flows in April and May (green band), decreased to lower-than-normal or very-low flows in June, and generally were within the median range for the rest of the year.

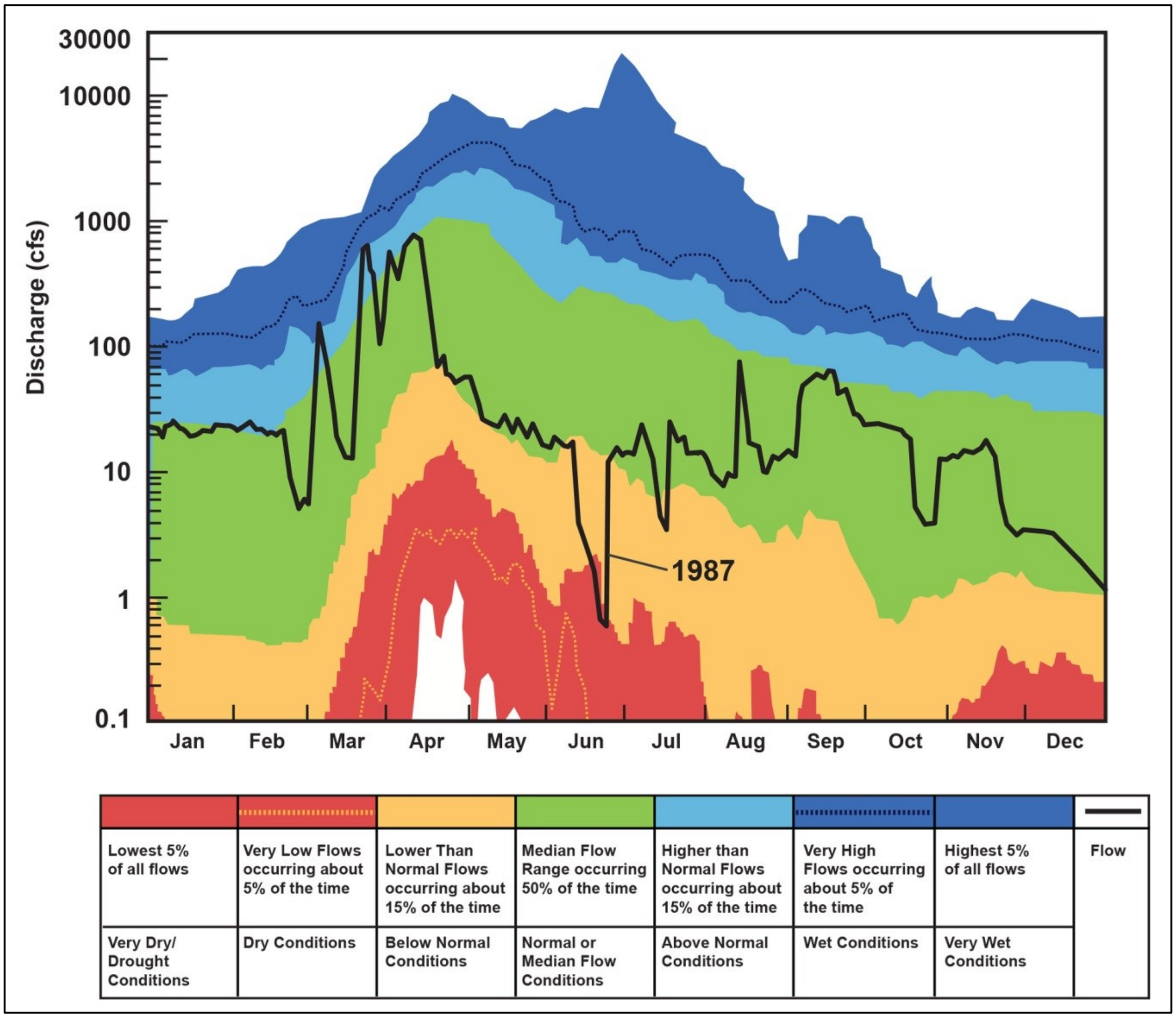

Figure 3-5 Summary of Mean Daily Flows in the Souris River above Minot

Data Source: USGS gage 05117500 (USGS 2013a)

Souris River Flow Trends

In addition to seasonal ranges in flows each year, flows vary from year to year and between gages throughout the basin. Figure 3-6 shows the 5-year running average of annual flows over the period of record for the gage above Minot (May 1, 1903 to October 4, 2011). Analysis of daily flows for this period of record shows that there have been cycles of lower and higher flows over the past 100 years, with both droughts and periods of higher flows lasting several years, and up to a decade in some instances. Whether these trends will continue into the future is unknown, particularly with changes due to global climate change. (See the Climate Change discussion in Chapter 4.)

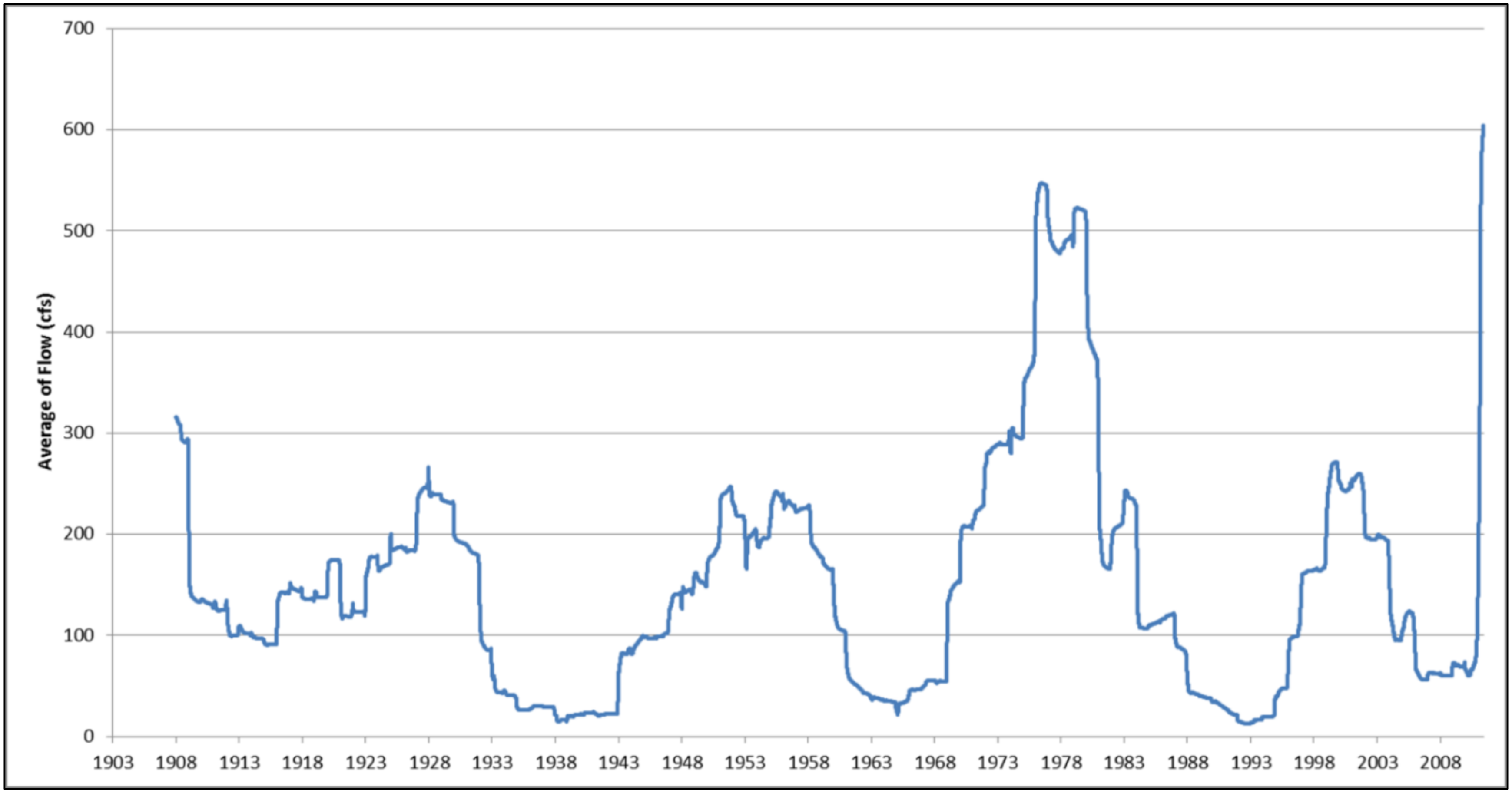

Figure 3-6 5-Year Running Average Annual Flows for the Souris River above Minot

Data Source: USGS gage 05117500 (USGS 2013a)

Most of this analysis focuses on the USGS gage above Minot, which has the longest record and is closest to where the Minot Water Treatment Plant (WTP) is located. However, surface hydrology varies somewhat at different locations along the Souris River. Figure 3-7 shows box and whisker plots for the gage above Minot and the three gages downstream toward the Canadian border (Figure 3-2). Colored bars extend from the 25-percent exceedance to the 75-percent exceedance flow; the bar in the middle of the blue bar is the median flow; and the upper and lower whiskers extend to the 5-percent and 95-percent exceedance flows. The data are based on analysis of daily flows at the Souris River gage above Minot (May 1, 1903 to October 4, 2011), Souris River near Verendrye (April 1, 1937 to October 4, 2011), Souris River near Bantry (March 1, 1937 to October 4, 2011), and Souris River near Westhope (August 1, 1929 to October 4, 2011).

The data display the expected increase in median flows downstream of Minot, at Verendrye and Bantry, due to the increasing size of the contributing watershed area (Figure 3-2, Table 3-4). However, the gage near Westhope at the Canadian border has lower median and 75-percent exceedance flows for several months, particularly during winter. The reason for this is unclear, although two factors may play a role. The first factor is that winter flow records during periods of freezing are less accurate than those outside of the winter season. The second factor may have to do with flow through the J. Clark Salyer NWR, which lies between the Bantry and Westhope gages. Although the refuge's management plan does not include higher water use or retention during winter months, the river flows through several retention ponds, and portions of flows may freeze in these ponds rather than flowing through (Durbian, pers. comm., 2013). In general, flows are maintained above 20 cfs between June and October to comply with the Water Supply and Flood Control Agreement.

Low Flows

Low flows on the Souris River are part of the normal seasonal flow regime and may also occur for extended periods during drier years or drought cycles. The seasonal insufficiency of flows in the Souris River has long been acknowledged and is one of the motivating factors behind the dominance of groundwater development to increase water supply (Kehew 1983). Based on Figure 3-4, flows below 1 cfs occurred more than 25 percent of the time in the months of October, January, and February; and flows near zero cfs occurred 5 percent of the time in all months except April and May, where the flows were about 3 and 1 cfs, respectively. Based on an analysis of the period of record for the USGS gage above Minot, the 7-day average minimum annual flow is about 0.7 cfs (USGS 2013a).

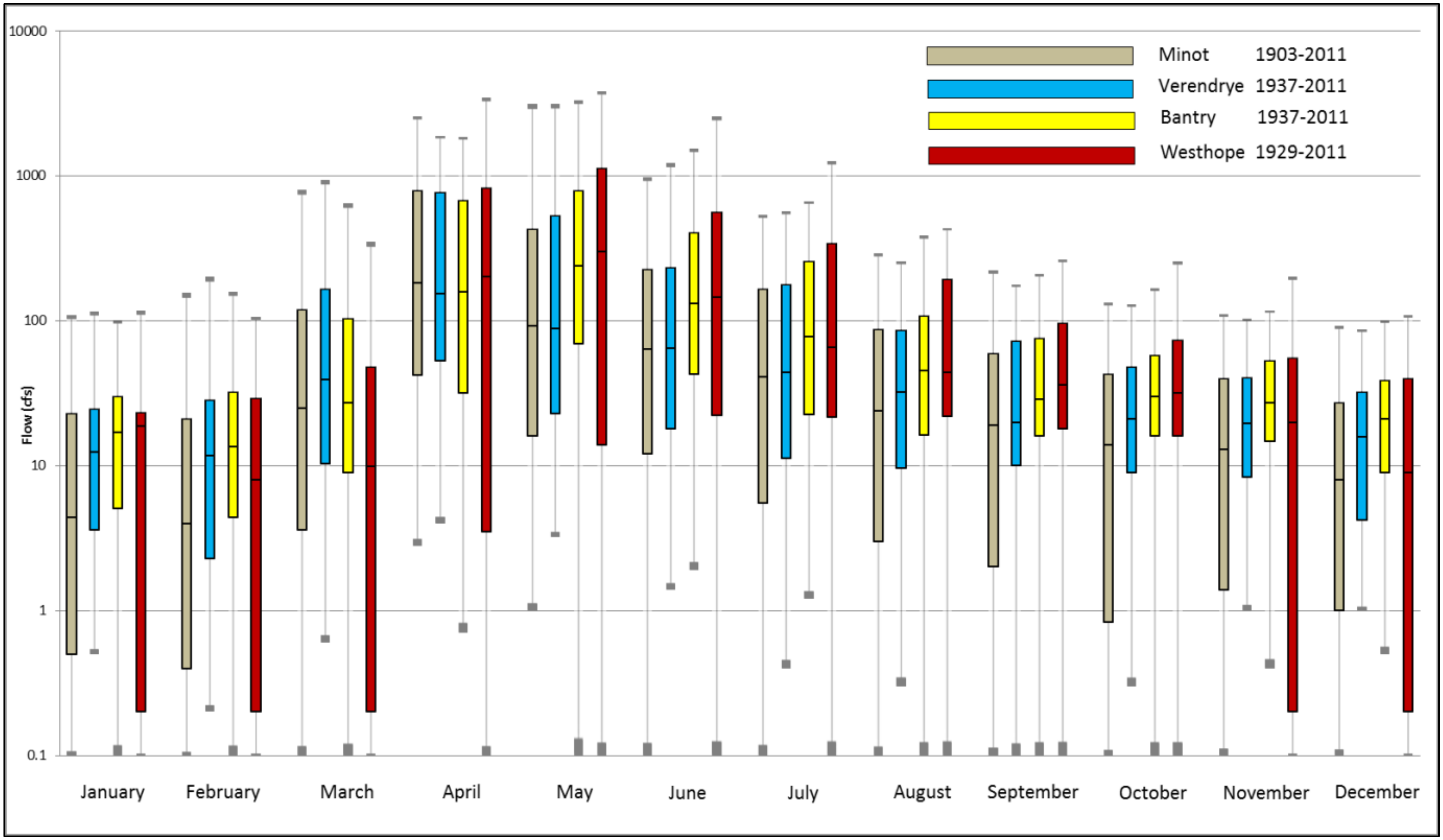

Figure 3-7 Box Plot Comparisons of Monthly Streamflows for the Souris River at Four Selected Gages

Data Source: USGS gages on the Souris River (USGS 2013a)

Flood Flows

High flows during spring from snowmelt runoff and spring storms are part of the normal seasonal flow regime, and floods on the Souris River are also not unusual. Flood protection projects for Minot and other communities along the Souris River have been underway since the 1930s (Barr Engineering et al. 2012). The goal of the operating agreement for the upstream reservoirs is to reduce flood flows to non-damaging levels (approximately 5,000 cfs in the vicinity of Minot). However, in June 2011, the Souris River peaked at nearly 27,000 cfs, which was more than double the prior flood of record in 1904 of 12,000 cfs. This flow falls between a 250- and 400-year flood events (Barr Engineering et al. 2012). Recorded peak flows above 5,000 cfs also occurred in 1969, 1975, 1976, and 1979. A huge flood occurred in 1882 prior to the period of record that was estimated to be comparable to the 2011 flood (Table 3-5) (Barr Engineering et al. 2012). The highest seasonal flows typically occur in the spring (Figure 3-7). All of the largest historical floods have occurred between April and June.

Table 3-5 Souris River Floods above 5,000 cfs for the Period of Record

Year	Date	Peak Streamflow (cfs)
1904	April 20	12,000
1969	April 19	6,020
1975	May 13	5,700
1976	April 17	9,350
1979	May 09	5,960
2011	June 25	26,900

Note:
cfs = cubic feet per second
Source: Barr Engineering et al. 2012

Water Quality

The water quality of the Souris River at the International Boundary has been monitored by the ISRB since 1990. (It was formerly conducted by the Souris River Bilateral Water Quality Monitoring Group.) The water quality objectives are established at the two border crossings. At a basin-wide scale, the principal water quality concerns relate to elevated concentrations of total dissolved solids (TDS), depleted dissolved oxygen, and high levels of nutrients, especially phosphorus (ISRB 2010, 2011). These characteristics are generally associated with nonpoint pollution from agriculture, and the naturally high levels of phosphorus in prairie soils. Winter anoxic conditions and fish kills in the Souris River basin have been documented on many occasions. Factors causing low oxygen levels have not been determined, but the ISRB indicated that increased sediment oxygen demand, macrophyte decomposition, organic enrichment, ground water influence, photosynthesis suppression, low flow, or dams were possible contributors (ISRB 2010, 2011).

Some reports indicate that water of the Souris River has a large concentration of suspended sediment during periods of peak flow (Pettyjohn 1967) or poor water quality during relatively high flows if releases from Lake Darling follow a period of low flow in the river (Pusc 1994). However, Barr Engineering (2013) analyzed the available suspended sediment data from USGS records at several gages on the Souris River and noted that the concentrations are low and do not vary greatly along the river (Figure 3-8).

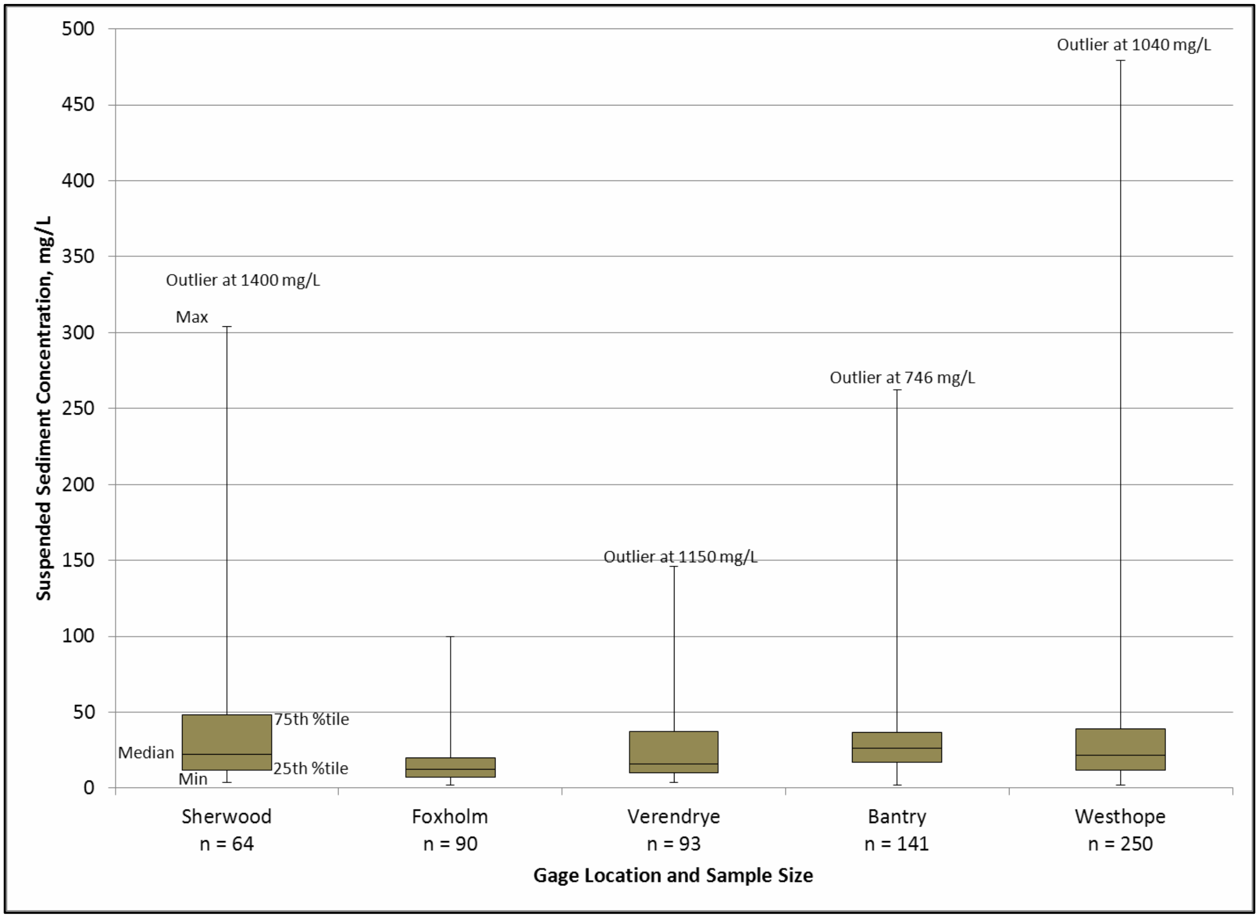

Figure 3-8 Suspended Sediment Concentrations along the Souris River

Source: Barr Engineering 2013

Additionally, a study by Klimetz et al. (2009) to establish "background" or "reference" rates of suspended-sediment transport for all Level III Ecoregions in U.S. Environmental Protection Agency (EPA) Region 8 (which includes the Souris River basin) found that approximately half of the stream channels evaluated in Ecoregion 46 were considered "stable" during the suspended-sediment sampling period of record and at the time of recent field assessments (mid 2000s). In comparison to other parts of the country, these suspended-sediment yield values are relatively low, even for the unstable channels.

The Souris River is designated by the State of North Dakota as a Class IA stream (NDCC 33-16-02.1-09). This classification is to provide and protect water quality that supports propagation and/or protection of resident fish species and other aquatic biota; supports swimming, boating, and other recreation activities; and is suitable for municipal and domestic use following appropriate treatment, except where natural conditions exceed Class I criteria for municipal and domestic use (NDDH 2012). In addition to numeric and narrative standards and the beneficial uses they protect, a third element of the water quality standards is antidegradation. The fundamental concept of antidegradation is the protection of waterbodies that currently have better water quality than applicable standards. The State has three tiers of antidegradation protection; Category 1 is a very high level of protection and automatically applies to all Class I and IA rivers and streams such as the Souris River.

The State considered six beneficial uses (aquatic life, recreation, drinking water, agriculture, industrial, and fish consumption) for purposes of assessment relative to Clean Water Act Section 305(b) reporting[2] and Section 303(d) listing.[3]

The 2012 Souris River 303(d) listing cites impairment to aquatic resources from sedimentation/siltation and to recreation by fecal coliform for segments of the river near Minot. However, all listed segments on the Souris River are in the state's "low" priority category and scheduled for total maximum daily load (TMDL) development 8 to 13 years in the future (NDDH 2012).

The Souris River above Minot has a wide range of chemical quality and is generally a calcium-sodium-bicarbonate waterbody with TDS concentrations from < 200 milligrams per liter (mg/L) to as much as 1,300 mg/L (Pusc 1994). Some seasonality in water quality was noted decades ago, such as the higher mineralization (larger TDS) during late fall to early spring when flow was dominated by groundwater discharge (Pettyjohn and Hutchinson 1971). The City of Minot's wastewater wetland treatment system releases high-quality effluent during non-ice conditions, which increases flow and enhances aesthetics in the reach. The State considers this highly beneficial since the Souris River has a history of poor river quality and low- or no-flow conditions during several months of the year (NDDH 2012).

A low-flow (10.5 to 47.0 cfs) water quality study along the Souris River downstream of Lake Darling to the J. Clark Salyer NWR (Wesolowski and Nelson 1987) described this section of river as a slow-moving, very low gradient system. The field tests identified the Minot reach as having a long concentration time, very low mean velocity, low dispersion efficiency, and low reaeration coefficients.

Water quality data from the USGS National Water Information System database for the gage on the Souris River above Minot (USGS gage 05117500) were analyzed for the full period of record and compared with both EPA drinking water standards and the State of North Dakota's standards for Class 1A water bodies for beneficial uses, including standards supporting aquatic life (Table 3-6).

These long-term data indicate that mean concentrations of the water quality parameters do not exceed EPA's primary drinking water standards (Table 3-6). Mean values do consistently exceed

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2 Each state must develop a program to monitor the quality of its surface water and groundwater and prepare a report describing the status of its water quality. The EPA compiles the data from the state reports, summarizes them, and transmits the summaries to Congress along with an analysis of the status of water quality nationwide. The 305(b) process is the principal means by which the EPA, Congress, and the public evaluate whether U.S. waters meet water quality standards, the progress made in maintaining and restoring water quality, and the extent of remaining problems.

3 This section of the Clean Water Act requires states, territories, and authorized tribes to develop lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop total maximum daily loads (TMDLs) for these waters. A "TMDL" is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.

secondary drinking water standards for iron, sulfate, and TDS. Mean values for sodium also exceed the advisory standard. Qualitative assessment of the sequence of observed exceedances for these four parameters showed a tendency for higher values in the most recent decade, but the datasets are not suitable for formal statistical trend analysis. Additionally, the maximum values for aluminum and pH are also outside the drinking water standards, but mean values are within an acceptable range.

Comparison of the water quality data with state standards indicates that several parameters exceed standards for Class IA streams and/or those for aquatic life (Table 3-6). The average for nitrate exceeds the state standard, but review of the observations indicates that no exceedances occurred after the mid-1980s. The maximum values for aluminum, pH, sulfate, and temperature are over the acceptable state limit, and the minimum dissolved oxygen value is below the recommended level. The average values for fecal coliform exceed the state standard, the maximum is well above limits, and these exceedances were consistent during sampling in the 1980s as well as since the late 1990s. However, the data sampling protocols for these parameters do not fit all temporal and statistical aspects of state-approved methods, which limits the ability to conclude that the parameters are not meeting state standards.

Souris River Geomorphology

Geologic Framework

The Souris River exhibits two general reach types, each with topography that reflects differences in their glacial origin: (1) low-relief plains that originated as glacial lakes; and (2) high-relief valleys that originated as glacial lake spillways. The glacial lake spillway reaches were formed from multiple episodes of catastrophic floods from upstream glacial lakes (e.g., Lake Arcola, Lake Regina) during the last glacial period. The glacial-lake spillway reaches have an inner zone with a trench-shaped channel (eroded in bedrock) that varies from approximately 0.6 to 1.9 miles wide and between 100 and 325 feet deep (Lord and Kehew 1990). The outer zone is a more irregular topographic surface with scour and lag deposits also attributed to the glacial-lake outburst floods. The Souris River valley between Burlington and Velva, and including the vicinity of Minot, is one of the spillway trench valley segments.

In marked contrast to the extreme erosive flood events that produced the underlying trench of the Souris River in this reach, river processes after the glacial retreat (during the early Holocene) included rapid aggradation (filling in with sediment) across the trench-valley floor and alluvial fan formation along the side margins. Wind-deposited materials were interlayered on the river deposits during the warmer/drier mid-Holocene. Since then, there has been little geologic modification of the overall Souris River valley configuration and accumulated sediments (Lord and Kehew 1990).

Table 3-6 Souris River Water Quality

Parameter	Units [a]	EPA Standards			Class IA Stream Standard	Max	Min	Mean	Total (n) Samples	Period of Record	Frequency
		Drinking Water	Aquatic (Acute)	Aquatic (Chronic)							
Primary Standards											
Arsenic	µg/L	10	340	150	—	**21**	1.0	7.2	37	Nov-81 to Aug-11	Monthly
Barium	µg/L	2,000	—	—	1,000	194	26	77	84	Nov-81 to Aug-11	Monthly
Berylium	µg/L	4	—	—	—	**47**	0.01	1.80	84	Feb-99 to Aug-11	Monthly
Cadmium	µg/L	5	2.1	0.3	—	1.0	0.01	0.13	84	Feb-99 to Aug-11	Monthly
Chromium	µg/L	100	1,800	86	—	7.4	0.07	0.80	84	Feb-99 to Aug-11	Monthly
Copper	µg/L	1,300	14	9.3	—	12	0.61	2.50	84	Feb-99 to Aug-11	Monthly
Lead	µg/L	15	82	3.2	—	2.4	0.06	0.50	83	Feb-99 to Aug-11	Monthly
Selenium	µg/L	50	20	5.0	—	3.0	0.19	1.30	84	Feb-99 to Aug-11	Monthly
Nitrate + Nitrite [b]	mg/L	10	—	—	—	**13**	6.20	8.50	17	Nov-81 to Aug-11	Sporadic
Nitrates	mg/L	—	—	—	1.0	**7.5**	0.1	**1.26**	29	Sep-69 to Aug-11	Sporadic
Secondary Standards											
Aluminum	µg/L	50–200	750	87	—	**1,010**	6.5	118	82	Mar-99 to Aug-11	Monthly
Chloride	mg/L	250	—	--	175	128	3.2	33	170	Sep-69 to Aug-11	Sporadic through 1999, then monthly
Fluoride	mg/L	2	—	—	—	0.7	0.1	0.24	170	Sep-69 to Aug-11	Sporadic through 1999, then monthly
Iron	µg/L	300	—	—	—	**1,730**	33	**359**	84	Feb-99 to Aug-11	Monthly
pH	SU	6.5–8.5	—	--	7.0–9.0	**9.5**	**6.7**	8.2	122	Nov-81 to Aug-11	Monthly
Sulfate	mg/L	250	—	—	450	**903**	53	**285**	170	Sep-69 to Aug-11	Sporadic through 1999, then monthly
TDS	mg/L	500	—	—	—	**2,300**	182	**716**	128	Sep-69 to Aug-11	Sporadic through 1999, then monthly

Parameter	Units [a]	EPA Standards			Class IA Stream Standard	Max	Min	Mean	Total (n) Samples	Period of Record	Frequency
		Drinking Water	Aquatic (Acute)	Aquatic (Chronic)							
Zinc	µg/L	5,000	120	120	—	60	10	24	5	Nov-81 to Aug-83	Sporadic
No Standards Established											
Specific Conductance	uS/cm	—	—	—	—	3,170	301	1,275	126	Nov-81 to Aug-11	Monthly
Dissolved Oxygen	mg/L	—	—	—	>5	17	**0.1**	9.1	116	Nov-81 to Aug-11	Sporadic through 1999, then monthly
Suspended Solids	mg/L	—	—	—	—	99	4	16.9	91	Nov-81 to Aug-11	Sporadic through 1999, then monthly
Phosphorus	mg/L	—	—	—	—	1.34	0.08	0.35	99	Nov-81 to Aug-11	Sporadic through 1999, then monthly
Hardness	mg/L $CaCO_3$	—	—	—	—	960	98.7	333	170	Sep-69 to Aug-11	Monthly
Calcium	mg/L	—	—	—	—	161	22	61.8	170	Sep-69 to Aug-11	Monthly
Magnesium	mg/L	—	—	—	—	140	10	43.2	170	Sep-69 to Aug-11	Monthly
Sodium [b]	mg/L	20	—	—	—	**449**	19	**136**	170	Sep-69 to Aug-11	Monthly
Cyanide	mg/L	—	22	5.20	—	0.1	0.1	0.1	9	Nov-81 to Aug-83	Sporadic
Mercury	µg/L	—	1.70	0.01	—	1	0.1	0.15	37	Nov-81 to Jul-82	Sporadic
Nickel	µg/L	—	470	52	—	1	1	1	2	Apr-82 to Jul-82	Sporadic
Silver	µg/L	—	3.80	—	—	1	1	1	9	Nov-81 to Aug-83	Sporadic
Temperature	°F	—	—	—	85	**88.7**	31.28	49	395	Nov-69 to Aug-11	Monthly
Fecal Coliform (Rec Season)	pounds/ 100 mL	—	—	—	126	**6,000**	1	**151**	64	Nov-81 to Sep-05	Sporadic

Notes: **Bold** indicates that one of the standards is exceeded.

[a] µg/L = micrograms per liter; mg/L = milligrams per liter; SU = standard unit; $CaCO_3$ = calcium carbonate; °F = degrees Fahrenheit; uS/cm = microSiemens per centimeter at 25 °C

[b] Sodium level is not an EPA standard; it is an advisory for acceptable levels of sodium.

Source: USGS 2013a

Flood Control Modifications

Flood risk reduction measures along the Souris River have been constructed over the past several decades and include upstream reservoirs and levees and channel modifications in the reach extending through Minot that have directly modified the river and floodplain geomorphology (Figure 3-9). In addition to the federal levees shown in the figure, other sections of non-federal levees in are present in this vicinity.

Throughout the City of Minot, most of the 8 miles along the Souris River has been channelized and straightened as a part of previous flood control projects (Figure 3-9). Armored levees form the channel banks in many locations, constructed where the natural banks were less than 2 feet above the estimated 100-year water surface (to provide a levee crest elevation with 3 feet of freeboard). Almost the entire river through Minot was modified; excavation was done in the channel, providing a bottom width range of 35 to 40 feet, with side slopes generally 1 vertical foot for every 3 horizontal feet. Nine channel cutoffs were also constructed in the city, with channel bottoms from 35 to 40 feet wide. Channel grade control structures were installed out of reinforced concrete to maintain pools in the river or divert normal stream around the cutoff locations. The Minot golf course is one of the few areas in the vicinity where the river is not confined by levees or steep valley walls (Barr Engineering 2013).

The geomorphic effects from the construction of flood protection levees and the stream's response over the past several decades at Minot have decreased opportunities for overbanking onto the floodplain and reduced the influence of surface water flows as a driving force for groundwater recharge from the river during small to moderate flood flows.

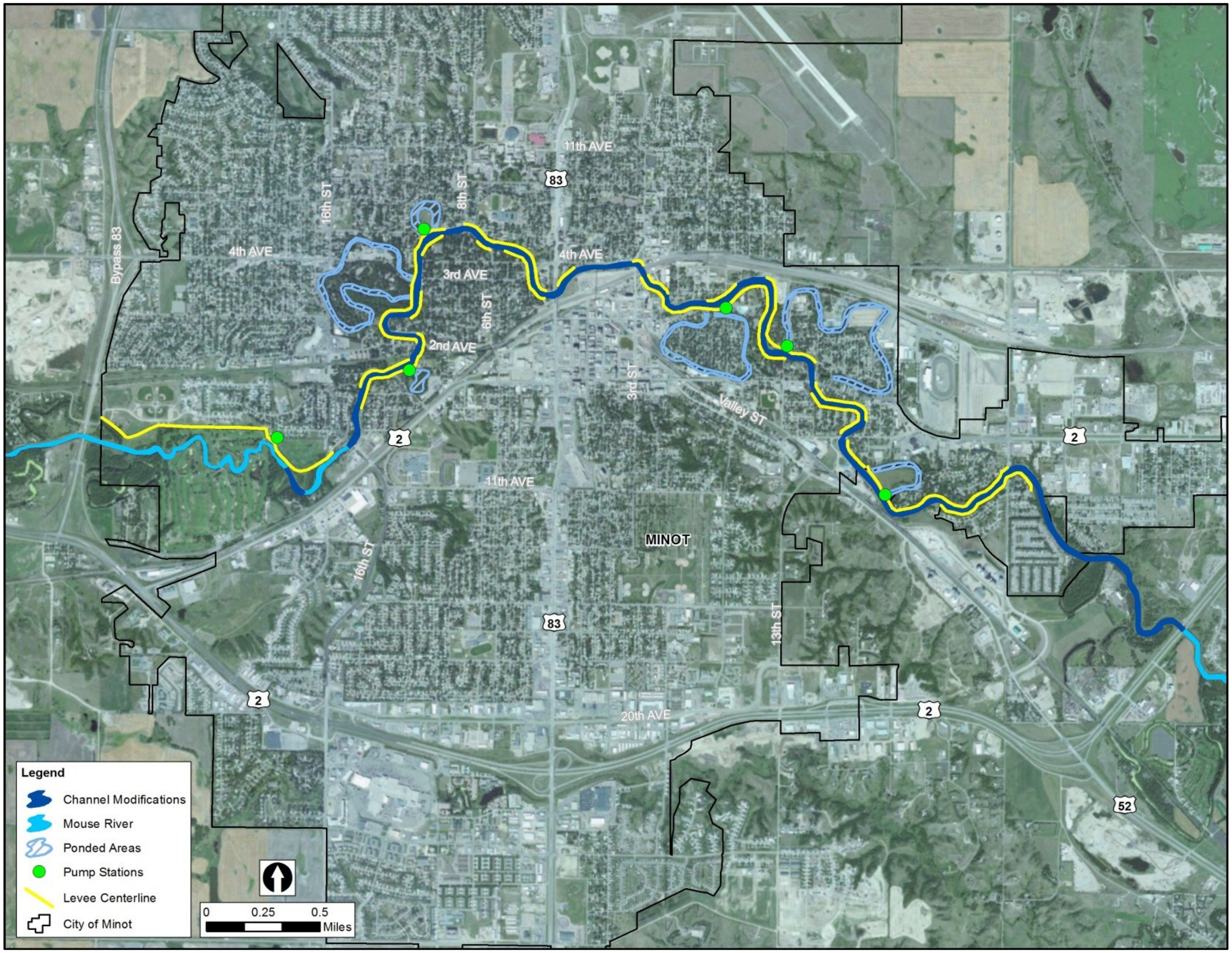

Figure 3-9 Existing Leveed and Channelized Sections of the Souris River in Minot

Source: Barr Engineering et al. 2012

Existing Channel Conditions

Recent studies for the purpose of flood protection planning (Barr Engineering 2013) identified nine reaches along the Souris River having similar geomorphic characteristics (e.g., valley, channel, and sediment characteristics). The vicinity of Minot is notable because it is the least sinuous (meandering) of any of the free-flowing segments of the Souris River, the valley slope is steeper, and the sand supply from valley and tributaries is high (Barr Engineering 2013).

Streambanks have been modified by excavation and levee construction, and streambank materials have been altered during emergency response to floods. The streambed is dominated by fine sand, except for the areas of constructed grade controls. The levees were constructed from locally available materials, generally consisting of sandy silty clay (Barr Engineering et al. 2012). Field surveys after the 2011 flood of record indicated remarkably few areas of erosion and/or sand deposition despite the extreme flows relative to channel capacity (Barr Engineering 2013).

Review of the available historical cross-section field surveys by the USGS indicates that the Souris River channel has relatively similar width at Sherwood, Minot, and Verendrye, but is larger and deeper at Bantry (Barr Engineering 2013). Recent geographic information system (GIS), field analysis, and hydraulic modeling at the reach scale (Barr Engineering et al. 2012; Barr Engineering 2013) also suggest that, while channel capacity in the City of Minot is at or above 5,000 cfs, many areas between Burlington and Velva have channel capacities as low as 600 or 1,000 cfs. These lower channel capacity values likely represent bankfull at the native streambank (rather than at levees). Hydrologic statistics also indicate that the bankfull capacity of unleveed sections on the Souris River between Burlington and Velva is near these values, since recent flood protection enhancement studies (Barr Engineering et al. 2012; Barr Engineering 2013) determined the 50-percent-annual-chance (2-year) flow to be 1,150 cfs.

For the purpose of describing existing geomorphic characteristics in relationship to overbanking flows, channel bankfull capacity in the unleveed portions of the Souris River of the study reach between Burlington and Velva is estimated as 600 to 1,000 cfs. These thresholds were applied to the full hydrologic record of daily flows to describe the number of times flows exceeded the thresholds (events), the duration of events (days), and the seasonal timing (tracked as the Julian day of the year, where January 1^{st} is Julian day 1, and December 31^{st} is Julian day 365) of potential overbanking for unleveed portions of the Souris River (Table 3-7). Events with flows over 600 cfs are more common than those over 1,000 cfs, the overbanking events occur in spring (early May), and the median duration is around 10 to 11 days. All of these characteristics would be in the expected normal range for a stable snowmelt stream channel.

Table 3-7 Souris River Overbanking Events under the Existing Channel Capacity for the Historical Hydrologic Record (1903 – 2011)

Parameter	Units	Bankfull Channel Capacity	
		600-cfs Events	1,000-cfs Events
Events Exceeding Bankfull Capacity	Number of events	113	75
Minimum Duration	Days	1	1
Median Duration	Days	10	11
Maximum Duration	Days	178	169
Median First Day of Occurrence	Days	121 (May)	122 (May)

Note:
cfs = cubic feet per second
Data Source: USGS 2013a

In addition to overall channel capacity, the shape of the channel also controls parameters such as exposure of the streambanks and/or exposure of the streambed, risks of bank erosion, sediment transport, and potential vegetation encroachment. Identifying the approximate flow range where a stream transitions from spreading out flow across the bed of the channel to filling the channel above the “toe of bank” (the bottom of the streambank where steep bank slope angles toward the middle of the channel) provides information for interpreting the potential effects of hydrologic changes.

Graphic analyses of the long-term stage-discharge and width-discharge relationships at the USGS gage above Minot were performed to identify breaks in slope. The available information suggests that the toe of the streambank becomes inundated around a channel width of 40 to 50 feet, and at flows somewhere in the range of 25 to 100 cfs. When flows are less than this threshold, the complete streambank face and toe of bank becomes exposed, which reduces natural geomorphic bank erosion risks.

These thresholds were applied to the full hydrologic record of daily flows outside of the winter season to focus on events during the growing and recreation seasons (March 1 to November 30). The analysis identifies the number of times flows drop below the thresholds (events), the duration of events (days), and the seasonal timing (median Julian day) of potential toe of bank exposure on the Souris River (Table 3-8). These low-flow events are in mid-summer (August); there are more, shorter events under 25 cfs and slightly fewer, but longer events under 100 cfs. These characteristics are consistent with other observations and the hydrologic statistics showing that the Souris River is highly seasonal, having periods of low or zero flow.

Table 3-8 Souris River Toe-of-Bank Exposure Events under the Existing Channel Capacity and the Historic Hydrologic Record (1903 – 2011)

Parameter	Units	Toe of Bank Exposure	
		25-cfs Events	100-cfs Events
Flow Events below Threshold	Number of events	444	410
Minimum Duration	Days	1	1
Median Duration	Days	16	27
Maximum Duration	Days	275	275
Median First Day of Occurrence	Days	229 (August)	224 (August)

Note:
cfs = cubic feet per second.
Data Source: USGS gage 05117500 (USGS 2013a)

Major Aquifers near Minot

Groundwater resources of the Minot area have been extensively studied for decades, since groundwater has been important in meeting water supply needs. All of the significant aquifers in the Minot area are in the Coleharbor Group and Oahe Formation geologic units (Kehew 1983). The Coleharbor group is sediment deposited during glaciation with mixed materials (till, fluvial sands and gravels, lacustrine silts and clay); the Oahe Formation includes younger stream channel, wind deposits, and landslide materials (Pusc 1994). The groundwater levels in the vicinity are generally about 12 to 15 feet below ground surface, but can be within 4 feet or more than 60 feet below the surface (Barr Engineering et al. 2012). In the early 1900s, the static water levels in the Minot aquifer were a few to several feet above the river (Akin 1947), and the river reach was gaining water from groundwater discharge. Under present conditions, the river reach is typically losing water to groundwater (i.e., the river is an important source of recharge to groundwater).

Figure 3-10 shows the major glaciofluvial aquifers in the vicinity of Minot, including the Souris Valley and Sundre aquifers, as well as the locations of the city's wellfields. The Minot aquifer is the major water-bearing unit of the Souris Valley aquifer. The Northwest Buried-Channel aquifer, located northwest of Minot, merges with the Minot aquifer and has confined water at depths over 200 feet below the ground surface that provides inflow to the Minot aquifer at a rate near 200,000 gallons per day (Pusc 1994). The Sundre aquifer is overlain by the Souris Valley aquifer system near the Souris River floodplain and lies in the same eroded bedrock channel as the Northwest Buried-Channel and South Hill aquifers, but it is separated by a reduced transmissivity barrier on the western section of the aquifer southeast of the City of Minot (Pusc 1987). The Minot aquifer has been used as a source of public water supply by the City of Minot for the past 95 years, in conjunction with the Sundre aquifer and the Souris River.

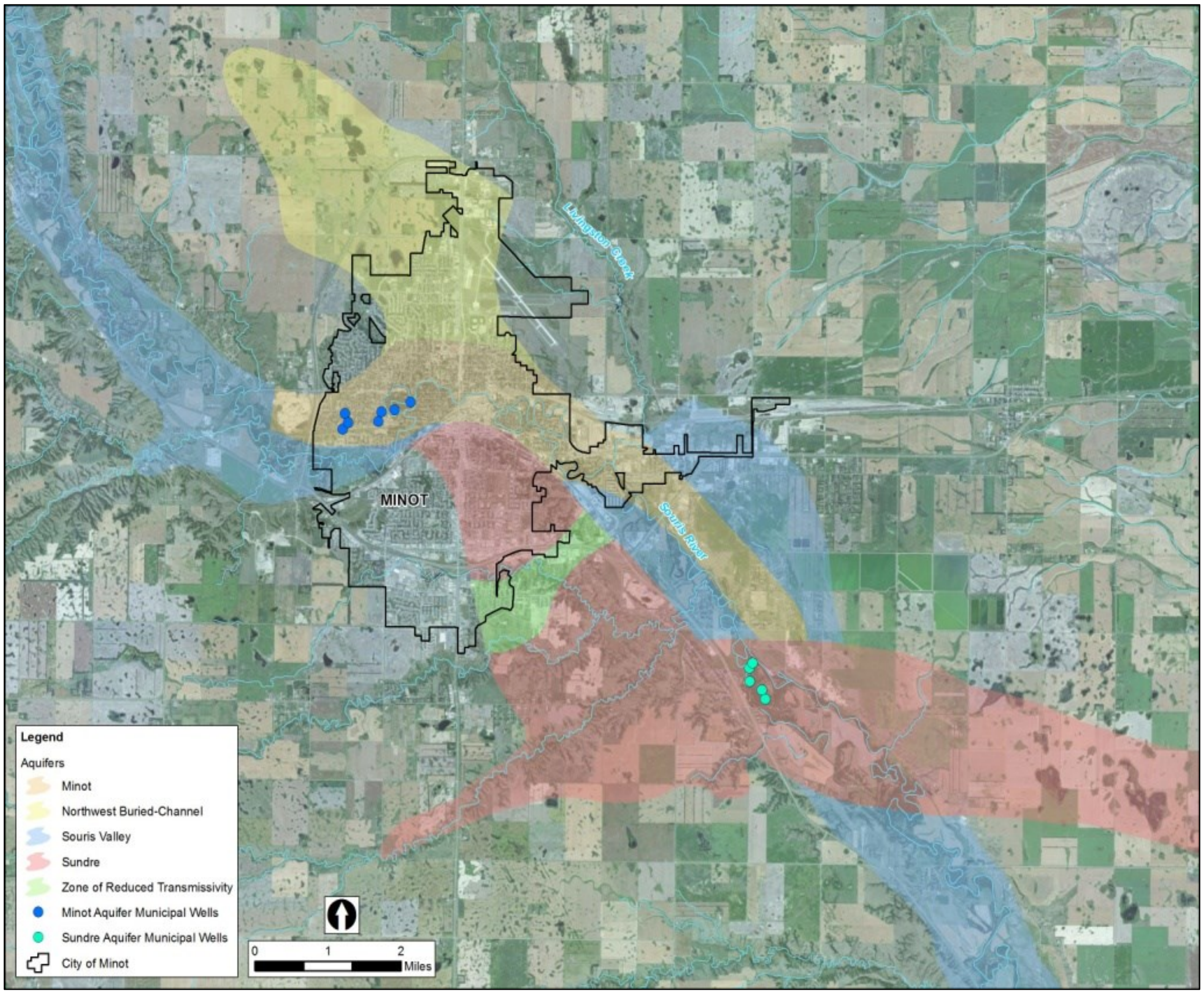

Figure 3-10 Major Aquifers and Municipal Wellfields near Minot

Minot Aquifer

The Minot aquifer is the major water-bearing unit of the Souris Valley aquifer in the vicinity of the City of Minot. It has a very coarse, sandy gravel matrix that includes an abundance of boulders (Pusc 1994). The extent of the Minot aquifer is approximately 6 to 7 square miles. The saturated thickness of the aquifer is highly variable and ranges from approximately 35 to 200 feet. It is overlain by and somewhat confined by 50 to 100 feet of alluvial clay and silt (on the eastern end) and overlain by 100 feet of sand and gravel on the western end. While there has been some disagreement about the quantity of recharge to the aquifer from direct inflow from the Souris River, river recharge has long been acknowledged as an important contributor to the water supply in the aquifer (Akin 1947, Pettyjohn 1967). River recharge is estimated to contribute up to 17 percent of the annual recharge to the Minot aquifer (Pettyjohn and Hutchinson 1971). Much of this recharge occurs during high-flow events in the river. The Minot aquifer rises seasonally in response to recharge from precipitation and input from the rising river (concurrent with reduced pumping during spring). Groundwater levels fall during summer and fall due to reduced river recharge and increased pumping (Pusc 1994).

Water Quantity

The City of Minot currently operates seven 12- to 14-inch-diameter production wells within the Minot aquifer. The wells are installed to an average depth of 140 feet below the ground surface, with a screened interval of 120 to 160 feet below the surface. Additionally, two 12-inch-diameter wells and a 16-inch-diameter well are not currently in service due to casing and pump issues (Sorenson, pers. comm., 2012). The city's withdrawals from the Minot aquifer from 1976 to 2010 averaged approximately 2 million gallons per day (mgd), resulting in approximately 15 feet of modern drawdown in the aquifer (Schuh 2010) (Figure 3-11). The rapid rise of the aquifer level in 2011 is related to the major flood event that recharged the aquifer and also damaged infrastructure to the degree that the wellfield was offline for an extended period of time (Schuh, pers. comm., 2011).

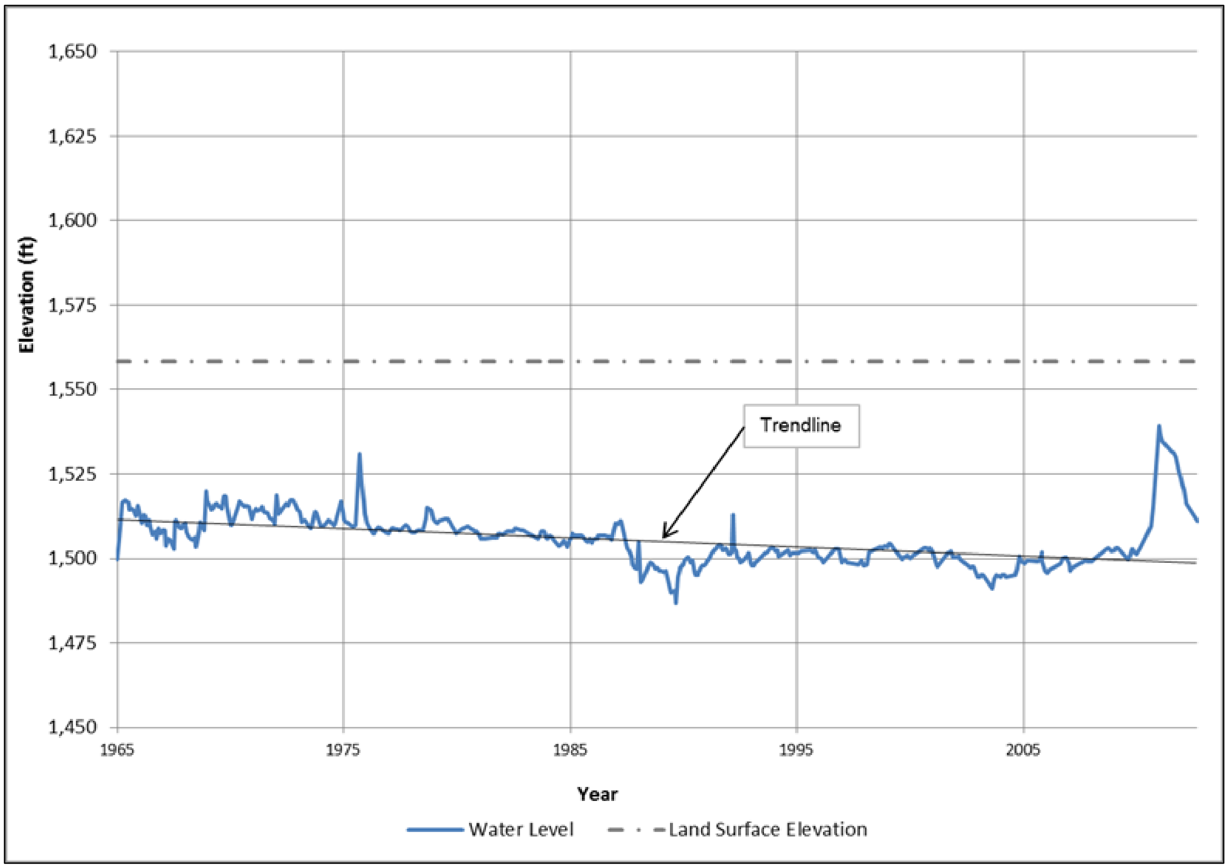

Figure 3-11 Groundwater Level Changes in the Minot Aquifer

Data Source: SWC 2013a

The SWC originally determined that the sustainable yield of the Minot aquifer was 3.0 mgd, but lowered this estimate to 2.0 mgd in 1993 (Pusc 1994). However, the continuing downward trend in aquifer levels during the period when withdrawals averaged 2.0 mgd indicates that the aquifer cannot sustain this level of withdrawal or support additional withdrawals without some type of supplemental recharge. Historical concerns about falling groundwater levels in the first half of the 1900s prompted early studies of the feasibility of artificial recharge in the western portion of the Minot aquifer (Akin 1947; Pettyjohn 1967). Between 1965 and 1975, as much as 2.6 billion gallons were recharged at the city's settling basin, but that facility was destroyed by flooding in the mid-1970s and not replaced (Pusc 1994).

Allocations

Although the Minot aquifer has physical constraints, such as limited areal extent, thickness, and annual recharge, it has no defined regulatory constraints. The SWC assesses applications for additional water use from the Minot aquifer on a case-by-case basis. As of April 2012, there were three permitted allocations in the Minot aquifer, totaling 10.15 mgd of groundwater (Table 3-9) (SWC 2013a). There may be additional undocumented private wells drawing water from the aquifer that fall below the permitting threshold.

Table 3-9 Minot Aquifer Allocations

Water Permit Holder	Water Permit Number	Date of Permit	Allocation (mgd)	Water Use
City of Minot	783	1/21/1959	10.0	Municipal
Mr. Tom Aasen	3102	5/30/1978	0.018	Irrigation
Gravel Products, Inc.	2300	6/7/1976	0.134	Industrial

Note:
mgd = million gallons per day
Source: SWC 2013a

Water Quality

Water quality of groundwater resources in North Dakota is generally good, but tends to be highly mineralized, although the water in unconsolidated aquifers can readily be treated for most uses (Paulson 1983). Water quality data for the Minot groundwater system include sporadic data from a few production wells in the early 1900s (Akin 1947). Long-term data from Minot aquifer observation and production wells since the 1960s were reviewed from the SWC database (SWC 2013a). Nine municipal wells in the Minot aquifer had at least 10 multiparameter groundwater quality samples over the modern period of record, and are used to characterize the aquifer (Table 3-10).

These long-term data indicate that mean concentrations of the water quality parameters in the Minot aquifer do not exceed EPA's primary drinking water standards (Table 3-10). Only the maximum observations for arsenic and nitrate exceed primary drinking water standards. The arsenic exceedance is only for one sample at one well. The nitrate exceedance only occurs at one well. Mean values for iron, manganese, and TDS, and the maximum values for chloride and sulfate consistently exceed secondary drinking water standards. All nine of the production wells have exceedances of iron, manganese, sulfate, and TDS. Only one of the wells exceeds the chloride standard. All values for sodium exceed the advisory standard, since even the minimum value is over 20 mg/L. The minimum pH value is at the lower limit of the EPA drinking water standard at one well, but the mean and maximum are within an acceptable range for all nine wells.

Table 3-10 Minot Aquifer Water Quality

Water Quality Parameter	EPA Drinking Water Standard	Units [a]	Maximum	Minimum	Mean	Total (n) Samples
Primary Standards						
Arsenic	10	µg/L	**10.2**	6.2	8.4	3
Fluoride	4	mg/L	0.5	0.1	0.3	234
Nitrate	10	mg/L	**17.2**	—	1.2	198
Secondary Standards						
Chloride	250	mg/L	**340.0**	24.0	112.4	235
Iron	0.3	mg/L	**11.9**	—	**2.9**	234
Manganese	0.05	mg/L	**2.3**	0.0	**0.5**	225
pH	6.5–8.5	su	8.4	6.5	7.7	231
Sulfate	250	mg/L	**472.0**	26.0	207.5	235
TDS [b]	500	mg/L	**1,440.0**	**558.0**	**1,081.0**	235
No Standards Established						
Bicarbonate	—	mg/L	882.0	473.0	723.4	235
Boron	—	mg/L	0.6	—	0.3	95
Calcium	—	mg/L	200.0	29.0	98.0	235
Carbonate	—	mg/L	19.0	—	0.1	151
Hardness	—	mg/L	810.0	140.0	400.4	235
Magnesium	—	mg/L	76.0	16.0	37.8	235
Potassium	—	mg/L	16.0	3.7	6.9	234
Silica	—	mg/L	33.2	12.9	23.9	155
Sodium	20 [c]	mg/L	379.0	67.0	253.4	234

Notes:
n = number; TDS = total dissolved solids
Bold indicates exceedance of EPA primary or secondary standard.
[a] mg/L = milligrams per liter; µg/L = micrograms per liter; su = standard unit
[b] North Dakota State Standard for Class I groundwaters: TDS < 10,000 mg/L
[c] Sodium level is not an EPA standard; it is an advisory for acceptable levels of sodium.
Source: SWC 2013a

Sundre Aquifer

The Sundre aquifer is a buried sand and gravel aquifer in a buried bedrock valley in the vicinity of Minot (Figure 3-11). The aquifer varies in width from approximately 1 to 2 miles, with a total length of approximately 18 miles, and it extends from Ward County near Minot into McHenry County. The aquifer varies in thickness from approximately 30 to 250 feet, with an average thickness of 120 feet. The Sundre aquifer is estimated to receive approximately 3 percent of its annual recharge via direct infiltration from the Souris River (Pusc 1987). Much of this recharge occurs during high-flow events in the river.

Water Quantity

The Sundre aquifer was developed in 1977 as an additional source of potable water for the City of Minot to supply the rise in demand resulting from population growth and to reduce the withdrawals from the Minot aquifer, which had increased to approximately 4.5 mgd in 1976. The City of Minot operates five 16-inch-diameter production wells in the Sundre aquifer. These wells are installed to an average depth of 200 feet below the ground surface, with a screened interval of approximately 200 to 260 feet below the ground surface. During the period from 1977 to 2010, the city's withdrawals from the Sundre aquifer averaged approximately 3.1 mgd and resulted in approximately 60 feet of drawdown in the aquifer (Figure 3-12). The rapid rise of the aquifer level in 2011 is related to the major spring flooding event, which resulted in effects similar to those described for the Minot aquifer.

The SWC determined that the sustainable yield of the Sundre aquifer was 6.0 mgd (Pusc 1987). However, based on current information, the continuing downward trend of the water level during the period when withdrawals averaged 3.1 mgd indicates that the aquifer cannot sustain this level of withdrawal or support additional withdrawals without some type of supplemental recharge.

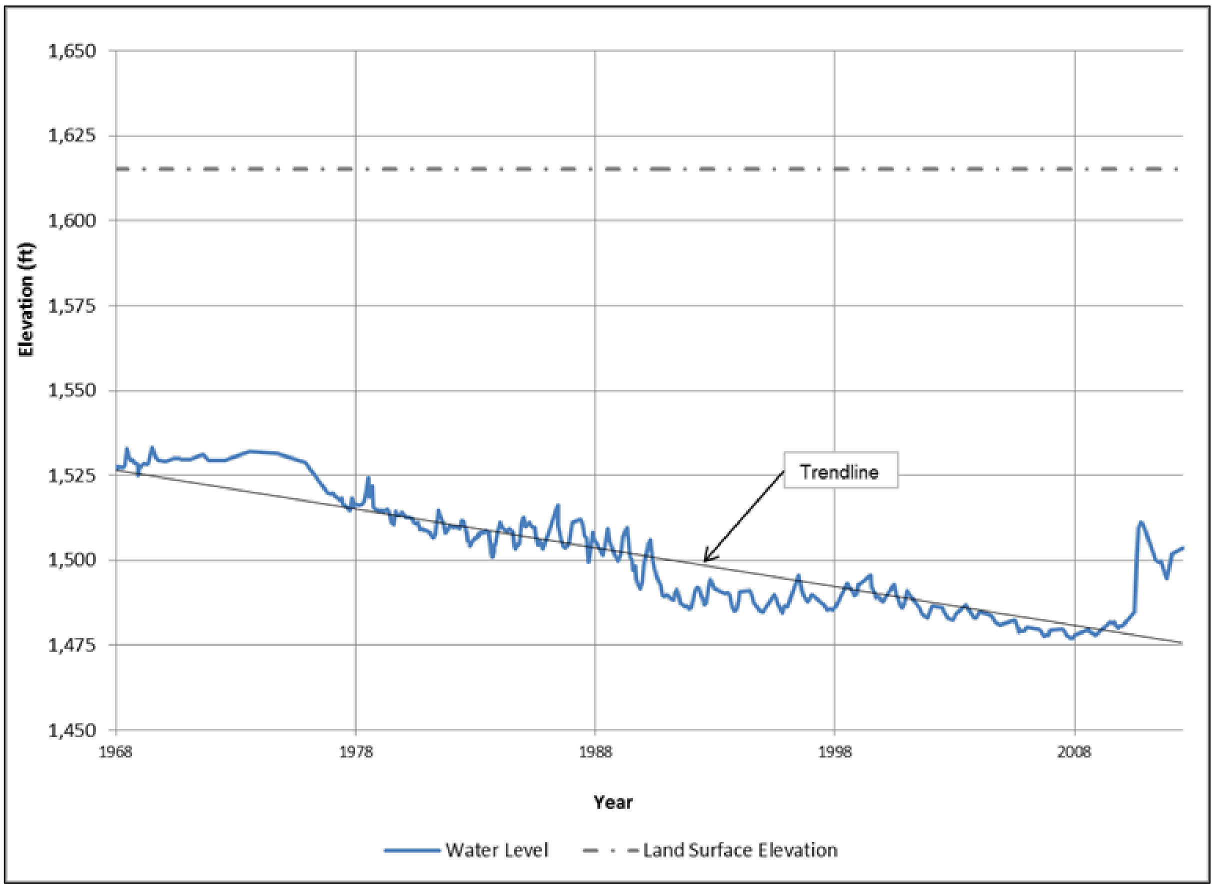

Figure 3-12 Groundwater Level Changes in the Sundre Aquifer

Data Source: SWC 2013a

Allocations

Although the Sundre aquifer has physical constraints, such as limited areal extent, thickness, and annual recharge, it has no defined regulatory constraints. The SWC assesses applications for additional water use from the Sundre aquifer on a case-by-case basis. As of April 2012, there were three permitted allocations in the Sundre aquifer (Table 3-11) totaling 6.67 mgd of groundwater. There may be additional undocumented private wells drawing water from the aquifer that fall below the permitting threshold.

Table 3-11 Sundre Aquifer Allocations

Water Permit Holder	Water Permit Number	Date of Permit	Allocation (mgd)	Water Use
City of Minot	1743	9/16/1970	6.00	Municipal
Sundre Sand and Gravel	1745	12/9/1970	0.04	Industrial
North Prairie Rural Water District	1942	5/17/1973	0.63	Municipal

Note:
mgd = million gallons per day
Source: SWC 2013a

Water Quality

Long-term data from Sundre aquifer observation and production wells since the 1960s were reviewed from the SWC database (SWC 2013a). Thirty observation wells and five municipal wells in the Sundre aquifer had at least 10 multiparameter groundwater quality samples over the period of record that were used to characterize the aquifer (Table 3-12).

These long-term data indicate that mean concentrations of the water quality parameters in the Sundre aquifer do not exceed EPA's primary drinking water standards. Only the maximum observations for arsenic and nitrate exceed primary drinking water standards. The arsenic exceedances include medians over 10 at three of the five municipal wells. In contrast, the nitrate exceedance is only at non-production wells. Mean values for iron, manganese, and TDS, and the maximum values for chloride and sulfate consistently exceed secondary drinking water standards. All five of the production wells have exceedances of iron, manganese, sulfate, and TDS. Three of the municipal wells have means exceeding the sulfate standard. None of the production wells has a chloride exceedance. All sodium values exceed the advisory standard, since even the minimum level is over 20 mg/L. The maximum pH value is at the upper limit of the EPA drinking water standard, but not at any of the municipal wells.

Table 3-12 Sundre Aquifer Water Quality

Water Quality Parameter	EPA Drinking Water Standard	Units [a]	Maximum	Minimum	Mean	Total (n) Samples
Primary Standards						
Arsenic	10	µg/L	**18.0**	4.0	8.6	13
Fluoride	4	mg/L	1.1	0.1	0.3	809
Nitrate	10	mg/L	**17.0**	—	1.4	764
Secondary Standards						
Chloride	250	mg/L	**324.0**	3.3	49.4	810
Iron	0.3	mg/L	**31.0**	—	**1.9**	810
Manganese	0.05	mg/L	**1.0**	0.0	**0.3**	810
pH	6.5–8.5	su	**8.7**	7.0	7.8	805
Sulfate	250	mg/L	**1,100.0**	72.0	**402.0**	810
TDS[b]	500	mg/L	**2,330.0**	418.0	**1,154.9**	810
No Standards Established						
Bicarbonate	—	mg/L	987.0	120.0	590.1	810
Boron	—	mg/L	0.6	—	0.2	657
Calcium	—	mg/L	290.0	5.5	125.4	810
Carbonate	—	mg/L	18.0	—	0.1	718
Hardness	—	mg/L	1,100.0	71.0	463.1	810
Magnesium	—	mg/L	100.0	1.9	36.4	810
Potassium	—	mg/L	65.0	3.5	7.8	810
Silica	—	mg/L	32.0	0.9	25.6	742
Sodium	20[c]	mg/L	460.0	27.8	225.9	810

Notes:
TDS = total dissolved solids
Bold indicates exceedance of EPA primary or secondary standard.
[a] mg/L = milligrams per liter; µg/L = micrograms per liter; su = standard unit
[b] North Dakota State Standard for Class I groundwaters: TDS < 10,000 mg/L.
[c] Sodium level is not an EPA standard; it is an advisory for acceptable levels of sodium.
Source: SWC 2013a

Missouri River Basin Surface Waters

Missouri River Mainstem Reservoir System and Operations

The Missouri River extends 2,619 miles from its source at Hell Roaring Creek in Montana to its confluence with the Mississippi River in Missouri near the Illinois border. The Missouri is the longest river in the United States, draining one-sixth of the country, and it is the main river in the Missouri River drainage basin. The U.S. Army Corps of Engineers (Corps) operates six dams and reservoirs on the Missouri River that are located in Montana, North Dakota, South Dakota, and Nebraska (Figure 3-13) and referred to as the Missouri River Mainstem Reservoir System

(Missouri River System).[4] This system of dams and reservoirs has the capacity to store 72.3 million ac-ft (MAF) of water (Corps 2007), which makes it the largest reservoir system in North America (Figure 3-14). The Corps operates the Missouri River System to serve congressionally authorized purposes of flood control, navigation, irrigation, hydropower, water supply, water quality, recreation, and fish and wildlife.

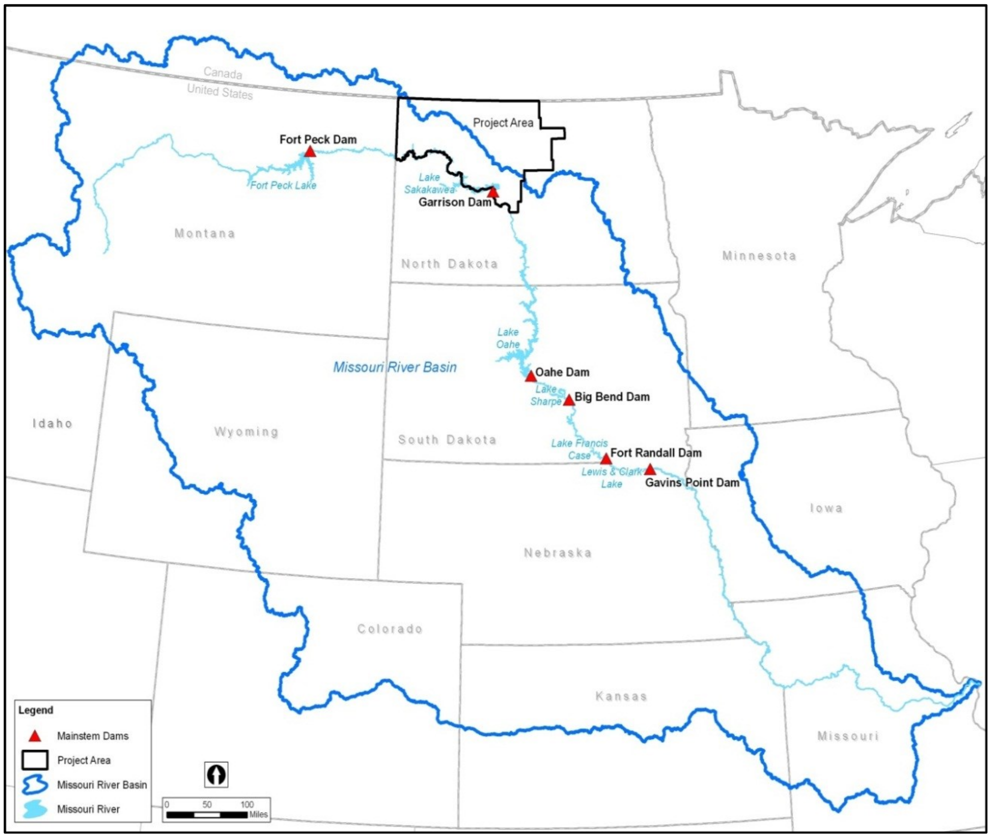

Figure 3-13 Missouri River Drainage Basin and Corps Dams

4 Information presented on the Missouri River Reservoir System and its operation is summarized from the *Missouri River Mainstem Reservoir System, System Description and Regulation* (Corps 2007) and other Corps reports as identified in the text and "References" chapter.

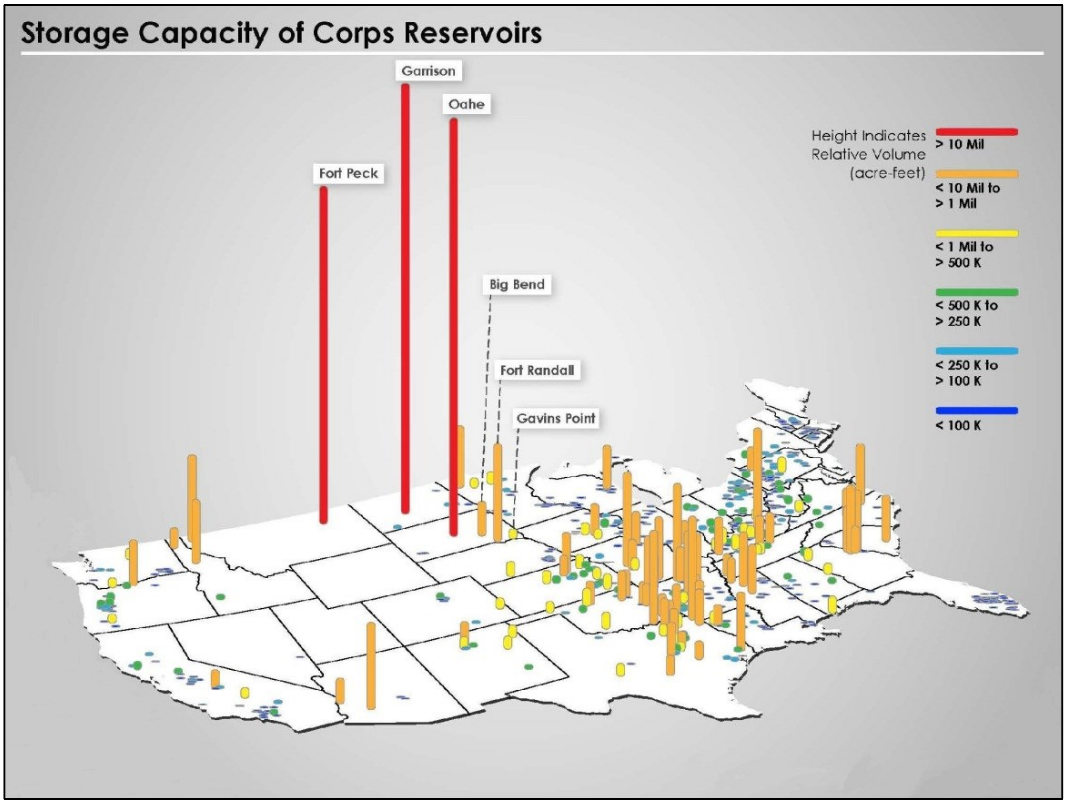

Figure 3-14 Storage Capacity of Corps Reservoirs

System Storage

> **System Storage** – the total volume of water storage available in the reservoirs of the System.
>
> **Reservoir Storage** – the volume of water storage available in a specific reservoir in the System.

"System storage capacity" refers to the volume of space available within all of the Missouri River System reservoirs to store water for later use. "Reservoir storage capacity" refers to space available within a specific reservoir. System storage capacity is divided into four unique storage zones for regulation purposes (Corps 2007). Figure 3-15 shows the system storage capacity for all reservoirs as a single illustration. Storage capacity available in the larger reservoirs is shown in Figure 3-16. The total gross storage capacity of the upper three reservoirs is approximately 65.6 MAF; all six reservoirs combined have a current storage capacity of approximately 72.3 MAF (Corps 2013a).

The bottom 25 percent of the total system storage capacity is designated as the "permanent pool" and accounts for approximately 17.4 MAF (Figure 3-15). This pool is designed for sediment storage, minimum reservoir levels for fisheries, and minimum hydropower reservoir levels. Above the permanent pool is the largest storage zone comprising 53 percent of the total system storage capacity: the "carryover multiple use zone." This carryover multiple use zone holds approximately 38.6 MAF (Figure 3-15). This zone is designed to store water to serve all authorized purposes. Above the carryover multiple use zone is the "annual flood control and multiple use zone," which accounts for 16 percent of the total storage capacity – approximately 11.6 MAF. This is also the desired operating zone of the Missouri River System. At the top is the 6 percent of system storage capacity known as the "exclusive flood control zone." This zone, which has a capacity of approximately 4.7 MAF, is only used during extreme flooding conditions like the basin experienced in 2011. Water within this zone is evacuated (i.e., drawn down by reservoir releases) as soon as downstream conditions allow. Table 3-13 shows the reservoir storage zones for each of the reservoirs; they are listed by Corps project (i.e., dams).

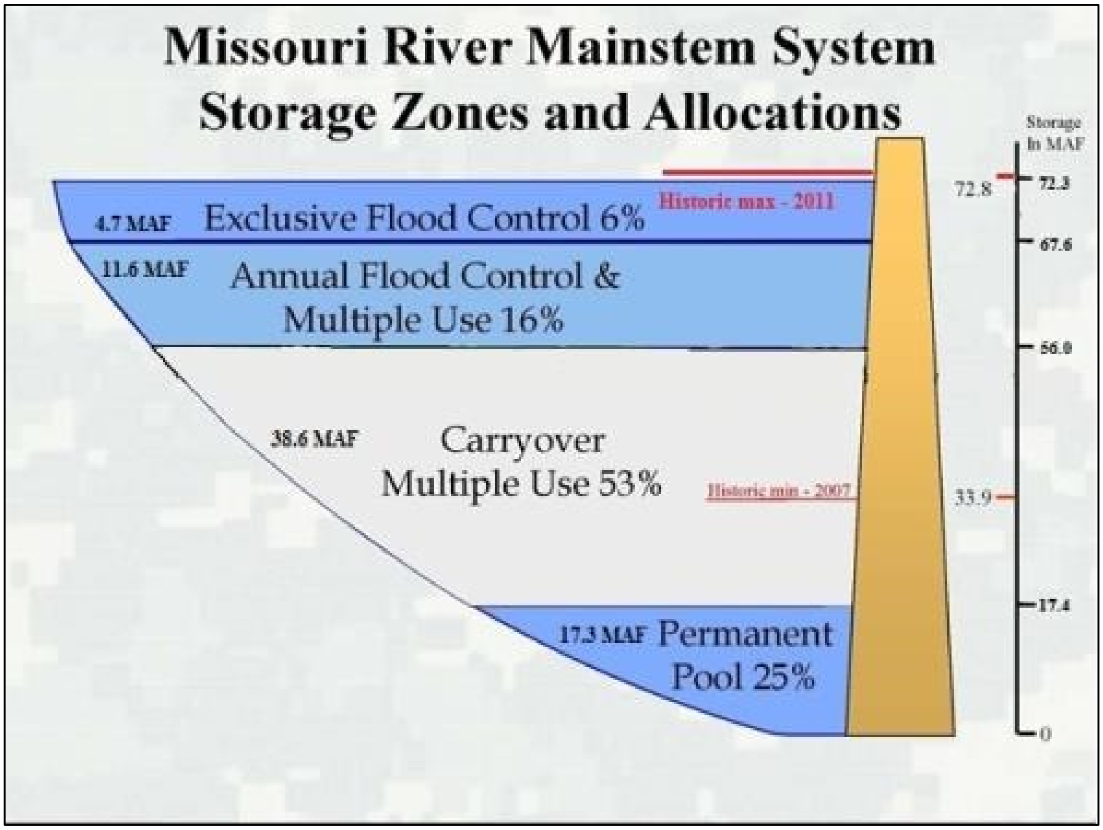

Figure 3-15 Storage Capacity of Missouri River Mainstem System (storage in MAF to top of zone in 2010)

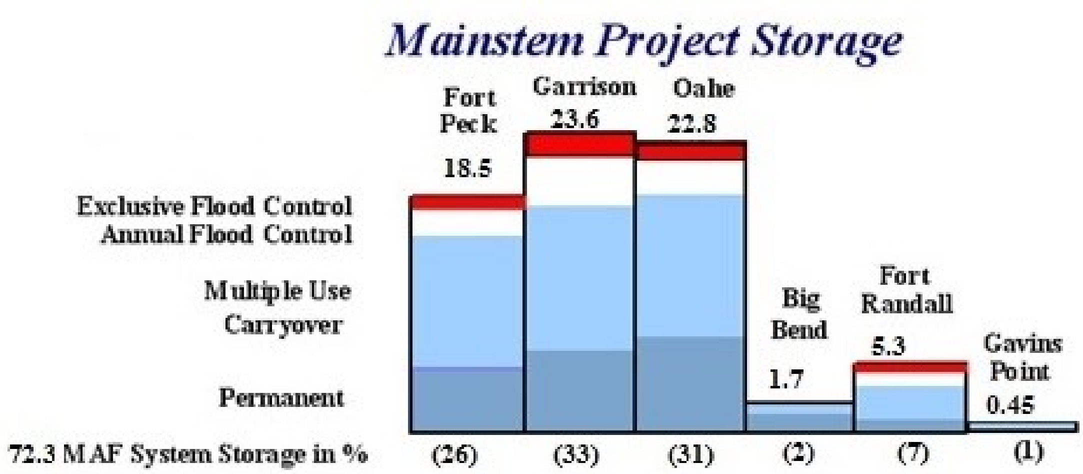

Figure 3-16 Missouri River Mainstem System Reservoir Storage Capacity (2010)

Table 3-13 Reservoir Storage Zones by Corps Project

Project	Top of Permanent Pool		Top of Carryover Multiple Use		Top of Flood Control & Multiple Use		Top of Exclusive Flood Control	
	Storage (MAF)	Elev. (ft msl)	Storage (MAF)	Elev. (ft msl)	Storage (MAF)	Elev. (ft msl)	Storage (MAF)	Elev. (ft msl)
Fort Peck	4.1	2,160.0	14.8	2,234.0	17.5	2,246.0	18.5	2,250.0
Garrison	5.0	1,775.0	17.8	1,837.5	22.1	1,850.0	23.6	1,854.0
Oahe	5.2	1,540.0	18.5	1,607.5	21.7	1,617.0	22.8	1,620.0
Big Bend	1.2	1,415.0	1.5	1,420.0	1.6	1,422.0	1.7	1,423.0
Fort Randall	1.5	1,320.0	3.1	1,350.0	4.3	1,365.0	5.3	1,375.0
Gavins Point	0.3	1,204.5	0.3	1,204.5	0.4	1,208.0	0.5	1,210.0
Total System	**17.3**	**—**	**56.0**	**—**	**67.6**	**—**	**72.3**	**—**

Note:
ft msl = feet above mean sea level; MAF = million acre-feet
Source: Corps 2013a

The storage capacity of the six reservoirs ranges from 23.6 MAF at Garrison Dam (Lake Sakakawea) to 0.5 MAF at Gavins Point Dam (Lewis and Clark Lake) (Corps 2013a). The upper three reservoirs contain the majority of the combined storage capacity with approximately 64.9 MAF, which is almost 90 percent of the gross system storage capacity (Figure 3-16). As a result, these three projects experience most of the variability in reservoir levels during periods of very high runoff or extended drought. The other three downstream reservoirs (Lake Sharpe at Big Bend Dam, Lake Francis Case at Fort Randall Dam, and Lewis and Clark Lake at Gavins Point Dam) are operated much the same no matter the runoff conditions.

System Runoff

"Runoff" is the amount of precipitation (rainfall and snow) that falls on the Missouri River basin and enters the reservoir system. It can be estimated at a number of points in the watershed based on meteorological and streamflow data. On average, 23 percent of the annual runoff above Sioux City, Iowa occurs in March and April from snowmelt and early spring rains (Corps 2007). Roughly 48 percent of the annual runoff occurs in May, June, and July from the mountain snowpack melting plus late spring and summer rains.

Although the annual runoff can vary dramatically from year to year, the average annual runoff above Sioux City, Iowa is 25.2 MAF (Corps 2007). Corps records dating back to 1898 indicate that runoff has varied from a high of 61.0 MAF in 2011 to a low of 10.7 MAF in 1931 (Corps 2007). In this 109-plus year period, the Missouri River basin has experienced four periods of significant drought. These include the record 12-year drought from 1930 to 1941, the 8-year drought from 1954 to 1961, and the 6-year drought that began in 1987 and ended abruptly with the flood of 1993. A more recent significant drought occurred between 2000 and 2007. This was the longest lasting drought since the system reservoirs first filled with water in 1967. This drought resulted in a historical low system storage level of 33.9 MAF.

Not all of the runoff from the drainage basin is available for storage in the reservoirs or release for downstream purposes. Some runoff is lost through evaporation; some is diverted or withdrawn and used for agricultural, municipal, or industrial uses; and some is regulated by upstream reservoirs, as discussed below.

System Operations

The Missouri River System is regulated to serve the congressionally authorized purposes of flood control, navigation, hydropower, irrigation, water supply, water quality control, recreation, and fish and wildlife. The six dams and reservoirs are operated by the Corps as an integrated system, guided by the *Missouri River Mainstem Reservoir System Master Water Control Manual* (Master Water Control Manual) (Corps 2006). In order to achieve the multipurpose benefits for which the system was authorized and constructed, the six system reservoirs are operated as a hydraulically and electrically integrated system. This means dam releases are coordinated in an effort to maintain desired levels in each reservoir and to meet flow requirements of downstream system purposes. Overall system regulation follows the water control plan presented in the Master Water Control Manual.

An annual operating plan (AOP) is developed that presents forecasts of the system regulation for the upcoming year to serve the authorized purposes under varying hydrologic conditions (Corps 2007). A Draft AOP is prepared and circulated for public review by October of each year. Public meetings are generally held in October. After consideration of tribal and public comments, a Final AOP is published in December or January. Spring public meetings are conducted to provide an update on the current hydrologic conditions and projected system regulation for the remainder of the year relative to implementing the Final AOP.

Missouri River System regulation is in many ways a repetitive annual cycle; most of the year's water supply is produced by runoff from winter snows and spring and summer rains, which increase system storage. The Water Control Calendar of Events (Figure 3-17) displays the time sequence of these cyclic events.

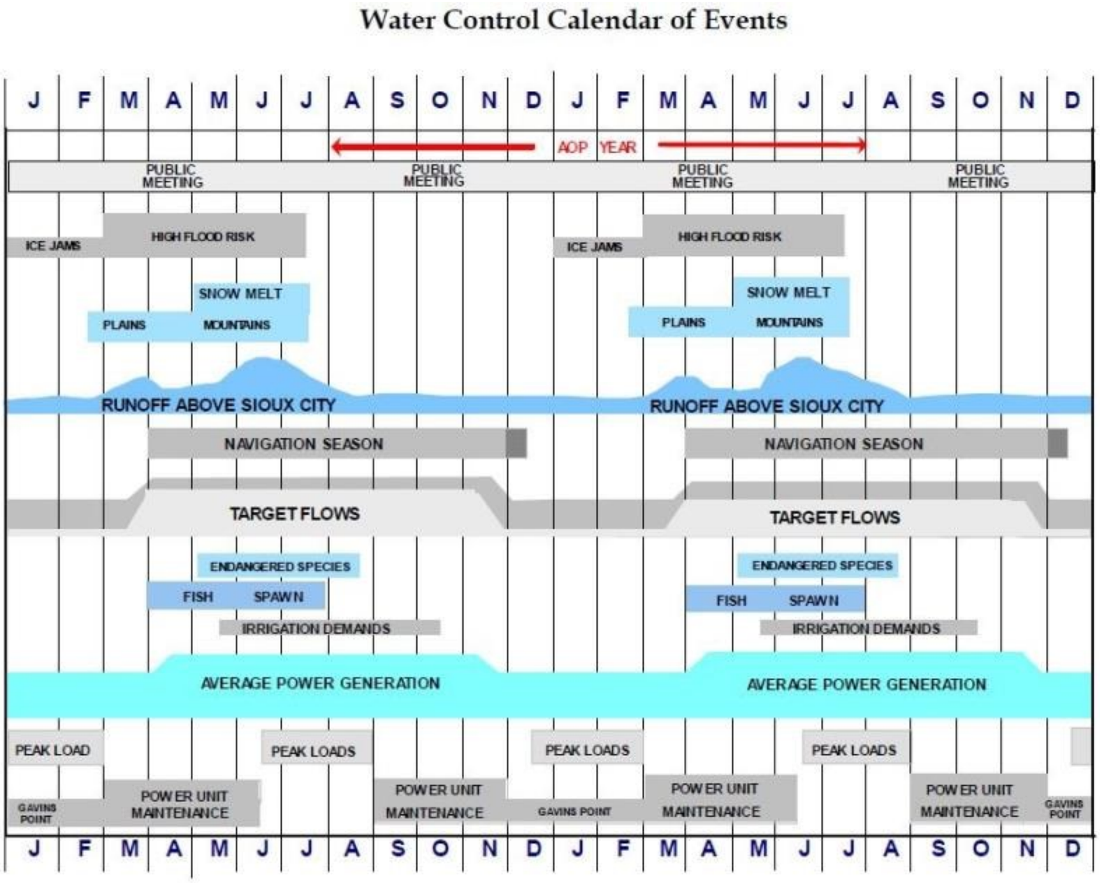

Figure 3-17 Water Control Calendar of Events for Missouri River Operations

Source: Corps 2007

The annual target is to draw the Missouri River System reservoirs down to the bottom of the annual flood control and multiple use zone by March 1 (Figure 3-15). Because the major portion of the annual runoff enters the reservoirs between March and July, storage accumulates and usually reaches a peak during early July. Water releases from system dams are scheduled throughout the remainder of the year to provide support for hydropower production and other authorized purposes. Reservoir releases during the summer and winter are generally higher than those in the spring and fall because of increased demand for hydropower.

During periods of normal to above-normal runoff, water releases from the reservoirs remove water stored in the annual flood control and multiple use zone (Figure 3-15), drawing the reservoir down to the top of the carryover multiple use zone by the following March 1, when the cycle begins once more. During periods of extended drought, water is taken from the large carryover multiple use zone. The conservation storage provided in the carryover multiple use zones of the six mainstem reservoirs was designed to serve all authorized project purposes through a drought like that of the 1930s, although at reduced levels.

The water levels of each of the six reservoirs are checked daily and compared to the water control plan and the AOP. Adjustments to the amount of water transferred between reservoirs are made when necessary to achieve the desired volume of water in each reservoir and to maximize power generation. The upper three reservoirs (Fort Peck, Garrison, and Oahe) have a total storage capacity of 64.9 MAF, including 37 MAF of carryover multiple use storage plus an additional 10.2 MAF of annual flood control multiple use storage. This volume of storage provides flexibility to the Corps, allowing the agency to adjust intrasystem regulation (i.e., balancing storage levels among reservoirs) to better serve the authorized purposes (Corps 2013a).

Intrasystem regulation is an important tool in the management of water in the Missouri River System to meet the authorized purposes. It is used to regulate individual reservoir levels to balance or unbalance the water in storage, to balance the annual system regulation by anticipating unusual snowmelt runoff, to maintain the seasonal capability of the hydropower system, and to improve conditions for fish spawning and recruitment in the reservoirs. It also can be used to maintain stages on the open river reaches between the mainstem dams.

Intrasystem adjustments are also used to meet emergencies, including protection of human health and safety, protection of significant historic and cultural properties, and to meet the provisions of applicable laws, including the Endangered Species Act. These adjustments are made to the extent reasonably possible after evaluating impacts on other system uses. They are generally short term and continue only until the issue is resolved.

Dam Releases

Dam releases refers to water discharged through the hydropower units or over a dam or spillway to move water downstream through the system to achieve authorized purposes. Factors that influence intrasystem regulation may vary widely from year to year; however, regulation of the system generally follows a regular seasonal pattern (Figure 3-17). Factors such as the amount of storage and the magnitude and distribution of inflow received during the year can affect the timing and magnitude of individual dam releases. Adjustments to dam releases are made to achieve a desired water volume in each reservoir and to maximize power generation.

Water releases from the upper three reservoirs are based on the need to balance the effects of depletions, sedimentation, and flood storage evacuation while ensuring that Gavins Point Reservoir contains the volume of water necessary to meet downstream requirements. Water releases from Gavins Point Dam are made to meet lower Missouri River navigation targets and flood control requirements, and to meet flood storage release requirements from the system reservoirs, as well as lower Missouri River flow requirements in non-navigation years. Summer releases from Gavins Point Dam are generally at their highest during the navigation season, when downstream flow requirements are highest. During the winter, with the onset of the non-navigation season, the conditions are reversed. Gavins Point Dam water releases decrease by about one-third to slightly more than one-half of summer release levels. Under existing conditions the simulated average annual releases out of Gavins Point Dam from 1930 to 2010 are 24,633 cfs (Corps 2013a).

Sedimentation

The Missouri River System was built with the knowledge and understanding that, over time, the sediments carried by the Missouri River and its tributaries would slowly accumulate in the bottom of the reservoirs (Figure 3-18).

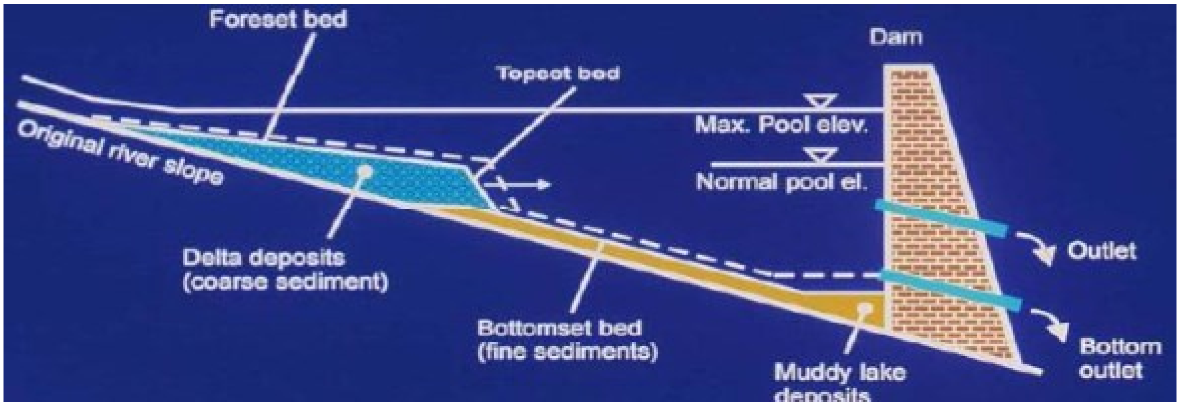

Figure 3-18 Sediment Accumulation behind Dams

Source: Corps 2012a

One effect of this sedimentation is that it slowly fills the reservoirs, resulting in a reduction of the available space to store water. The permanent pool of each reservoir was designed as storage space that would fill with sediment at some point in the future.

Continuing hydrographic resurveys, sediment sampling activities, and special studies of the mainstem reservoirs aid in planning and in meeting short-term and long-term needs related to sediment (Corps 2007). Each reservoir reach is surveyed periodically (at 10- to 25-year intervals) to update reservoir capacities, evaluate impacts of erosion or sedimentation on project functions, and for other purposes relevant to the Corps' operation of the Missouri River System. These surveys are occasionally (once every 5 years) supplemented with reconnaissance inspections of major problem areas, particularly after high flood events. Sediment accumulation over the years has resulted in losses of system storage capacity (Corps 2013a). The accumulation of sediment in reservoir headwaters and at the mouths of sediment-laden tributaries has affected project purposes by reducing channel capacity and raising water surfaces, in some instances by several feet. Table 3-14 shows the change in storage capacity that has occurred since 1973.

Table 3-14 Changes in System Storage Capacity over Time due to Sedimentation

Source Report	Total System Storage Capacity (MAF)	Storage Capacity at Base of Flood Control Pool (MAF)	Storage Capacity Lost due to Sedimentation since 1974 (MAF)
1972 – 1974 Annual Operating Plan	74.7	58.3	N/A
1989 Master Manual	73.9	57.6	0.8 MAF
August 2009	73.1	56.8	1.5 MAF

Note:

MAF = million acre-feet; N/A = not applicable

Source: Corps 2013a

Water Quality

In general, Missouri River System water quality conditions reported by the Corps (2007) are favorable. Some water quality issues can be attributed to regulation of system reservoirs, while others are largely unrelated to system operations.

Potential water quality concerns attributable to the system or its regulation include: (1) possible gas supersaturation in tailwater areas if spillway releases are made from Fort Peck and Gavins Point; (2) dissolved oxygen depletion in the hypolimnion[5] of the reservoirs later in the summer prior to fall turnover; (3) low dissolved oxygen levels in tailwater areas due to hypolimnetic reservoir releases during the late summer; and (4) localized algal blooms due to accumulation and recycling of nutrients in the reservoirs.

Concerns attributable to natural and anthropogenic sources and land or water use policies originating in or affecting areas outside the reservoir boundaries include (1) pesticides detected in reservoir waters; (2) high levels of selenium in the Missouri River and many of its tributaries; (3) elevated levels of mercury in fish caught in the reservoirs; and (4) increased rates of eutrophication in the reservoirs due to nutrient enrichment. Changing river channels and low reservoir levels have also led to water quality problems for some water intakes. Low flows downstream from Gavins Point Dam may affect the ability of thermal power plants to meet National Pollutant Discharge Elimination System (NPDES) permit standards for discharging cooling water back into the Missouri River and may increase the sediment content in some water supply systems.

The water quality in the reservoirs is generally considered good and is expected to remain good. Water quality data acquired from the EPA STORET Database (EPA 2012a) for two stations on Lake Sakakawea near Garrison Dam suggest that water quality in this lake is generally good (Table 3-15). Average concentrations of the water quality parameters collected from these two stations would meet primary and secondary drinking water standards with conventional treatment technologies.

[5] The lower and colder layer of water in a lake, largely stagnant and remaining at a constant temperature.

Table 3-15 Lake Sakakawea Water Quality Data from two EPA STORET Stations near Garrison Dam

Parameter	Frequency	Station Name and Sampling Agency	Period of Record	EPA Standard	Number of Observations	Min	Max	Mean
Primary Standards								
Arsenic (ug/L)	Monthly (Spring - Fall)	Lake Sakakawea - ND Dept. of Health	06/12/95 to 09/22/11	10	109	1	9.96	2.15
Barium (ug/L)	Monthly (Spring - Fall)	Lake Sakakawea - ND Dept. of Health	06/12/95 to 09/22/11	2,000	120	41.4	73.1	53.11
Beryllium (ug/L)	Sporadic	GARLK1390A - US ACoE	08/25/04 to 08/21/07	4	3	0.5	2	1.5
Cadmium (ug/L)	Sporadic	GARLK1390A - US ACoE	08/25/04 to 08/21/07	5	5	0.2	0.5	0.38
Chromium (ug/L)	Monthly (Spring - Fall)	Lake Sakakawea - ND Dept. of Health	06/12/95 to 09/22/11	100	26	0.21	11.6	1.52
Copper (ug/L)	Monthly (Spring - Fall)	Lake Sakakawea - ND Dept. of Health	06/12/95 to 09/22/11	1,300	100	1.02	16.4	2.37
Lead (ug/L)	Monthly (Spring - Fall)	Lake Sakakawea - ND Dept. of Health	06/12/95 to 09/22/11	15	25	0.47	12.7	2.69
Selenium (ug/L)	Monthly (Spring - Fall)	Lake Sakakawea - ND Dept. of Health	06/12/95 to 09/22/11	50	80	0.25	90.4	3.55
Nitrate + Nitrite (mg/L)	Sporadic	GARLK1390A - US ACoE	06/25/01 to 09/25/01	10[a]	4	0.02	0.03	0.023
Secondary Standards								
Aluminum (ug/L)	Monthly (Spring - Fall)	Lake Sakakawea - ND Dept. of Health	05/17/99 to 09/22/11	50-200	44	50	435	108.2
Chloride (mg/L)	Monthly (Spring - Fall)	Lake Sakakawea - ND Dept. of Health	06/16/93 to 09/22/11	250	155	8.2	11.2	9.52
Iron (ug/L)	Monthly (Spring - Fall)	Lake Sakakawea - ND Dept. of Health	06/16/93 to 09/22/11	300	143	9	2,070	102.3
pH (SU)	Sporadic	GARLK1390A - US ACoE	02/1/99 to 09/22/11	6.5-8.5	1794	7.1	8.91	8.17
Sulfate (mg/L)	Sporadic	GARLK1390A - US ACoE	06/12/95 to 06/23/09	250	42	121	180	160.7
TDS (mg/L)	Sporadic	GARLK1390A - US ACoE	06/25/01 to 06/23/09	500	44	363	532	440.9
Zinc (ug/L)	Monthly (Spring - Fall)	Lake Sakakawea - ND Dept. of Health	06/12/95 to 09/22/11	5,000	82	1.09	42.7	7.61

Parameter	Frequency	Station Name and Sampling Agency	Period of Record	EPA Standard	Number of Observations	Min	Max	Mean
Parameter	Frequency	Station Name and Sampling Agency	Period of Record	EPA Standard	Number of Observations	Min	Max	Mean
No Standards Established								
Specific Conductance (uS/cm)	Sporadic	GARLK1390A - US ACoE	02/1/99 to 09/22/11	-	1794	366	1,444	605
Dissolved Oxygen (mg/L)	Sporadic	GARLK1390A - US ACoE	02/1/99 to 09/22/11	-	1864	3.8	12.7	8.66
Suspended Solids (mg/L)	Sporadic	GARLK1390A - US ACoE	06/25/01 to 06/23/09	-	51	4	55	5.62
Phosphorus (mg/L)	Sporadic	GARLK1390A - US ACoE	05/25/06 to 09/22/09	-	89	0.0 1	0.37	0.028
Hardness (mg/L CaCO3)	Sporadic	GARLK1390A - US ACoE	06/25/01 to 08/21/07	-	15	155	242	213.7
Calcium (mg/L)	Monthly (Spring - Fall)	Lake Sakakawea - ND Dept. of Health	06/16/93 to 09/22/11	-	151	41. 4	59.2	50.24
Magnesium (mg/L)	Monthly (Spring - Fall)	Lake Sakakawea - ND Dept. of Health	06/16/93 to 09/22/11	-	151	16. 6	25.2	20.02
Sodium (mg/L)	Monthly (Spring - Fall)	Lake Sakakawea - ND Dept. of Health	06/16/93 to 09/22/11	20[b]	151	43. 5	72.4	55

Notes:

[a] 10 mg/l is the standard for nitrate, not nitrate + nitrate. However, the nitrite concentration is usually very low in surface water.

[b] The EPA established a guidance level based on health and taste for sodium, but this is not an actionable standard.

Missouri River System Depletions

As previously stated, the Missouri River System is operated to meet multiple authorized purposes and is a complex process. Use of water from the system for these authorized purposes results in varying levels of impacts, depending primarily on the volume of water being removed. Reclamation worked collaboratively with the Corps to complete an analysis of the impacts that existing and reasonably foreseeable future water depletions have on the system. This analysis was accomplished using the best available information assembled by Reclamation and the Corps. Detailed information regarding the Corps' analysis using the Daily Routing Model (DRM) is included in the report *Cumulative Impacts to the Missouri River for the Bureau of Reclamation's Northwest Area Water Supply Project* (Corps 2013a) and in Appendix D. A simulation of the current water control plan for the Missouri River using the DRM quantified the existing conditions on the Missouri River for the SEIS analysis.

The basis of the analysis was the Corps' DRM. The DRM was developed during the 1990s as part of the *Missouri River Mainstem Reservoir Master Water Control Manual Review and Update EIS* (Corps 2004a) to simulate and evaluate alternative system regulation for all authorized purposes under a widely varying long-term hydrologic record. For this SEIS analysis (Corps 2013a), the DRM was used as an analytical tool to estimate the hydrologic effects that depletions have on Lake Sakakawea, the other system reservoirs, and free-flowing reaches of the Missouri River. This model provides daily time-step data used for the impact models developed by the Corps. The DRM simulates an 81-year historical period from1930 to 2010 routing inflows through the Missouri River System following the criteria of the current water control plan, as outlined in the Corps' 2006 Master Water Control Manual. Details of the Corps' analysis for the SEIS are summarized in Appendix D. The analysis was completed using the updated present-level Missouri River depletions data developed by Reclamation, as described in Appendix D and shown in Table 3-16.

Reclamation updated Missouri River monthly depletions from Missouri River reaches for the period of record, 1929 to 2007. These depletion values were applied to the historical natural flow record to determine present-level depleted streamflows. Table 3-16 shows average annual present-level depletions at a 2007-level of Missouri River basin development for the period of record for each reach of the Missouri River. Under the Master Water Control Manual (Corps 2006), this 12.7 MAF of total depletions comes out of the carryover multiple use pool, which holds about 38.6 MAF systemwide (Figure 3-16). This analysis determined that present-level depletions account for approximately 33 percent of the water stored in the carryover multiple use pool.

Table 3-16 Missouri River Average Annual-Present-Level Depletions (kAF)

Missouri River Reaches	Agricultural Diversions	Public Supply Depletions	Industrial Supply Depletions	Reclamation Storage	Transbasin Diversions[a]	Total Present Level (2010)
Above Fort Peck	2,126.8	16.4	0.6	65.2	0.0	2,209.0
Fort Peck to Garrison	3,431.1	19.7	7.6	76.2	-182.7	3,351.9
Garrison to Oahe	297.7	10.5	2.9	21.7	0.0	332.8
Oahe to Big Bend	12.5	0.3	0.0	0.0	0.0	12.8
Big Bend to Fort Randall	122.3	1.0	0.0	0.0	0.0	123.3
Fort Randall to Gavins Point	882.0	1.0	0.0	8.8	0.0	891.8
Gavins Point to Sioux City	311.5	5.3	0.8	47.2	0.0	364.8
Sioux City to Omaha	243.3	8.0	0.0	0.0	0.0	251.3
Omaha to Nebraska City	3,602.6	277.8	16.7	215.5	-392.8	3,719.8
Nebraska City to St. Joseph	69.5	1.9	0.2	0.0	0.0	71.6
St. Joseph to Kansas City	1,084.8	44.8	0.1	49.5	0.0	1,179.2
Kansas City to Boonville	23.2	55.6	0.3	0.0	0.0	79.1
Booneville to Herman	67.1	18.3	0.3	0.0	0.0	85.7
Total	**12,274.4 (12.27 MAF)**	**460.5 (0.46 MAF)**	**29.4 (0.03 MAF)**	**484.0 (0.48 MAF)**	**-575.5 (-0.58 MAF)**	**12,673.1 (12.67 MAF)**

Notes:

kAF = thousand acre-feet; MAF = million acre-feet

[a] Transbasin diversions include water imported into the Missouri River basin. See Reclamation 2012c for more detail.

Source: Reclamation 2012c

In addition to the water uses shown in Table 3-16, some depletion of the Missouri River system can be attributed to natural causes, such as evaporation. The Corps (2006) estimates the total average annual water loss due to evaporation on all Missouri River System reservoirs at 3.1 MAF. The average annual water loss due to evaporation on Lake Sakakawea alone is almost 1 MAF. The average evaporation from each mainstem system reservoir accounts for about a 3-foot reservoir level change annually (Corps 2006).

Audubon Lake

Audubon Lake is a sub-impoundment of Lake Sakakawea located east of U.S. Highway 83 that was formed by the construction of the Snake Creek embankment. Lake Sakakawea water is pumped by Reclamation from the Snake Creek Pumping Plant into Audubon Lake.

Water Quantity

The water level in Audubon Lake is maintained fairly constant throughout the year (Figure 3-19), at an average surface elevation of 1,845.8 feet mean sea level (msl). The water level is maintained at 1,847 feet msl from ice-out through the summer for recreation, fish, and wildlife, and to ensure that adequate quantities of water are available for transmission through the McClusky Canal to meet downstream water needs. The water level is lowered to 1,845 feet msl over the winter for freshening and to protect stabilized islands.

Water Quality

Water quality data from three sampling stations on Audubon Lake were acquired from the USGS (USGS 2012a) and indicate that average concentrations of the parameters collected at each site do not exceed primary or secondary drinking water standards.

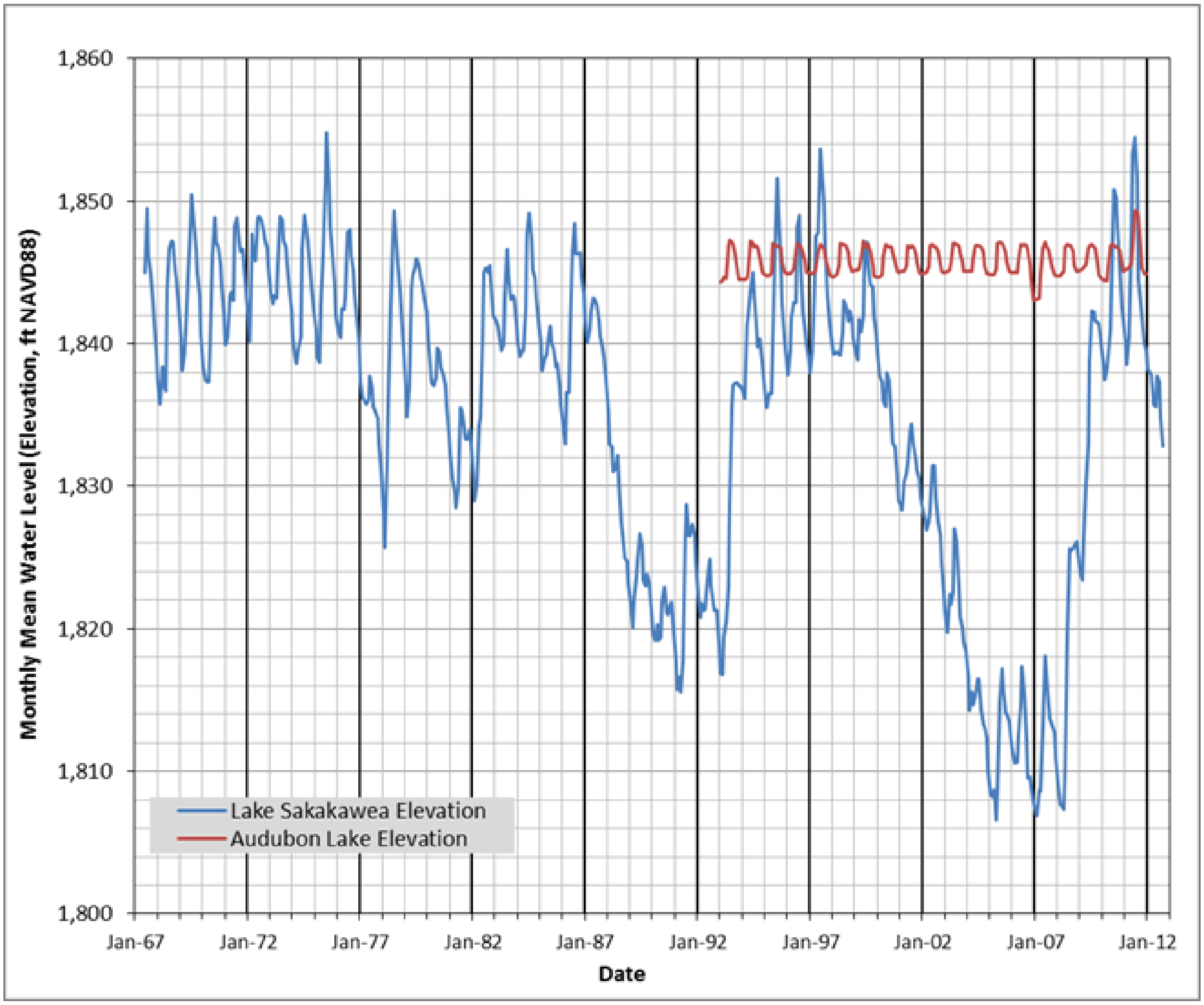

Figure 3-19 Audubon Lake and Lake Sakakawea Water Surface Elevations (1967 – 2012)

Note: Water surface elevations measured near the Snake Creek Pumping Plant.

Sources: USGS 2012a; Reclamation 2012c

Fisheries and Aquatic Invertebrates

The affected environment for fisheries and aquatic invertebrates includes surface waterbodies in both the Missouri River and Hudson Bay basins, with emphasis on the Project Area, that support common and special-status freshwater fish species and aquatic invertebrates. Many of the fish species support recreational and/or commercial fisheries.

GIS data were used to determine the number and locations of surface water features in proximity to Project components. Additional data sources used to describe the affected environment include fish stocking and public fishing waters information collected from the North Dakota Game and Fish Department (NDGFD) and the *North Dakota Comprehensive Wildlife Conservation Strategy 2005* (NDGFD 2005), and contact with biologists at the NDGFD. Fisheries and other ecosystem components of the Hudson Bay basin that could be affected by the introduction of AIS are described in the "Aquatic Invasive Species" section of this chapter.

Streams in North Dakota are classified based on their potential to meet beneficial uses as identified in North Dakota Administrative Code (NDAC) 33-16-02 Standards of Water Quality for State of North Dakota (NDDH 1999):

Class I	Quality capable of supporting propagation of life of resident fish and other aquatic biota and suitable for boating, swimming, and other water recreation. Quality after treatment by coagulation, settling, filtration, and chlorination shall meet bacteriological, physical, and chemical requirements for municipal use.
Class IA	Same as Class I but softening may be required for municipal use.
Class II	Same as Class IA but additional treatment may be needed to meet drinking water requirements. Some streams may be intermittent.

The Souris River is a Class IA stream.

Lakes are classified based on the type of fishery that could be supported:

Class 1	Cold water fishery
Class 2	Cool water fishery
Class 3	Warm water fishery
Class 4	Marginal fishery
Class 5	No fishery due to high salinity

There are three fishery stream value classifications (Service et al. 1978) for streams crossed by pipelines:

Class I	Highest-valued fishery resource	Souris River
Class II	High-priority fishery resource	Spring Coulee
Class III	Substantial fishery resource	Boundary Creek and tributaries south of the town of Souris

Perennial waterbodies located within the Project Area that provide habitat for fish and aquatic invertebrates are shown in Figure 3-20. Project components, however, would only be located near, under, or in a few of these waterbodies. Waterbodies potentially affected by the Project alternatives (in Bottineau, Renville, McLean, and Ward counties) are included in Table 3-17. Additional detail regarding surface waterbodies is provided above under Water Resources.

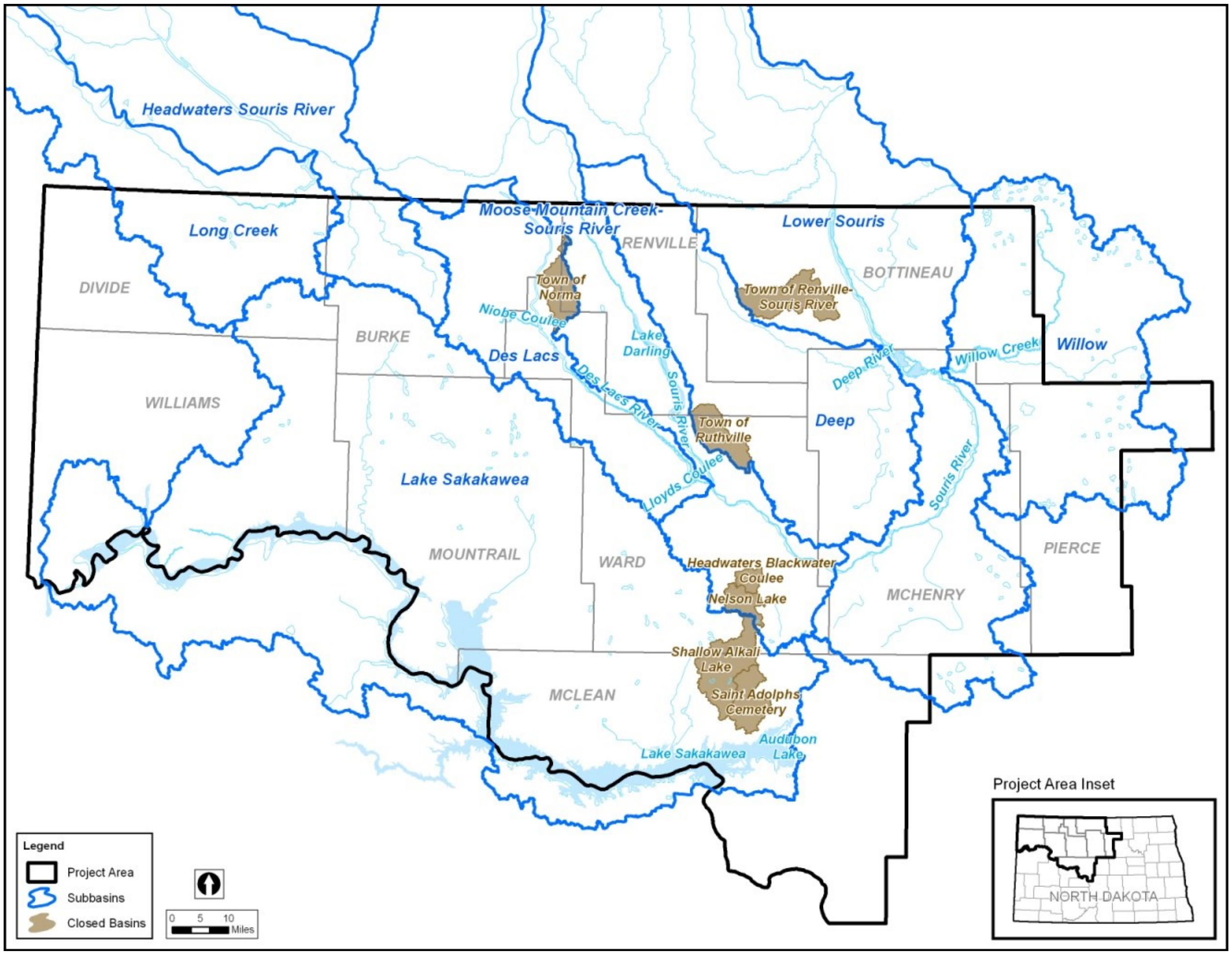

Figure 3-20 Perennial Waterbodies in the Project Area Subbasins

Table 3-17 Waterbodies Potentially Affected by Project Alternatives

Waterbody	Tributary	Secondary Tributary
Lake Sakakawea	Audubon Lake	—
	Douglas Creek	West Branch Douglas Creek Middle Branch Douglas Creek East Branch Douglas Creek
	White Earth River Malnourie Creek Beaver Creek Tobacco Garden Creek Thorsen Creek Long Creek Stony Creek	—
Des Lacs Lake Des Lacs River Lloyds Coulee Niobe Coulee	—	—
Souris River Lake Darling	—	—
Lower Souris River	Stone Creek Boundary Creek Deep River	—
Deep River	Little Deep Creek Little Deep River	—
	Cut Bank Creek	Egg Creek Hay Coulee South Egg Creek Buffalo Lodge Lake North Lake
Willow Creek	Oak Creek Ox Creek Mud Creek Indian Creek	—

Fish species of recreational or commercial value occur in waterbodies throughout the Missouri River and Hudson Bay basins. North Dakota's public fishing waters range from small impoundments to large river systems and reservoirs. Coldwater (trout, salmon), coolwater (walleye, yellow perch, northern pike), and warmwater (catfish / bullhead, sunfish, bass) fish are present in these waters. In addition to recreational or commercial species, some lakes and rivers could contain fish of conservation priority (Level I), as identified in *North Dakota's Comprehensive Wildlife Conservation Strategy 2005* (NDGFD 2005). Non-game fish of conservation priority (Level I) include pearl dace, sicklefin chub, and sturgeon chub. The pallid sturgeon is the only federally listed species that occurs in the Project Area (located within the Missouri River basin); this species is described below under Federally Protected Fish Species.

Level I species are those that have a high level of conservation priority because of declining status in North Dakota or across their range, or because the high rate of occurrence in North Dakota constitutes the core of the species breeding range, but the species may be at risk rangewide.

Lakes, rivers, ponds, and perennial and intermittent streams provide habitat for fish either throughout or during portions of the year. These waterbodies also support spawning, foraging, rearing, refuge, and/or migratory use by fish. Spawning periods and habitats, as well as general habitat requirements, for common recreational and commercial fish species are provided in Appendix G (Table G2.1a). After spawning, the type and amount of habitat required for larval and juvenile fish rearing vary depending on the species, life history stage, and site-specific conditions.

A number of the streams within the Project Area have intermittent flow and thus only provide habitat for fish when water is present, while others have perennial flow. Of the 29 streams that would be crossed by Project pipelines for the inbasin alternatives, 22 are smaller streams and 7 are larger, perennial streams. Similarly, of the 23 streams that would be crossed by Project pipelines for the Missouri River alternatives, 21 are smaller streams and 2 are larger, perennial streams. Major waters are described below.

Missouri River Mainstem Reservoir System

The Missouri River is regulated by six dams operated by the Corps. These dams have a profound effect on the river's fisheries and other aquatic resources. The Corps recently completed an EIS (Corps 2004a) on operation of the Missouri River dams. The following discussion is summarized from that EIS.

Over 156 fish species have been documented in the Missouri River, including many species that have been introduced into the mainstem reservoirs and riverine reaches. The endangered pallid sturgeon has also been documented in the Missouri River and is addressed in the "Federally Protected Species" section of this chapter. The dams have created a variety of reservoir habitats that differ greatly from the natural (pre-impoundment) habitats in the river. Reservoir habitats are deep and large, providing for both warmwater and coldwater species. Reservoir fisheries are detailed in the Master Water Control Manual (Corps 2006) and in the Master Plan for each reservoir (Corps 2002, 2003, 2004b, 2007, 2008, 2010).

Operation of the dams has also changed the hydrologic regime, water temperature, sediment transport, substrate, and water chemistry in the free-flowing reaches between dams. Coldwater fish species can dominate the tailrace areas below the large upper three reservoirs, while warmwater native species dominate the more natural riverine areas found below the tailrace areas and lower system dams. Riverine fisheries are detailed in the Master Water Control Manual (Corps 2006) and in recent Corps EISs (Corps 2011a, 2011b).

Lake Sakakawea

Water levels in Lake Sakakawea are managed by the Corps. Both coldwater and warmwater habitats are present. Coldwater habitat is present through the summer and fall months at deeper depths. Chinook salmon and rainbow smelt use this habitat (USDOI 2007). Other coldwater/coolwater species include walleye, sauger, northern pike, and trout. Warmwater species present include both native and nonnative fish that have adapted to lacustrine (lake) conditions. These species include smallmouth bass, goldeye, carp, channel catfish, river carpsucker, crappie, and emerald shiner (USDOI 2007).

Fisheries management is based on recommendations from the state agencies responsible for fisheries management, including Montana and North Dakota. The primary management species are walleye, sauger, and Chinook salmon, with northern pike, trout, and smallmouth bass also managed. To monitor habitat for coldwater species, the North Dakota Department of Health and NDGFD have, since 2002, conducted weekly sampling of dissolved oxygen and temperature and monthly sampling of water quality at seven locations (NDDH 2012). Lake Sakakawea is considered not supporting of fish for human consumption under Section 303(d) of the Clean Water Act due to methylmercury pollution (NDDH 2012).

Audubon Lake, a subimpoundment of Lake Sakakawea, has similar species to those found in Lake Sakakawea; however, the shallower, warmer water does not support coldwater species (USDOI 2007).

Souris River

The Souris River supports 24 identified fish species, including walleye, northern pike, yellow perch, and black and brown bullhead (Picha et al. 2008). Numerous aquatic mussels, pill clams, and snails also occur in the river and its tributaries. Some species are generally year-round residents of the river under various flow levels, while less hardy species come from Lake Darling during high-flow years and persist as long as adequate water quality and habitat are present. During low-flow periods, fish kills occur when conditions become inhospitable for fish.

The 2012 Souris River 303(d) listing cites impairment to aquatic resources from sedimentation or siltation for segments of the river near Minot. However, all listed segments on the Souris River are in the State’s low priority category and scheduled for TMDL development 8 to 13 years in the future (NDDH 2012).

Intermittent Streams

Numerous intermittent streams are present in the Project Area, and a number of these would be crossed by proposed Project pipelines.

Prairie Pothole Lakes and Wetlands

The affected environment is characterized by an abundance of prairie pothole lakes and wetlands. Permanent wetlands are home to many fish, including northern pike, perch, and walleye (Herman and Johnson 2008).

Aquatic Invertebrates

A variety of invertebrates, including mussels, snails, and benthic (bottom-dwelling) macroinvertebrates, can be found in streams, lakes, and wetlands within the Missouri River and Hudson Bay basins (scientific names of species are included in Appendix G).

Souris River

A 2007 study found that Souris River basin sites exhibited benthic macroinvertebrate assemblages consistent with existence of good water quality and habitat (Haugerud and Ell 2007). Numerous aquatic mussels, pill clams, and snails also occur in the river and its tributaries.

Missouri River

Missouri River sandbars and river channels are home to a variety of invertebrate species, including mussels, snails, and benthic macro-invertebrates (Angradi et al. 2006; Angradi et al.

2009; Le Fer 2006; USGS n.d.). Mussel species have also been described for Missouri River habitats (South Dakota Game, Fish and Parks 2000, 2005). Missouri River reservoirs, as well as small, medium, and large bays, are dominated by oligochaetes and chironomids, with composition and density of the benthos strongly influenced by depth (Scharold et al. 2010).

Prairie Potholes

The Project Area includes a number of prairie pothole lakes and wetlands. Prairie pothole wetlands function as groundwater recharge sites, flow-through systems, and/or groundwater discharge sites; and this hydrology influences the aquatic invertebrates that inhabit these areas. Invertebrates found in prairie wetlands include gastropods, rotifer, crustacea, and insects including ephemeroptera, odonata, choleoptera, diptera, and hymenoptera. Assemblages of aquatic invertebrates in prairie pothole wetlands are limited in their diversity and include mostly ecological generalists due to harsh environmental conditions, including lack of water, freezing, and steep salinity gradients. Past invertebrate studies in this area support the idea that these wetlands have low invertebrate diversity compared to other wetland classes across the United States. Seasonal drawdown, as well as the longer term wet-and-dry cycle affects the hydroperiod of the wetlands and also the ecology of its aquatic invertebrates. Existing anthropogenic disturbance to aquatic invertebrates in the prairie pothole region includes sedimentation, dewatering, and road construction (Euliss et al. 1999).

Aquatic Invasive Species

The affected environment for AIS of concern is composed of the Missouri River basin, which is a potential source of AIS, and the Hudson Bay basin, which includes Canada's Lake Winnipeg and the surrounding communities and is the potential receptor of AIS. The Lake Winnipeg area was included since the Souris River in Minot flows north into Manitoba where it meets the Red River and eventually terminates in Lake Winnipeg. Thus, impacts from AIS transfer to the Souris River could occur in this area. Information in this section is summarized from the detailed analysis conducted on AIS for this Project. The Transbasin Effects Analysis Technical Report (Appendix E) documents the current North American distribution of AIS, especially within the Missouri River basin, Hudson Bay basin, and adjacent drainage basins. This report was peer reviewed by technical experts both within and outside of Reclamation and builds on previous work conducted for the Project.

The list of AIS considered in this SEIS has been developed and refined over the past 10 years (Appendix E). Initially, invasive species were identified during a risk and consequence analysis conducted in support of an EIS for the Red River Valley Water Supply Project (USGS 2005a). That project is similar to the Project evaluated in this SEIS and would also involve a water transfer from the Missouri River basin to the Hudson Bay basin to meet municipal, rural, and industrial water needs. The list of species for the Red River Valley project was developed by an interagency technical team that included representatives from USGS, Reclamation, EPA, the Service, NDGFD, Minnesota Department of Natural Resources, Environment Canada, Canada Department of Fisheries and Oceans, and Manitoba Conservation (USGS 2005a, 2005b). The species evaluated in that analysis included both microscopic (viruses, bacteria, protozoa, myxozoa, and cyanobacteria) and macroscopic (vascular plants, mollusks, crustaceans, and fishes) organisms.

As part of the previous EIS for the Project (Reclamation 2008), Reclamation worked collaboratively with the USGS to conduct a biota transfer risk analysis (USGS 2007a). Invasive species included in that analysis were the high-priority species identified in the risk and consequence analysis conducted for the Red River Valley project (USGS 2005a). Because the analysis conducted for that project concluded that the risk of transferring macroscopic organisms through a system like this Project was practically zero (USGS 2005a), no further analysis of macroscopic transfer risk was conducted in this SEIS.

In their comments on the 2007 Draft EIS for this Project, Manitoba Water Stewardship (2007) identified additional fish pathogens and parasites that they suggested should be evaluated. The microscopic species evaluated for the Red River Valley project (USGS 2005a) and the Final EIS for this Project (USGS 2007a; Reclamation 2008), the additional fish pathogens and parasites identified by Manitoba Water Stewardship (2007), and three mollusk species (quagga mussels, zebra mussels, and New Zealand mudsnails) are analyzed as AIS in this SEIS.

Aquatic Invasive Species of Concern

Table 3-18 includes both the taxonomic groups and common names of individual AIS evaluated in this SEIS. Some of these AIS do not have common names; therefore, their scientific names appear in the table. The list of AIS includes seven major taxonomic groups of organisms exhibiting a range of sizes and susceptibilities to chemical and physical variables (e.g., biota treatment options). A broad range of life histories was evaluated to ensure that the biota treatment options being considered would protect against a variety of species, including unknown and emerging organisms. The relative sizes of the species are shown in Figure 3-21.

The National Wild Fish Health Survey Database hosted by the Service (2011a) regularly updates detection data for a variety of fish pathogens and parasites in the continental United States, including several, but not all, of the AIS evaluated in this SEIS. The USGS Non-Indigenous Aquatic Species database maintains records for observation data of potentially invasive invertebrates, including quagga mussels, zebra mussels, and New Zealand mudsnails. These sources were used to develop maps illustrating the distribution of AIS in the Hudson Bay basin and in adjacent and neighboring drainage basins (below and in Attachment 1 of Appendix E). Several AIS are currently known to exist in adjacent basins but have not been detected in the Hudson Bay basin (Table 3-18; Appendix E, Attachment 1). Other AIS have already been detected in the Hudson Bay basin and are included in the table to provide a complete overview of the existing conditions.

Table 3-18 Aquatic Invasive Species of Concern

Taxonomic Group		Common Name of Species or Disease / Condition	Present in the Hudson Bay Basin	Present in the Missouri River Basin
Virus		Infectious pancreatic necrosis virus (IPNV)	Unknown	Unknown
		Infectious hematopoietic necrosis virus (IHNV)	Unknown	Unknown
		Viral hemorrhagic septicemia virus (VHSV)	Unknown	Unknown
		Channel catfish virus (CCV)	Unknown	Unknown
		Spring viremia of carp virus (SVCV)	Unknown	Unknown
		Infectious salmon anemia virus (ISAV)	Unknown	Unknown
Bacteria		Bacterial kidney disease (BKD)	Yes	Yes
		Furunculosis	Yes	Unknown
		Strep	Yes	Yes
		Columnaris disease	Yes	Unknown
		Pseudomonas aeruginosa	Yes	Yes
		Cholera	Unknown [a]	Unknown [a]
		Edwardsiella spp. infections	Yes	Unknown
		Mycobacterium spp. infections	Yes	Yes
		Enteric redmouth disease (ERM)	Yes	Yes
		E. coli	Yes	Yes
		Legionnaire's disease	Unknown	Unknown
		Salmonella	Yes	Yes
Animalia	Mollusks	Zebra mussel	Yes	Yes
		Quagga mussel	Unknown	Yes
		New Zealand mudsnail	Unknown	Yes
	Parasites	*Polypodium*	Yes	Yes
		Whirling disease	Unknown	Yes
		Actheres pimelodi (parasitic copepod)	Yes	Unknown
		Ergasilus spp. (parasitic copepod)	Yes	Unknown
		Icelanonchohaptor microcotyle (parasitic flatworm)	Unknown	Yes
		Corallotaenia minutia (Parasitic tapeworm)	Yes	Unknown
Protozoa		*Giardia* (backpacker's diarrhea)	Yes	Yes
		Entamoeba histolytica	Unknown	Unknown
		Cryptosporidium	Yes	Yes
		Ich or white spot disease	Yes	Yes
		Ichthyophonosis	Unknown	Unknown
Fungi		Branchiomycosis	Yes	Yes
		Saprolegniosis or winter fungus disease	Yes	Yes
		Black yeast	Yes	Yes

Taxonomic Group	Common Name of Species or Disease / Condition	Present in the Hudson Bay Basin	Present in the Missouri River Basin
	Phoma herbarum	Yes	Yes
Cyanobacteria	Anabaena flos-aquae (blue-green algae)	Yes	Yes
	Microcystis aeruginosa (blue-green algae)	Yes	Yes
	Aphanizomenon flos-aquae (blue-green algae)	Yes	Yes

Notes:

NA = not applicable; Unknown = has not been detected; not currently known to be present

[a] The bacterium that causes cholera is not known to be present; however, other species of this genus are ubiquitous in aquatic systems. Source: Appendix E, "Life History Characteristics and Distribution" section.

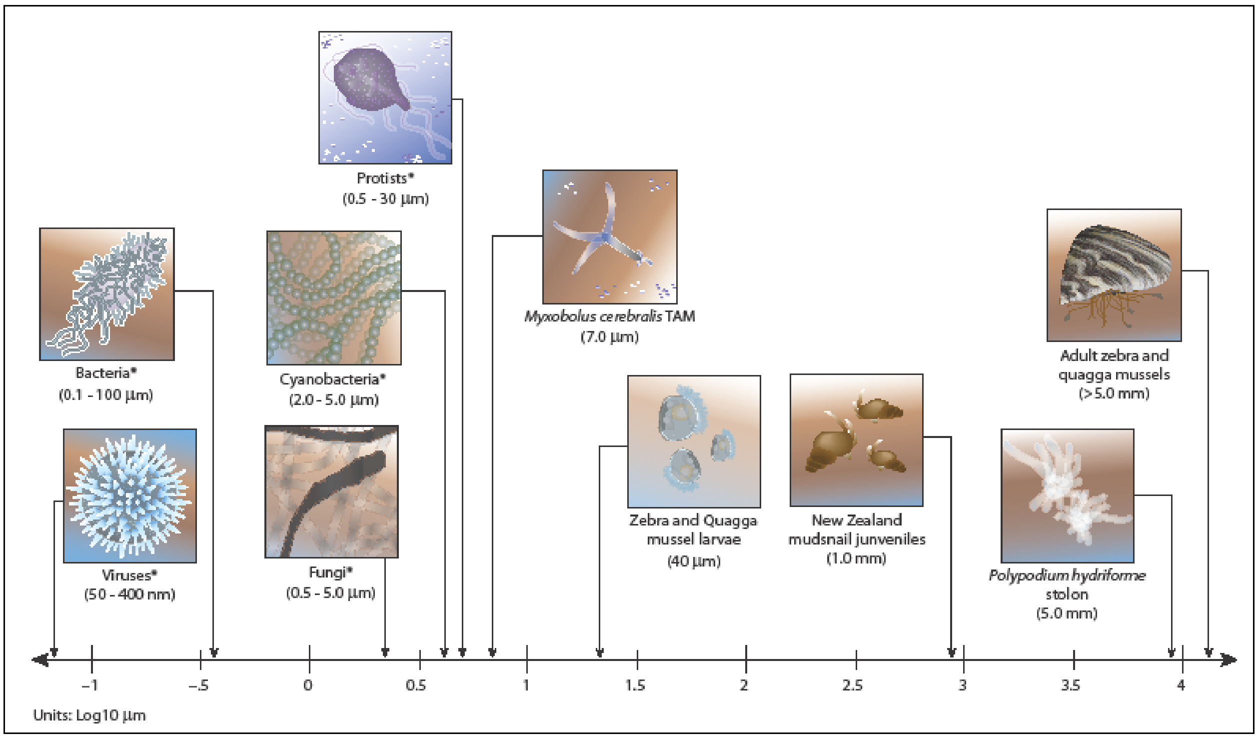

Figure 3-21 Relative Sizes of Aquatic Invasive Species of Concern

Fish Pathogens and Parasites

Some fish species of the Hudson Bay basin could be susceptible to infection from AIS and, therefore, potentially at risk from a transbasin introduction (Table 3-19). Fish pathogens and parasites may be host-specific or capable of infecting a variety of species. The documented fish pathogen and parasite communities in the source basin (Missouri River basin) and the receiving basin (Hudson Bay basin) are quite similar, particularly for fish species that occur in both basins. Dick et al. (2001) reported only 2 out of 44 parasites that occurred in the Missouri River in North Dakota that have not been detected in the Red River basin or other Manitoba waters. The lack of detection of AIS does not necessarily rule out its presence in the Hudson Bay basin. Therefore, several AIS not yet reported may in fact already be present in the receiving waters. Further, while it is possible that there are unknown or undocumented fish diseases in Lake Sakakawea, it is unlikely that such diseases would cause adverse effects in the Hudson Bay basin and still remain undetected in Lake Sakakawea. Again, a wide variety of life history categories was evaluated in the Transbasin Effects Analysis Technical Report (Appendix E) to ensure that the biota treatment options considered in this SEIS would protect against a variety of species, including unknown and emerging organisms. The examples below of documented invasions of select AIS, representing major life history categories, provide a basis to qualitatively describe potential environmental effects in the Hudson Bay basin.

Table 3-19 Potential Aquatic Receptors of Concern in the Hudson Bay Basin

	Criteria [a]		
Common Name	**Special Status?**	**Recreational / Commercial Value?**	**Susceptibility to Aquatic Invasive Species of Concern and / or Disease**
Brook Trout	No	Yes [CA,U.S.]	BKD, whirling disease [b]
Brown Bullhead	No	Yes [CA,U.S.]	*Edwardsiella* spp. infections, VHSV
Brown Trout	No	Yes [CA,U.S.]	BKD, ich/white spot disease, ERM, furunculosis, IHNV, ISAV, VHSV, whirling disease [b]
Channel Catfish	No	Yes [CA,U.S.]	CCV, *Edwardsiella* spp. infections, ERM, black yeast, ich/white spot disease), furunculosis, saprolegniosis/winter fungus disease, VHSV
Common Carp	No	Yes [CA,U.S.]	BKD, furunculosis, SVCV, VHSV
Chinook Salmon	No	Yes [U.S.]	BKD, Columnaris disease, ERM, furunculosis, IHNV, ISAV, Saprolegnia, VHSV, whirling disease [c]
Crappie	No	Yes [CA,U.S.]	Columnaris disease, *Edwardsiella* spp. infections, ERM, VHSV
Fathead Minnow	No	Yes [U.S.]	Furunculosis, VHSV
Lake Sturgeon	E [c]	Yes [CA,U.S.]	*Polypodium*
Lake Trout	SC [a]	Yes [CA,U.S.]	BKD, black yeast, furunculosis, ISAV, IPNV, *Phoma herbarum*, VHSV, whirling disease [d]
Lake Whitefish	No	Yes [CA]	Furunculosis, VHSV, whirling disease [d]
Lake Winnipeg Physa Snail	E [c]	No	Zebra mussel invasion, quagga mussel invasion, New Zealand mudsnail invasion
Large-Mouth Bass	No	Yes [CA,U.S.]	*Edwardsiella* spp. infections, VHSV
Mapleleaf Mussel	E [c,d]	No	Zebra mussel invasion, quagga mussel invasion, New Zealand mudsnail invasion, any pathogens that adversely affects the fish host (catfish)

Common Name	Criteria [a]		
	Special Status?	Recreational / Commercial Value?	Susceptibility to Aquatic Invasive Species of Concern and / or Disease
Muskellunge	No	Yes [CA,U.S.]	VHSV
Northern Pike	No	Yes [CA,U.S.]	Furunculosis, SVCV, VHSV
Rainbow Trout	No	Yes [CA,U.S.]	Furunculosis, ISAV, VHSV, whirling disease [e]
Sauger	No	Yes [CA,U.S.]	Furunculosis, columnaris disease, VHSV
Shortjaw Cisco	T [c]	No	Zebra mussel invasion, quagga mussel invasion, New Zealand mudsnail invasion, whirling disease [d]
Small-Mouth Bass	No	Yes [CA,U.S.]	Furunculosis, VHSV
Walleye	No	Yes [CA,U.S.]	Furunculosis, columnaris disease, ERM, VHSV
White Bass	No	Yes [CA,U.S.]	VHSV
White Sucker	No	Yes [CA,U.S.]	VHSV
Yellow Perch	No	Yes [U.S.]	Columnaris, furunculosis, VHSV

Notes:

a Criteria pertain only to fisheries and organisms falling within the U.S. portion of the Hudson Bay basin (U.S. HUC-2 Souris-Red-Rainy Region) and the Province of Manitoba.

b Partial resistance, clinical disease rare or only develops at high parasite doses

c Susceptible, clinical disease common at high parasite doses but greater resistance is seen at low parasite doses

d Susceptibility is unknown or unclear at this time due to conflicting reports or insufficient data

e Highly susceptible; clinical disease common

SC Species of Concern, Montana Department of Fish, Wildlife and Parks

Source: Appendix E, “Aquatic Receptors of Concern” section

T Threatened Species

E Endangered Species

CA Canada (Manitoba)

U.S. United States (North Dakota, South Dakota, and Minnesota)

BKD bacterial kidney disease

CCV channel catfish virus

ERM enteric redmouth disease

IHNV infectious hematopoietic necrosis virus

IPNV infectious pancreatic necrosis virus

ISAV infectious salmon anemia virus

SVCV spring viremia of carp virus

VHSV viral hemorrhagic septicemia virus

Viruses

Viruses can affect both wild and cultured fisheries in aquatic systems. Many viruses have a greater effect on hatchery-raised fishes due to the increased concentration and availability of suitable hosts in reservoirs, as well as the high frequency of impaired water quality characteristic of these crowded facilities.

Viral hemorrhagic septicemia virus (VHSV) is a serious viral pathogen that can infect a wide variety of freshwater and marine fish species. For instance, there are currently 28 species of freshwater fish found in the Great Lakes basin that are currently regulated by the VHSV Federal Order (USDA 2009). However, there are far more species of fish that are susceptible to infection with this pathogen, which has been associated with freshwater fish kills in the Great Lakes, including black crappie, bluegill, common carp, freshwater drum, American gizzard shad, muskellunge, round goby, white bass, and yellow perch (MnDNR 2011). Species known to act as reservoirs (generally asymptomatic but can spread the virus) for VHSV include burbot; channel catfish; Chinook salmon; lake trout; northern pike; rock bass; and several species of suckers, shiners, and redhorse (MnDNR 2011). This pathogen is therefore, of particular interest to regulators and the public in both the United States and Canada.

VHSV was first detected in the Great Lakes basin in 2003; however, the source and timing of its introduction to this system is unknown. It is possible that the virus was present for several years before that initial isolation. Several susceptible host fish species inhabit the Hudson Bay basin, including black crappie, lake whitefish, largemouth bass, muskellunge, rainbow trout, sauger, smallmouth bass, walleye, white bass, and yellow perch (Michigan DNR 2012) (Table 3-19). Measurable mortalities were first observed in 2005, including large declines of freshwater drum and round goby (Kipp and Ricciardi 2012). As of 2009, VHSV infections in North America appeared to be limited to the Great Lakes region from Wisconsin to New York State (USDA 2009) (Figure 3-22). By 2010, the disease had spread throughout the Great Lakes (ISU 2012) leading to recorded mortalities of largemouth bass in Budd Lake, Michigan. The mortalities caused by VHSV have exceeded 100 metric tons (MT) of fish in the Great Lakes (Michigan DNR 2009). To date, VHSV has not been detected in the Missouri River basin or Hudson Bay basin (Bensley et al. 2011; Service 2011a) (Figure 3-22).

Figure 3-22 Virus Distribution – North America

Sources: Bowser 2009; Garver et al. 2007; ISU 2007a, 2010; Leighton 2011; Midwest Pond and Koi Society 2012; MnDNR 2011; Service 2011a; Tarrab et al. 1996; USDA 2004; Whelan 2009

Bacteria

Bacterial pathogens spread easily among fish and are often difficult to treat. Their presence in wild populations may go undetected until significant mortalities occur within a population. Some diseases can cause low-level sustained mortality that can result in significant losses over time.

Enteric redmouth disease (ERM) is a systemic bacterial infection of fish that primarily affects salmonids, including rainbow trout, sockeye salmon, Atlantic salmon, Chinook salmon, and brown trout, and disease is most frequently associated with hatchery facilities. The disease was first reported in Idaho rainbow trout by Rucker in the 1950s (Bullock and Cipriano 1990). Since then, ERM has been reported from hatcheries across the globe, including in Australia, the United Kingdom, mainland Europe, South Africa, and Canada (Bruno 1990), and has spread to virtually all trout-producing regions of the United States, Canada, and Europe (Bullock 1984). ERM currently causes significant yearly mortalities and monetary losses (Tobback et al. 2009). In Canada, the disease has been detected in British Columbia, Saskatchewan, Ontario, and Nova Scotia (Bullock et al. 1978).

ERM was identified in a black crappie collected from Lake Traverse, near the border of South Dakota within the Hudson Bay basin (Bensley et al. 2011) (Figure 3-23). The disease has also been reported in several non-salmonid species, including channel catfish, rainbow smelt, mountain whitefish, walleye, blacknose dace, and speckled dace. The current U.S. distribution includes Alaska, Washington, Montana, Idaho, California, Arizona, South Dakota, Minnesota, Wisconsin, Michigan, Virginia, and New York (Figure 3-23). This pathogen represents an AIS that is present in adjacent basins, as well as the Hudson Bay basin.

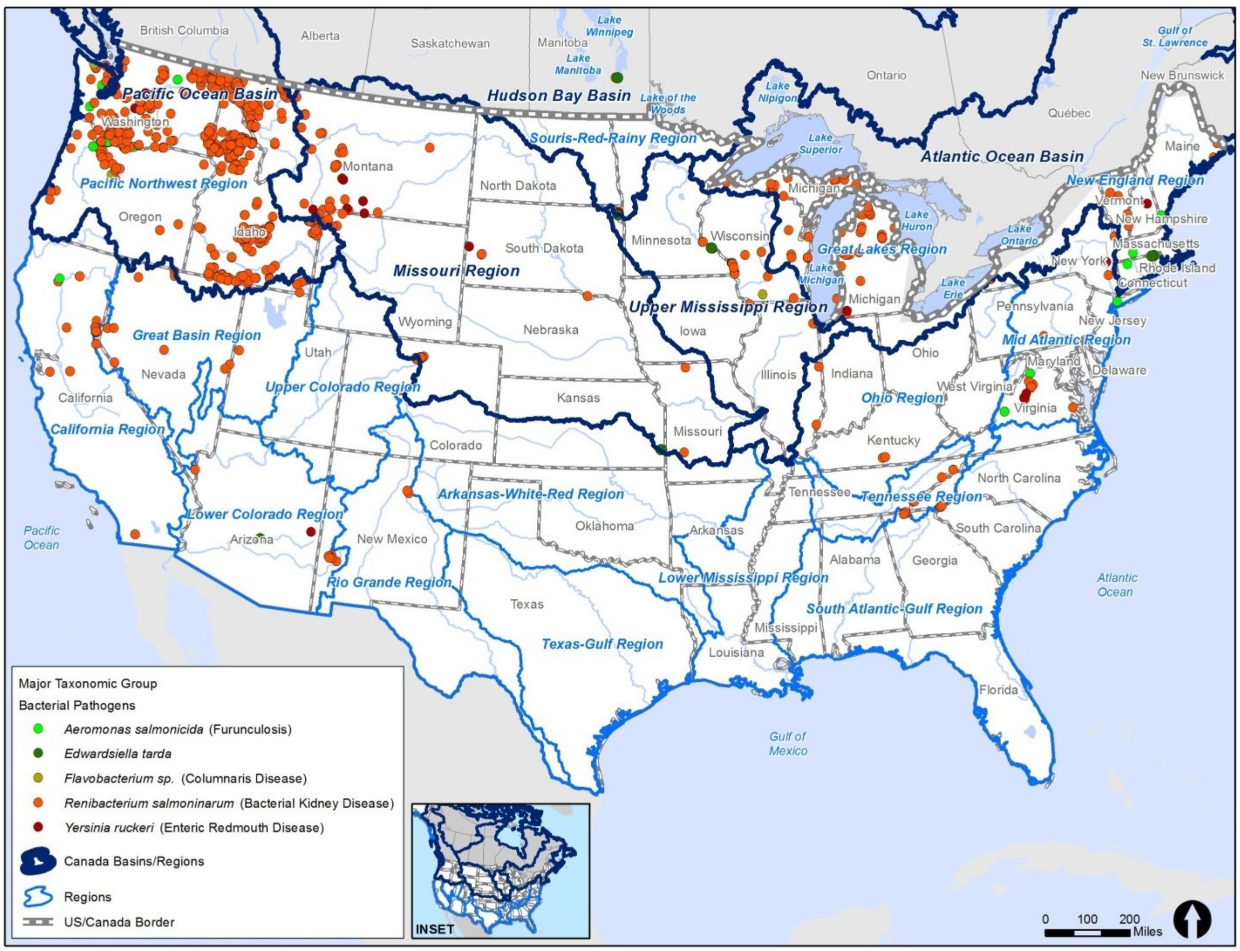

Figure 3-23 Bacterial Distribution – North America Animal Parasites

Source: Service 2011a

Whirling disease is typically a disease of juvenile salmonids, which has caused some changes to coldwater fisheries in North America (Elwell et al. 2009; Alexander 2010). Different species of host salmonids appear to have unique susceptibilities to whirling disease: rainbow trout and sockeye salmon are highly susceptible; Chinook salmon, brook trout, and Atlantic salmon are considered to have intermediate susceptibility; and brown trout and coho salmon appear to have low susceptibility (Markiw 1992; Nehring 2006). Studies investigating the susceptibility of other species have been largely inconclusive. For example, some wild mountain whitefish have exhibited clinical signs of the disease (Pierce et al. 2011); however, studies evaluating lake trout, lake whitefish, and Arctic grayling have been both contradictory and inconclusive (Hedrick et al. 1999).

Resistance may occur in naturally reproducing populations in areas where the whirling disease parasite is endemic. Preliminary research on wild rainbow trout of the Madison River, Montana suggests that rainbow trout that survived the severe outbreak in the 1990s may have passed along genetic resistance to their offspring and subsequent generations (Vincent 2006).

Whirling disease has been found in the upper Missouri River basin including Montana and Wyoming, but has yet to be detected in North Dakota or Canada (Figure 3-24). It has also been observed in the Great Lakes and the Pacific Ocean basin but not in the Upper Mississippi region. With the exception of rainbow trout, which are continually stocked in Manitoba waters (Manitoba 2012), susceptible fish species, such as salmonids, are absent or less common in the Souris River drainage. Several species that are resistant to infection or that are of unknown susceptibility are present in the Hudson Bay basin, including lake trout, lake whitefish, shortjaw cisco, brown trout, and brook trout (Table 3-19). In addition, a large stretch of warm, turbid waterways lies between the naturally infected populations of salmonids in western Montana and the stocked populations in the upper Missouri River basin in eastern Montana and North Dakota (Holm, pers. comm., 2011), which represents a natural impediment to parasite spread to the lower Missouri River and Lake Sakakawea.

Whirling disease presents a serious threat to coldwater fisheries in North America and has been implicated in the decline of sensitive trout populations. Juvenile rainbow trout in the Madison River in Montana suffered a 50-percent decline due to whirling disease (McMahon et al. 2010). In Colorado’s Gunnison River, fry and fingerling trout recruitment was severely affected by the disease and was followed by a 99-percent decline of trout populations in the river (Elwell et al. 2009). Cutthroat trout suffer the highest mortality rates of all susceptible trout species (Nehring 2006); a 99-percent decline in cutthroat populations occurred following the establishment of whirling disease in the Yellowstone River region (Alexander 2010). In the Madison and Missouri rivers (“blue ribbon reach” in western Montana), a 50- to 80-percent decline in yearling production of rainbow trout was recorded. During the monitoring period, however, the number of adult trout greater than 2 years old was stable and normal (Leathe et al. 2002).

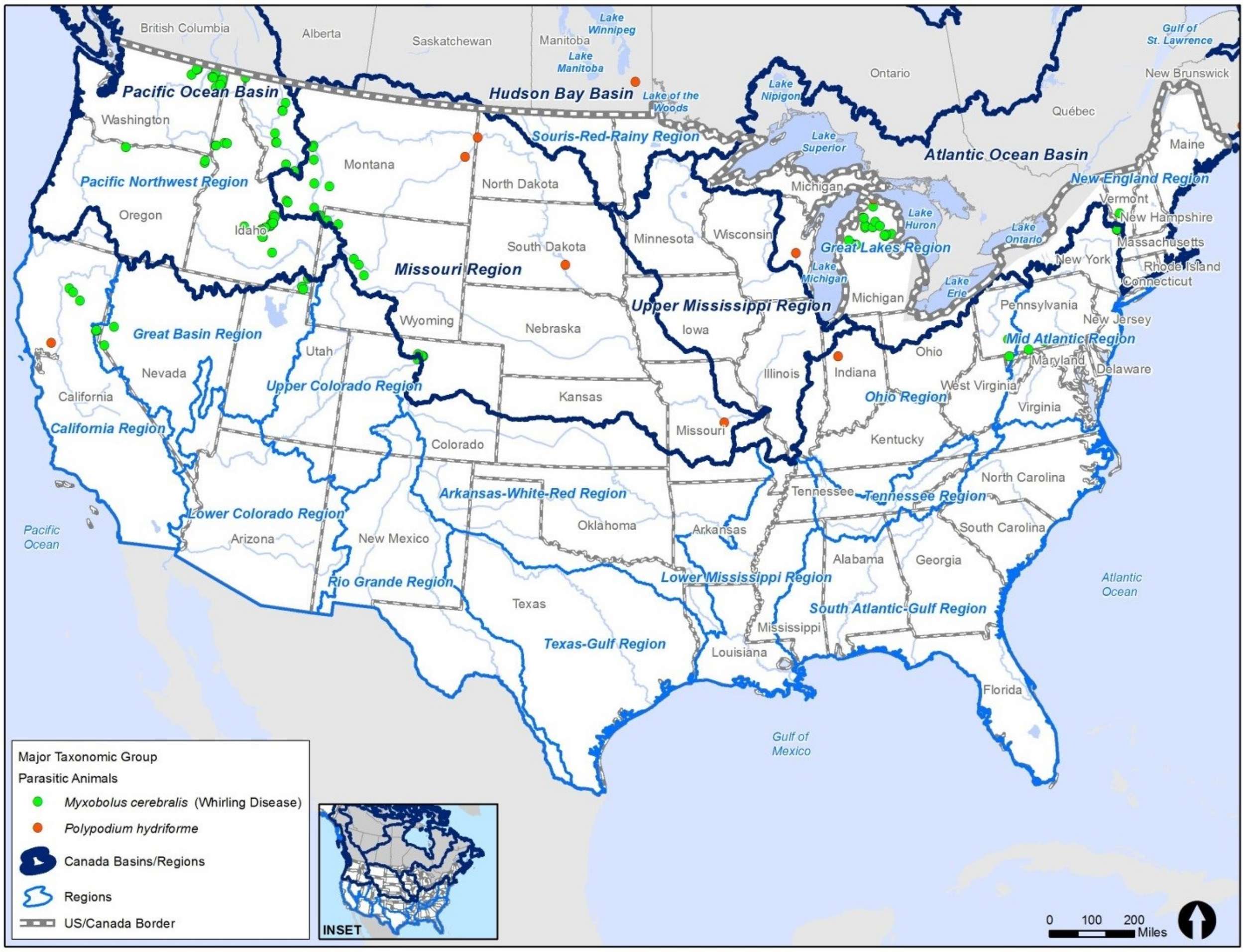

Figure 3-24 Animal Parasite Distribution – North America

Sources: Bartholomew and Reno 2002; Bensley et al. 2011; Choudhury and Dick 1993; Hoffman et al. 1974; Holloway et al. 1991; Indiana Department of Natural Resources 2005; Raikova et al. 1979; Sepúlveda et al. 2010; Service 2011a; Thomas and Muzzall 2009.

Invasive Mollusks

Invasive mollusks are notorious for their tendency to colonize water supply pipes, public water supply plants, and industrial facilities, which frequently leads to constricted flow and reduced intake function. Mollusks are able to disperse rapidly throughout aquatic systems via connected waterways and overland travel (attached to boat hulls or contained in live wells and transported by trailer). They can have major effects on invaded ecosystems by competing directly with native organisms for food and space or indirectly by altering parasite communities (Brown et al. 2008). Zebra mussels can cause significant ecological and economic damage. Adult zebra mussels are also known for their ability to attach and rapidly colonize any suitable surface, such as the inner walls of pipes, leading to water works function impairment (Higgins and Vander Zanden 2010; Benson et al. 2012a).

Zebra mussels were introduced to North America in 1988 in the ballast water of a transatlantic vessel. Within 10 years, the mussels had spread throughout the Great Lakes region and are now common throughout the Upper Mississippi region (Figure 3-25). Zebra mussels were recently reported in the Hudson Bay basin, including the Red River near Wahpeton, North Dakota in July 2010 and (Big) Pelican Lake, Minnesota in September 2009 (Manitoba Water Stewardship

2012). In October 2013, they were confirmed in Lake Winnipeg, Manitoba Canada. Adult mussels were found on the hull of a private boat and a dock at Winnipeg Beach and on dry-docked fishing boats approximately 5 miles north in Gimli, Manitoba (Manitoba Water Stewardship 2013). Winnipeg Beach lies approximately 15 miles north of the southern end of Lake Winnipeg where the Red River drains into the lake. Further sampling in October 2013 resulted in additional detections at Gimli Harbour, Willow Point (south of Gimli), and Balsam Bay Harbour (east of Gimle and north of Beaconia). Some of the mussels were found attached to the hulls of private boats (USGS 2013b). The source(s) of the mussels in the lake is currently unknown.

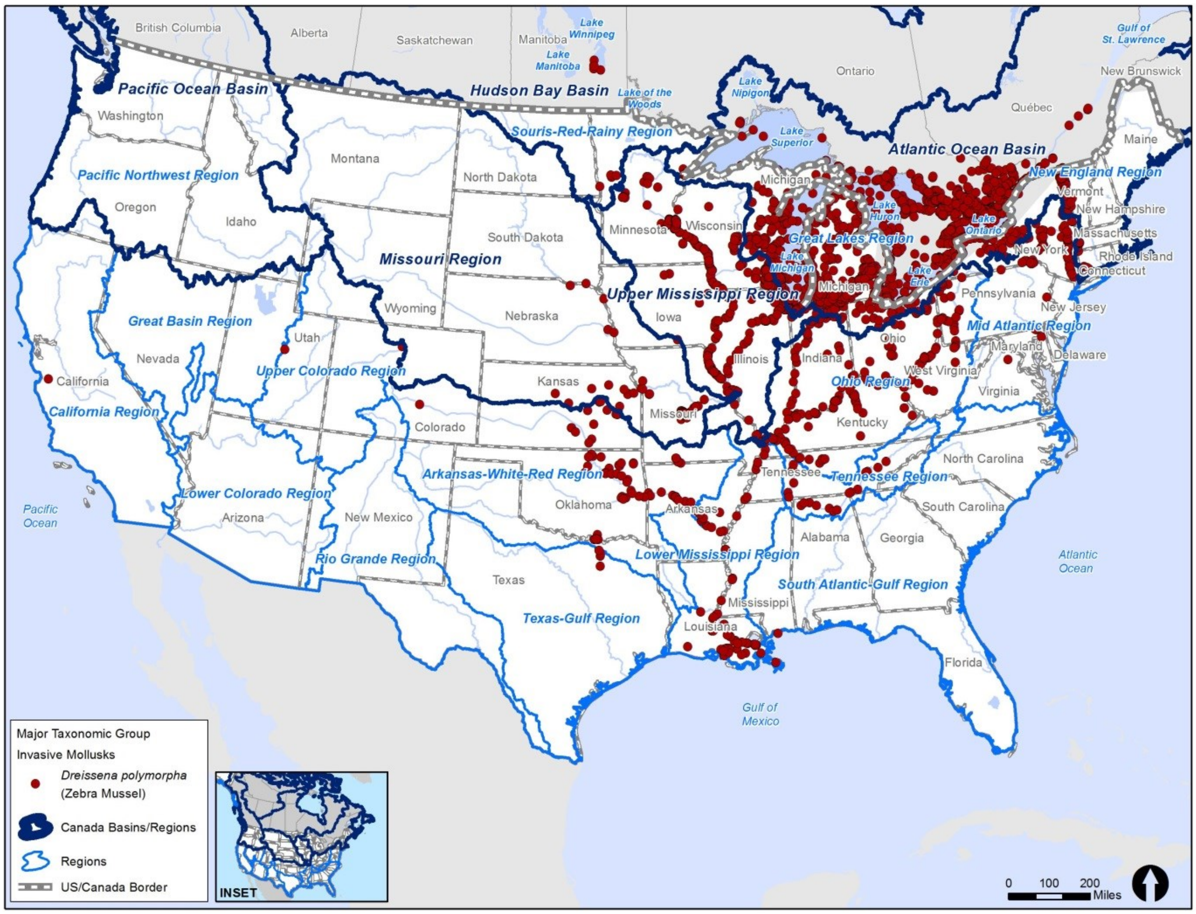

Figure 3-25 Zebra Mussel Distribution – North America

Sources: Manitoba Water Stewardship 2013; USGS 2012b, 2013b

Recent modeling efforts suggest that commercial navigation has been the most important determinant of the early invasion into the Missouri and Mississippi rivers and that recreational boating has contributed to the continued penetration of the species into smaller waterbodies (Mari et al. 2011).

Zebra mussel populations filter large volumes of water during feeding action, which can reduce phytoplankton abundance, thus causing significant ecosystem alterations including the disruption of food webs. For example, phytoplankton biomass declined 85 percent following a zebra mussel invasion of the Hudson River in the northeastern United States (Benson et al. 2012a). Such a decrease in suspended biomass can result in increased water clarity, allowing sunlight to penetrate deeper into the water column, which in turn allows aquatic plants to become established in areas they were previously absent (Karatayev et al. 2007). Conversely, aquatic plants can be negatively affected when colonized by juvenile zebra mussels. This can be detrimental to the ecosystem that relies on a healthy aquatic plant community due to the resulting decrease in dissolved oxygen, cover for fish, and substrate for aquatic invertebrates. In addition, as phytoplankton are consumed, dissolved organic carbon concentrations, which are integral to a health aquatic ecosystem, may decline (Benson et al. 2012a).

Zooplankton can also be affected by zebra mussel invasion. For example, zooplankton abundance dropped 55 to 71 percent following the 1989 invasion of Lake Erie, and 70 percent following the 1992 invasion of the Hudson River (Benson et al. 2012a). These effects are attributed to reduction of available food (e.g., phytoplankton) and direct predation (via filter-feeding) of microzooplankton. Increased competition in the zooplankton community for newly limited food could also result from zebra mussel invasion.

Zebra mussel invasions can cause ecosystem effects that reverberate through aquatic foodwebs, eventually affecting higher trophic levels, such as fish (Raikow 2004). For example, wild lake whitefish may have exhibited adverse effects following the introduction of zebra mussels to the Great Lakes. The overall body condition and growth of lake whitefish in southern Lake Michigan appeared to decline as prey consumption shifted to mussels, which have lower energy and nutrient content (NOAA n.d.). In addition, lake whitefish experienced near reproductive failure for 5 consecutive years following the zebra mussel invasion of Lake Ontario (Hoyle et al. 2008). A decrease in juvenile and adult abundance was observed, which was attributed to decreased juvenile survival, significant declines of adult body condition, and reduced production of young-of-the-year fish (Hoyle et al. 1999). This appeared to be another example of effects related to diet replacement of previous prey items with low nutritional zebra mussels (zebra mussels were present in 90 percent of lake whitefish stomachs) (Hoyle et al. 1999, 2008). As a result, lake whitefish fishery declines led to reduced quota for commercial fishermen (Hoyle et al. 2008).

Cyanobacteria

All three species of cyanobacteria are already present in the Hudson Bay basin, including Lake Winnipeg. Thus, the introduction of additional cyanobacterial cells or toxins would be unlikely to result in deleterious impacts. Increased cyanobacterial abundance is partially linked to nutrient influx, which is characteristic of agricultural runoff and waterbodies near populated areas where periodic or frequent sewage discharges occur.

Pathways for the Introduction of Aquatic Invasive Species of Concern

Some invasive species, when freed from the natural controls of their native range, can reproduce and expand their populations in newly encountered waterways and spread from one drainage basin to another (Oregon Department of Environmental Quality 2009). The management of a population’s spread becomes more problematic as other vectors work to rapidly distribute it (Minchin 2007). For example, zebra mussels accidentally delivered to the United States from Europe in ship ballast water have since spread via other routes, including boat and ship hulls (Service 2011b; USGS 2007b).

Most AIS are exceptionally small; therefore, thousands of cells (or organisms since the majority of AIS are single-celled microorganisms) could potentially be contained in a single drop of untreated water or in waste products from birds, fish, and mammals. Concentrations of AIS vary widely between different potential sources. For example, fish pathogens are often found in exceptionally low numbers in surface waters (often making detection difficult), whereas piscivorous (fish-eating) birds' gastrointestinal systems may contain millions of microorganisms following the consumption of infected fish. The viability of individual transfer pathways also varies, as does the potential for AIS introduction to result in successful establishment. This variability limits the ability to directly compare the volumes of transferred water or materials and assess transfer risk. Volume is, however, less important than other factors, due to the potential for viable AIS to be present in exceptionally small water volumes.

A number of pathways, or connections, are present that potentially could facilitate the transfer of AIS to the Hudson Bay basin from adjacent or neighboring drainage basins, including the Missouri River basin, the Atlantic Ocean basin (contains the Great Lakes), the Arctic Ocean basin, the Pacific Ocean basin (which contains the Columbia River and its watersheds), and the Upper Mississippi River basin (Figure 3-26). Potential biota transfer pathways linking these drainage basins with the Hudson Bay basin are diverse and include natural (e.g., basin-to-basin connections, weather events), biotic (e.g., birds, mammals, fish), and abiotic (e.g., engineered interbasin water diversions, bilge water/live well releases, bait buckets, aquaculture) mechanisms (Appendix E).These potential transfer mechanisms are important for understanding baseline risk in the absence of the Project (no Project). Example non-Project pathways shown in Table 3-20 and discussed below are relevant in the context of potential AIS transfer to the Hudson Bay basin, unless otherwise noted. (Refer to Appendix E for further details regarding non-Project pathways.)

Table 3-20 Physical and Biological Biota Transfer Pathways

• Interbasin Connections and Water Diversions	• Aquaculture Facilities
• Intrabasin Connections	• Stocking/Hatcheries
• Hull/Anchor/Superstructure Fouling	• Recreational Boating
• Canals and Diversions	• Fish Transport
• Pet/Aquarium Releases	• Avian Transport
• Aquatic Plants	• Mammalian Transport
• Fishing Equipment	• Weather-Related Events
• Use and Disposal of Live Bait	• Climate Change

Figure 3-26 Hudson Bay Basin and Adjacent Drainage Basins

Sources: GeoGratis 2012; USGS 2012c

Interbasin Connections and Water Diversions

Interbasin connections and diversions have the potential to transport AIS across drainage basin boundaries. Conveyance risk may be different depending upon the water transfer mechanisms. Several interbasin water diversions have been constructed in the United States and Canada, many of which are located in the vicinity of the Project (Appendix E). Additionally, basin divides may overflow naturally during flood conditions (Davies et al. 1992; Spading 2000), providing a potential conduit for biota movement to neighboring drainages. Basin divides, including continental divides, are not necessarily a formidable barrier. For example, near Browns Valley, Minnesota, the Little Minnesota River (within the Mississippi River basin) passes within approximately 800 yards of Lake Traverse (within the Hudson Bay basin). At this location, the left bank of the Little Minnesota River forms the divide between the two major drainage basins.

Breakout flows overtopping the basin divide have a recurrence interval of approximately 10 years, providing a relatively frequent natural connection between the basins (Spading 2000).

The boundaries between hydrologic basins in much of the Project area are poorly defined due to the low relief of the land and lack of geographic features that would otherwise provide discrete drainage separations. Because of the poorly defined basin boundaries, it is also unlikely that they contain uniquely distinct biological assemblages. For example, Dick et al. (2001) reported only 2 out of 44 parasites that occurred in the Missouri River have not also been reported in the Red River drainage or other Manitoba waters. Furthermore, they noted that the parasite communities from fish species that are common to both drainages are similar.

Intrabasin Connections

Intrabasin connections represent natural and anthropogenic mechanisms by which AIS could move between sub-basins within major hydrologic basins (e.g., Devils Lake basin and Red River basin). Closed sub-basins are generally isolated drainages that may contain and support unique biological assemblages. Species not found elsewhere could escape through natural or man-made outlets that provide a temporary intrabasin link to adjacent drainages.

Hull/Anchor/Superstructure Fouling

AIS (invasive mollusks) can attach themselves to hulls, anchors, and exterior surfaces of shipping vessels and barges and be transported outside of their native habitats (LSWG 2009). Larvae and other sub-adult life stages of AIS can be released into new waters, attached directly to port infrastructure, or dislodged during dry dock operations, establishing residence as invasive aquatics.

Canals and Diversions

Canals and channels for shipping goods and bulk water diversions create artificial connections that allow free movement of AIS across physical barriers between (interbasin) and within (intrabasin) watersheds. For example, the Chicago Sanitary and Ship Canal likely provided zebra mussels to the Mississippi River basin following establishment in the Great Lakes (Kerr et al. 2005).

Pet/Aquarium Releases

Several species of exotic plants and animals have been introduced into the Great Lakes basin through accidental aquarium releases (Kerr et al. 2005). The aquarium trade is likely responsible for the introduction of several bivalve diseases in the northern hemisphere. Even a small amount of biomass can distribute potential disease agents, including AIS in the following life history categories: bacteria, viruses, fungi, and protozoa.

Aquatic Plants

Water gardens frequently use exotic plants, fish, reptiles, and invertebrates that can escape into the natural environment. Gardens that occur in areas prone to flooding pose the greatest risk, because species are more likely to be released during high-water events. Improper disposal of unwanted species into storm sewers, ditches, or waters could result in introductions of infectious pathogens (AIS) to nonnative habitats (LSWG 2009).

Fishing Equipment

Anglers and commercial fishers can transfer AIS via boats and equipment. AIS can accumulate on nets, waders, lures, anchors, boat hulls and trailers, livewells, bilges, motors, and other equipment (LSWG 2009). Some species can survive for extended periods in boat livewells. The release of livewell and bilge contents can facilitate AIS transfers when boats are transported between waterways.

Use and Disposal of Live Bait

Improper disposal of baitfish via the bait buckets could aggravate the spread of invasive species by introducing nonnative plants, invertebrates, and pathogens (AIS). Furthermore, improper disposal of live bait infected with AIS pathogens or parasites can affect native fish populations (LSWG 2009).

Aquaculture Facilities

Populations of organisms such as fish, crustaceans, mollusks, and aquatic plants are cultivated under controlled and often crowded conditions in either land-based aquaculture facilities or cage operations (NMFS and Service 2005). Cultivated species are not usually native to the areas and/or waters where they are bred and raised. Invading aquatic organisms can sometimes displace native species or carry diseases not found naturally in some aquatic habitats. Wild fish and other aquatic organisms may therefore exhibit vulnerability to introduced AIS due to their lack of natural disease resistance.

Stocking/Hatcheries

Hatchery fish are stocked in waterways in an effort to enhance sport and commercial fishing. Stocking may result in the accidental introduction of AIS to aquatic ecosystems. Certain life history characteristics allow some species to survive and pass into nonnative waters even when stocking is managed to prevent transfer (LSGW 2009). Unauthorized stocking is typically conducted for the purpose of creating a new fishery or to manipulate existing fish stocks. AIS fish pathogens and parasites may also be transferred in infected fish during stocking efforts.

AIS can also be introduced into nonnative waters via contaminated gear, stocking water, or in the stomach of stocked fish. The New Zealand mudsnail is capable of live passage through the digestive systems of some fish species (Aquatic Nuisance Species Task Force 2006). Whirling disease, which can be transmitted by infected fish and fish parts, is thought to have been inadvertently introduced into U.S. waters in the 1950s through the transfer of infected fish or fish product from Europe (Elwell et al. 2009).

Recreational Boating

Water recreation activities involving boats, water skis, wake boards, pull ropes, and personal flotation devices have the potential to transfer nonnative hitchhikers, such as larvae or algae between waterbodies (LWSG 2009). Recreational boaters represent an important secondary transfer pathway for AIS. For example, recreational boaters using the Rideau Canal are widely considered the source of zebra mussels from the Great Lakes to the Rideau River (Kerr et al. 2005).

Fish Transport

AIS can be diffusively dispersed via gradual intrabasin downstream or upstream movement of introduced fish, providing a mechanism for transferring harbored pathogens and parasites. Dispersal can be limited by unsuitable habitat, competing species, and physical barriers such as dams and fish screens.

Avian Transport

Small organisms such as animal larvae, plant propagules, and parasites usually rely on larger, more mobile species for dispersal. Birds have been shown to transport small organisms (hitchhikers) that were recently ingested or that have become adhered to skin or feathers (Charalambidou and Santamaría 2005; Green et al. 2008; Koel et al. 2010). The receiving waters of the Hudson Bay basin contain important waterbird habitat that support large populations of migrating and resident birds (Environment Canada 2012).

Passive dispersal of invertebrates by nomadic birds has recently been demonstrated (Charalambidou and Santamaría 2005; Green et al. 2008). Living, viable myxospores of the whirling disease parasite survived digestion by piscivorous (fish-eating) birds fed infected rainbow trout. In addition, some snails have been known to survive digestion by ducks (Cadée 2011).

Mammalian Transport

Mammal movement and migration represents a viable and important mechanism for transferring AIS across hydrologic basins. Bacteria and protozoa are common inhabitants of the gastrointestinal tract of mammals and therefore may be released in the manure of livestock and wildlife (Pachepsky et al. 2006). Invertebrate animals may also be transported by mammals. Some hardy invertebrates such as gastropods and mussels may be transported on mud fixed to larger animals such as mammals (Vanschoenwinkel et al. 2008; Waterkeyn et al. 2010).

Weather-Related Events

Storm events, major floods, and high winds can provide natural pathways for dispersal of invasive organisms across hydrologic basin boundaries. During high-water and flood events, interbasin water exchange can occur through wetlands, rivers, and streams. The proximity of waterbodies and drainage basins may influence the probability of biota transfers (Davies et al. 1992).

Weather events can indirectly contribute to invasive species expansion by increasing habitat disturbance. This disturbance could potentially provide an opportunity for the establishment and/or spread of existing AIS (Burgiel and Muir 2010).

Climate Change

Dispersal of invasive species to new aquatic systems may be facilitated by increasing water temperatures associated with climate change (Chu et al. 2005). Climate change may encourage the establishment of nonnative species by affecting abiotic factors such as water temperature and flow rate. Changes to these physical parameters can influence plant community structure and lead to loss of ecosystem diversity (Sandel and Dangremond 2012).

The current ranges of some native species, such as channel catfish and the pathogens they harbor (e.g., CCV, VHSV), are expected to expand with increasing air temperatures (Rahel and Olden 2008). In some cases, climate change may simply open up niches for invasive species that were previously filled by native species (Kappes and Haase 2012).

Aquatic Habitat Potentially at Risk from Introductions of Aquatic Invasive Species of Concern

Aquatic habitats of the Hudson Bay basin that may support organisms potentially at risk from AIS associated with the Project include the Souris River and downstream to Lake Winnipeg in the Province of Manitoba. The Souris River is a tributary to the Assiniboine River, which flows into Lake Winnipeg via the Red River. These waterbodies flow through the Prairie Pothole Region. The Souris River, whose headwaters are located in southeastern Saskatchewan, flows south into North Dakota through Minot, then bends northward and re-enters Canada, joining the Assiniboine near Brandon, Manitoba. Substrate in the Souris River is predominantly silt and clay deposited in what was historically glacial Lake Souris. The Souris and Assiniboine rivers support a variety of fish species (Saskatchewan Watershed Authority 2012).

Lake Winnipeg is the tenth largest body of freshwater in the world. Water quality in Lake Winnipeg is threatened by nutrient loads, primarily from municipal and agricultural sources. The lake is used for fisheries, recreation, tourism, and hydropower; and it also provides water to downstream watersheds and communities (Lake Winnipeg Research Consortium 2012).

Potential Aquatic Receptors of Concern

Aquatic receptors include commercially and recreationally valuable fish species that could potentially be at risk from the introduction and establishment of AIS through a variety of pathways. Ecological receptors potentially susceptible to the establishment of AIS could be directly affected by infection or indirectly affected as a result of community shifts, such as loss of food source prey or the creation of new niche habitat. The geographic distribution and extent of susceptible host species may affect the success of an establishment of AIS populations (Appendix E). Some potential aquatic receptors in the Hudson Bay basin (including Canada) that may be directly susceptible to AIS are presented in Table 3-19.

> **Aquatic receptors** are organisms potentially at risk from impacts associated with the establishment of invasive species

Trans-Border Economics Related to Invasive Species

The introduction and establishment of AIS can have effects on local economies in the Hudson Bay basin. Non-indigenous fish pathogens and parasites can affect economic sectors, including recreational and commercial fishing and non-fishing recreation. However, there is relatively limited theoretical and empirical literature regarding the economic costs associated with invasive species establishment (Lovell and Stone 2005).

The geographic area of the economic analysis focus is on the Canadian region of the Hudson Bay basin that could be the recipient of AIS, particularly the province of Manitoba and the communities adjacent to Lake Winnipeg. This waterbody was given special attention due to concerns regarding potential AIS-related effects upon its valuable commercial and recreational fisheries. Appendix E provides additional details regarding the general economic conditions in Manitoba and the Winnipeg area, as well as economic sectors, including recreational and commercial fishing and aquaculture that could potentially be affected in the event of AIS establishment.

General Economic Conditions in Manitoba

Manitoba has a robust, service-based economy supported by a rapidly growing population. In 2010, over half of Manitoba's population of 1.2 million lived in the Census Metropolitan Area (CMA) of Winnipeg. The CMA includes the core city of Winnipeg, as well as neighboring municipalities where at least 50 percent of the labor force works in the core city. Rural municipalities in the Winnipeg CMA include Richot, Tache, Springfield, East St. Paul, West St. Paul, Rosser, St. Francois Xavier, Headingly, St. Clements, and Brokenhead First Nation (Chief Administrative Officer 2007).

Population growth throughout the province is fueled by interprovincial migration and a strong regional job market. Low wages and a low cost of living help to make the Winnipeg CMA one of the most desirable places to conduct business in Canada. In 2007, the Winnipeg median hourly wage was approximately 20 percent lower than that in British Columbia, Alberta, and Ontario, making Winnipeg one of the lower cost centers for business in North America (City of Winnipeg 2007). The favorable business environment is one factor accounting for higher gross domestic product (GDP) growth in Manitoba than any other Canadian province between 2005 and 2009. GDP growth was 2.4 percent in 2010.

More than 23,000 permanent residents live in 30 communities along the shores of Lake Winnipeg, not including the Winnipeg CMA. Some areas and villages, particularly 10 First Nation communities, rely heavily on income from commercial fishing at Lake Winnipeg and other fisheries in waterbodies elsewhere in the Hudson Bay basin. In addition, many of the First Nation communities rely on subsistence fishing as an important source of food and as a central element of their culture. First Nation treaty rights and entitlements in Manitoba provide for Aboriginal rights to hunt, trap, and fish on ancestral lands (AADNC 2010).

Economic Sectors in Manitoba Potentially at Risk from Aquatic Invasive Species of Concern

Economic sectors comprising the potentially affected human environment for the introduction of AIS include those related to commercial fishing and aquaculture, recreational fishing, and non-fishing recreational activities.

Commercial Fishing

In 2006/2007, commercial fisheries in Manitoba accounted for 36 percent of total freshwater landings and 39 percent of the total value of landings in Canada (approximately 11,758 MT of fish valued at $27.5 million that year in 2011 U.S. dollars). The 2009/2010 harvest in Lake Winnipeg represents the largest source of commercial freshwater landings in Manitoba, accounting for approximately 46 percent of the total fish weight and 68 percent of total Manitoba landed fish value in 2006/2007.

Most fishing in Lake Winnipeg is in the South Basin, near the convergence of the Red River. Much of the commercial fishing activity in Manitoba is by part-time rather than full-time anglers. Approximately 80 percent of commercial fishers are of First Nation heritage (Lake Winnipeg Implementation Committee 2007).

The Lake Winnipeg commercial fishery is dominated by three quota species, walleye, whitefish, and sauger, of which walleye is the most important in terms of both tons caught and total value. Although sauger represents a relatively minor species in terms of tons caught compared to walleye and whitefish, nearly all sauger caught in Canada are caught in Manitoba, with 89 percent of this catch from Lake Winnipeg.

Recreation

Recreation and tourism around Lake Winnipeg generate an estimated $111 million in revenue per year (Lake Winnipeg Stewardship Board 2011). Recreational visitation to Lake Winnipeg is increasing steadily, driven both by the popularity of recreational activities and of lakeside retirement and vacation homes. Although Manitoba has a sizeable recreational fishing sector, Lake Winnipeg accounts for a small percentage of the total recreational fishing in Manitoba. In 2010, only 12 percent of Manitoba's active recreational anglers fished on Lake Winnipeg. Lake Winnipeg is not especially well suited as a recreational fishing destination due to its size, rough weather conditions, and its commercial fishing orientation (Brickley, pers. comm., 2012). Perch dominates recreational catch on Lake Winnipeg; and other targeted species include walleye, northern pike, channel catfish, and smallmouth bass.

Commercial Aquaculture

Aquaculture operations are unusually vulnerable to disease outbreak due to the crowded conditions of raised populations. Depending upon the disease or condition, an infection may require all individuals to be euthanized, with resulting high costs.

Government-run hatcheries dominate the aquaculture sector in Manitoba; commercial aquaculture is a small industry when compared to other regions of Canada. From 2007 to 2009, Manitoba produced an average of 16 MT, while all of Canada produced an average of more than 6,600 MT (Manitoba Water Stewardship 2004; Statistics Canada 2009; Appendix E). The small number of operations in Manitoba is limited by harsh winter conditions and a limited fish market for reared species. The primary use of Manitoba aquaculture trout (mainly rainbow trout) is for onsite or small-scale private pond fishing, although a small number of raised trout supplement public stocking efforts. Other aquaculture species include Arctic char, brown trout, and brook trout.

Paleontological Resources

The term "paleontological resource" means any fossilized remains, traces, or imprints of organisms, preserved in or on the earth's crust, that are of paleontological interest and that provide information about the history of life on earth. This section summarizes the types of paleontological resources in the Project Area.

P.L. 111-011, Title VI, Subtitle D, Paleontological Resources Preservation Act (PRPA) (123 Stat. 1172; 16 U.S.C. 470aaa) requires the Secretary of the Interior to manage and protect paleontological resources on federal land using scientific principles and expertise. The PRPA includes specific provisions addressing casual collection and management of paleontological resources only from federal or Indian (trust) lands managed by the Secretary of the Interior or on federal land managed by the U.S. Forest Service.

The geology of an area can tell us much about the potential for paleontological resources. For example, in the Project Area, fossils are deeply buried in bedrock (sedimentary rock) covered by glacial till (100 to 800 feet deep), which generally does not contain fossils.

Olson (1998) describes the geology of the Project Area as follows:

> *"The Drift Plains are characterized by flat, ground moraine plains with little relief. The plains have a mantle of Pleistocene glacial drift sediments overlying an erosional surface that was beveled nearly flat by repeated advances of Pleistocene continental glaciers. Many small ponds and marshes dot the surface, reflecting a drainage system that overall is poorly developed (Hainer 1956). The major drainage in the Project Area is the Souris River, and its principal tributaries are the Des Lacs River; Deep River, which is fed by Cut Bank Creek and Little Deep Creek; Wintering River; and Willow Creek with its tributary, Ox Creek.*
>
> *The Missouri Plateau in Williams County is covered by a thick deposit of glacial drift (Hainer 1956). Drainages here are more integrated than on the Drift Prairie of the Missouri Coteau and there are fewer ponds and wetlands (Freers 1973). Drainages are typically intermittent or ephemeral and all drain into the Missouri River.*
>
> *The Missouri Coteau is also the product of continental glaciation. The Coteau rises 100-150m (300- 400 feet) above the general level of the adjacent Drift Prairie and is buttressed against the Missouri Plateau. The dominant topographic feature of the Coteau is hummock, knob-and-kettle terrain which was created when continental glaciers stagnated in place. Portions of these glaciers were covered with a thick insulating mantle of supra-glacial draft which retarded melting of the underlying ice relative to areas without (or with less of) an insulating cover. Covered areas eventually became the potholes and wetlands seen today. The modem knobs are composed of drift and outwash that was concentrated by slumping and flow into more rapidly melting areas of the glaciers (Clayton 1967).*
>
> *Glacial sediments form a covering as great as 500 to 600 feet thick on top of bedrock in places on the Missouri Coteau (Bluemle 1991). Near Kenmare, Renville County, such sediments are 800 feet thick, the deepest glacial deposits in the state (ibid).*"

Hoganson (pers. comm., 1996) provided a list of known paleontological resources for the Environmental Assessment that was prepared for the Project in 2001 (SWC et al. 2001) and included counties where new facility construction is proposed, including McLean and Ward Counties. No new areas of fossil resources were found during the Project construction that has already taken place (refer to Appendix A) (Kihm, 2003; Hoganson pers. comms. 2002, 2004, 2013; Hoganson 2007, 2008). However, undiscovered sites may be present, particularly along the banks of Lake Sakakawea. Bluemle (1991) reported that Coleharbor Group sediments found in the Project Area have produced abundant fossils in parts of North Dakota. Such fossils include tree and other plant pollen; fish; aquatic snail and clam shells; land snails; insects; ostracods; and bones from beaver, caribou, elk, mammoth, and bison—although Kihm (2003) reported the Coleharbor Group outcrop rarely contains fossils. Hoganson (2007) also noted that glacial till and alluvium in the Project Area generally lacks fossils.

Land Use

The affected environment for land use is defined as the area temporarily disturbed by construction activity (including equipment and materials staging areas) and the surface area or "footprint" occupied by permanent Project-related structures and facilities. For linear Project components, the affected environment includes a 110-foot-wide corridor centered on the proposed collector lines, feeder lines, and bulk distribution pipelines for each action alternative.

In addition to land use, this section discusses recreational resources and farmland. A regional description of existing land use, recreational resources, and farmland is presented to provide a context to the impact discussion presented in Chapter 4. Information for this section was obtained from a variety of GIS mapping sources; satellite imagery available on Google Earth; and a number of federal, state, and local agency websites.

Land Uses

The Project Area encompasses more than 10.5 million square miles of semi-arid prairie in northwest North Dakota. It includes large expanses of agricultural land and open rangeland, interspersed with small towns and rural communities. The largest municipality is the City of Minot with a population of more than 40,000 residents. Most rural communities and small towns have fewer than 500 residents (North Dakota State Data Center 2011). Approximately 95 percent of the land within the Project Area is privately owned, generally in the form of large farms and ranches. The average farm is approximately 1,200 acres (USDA 2007). Smaller privately owned residential lots and commercial properties are located in the cities of Minot, Williston, Bottineau, Burlington, and Kenmare and in other towns and rural communities.

Figure 3-27 shows generalized land cover in the Project Area using GIS mapping data developed by the USGS (2010). The map illustrates four main land cover categories: developed land, agricultural land, prairie and grasslands, and shrublands and forested land. Developed land includes a mix of residential, commercial, and industrial land uses; and agricultural land includes cultivated cropland, irrigated agriculture, livestock grazing, and hay production. As can be seen in Figure 3-26, most of the Project Area is composed of agricultural land with much smaller amounts of developed land, prairie and grasslands, and shrublands and forested land.

Table 3-21 identifies the generalized land cover types that would be directly affected by construction and operation of the various Project components, using the same USGS data. At this scale of analysis, two additional land cover types have been identified: developed, open space area and wetlands. The USGS (2010) has characterized developed, open space areas as containing small amounts of impervious surface (less than 20 percent) and large amounts of vegetation (primarily grasses planted for erosion control, aesthetic purposes, or recreation). A review of aerial photos indicates that the impervious surfaces are likely roads and that the vegetated areas are most likely in agricultural use. Wetlands are areas identified as wetlands in the National Wetlands Inventory (Service 2012a).

Figure 3-27 Land Cover in the Project Area

Source: USGS 2010

Table 3-21 Land Cover Types Potentially Affected by Alternative Components

Alternative Component	Land Cover Type	
Recharge Facility 1 – Minot Aquifer (intake structure and feeder lines, sediment settling facility, recharge basin, recharge wells) [a]	Developed land Developed, open space Cultivated cropland	Wetlands Mixed-grass prairie shrubland
Recharge Facility 2 – Sundre Aquifer (intake structure and feeder lines, sediment settling facility, recharge basin, recharge wells) [a]	Developed, open Space Cultivated cropland Pasture/hay	Wetlands Shrubland
Peaking Well Facilities (6) [a]	Developed land Developed, open space Pasture/hay	Wetlands Shrubland
Upgraded Collector Lines [a]	Developed land Developed, open space Cultivated cropland	Pasture/hay Wetlands Shrubland
Intake and Pump Station at Lake Sakakawea [b]	Developed land Developed, open space	Wetlands Shrubland
Biota WTP and Pump Station [b]	Cultivated cropland	Wetlands
South Prairie Storage Reservoir [b]	Cultivated cropland Developed, open space	Wetlands
Bulk Distribution Pipelines [c]	Developed land	
Upgraded Minot WTP [c]	Developed land	
Storage Reservoirs (2) (near Lansford and Bottineau) [c]	Developed land Developed, open space	Pasture/Hay
Pump Stations (6) (near Lansford, Mohall, Tolley, Renville County Corner Stations, and Bottineau [2 units]) [c]	Developed land Developed, open space Cultivated cropland	Mixed-grass prairie Shrubland

Notes:
[a] Inbasin alternatives.
[b] Missouri River alternatives.
[c] All alternatives.

Protected Lands

The Project Area includes several types of special land uses protected by federal legislation and federal and state land management programs. These include NWRs, waterfowl production areas (WPAs), wetland and grassland easements managed by the U.S. Fish and Wildlife Service (Service), and wildlife management areas (WMAs) managed by the NDGFD. Each of these types of protected lands is described below.

National Wildlife Refuges

The National Wildlife Refuge System is a national network of lands and waters set aside to conserve America's fish, wildlife, and plants. NWRs are managed by the Service for the conservation, management, and restoration of fish, wildlife, and plant resources and their habitats (Service 2012b). They are open to wildlife-dependent recreational uses such as hunting, fishing, wildlife observation, photography, environmental education, and interpretation. The National Wildlife Refuge System is managed in accordance with the National Wildlife Refuge System Improvement Act of 1997 (P.L. 105-57), which includes the following main provisions:

- A strong and singular wildlife conservation mission for the Refuge System.

- A requirement that the Secretary of the Interior maintain the biological integrity, diversity and environmental health of the Refuge System.
- A new process for determining compatible uses on refuges.
- A recognition that wildlife-dependent recreational uses involving hunting, fishing, wildlife observation and photography, and environmental education and interpretation, when determined to be compatible, are legitimate and appropriate public uses of the Refuge System.
- That these compatible wildlife-dependent recreational uses are the priority general public uses of the Refuge System.

Three NWRs located within the Project Area could potentially be affected by construction and/or operation of facilities associated with the action alternatives: J. Clark Salyer NWR, Upper Souris NWR, and Audubon NWR (Figure 3-28). Each is described in more detail below.

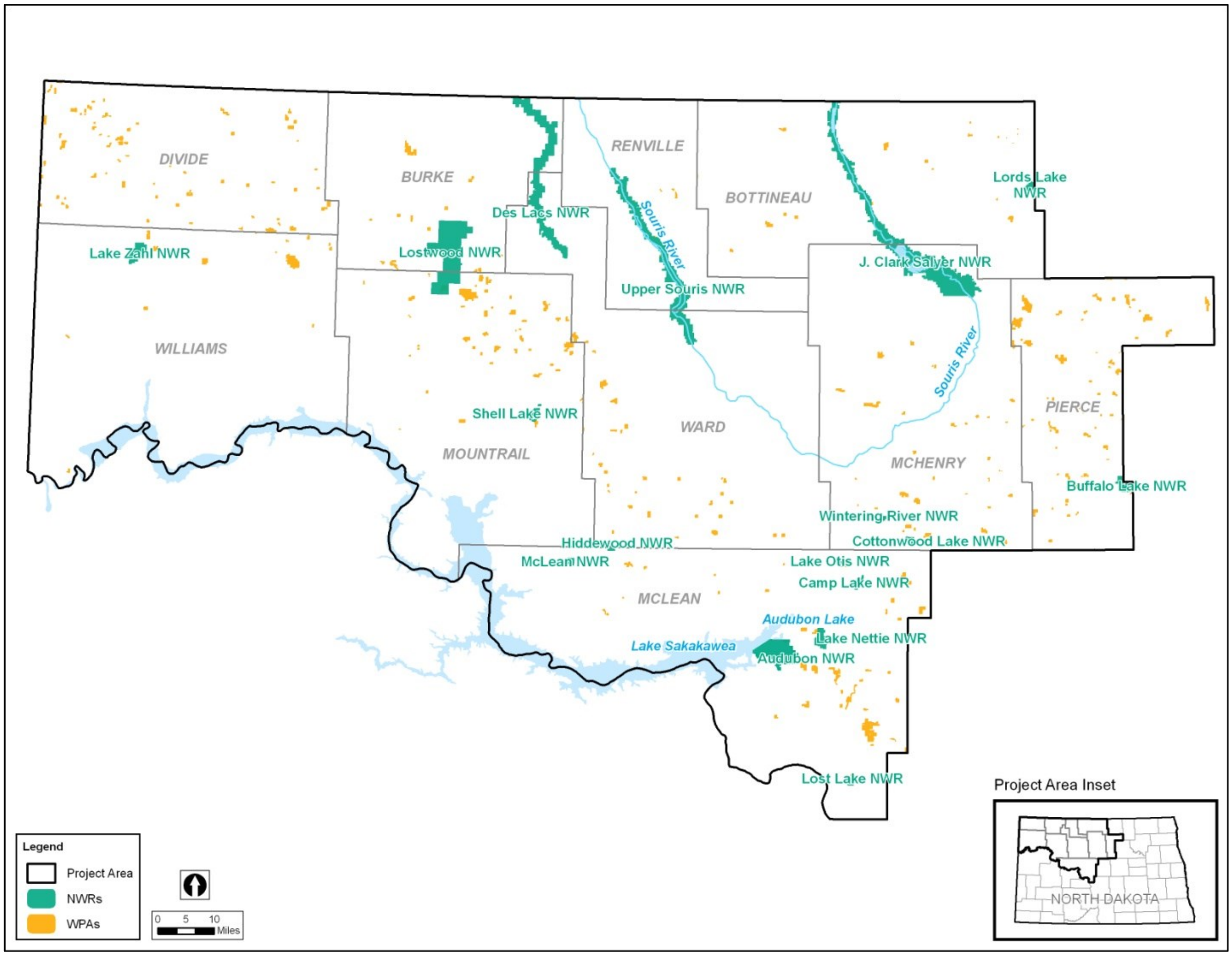

Figure 3-28 National Wildlife Refuges and Waterfowl Production Areas

Upper Souris National Wildlife Refuge

The Upper Souris NWR encompasses an estimated 32,000 acres located in northwestern North Dakota and extends for nearly 30 miles along the Souris River. The refuge was established in 1935 as a refuge and breeding ground for migratory birds and other wildlife. It is managed by the

Service as an important unit in a series of NWRs in the Central Flyway great waterfowl migration corridor. Up to 350,000 waterfowl have been counted on the refuge during spring and fall migrations, including Tundra swans, pintails, canvasbacks, redheads, and buffleheads. As many as five species of grebes have been seen on the refuge during the summer (Service 2012c).

Other bird species that use this refuge during parts of the year include cormorants, great blue herons, while pelicans, Baird's sparrow, LeConte's sparrow, sharp-tailed sparrow, and Sprague's pipit. White-tailed deer, muskrats, raccoons, and mink are common; and antelope can be seen on the hills above the valley. Elk and moose have also been sighted here, albeit rarely (Service 2012c).

Boat and shore fishing is allowed at 13 designated sites on Lake Darling and the Souris River. Portions of the refuge are open to deer and upland bird hunting. The refuge includes several walking trails, an auto tour route, and two canoe trails that provide wildlife viewing and photography opportunities (Service 2012c).

J. Clark Salyer National Wildlife Refuge

The J. Clark Salyer NWR is a 58,700-acre refuge located along the Souris River and extending south from the Canadian border for approximately 45 miles; it is the largest refuge in North Dakota. The refuge was established in 1935 as a refuge and breeding ground for migratory birds and other wildlife. Diverse habitat types found in the Salyer refuge including mixed-grass prairie, river valley, marshes, sandhills, and woodlands that support an abundance of wildlife. The refuge is an important feeding and resting area for hundreds of thousands of waterfowl that migrate annually through the Central Flyway; this refuge is also one of the most important duck production areas in the United States. More than 300 species of birds have been observed here since it was established, and nearly 125 species nest on the refuge. This refuge is also designated as a Globally Important Bird Area and is a regional site in the Western Hemisphere Shorebird Reserve Network (Service 2012d).

Nesting waterfowl include gadwall, blue-winged teal, mallard, and Canada goose; summer residents include many species of shorebirds and grebes, the white pelican, sandhill crane, lark bunting, longspurs, and Baird's and LeConte's sparrows. Other water-dependent birds include American white pelicans, western and eared grebes, white-faced ibis, and black terns. Upland habitat is home to Sprague's pipits, Baird's and LeConte's sparrows, and upland sandpipers, along with sharp-tailed grouse, ring-necked pheasants, gray partridges, ruffed grouse, and wild turkeys. Mammals found in the marshes on the refuge include beaver, mink, muskrats, raccoon, and weasel. On higher ground, including the sandhills area of the refuge, mammals include white-tailed deer, moose, coyote, red fox, badger, porcupine, and snowshoe hare (Service 2012d).

Fishing is permitted at 14 public fishing areas, and portions of the refuge are open to deer and upland game hunting in accordance with state seasons and regulations. The refuge includes two auto tour routes and a 13-mile canoe trail on the Souris River that provides opportunities for wildlife viewing and photography (Service 2012d).

Audubon National Wildlife Refuge

The Audubon NWR is a 14,735-acre refuge located adjacent to Audubon Lake. The refuge was established in 1956 as the Snake River NWR following construction of the Garrison Dam on the Missouri River. The refuge was created to replace wildlife habitat that was lost due to the creation of Lake Sakakawea by the Garrison Dam. The refuge was renamed Audubon NWR in 1967 in honor of John James Audubon, one of the great naturalists and wildlife painters of the 19th century. The refuge includes native prairie, planted grasslands, and numerous pothole wetlands managed to meet the needs of waterfowl and other migratory birds, threatened and endangered species, and resident wildlife. Pumps and siphons are used to move water from Lake Audubon to fill wetlands that would otherwise be dry in drought years (Service 2012e).

Wildlife species seen on the refuge include 246 bird, 34 mammal, 5 reptile, 4 amphibian, and 37 fish species. Mammals include shrews, bats, beavers, weasels, badger, skunk, and mink. Common reptiles found on the refuge include the common snapping turtle, western painted turtle, plains garter snake, and smooth green snake; amphibians include the plains spadefoot toad, leopard frog, chorus frog, and tiger salamander (Service 2012e).

Deer hunting and upland bird hunting are permitted on the refuge, and winter ice fishing takes place at Lake Audubon. The refuge includes an auto-tour route and a 1-mile self-guided trail that provide opportunities for wildlife viewing and photography. Visitors are permitted to walk freely through the prairie grasslands and along the shores of Lake Audubon (Service 2012e).

Waterfowl Production Areas

The Service manages 677,000 acres of WPAs, primarily in the Prairie Pothole Region of the Dakotas, Minnesota, and Montana. WPAs are properties purchased by the Service with funds generated from the sale of Federal Duck Stamps for the purpose of increasing the production of migratory birds, particularly waterfowl. North Dakota is home to more than one-third of the nation's WPAs (Service 2007a). These areas are open to hunting, fishing, and trapping, as well as other uses such as wildlife observation, photography, and environmental education. Figure 3-27 shows the distribution of WPAs across the Project Area.

Wetland and Grassland Easements

Wetland and grassland easements may also be present in the Project Area. Wetland easements are legal agreements with the Service that pay landowners to permanently protect wetlands on their property. Wetlands covered by an easement cannot be drained, filled, leveled, or burned. When easement wetlands dry up naturally, they can be farmed, grazed, or hayed. Easement wetlands are also part of the National Wildlife Refuge System. More than 1,200,000 wetland acres are permanently protected by wetland easement in the states of North Dakota, South Dakota, and Montana (Service 2012f).

A grassland easement is similar to a wetland easement and in North Dakota is frequently used in combination with wetland easements to protect grass uplands around wetlands. The Service pays landowners to permanently maintain their land in grass. Easement terms typically restrict haying, mowing, and grass seed harvest until after July 15 of each year. This restriction allows grassland nesting species, such as ducks and pheasants, to complete their nesting before the grass is disturbed. Landowners maintain permanent vegetative cover and grazing is allowed at any time. Landowners retain the right to open or close their land to hunting and trapping. Grassland easements are also part of the National Wildlife Refuge System (Service 2012g).

Wildlife Management Areas
The Corps owns most of the land along the shorelines of Lake Sakakawea and Audubon Lake within the Project Area. Portions of these lands are leased to the NDGFD as WMAs. WMAs are generally composed of habitats that are important for wildlife such as native grasslands, wetlands, watersheds, and forest lands. WMAs are open to the public for recreational purposes, generally hunting, fishing, nature study, hiking, and primitive camping. The NDGFD manages WMAs on private land near Lake Sakakawea and Audubon Lake (NDGFD 2012a).

Recreation

Project Area
Recreational activities and opportunities within the Project Area are typical of North Dakota's rural and undeveloped lands; these include hunting, fishing, boating, camping, and hiking. Hunting occurs on both private and public lands in rural areas and on lands within NWRs, WPAs, and WMAs, as described previously. Fishing and boating are common activities on rivers and lakes in the Project Area, including the Souris River, Lake Sakakawea, and Audubon Lake. Boat ramps are available on most waters open to public fishing (NDGFD 2012b).

A survey conducted by the Service in 2006 estimated that 88,000 North Dakota residents and 18,000 non-residents fished a total of 953,000 days in 2006. A total of 86,000 North Dakota residents and 42,000 non-residents hunted 1.3 million days (an average of 11 days per hunter) that same year (Service et al. 2008). A statewide survey of 1,200 residents ages 18 years or older conducted by the North Dakota Parks and Recreation Department in 2007 identified the types of outdoor recreation activities (not including hunting and fishing) in which state residents participated (NDPR 2012). The 10 most popular outdoor recreation activities mentioned during the survey are listed in Table 3-22. These statewide activity patterns and participation rates are likely to be similar to those within the Project Area.

Table 3-22 Popular Outdoor Recreation Activities in North Dakota

Activity	Percent Participating	Average Annual Participation Rate (days per year)
Walking, Jogging, Hiking	86.5	111
Pleasure Driving	71.8	35
Picnicking	69.7	13
Bicycling	59.8	57
Swimming	56.2	33
Camping	48.8	18
Boating, Water Skiing	47.1	24
Golf	42.6	29
Basketball	39.4	46
ATV, Off-Road Motorcycling, Snowmobiling	37.0	58

Source: NDPR 2012

Camping sites and trails for hiking, mountain biking, horseback riding, and cross country skiing are available in several state parks, recreation areas, and forests in the Project Area. The Corps provides camping, picnic tables, and boat launch facilities on the north shore of Audubon Lake at the East Totten Trail Campground near Garrison and on the south shore of Lake Sakakawea at the Wolf Creek Campground (Corps 2012b).

Major recreational trails in the affected environment include the Lewis and Clark Trail, which follows the Missouri River through the southern portion of the Project Area and the North Country National Scenic Trail, which crosses portions of the Audubon NWR, the shores of Lake Sakakawea, and Garrison Dam, before terminating at Lake Sakakawea State Park (Lewis and Clark Trail 2012; North County Trail Association 2012).

An extensive network of snowmobile trails operated by the North Dakota Parks and Recreation Department is also present in the Project Area. Many of the trails are located on easements across private land and are most concentrated in Ward and Bottineau Counties (Snowmobile North Dakota 2012).

Recreational opportunities are also available in most cities and towns throughout the Project Area. Project-related facilities in or near the City of Minot would occur within a ½ mile of numerous public parks, trails, ball fields, and public golf courses. Several of these recreational facilities are located along portions of the Souris River where flows could be affected due to Project operations. These include Dakota Bark Park, the Souris Valley Golf Course, Wee Links Golf Park, Moose Park, Oak Park, Nubbin Park, Riverside Park, Via-View Park, Roosevelt Park, Green Valley Park, Bison Plant Trails, and numerous other hiking/biking trails that parallel the river. Sport fishing from riverbanks and fishing piers in the City of Minot is also a popular activity during favorable flow conditions on the Souris River.

Missouri River Mainstem Reservoir System

The six reservoirs of the Missouri River System and the Missouri River reaches between and downstream of these reservoirs provide recreation opportunities. Recreational activity is a source of income for businesses catering to boating, hunting, fishing, camping, and other recreational pursuits.

Over 80,000 acres of recreational lands are located along nearly 6,000 miles of Missouri River System reservoir shoreline. Recreation at Missouri River System projects consists of both water- and land-based activities. Water-based recreation includes boating, fishing, water skiing, jet skiing, and swimming.

According to visitation data maintained through 1999 by the Corps in the Natural Resource Management System database, a total of 6,731,800 visits (person-trips) are made per year to the six Missouri River System projects (Corps 2006).

According to economic data (Corps 2006), a total of $108.26 million in visitor spending is generated annually from the purchase of goods (excluding durable goods like boats and campers) within 30 miles of the six projects, with 56 to 66 percent of the spending being captured by the local economy as direct sales effects. With multiplier effects, visitor-trip spending supports an estimated 2,957 jobs in the local communities surrounding the lakes and results in $109.67 million in total sales and $56.95 million in total income annually.

Farmland

The Farmland Protection Policy Act of 1994 was enacted to reduce the amount of highly productive farmland being converted to nonagricultural uses as a result of various federal programs. The act defines farmland as prime farmland, unique farmland, and land of statewide or local importance. Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses. (The land could be cropland, pastureland, rangeland, forest land, or other land, but not urban built-up land or water.) Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops. Farmland of statewide or local importance is land, in addition to prime and unique farmlands, that is of statewide or local importance for the production of food, feed, fiber, forage, and oil seed crops as determined by the appropriate state agency or agencies (NRCS 2012). GIS mapping data from the Natural Resources Conservation Service indicate that there are extensive areas of prime farmland in Renville and Bottineau counties, and smaller and more scattered areas of prime farmland in Ward and McLean counties (Figure 3-29). Farmland of statewide or local importance is located throughout the Project Area but is concentrated in Ward, Burke, Divide and Williams counties. No unique farmland is known to be present within the Project Area. Areas of potentially affected prime farmland in the Project Area would be limited to locations adjacent to the proposed bulk distribution pipeline in Ward, Renville, and Bottineau counties.

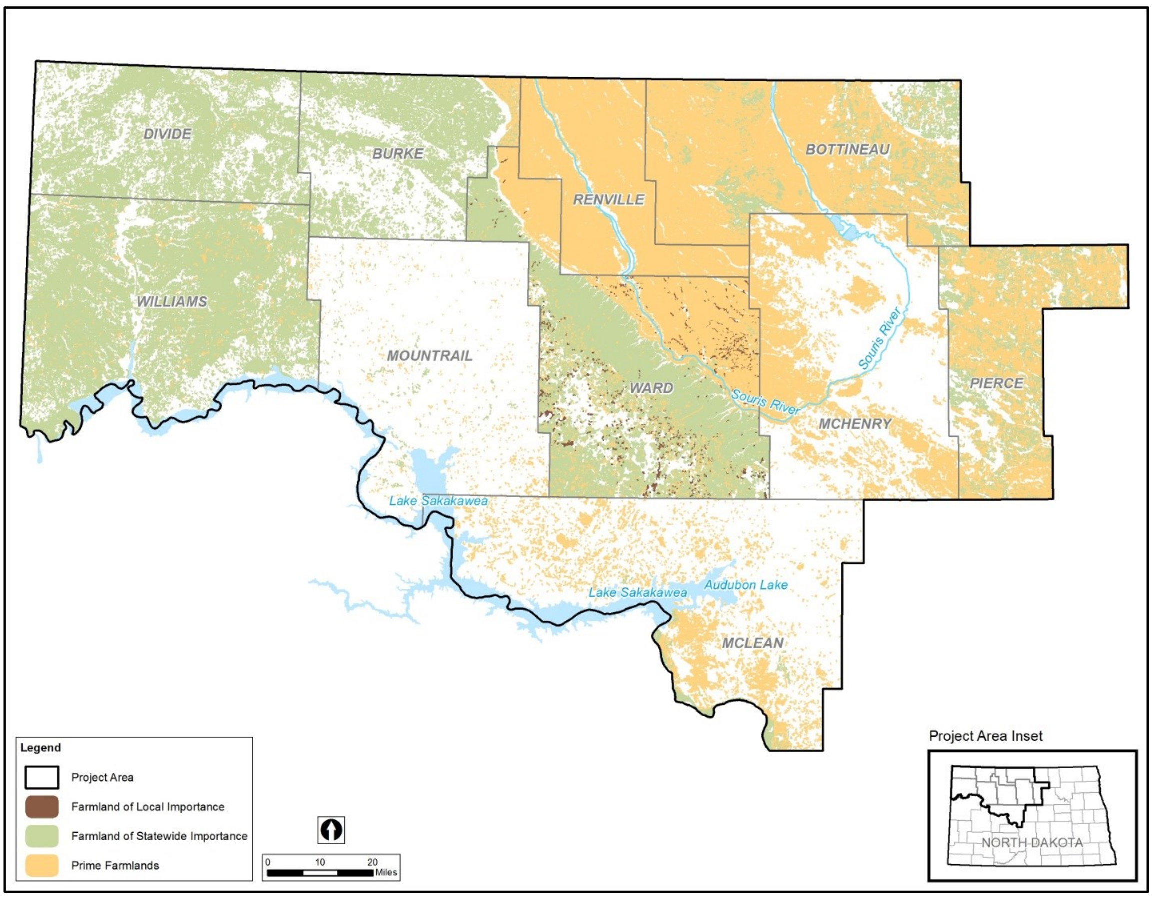

Figure 3-29 Project Area Farmland
Source: NRCS 2013

Vegetation

The affected environment for upland vegetation includes a ½-mile corridor along either side of the proposed pipelines and around other facilities. Riparian, wetland, and aquatic habitats are addressed in the Wetlands and Riparian Areas and Fisheries and Aquatic Invertebrates sections of this chapter. Vegetation mapping data are derived from the 2010 GAP GIS dataset (Strong 2010). Because the habitat descriptions for the 2010 GAP data have not yet been published, the descriptions below have been compiled from a variety of sources. USGS topographic maps also were referenced.

Vegetation Habitat Types

Much of the area where Project facilities would be located is already developed and contains little or no native vegetation. Vegetation in developed areas provides limited habitat for wildlife species adapted to living with human activities. Four major habitat types are present in the remaining areas:

- Agricultural land (cultivated cropland and pasture/hay)
- Grassland
- Shrubland and forested land
- Developed or otherwise disturbed land

Agricultural Land

Agricultural lands include cultivated cropland and pasture/hay. Cultivated crops include small grains such as durum wheat, spring wheat, barley, and oats. Specialty crops are also grown in rotation with small grains, such as canola, sunflowers, dry edible peas, corn, and flax (USDA-National Agricultural Statistics Service 2011). Pasture/hay includes planted rangeland and tame haylands grown for forage crops for harvest, for grazing, and the Conservation Reserve Program. The plant species composition of both planted rangeland and tame haylands vary from one area to another. Often the species planted are introduced species such as smooth brome, crested wheatgrass, alfalfa, and sweet clover although some plantings are native grass species (Strong 2005).

Grasslands

Two types of grassland are present: Northwestern Great Plains mixed-grass prairie and Western Great Plains tallgrass prairie.

Northwestern Great Plains Mixed-Grass Prairie

Northwestern Great Plains mixed-grass prairie consists primarily of native rangeland, with some undisturbed areas of native grassland. It is found on the rolling hills of the Missouri Coteau, which rise 150 to 500 feet above the Drift Prairie. This mixed-grass prairie is typically dominated by grasses, particularly western wheatgrass. Other species include prairie junegrass, little bluestem, green needlegrass, blue grama, and needle and thread (NDGFD 2005; Montana Natural Heritage Program and Montana Fish, Wildlife and Parks 2012a). Forb species typical of this vegetation type include pasque flower, yarrow, gumweed, golden aster, prairie rose, Missouri milkvetch, purple loco, lead plant, purple prairie-clover, gaura, harebell, goldenrod, purple coneflower, fringed sage, and many others (NDGFD 2005).

Western Great Plains Tallgrass Prairie

Minimal amounts of Western Great Plains tallgrass prairie are present in the vicinity of some of the proposed facilities. Where present, it may occur either as small patches interspersed within Northwestern Great Plains mixed-grass prairie, or it may be associated with upland terraces above the floodplain. This prairie is typically dominated by big bluestem and may also include Indiangrass, little bluestem, western wheatgrass, porcupine grass, and prairie dropseed. In addition to these grasses, forbs occur in varying densities.

Shrublands and Forested Land

Three types of upland shrublands and forested lands are present near the proposed facilities: Northwestern Great Plains shrubland, Western Great Plains wooded draw and ravine, and Western Great Plains dry bur oak forest and woodland.

Northwestern Great Plains Shrubland

Northwestern Great Plains shrubland is also found on the rolling hills of the Missouri Coteau, and only negligible amounts are present near some of the proposed facilities. While these shrublands can occur on any landscape aspect, they are more common on mesic sites (sites having or characterized by moderate or a well-balanced supply of moisture) with moderately shallow or deep fine to sandy loam soils, particularly near breaklands or on upper terraces (Montana Natural Heritage Program and Montana Fish, Wildlife and Parks 2012b). These shrublands may expand when fire is suppressed in grasslands. Dominant shrubs include snowberry, serviceberry, skunkbush sumac, silver buffaloberry, shrubby cinquefoil, silverberry and horizontal rug juniper. The herbaceous component is similar to the adjacent Northwestern Great Plains mixed-grass prairie. Areas mapped as recently burned shrubland are included in this category.

Western Great Plains Wooded Draw and Ravine

Western Great Plains wooded draw and ravine vegetation is typically associated with highly intermittent or ephemeral streams, particularly on canyon bottoms or steep northern slopes, and only negligible amounts are present near some of the proposed facilities. In the Northwestern Great Plains, green ash, American elm, cottonwood, willow species, aspen, paper birch, and boxelder maple are typically present (Strong 2005; Montana Natural Heritage Program and Montana Fish, Wildlife and Parks 2012c). In the Missouri Coteau, green ash or chokecherry are the usual dominants.

Western Great Plains Dry Bur Oak Forest and Woodland

Western Great Plains dry bur oak forest and woodland occurs in upland areas in the Project Area, usually as patches on buttes and foothills, but is generally not present near most of the proposed facilities. The dominant tree species in this forest is bur oak. Other tree species include aspen, junipers, and ash. Shrubs typical of these forests and woodlands include snowberry, serviceberry, and beaked hazelnut. The herbaceous understory is moderately dense to sparse and consists primarily of prairie grasses or woodland sedges (Natureserve 2009).

Federally Protected Plant Species

No federally listed plant species occur in the Project Area. North Dakota does not designate plant species as conservation priority species. Therefore, no plant species protected by federal or state regulations are present.

Wetlands and Riparian Areas

Wetlands are areas inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support (and under normal conditions do support) a prevalence of vegetation typically adapted for life in saturated soil conditions (Corps 1987). Wetlands are important for flood and erosion control, water quality, and wildlife habitat, and they provide important recreation opportunities for North Dakota residents. They help to protect the quality of surface water by impeding the erosive forces of moving water and trapping waterborne sediment and associated pollutants, assisting the purification of surface water and groundwater resources, maintaining base flow to surface waters through the gradual release of stored floodwaters and groundwater, and providing a natural means of flood control and storm drainage protection through the absorption and storage of water during high-runoff periods.

The affected environment for wetlands includes a ½-mile corridor on either side of the proposed pipelines and around other facilities, as well as around surface water and groundwater bodies that could be affected by Project operation, including changes in water surface elevation and inbasin withdrawals. Wetlands within the Project Area were identified with the use of mapping data available from the National Wetlands Inventory (Service 2012a).

Wetlands within the Affected Environment

The Project would be located within the Prairie Pothole Region of North Dakota, which is discussed in further detail later in the Wildlife section of this chapter. This area receives much of its water from spring snowmelt and is widely interconnected with groundwater lenses that help maintain wetlands (Euliss et al. 1999). Wetlands are present in a number of areas, including those adjacent to the Souris River and Audubon Lake and along the proposed bulk distribution pipeline corridor. Wetlands in the affected environment were classified using the wetland classification system described by Cowardin et al. (1979) as lacustrine (lakes), riverine (rivers, perennial and intermittent streams), and palustrine (ponded) wetlands. Palustrine wetlands are mostly associated with prairie pothole systems. These ponded wetlands can serve a variety of hydrologic functions. They may store surface water or groundwater, recharge groundwater with surface water, provide surface water from groundwater, and provide a source of atmospheric water. In addition, they provide habitat to a variety of aquatic organisms (LaBaugh et al. 1998). However, it is common among prairie pothole wetlands that they may not be naturally integrated into the surface water and groundwater system, meaning there may not be inflow or outflow between the wetland and nearby surface water or groundwater (LaBaugh et al. 1998). Hydrologic interactions of water in prairie pothole wetlands with groundwater and surface water is not well understood because there is considerable variability between individual wetlands (Winter 1989).

Additionally, wetlands occur within and adjacent to perennial and intermittent drainages, such as the impounded lacustrine wetlands along the Souris River, particularly in the area of the Upper Souris River and J. Clark Salyer NWRs and Lake Darling. Table 3-23 shows the acreages of the various wetland types that are located throughout the Souris River basin; descriptions of each type follow.

Table 3-23 Wetland Types within the Souris River Basin

Wetland Type	Acres [a]
Riverine (perennial and intermittent streams)	5,065
Lacustrine (lakes)	78,252
Palustrine Emergent	360,702
Palustrine Forested Vegetation	2,090
Palustrine Scrub-Shrub	1,878
Palustrine Unconsolidated Bottom	976
Palustrine Aquatic Bed	21,442
Palustrine Unconsolidated Shore	276
Total	**470,681**

Note:
[a] All acreages are approximate.
Source: Service 2012a

Riverine Wetlands

Riverine wetlands that occur in the affected environment are classified as lower perennial aquatic bed (Cowardin et al. 1979). Water is usually, but not always, flowing in riverine wetlands. The Souris and Missouri Rivers (non-reservoir) would be considered riverine wetlands.

Lacustrine Wetlands

Lacustrine wetlands include permanently flooded lakes, reservoirs, and intermittent lakes. Lacustrine wetlands generally lack vegetation except around the edges. Lake Sakakawea, Audubon Lake, and Lake Darling would be considered lacustrine wetlands.

Palustrine Emergent (PEM) Wetlands

These wetlands are characterized by erect, rooted, herbaceous hydrophytes (i.e., aquatic plants), excluding mosses and lichens. Wildlife frequently use these areas for nesting and feeding, particularly during migration. Water regimes associated with PEM wetlands within the Project Area include temporarily flooded, seasonally flooded, and semi-permanently flooded regimes. Some PEM wetlands in the Project Area are partially drained, ditched, diked, impounded, or created through the excavation of soils.

Palustrine Scrub-Shrub (PSS) Wetlands

These wetlands are dominated by woody vegetation less than 20 feet tall. PSS wetlands supply an abundance of food and cover resources for mammals and birds, and provide the necessary breeding habitat for many migratory bird species. All PSS wetlands within the Project Area have a temporarily flooded water regime.

Palustrine Unconsolidated Bottom (PUB) Wetlands

PUB wetlands have a muddy or silty substrate with less than 30 percent vegetative cover. In the Project Area, these wetlands were created through the excavation of soils and are intermittently exposed; meaning surface water is present throughout the year except in drought years.

Palustrine Aquatic Bed (PAB) Wetlands

These wetlands are dominated by plants that grow principally on or below the water surface for most of the growing season in most years. All PAB wetlands within the Project Area have a semi-permanently flooded water regime. Some of these wetlands in the Project Area were created through the excavation of soils.

Palustrine Unconsolidated Shore (PUS) Wetlands

PUS wetlands have unconsolidated substrates with less than 75 percent areal cover of stones, boulders, or bedrock, and less than 30 percent areal cover of vegetation other than pioneering plants. “Pioneering plants” are those that become established during brief periods when growing conditions are favorable. Examples of this wetland type include beaches and bars.

Vegetation types that can be found in these wetlands include wetland low prairie, wet meadow, shallow-marsh emergent, deep marsh emergent, fin emergent, submerged and floating aquatic, natural drawdown, and cropland drawdown vegetation (Stewart and Kantrud 1972).

Aquatic ecology of riverine, lacustrine, and palustrine wetlands is discussed in the “Fisheries and Aquatic Invertebrates” section of this chapter.

Riparian Areas within the Affected Environment

Riparian areas are the areas of vegetation that occur along and are influenced by streams. Riparian areas serve a variety of functions in the Souris River watershed, including dissipation of stream energy, wildlife habitat, water storage, and a source of organic material input for the stream system. Vegetation within these areas may be forest, shrub, and or/herbaceous types.

Forested riparian areas occur along the Souris River typically in areas where there is a meandering channel and/or oxbows. In these areas, green ash is dominant, with bur oak, boxelder, estern cottonwood, and balsam poplar also occurring. In shrub areas, vegetation commonly includes redosier dogwood, chokecherry, and willow (Service 2007b). The majority of riparian areas in the Souris River watershed are herbaceous. Vegetation in these areas includes a variety of forbs, grasses, and sedges that are generally deep rooted and tolerant of flooding.

Common Wildlife

The affected environment for wildlife includes the entire Project Area due to their mobility. The Project Area (Figure 3-1) includes a diversity of wildlife, including big game animals, small and medium-sized game animals and furbearers, waterfowl and game birds, and many other non-game animals. Wildlife habitats in the Project Area primarily include agricultural lands interspersed with mixed-grass prairie, wetlands, and woodland habitat. These vegetation communities provide foraging, cover, and breeding habitats for wildlife. Regional and important wildlife habitats in the area are described and illustrated later in this section. Wildlife conservation habitats occurring within the Project Area are discussed in the Land Use section of this chapter.

The analysis of affected environment for wildlife was conducted primarily using data from the following sources:

- Service – NWR location and species use, WPAs, special-status species, *Birds of Conservation Concern 2008*
- USGS – species information
- NDGFD – species information, hunting and trapping information, *North Dakota Comprehensive Wildlife Conservation Strategy 2005*
- Ducks Unlimited – species information

Description of Common Wildlife in the Project Area

Representative big game animals, small and medium-sized game animals and furbearers, game birds, and non-game animals that may occur in the Project Area, together with the habitats they use, are described in Appendix G, Table G2-3. Some animals, such as white-tailed deer and coyote, are present across the entire Project Area in all counties, whereas other animals, such as ruffed grouse, are present only within a single county. Table G2-3 identifies the habitats used by each wildlife species. Many common animals are valued game resources; hunting for big and small game animals, furbearers, upland game birds, and waterfowl occurs primarily during the spring or fall.

Big Game

Pronghorn antelope, mule deer, and elk are most frequently found in the southern and western portion of the state. However, they may occur in smaller numbers in suitable habitat within the Project Area. Moose are found in the northern and eastern part of the state. The primary range of the mountain lion lies outside of the Project Area; however, this species is occasionally found throughout North Dakota. White-tailed deer is the most common big game mammal in the Project Area and occurs throughout North Dakota.

White-tailed deer are generally found in wooded and wetland areas with dense emergent vegetation, and they thrive in areas containing a mix of farmland and native habitat. Forested habitats are very important feeding and bedding areas for white-tailed deer, particularly during the winter. White-tailed deer are known to be migratory in North Dakota between their summer and winter ranges, with an average distance of between 12 and 164 miles (Smith 2005 as cited in Dyke et al. 2011). They do not have identifiable migration corridors, but rather appear to disperse in all directions (Dyke et al. 2011).

Small and Medium-Sized Game Animals and Furbearers

Small and medium-sized mammals found in the Project Area include furbearers such as mink, muskrat, white-tailed jackrabbit, badger, red fox, striped skunk, raccoon, long-tailed weasel, eastern cottontail, fox squirrel, and coyote. These mammals are commonly found throughout North Dakota.

Waterfowl and Game Birds

Shorebirds, ducks, geese, and other waterfowl are common; and large numbers of geese and ducks migrate through the area during spring and fall. The Missouri Coteau ecoregion and the Souris River watershed provide important breeding habitat for 12 species of waterfowl (Stewart 1975). The availability of shallow wetlands and upland cover provides excellent nesting and rearing habitat for these species. Additional migrants pass through the Project Area traveling to and from their northern breeding grounds during spring and fall. All migratory birds are protected by the Migratory Bird Treaty Act (MBTA) of 1918. Non-migratory birds, including non-native birds such as European starling and house sparrow and non-native upland game birds such as the pheasant are not protected by the MBTA.

Small game bird species found within the Project Area include sharp-tailed grouse, gray partridge, ring-necked pheasant, ruffed grouse, Wilson's snipe, and wild turkey. Resident game birds (such as wild turkeys and grouse) are not protected by the MBTA. However, some native game birds are considered species of conservation concern and are discussed further below. Wilson's snipe is a migratory game bird that is protected by the MBTA and as such, hunting seasons and limits are set and regulated by the Service and state wildlife management agencies.

Non-Game Mammals

Non-game mammals that occur in the Project Area include the big brown bat, little brown bat, masked shrew, meadow vole, and thirteen-lined ground squirrel (Grondahl n.d.). These mammals are found throughout North Dakota and are common within the Project Area.

Non-Game Birds

The golden eagle occurs in North Dakota, although it is not commonly found within the Project Area (Dyke et al. 2011). This species is protected under the Bald and Golden Eagle Protection Act. Other raptors include the turkey vulture, red-tailed hawk, American kestrel, prairie falcon, burrowing owl, great horned owl, and short-eared owl. Numerous songbirds inhabit the area, including the western meadowlark, house sparrow, lark bunting, and American goldfinch (Stewart 1975; Cornell University 2011). Non-game birds listed as Birds of Conservation Concern (Service 2008) potentially occurring in the Project Area include Nelson's sharp-tailed sparrow, Franklin's gull, and McCown's longspur. (A complete list of non-game birds listed as Birds of Conservation Concern that may occur in the Project Area is in Appendix G, Table G2-2.)

Amphibians and Reptiles

Many species of reptiles and amphibians inhabit North Dakota. Reptiles include the western painted turtle, common snapping turtle, common garter snake, plains garter snake, redbelly snake, smooth green snake, western hognose snake, bullsnake, racer, and prairie rattlesnake (USGS 2006). Common amphibians include the Plains spadefoot toad, Woodhouse's toad, Great Plains toad, Canadian toad, northern leopard frog, wood frog, western chorus frog, and tiger salamander (USGS 2006).

Insects

Insects that occur in the Project Area include butterflies (e.g., skippers, swallowtails, whites, and sulphurs; gossamer and winged butterflies; and brush-footed butterflies), dot-tailed whiteface dragonfly, Plains forktail damselfly, and tiger beetle.

Description of Wildlife Habitats in the Project Area

Regional Wildlife Habitats

North Dakota is home to a variety of wildlife habitats, and the Project Area is close to four major regions: Drift Prairie, Missouri Coteau, Turtle Mountains, and Missouri Slope (NDGFD 2004), as shown in Figure 3-30. These regional habitats and the species common to each are described below. Table 3-24 identifies the characteristic wildlife associated with the major regional wildlife habitats.

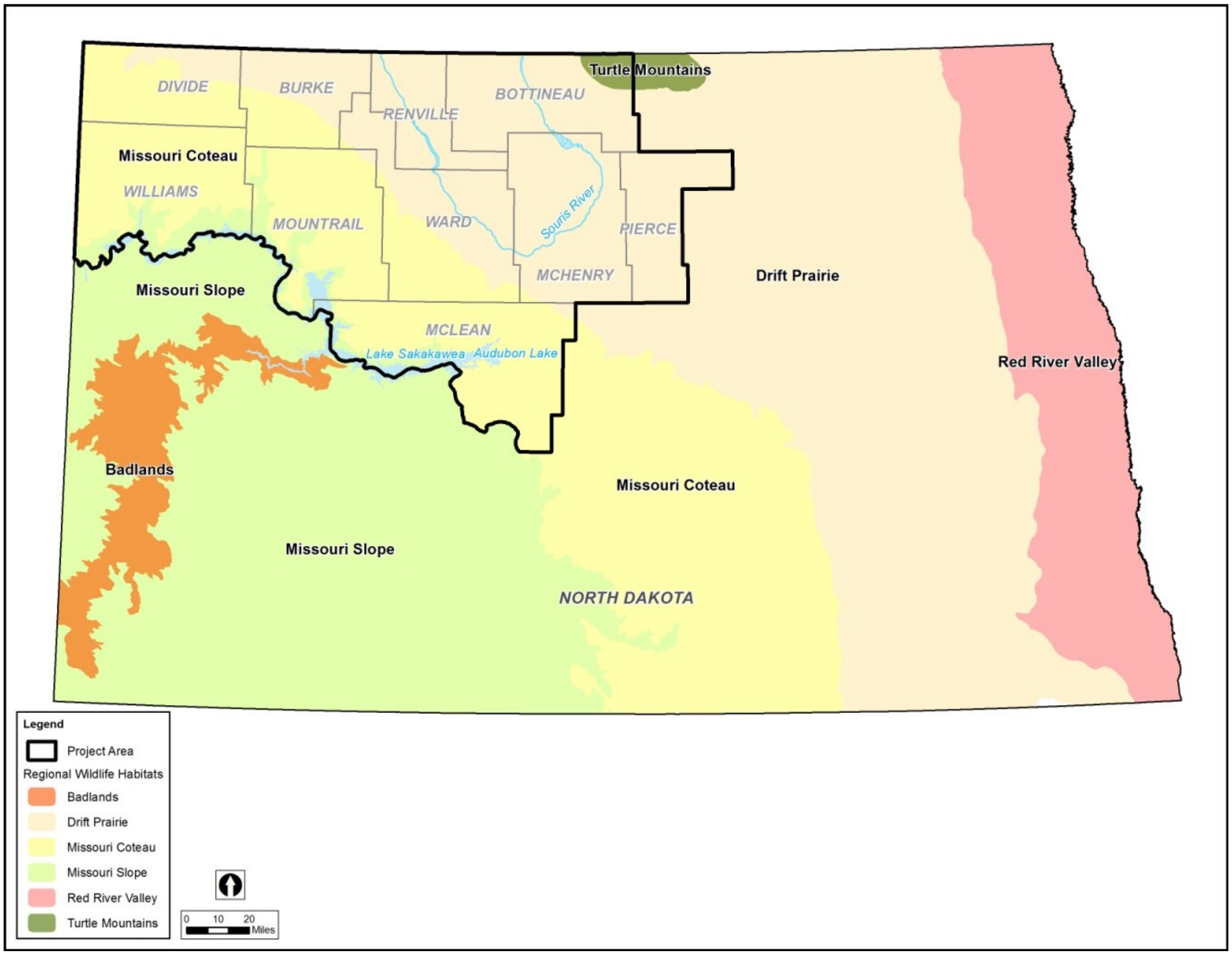

Figure 3-30 Major Habitats

Table 3-24 Characteristic Wildlife Associated with Regional Wildlife Habitats

Regional Wildlife Habitat	Mammals	Birds	Reptiles and Amphibians
Drift Prairie	Northern short-tailed shrew, white-tailed jackrabbit, snowshoe hare, Franklin's ground squirrel, thirteen-lined ground squirrel, Northern pocket gopher, olive-backed pocket mouse, Western harvest mouse, deer mouse, Northern grasshopper mouse, prairie vole, meadow vole, meadow jumping mouse, Western jumping mouse, coyote, red fox, raccoon, badger, striped skunk, white-tailed deer, moose	American wigeon, green-winged teal, mallard, blue-winged teal, Northern shoveler, gadwall, lesser scaup, red-tailed hawk, American kestrel, gray partridge, ring-necked pheasant, spotted sandpiper, killdeer, mourning dove, common nighthawk, Western kingbird, Eastern kingbird, horned lark, American crow, Eastern bluebird, common yellowthroat, clay-colored sparrow, vesper sparrow, savannah sparrow, Western meadowlark, brown-headed cowbird	American toad, Great Plains toad, Woodhouse's toad, Northern leopard frog, chorus frog, tiger salamander, plains garter snake, common garter snake
Missouri Coteau	White-tailed jackrabbit, snowshoe hare, thirteen-lined ground squirrel, Northern pocket gopher, olive-backed pocket mouse, Western harvest mouse, deer mouse, Northern grasshopper mouse, prairie vole, meadow vole, meadow jumping mouse, coyote, red fox, raccoon, badger, striped skunk, white-tailed deer	American wigeon, green-winged teal, mallard, blue-winged teal, Northern shoveler, gadwall, lesser scaup, red-tailed hawk, American kestrel, gray partridge, ring-necked pheasant, spotted sandpiper, killdeer, mourning dove, common nighthawk, Western kingbird, Eastern kingbird, horned lark, American crow, Eastern bluebird, common yellowthroat, clay-colored sparrow, vesper sparrow, Savannah sparrow, Western meadowlark, brown-headed cowbird	Great Plains toad, Woodhouse's toad, Northern leopard frog, chorus frog, tiger salamander, plains garter snake, common garter snake, yellowbelly racer, bullsnake
Turtle Mountains	Little brown bat, big brown bat, Eastern red bat, Eastern cottontail, Northern flying squirrel, beaver, white-footed mouse, meadow vole, Western jumping mouse, porcupine, coyote, red fox, raccoon, weasel, elk, white-tailed deer	turkey vulture, sharp-shinned hawk, broad-winged hawk, red-tailed hawk, bald eagle American kestrel, ruffed grouse, wild turkey, great horned owl, downy woodpecker, hairy woodpecker, yellow-shafted flicker, willow flycatcher, common crow, ruby-crowned kinglet, American robin, gray catbird, yellow-throated vireo, song sparrow, American goldfinch, horned grebe	American toad, gray tree frog, wood frog, common garter snake, plains garter snake, Northern redbelly snake
Missouri Slope	Thirteen-lined ground squirrel, Northern pocket gopher, olive-backed pocket mouse, Ord's kangaroo rat, Western harvest mouse, deer mouse, Northern grasshopper mouse, prairie vole, meadow vole, meadow jumping mouse, coyote, red fox, raccoon, badger, striped skunk, mountain lion, bobcat, elk, mule deer, white-tailed deer, pronghorn	Mallard, blue-winged teal, Northern shoveler, gadwall, red-tailed hawk, American kestrel, merlin, gray partridge, ring-necked pheasant, wild turkey, killdeer, mourning dove, common nighthawk, Western kingbird, Eastern kingbird, horned lark, Eastern bluebird, mountain bluebird, common yellowthroat, clay-colored sparrow, vesper sparrow, lark sparrow, Savannah sparrow, Western meadowlark, brown-headed cowbird	Woodhouse's toad, Great Plains toad, Northern leopard frog, Western chorus frog, tiger salamander, common garter snake, plains garter snake, yellowbelly racer, bullsnake, prairie rattlesnake

Drift Prairie

Most of the Project Area lies within this region. The landscape of the Drift Prairie habitat is characterized by flat to gently rolling hills composed of glacial drift. Vegetation consists of mixed-grass prairie of western wheatgrass, green needlegrass, side oats grama, and blue grama. The area has a high concentration of temporary and seasonal wetlands, which create favorable conditions for duck nesting and migration. The soil is very productive and has resulted in extensive cultivation of the land, with many wetlands drained or simply tilled and planted. Much of the area is extensively tilled for spring wheat and other small grains, sunflowers, and alfalfa. Valuable waterfowl habitat is concentrated in state- and federally sponsored duck production areas (Bryce et al. 1998).

Missouri Coteau

The southern portion of the Project Area lies within this region. The landscape here is characterized by rolling and irregular terrain composed of mixed-grass prairie interspersed with a variety of wetlands. The wetlands of the Missouri Coteau and the neighboring Prairie Pothole Region provide wildlife habitat and are the major waterfowl production areas in North America. Land use is a mixture of tilled agriculture (small grains and row crops) in flatter areas and grazing land on steeper slopes (Bryce et al. 1998).

The Missouri Coteau Region of North Dakota is a prime waterfowl nesting region of North America. Eighteen counties make up the Coteau and contain over 1 million temporary, seasonal, and semi-permanent wetlands that cover over 1.3 million acres (Figure 3-29). The average density of these three classes of wetlands reaches nearly 42 per square mile. These numerous wetlands coupled with the presence of adequate cover attract millions of nesting waterfowl and shorebirds each year (Nyren and Dewald 2012).

Turtle Mountains

The northeast part of Bottineau County lies within this region. This landscape is characterized as a platform of rolling terrain. Vegetation consists of deciduous forests. High concentrations of temporary and seasonal wetlands similar to the Missouri Coteau create favorable conditions for duck nesting and migration. In addition, the Turtle Mountains contain large, deep, and numerous lakes. The forest soils are erodible and poorly suited for cropland, although there is some clearing for pastureland (Bryce et al. 1998).

Missouri Slope

A small southwestern portion of the Project Area lies within this region. The landscape of this region is characterized by irregular topography with an occasional butte rising above the landscape. Complex drainage systems cut breaks through the topography. Shrub steppe, or prairie with a large component of sagebrush, occurs scattered throughout. Wetland basins are minimal, constituting about several hundred-thousand acres. Vegetation consists of western wheatgrass, needle and thread, prairie junegrass, and green needlegrass. Dryland farming is the predominant land use, although some cattle grazing also occurs (Bryce et al. 1998; NDGFD 2005).

Important Wildlife Habitats

Important wildlife habitats in the Project Area include the Prairie Pothole Region and the Central Flyway, each of these is discussed further below.

Prairie Pothole Region

As mentioned in other sections of Chapter 3 (Fisheries and Aquatic Invertebrates and Wetlands and Riparian Areas), the Prairie Pothole Region consists of millions of shallow depressions formed by receding glaciers from the last ice age that are now seasonal wetlands, known as prairie potholes. These potholes encompass a myriad of small wetlands ranging from wet meadows and shallow ponds to saline lakes, marshes, and fens. Some prairie pothole marshes are temporary, while others may be essentially permanent. Habitat in the majority of the wetlands consists of submerged and floating aquatic plants within the deeper water at the center of the pothole while bulrushes and cattails generally grow closer to shore, and wet, sedge marshes lie next to upland areas (EPA 2012b). The larger saline lakes contain little or no emergent vegetation due to the high salinity. Species associated with saline lakes include the American avocet, willet, and Wilson's phalarope. A federally threatened species, the piping plover, is often associated with saline lakes and is discussed in the Federally Protected Species section.

The Prairie Pothole Region within North Dakota is a key breeding area and a significant contributor to continental waterfowl populations. Figure 3-31 shows the extent of the Prairie Pothole Region within North Dakota. In 2005, there were an estimated 4.1 million breeding ducks settled across North Dakota (Ducks Unlimited 2012a). Increased agricultural and commercial development have altered or destroyed wetland habitats such that only an estimated 40 to 50 percent of the region's original prairie pothole wetlands remain undrained today (EPA 2012b).

The Great Plains and Prairie Pothole Region are the most important and threatened waterfowl habitats in the United States (Ducks Unlimited 2012a). Millions of waterfowl pass through the Prairie Pothole Region each spring, nesting in the grasslands which provide important breeding habitat for pintails, mallards, gadwall, blue-winged teal, shovelers, canvasbacks and redheads. The region is also important as migration habitat for waterfowl breeding in the boreal forest and arctic, such as lesser scaup, wigeon, green-winged teal, Canada geese, and snow geese. Wetland and grassland communities such as the prairie potholes also provide habitat for a vast array of indigenous wildlife species, including other ground-nesting birds (Service 2012b).

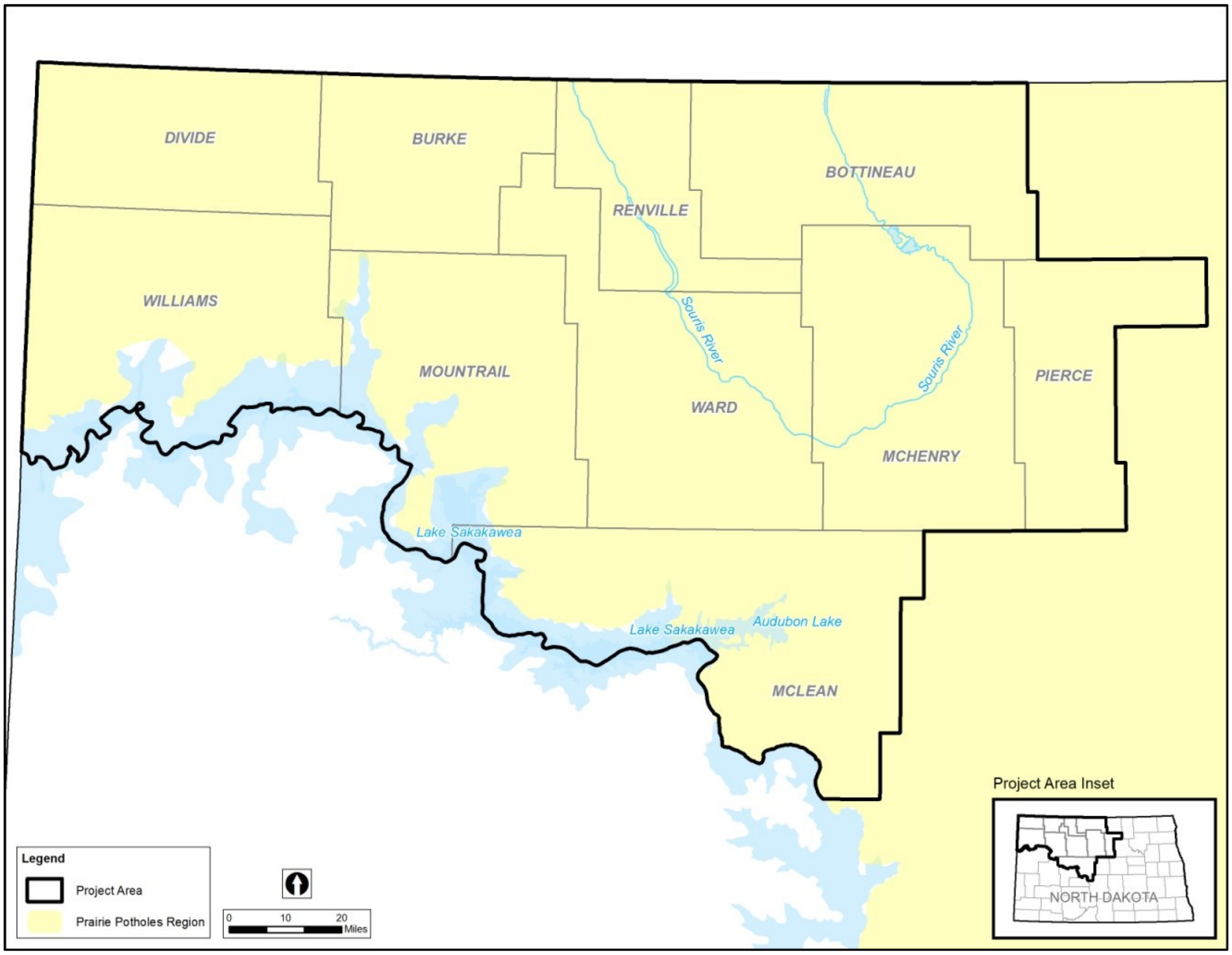

Figure 3-31 Prairie Pothole Region

Source: Ducks Unlimited 2012a

Central Flyway

Waterfowl follow distinct, traditional migration corridors, or flyways, in their annual travels between breeding and wintering areas. The Central Flyway is a bird migration route that covers more than 1 million square miles across North America's interior, from Canada's boreal forest and parklands across the Great Plains down to the Texas Gulf Coast; it is home to a large percentage of North America's ducks and geese. The Central Flyway includes North Dakota, South Dakota, Texas, Oklahoma, Kansas, and Nebraska; portions of Montana, Wyoming, Colorado, and New Mexico east of the Basin Divide; the Canadian provinces of Alberta and Saskatchewan; and the Northwest Territories (Ducks Unlimited 2012b).

Birds that are managed under the Central Flyway Council include migratory shore and upland game birds such as mourning doves, sandhill cranes, snipes, and woodcocks, and waterfowl such as ducks and geese.

Wildlife Conservation Habitats

A number of wildlife conservation habitats lie within or close to the Project Area. These areas are further discussed in the Land Use section of this chapter.

Federally Protected Species

The affected environment for federally protected species includes the entire Project Area due to their mobility (Figure 3-1). Wildlife conservation habitats occurring within the Project Area are discussed in the Land Use section of this chapter.

The Service, as required by the Endangered Species Act (ESA), provided a list of federally endangered, threatened, and candidate species that are or may be present in the Project Area (Appendix G) and those most likely to be found within the Project Area are discussed below.

Description of Federally Protected Species in the Project Area

Species listed as threatened and endangered under the ESA, as well as candidate species that may occur in the Project Area, together with the habitats they use, are described in Appendix G, Table G2-3.

Gray Wolf (Endangered)

North Dakota

The gray wolf is an infrequent visitor to North Dakota, occasionally entering the state from Minnesota or from the province of Manitoba, Canada. However, lone wolves occasionally appear, primarily in the eastern portion of the state. Pups were reported in the Turtle Mountains of North Dakota; one wolf sighting was confirmed in early 2004, and two wolf depredation incidents were verified north of Garrison in late 2005 (71 FR 15266). In 2003, the Service changed the classification of the gray wolf under the ESA, and three separate ESA listings for the species were established, which correspond to three geographic areas in the lower 48 states with gray wolf recovery programs. North Dakota and Minnesota wolves are within the Gray Wolf Eastern Distinct Population Segment. On December 28, 2011, the Service announced the final rule to delist the gray wolf in the western Great Lakes, and the wolf was no longer protected under the ESA after January 27, 2012 (76 FR 81666).

The gray wolf was delisted in Minnesota and in the portion of North Dakota north and east of the Missouri River at the North Dakota/South Dakota state line upstream to Lake Sakakawea and east of the centerline of Highway 83 to the Canadian border as of January 27, 2012, but remains listed as endangered in western North Dakota. Therefore, in the Project Area the wolf is considered delisted east of Highway 83 and endangered west of Highway 83. The Service reopened the comment period on the proposed delisting several times due to additional information on the nature of wolf taxonomy (the Service now recognizes three wolf subspecies in the United States), and a final decision was anticipated by the end of 2014. A recent court decision (December 2014 Civil Action No. 13-186(BAH) Humane Society v. Sally Jewell (DOI) v. State of Wisconsin etc.) vacates designating a western Great Lakes Distinct Population Segment. The delisting of this distinct population segment has been vacated, and the species is now considered endangered throughout North Dakota. Due to the relative absence of secluded habitat in most of North Dakota, there is considerable uncertainty regarding whether a wolf pack will establish or become more common in the state. However, due to proximity, as the Minnesota and Canada populations continue to increase, North Dakota should expect to see additional transients.

Northern Long-Eared Bat (Proposed Endangered)

Population Rangewide

The northern long-eared bat ranges across much of the eastern and northcentral United States, and all Canadian provinces west to the southern Yukon Territory and eastern British Columbia. In the United States, the species' range reaches from Maine west to Montana; south to eastern Kansas, eastern Oklahoma, and Arkansas; and east to the Florida panhandle (Figure 3-32). In the west, this bat can be found in caves and abandoned mines of the Black Hills of South Dakota and Wyoming, and in the badlands areas of the Dakotas. Summer habitat can be found in large forested areas along the Missouri River and in the Turtle Mountains.

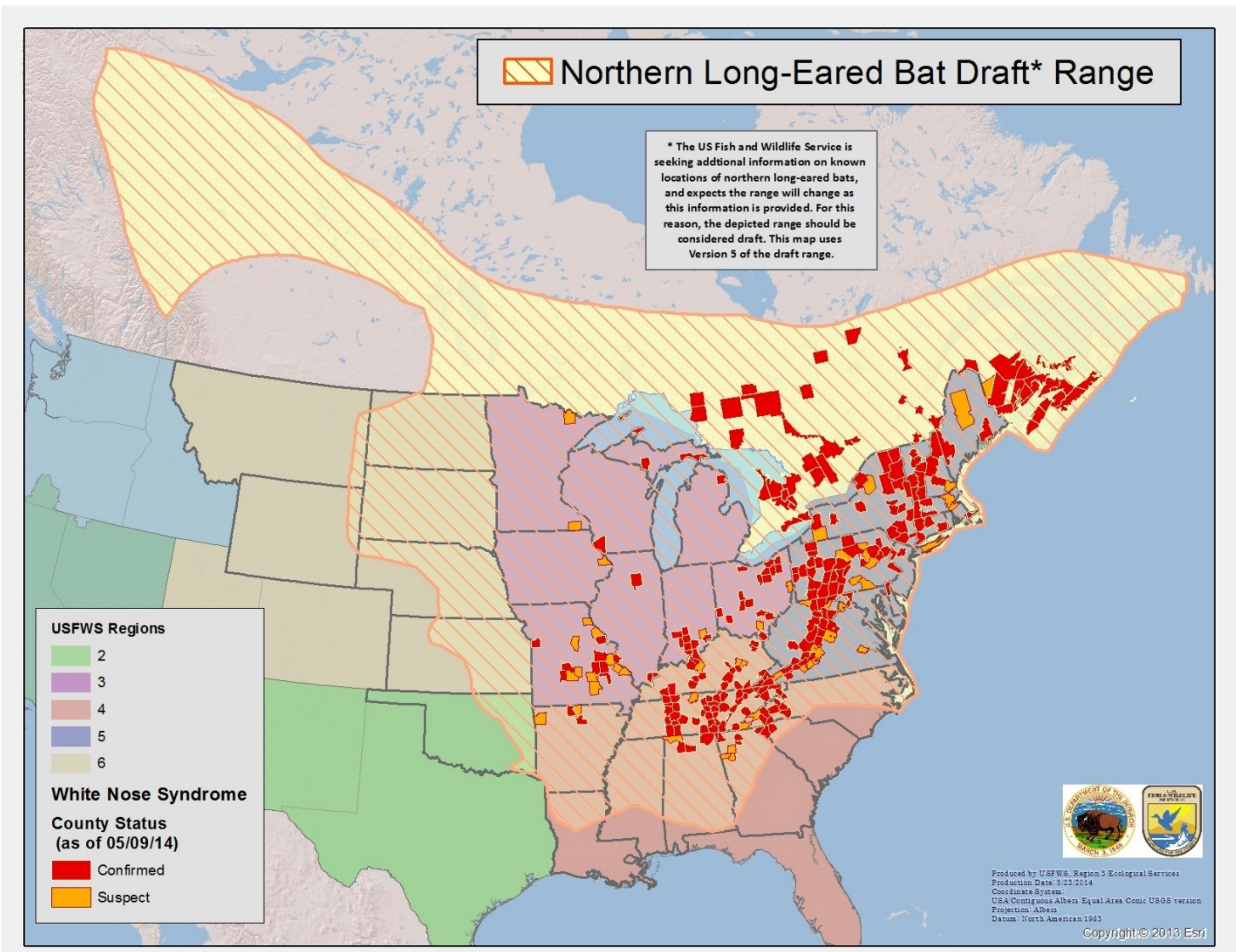

Figure 3-32 Range of the Northern Long-Eared Bat

This species winter habitat includes hibernacula that usually include caves or abandoned mines. During summer, they favor tree roosts and form small colonies. Buildings can also act as roosts. These bats usually tuck themselves under small crevices such as under the bark of large trees. Bats usually emerge at dusk to forage in upland and lowland woodlots and tree-lined corridors, feeding on insects that they catch while in flight using echolocation. This species also feeds by gleaning insects from vegetation and water surfaces. As with many other bat species, these bats migrate between their winter hibernacula and summer habitat. The spring migration period likely runs from mid-March to mid-May, with fall migration likely between mid-August and mid-October.

The biggest threat to this bat is white-nose syndrome (WNS). If this disease had not emerged, it is unlikely that the northern long-eared population would be declining so dramatically. Since symptoms were first observed in New York in 2006, WNS has spread rapidly in bat populations from the Northeast to the Midwest and the Southeast. Population numbers of these bats have declined by 99 percent in the Northeast, which along with Canada has been considered the core of the species' range. The degree of mortality attributed to WNS in the Midwest and Southeast is currently undetermined. Although there is uncertainty about how WNS will spread through the remaining portions of the species' range, it is expected to spread throughout the United States.

North Dakota

Little work has been conducted to document the distribution of the northern long-eared bat in North Dakota (Gillam and Barnhart 2011). Summer surveys in North Dakota (2009–2011) documented the species in the Turtle Mountains, the Missouri River Valley, and the Badlands (Gillam and Barnhart 2011). Gillam and Barnhart (2011) found most of this bat species using tree roosts, particularly cottonwoods. To date, no hibernacula have been described in the state, nor has bat activity been documented during the winter months, but survey work continues searching for hibernacula in Theodore Roosevelt National Park. Based on their ecology and range, this species could occur in the Project Area during the summer in forested areas along the Missouri River, along the Souris River, and in the Turtle Mountains in the vicinity of Bottineau.

Interior Least Tern (Endangered)

Population Rangewide

The interior least tern nests on the Mississippi, Missouri, Arkansas, Red, Rio Grande, Kansas, Platte, Loup, Niobrara, Canadian, Cheyenne, Ohio, and Yellowstone rivers. Rangewide estimates from 1999 indicated that about 7,400 birds were in existence (Service 2000). More recent estimates by the Service (2005) report a considerable increase, and the population is now estimated at about 12,000 birds. This does not represent a complete census, however, because certain segments of some rivers are surveyed in one year but not in another. The Service (2005) reports that this total estimate is likely a minimum. The interior least tern recovery plan established a goal of 7,000 terns rangewide, maintained for 10 consecutive years. The current estimate of over 12,000 terns greatly exceeds this goal; however, the recovery plan goals for least terns in all drainage basins have not been reached, and most areas have not been monitored for 10 years. The recovery plan has not been revised since it was written in 1990, and recovery goals may need to be updated.

The first complete rangewide survey for interior least terns was conducted in 2005 (Lott 2006). A total of 17,587 interior least terns were counted in association with 491 different colonies. Just over 62 percent of these birds were on the lower Mississippi River (10,960 birds on over 770 river miles). Four additional river systems accounted for 33.9 percent of the remaining least terns, with 12.1 percent on the Arkansas River system, 10.4 percent on the Red River system, 7.1 percent on the Missouri River system, and 4.3 percent on the Platte River system. Smaller numbers were counted on other rivers, including the Ohio River system (1.5 percent), the Trinity River system in Texas (1.5 percent), the Rio Grande/Pecos River system in New Mexico and Texas (0.8 percent), and the Kansas River system (0.5 percent) (Lott 2006).

Missouri River Mainstem Reservoir System

Least terns are found nesting throughout the Missouri River System. The majority of these birds nest on free-flowing stretches of the Missouri River below Fort Peck, Garrison, Fort Randall, and Gavins Point dams. The shorelines of the mainstem reservoirs also provide important nesting habitat, particularly during dry years when reservoir levels are declining. Least tern adult numbers on the Missouri River have varied from a low of 273 birds in 2011 to a high of 1,010 birds in 2007 (Figure 3-33). The average number over 26 years of record has been 731 adults (Corps 2013b). The Corps (2013a) found that least tern adults on the Missouri River have decreased in each of the past 4 years until an increase in 2012 following the 2011 flood. As noted above, the 273 least tern adults in 2011 represents a record low for the species in 26 years of censuses on the Missouri River. The decline could be attributed to record inflows into the Missouri River System in 2011 that inundated much of the birds' habitat within the system. The increased bird numbers are attributed to large areas of new habitat created by the record flows of 2011 and receding water levels experienced in 2012.

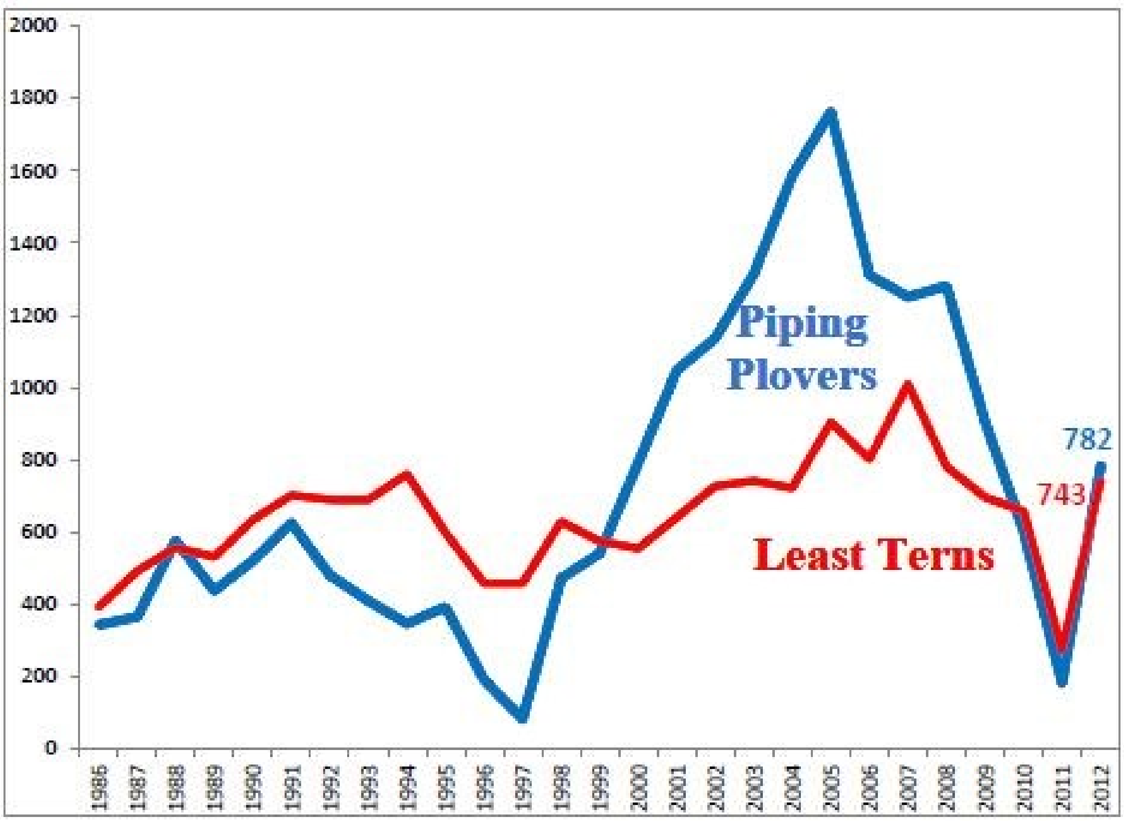

Figure 3-33 Missouri River Least Tern and Piping Plover Adult Census (1985 – 2012)

Source: Corps 2013b

North Dakota

In North Dakota, least terns nest on sparsely vegetated sandbars on the Missouri and Yellowstone rivers and on shorelines of Missouri River reservoirs, including Lake Sakakawea and Lake Oahe. The majority of least terns in North Dakota nest on the Garrison Reach of the Missouri River. Least terns feed mostly on small fish. Breeding season lasts from May through August, with peak nesting from mid-June to mid-July.

Whooping Crane (Endangered)

Population Rangewide

Whooping crane recovery efforts have made great strides over the years, with new populations being established in Florida and Wisconsin. The birds that migrate through North Dakota are part of the Aransas-Wood Buffalo population. The total Aransas-Wood Buffalo population is currently estimated at 279 birds, plus approximately 37 chicks fledged from a record 75 nests that migrated in fall 2011 (Whooping Crane Conservation Association 2012). This will likely yield a wintering population exceeding 300 birds.

The whooping crane recovery plan (Canadian Wildlife Service and Service 2007) includes scientific information about the species and provides objectives and actions needed to down-list the species. Recovery actions designed to achieve these objectives include protection and enhancement of the breeding, migration, and wintering habitat for the Aransas-Wood Buffalo population. The goals are to allow the wild flock to grow and reach ecological and genetic stability; reintroduction and establishment of geographically separate self-sustaining wild flocks to ensure resilience to catastrophic events; and maintenance of a captive breeding flock that is genetically managed to retain a minimum of 90 percent of the whooping cranes' genetic material for 100 years.

North Dakota

The whooping crane passes through North Dakota each spring and fall while migrating between its breeding territory in northern Canada and wintering grounds on the Gulf of Mexico. Frequently, whooping cranes migrate with sandhill cranes. Whooping cranes inhabit shallow wetlands but may also be found in upland areas, especially during migration. The whooping crane prefers freshwater marshes, wet prairies, shallow lakes, and wastewater lagoons for feeding and loafing during migration.

Overnight roosting sites usually have shallow water in which whooping cranes stand. Whooping cranes roost on unvegetated sandbars, wetlands, and stock dams. Fall migration occurs in North Dakota from late September to mid-October, while spring migration occurs from late April to mid-June. These birds can show up in all parts of North Dakota, although most sightings occur in the western two-thirds of the state. Whooping cranes are usually found in small groups of seven or fewer individuals and are easily disturbed when roosting or feeding.

In 2010, the Service produced Whooping Crane Migration Corridor Maps (Service 2010) that outline the percentage of confirmed crane sightings based on current and historical sighting reports. The Project Area is located within the migration corridor, as shown in Figure 3-34. Confirmed whooping crane sightings, ranging from 75 to 95 percent, have occurred in each county in the Project Area. Many sightings occurred along the Missouri River corridor and in the northwest corner of the Project Area.

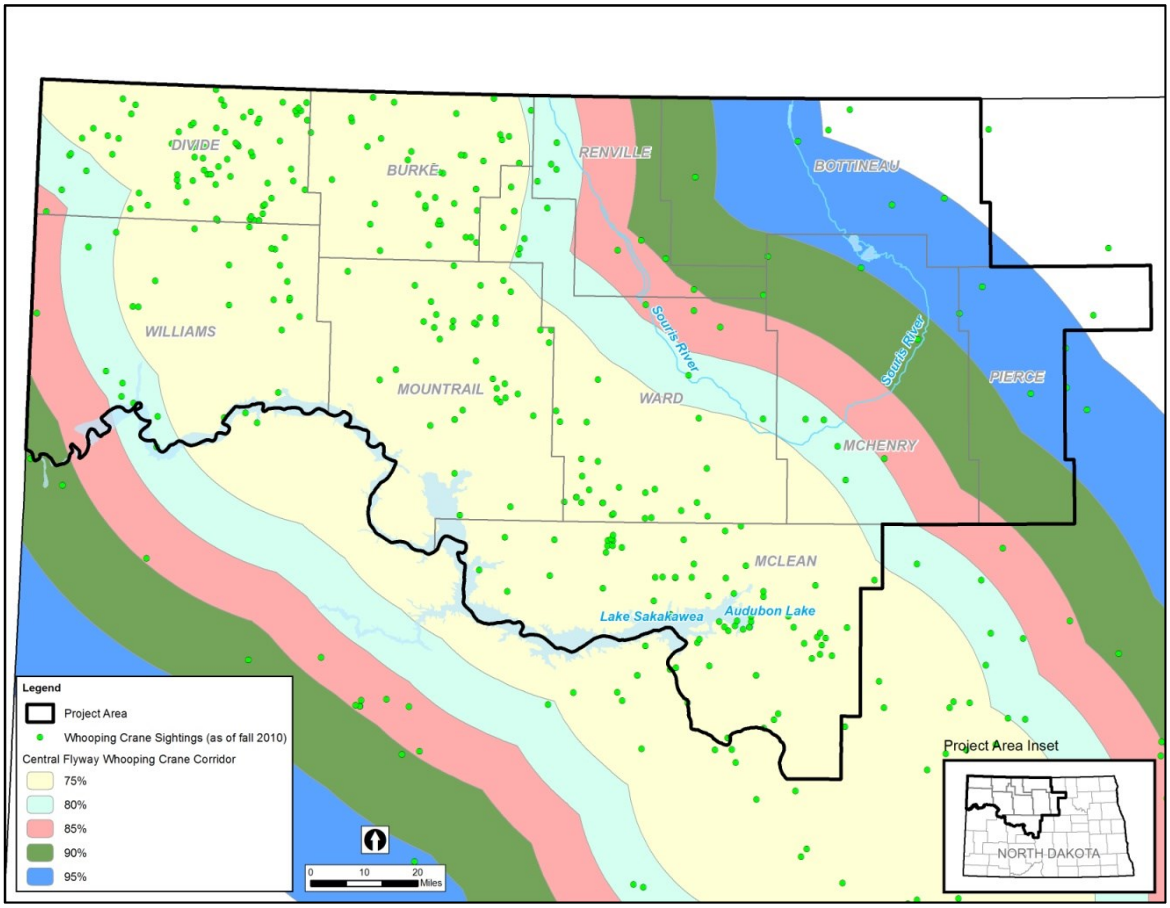

Figure 3-34 Central Flyway Whooping Crane Corridor and Sightings

Source: Service 2010

Piping Plover (Threatened)

Population Rangewide

The Service listed piping plovers as endangered in the United States Great Lakes area and Canada (Ontario), while the remaining Atlantic and northern Great Plains birds, including those in Canada (Manitoba), were listed as threatened in 1985 (50 FR 50726). Migrating piping plovers and those in wintering areas were classified as threatened (Service 2003). The Service considers the listed entities to be composed of three separate breeding populations: northern Great Plains, Great Lakes, and Atlantic Coast piping plovers.

Critical habitat was designated separately for the northern Great Plains and Great Lakes populations, as well as for wintering populations. The biological opinions for the Platte River Recovery Implementation Program (Service 2006) and the operation of the Missouri River (Service 2000) indicate that the Service has determined that the northern Great Plains population of the piping plover is an appropriate population to consider for purposes of Section 7 consultation.

This SEIS addresses the northern Great Plains population. A rangewide census and habitat characterization of the piping plover was conducted across all known suitable breeding and winter habitat in 1991, 1996, 2001, 2006, and 2011. This International Piping Plover Census provides the most reliable information on rangewide population trends. The census is conducted every 5 years and provides comprehensive data on the distribution and abundance of all piping plover populations, including the northern Great Plains population. However, the 2011 final census results are not yet available and the census was very much affected by record high water levels throughout the northern Great Plains. Preliminary results from the 2011 census for the Great Plains and Prairie regions show the lowest record of all census years, with numbers just over 2,000 birds (Elliott-Smith and Haig 2012). The highest number of plovers was found during the 2006 census, with over 4,600 birds (Elliott-Smith et al. 2009).

Missouri River Mainstem Reservoir System

Piping plover adult numbers on the Missouri River have varied from a low of 82 adults in 1997 to a high of 1,764 adults in 2005 (Figure 3-33). The Corps (2013a) found the average number over 27 years to be 731 adults and that adult numbers on the Missouri River have decreased in each of the past 3 years but increased after the 2011 flood. Record inflows into the Missouri River System inundated much of the birds' habitat in 2011 on the rivers as well as the reservoirs, and the 2011 adult census of 182 piping plovers represents the second lowest adult census for the species on the Missouri River in 26 years. The increased bird numbers are attributed to large areas of new habitat created by the record flows of 2011 and receding water levels experienced in 2012.

North Dakota

Piping plovers use barren sand and gravel shorelines of the Missouri River, including its reservoirs and shorelines of prairie alkali lakes. Critical habitat has been designated for the piping plover in North Dakota (67 FR 57638) in riverine and reservoir reaches. Areas designated include Lake Sakakawea, Audubon Lake, Lake Oahe, and riverine reaches in North Dakota below Fort Peck and Garrison dams. Within the Project Area, prairie and alkali lakes and wetlands have also been designated as piping plover critical habitat in Burke, McLean, Montrail, Pierce, Renville, Sheridan, Ward, and Williams counties.

Sprague's Pipit (Candidate)

Population Rangewide

The breeding range for the Sprague's pipit occurs throughout North Dakota, except for the easternmost counties. In Canada, Sprague's pipits breed in southeastern Alberta, the southern half of Saskatchewan, and in southwest Manitoba (Robbins and Dale 1999). The breeding range in the United States has contracted to the north and west in North Dakota and Minnesota, and north in Montana.

North Dakota

The breeding range for the pipit in North Dakota comprises the western two-thirds of the state. Sprague's pipits arrive on the breeding grounds from the third week of April to mid-May (Maher 1973; Stewart 1975 cited in Jones 2010); some individuals linger on the wintering grounds into early May. Pair formation begins shortly after arrival on the breeding grounds, and eggs are laid between the second week of May through early August (Sutter 1996; Davis 2003; Jones et al. 2010 cited in Jones 2010). Sprague's pipits build ground nests in grasslands primarily filled with native grasses of intermediate height and density, with little bare ground and few shrubs; many times the nest is at the base of a dense tussock of grass (Sutter 1997; Dieni and Jones 2003 cited in Jones 2010). Native prairie exists in areas of dense wetland basins that preclude agricultural practices with the exception of grazing livestock. Sprague's pipits do not occur on North Dakota grasslands that had not been burned for more than 8 years; breeding abundances are highest from 2 to 7 years after a fire (Madden 1996 cited in Jones 2010). In North Dakota, a greater abundance of Sprague's pipits was reported from moderately to heavily grazed pastures (Kantrud 1981 cited in Jones 2010).

Populations in North Dakota have declined dramatically due to the conversion and deterioration of remaining native prairie habitat. The North Dakota Heritage database provided available records for Sprague's pipit within the Project Area (Duttenhefner, pers. comm., 2012). These records show occurrences of this species in Montrail, McLean, and Divide counties and the Pierce / McHenry county border. Many of their records are older, but a survey of Birding on the Net (2012) lists breeding records in 2012 for this species in McHenry and Divide counties. The principal causes for the declines in Sprague's pipit populations are habitat conversion to seeded pasture, hayfield, and cropland, as well as overgrazing by livestock. There is evidence that Sprague's pipits avoid roads and trails on the breeding grounds (75 FR 56028).

Rufa Red Knot (Proposed Threatened)

Population Rangewide

The red knot, a robin-sized shorebird, migrates annually between its breeding grounds in the Canadian Arctic and several wintering regions, including the Southeast United States, the Northeast Gulf of Mexico, northern Brazil, and Tierra del Fuego at the southern tip of South America. During both the northbound (spring) and southbound (fall) migrations, red knots use key staging and stopover areas to rest and feed. Long-distance migrant shorebirds are highly dependent on the continued existence of quality habitat at a few key staging areas. These areas serve as stepping stones between wintering and breeding areas. Many of the key migration staging areas are along the coasts, and most records in the interior states show small groups (fewer than 10) of knots. There are multiple records in nearly every interior state, including North Dakota and other states along the Missouri River (78 FR 60024). The final rule for listing the red knot as threatened was published December 11, 2014 (79 FR 73706).

North Dakota

North Dakota migration records are scarce. Between 2002 and 2013 North Dakota Bird List Serve (www.listserve.nodak.edu) records identify eight counties in North Dakota within the migration route (McPhillips 2014). These counties include Ward and Williams counties, which are in the Project Area. Records exist for both spring and fall migration, and birds frequently are seen in small numbers (1 - 25) (McPhillips 2014). Migration habitats are documented as being similar to habitats used by piping plovers and include wetlands with shoreline (typically alkali lakes in North Dakota or sewage lagoons with mudflats) and the Missouri River (Service 2014).

Dakota Skipper (Threatened)

Population Rangewide

Dakota skippers are small butterflies that are found widely scattered across the tallgrass and mixed-grass prairie of Illinois, Iowa, Minnesota, South Dakota, North Dakota, Manitoba, and Saskatchewan (Service 2002b). The distribution of the Dakota skipper has become extremely fragmented, mostly due to prairie conversion. Dakota skippers no longer exist in Iowa or Illinois and are currently distributed in western Minnesota, the eastern half of North Dakota, and northeastern South Dakota at much reduced levels (Service 2002b). The Dakota skipper was listed as threatened in November 2014 (FR 79:206:63672-63748).

North Dakota

Dakota skippers are found in native prairie containing a high diversity of wildflowers and grasses. Habitat includes two prairie types: (1) low (wet) prairie dominated by bluestem grasses, wood lily, harebell, and smooth camas; and (2) upland (dry) prairie on ridges and hillsides dominated by bluestem grasses, needlegrass, pale purple and upright coneflowers, and blanket flower.

In North Dakota, the species has disappeared from all but two sites in recent years (Service 2002b). Most of the locations for the Dakota skipper are on private lands in Minnesota and North Dakota, which are documented in a Service Status Assessment on this species (Service 2002b). Conversion and fragmentation of native prairie habitat are the primary reasons for loss of habitat for this species. Lack of prairie management has also been noted as an area of concern. In the Project Area, Dakota skippers may be found in McHenry, Burke, Bottineau, Mountrail, and Ward counties.

Pallid Sturgeon (Endangered)

Population Rangewide

Pallid sturgeon have been documented in the Missouri River between Fort Benton and the headwaters of Fort Peck Reservoir, Montana; downstream from Fort Peck Dam to the headwaters of Lake Sakakawea, North Dakota; downstream from Garrison Dam, North Dakota to the headwaters of Lake Oahe, South Dakota; from Oahe Dam downstream to within Lake Sharpe, South Dakota; between Fort Randall and Gavins Point Dams, South Dakota and Nebraska; downstream from Gavins Point Dam to St. Louis, Missouri; in the lower Yellowstone River, Montana and North Dakota; in the lower Big Sioux River, South Dakota; in the lower Platte River, Nebraska; in the lower Niobrara River, Nebraska; and in the lower Kansas River, Kansas. Pallid sturgeon observations and records have increased with sampling effort in the middle and lower Mississippi River (Service 2013b). Additionally, in 1991, the species was identified in the Atchafalaya River, Louisiana; and in 2011, pallid sturgeon were documented entering the lower reaches of the Arkansas River (Service 2013b).

Missouri River Population

The pallid sturgeon occupies the Missouri and Yellowstone rivers in North Dakota. The majority of the sturgeon in North Dakota are in the Yellowstone River and upstream of the Yellowstone River confluence with the Missouri River. Approximately 50 wild adult pallid sturgeon are estimated to exist in the Missouri River upstream of Fort Peck Reservoir (Service 2007c). An estimated 125 wild pallid sturgeon remain in the Missouri River downstream of Fort Peck Dam to the headwaters of Lake Sakakawea, as well as in the lower Yellowstone River (Jaeger et al. 2009). Current abundance estimates are lacking for the Missouri River between Gavins Point Dam and St. Louis, Missouri. (Service 2013b).

Water levels in the reservoirs impounded by Fort Peck Dam (Fort Peck Reservoir), Montana and Garrison Dam (Lake Sakakawea), North Dakota may be impediments to larval pallid sturgeon survival (Service 2013b). However, two confirmed wild larval pallid sturgeon were found at the mouth of the Milk River in 2011 and in 2012 on the Yellowstone River (SWC 2013b).

The Service (2013b) estimates that an isolated remnant population of less than 50 individuals remains in the Garrison reach of the Missouri River below Garrison Dam. Garrison Reservoir is not preferred pallid sturgeon habitat. In fact, Lake Sakakawea is considered an impediment to larval pallid sturgeon survival (Service 2013b). The Missouri River in North Dakota is in the Great Plains Management Unit and is identified as such in the *Draft Recovery Plan for the Pallid Sturgeon (Scaphirhynchus albus)* (Service 2013b). The Great Plains Management Unit is defined as the Great Falls of the Missouri River, Montana to Fort Randall Dam, South Dakota. This unit includes important tributaries like the Yellowstone River, as well as the Marias and Milk Rivers. The biggest issues that negatively influence pallid sturgeon throughout the Great Plains Management Unit include blocked passage; entrainment; and factors affecting recruitment, including flows and temperature (Service 2013b).

Species of Conservation Priority

The NDGFD maintains a list of species of conservation priority at three levels:

- Level-I: Species in greatest need of conservation
- Level II: Species in need of conservation, but are addressed by other wildlife programs
- Level III: Species in moderate need of conservation, but are on the edge of their range in North Dakota

The *North Dakota Comprehensive Wildlife Conservation Strategy 2005* (NDGFD) addresses the distribution, abundance, habitat requirements, threats, management goals, and monitoring techniques for each of these species. The list of NDGFD Level I species of conservation priority is provided in Appendix G.

The Service maintains lists of Birds of Conservation Concern by bird conservation region as well as by Service region. The Project falls within Bird Conservation Region 11 (Prairie Potholes) and Service Region 6 (Mountain-Prairie Region). The list of Birds of Conservation Concern for both regions also is provided in Appendix G.

Historic Properties

This section summarizes the types of cultural resources in the area of potential effects (APE) that could be affected by Project alternatives. "Cultural resources" are the physical remains of a site, building, structure, object, district, or property of traditional religious and cultural importance to Native Americans. "Historic properties" are significant cultural resources that are either included on or have been determined eligible for listing on the National Register of Historic Places. Because most of the cultural resources in the APE have not been evaluated to determine eligibility for listing, the more generic term—cultural resources—is used in this discussion. The terms used in this section are defined in the blue box to the right.

Because the proposed Project is a federal action, it must comply with federal legislation concerning historic properties, specifically Section 106 of the National Historic Preservation Act of 1966,(NHPA), as amended. The NHPA requires federal agencies to consider the effects of federal undertakings on historic properties. An "undertaking" refers to any federal action involving federal land, funding, or issuance of a permit. Cultural resource locations are exempt from public disclosure to protect resources from potential vandalism and to retain confidentiality of resources culturally sensitive to tribes. Thus, specific locations for prehistoric cultural resources and traditional cultural properties are not included in this discussion or in Chapter 4.

NHPA compliance for the Project was officially initiated by Reclamation on February 10, 1993, under an existing statewide programmatic agreement (Programmatic Agreement between the Bureau of Reclamation, the Advisory Council on Historic Preservation, and the North Dakota State Historic Preservation Officer for the Implementation of Reclamation Undertakings in North Dakota). Previous compliance with the NHPA Section 106 for facilities that have already been constructed is discussed in Appendix A.

For historic properties, the affected environmental analysis area covers an

Cultural Resources Terms

Archaeological Site – is physical evidence or remains of past human activity at a specific location. Prehistoric archaeological sites predate written records, and historic archaeological sites generally are associated with European exploration and settlement of the area.

Architectural Site – is a building, which is a structure created to shelter any form of human activity (such as a house, barn, church, or hotel) or a structure. A structure is composed of interdependent and interrelated parts in a definite pattern or organization (such as bridges, tunnels, canals, or fences).

Cultural Resource – The physical remains of a site, building, structure, object, district, or property of traditional religious and cultural importance to Native Americans.

Historic Property – Any prehistoric or historic site, building, structure, object, district, or property of traditional religious and cultural importance to Native Americans that is included in or has been determined eligible for listing in the National Register of Historic Places. Only historic properties are protected under the National Historic Preservation Act.

Isolated Find – is a location with fewer than five artifacts, which shows little potential for additional finds. Finds are generally not considered to qualify as historic properties.

National Register of Historic Places – A registry maintained by the Secretary of the Interior of sites, buildings, structures, objects, or districts or properties of traditional religious and cultural importance to Native Americans that have local, state, regional, or national historic or prehistoric significance.

Site Lead – is a site that was insufficiently recorded or reported by the public but not professionally verified. Site leads are generally not considered to qualify as historic properties without verification and evaluation.

State Historic Preservation Officer – The individual appointed or designated in accordance with the National Historic Preservation Act, who is the official representative of a state for the purposes of complying with Section 106 of the Act.

Tribal Historic Preservation Officer – The individual appointed or designated in accordance with the National Historic Preservation Act, who is the official representative of an Indian tribe for the purposes of complying with Section 106 of the Act.

area 142 miles long and 1 mile on either side of the Project corridor in Bottineau, McLean, McHenry, and Ward counties, North Dakota. This also includes 1 mile on either side of the Souris River from Minot to the Canadian border.

Souris River Valley resources and previous investigations within the APE of the proposed alternatives were identified by a Class I file search at the State Historical Society of North Dakota (Burns 2013) and by consulting with tribes. A 2-mile-wide corridor was evaluated for each proposed construction pipeline segment and around proposed facilities (including intakes, reservoirs, wells, and recharge reservoirs) to develop baseline information. Some proposed facility locations have not yet been surveyed at a Class III level (intensive, pedestrian inventory). The purpose of the Class I inventory is to identify known historic properties and previous investigations.

Missouri River Valley resources were identified using best available information from previous Corps documents, such as environmental impact statements and reservoir master plans (Corps 2002, 2003, 2004b, 2005, 2006, 2008, 2010, 2011a, 2011b).

Existing Conditions

The APE of the alternatives lies in the Souris and Garrison study units, as described in the North Dakota statewide comprehensive plan (SHSND 2008). The Souris River Study Unit exhibits ground moraine with generally low relief and numerous potholes. The Missouri Trench in the Garrison Study Unit is covered with a thin glacial deposit, while the Coteau Slope has abundant potholes and sloughs. A prominent feature in the Garrison unit is Lake Sakakawea, a reservoir included in the Missouri River System. Plant and animal life for both study units are described in the Vegetation, Fisheries and Aquatic Invertebrates, and Common Wildlife sections of this chapter.

Cultural Overview

The following cultural overview is adapted from the Class 1 Inventory Report (Burns 2013) based on the Souris River and Garrison study units in the *North Dakota Comprehensive Plan for Historic Preservation: Archaeological Component* (SHSND 2008). The chronological framework for the Project Area is divided into stages as identified and described below.

Paleo-Indian Period 9500 to 5500 BC

The Project Area located in the Souris River Study Unit is in an area that has more Paleo-Indian sites than any other part of North Dakota; there seems to have been a steady use of the area from about 8000 BC to about 5500 BC. Cultural materials discovered thus far are limited to stone tools and stone tool manufacturing by-products (flakes and cores). Because some of the stone was not available locally, there must have been trade or travel to obtain this material. Paleo-Indian artifacts are found more commonly in the upland plains due to minimal sediment deposit and some erosion. Subsistence practices during this time period consisted of hunting mastodons, mammoths, giant bison, and camel. These large herd animals would have inhabited large grassland areas adjacent to major waterbodies (SHSND 2008).

Plains Archaic Period 5500 to 400 BC

Due to severe drought conditions, much of the Souris River basin may have been uninhabitable during this period. The Missouri River with its larger and more reliable water source attracted more activity than the Souris River. Early Plains Archaic settlements are not well known along the Souris River, but the Garrison Study Unit has a large number of sites and finds from this period, including some deeply stratified sequences. Late Plains Archaic settlements are better represented in the Souris River Unit than Early Plains Archaic, including residential bases, temporary camps, and burial locations. Burials are in shallow pits capped with cairns. This practice continued into the Plains Village period.

Megafauna were no longer available, but large mammals, such as bison, remained important food sources, along with wild plant foods. Domesticated dogs apparently served as a supplemental food as well as beasts of burden (SHSND 2008:11.59).

Plains Woodland Period 400 BC to AD 1200

Although sharing similarities with the Plains Archaic Period, Plains Woodland adaptations include building mounds for cemeteries, some gardening, and producing ceramic vessels for cooking. This is also the period when the bow and arrow is introduced. Increased contact between neighboring populations trading materials and technologies is a hallmark of the period. Residential settlements were primarily located on floodplains and low terraces in major river valleys. This period is very well represented in the Garrison Study Unit. Plants were a major food source and bison continued to be the most important game animal (SHSND 2008:11.63).

Plains Village Period AD 1200 to 1780

Although earthlodge villages have not been found yet within the Souris Study Unit, Plains Villagers are reported to have traveled through this area while hunting, gathering, and trading. Bison were a primary meat source, but gardening near semi-permanent villages along the Missouri River was an important food source. The Garrison Study Unit had few permanent village settlements prior to AD 1780. After that it became a refuge for the Mandan, Hidatsa, and Arikara. A broad range of technologies was implemented to produce tools, facilities, and structures using wood, stone, ceramic, bone, and shell.

Equestrian/Fur Trade Period AD 1780 to 1880

Subsistence practices of horse-mounted hunter-gatherer populations consisted mainly of hunting bison, as well as gathering traditional wild prairie plants. Often, bison meats and hides were traded for garden produce from the Mandan and Hidatsa. During this period, European trading goods were important and obtained by trading hides and fur with European fur traders.

Euro-American Settlement (1858 to Present)

The Dakota Territory (1858 to 1889) was the northernmost land bought from France in the 1803 Louisiana Purchase, and in 1818 the United States obtained the northeastern portion of the Dakota Territory in a treaty with Great Britain. Dakota Territory included North Dakota, South Dakota, and much of present-day Montana and Wyoming. After becoming an incorporated territory in 1861, the population was slow to increase due to Indian attacks. Eventually, the population increased during the “Dakota Boom,” from 1870 to 1880, as a result of railroad growth and passage of the Homestead Act of 1862. Many settlers came from Germany and the

Scandinavian countries of Norway and Sweden. The economic base was agriculture, mining, and cattle ranching (FWP 1938).

Fur Trade. Before and after the Lewis and Clark 1803 to 1806 expedition, explorers such as Sieur de la Verendrye, David Thompson, Charles Chaboillez, Alexander Henry, and Manuel Lisa ventured into the area either looking for trade routes or to establish fur trade posts. Consequently, "between 1806 and 1850 Spaniards from St. Louis, Frenchmen from Quebec, Scots and Britons from Hudson's Bay and Montreal, and Americans working either as free traders or engages for a dozen fur companies" headed into the region (FWP 1938; Lamar 1996: 27).

Forts. Most forts in the region were constructed in the 19th century. These included trading outposts, primarily fur trade and military posts to protect supply routes, trails, trade, and settlers. These forts, prior to introduction of the railroad, were along the Missouri River. Some of the more notable forts include Fort Mandan, Fort Lisa, Fort Henry, Fort Clark, Fort Union, Fort Berthold, Fort Buford, Fort Rice, Fort Totten, and Fort Abraham Lincoln (FWP 1938; SHSND 2008).

Trails. The River Trail originally was a Native American trail that was later used by Euro-American fur traders. Later, the trails connected military posts. These military posts (such as Fort Totten) protected trails and the people traveling on them. Eventually trails were replaced by railroads.

River Boats. The Missouri River was important to settlement and expansion of the Dakota Territory and was used for river transportation. River boats, such as rafts, sailboats, row boats, Mackinaws, keel boats, and steamboats, brought explorers and fur traders into the Dakota Territory. River transportation became increasingly important for transporting goods to outposts and returning furs downstream. Steamboats replaced the keel boats and were used for cargo and passenger transportation. The riverboat industry became a popular mode of transportation, easily delivering goods to remote areas. Shipping on the Missouri River continued until the 1930s.

Railroads. Major development of railroads in the Dakota Territory occurred in the 1870s and 1880s by the Northern Pacific Railroad and the Great Northern Railroad. Federal land grants were given to the Northern Pacific Railroad, who in turn sold the land, while the Great Northern Railroad bought its lands from the federal government and promoted settlement along its lines (FWP 1938).

Agriculture. The Federal Homestead Act of 1862 offered free land to any adult who would cultivate and improve his or her 160 acres of land and live on it for 5 years. An additional 160 acres could be obtained for a tree claim, and a third tract of land could be acquired before or after the land was surveyed. Crops planted and harvested included spring wheat, durum, flaxseed, barley, oats, sugar beets, corn, hay, red clover, alfalfa, sweet clover, and seed potato. Cattle and sheep ranching, poultry raising, and bee keeping were a part of the farm and ranching economy.

North Dakota (1889 to Present)

North Dakota became the 39th state to enter the Union on November 2, 1889. Industrial development increased after statehood. The railroad industry expanded and peaked in 1905 through competition between the Great Northern Railway and the Soo Line. Large lignite mines opened, and local brickworks and flour mills flourished in the state. Entrepreneurs built stores, shops, and offices. While rural areas relied on small local general stores, city consumers had more choice with department retail stores. In 1919, the Bank of North Dakota at Bismarck opened and became a large and powerful economic force. In western North Dakota, some shacks erected to establish residence under the Federal Homestead Act were still in use in the early 20th century (FWP 1938).

Economic depression started with the 1920 collapse of wartime prices for grain. In 1921, more banks closed than in any other year, resulting in farm foreclosures. At the same time, farm size increased, and many farmers mechanized their operations. A dramatic shift to motorized transportation put a greater emphasis on better roads and bridges (SHSND 2012).

The Great Depression slowed progress and spurred change. Rural populations decreased while the cities grew. Cooperatives enjoyed a renewed popularity as farmers banded together to market their produce and reduce the cost of farming. Farmers Unions built local elevators and organized oil cooperatives that served the needs of the rural community. Despite economic problems, crop failures, dust storms, and extreme weather, North Dakota visibly modernized during the 1930s. Highways, state parks, and city services throughout the state were improved by federal relief programs. State departments undertook public health and safety problems, and a movement for consolidated law enforcement was started with formation of a State Highway Patrol in 1935. Rural schools consolidated at an increasing rate.

Public utilities extended their reach through development of rural electric cooperatives; the first, Baker Electric of Cando, energized its lines in 1938 (SHSND 2012). In the 1940s, with more favorable weather and improved crop yields, farmers benefitted by the higher prices stimulated by America's entry into World War II. By the end of the war, farm debt had dropped noticeably, and the industrial economy continued to prosper. In 1946, Missouri River flood control and diversion of the river's waters for irrigation and industrial development began with construction of Garrison Dam (SHSND 2012). Development of natural resources expanded in 1951, when oil was discovered within the Bakken near Tioga.

Communication and interstate transportation systems improved and expanded in the 1950s. By the 1960s, a large Air Force base had been built in Minot.

Project Area Cultural Resources

Souris River Study Unit

The Class I literature review (Burns 2013) recorded 184 manuscripts, 141 unevaluated cultural resources, 38 ineligible cultural resources, 6 cultural resources recommended to be eligible for inclusion on the National Register of Historic Places, and 25 isolated finds. Types of sites in the APE include prehistoric resources – cultural resource scatters, cairn, isolated chipped stone flaking debris – and historic resources – bridges, town sites, quarry/mine, trail, buildings, Masonic Temple, viaduct, and a grain elevator. Because of the lack of cultural resource investigations, site density is low with 1 site per 44 square miles.

Garrison Study Unit

Site density in the Garrison Study Unit is higher with 1 site per 3.4 square miles. Much of the history and prehistory of the unit has been shaped by the Missouri River. To the aboriginal peoples in prehistoric times, the river served as a major highway for trade and travel. Rich floodplain soils offered an excellent place for the earthlodge village peoples (Mandan, Hidatsa, and Arikara) to raise crops. Regular floods replenished soil nutrients and subsoil moisture for the season. Tribes of the Missouri River basin and the Corps' Cultural Resources Programs (Omaha and Kansas City districts) have been active in identifying, preserving, and protecting cultural sites in the Missouri River basin. Table 3-25 shows historic and prehistoric sites located on Corps land in the Omaha District.

Table 3-25 Cultural Resources at Missouri River Mainstem Projects

Cultural Resources	Fort Peck	Garrison	Oahe [a]	Big Bend	Fort Randall	Gavins
Cultural Resources	5	800	1949	390	351	80
Historic Properties [b]	1	40	61	145	24	5
Shoreline Miles	1,520	1,340	2,250	200	540	90
Number of Resources per Shoreline Mile	n.a.[c]	0.6	0.9	2	0.3	0.9

Notes:

[a] This number includes sites that are located on transferred Title VI lands.

[b] The number of known cultural resources that are listed in, eligible for, or potentially eligible for listing in the National Register of Historic Places. The number of historic properties is expected to increase.

[c] Not available. Surveys incomplete.

Source: Corps 2010

Indian Trust Assets

The affected environment for Indian Trust Assets (ITAs) is the Project Area. The United States has a "trust responsibility" to protect and maintain rights and property reserved by or granted to federally recognized American Indian tribes or to Indian individuals. This trust responsibility derives from the historical government-to-government relationship between the federal government and tribes as expressed in treaties, agreements, and federal law (e.g., statutes, executive orders). This responsibility requires that all federal agencies, including Reclamation, take all actions reasonably necessary to protect ITAs.

ITAs are defined as legal interests in property held in trust by the United States for federally recognized Indian tribes and /or individuals within these tribes. Examples of trust assets include "lands, minerals, hunting and fishing rights, and water rights" (Reclamation 1993). The ITAs that may be affected by the Project include:

- Trust lands
- Hunting, fishing, and gathering rights
- Water rights

Trust lands are property set aside for Indians with "…the United States holding naked legal title and the Indians enjoying the beneficial interest" (Canby 1991). Trust lands are most often encountered within or near Indian reservations.

According to Reclamation's (1993) ITA policy, hunting, fishing, and gathering rights, as specifically retained or relinquished in treaties, may qualify as ITAs. This is because the right to continue hunting, fishing, and gathering was often retained in many treaties. Although the courts have not ruled on whether these activities constitute ITAs, they are treated as such in this SEIS.

Indian water rights, both surface water and groundwater, are a matter of federal law. The basis for this stems from the U.S. Supreme Court's decision in *Winters v. United States* (1908), which enunciated the Winters Doctrine. According to the doctrine, the establishment of an Indian reservation implied that sufficient water was reserved (or set aside) to fulfill purposes for which the reservation was created, with the priority date being the date the reservation was established. As such, Indian water rights, when quantified, constitute an ITA. In *Arizona v. California* (1963) the U.S. Supreme Court held that water allocated should be sufficient to meet both present and future needs of the reservation to assure the viability of the reservation as a homeland. Case law also supports the premise that Indian reserved water rights are not lost through non-use.

Federally Recognized Indian Tribes

The federally recognized tribes that currently reside in the Missouri River basin or that have historic ties to the basin through treaties are shown in Figure 3-35. Royce (1899) was the source for identifying those tribes that have historic ties to the basin through treaties.

Letters were sent to 27 of these tribes during the NEPA scoping period. Thirteen of these are located directly on the Missouri River, while the remainder are scattered throughout the basin. The letters were sent to determine each tribe's interest in acting as a Cooperating Agency, formally request consultation, and identify ITAs that potentially could be affected by the Project. The tribes also were extended an invitation to meet with Reclamation to discuss possible impacts on potentially affected ITAs. Details regarding the government-to-government consultation conducted with the 27 tribes is included in Chapter 5.

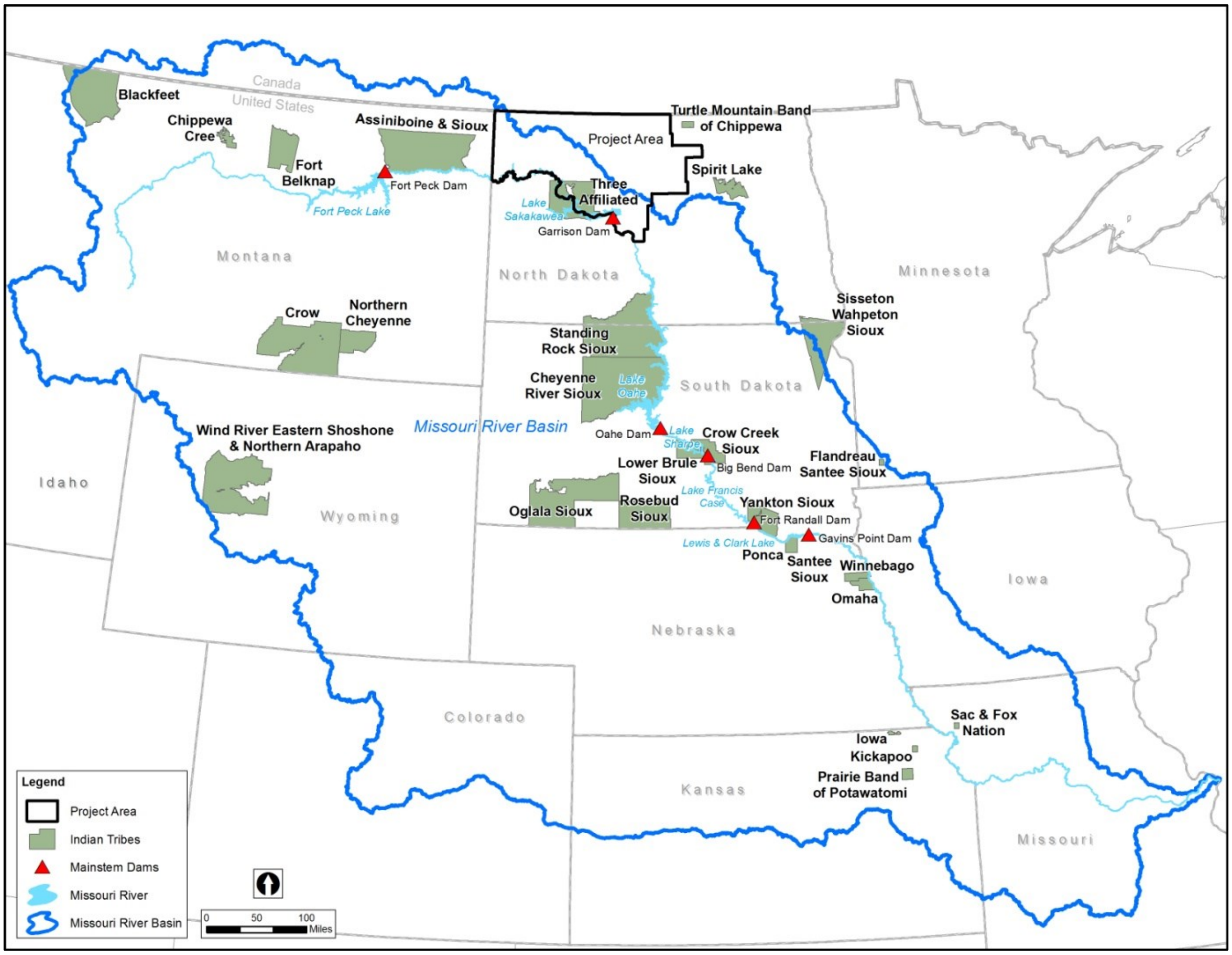

Figure 3-35 Missouri River Basin Indian Tribes

Identified Indian Trust Assets

Trust Lands

All facilities would be located outside of Indian reservations and any trust lands.

Hunting, Fishing, and Gathering Rights

Many of the treaties with the tribes in the Missouri River basin provide for continued hunting, fishing, and gathering on ceded lands (lands tribes gave up to the United States through treaties).

Water Rights

In the Missouri River basin, 27 tribes were identified as having reservations within the Project Area, 13 of which have reservations located directly on the Missouri River. Several of these tribes are in various stages of quantifying their water rights.

Currently, the only tribal reserved water rights that have been quantified or are being quantified are:

- State of Wyoming litigation with tribes of the Wind River Reservation and United States (adjudicated under the McCarran Amendment, Civil No. 4993 Wyoming 5th District 753 P.2d 76 Wyoming v. U.S. 492 U.S. 406 (1989) (Wyo1988) 803 P.2d 61 (Wyo 1990) 835 P.2d 273 (Wyo 1992) 899 P.2d 848 (Wyo 1995) 48 P.3d 1040 (Wyo 2002)
- Compact between the State of Montana and the tribes of the Fort Peck Reservation
- Compact between the State of Montana and the tribes of the Fort Belknap Reservation (ratified by the state legislature, awaiting Congressional approval)
- Compact between the State of Montana and the Crow Tribe (Congress and the Tribe Claims Resolution Act, P.L. 111–291—DEC. 8, 2010 124 Stat. 3097 Title IV—Crow Tribe Water Rights Settlement)
- Compact between the State of Montana and the tribes of the Rocky Boys Reservation (Chippewa Cree Tribe of the Rocky Boy's Reservation Indian Reserved Water Rights Settlement and Water Supply Enhancement Act of 1999, P.L. 106-163)
- Compact between the State of Montana and the Northern Cheyenne Tribe (Northern Cheyenne Reserved Water Rights Settlement Act [P.L. 102-374])
- Compact between the State of Montana and the tribe of the Blackfeet Reservation (ratified by the state legislature, awaiting Congressional approval)

The Corps is the federal agency responsible for operations of the Missouri River and has recognized that certain Missouri River basin tribes are entitled to water rights in streams running through and along their reservations under the Winters Doctrine. Operational decisions concerning the Missouri River System are based on the water that is currently in the system and demands placed upon it. The Corps recognizes tribal water rights to the mainstem irrespective of whether those rights have been quantified. In doing so, the Corps has recognized that future quantification of these rights could affect operations. With respect to Indian water rights, the Master Water Control Manual (Corps 2006) states:

> *"When a Tribe exercises its water rights, these consumptive uses will then be incorporated as an existing depletion. Unless specifically provided for by law, these rights do not entail an allocation of storage. Accordingly, water must actually be diverted to have an impact on the operation of the System. Further modifications to System operation, in accordance with pertinent legal requirements, will be considered as Tribal water rights are exercised in accordance with applicable law."*

Socioeconomics

Factors that influence the socioeconomic resources within the Project Area and the Missouri River basin are discussed separately in this section. Activities and factors that influence the Project Area's economic sectors are described here to provide insight into the current state of the economy and how various factors influence those sectors. The Corps maintains data and uses various methods and models to calculate economic benefits associated with the use of water from the Missouri River. These data and tools are the best available information on the economic uses and resources, which include flood control, navigation, hydropower generation, water supply, and recreation. These data were used to analyze how the No Action and action alternatives could affect the economic uses and resources.

Project Area Economic Resources

The affected environment for socioeconomics is the 10-county Project Area, including population, housing, the economic base (employment and income), and lifestyle and social values within the Project Area. Recreational resources are addressed in the “Land Use” section of this chapter and under “Economic Resource Conditions on the Missouri River in Response to Existing Depletions.” State- and national-level data are provided for comparison of regional and local characteristics.

Key data sources used to describe the socioeconomic characteristics of the counties within the Project Area include 2000 and 2010 Census Bureau data, 2007 to 2011 American Community Survey Census Bureau data, 2007 U.S. Department of Agriculture data, North Dakota agency reports and information, telephone interviews with key local officials, and published reports.

Regional Oil and Gas Development

Development of the Bakken oil field in northwest North Dakota has resulted in considerable increases to the area population, housing, employment, income, and taxes. The resulting socioeconomic impacts in the Project Area have at least temporarily shifted the baseline for the socioeconomic analysis. These effects and the typical oil boom cycle are reviewed briefly below.

The most notable increase in development of the Bakken oil field has occurred since 2009, making North Dakota the second largest producer of crude oil in the United States. Population, housing, and economic growth associated with this increased development is at least partially reflected in the 2010 Census Bureau data used as the basis for much of this discussion. Where appropriate, these data have been supplemented through contacts with local officials in counties and cities in which Project construction is expected to occur.

In 2008, USGS estimated that 4.3 billion barrels of recoverable reserves existed in the Bakken formation (including North Dakota, eastern Montana, and the neighboring provinces of Saskatchewan and Manitoba), but subsequent estimates by states and companies have risen to as much as 10 to 11 billion barrels (EPRINC 2011). Production has increased from 138,000 barrels of oil per day in January 2008 to 558,254 barrels per day in February 2012 (EPRINC 2011; North Dakota Petroleum Council 2012). Analysts estimate that production could reach 700,000 barrels per day in the next several years (EPRINC 2011).

It is difficult to project how long the oil boom will continue in North Dakota, particularly with the potential for additional oil field development of the even larger Three Forks formation, located under the Bakken formation. This formation is part of the larger Williston basin, which underlies sections of North Dakota, Montana, South Dakota, Saskatchewan, and Manitoba. This formation is already being drilled, and reserve estimates and drilling may increase (EPRINC 2011).

Oil and gas development has had positive effects on the overall North Dakota economy and tax revenues, as well as on employment. Simultaneously, it challenges state and local governments and private developers to provide adequate housing, public services, and public utilities, which may entail financial risks in the event of a downturn in oil and gas development (EPRINC 2011).

Difficulties that state and local governments face in trying to plan for their changing needs during periods of oil and gas development have been studied and documented for years. Some of the studies are specific to North Dakota. (See, for example, Poremba 1982.)

Population Characteristics and Projections

Population characteristics for the Project Area, North Dakota, and the United States are presented in Table 3-26. With the exception of Ward County, all counties in the Project Area (highlighted in bold in Table 3-26) are largely composed of sparsely populated rural areas, with population density ranging from 1.6 to 10.8 people per square mile. In 2010, Ward County had an average of almost 31 people per square mile, compared to less than 10 people per square mile in North Dakota and 87 people per square mile nationwide (U.S. Census Bureau 2012a).

The 2010 county populations ranged from 1,968 in Burke County to 61,675 in Ward County. Ward County contained the largest population of all other counties in the Project Area and had about 9 percent of the total state population in 2010. The 2010 total population in the Project Area was 123,398 people. Average household sizes ranged from 2.05 people per household in Divide County to 2.55 people per household in Mountrail County, compared to 2.30 people in the state of North Dakota and 2.58 people per household in the United States (U.S. Census Bureau 2012a).

Mountrail County had the largest population growth from 1990 to 2010 with an increase of 9.3 percent, while Ward County increased by 6.5 percent. These were greater than the 5.3-percent increase for the state of North Dakota, but less than the 24.1-percent increase across the United States. A population change of 10 percent or less over a 10-year period is considered to be a minor population change, a change of 10 to 20 percent is considered to be moderate, and changes of greater than 20 percent are considered to be major (U.S. Census Bureau 2000, 2012a).

Population growth in Mountrail County primarily occurred in New Town, which has grown almost 40 percent during the last two decades, while population growth in Ward County primarily occurred within the City of Minot, which has grown almost 20 percent during the last two decades. Minot is the fourth largest city in North Dakota at almost 41,000 people in 2010.

The populations in all other counties outside of Mountrail and Ward declined from 1990 to 2010 (U.S. Census Bureau 2000, 2012a). The largest decline occurred in Burke County, which declined by 34.4 percent during this time period.

Table 3-26 Population and Population Change

County / City	Population			Percent Change			2010 Population Density (people per square mile)	2010 Household Size (people per household)
	1990	2000	2010	1990 to 2000	2000 to 2010	1990 to 2010		
Bottineau	8,011	7,149	6,429	-10.8	-10.1	-19.7	3.9	2.17
Bottineau	2,598	2,336	2,211	-10.1	-5.4	-14.9	2,211.0	2.02
Maxbass	123	91	84	-26.0	-7.7	-31.7	420.0	1.95
Souris	97	83	58	-14.4	-30.1	-40.2	580.0	1.81
Westhope	578	533	429	-7.8	-19.5	-25.8	1,430.0	2.15
Willow City	281	221	163	-21.4	-26.2	-42.0	354.3	1.94
Burke	3,002	2,242	1,968	-25.3	-12.2	-34.4	1.8	2.15
Divide	2,899	2,283	2,071	-21.2	-9.3	-28.6	1.6	2.05
McHenry	6,528	5,987	5,395	-8.3	-9.9	-17.4	2.9	2.25
Upham	205	155	130	-24.4	-16.1	-36.6	1,400.0	1.94
Deering	99	118	98	19.2	-16.9	-1.0	393.9	2.45
McLean	10,457	9,311	8,962	-11.0	-3.7	-14.3	4.2	2.25
Mountrail	7,021	6,631	7,673	-5.6	15.7	9.3	4.2	2.55
Pierce	5,052	4,675	4,357	-7.5	-6.8	-13.8	4.3	2.23
Rugby	2,909	2,939	2,786	1.0	-5.2	-4.2	1,466.3	2.11
Renville	3,160	2,610	2,470	-17.4	-5.4	-21.8	2.8	2.28
Mohall	931	812	783	-12.8	-3.6	-15.9	711.8	2.27
Sherwood	286	255	242	-10.8	-5.1	-15.4	806.7	2.20
Ward	57,921	58,795	61,675	1.5	4.9	6.5	30.6	2.36
Berthold	409	466	454	13.9	-2.6	11.0	1,135.0	2.73
Burlington	995	1,096	1,060	10.2	-3.3	6.5	1,766.7	2.66
Des Lacs	216	209	204	-3.2	-2.4	-5.6	408.0	2.62
Kenmare	1,214	1,081	1,096	-11.0	1.4	-9.7	913.3	2.18
Minot	34,544	36,567	40,888	5.9	11.8	18.4	2,346.1	2.20
Williams	21,129	19,761	22,398	-6.5	13.3	6.0	10.8	2.35
Total Cities	45,485	46,962	50,686	3.2	7.9	11.4	1,089.5	2.22
Total Project Area	125,180	119,444	123,398	-4.6	3.3	-1.4	6.7	2.3
State of North Dakota	638,800	642,200	672,591	0.5	4.7	5.3	9.7	2.30
United States	248,709,873	281,421,906	308,745,538	13.2	9.7	24.1	87.4	2.58

Note:
Bold denotes counties in the Project Area.
Sources: U.S. Census Bureau 2000, 2012a

As described in Chapter 2, a needs assessment was conducted to project water needs for the Project Area through 2060 (Table 3-27).

Project Area population is projected to record an increase of 492 people between 2010 and 2060. Bottineau County has the greatest projected population decrease (3,979 people by 2060), while Ward County is projected to increase the most (9,051 people) (Reclamation 2012a).

Table 3-27 Population Projections

County	2010 Population	Population Projection					Change in Population (2010-2060)
		2020	2030	2040	2050	2060	
Bottineau	6,429	5,614	4,823	4,032	3,241	2,450	-3,979
Burke	1,968	1,648	1,434	1,260	1,112	984	-984
Divide	2,071	1,812	1,640	1,500	1,382	1,279	-792
McHenry	5,395	4,837	4,271	3,704	3,138	2,571	-2,824
McLean	8,962	8,478	8,168	7,914	7,699	7,513	-1,449
Mountrail	7,673	7,760	8,086	8,412	8,738	9,064	1,391
Pierce	4,357	4,000	3,652	3,305	2,957	2,610	-1,747
Renville	2,470	2,237	2,093	1,975	1,876	1,789	-681
Ward	61,675	63,218	65,095	66,972	68,849	70,726	9,051
Williams	22,398	22,365	23,000	23,634	24,269	24,903	2,505
Total Project Area	**123,398**	**121,969**	**122,262**	**122,708**	**123,260**	**123,890**	**492**

Source: Reclamation 2012a

Oil and Gas Development: Effects on Population

During a boom-bust cycle, the population changes in response to changes in labor demand. The Project Area overlaps the Bakken oil and gas exploration area in northwest North Dakota (Figure 3-36). Mountrail and Williams were two of the top-producing counties in 2011 (North Dakota Petroleum Council 2012). In northwest North Dakota (which includes eight counties, four of which are not in the Project Area), the population increased by 23,000 between 2000 and 2010, with an additional 19,000 people projected to relocate to the area from 2010 through 2030 (North Dakota Housing Finance Agency 2010).

The most notable increase in the development of the Bakken oil field dates from the year 2009; thus, the boom is already partially reflected in the 2010 Census Bureau data. It is important to note that the U.S. Census accounts only for permanent residents. Temporary residents that might live in recreational vehicle (RV) parks or campgrounds, hotels/motels, and other rentals, together with those that travel between counties and communities, are not counted although they may increase demand for use of the services and resources.

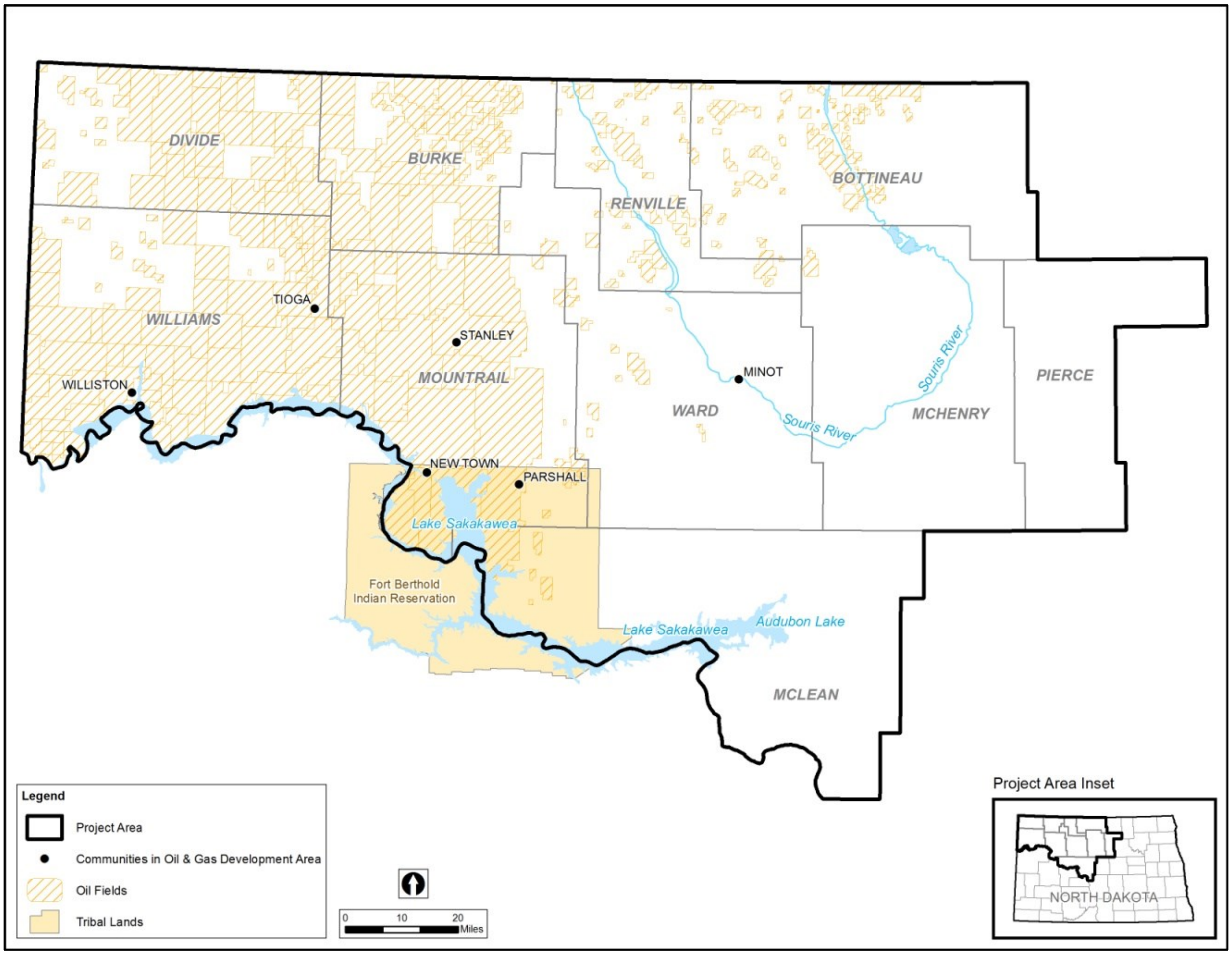

Figure 3-36 Oil and Gas Development

Associated with the boom, population growth has increased the most in counties and communities on the western side of the Project Area. As of the 2011 Census estimates, Williston was the first- and Minot the eighth-fastest growing micro area in the nation from 2010 to 2011. A Census "micro area" contains an urban core population of at least 10,000 but less than 50,000. Williams County was the third-fastest growing county in the nation from 2010 to 2011 (U.S. Census Bureau 2012b). According to 2011 Census estimates, the population in Ward County increased by almost 4 percent from 2010 to 2011, adding about 2,400 new residents. Notable estimates on population change from 2010 through 2030 for communities that have been most affected by oil and gas development include New Town (23 percent), Parshall (29 percent), and Stanley (31 percent) in Mountrail County and in Williams County, Tioga (26 percent) and Williston (29 percent) (North Dakota Housing Finance Agency 2010).

Increased activity in the oil and gas sector generates new employment opportunities in the Project Area. As many of the new direct (oil extraction industry) and indirect (supporting industry) jobs that are created are filled by an influx of temporary and permanent workers, surrounding communities face increased demand for public services. However, while the initial phase of oil extraction creates several jobs associated with drilling each new well, only a fraction of these jobs will be required for operation (Holeywell 2011; Jacquet 2009). It is expected that the population in the Project Area will dramatically decrease in the next 10 to 20 years as the drilling phase of the boom recedes and operations begin (Holeywell 2011). This population decrease will be tempered as counties and communities with population growth from oil and gas development may plan to retain some of these residents after the boom recedes. For example, the Community Development Director of Divide County (which, like many other counties in the area, had been shrinking since the Great Depression) indicated that Divide County hopes to retain at least one-eighth of the in-migrant workers as permanent residents (Hellmuth, pers. comm., 2012).

Housing Characteristics

Permanent Housing

The availability of vacant housing is a function of the housing stock (mainly rental and short-term accommodations), housing demand related to economic and population growth, and demand for housing from other sources. The existing stock of housing units in the Project Area is shown in Table 3-28.

Total housing stock in the Project Area was estimated at 60,455 units in 2010. Of this total, more than 51,000 units were occupied, and about 70 percent of those units were occupied by the owners. Ward County had both the greatest population concentration and the most housing units (26,700) (U.S. Census Bureau 2013).

The 2010 U.S. Census counted a total of 9,448 vacant housing units within the Project Area, representing a 15.6-percent vacancy rate. By comparison, the State of North Dakota and the United States as a whole each had a vacancy rate of 11.4 percent. Ward County had the lowest vacancy rate (6.4 percent) and the greatest number of unoccupied units (1,715). Of the total unoccupied units, 5,064 were year-round units and 4,384 were seasonal, recreational, and occasional use units (U.S. Census Bureau 2013). These vacancy rates have decreased in areas most affected by the oil and gas boom (discussed above), subsequent to the 2010 Census.

Temporary / Seasonal Housing

The U.S. Census defines seasonal, recreational, and occasional use units as vacant units intended for use in certain seasons or for weekends or other occasional use throughout the year. Unoccupied seasonal, recreational, and occasional use units were concentrated in McLean, Bottineau, and Mountrail counties (70 percent); Pierce County had the fewest, at about 80 units (U.S. Census Bureau 2012a).

In addition to unoccupied housing units available in the Project Area, hotels, motels, RV parks, and campgrounds also provide opportunities for temporary, short-term accommodations. Short-term accommodations are more flexible and likely would be the preferred form of housing for many non-resident construction workers.

Oil and Gas Development: Effects on Housing

Oil and gas development in northwest North Dakota has increased housing demand. Data from the U.S. 2010 Census on unoccupied units and vacancy rates by county (Table 3-28) may not reflect current demand from oil and gas development on communities. Additional housing need forecasts have been generated since the 2010 census was conducted. One study specifically evaluating the impacts of oil and gas development in eight northwestern North Dakota counties (four of which are in the Project Area) estimated that 8,900 additional housing units (a 14.7-percent increase compared to the 2010 Census levels) would be required to meet the 2030 projected population levels (Ondracek et al. 2011). A statewide 2010 to 2025 housing needs assessment and forecast found that Region I (Divide, McKenzie, and Williams counties) would need 5,094 units (a 34.9-percent increase) and Region II (Bottineau, Burke, McHenry, Mountrail, Pierce, Renville, and Ward counties) would need 9,022 units (a 21.3-percent increase) using one method, or 20,854 units (142.7-percent increase) and 13,725 units (32.3-percent increase), respectively, using a second method (North Dakota Housing Finance Agency 2012). Short housing supply and high incomes of new oil and gas workers can increase the price of owning and renting a home to the detriment of the average citizen in boom regions, while simultaneously providing a significant increase in income for property owners and rental businesses.

For instance, in 2012, the average oil and gas extraction wage was $89,020, which is 117.5 percent greater than the statewide average wage (North Dakota Petroleum Council 2012). In Burke, Divide, and Ward counties, housing unit rents that were between $300 and $600 a few years ago now range between $1,200 and $1,500 (Hellmuth, pers. comm., 2012; Jensen, pers. comm., 2012; Larsen, pers. comm., 2012). Similarly, in Renville County, houses that sold for approximately $50,000 5 years ago now can sell for $120,000 or higher (Titus, pers. comm., 2012).

In addition, hotels are often booked and apartments are in short supply in many of these communities. In Ward County, in the past 10 years, nightly rates at hotels have increased from $60 to $150, while apartment rents have increased from $600 per month to between $1,200 and $1,500 per month (Larsen, pers. comm., 2012). To meet their housing needs, workers often rely on campers and RVs as well as “man-camps” operated by private companies. These options can be restricted, however. Communities frequently offer extended stays for campers and RV parks but limit stay duration in the summer tourism season. Counties and communities also are planning man-camp ordinances to restrict where and how they can develop.

Table 3-28 2010 Housing Characteristics

County	Total Housing Units	Vacancy Rate (%)	Occupied Units			Unoccupied Units		
			Total	Owner Occupied	Renter Occupied	Total	Year-Round Units	Seasonal, Recreation & Temporary Use Units
Bottineau	4,341	34.8	2,832	2,297	535	1,509	533	976
Burke	1,340	31.9	913	732	181	427	288	139
Divide	1,324	26.2	977	784	193	347	243	104
McHenry	2,948	19.4	2,377	1,962	415	571	444	127
McLean	5,590	30.3	3,897	3,158	739	1,693	531	1,162
Mountrail	4,119	32.2	2,793	1,974	819	1,326	419	907
Pierce	2,199	16.6	1,835	1,381	454	364	286	78
Renville	1,386	23.4	1,061	826	235	325	168	157
Ward	26,744	6.4	25,029	15,920	9,109	1,715	1,398	317
Williams	10,464	11.2	9,293	6,442	2,851	1,171	754	417
Total Project Area	60,455	15.6	51,007	35,476	15,531	9,448	5,064	4,384
State of North Dakota	317,498	11.4	281,192	183,943	97,249	36,306	24,823	11,483
United States	131,704,730	11.4	116,716,292	75,986,074	40,730,218	14,988,438	4,649,298	4,649,298

Source: U.S. Census Bureau 2012a

Project Area Economy

The economy within the Project Area is characterized below, including data on employment by industry, unemployment rates, income characteristics, and agricultural activity.

Employment

Industry-specific employment information provides insight into the size and structure of a regional economy. Appendix H presents employment by industry and the unemployment rate for the Project Area, state, and nation. Total employment in all sectors in the Project Area was estimated to be 62,510 jobs in 2011.

The primary industrial sectors employing the most people in the Project Area were educational services, health care, and social assistance, with 22.5 percent of the workforce; followed by the agriculture, forestry, fishing and hunting, and mining sector, with 13.2 percent of the workforce; and retail trade, with 12.2 percent of the workforce. As indicated by the proportion of the workforce employed in the agriculture, forestry, fishing and hunting, and mining sector, agriculture is particularly important in Divide and Burke counties, with 30.7 percent and 32.7 percent of the workforce, respectively, employed in this sector. In contrast, only 4.7 percent of the workforce in Ward County, which is more urban, was employed in the agricultural sector. Ward County has a relatively high retail industry, with 14.9 percent of the workforce employed in retail trade (U.S. Census Bureau 2013).

In 2011, there were an estimated 1,648 unemployed people in the Project Area, 910 of which were in Ward County. The unemployment rate was very low at 1.7 percent, below the North Dakota rate of 2.4 percent and less than one-third of the national rate of 5.6 percent. Generally, 5 to 6 percent unemployment is considered to be full employment, taking into account those looking for work as they initially enter the workforce or those who are changing jobs. Divide County had the lowest unemployment rate at 0.3 percent, while Mountrail County had the highest at 2.6 percent (U.S. Census Bureau 2013).

Income

The 2011 median household income, mean household income, and per capita income data are provided in Appendix H. Median household income ranged from $40,139 in Pierce County to $62,082 in Williams County. Mean household income ranged from $48,152 in Pierce County to $75,804 in Williams County. Williams County was the only county in the Project Area to have a higher mean household income than the nation in 2011 (U.S. Census Bureau 2013).

Agricultural Activity

As stated above, agriculture is an important economic activity in the Project Area and for the state of North Dakota. Appendix H provides information regarding the number and acreage of farms and the market value for selected agricultural products. There were 7,156 farms in 2007, with the most located in McLean County. The average farm size ranged from 1,097 acres in Pierce County to 1,573 acres in Mountrail County (USDA 2007).

In 2007, the Project Area agricultural product market value totaled almost $1.2 billion, while value produced in all of North Dakota surpassed $6 billion. Bottineau, Ward, and McLean counties were very similar and had the greatest agricultural sales, ranging from just over $163.4 million to $167.9 million. The vast majority of these sales were from growing crops, with sales from those three counties ranging from just over $145.8 million (89.2 percent) to $159.0 million (92.5 percent) (USDA 2007).

Within the Project Area, wheat accounted for the most crop acreage, with almost 2.7 million acres planted, followed by corn with 101,032 acres planted. McLean County had the greatest acreage of corn and Ward County had the greatest acreage of wheat. For livestock production, cattle, and calves accounted for most of the production, with almost 170,000 head sold (USDA 2007).

Oil and Gas Development: Effects on the Economy

Oil and gas development has had positive effects on the overall North Dakota economy, particularly on employment. In June 2012, North Dakota had the lowest unemployment rate in the country at 2.9 percent.[6] A recent economic study found that the oil and gas industry in North Dakota generated $2.8 billion in expenditures, a portion of which included income for 18,328 full-time equivalent jobs (Bangsund and Leistritz 2011). Many local residents in the Project Area find work in the following oil and gas-related jobs: servicing well fields, transporting water and other materials, building new roads and site pads, repairing and washing trucks, and other maintenance jobs. Local employment has been stimulated in businesses and public services which have opened or expanded as a result of oil and gas development. However, some counties and communities have lost public service personnel to the oil and gas industry and have struggled to find replacements (Jensen, pers. comm., 2012).

Missouri River Related Economic Uses and Resources

As discussed in the Missouri River water resources section of this chapter, the Missouri River System was developed for multiple authorized purposes, many of which have socioeconomic value to the numerous states located within the basin, as well as national economic values. The following paragraphs describe the economic uses and resources associated with the Missouri River as analyzed and reported by the Corps, which is the lead federal agency responsible for the management and operations of the Missouri River System.

Economic Resource Conditions on the Missouri River in Response to Existing Depletions

Table 3-29 summarizes the current economic resource conditions on the Missouri River in response to existing depletions. Each economic resource has a different metric to quantitatively describe current conditions. The metric is based on an average annual value computed for each resource that is discussed in the various resource sections in this chapter. The most recent data compiled by the Corps for Missouri River economics are based on 2002 values. These metrics are described in greater detail in the Corps (2013a) report *Cumulative Impacts to the Missouri River for the Bureau of Reclamation's Northwest Area Water Supply Project*.

[6] U.S. Bureau of Labor Statistics (2012) unemployment rate, seasonally adjusted as of June 2012.

Table 3-29 Missouri River Average Annual Benefits (1930 – 2002)

Use / Resource	Resource Average Annual Value	Reservoir / Dam	Upper River [a]	Lower River [b]
Flood Control ($ millions)	393.78	-0.52	81.24	313.06
Navigation ($ millions)	6.75			Sioux City 0.87 Omaha 0.66 Nebraska City 0.41 Kansas City 4.81
Navigation Season Length (months)	24	NA	NA	NA
Hydropower Benefits ($ millions)	628.84	Fort Peck 60.39 Garrison 126.30 Oahe 184.36 Big Bend 111.40 Fort Randall 108.01 Gavins Point 38.37	NA	NA
Hydropower Revenues ($ millions)	262.52	NA	NA	NA
Hydropower Capability and Generation (megawatts)	2,094	NA	NA	NA
Water Supply ($ millions)	607.77	19.69	95.81	492.27
Recreation ($ millions)	82.37	Upper three reservoirs 29.4 Lower three reservoirs 29.01	4.5	19.47
National Economic Development ($ millions)	1,719.52	636.44		1083.09

Notes:

NA = not available

[a,b] The Corps defines the “Upper River” as above Gavins Point Dam and the “Lower River” as below Gavins Point Dam (Corps 2013a).

Source: Corps 2013a

Missouri River Flood Control

Planning and subsequent regulation for the authorized flood control purpose of the Missouri River System constitutes a major portion of the Master Water Control Manual (Corps 2006). Flood control is given the highest operational priority during periods of significant runoff, when loss of life and property could occur. The flood damage prevention provided by the system has been greater than originally envisioned because of the protection provided to the urban areas in the basin during the 1993 and 1997 flood events. Without this protection, these areas would have sustained extensive damages to infrastructure and property (Corps 2006). The estimated $24.8 billion in accumulative damages prevented by the system exceeds the cost of building the entire system in today’s dollars. Five specific years (1993, 1995, 1996, 1997, and 1999) have resulted in more than 60 percent of the total damages prevented, primarily due to the protection of urban areas downstream of the system. In 2011, flood control management prevented nearly $8.2 billion in damage (Corps 2012c).

Missouri River Hydropower

Hydroelectric power on the Missouri River plays an important role in meeting the electricity demands of the upper Midwest in the United States. The six mainstem dams on the Missouri River support 36 hydropower units with a combined plant capacity of 2,501 megawatts of potential power generation. These units provide an average of 10 million megawatt-hours (MWh) of energy per year. Power generation at the six mainstem dams generally follows the seasonal pattern of water movement through the Missouri River System; however, adjustments are made, when possible, to provide maximum power production during summer and winter when demand is high.

The Corps constructed these hydroelectric facilities as part of a larger effort to develop multipurpose water projects. In addition to power generation, project functions include flood control, irrigation, navigation, and recreation. These projects must be operated in a way that balances their authorized purposes and in many instances, power is not the primary use. Nearly all of the water that flows into the Missouri River passes through hydropower turbines.

Missouri River Navigation

The Missouri River Bank Stabilization and Navigation Project was authorized by Congress in the Rivers and Harbors Act of 1945 and provides for a 9-foot-deep channel, a minimum of 300 feet wide from Sioux City to the mouth of the river near St. Louis, a distance of 735 miles. Navigation on the Missouri River is limited to the normal ice-free season, with a full-length flow support season of 8 months.

Major commodities transported on the Missouri River include agricultural products (farm and food products); chemicals, including fertilizers; petroleum products, such as asphalt; manufactured goods, including building products such as cement; and materials such as sand and gravel used to maintain the Missouri River System. During 1994, the total transported via Missouri River navigation was 8.5 million tons, which was a record high, and commercial shipping was 1.8 million tons. Commercial tonnage on the Missouri River has declined since 2000 due to drought. Drought has reduced navigation with shallower draft and shorter seasons. Navigation is less economically feasible during extended drought periods. As a result, the estimated commercial tonnage dropped from the 8.5-million-ton high in 1994 to an estimated 0.3 million tons in 2006.

The length of the navigation season during extended drought periods is reduced in accordance with the Master Water Control Manual (Corps 2006). A shortened navigation season occurred in 1981, 1988 to 1992, and 2003 to 2006. The level of navigation service is determined by the amount of water in storage on March 15 and July 1 of each year. High flows can also disrupt navigation. The river is generally closed to navigation when stages become so high that towboat propeller wash and waves from the tow can damage the levees.

Missouri River Water Supply and Irrigation

Missouri River System regulation has assured a relatively uniform supply of water for downstream municipalities and industrial uses, providing more than adequate flow in the river to meet the requirements for those using the Missouri River for their water supply. At times, releases from individual system projects have been adjusted to assure continued satisfactory functioning of water intakes in the short term. The Missouri River System is a source of water for municipal water supply; irrigation; cooling water; and commercial, industrial, and domestic uses. Approximately 1,600 water intakes of widely varying size are located within the system and the lower Missouri River. Access to water is a key concern because low water levels increase the cost of getting water from both the reservoirs and the Missouri River (Corps 2006). The Corps does not ensure access to a water supply based on a certain river stage or reservoir level, only that the quantity of water required will be available at that location. The Corps has considered accessing Missouri River water as the user's responsibility (Corps 2006).

Economic Resources Associated with Transbasin Transfer of Invasive Species

A summary of transborder economics related to invasive species is discussed in the "Aquatic Invasive Species" section above, addressing potential effects on local economies in the Hudson Bay basin related to recreational and commercial fishing and non-fishing recreation.

Environmental Justice

The affected environment for environmental justice is the Project Area counties and communities. An evaluation of environmental justice impacts is mandated by Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (February 11, 1994). This Executive Order directs federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. The impacts of an action can be considered disproportionately high and adverse if the percentage of total impacts imposed on a specific group is greater than the percentage of the total population in a given area represented by that group. For this analysis, a community of concern is defined by either race or ethnicity (i.e., minority) or by low income.

Population Percentage Criteria

To assess potential environmental justice concerns related to the proposed Project in accordance with Council on Environmental Quality guidance, the following two separate analyses within the affected environment were performed:

- A *50-percent criterion* population analysis to identify those counties and communities within the affected environment in which minority and / or low-income individuals equal or exceed 50 percent of the population.
- A *meaningfully greater criterion* population analysis to compare minority and / or low-income population percentages within counties and communities to statewide reference populations. A "meaningfully greater population" is defined as a minority and / or low-income population within an individual county or community that is equal to or greater than 120 percent (1.2 times) of the statewide reference population. This criterion level was selected because it is commonly used for NEPA compliance by federal agencies.

If a county or community meets either of these criteria, it indicates that there is a potential for environmental justice populations to experience disproportionate effects.

Populations within Counties

An initial identification of potential minority or low-income populations was conducted at the county level. U.S. Census Bureau data were used to identify potentially affected populations, which are shown in Figure 3-37 and Table 3-30.

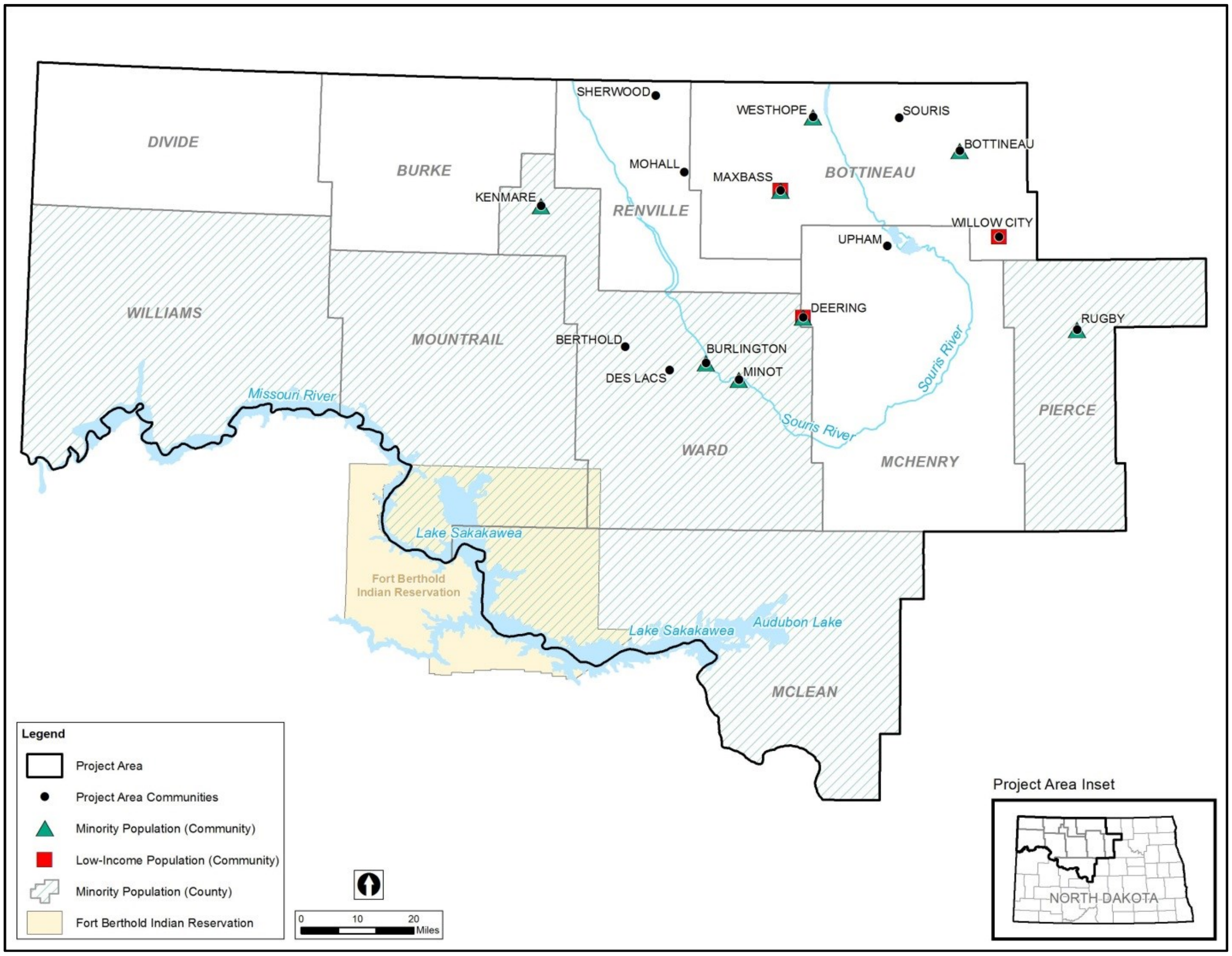

Figure 3-37 Minority and Low-Income Populations

Table 3-30 Minority and Low-Income Populations by Project Area County

County	2010 Total Population	2010 Minority Populations						2010 Hispanic or Latino Ethnicity	2011 Low-Income Populations
		African American	Native American or Alaskan Native	Asian or Pacific Islander	Other [a]	Two or More Races	Aggregate (Total) of Racial Minorities		
Bottineau	6,429	25 (0.4%)	136 (2.1%)	16 (0.2%)	22 (0.3%)	117 (1.8%)	316 (4.9%)	82 (1.3%)	758 (12.4%)
Burke	1,968	4 (0.2%)	15 (0.8%)	14 (0.7%)	0 (0.0%)	11 (0.6%)	44 (2.2%)	37 (1.9%)	160 (8.2%)
Divide	2,071	5 (0.2%)	11 (0.5%)	7 (0.3%)	1 (0.0%)	17 (0.8%)	41 (2.0%)	30 (1.4%)	210 (10.5%)
McHenry	5,395	8 (0.1%)	30 (0.6%)	16 (0.3%)	18 (0.3%)	48 (0.9%)	120 (2.2%)	8 (0.1%)	706 (13.2%)
McLean	8,962	8 (0.1%)	625 (7.0%)*	14 (0.2%)	19 (0.2%)	138 (1.5%)	804 (9.0%)	111 (1.2%)	867 (9.9%)
Mountrail	7,673	16 (0.2%)	2,348 (30.6%)*	16 (0.2%)	62 (0.8%)*	196 (2.6%)*	2,638 (34.4%)*	286 (3.7%)*	1,080 (14.7%)
Pierce	4,357	20 (0.5%)	170 (3.9%)	4 (0.1%)	29 (0.7%)*	34 (0.8%)	257 (5.9%)	44 (1.0%)	490 (11.9%)
Renville	2,470	2 (0.1%)	10 (0.4%)	5 (0.2%)	5 (0.2%)	29 (1.2%)	51 (2.1%)	24 (1.0%)	168 (7.0%)
Ward	61,675	1,542 (2.5%)*	1,630 (2.6%)	667 (1.1%)	428 (0.7%)*	1,690 (2.7%)*	5,957 (9.7%)	1,869 (3.0%)*	5,924 (10.1%)
Williams	22,398	63 (0.3%)	899 (4.0%)	84 (0.4%)	69 (0.3%)	644 (2.9%)*	1,759 (7.9%)	436 (1.9%)	1,812 (8.4%)
Affected Environment County Total	**123,398**	**1,693 (1.4%)**	**5,874 (4.8%)**	**843 (0.7%)**	**653 (0.5%)**	**2,924 (2.4%)**	**11,987 (9.7%)**	**2,927 (2.4%)**	**12,175 (10.3%)**
North Dakota Exceedance Criteria[b]	—	1.4%	6.5%	1.3%	0.6%	2.2%	12.0%	2.4%	14.8%
State of North Dakota	672,591	7,960 (1.2%)	36,591 (5.4%)	7,229 (1.1%)	3,509 (0.5%)	11,853 (1.8%)	67,142 (10.0%)	13,467 (2.0%)	78,888 (12.3%)
United States	308,745,538	38,929,319 (12.6%)	2,932,248 (0.9%)	15,214,265 (4.9%)	19,107,368 (6.2%)	9,009,073 (2.9%)	85,192,273 (27.6%)	50,477,594 (16.3%)	42,739,924 (14.3%)

Notes:

[a] The "Other" racial category accounts for those individuals who marked "Some other race," a category included in the 2010 Census for respondents who were unable to identify with the five Office of Management and Budget's race categories. Respondents who provided write-in entries such as Moroccan, South African, Belizean, or a Hispanic origin (for example, Mexican, Puerto Rican, or Cuban) are included in the "Other" race category.

[b] As described above, a meaningfully greater criterion population analysis compares minority and/or low-income population percentages within counties to statewide reference populations. For this SEIS, “meaningfully greater” is defined as 20 percent greater levels (i.e., a multiplier of 1.2) of minority or low-income populations than exist for the state. Statewide exceedance criteria percentages are 1.2 times the actual Environmental Justice group population percentages for North Dakota.

* Denotes minority populations and low-income individuals that were meaningfully greater than the corresponding minority population or low-income individual at the state level in the relevant racial/ethnic or low-income category columns.

Sources: U.S. Census Bureau 2012a, 2013

Populations within Communities

Populations within communities were identified from census places. A "census place" is a population concentration that is incorporated in a city, town, or village or as a census-designated place which is unincorporated (i.e., lacking a local government and city limits). As shown in Figure 3-37 and Table 3-31, the 15 communities within the Project Area contained 8 minority populations and 3 low-income populations.

Minority Populations in the Affected Environment

Minority populations are members of one of the following racial groups: African Americans, American Indians or Alaskan Natives, Asians, Native Hawaiians or other Pacific Islanders, "Other" races, multiracial, or Hispanic or Latino (CEQ 1997). The 2010 decennial Census was used to assess the county and community minority populations in the Project Area.

Populations within Counties

The percent of minority populations by county are listed in Table 3-29. There were 11,987 minority people identified in the 2010 Census, representing 9.7 percent of the total population. There were also 2,927 Hispanic or Latino people identified in the 2010 Census, representing 2.4 percent of the total population. The most prevalent minority population was Native Americans or Alaska Natives, including 5,874 people and representing 4.0 percent of the total population. The greatest concentrations of these Native American or Alaskan Native populations included 30.6 percent in Mountrail County, 7.0 percent in McLean County, 4.0 percent in Williams County, and 3.9 percent in Pierce County (U.S. Census Bureau 2012a). The second most common minority population was Hispanic or Latino, with 2,927 people and representing 2.4 percent of the total population. In comparison, in 2010, 10.0 percent of residents in the state of North Dakota were minorities, with 5.4 percent being Native Americans or Alaskan Natives and 2.0 percent being Hispanic or Latino (U.S. Census Bureau 2012a).

The 2010 Census showed that no minority population exceeded 50 percent of the total county population in any county. Minority populations that were meaningfully greater than the corresponding minority population at the state level are identified with an asterisk (*) in the relevant racial/ethnic category columns in Table 3-31. A Native American or Alaskan Native population was identified in Mountrail and McLean Counties, which are partially located within the Fort Berthold Indian Reservation. In Mountrail County, populations of multiracial, Hispanic or Latino, and "Other" ethnicities were also identified; and in Pierce County, a population of "Other" ethnicity was identified. In Ward County, populations of African American, multiracial, Hispanic or Latino and "Other" ethnicities were identified. Williams County contained a multiracial population.

Populations within Communities

Table 3-31 summarizes minority populations within Project Area communities meaningfully greater than the statewide averages, which are also identified with an asterisk (*) in the relevant racial / ethnic category columns. For each of the 15 communities, the percentage of each community's population represented by each minority classification (each race, aggregate race minority population, and Hispanic / Latino ethnic origin) was calculated and compared to the two criteria described above (U.S. Census Bureau 2012a).

No communities exceeded the 50-percent criterion for minority populations. There were 14 meaningfully greater minority populations that occurred within 8 communities (Table 3-30). Of these populations, four were identified in Minot; two each were identified in Deering, Kenmare, and Maxbass; and one each was identified in Bottineau, Burlington, Rugby, and Westhope.

The four meaningfully greater minority populations in Minot were African American, Hispanic or Latino, multiracial, and an "Other" population. Asian or Pacific Islander populations were identified in Deering. Multiracial populations were also identified in Bottineau, Deering, Maxbass, and Westhope; and "Other" populations were also identified in Burlington, Kenmare, Maxbass, and Rugby. Finally, Hispanic or Latino populations were also identified in Kenmare.

Low-Income Populations in the Affected Environment

Low-income populations were identified using poverty data from the U.S. Census Bureau's American Community Survey 2007 to 2011 5-year estimates (U.S. Census Bureau 2013). As with minority populations, low-income populations were identified using the absolute 50-percent and the relative 120-percent greater criteria, first for counties and then for communities.

Populations within Counties

The 2007 to 2011 5-year Census estimates showed that no low-income population exceeded the criteria of 50 percent of the total county population or were meaningfully greater than the corresponding low-income population at the state level in any county (Table 3-31).

Populations within Communities

Populations within communities meeting either of the absolute 50-percent or the 120-percent meaningfully greater criteria are described here. No community exceeded the 50-percent criterion for low-income populations. Of the 15 communities, 3 contained low-income populations: Deering, Maxbass, and Willow City (Table 3-31, Figure 3-36).

Table 3-31 Minority and Low-Income Populations by Project Area Community

Community	2010 Total Population	2010 Minority Populations						2010 Hispanic or Latino Ethnicity	2011 Low-Income Populations
		African American	Native American or Alaskan Native	Asian or Pacific Islander	Other [a]	Two or More Races	Aggregate (Total) of Racial Minorities		
Berthold	454	1 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (1.1%)	6 (1.3%)	8 (1.8%)	7 (1.4%)
Bottineau	2,211	15 (0.7%)	91 (4.1%)	11 (0.5%)	4 (0.2%)	48 (2.2%)*	169 (7.6%)	30 (1.4%)	239 (11.5%)
Burlington	1,060	1 (0.1%)	29 (2.7%)	2 (0.2%)	8 (0.8%)*	22 (2.1%)	62 (5.8%)	22 (2.1%)	69 (6.1%)
Deering	98	0 (0.0%)	0 (0.0%)	3 (3.1%)*	0 (0.0%)	4 (4.1%)*	7 (7.1%)	2 (2.0%)	38 (32.8%)*
Des Lacs	204	0 (0.0%)	4 (2.0%)	0 (0.0%)	0 (0.0%)	3 (1.5%)	7 (3.4%)	1 (0.5%)	2 (1.2%)
Kenmare	1,096	2 (0.2%)	7 (0.6%)	8 (0.7%)	13 (1.2%)*	15 (1.4%)	45 (4.1%)	28 (2.6%)*	108 (10.4%)
Maxbass	84	0 (0.0%)	1 (1.2%)	0 (0.0%)	1 (1.2%)*	7 (8.3%)*	9 (10.7%)	1 (1.2%)	44 (44.0%)*
Minot	40,888	933 (2.3%)*	1,328 (3.2%)	418 (1.0%)	262 (0.6%)*	1,084 (2.7%)*	4,025 (9.8%)	1,117 (2.7%)*	4,805 (12.4%)
Mohall	783	2 (0.3%)	9 (1.1%)	1 (0.1%)	3 (0.4%)	8 (1.0%)	23 (2.9%)	10 (1.3%)	82 (11.6%)
Rugby	2,876	8 (0.3%)	166 (5.8%)	1 (0.1%)	26 (0.9%)*	32 (1.1%)	233 (8.1%)	36 (1.3%)	368 (14.3%)
Sherwood	242	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.8%)	2 (0.8%)	1 (0.4%)	11 (4.8%)
Souris	58	0 (0.0%)	1 (1.7%)	0 (0.0%)	0 (0.0%)	1 (1.7%)	2 (3.4%)	0 (0.0%)	5 (10.0%)
Upham	130	1 (0.8%)	1 (0.8%)	1 (0.8%)	0 (0.0%)	2 (1.5%)	5 (3.8%)	0 (0.0%)	23 (14.6%)
Westhope	429	0 (0.0%)	5 (1.2%)	2 (0.5%)	0 (0.0%)	14 (3.3%)*	21 (4.9%)	2 (0.5%)	58 (12.7%)
Willow City	163	1 (0.6%)	4 (2.5%)	0 (0.0%)	0 (0.0%)	3 (1.8%)	8 (4.9%)	1 (0.6%)	50 (22.2%)*
Affected Environment Community Total	**50,776**	**964 (1.9%)**	**1,646 (3.2%)**	**447 (0.9%)**	**317 (0.6%)**	**1,250 (2.5%)**	**4,624 (9.1%)**	**1,259 (2.5%)**	**5,909 (11.6%)**
North Dakota Exceedance Criteria [b]	—	1.4%	6.5%	1.3%	0.6%	2.2%	12.0%	2.4%	14.8%
State of North Dakota	672,591	7,960 (1.2%)	36,591 (5.4%)	7,229 (1.1%)	3,509 (0.5%)	11,853 (1.8%)	67,142 (10.0%)	13,467 (2.0%)	78,888 (12.3%)

Community	2010 Total Population	2010 Minority Populations						2010 Hispanic or Latino Ethnicity	2011 Low-Income Populations
		African American	Native American or Alaskan Native	Asian or Pacific Islander	Other [a]	Two or More Races	Aggregate (Total) of Racial Minorities		
United States	308,745,538	38,929,319 (12.6%)	2,932,248 (0.9%)	15,214,265 (4.9%)	19,107,368 (6.2%)	9,009,073 (2.9%)	85,192,273 (27.6%)	50,477,594 (16.3%)	42,739,924 (14.3%)

Notes:

[a] The "Other" racial category accounts for those individuals who marked "Some other race," a category included in the 2010 Census for respondents who were unable to identify with the five Office of Management and Budget's race categories. Respondents who provided write-in entries such as Moroccan, South African, Belizean, or a Hispanic origin (for example, Mexican, Puerto Rican, or Cuban) are included in the "Other" race category.

[b] As described above, a meaningfully greater criterion population analysis compares minority and / or low-income population percentages within communities to statewide reference populations. For this SEIS, "meaningfully greater" is defined as 20 percent greater levels (i.e., a multiplier of 1.2) of minority or low-income populations than exist for the state. Statewide exceedance criteria percentages are 1.2 times the actual Environmental Justice group population percentages for North Dakota.

* Denotes minority populations and low-income individuals that were meaningfully greater than the corresponding minority population or low-income individual at the state level in the relevant racial / ethnic or low-income category columns.

Sources: U.S. Census Bureau 2012a, 2013.

Chapter Four – Environmental Impacts

Introduction

This chapter describes the consequences of the No Action Alternative and the direct, indirect, and cumulative effects of the action alternatives on the following environmental resources and issues, as described in Chapter 3:

- Water Resources
- Fisheries and Aquatic Invertebrates
- Aquatic Invasive Species
- Paleontological Resources
- Land Use
- Vegetation
- Wetlands and Riparian Areas
- Common Wildlife
- Federally Protected Species
- Historic Properties
- Indian Trust Assets
- Socioeconomics
- Environmental Justice

Direct effects are caused by the action and occur at the same time and place.

Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.

Cumulative effects are impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

40 CFR 1508.7 and 1508.8

The action alternatives could have effects on other resources, as well, but they are expected to be minor and are discussed in Appendix I - Other Minor Issues.

In compliance with an order by the U.S. District Court for the District of Columbia, this SEIS includes a hard look at and analysis of potential impacts of Project alternatives on natural and economic resources within Canada's Hudson Bay basin. Furthermore, the Boundary Waters Treaty of 1909 states, "boundary waters and waters flowing across the [U.S.-Canadian] boundary shall not be polluted on either side to the injury of health or property on the other [side of the international boundary]." The Dakota Water Resources Act of 2000 directs the Secretary of the Interior, in consultation with the Secretary of State and the Administrator of the U.S. Environmental Protection Agency (EPA), to determine that adequate treatment can be provided to meet the requirements of the Boundary Waters Treaty prior to construction of any water systems authorized under the act that delivers Missouri River water into the Hudson Bay basin. The analysis completed by Reclamation and the Cooperating Agencies fulfills the directives of the Boundary Waters Treaty and the Dakota Water Resources Act (P.L. 106-554, Title VI, Section 602).

Approach to the Impact Analysis

Chapter 3 describes the affected environment, or existing condition of various resources that may be affected by the proposed action alternatives. In this analysis, the consequences of the No Action Alternative (future conditions through 2060) are identified by comparing to existing conditions. The No Action Alternative is the basis against which all other alternatives are compared to identify potential impacts. This approach is consistent with Council on Environmental Quality guidance and *Reclamation's NEPA Handbook* (Reclamation 2012b).

> **Consequences:** Anticipated changes to resources under the No Action Alternative.
>
> **Impacts/Effects:** Anticipated changes to resources attributable to the construction or operation of the action alternatives.

The consequences of the No Action Alternative are described qualitatively for most resources because it is not fully known what the Project members would do in the absence of the Project, and NEPA does not require a lead agency to speculate what changes might occur if a project were not implemented. The consequences that might occur are disclosed to the extent that is reasonable. As an example, under the No Action Alternative, a number of Project members would have water that did not meet primary and/or secondary drinking water standards and some would have insufficient water supplies. This would have socioeconomic implications, and while the exact consequences are not known, the types of consequences that are likely to occur are described. Consequences that are more predictable, such as changes to groundwater levels in the Minot and Sundre aquifers, are described to the extent that information is available.

Impacts of the action alternatives are quantified wherever possible and are analyzed by comparing them to what is expected to occur under the No Action Alternative. The impacts resulting from the construction of Project components are based on the current Project design, details of which are included in Appendix J. As noted in Chapter 2, the action alternatives have been designed at an appraisal level, and therefore, only a general location of the components has been identified. Advanced engineering phases of the proposed action would refine this information and ultimately determine the final locations of the components. The appraisal-level design allows Reclamation to assess the potential impacts of the action alternatives for comparative purposes. As the design progresses, the precise locations of components would be further refined to comply with Reclamation's standard best management practices (BMPs), which are included in Appendix F. These include measures requiring construction to avoid impacts on existing land uses, including wildlife refuges and other sensitive areas, and to comply with all federal, state, and local laws.

After identifying the impacts that could occur based on the current design, the impact analyses then consider the extent to which the BMPs, which include general construction measures and measures specific to each of the resources included in Chapter 4, would be able to reduce or avoid impacts on these resources. Given the implementation of the BMPs, most impacts would be temporary (lasting only during the construction period or ending soon thereafter), although some permanent impacts also would occur; these are primarily associated with the construction of aboveground facilities and with Project operations. As discussed in Appendix A, Constructed Project Components, to date the construction of Project facilities has resulted in less than 3 acres of permanent impacts on previously disturbed land. These impacts on the land resources were considered in the effects analysis but did not contribute to cumulative effects.

> **Temporary impacts** generally are associated with construction activities and have a short-term effect. The resource would be restored to its previous condition within 1 to 3 years.
>
> **Permanent impacts** are long-term changes or reoccurring changes to a resource.

Each section also describes environmental commitments that are intended to mitigate adverse environmental impacts that could not be fully avoided by the implementation of the BMPs. (A complete list is included in Appendix F.) Each section concludes whether any unavoidable adverse impacts would remain after the BMPs and environmental commitments were implemented. The impact analysis has been conducted using the best available information regarding the Project design. Should subsequent revisions be made to the appraisal-level design that would result in significant changes that are outside the scope of the SEIS analyses, additional NEPA analysis would be conducted as necessary to fully evaluate and disclose the impacts.

In order to quantify construction impacts of the action alternatives where possible, a geographic information systems (GIS) analysis was used to quantify the amount of various resources (e.g., vegetation, wetlands, land uses, wildlife habitat) located in a component's footprint. The footprints of each component are included in the description of the action alternatives in Chapter 2. For linear components such as pipelines, the footprint includes a 110-foot-wide corridor centered on the proposed pipelines' location as identified in the appraisal-level design. This corridor is generally wider than the actual area in which construction impacts would occur. Therefore, the estimated temporary impacts represent the maximum potential disturbance. Information was used from the most current U.S. Geological Survey (USGS) land cover and hydrology databases (USGS 2010) and the U.S. Fish and Wildlife Service (Service) National Wetlands Inventory (NWI) database (Service 2012a). The USGS land cover categories assessed include cultivated cropland; developed land; developed, open space;[1] mixed-grass prairie; and shrubland. The land cover data are coarse in scale, meaning that they provide a broad identification of existing land cover conditions across the Project Area; the land cover database typically uses a scale greater than 1:100,000. Actual conditions at a given location may vary from what is included in the land cover database, but this is the best information currently available to evaluate impacts across a large geographic area. The land cover data were supplemented with the NWI database, which more accurately represents potential wetlands affected by the action alternatives. The NWI database depicts the approximate wetland locations drawn at a scale of 1:24,000.

The analyses recognize that there are links between resources. For example, if an alternative affects streamflows, it may also in turn affect aquatic communities, wetlands, and riparian areas. Changes in these resources could then affect wildlife. Throughout these impact assessments, linkages are discussed where appropriate and are quantified when possible.

The analyses also are based on the best available information for each resource, and this varies depending on the geographic area. This is particularly noticeable in the evaluation of impacts associated with withdrawing water from Souris and Missouri rivers and is due to the differences in size and management of the Hudson Bay basin, where the Souris River is located, and the Missouri River basin. The Missouri River is the longest river in the United States and has been extensively modified to provide authorized uses of the Missouri River Mainstem Reservoir System (Missouri River System) by the U.S. Army Corps of Engineers (Corps), which carefully regulates flows from the multiple dams in the system. Because it is a managed river system that flows through major population centers, many studies, models, and datasets are available to

1 The USGS (2010) has characterized developed, open space areas as containing small amounts of impervious surface (less than 20 percent) and large amounts of vegetation (primarily grasses planted for erosion control, aesthetic purposes, or recreation).

describe flows and help estimate potential impacts from the Missouri River alternatives on the system. The Souris River, in contrast, is much smaller, originates and terminates in Canada, flows through comparatively less populated areas, and is much less regulated, particularly in the portion that flows through the United States (Figure 3-2). Although flows are subject to the "Agreement between the Governments of Canada and the United States for Water Supply and Flood Control in the Souris River Basin" (ISRB 2000), flow models have not been developed, limited data are available, and less is known about the basin in general.

Each resource is discussed in a separate section, and each section is organized in a similar manner, as shown in Table 4-1. Common and scientific names of species are consolidated in Appendix G and also appear where appropriate in sections of this chapter.

Table 4-1 Organization of Resource Area Sections of Chapter 4

Section Name	Contents
Introduction	Describes the types of issues to be addressed.
Methods	Describes the methods used to analyze impacts.
Results—No Action	Qualitatively describes the consequences of the No Action Alternative.
Results—Action Alternatives	Summarizes the effects that are common to each of the four action alternatives, as well as effects that are common to the inbasin and Missouri River alternatives, respectively, where applicable. Potential impacts of the action alternatives are described based on the Project as it is currently designed. BMPs (Appendix F) are then considered to determine whether they would effectively minimize or avoid impacts. The discussion of the impacts that are common to the action alternatives is followed by a discussion of the impacts that are specific to each alternative. In particular, each of the action alternatives includes different combinations of water sources, which could result in different impacts on the water-dependent resources, such as wetlands and riparian areas, fisheries and aquatic invertebrates, and wildlife. Resources such as land use and historic properties could also be affected by changes in river flows.
Environmental Commitments	Describes the environmental commitments that would be applied as needed to further reduce environmental effects of the action alternatives and concludes whether any unavoidable adverse effects would occur.
Cumulative Effects	Describes the cumulative effects of each alternative in combination with those of other known, reasonably foreseeable projects that would affect similar resources in the Project Area.
Summary	Compares and contrasts the effects of the No Action Alternative and the action alternatives.

Adaptive Management

Managers in many fields adjust their strategies as new information accumulates and as new practices are developed. Adaptive management is a strategy for addressing a changing and uncertain environment that relies on common sense and learning, and it would be applied to this Project. Adaptive management looks for ways to understand the behavior of ecosystems and draws upon theories from ecology, economics and social sciences, engineering, and other disciplines. Adaptive management incorporates and integrates concepts such as social learning, operations research, economic values, and political differences with ecosystem monitoring, modeling, and science (National Research Council 2004).

The goal of adaptive management is to enhance scientific knowledge and reduce uncertainties. The uncertainties that are part of any system can come from a number of sources. Parma et al. (1998) and Regan et al. (2002) describe causes of uncertainty in natural systems. Sources of uncertainty include natural variability, incomplete data, and social and economic changes and events, all of which may affect natural resources systems. Adaptive management works to create policies that help organizations, managers, and other stakeholders respond to and even take advantage of unanticipated events (Holling 1978; Walters 1986; National Research Council 2004).

Application of adaptive management is intended to support actions when the scientific knowledge of their effects on ecosystems is limited (Holling 1978). This does not mean that actions are delayed or postponed until there is agreement that we have learned a sufficient amount about an ecosystem. Rather, adaptive management provides a means to adjust management actions when new information becomes available.

Adaptive management consists of a set of principles used to guide the implementation of management actions (National Research Council 2004). The fundamental principles of adaptive management, while useful for evaluating problems and adjusting strategies, are not designed to be a strict roadmap to a specific endpoint (National Research Council 2004). Rather, the principles set forth a mechanism that will assist in recognizing when changes occur and management should be adjusted. The principles are based on several important aspects of systems.

First, as we learn more about the interactions between humans, their environments, and potential impacts of human activities, there may be a need to develop new courses of action. Second, the environment in which we live is highly variable and is always changing, and these factors can impact operations of projects. Finally, the objectives that society has for a specific project and the outcomes from that project may change, resulting in a need to change how the project is operated (National Research Council 2004).

The basic theme of adaptive management is to continually evaluate project operations and develop courses of actions that can respond to change. This means that project managers must revisit objectives and develop a range of choices for how they will manage a project if changes occur. Managers must also use the information gained through evaluation and apply it to future decisions. A key to successful implementation of any adaptive management strategy is to involve stakeholders in the learning and evaluation processes.

Adaptive management has been used on water resource projects in many areas of the United States. For example, the U.S. Department of the Interior used an adaptive management approach to restoring riparian habitat in the Grand Canyon by releasing large quantities of water from Glen Canyon Dam and collecting data on the result to inform future management decisions. A number of projects have incorporated adaptive management to address recovery of threatened or endangered species, or in ecosystem restoration programs. For example, the Corps incorporated adaptive management into restoration efforts in the Florida Everglades.

Recently, Reclamation has used adaptive management strategies in the development of water projects in North Dakota. As projects are undergoing final design and construction, Reclamation has established teams of stakeholders to review projects for environmental compliance. These teams evaluate specific project features as they are being designed and built and monitor environmental compliance. This program allows construction to proceed despite changes (e.g., unanticipated discovery of cultural resources), respond to the changes, (re-route the pipe to avoid the site), and “adapt” to conditions in the field.

Adaptive management is based on input from a number of scientific, engineering, and social disciplines. As such, the use of adaptive management is not limited strictly to issues related to human impacts on the environment. For the purposes of this Project, Reclamation and the State of North Dakota would focus on two specific areas. Reclamation would develop an adaptive management plan, in accordance with the U.S. Department of the Interior's policy guidance (Order 3270 [2007]) and the report *Adaptive Management: the U.S. Department of the Interior Technical Guide* (Williams et al. 2007) in order to address Project uncertainties related to potential impacts associated with water resources, including impacts on national wildlife refuges (NWRs). If a Missouri River alternative was selected in the Record of Decision, an adaptive management strategy also would be developed to assess the effectiveness of the water treatment systems in reducing risks of transfer of non-native species. Because a key factor in the successful implementation of adaptive management is stakeholder involvement, Reclamation and the State of North Dakota would continue to engage the Impact Mitigation Team to implement adaptive management practices. This team, which is composed of federal, state, tribal, and local entities, would develop the specific adaptive management programs as necessary and provide input to Reclamation and the State of North Dakota.

Climate Change

Introduction

U.S. Department of the Interior Secretarial Order No. 3289 (2009) requires Reclamation to "consider and analyze potential climate change impacts when undertaking long-range planning exercises." Two aspects of climate change may be applicable to the Project. The first is whether an action alternative could contribute to climate change through Project-generated greenhouse gas emissions. The second is whether climate change could affect an action alternative. Effects of the Project on greenhouse gas emissions have been determined to be insignificant, and information on these effects is provided in Appendix I. This section describes potential climate change effects on the Project with respect to future water supply availability from the Missouri and the Souris rivers. These potential effects would occur under all action alternatives, as well as No Action.

Temperatures in the northern Great Plains have risen approximately 1.85 ºF between 1901 and 2008 and are projected to warm further during the remainder of 21st century (Reclamation 2011a). In Reclamation's Great Plains region, which includes the Missouri River basin and the United States portion of the Souris River basin, all areas have become more temperate, and some have experienced a general increase in mean annual precipitation with a decline in spring snowpack, including reduced snowfall-to-rain winter precipitation ratios and earlier snowmelt runoff (Reclamation 2011a).

Climate change is expected to continue and is considered reasonably foreseeable. Climate change is discussed in this chapter because of its broad geographic scope and its potential to affect many resources. This SEIS includes a quantitative analysis of how climate change could affect streamflow in the Missouri River and a qualitative description of potential climate change effects on Souris River flows. Additional information on climate change effects on the Missouri River is presented in *Climate Change Analysis for the Missouri River Basin* (Reclamation 2012c) and *Cumulative Impacts to the Missouri River for the Bureau of Reclamation's Northwest Area Water Supply Project* (Corps 2013a). Those reports are supporting documents to this SEIS.

Methods

Souris River Basin

No climate change studies have focused exclusively on the Project Area and the Souris River. However, regional and continental-scale climate change models and studies include the Project Area and have been reviewed and incorporated into this analysis. As described above, Reclamation includes climate change analysis for projects within its basins, the nearest of which is the adjacent Missouri River basin. As described in the section below and in the Water Resources section of Chapter 3, under Missouri River Mainstem Reservoir System and Operations, the Missouri River System has multiple reservoirs that are managed by the Corps, which has developed flow models that predict flows based on measured and projected runoff. Similar models have not been developed for the Souris River basin, and many of the data needed to develop such models for the Souris River basin are lacking. For example, historical flow records are incomplete or of short duration at many gage locations in the Souris River basin, documentation of historical depletions and operations of refuge impoundments is incomplete, and estimates of unregulated streamflow have not been developed. Obtaining the necessary data and developing the models to quantitatively evaluate this issue would be very costly and time-consuming, and is beyond the scope of analysis for this SEIS. Therefore, a qualitative analysis was conducted for the Souris River using model results developed for the adjacent Missouri River basin, regional climate change projections for temperature and precipitation, and regional climate change studies developed to help resource managers predict effects of climate change.

In July 2014, following the public release of the Draft SEIS, downscaled hydrologic projections for the U.S. portion of the Souris River became available. This new information has been considered, and additional information is included in the Results - Climate Change Effects on Souris River Flows section below.

Missouri River Basin

Reclamation, as part of the SECURE Water Act implementation activity, West-Wide Climate Risk Assessment (WWCRA), has developed runoff projections for the Missouri River basin covering the period from 1950 to 2099. The runoff projections were developed by running 112 downscaled climate change projections through a watershed runoff model (Variable Infiltration Capacity model, Liang et al. 1994). Development of the runoff projections is described in the WWCRA hydrologic projections technical report (Reclamation 2011b).

The runoff data for each of the projections were routed to each of the model nodes used in the Corps' Missouri River Daily Routing Model (DRM), which models flows and reservoir levels for the Missouri River System. For each projection and site (DRM node), change in mean monthly flows between a future period (2040 to 2069) and the reference hydrology period (1950 to 1999) was calculated, and the 5th, 25th, 50th, 75th, and 95th percentiles from all of the projections were estimated. These quantiles capture the uncertainty (lower bound, 5th percentile; upper bound, 95th percentile) in changes to mean monthly flows between the reference hydrology (1950 to 1999) and future hydrology periods (2040 to 2069) that could occur as a result of climate change. See Reclamation (2012c) for additional details on methods used to calculate monthly flow change factors.

The monthly flow change factors for five climate change scenarios (5th, 25th, 50th, 75th, and 95th percentiles) were used to modify the historical inflows for each reach included in the DRM, and the results were used to simulate the effects of climate change on the Missouri River. All simulations included projected reservoir sedimentation and reasonably foreseeable future depletions, including Project depletions that would occur under the Missouri River alternatives. The Corps analysis (Corps 2013a) focused on the hydrologic effects of four (5^{th}- through 75^{th}-percentile projections) of the five climate change scenarios because the fifth scenario (95^{th}-percentile projection) increased the inflows so dramatically (approximately 60 percent in the higher runoff months) that this scenario could not be simulated due to limitations of the DRM.

Results

Regional Climate Change Impacts

Potential future climate change effects in the region are primarily associated with projected increases in air temperatures and precipitation, and the cascading effects these changes would have on the ecosystem (Reclamation 2011a). Estimated climate change impacts on the various ecosystem components are discussed below.

Temperature and Precipitation

The Great Plains is projected to generally become warmer and wetter as a result of climate change. Figure 4-1 shows projected changes in mean annual temperature and precipitation over the Great Plains. The figure shows median projections from an ensemble of 112 climate projections. Within this region, the Northern Plains, including the Project Area, exhibits the greatest increases in both projected temperature and precipitation.

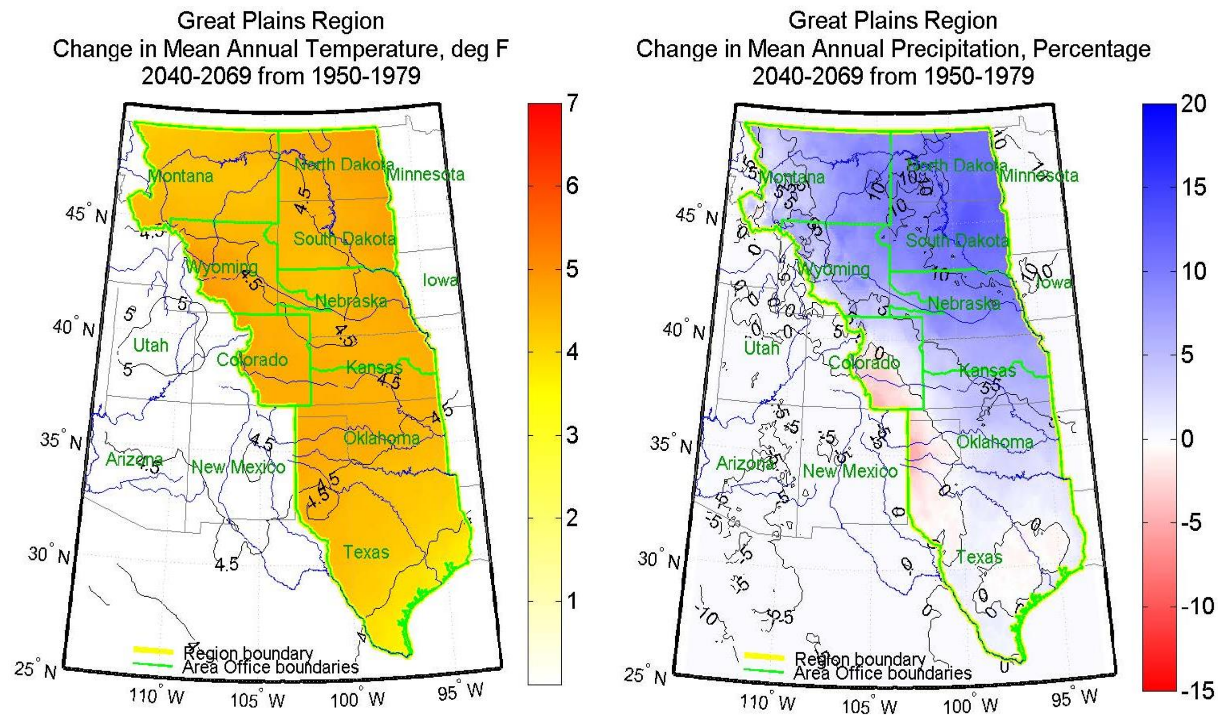

Figure 4-1 Projected Changes in Mean Annual Temperature and Precipitation for the Great Plains

Note: Figure shows the median projection from an ensemble of 112 downscaled climate projections.
Source: Reclamation 2011a

Runoff

Increased temperatures are expected to change the seasonal pattern of runoff and stream flow (Jacobs et al. 2001). In particular, projections show that warmer winters will result in more winter precipitation falling as rain and less as snow. As a result, snowpack will likely decrease, winter stream flow will increase, and spring runoff will occur earlier (Christensen et al. 2007).

Increases in extreme precipitation and runoff events could present flood control challenges at many locations, but possibly to a lesser extent in snowmelt-dominated basins, since the snowpack would be reduced. Currently, some floods in the Great Plains region are driven by local, convective precipitation events (spring and summer thunderstorms such as the one that contributed to the flood of 2011). Trapp et al. (2007) looked at future changes in deep convection (i.e., severe thunderstorms) due to a warming climate and found increases in the number of days with suitable conditions for warm-season severe storms for most of the Great Plains region, particularly in the summer months. The associated increase in heavy precipitation events inherent with deep convection could bring increased flood risk. Increased runoff from heavy precipitation events could increase nutrient concentrations in lakes and rivers. Combined with higher water temperatures, this could result in increased frequency and severity of toxic cyanobacterial blooms (EPA 2013b). Although precipitation extremes are likely to increase, there are still many uncertainties associated with predicting increased convective precipitation events at any specific location based on the results from current climate models.

For the 2050s relative to the 1990s, mean April 1st snow water equivalent is projected to decrease 38 percent in the Missouri River at Canyon Ferry, Montana (a representative upper basin location), and 81 percent in the Missouri River at Omaha, Nebraska (a representative lower basin location) (Reclamation 2011c). Mean annual runoff, however, is projected to increase at both locations (Reclamation 2011c).

Figure 4-2 shows box plots that illustrate the range of monthly flow changes for the 2040 to 2069 look-ahead period at Garrison Dam (a representative upper basin location) and Kansas City (a representative lower basin location) based on 112 downscaled climate and runoff projections. The box in the box plots represents the 25th- and 75th-percentile projections of the flow time-series. The whiskers represent the 5th- and 95th-percentile projections of the time-series, and the horizontal line within the box corresponds to the median projection of the flow time-series. Outliers (values outside the 5th and 95th percentiles) are represented with open circles. At Garrison Dam, the median monthly changes show increased flow from December to June and decreased flows from July to November, with a net increase in mean annual flow (median change in mean annual flow estimated from the 112 projections and 1950 to 1999 reference hydrology period) of about 6 percent over the 2040 to 2069 period. Similarly, at Kansas City, the median monthly changes show increased flow in most months, with a net increase in mean annual flow of about10 percent over the 2040 to 2069 period. Note that these box plots depict changes in modeled runoff and do not reflect changes in reservoir operations.

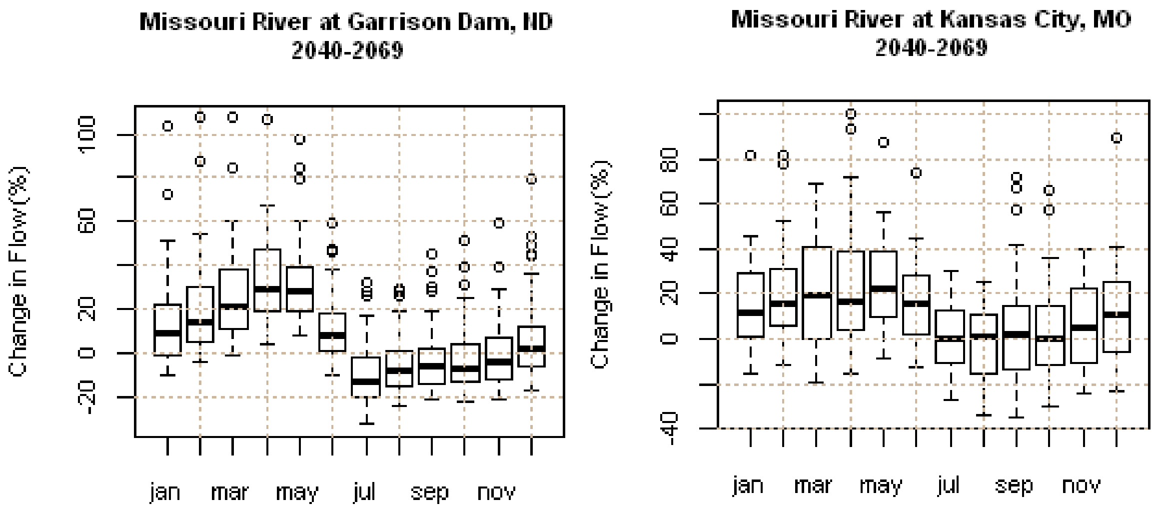

Figure 4-2 Boxplots of Monthly Change Factors at Representative Locations in the Missouri River Basin (2040 – 2069)

Note: Reference hydrologic period is 1950 – 1999; box plots are based on 112 downscaled climate and hydrologic projections.
Source: Reclamation 2012c

Most of the downscaled hydrologic projections show increased annual runoff in the Missouri River basin. Figure 4-3 shows simulated changes in historical runoff for the Missouri River basin upstream of Sioux City, Iowa from 1950 to 1999 (the reference hydrologic period) under projected 2040 to 2069 climatic conditions. The 5th-percentile projection shows decreased runoff, the 25th-percentile projection nearly matches historical runoff, and the 50th- to 95th-percentile projections show moderate to very large increases in runoff. Thus, about 75 percent of the projections show increased annual runoff, while about 25 percent decrease runoff.

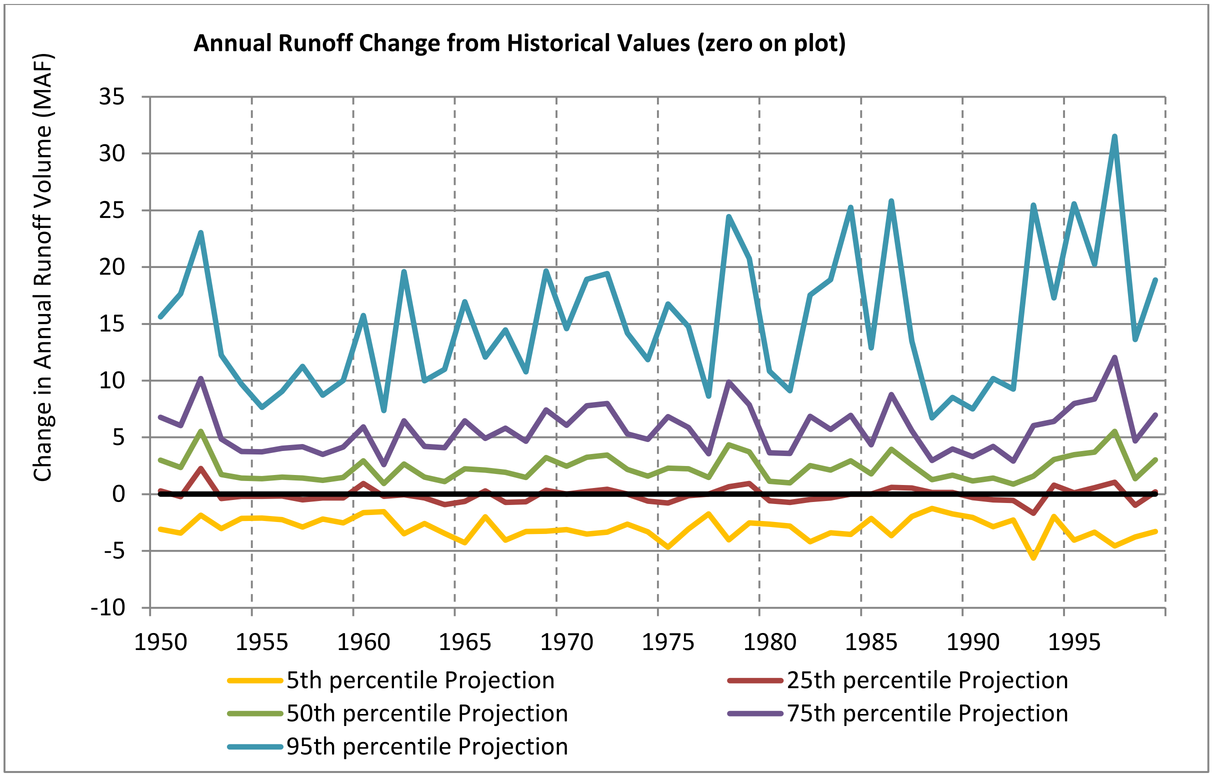

Figure 4-3 Simulated Annual Changes to Historical Runoff for the Missouri River Basin Upstream of Sioux City, Iowa for Five Climate Change Scenarios

Note: Reference hydrologic period is1950 – 1999.
Source: Modified from Corps 2013a

Groundwater

Natural groundwater recharge is likely to be affected by climate change. Reduced snowpack, earlier snowmelt, and reductions in spring and summer streamflow volumes originating from snowmelt likely will affect surface water supplies and could trigger heavier reliance on groundwater resources. In addition, if a larger percentage of annual precipitation is in the form of intense rain events with high runoff, less of that water could infiltrate and recharge aquifers (Reclamation 2011a).

Water Temperature

Potential future changes in water temperature are likely to occur as a result of increased air temperatures. Changes in water temperature could affect the spawning success of temperature-sensitive fish species. Increased water temperature could alter distributions of some invasive species and could decrease the effectiveness of chemical or biological agents used to control invasive species. Warmer water temperatures could also spur growth of algae, which could result in eutrophic conditions in lakes, declines in water quality, and changes in species composition (Reclamation 2011a).

Water Quality

Reclamation has summarized information related to climate change effects on water quality in the Great Plains, as follows:

> *"Whether water quality conditions improve or deteriorate under climate change depends on several variables, including water temperature, flow, runoff rate and timing, and the*

> *physical characteristics of the watershed. Climate change has the potential to alter all of these variables. Climate change impacts on surface water ecosystems very likely will affect their capacity to remove pollutants and improve water quality; however, the timing, magnitude, and consequences of these impacts are not well understood. Increased summer air temperatures could increase dry season aquatic temperatures and affect fisheries habitat."* (Reclamation 2011a:91.)

Fish and Wildlife

Reclamation has summarized information related to climate change effects on fish and wildlife in the Great Plains as follows:

> *"Projected climate changes are likely to have an array of interrelated and cascading ecosystem impacts. At present, most predicted impacts are primarily associated with projected increases in air and water temperatures and include increased stress on fisheries that are sensitive to a warming aquatic habitat, potentially improved habitat for quagga mussels bearing implications for maintenance of hydraulic structures, and increased risk of watershed vegetation disturbances due to increased fire potential. Other warming-related impacts include poleward shifts in the geographic range of various species, impacts on the arrival and departure of migratory species, amphibian population declines, and effects on pests and pathogens in ecosystems. Climate changes also can trigger synergistic effects in ecosystems and exacerbate invasive species problems."* (Reclamation 2011a:91.)

Climate Change Effects on Souris River Flows

Changes in modeled unmanaged flows due to climate change on the Missouri River were estimated using both climate change models and hydrologic models. Since hydrologic models are not available for the Souris River, projected changes in flows are estimated based on the projected changes in flows on the Upper Missouri River, regional climate change model projections, and regional climate change studies. Although estimated changes in flows are available for the Missouri River basin, they cannot be applied directly to the Souris River basin because the basins are different in terms of precipitation, size, longitude, average elevation, water management, and land use, all of which affect the magnitude and timing of flows (Figure 4-4 and Table 4-2).

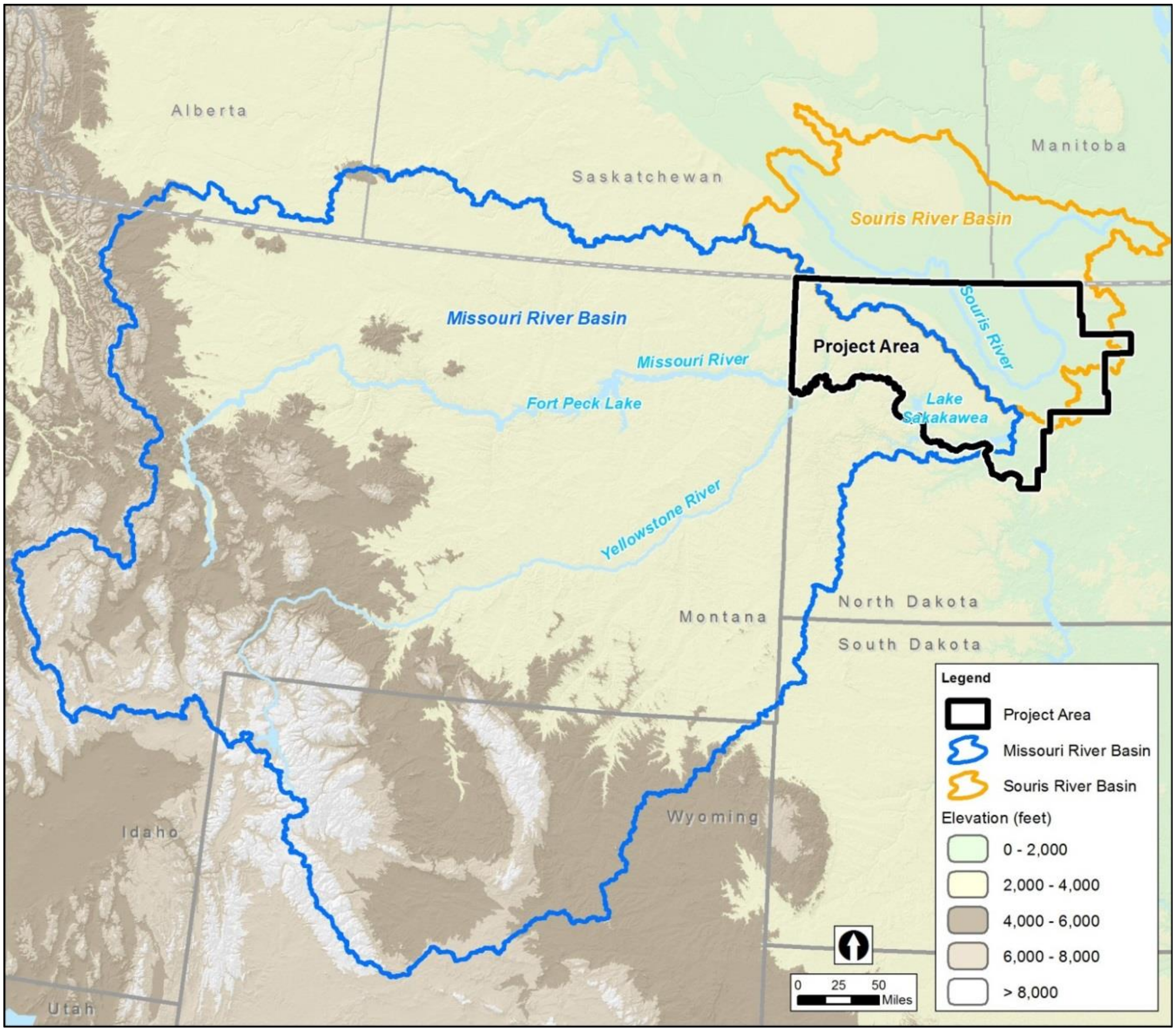

Figure 4-4 Missouri River Basin (above Garrison Dam) and Souris River Basin

Table 4-2 Comparison of Missouri River Basin and Souris River Basin Attributes

Attribute	Missouri River Basin	Souris River Basin
Length	951 miles (above Garrison Dam)	281 miles (above Westhope)
Average Annual Flow	22,680 cfs (measured post-dam construction at Bismarck)	269 cfs (at Westhope)
Average Annual Runoff	16,430,000 acre-feet (at Bismarck)	194,600 acre-feet (at Westhope)
Watershed Area	180,775 square miles (above Garrison Dam)	16,900 square miles (at Westhope; over 10,000 square miles do not drain to the Souris River)
Lowest/Highest Elevation	1,818 feet/13,600 feet	1,109 feet/2,762 feet
Average Elevation	4,154 feet	1,930 feet
Average Annual Precipitation	13 to 17 inches	10 to 20 inches

Note:
cfs = cubic feet per second
Sources: SWC 2005; USGS 2012d

As indicated in Table 4-2, the Missouri River basin above Garrison Dam is greater in most metrics, including annual flows and runoff (84 times greater) and contributing watershed area (27 times greater) and has an average elevation that is over twice as high as the Souris River basin. Average elevation affects the amount of precipitation that falls as snow and the timing of the snowmelt. Precipitation levels, however, are similar and increase from west to east across both basins.

Since the flows on the upper Missouri River are managed by the Corps with reservoirs that include Lake Sakakawea and Fort Peck, the natural seasonal variation in flows is heavily modified, which is why changes in monthly runoff (not adjusted for system management) were modeled as part of the climate change analysis for the Missouri River system. Figure 4-2 shows the estimated percent change for modeled unmanaged flows at Garrison Dam between the periods of 1950 to 1999 and 2040 to 2069. The model predicts that flows will be between 10 and 30 percent higher from January through June, peaking when spring snowmelt flows are highest in April. From June through November, flows were predicted to be 5 to 10 percent lower, with the greatest change in the summer months of July and August. Average annual runoff at Garrison Dam is predicted to increase about 6 percent between those two periods (Reclamation 2012c). These results match the regional projections for runoff in the northern Great Plains that winter precipitation and runoff will increase and that summer flows will decrease (Reclamation 2011a; Temperature and Precipitation and Runoff sections above).

Although changes in Souris River flows cannot be estimated quantitatively, the similar predictions for increased precipitation (about 10 percent) and increases in average annual temperatures (about 5 °F, resulting in warmer winters and warmer summers) across both basins supports the likelihood of higher winter flows, peak flows earlier in spring, and lower summer flows for the Souris River. There are several reservoirs on the Souris River upstream from Minot that are managed for multiple uses, but they are limited in their ability to store water and release flows during the summer because they are also managed for flood control and must maintain capacity to capture flood flows. (See the Water Resources section of Chapter 3 for more details.) Climate change studies also predict increases in the frequency of intense and heavy rainfall interspersed with longer relatively dry periods (Reclamation 2011a), so the already highly variable flows in the Souris River are likely to become even more variable over the duration of the Project. Potential climate change effects on Souris River basin groundwater levels and recharge rates are unknown.

Availability of New Hydrologic Projections (July 2014)

After the Draft SEIS was released for public review, downscaled hydrologic projections for the U.S. portion of the Souris River basin became available. Thus, it is now possible to partially quantify potential effects of climate change on Souris River flows. However, available data and models for the Souris River basin are still not comparable to those available for the Missouri River basin. Approximately 80 percent of the contributing drainage area for the Souris River above Minot lies within Canada, and this area is not covered by available hydrologic projections.

The downscaled hydrologic projections for the Missouri River basin used in the Draft SEIS analysis were based on 112 global climate projections developed by the World Climate Research Program (WCRP) through its Coupled Model Intercomparison Project Phase 3 (CMIP3). In 2012-2013, WCRP released global climate projections from CMIP Phase 5 (CMIP5). CMIP5 projections use a new generation of global climate models and an updated set of greenhouse gas emissions scenarios.

In July 2014, Reclamation and partners released an ensemble of 97 downscaled climate and hydrologic projections based on CMIP5 global climate projections. These hydrologic projections cover all of the contiguous United States, whereas previously available CMIP3-based hydrologic projections covered most of the western United States (but not the Souris River basin). Both CMIP3-based and CMIP5-based downscaled hydrologic projections are available for the entire Missouri River basin, while only CMIP5-based projections are available for the Souris River basin, and then only for the U.S. portion of the basin.

The downscaled CMIP3-based and CMIP5-based hydrologic projections are generally similar for most of the western United States, but there are differences, primarily related to differences in the climate models and emissions scenarios (Reclamation 2014). Although CMIP5 is newer, it has not been determined to be a better or more reliable source of climate projections compared to existing CMIP3 climate projections. Until additional studies are completed by the climate modeling community, CMIP5 projections should be considered an addition to (not a replacement of) the existing CMIP3 projections (Reclamation 2014).

For the Souris River above Minot, the median CMIP5-based hydrologic projection shows an increase of about 10 percent in mean annual runoff, which is similar to the CMIP5-based projection for the Missouri River above Garrison Dam.

Because no operations model exists for the Souris River, it is not possible to simulate changes in runoff on a daily or monthly timescale as was done for the Missouri River. However, the projected change in annual runoff can provide some perspective on potential climate change effects on Souris River flows.

Based on 109 years of historical flow records, the median annual flow of the Souris River at Minot is 82 cfs. Under the median hydrologic projection (a 10.5-percent increase in annual runoff), this flow will increase by about 9 cfs, which could slightly increase water supply for the three alternatives that include the use of Souris River. However, flows in the Souris River would still frequently be less than Project water demands (i.e., 100 percent of the flow withdrawn at times under inbasin alternatives). The slight increase in flows under the median hydrologic projection would not substantially decrease the significant adverse impacts of Project withdrawals on Souris River resources as disclosed in the Draft SEIS.

Climate Change Effects on Missouri River Reservoir Operations and Downstream Flows

The Corps manages the Missouri River System to meet authorized purposes. The current operational rules are dictated by the *Missouri River Mainstem Reservoir System Master Water Control Manual* (Master Water Control Manual) (Corps 2006). For this analysis, the Corps used the DRM to simulate reservoir operations using the current operational rules but adjusted input files to account for future sedimentation, depletions, and potential effects of climate change on monthly runoff. Thus, the baseline (no climate change) is the 1950 to 1999 reference hydrologic period adjusted to year 2060 level of development. Climate change effects (at the same level of development) are added or subtracted from the baseline to simulate future system operations.

Garrison Dam Operations

Lake Sakakawea, impounded by Garrison Dam, would be a Project water source for two of the alternatives evaluated in this SEIS. Climate change effects on reservoir water levels or dam releases could affect Project water supplies.

Figure 4-5 shows the difference in simulated end-of-month reservoir elevations between the baseline and three climate change hydrologic projections for the 50-year period of analysis. The three projections displayed (25^{th} percentile, 50^{th} percentile [median], and 75^{th} percentile) represent the middle half of the 112 projections that were developed. The median projection provides a sense of the anticipated effect, while the 25^{th} percentile (lower runoff) and 75^{th} percentile (higher runoff) display uncertainty associated with the projections. Note that for each projection displayed, the same monthly change factors were used for every year in the period of analysis. The median projection results in higher reservoir elevations (greater storage) in 88 percent of the months over the 50-year period of analysis. The 25^{th}-percentile projection is generally similar to the baseline, with slightly lower reservoir elevations in 65 percent of the months. The 75^{th}-percentile projection shows consistently higher reservoir elevations, with some months more than 20 feet higher than the baseline simulation. These results suggest that Lake Sakakawea elevations and reservoir storage are likely to increase in the future as a result of climate change.

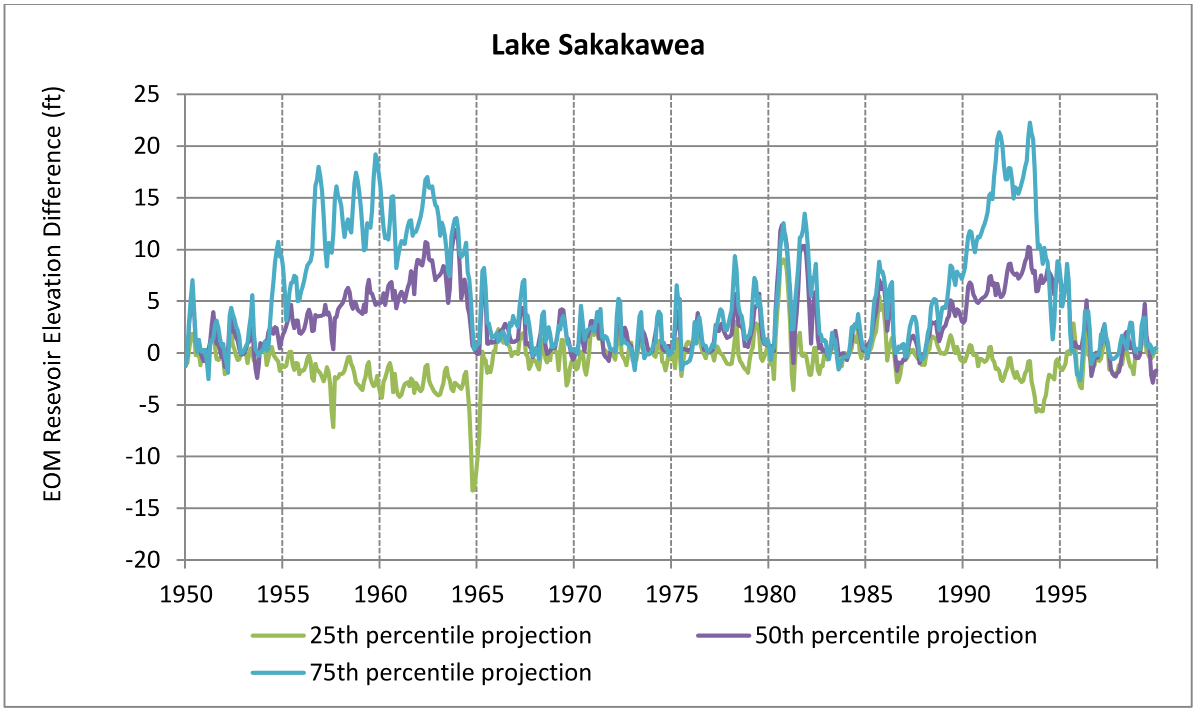

Figure 4-5 Differences in the End of Month Lake Sakakawea Water Surface Elevation Values for Three Climate Change Projections from the Baseline (No Climate Change)

Note: Reference hydrologic period is1950 – 1999.

Source: Modified from Corps 2013a

Garrison Dam discharge (i.e., streamflow below Garrison Dam) is also projected to increase under climate change. Figure 4-6 compares mean monthly and annual Garrison Dam discharge for the baseline and three climate change projections. The median projection shows increased mean discharge in all months, with an increase in mean annual discharge of about 7 percent. The 25th-percentile projection shows a slight decrease of about 3 percent in mean annual discharge, while the 75th-percentile projection results in an increased mean annual discharge of about 22 percent.

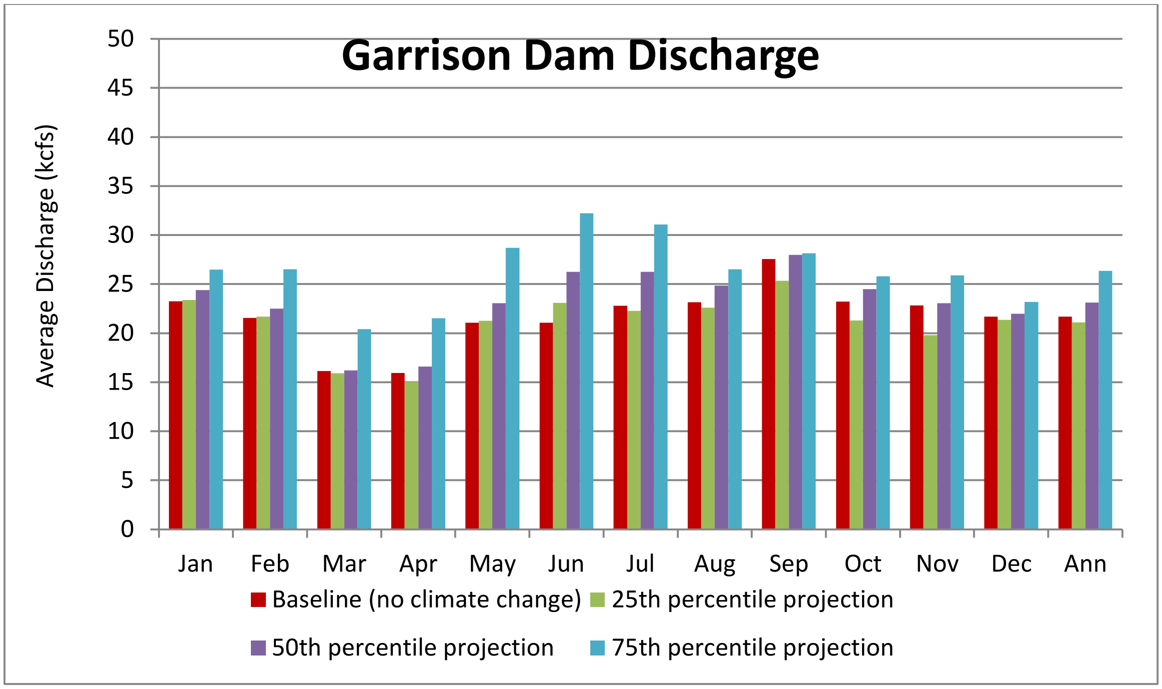

Figure 4-6 Average Monthly and Average Annual Releases from Garrison Dam for the Baseline (No Climate Change) and Three Climate Change Projections

Source: Modified from Corps 2013a

Figure 4-7 shows Garrison Dam mean annual discharge for the 50-year period of analysis for the baseline (no climate change) and three climate change projections. Again, the 25th-percentile projection most closely approximates the baseline, while the median and 75th-percentile projections show higher mean annual discharge in 43 and 45 years out of 50, respectively.

Streamflow in the Missouri River at Kansas City

Streamflows in the lower Missouri River basin are affected by mainstem dam and reservoir operations and runoff below Gavins Point Dam, the lowermost dam in the Missouri River System. Kansas City was selected as a representative location in the lower Missouri River basin to evaluate potential effects of climate change on streamflow.

Figure 4-8 compares mean monthly and annual discharge in the Missouri River at Kansas City for the baseline and three climate change projections. The pattern is similar to that at Garrison Dam, with the median projection showing increased mean discharge in all months, with an increase in mean annual discharge of about 12 percent. The 25th-percentile projection shows a very slight decrease of about 0.3 percent in mean annual discharge, while the 75th-percentile projection results in an increased mean annual discharge of about 27 percent.

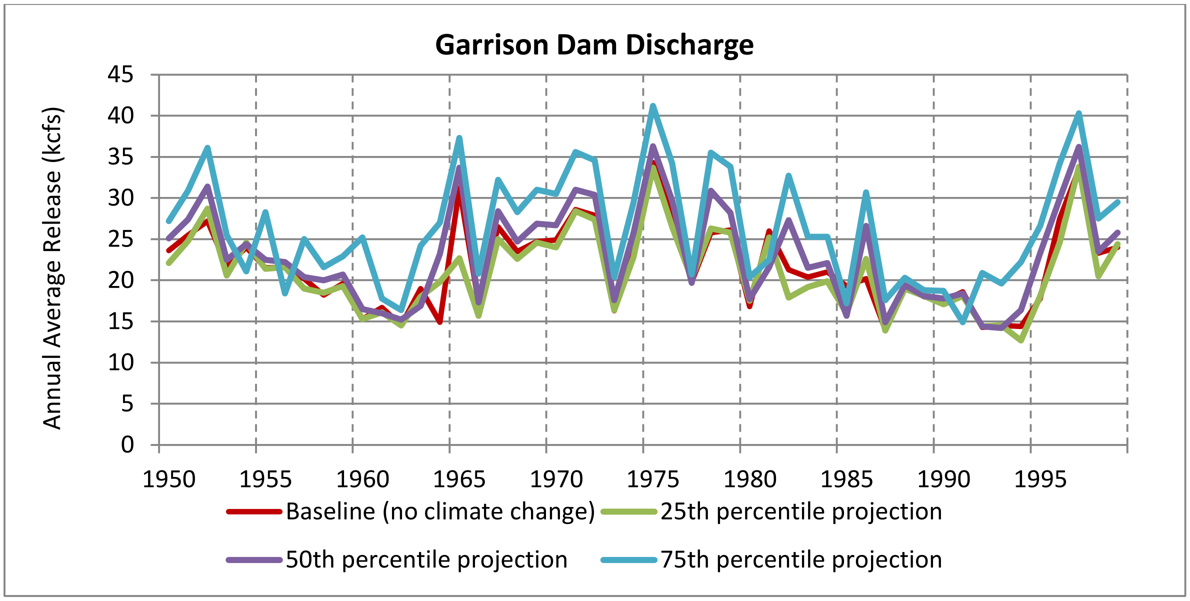

Figure 4-7 Simulated Average Annual Garrison Dam Discharge for Baseline (No Climate Change) and Three Climate Change Projections

Note: Reference hydrologic period is 1950 – 1999.

Source: Modified from Corps 2013a

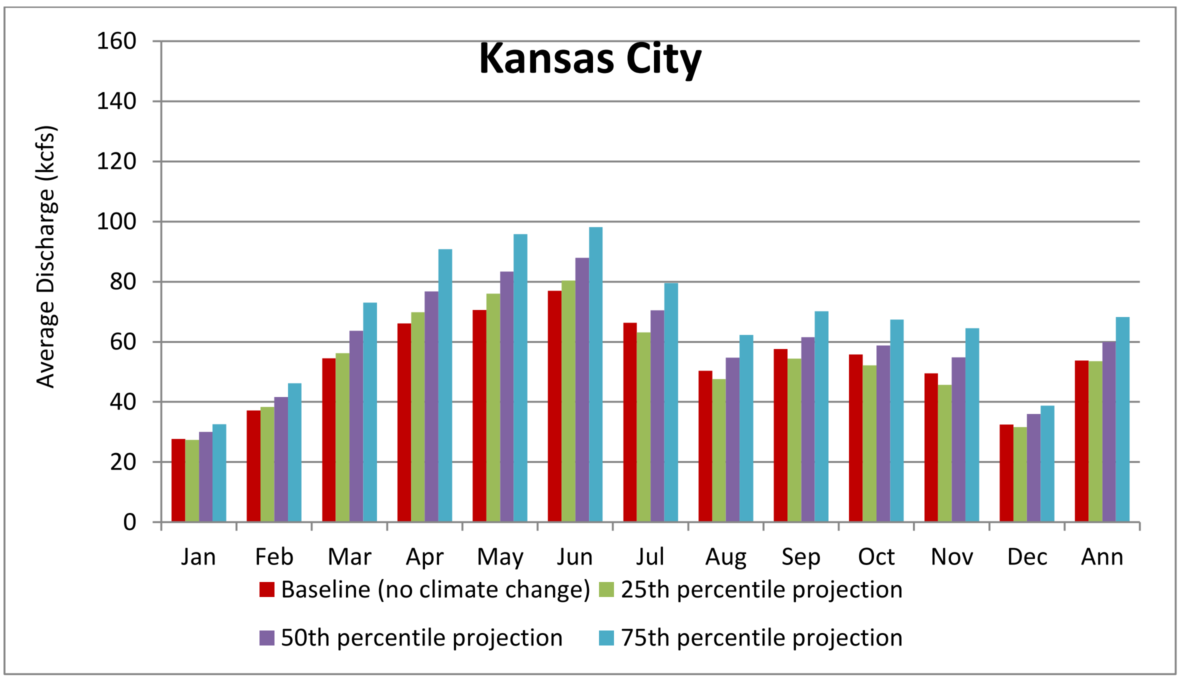

Figure 4-8 Simulated Average Monthly and Average Annual Streamflow in the Missouri River at Kansas City for Baseline (No Climate Change) and Three Climate Change Projections

Source: Modified from Corps 2013a

Figure 4-9 shows the difference in simulated average annual streamflow in the Missouri River at Kansas City between the baseline and three climate change hydrologic projections for the 50-year period of analysis. Under the median projection, average annual streamflow increases in every year of the period of analysis, with an average increase of about 6,200 cubic feet per second (cfs). The 25th-percentile projection approximates the baseline, and the 75th-percentile projection shows an average increase of about 14,500 cfs.

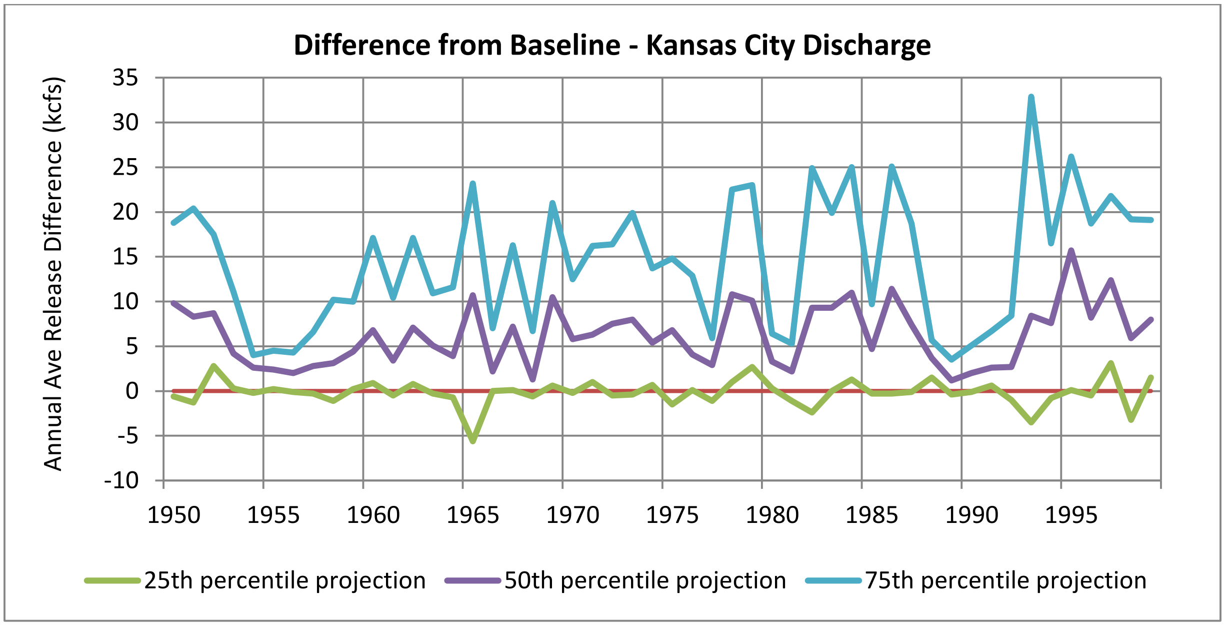

Figure 4-9 Simulated Changes to Average Annual Streamflow in the Missouri River at Kansas City for Three Climate Change Scenarios

Note: Reference hydrologic period is1950 – 1999.

Source: Modified from Corps 2013a

Relative Effects of Climate Change and Project Withdrawals

Three of the alternatives evaluated in this SEIS would withdraw water from the Souris River near Minot, which would affect flows downstream of the diversions during some months of the year. (See Water Resources section in this chapter for details.) As described above, climate change is likely to affect Souris River flows, but these potential effects have not been modeled. Average annual precipitation in the Souris River basin is likely to increase by about 10 percent, which may offset some of the withdrawals proposed under the alternatives using Souris River water.

Two of the alternatives evaluated in this SEIS would withdraw water from the Missouri River to meet Project demands. These withdrawals could affect reservoir elevations and streamflow in the Missouri River. Climate change could affect the timing and magnitude of runoff in the Missouri River basin, which would also affect reservoir elevations and streamflow.

Figures 4-10 and 4-11 compare potential effects of Project withdrawals and climate change on average annual elevation in Lake Sakakawea and average annual releases from Gavins Point Dam, the lowermost dam in the Missouri River System. In both cases, effects of Project withdrawals are very small compared to climate change effects. For example, DRM simulations indicate that Project withdrawals would lower the average elevation of Lake Sakakawea by 0.007 feet (0.8 inch).

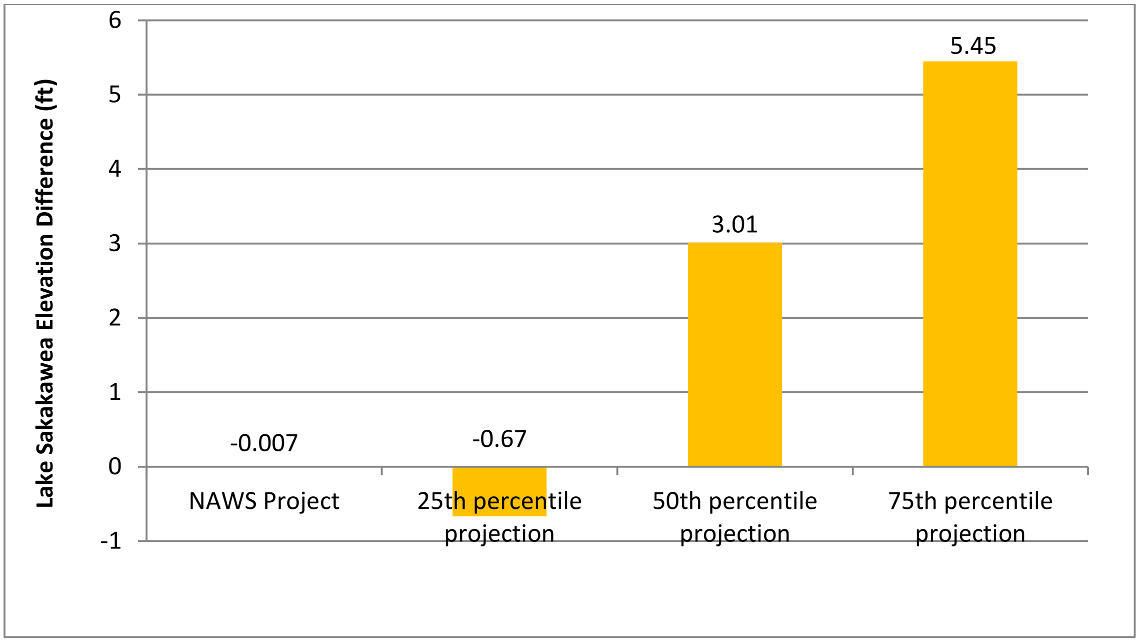

Figure 4-10 Relative Effect of Project Water Withdrawals and Three Climate Change Projections on Average Annual Lake Sakakawea Elevation

Source: Modified from Corps 2013a

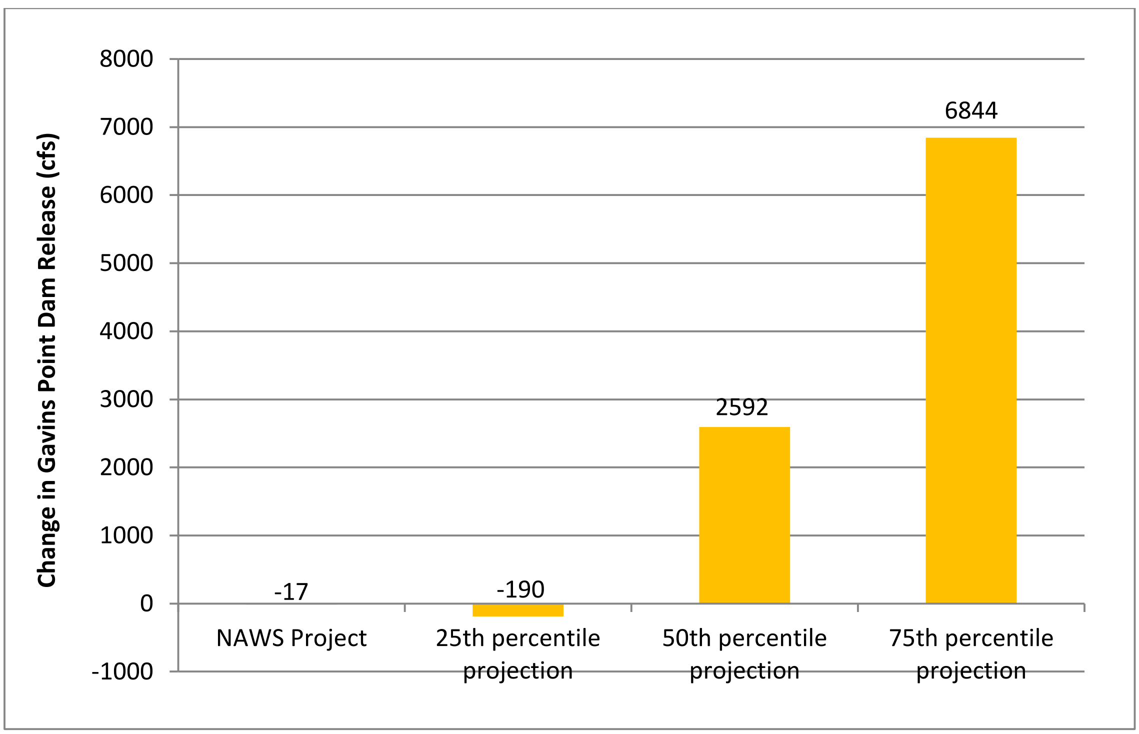

Figure 4-11 Relative Effect of Project Water Withdrawals and Three Climate Change Projections on Average Annual Gavins Point Dam Releases

Source: Modified from Corps 2013a

By comparison, the median climate change projection raises the average elevation by 3.01 feet. Thus, under the median projection, climate change would have 430 times as much effect in the opposite direction on Lake Sakakawea water surface elevations as would Project water withdrawals.

Likewise, Project withdrawals would decrease average Gavins Point Dam releases by 17 cfs, while the median climate change projection shows an increase in average releases by nearly 2,600 cfs, or 150 times the effect of the Project in the opposite direction.

Uncertainties

This analysis used best available datasets and modeling tools and followed methodologies documented in peer-reviewed literature. However, there are a number of analytical uncertainties that are not fully reflected in study results, including uncertainties associated with climate projection and assessing hydrologic impacts. Further details on uncertainties associated with climate and runoff modeling used in this analysis are available from the WWCRA technical report (Reclamation 2011b).

Summary

Based on regional climate change projections, the Souris River basin is likely to experience increased precipitation (about 10 percent) and increases in average annual temperatures (about 5 °F, resulting in warmer winters and warmer summers). These changes increase the likelihood of higher winter flows, peak flows occurring earlier in spring, and lower summer flows for the Souris River. Climate change studies also predict increases in the frequency of intense and heavy rainfall interspersed with longer relatively dry periods (Reclamation 2011a), so the already highly variable flows in the Souris River are likely to become even more variable over the duration of the Project.

The best available scientific information indicates that runoff in the Missouri River basin is likely to increase in the future due to climate change. Increased runoff would generally be reflected in higher reservoir levels, higher reservoir releases, and higher streamflow in the lower basin downstream of the mainstem reservoir system. The potential effects of climate change on the Missouri River are much greater than any effects attributable to Project water withdrawals.

Water Resources

Introduction

This section describes the potential consequences associated with the No Action Alternative and the impacts of the four action alternatives on surface water and groundwater hydrology, water quality, and fluvial geomorphology. Implementation of any of the alternatives (including the No Action Alternative) would affect water resources, either temporarily or permanently.

Consequences of the No Action Alternative include continued drawdown of the Minot and Sundre aquifers and insufficient quantities of water that meet primary and secondary drinking water standards for communities within the Project Area. Temporary impacts of the action alternatives generally are associated with the construction of buried pipelines and the water intakes on the Souris River or Lake Sakakawea. Permanent impacts may be associated with proposed long-term withdrawals from the Souris River and Missouri River, and changes in water use from the Minot and Sundre aquifers.

This section is organized slightly differently than the other sections in Chapter 4. The discussions of methods, results, environmental commitments, cumulative effects, and the summary that immediately follow this introduction focus on the impacts associated with construction of the Project components throughout the entire Project Area, as well as impacts associated with the use of water sources located within the Hudson Bay basin. These discussions are followed by another impact analysis that focuses specifically on the use of water from the Missouri River as part of the two Missouri River alternatives.

Project Area/Hudson Bay Basin

The following key issues are analyzed in this section:

- Erosion, sedimentation, and hazardous materials spills during construction, as well as the potential for disruption of streamflows during pipeline installation.
- Changes in quantity and timing of flows in the Souris River near Minot and downstream.
- Changes in groundwater recharge, storage, and availability in the Minot and Sundre aquifers.
- Changes in surface water and groundwater quality in the Souris River and the Minot and Sundre aquifers.
- Changes in geomorphic processes in the Souris River.

Methods

Construction Impacts

A GIS analysis of construction-related impacts was conducted using hydrographic data obtained from the national hydrography dataset (USGS 2013a) to determine which Project components would be constructed within or near streams and lakes. Stream crossings and crossing methods for each alternative were identified, along with potential impacts from these crossings. Potential impacts from the construction of Project pipelines and other components on surface water quality and hydrology from erosion, sedimentation, and spills of hazardous materials and from stream crossings were described, and the potential for BMPs and environmental commitments (Appendix F) to minimize or avoid impacts on waterways was then considered.

Operational Impacts

Two different units of measurement are used to describe quantities of water in this discussion: million gallons per day (mgd) and cfs. Municipal water supplies, associated engineering reports, and groundwater withdrawals are typically described in mgd; flows in rivers and streams are typically described using cfs. Occasionally flows in the Souris River are described in mgd if the flows appear in a table with other flows measured in mgd. A flow of 1.55 cfs equals 1 mgd.

Surface Water

Unlike the Missouri River basin, surface water runoff and reservoir operation models do not exist for the Souris River. (See Chapter 3 for details.) Developing a model with sufficient detail to simulate the variability and management scenarios on the Souris River would be expensive and would require several years of effort to collect data and to test and calibrate the model. Hydrologic data are available from five USGS gages on the mainstem Souris River, some with records dating back to 1903 (Table 3-4). Data from these gages and widely used hydrologic methods were used to characterize the No Action Alternative and, in combination with proposed withdrawals under each action alternative, used to estimate changes in flows and potential impacts for each action alternative (described in more detail below). Based on quantitative estimates in changes in flows at the USGS gage locations, potential impacts for each alternative were estimated for locations between gages.

Chapter 2 summarizes the assumptions underlying the development and design of each action alternative, including estimates of water demand, proposed capacities based on engineering estimates, availability of various sources of water, and the quantity and timing of withdrawals proposed for each alternative. Additional details regarding these factors are included in Appendix J.

Each action alternative includes operating assumptions that were used to simulate and estimate where, when, and how much water would be withdrawn from or added to each water source (Chapter 2). These assumptions were used to characterize the potential impacts of each action alternative on water resources in the Project Area. These assumptions were based on demand estimates, infrastructure capacity, and gage data for the period of record and do not include potential restrictions due to existing water rights; they therefore represent a maximum withdrawal scenario for purposes of assessing environmental impacts. The assumptions for withdrawals from the Souris River under the action alternatives are summarized in Table 4-3.

As described in the Water Resources section in Chapter 3, gage data for the period of record were obtained for the five USGS gages on the Souris River in the Project Area (Figure 3-2). Additional gages in Canada and on tributaries to the Souris River were considered for use in the analysis but were not analyzed in detail because the information from those gages did not add to the evaluation of impacts of the alternatives. Based on the operating assumptions that describe the timing and amount of withdrawals from the Souris River for each alternative (Table 4-3, Chapter 2), flow records for the period of record for the gage nearest Minot and the three gages downstream of Minot in the United States were analyzed to estimate the effect of proposed withdrawals.

The USGS gage above Minot is upstream of the City of Minot and has the longest period of record of the four gages analyzed. Because withdrawals for some of the action alternatives would occur at the Minot Water Treatment Plant (WTP) near downtown Minot, or at recharge basin intakes located upstream and downstream of the WTP, the gage above Minot was used as the primary source of data to analyze the effects of withdrawals in the Minot area and immediately downstream.

For purposes of analyzing potential effects of the withdrawals, the total daily withdrawal from all three intake sites was combined and subtracted from the daily data at the USGS gage on the Souris River above Minot for the entire period of record. Water would actually be withdrawn at up to three locations over approximately a 10-mile reach of the Souris River through Minot, and flows through this reach would vary accordingly.

In a downstream direction, the effects of water withdrawals would diminish as tributaries contribute flow to the Souris River. The next gage, 86 miles downstream at Verendrye, shows higher flows than the Minot gage for most months (Figure 3-7). However, the rates at which flows change along the Souris River between Minot and Verendrye have not been determined because there are no flow data available between the two gages. Therefore, the impact analysis focuses on the Souris River immediately downstream of the intakes in Minot where impacts would be most pronounced, and accrual of tributary flows and groundwater contributions would serve to lessen the effects with distance downstream from the intakes.

Table 4-3 Action Alternatives: Water Allocations and Operational Assumptions

Alternative	Assumptions
Groundwater with Recharge Alternative	▪ Withdraw from the Souris River for artificial recharge in March through August, when available, at a rate equal to the river flow or maximum rate of 56 mgd (87 cfs) up to a maximum annual allocation of 4.5 bgy. ▪ No Souris River withdrawals between September and February. ▪ Recharge the Minot and Sundre aquifers equally with withdrawn water at a rate of up to 56 mgd. ▪ Withdraw water from the Minot and Sundre aquifers at rates equal to the Project demand.
Groundwater with Recharge and the Souris River Alternative	▪ Withdraw from the Souris River for artificial recharge when available in March through August, at a rate equal to the river flow or maximum rate of 56 mgd (87 cfs) up to a maximum annual allocation of 4.5 bgy. ▪ No Souris River withdrawals from September through February. ▪ Recharge the Minot and Sundre aquifers equally with withdrawn water at a rate of up to 56 mgd. ▪ When available, direct deliver Souris River water to the Minot Water Treatment Plant in March through August at a rate equal to the monthly average Project demand minus 1.0 mgd up to 5.75 mgd. ▪ Withdraw water from the Minot and Sundre aquifers at rates equal to the Project demand (less direct delivery at a minimum rate of 1.0 mgd).
Missouri River and Conjunctive Use Alternative	▪ Withdraw up to 5.75 mgd from the Souris River for direct delivery from March through August at a rate of half the demand whenever the flow is more than twice the monthly average demand. ▪ No withdrawals from the Souris River when the flow is less than twice the monthly average demand. ▪ No Souris River withdrawals from September through February. ▪ Withdraw water from the Minot and Sundre aquifers at minimum rate of 1.0 mgd up to 2.6 mgd. ▪ Withdraw at least 2.0 mgd from the Missouri River at rates equal to the Project demand (less direct delivery from the Souris River and Minot and Sundre aquifers).
Missouri River and Groundwater Alternative	▪ No withdrawals from the Souris River under this alternative. ▪ Withdraw water from the Minot and Sundre aquifers at a minimum rate of 1.0 mgd up to 2.6 mgd. ▪ Withdraw water from the Missouri River at rates equal to the Project demand (less direct delivery from the Minot and Sundre aquifers).

Note:
bgy = billion gallons per year; cfs = cubic feet per second; mgd = million gallons per day

Two types of hydrologic analyses were used to characterize the potential effects of the Project: (1) time series analysis and trend analysis with subsequent hydrologic statistics and graphical comparisons; and (2) the Indicators of Hydrologic Alteration (IHA).

Time Series Analysis and Trend Analysis. The essential step of all of the hydrologic analyses was to create a baseline time series of flows for the Souris River and for each action alternative. The daily time series of streamflow data for the period of record from each of the four USGS gages from the above Minot gage downstream to the USGS gage near Westhope was used as the baseline streamflow time series. This baseline for each gage includes flow reductions from water rights withdrawals upstream of each gage throughout the historical period of record. (See Table 3-3 in Chapter 3 for details on water rights above and below the Minot gage.)

By subtracting the assumed operational withdrawals for each day in the historical time series, a new simulated time series for the period of record was created for each action alternative. The amount estimated to be withdrawn each day was based on the operational assumptions described in Chapter 2 and listed in Table 4-3 and was based in part on infrastructure capacity and estimated Project demand. The simulated with-Project flows for each gage and alternative include historical water rights withdrawals since those were part of the historical flow records used as the baseline. The estimated Project withdrawals do not consider potential limitations from the full exercise of senior water rights in the future because a detailed accounting of how those rights would be used cannot be accurately predicted due to the variability of annual flows and meteorological conditions.

For the Groundwater with Recharge Alternative, the maximum withdrawal limit of 56 mgd (based on the capacity of the infiltration basins or the mean daily flow, whichever was less) was subtracted from the mean daily flow starting in March and continuing until a total of 4.5 billion gallons were withdrawn. The point when 4.5 billion gallons was reached varied by year depending on the mean daily flows and the number of days that had less than the 56 mgd available for withdrawal. For the Groundwater with Recharge and the Souris River Alternative, additional water was withdrawn at a rate up to 5.75 mgd (based on the capacity of the intake structure) for direct delivery to the Minot WTP. This approach was applied to the USGS gage above Minot and the three downstream USGS gages near Verendrye, Bantry, and Westhope. The resulting time series were evaluated in a variety of ways to evaluate the impacts on streamflow for each alternative.

The entire period of record was examined to estimate changes in flows on the Souris River. Flow duration curves were developed that include average daily flows from the period of record arranged from high to low that allow exceedance probabilities to be estimated. Exceedance probabilities were also used to develop box and whisker diagrams showing the range of flows on a monthly basis. (See the No Action Alternative discussion for examples.)

In addition to the analyses using the whole period of record, years representing dry, normal, and wet conditions (based on the annual 75-percent exceedance flow, the median flow, and the 25-percent exceedance flow, respectively) were also selected as examples from the period of record to illustrate in more detail how the proposed withdrawals would affect the hydrology of the Souris River under those flow conditions. (See the "Groundwater with Recharge Alternative" discussion for examples.)

Using these years as examples allows for the simulation of withdrawals using actual flow data. Because there is no typical, average, or representative year, the hydrograph selected for each type of year varies considerably when compared to other years with similar annual flows. Therefore, they are used only to illustrate and compare the effects of each alternative using the same example hydrographs as a baseline.

Indicators of Hydrologic Alteration. The second hydrologic analysis technique used was the IHA, which was developed to quantify the effects associated with naturally or artificially altered flow regimes (Nature Conservancy 2013). The IHA uses flow data from the available period of record to calculate a series of hydrologic and temporal metrics, including the timing and duration of minimum and maximum flows of different intensities, rate of change in flows for flood events, and other parameters for the unaltered flow record and each alternative.

The historical flows from the period of record and the simulated flows developed for the first phase of the analysis described above (Project withdrawals were subtracted from the mean daily flows for the period of record) were used as inputs to the IHA model for each alternative. Table 4-4 displays the output of the IHA analysis for the historical record (No Action/Missouri

River and Groundwater alternatives, which also represent the existing condition) and the three alternatives that use Souris River water. Parameter group #1 gives the results for median monthly flows. Parameter group #2 gives results for minimum and maximum flows and median number of days with zero flows. Parameter group #3 gives the dates of the median annual minimum and maximum flows. Parameter group #4 gives the IHA-determined low and high pulse threshold values and the number and duration for a median year.

Table 4-4 Results of the IHA Analysis for the Souris River at the USGS Gage above Minot

	Non-Parametric IHA Scorecard: Median Values for Each Scenario			
	No Action/ Missouri River & Groundwater	**Groundwater with Recharge Alternative**	**Groundwater with Recharge & the Souris River Alternative**	**Missouri River & Conjunctive Use Alternative**
Normalization Factor	1	1	1	1
Mean Annual Flow (cfs)	152.4	136.8	135	150.1
Non-Normalized Mean Flow	152.4	136.8	135	150.1
Annual C.V.	3.3	3.6	3.7	3.4
Flow Predictability	0.2	0.3	0.3	0.2
Constancy/Predictability	0.7	0.8	0.8	0.7
Percent of Floods in 60-Day Period	0.4	0.4	0.4	0.4
Flood-Free Season	0	0	0	0
Parameter Group #1 – Results for Median Monthly Flows (cfs)				
October	14	14	14	14
November	15	15	15	15
December	7.2	7.2	7.2	7.2
January	4.6	4.6	4.6	4.6
February	3.8	3.8	3.8	3.8
March	20	0	0	14.58
April	160	73	64.45	153.0
May	74	0	0	65.1
June	57.5	25	16.45	48.6
July	34	30	21.1	34
August	23	12	3.103	23
September	19	19	19	19
Parameter Group #2 – Results for Minimum/Maximum Flows and Median Number of Days with Zero Flows				
1-Day Minimum	0.5	0	0	0.5
3-Day Minimum	0.7	0	0	0.7
7-Day Minimum	0.7	0	0	0.7
30-Day Minimum	1	0	0	1

	Non-Parametric IHA Scorecard: Median Values for Each Scenario			
	No Action/ Missouri River & Groundwater	**Groundwater with Recharge Alternative**	**Groundwater with Recharge & the Souris River Alternative**	**Missouri River & Conjunctive Use Alternative**
90-Day Minimum	4.5	1.0	0.7	4.5
1-Day Maximum	857	773	764.5	848.1
3-Day Maximum	772	763	754.5	764.1
7-Day Maximum	712.3	625.3	616.7	706.1
30-Day Maximum	389.6	330.0	321.1	384.0
90-Day Maximum	195.9	160.9	151.3	190.4
Number of Zero Days	0	73	83	0
Base Flow Index	0.007	0	0	0.007
Parameter Group #3 – Dates of Median Annual Minimum and Maximum Flows				
Date of Minimum	239	61	61	239
Date of Maximum	111	111	111	111
Parameter Group #4 – IHA-Determined Pulse Threshold Values; Number and Duration for a Median Year				
Low Pulse Count	1	3	3	1
Low Pulse Duration	23	30	26	23
High Pulse Count	3	3	3	3
High Pulse Duration	10.5	9.0	7.8	11.3
Low Pulse Threshold	2.3			
High Pulse Threshold	85			

Notes:

IHA = Indicators of Hydrologic Alteration; cfs = cubic feet per second; C.V. = coefficient of variation (standard deviation/mean)

Period of Analysis: 1904 to 2010 (107 years).

Sources: Data from USGS gage 05117500 (2013a); Nature Conservancy 2013

Depending on the resource area of interest, changes in specific flows or thresholds can be analyzed. For example, the change in the frequency, duration, and timing of near-zero flows (less than 1 cfs, or essentially no flow) is important to aquatic resources in the river and downstream water users. The change in frequency and duration for flows that overtop the river bank can be used to estimate changes in flooding events and wetland recharge. The IHA analysis indicates how flows of interest change under the action alternatives compared to baseline conditions, as well as how often and for how long. Analyses specific to each resource area are discussed in more detail in their respective sections.

Groundwater

Changes in groundwater recharge, storage, and availability from the two inbasin alternatives and the Missouri River and Conjunctive Use Alternative were analyzed by use of several approaches, including reviewing historical water use and groundwater level trends; using a water balance approach that compares proposed net withdrawals with historical withdrawals and then compares them to historical aquifer level trends; and incorporating the results of the Appraisal-Level

Design (ALD) Report (Appendix J) as appropriate; the latter report reviewed the available data to investigate the feasibility of using water from the Minot and Sundre aquifers and to assist in the development of alternatives. While the ALD Report includes useful information, it was not specifically developed to support this impact analysis.

Previous studies of the aquifers around Minot and their ability to supply water, along with data regarding the long-term water level trends from municipal use, provide a sufficient basis to estimate impacts associated with the Project alternatives. A sufficiently detailed regional groundwater model does not exist for the Minot and Sundre aquifers and the data necessary to develop, calibrate, and validate a detailed groundwater model are not available. As described in Appendix A of the ALD Report, in order to develop a model that is appropriate for more than an appraisal-level analysis, field testing would be required, including extensive exploratory well drilling, monitoring well construction, aquifer performance testing, and geologic data analysis. These data would be required to construct a more accurate and reliable groundwater model that would encompass a larger portion of the aquifers, would likely take 2 or more years to develop, and would be very expensive. Given the current stage of development of the alternatives using groundwater from the Minot and Sundre aquifers, the available information provides adequate detail to assess the general types of impacts that would occur and their magnitude.

Water Quality

The potential for changes in surface water quality as a result of the alternatives was addressed qualitatively. This analysis was based on a review and evaluation of existing water quality reports and studies, including Total Maximum Daily Load (TMDL) studies in the basin and USGS water quality records. This qualitative approach included the use of metrics of change for low flows to estimate potential water quality impacts, because some of the more likely potential water quality impacts could be related to low flows. For example, water temperatures may increase during periods of reduced flow due to slower-moving water and increased exposure time to solar radiation. Increased temperatures exacerbate some water quality issues such as dissolved oxygen levels, toxicity of some contaminants, and productivity of aquatic organisms (which may increase primary productivity and also fish mortality) (Nilsson and Renofalt 2008). As described in Chapter 3, the Souris River frequently experiences low- or no-flow conditions under existing conditions, and water temperatures may be in equilibrium with air temperatures. Reduced flows also exacerbate water quality issues from nutrients and pollutants added to the river because there is reduced capacity to dilute contaminants. Potential impacts on groundwater quality from operations were also addressed qualitatively by comparing the water quality of the Souris River water that would be used to recharge the Minot and Sundre aquifers with the historical water quality data available for those aquifers.

Geomorphology

Potential changes in geomorphic processes from the action alternatives were estimated by evaluating changes in flows that would affect channel-forming and sediment transport processes. The number and timing of high-flow and peak-flow events were analyzed, along with the number and timing of low-flow events that could lead to channel encroachment by vegetation and thus affect channel capacity and flow rate.

Results

No Action Alternative

Erosion and Sedimentation

Under the No Action Alternative, no additional construction would occur that is associated with the Project; therefore, there is no potential for erosion or sedimentation issues within the Project Area. Communities faced with water shortages or water supplies that do not meet EPA drinking water standards do not have plans other than the Project to address water supply issues. These communities may build treatment plants or develop new water sources at some point in the future that could affect erosion and sedimentation, but whether they will do so is speculative. Therefore, potential construction impacts on water resources are similarly speculative.

Changes in Quantity and Timing of Souris River Flows

Under No Action, there are no planned future withdrawals from the Souris River to meet water supply demands. The City of Minot has a permit and has the capacity to draw water from the Souris River, and did so during the 2011 flood event, but does not routinely use the river as a regular source to meet municipal demands. Prior to the drawdown of the local aquifers over the past few decades, the Souris River likely both gained water from and lost it to the underlying aquifers, depending on the season and levels of precipitation. With the drawdown of the aquifers over the past few decades, however, the Souris River now is generally thought to lose water to the aquifer in the reach through Minot due to the lowered water table (Figures 3-11 and 3-12 in Chapter 3, Water Resources section). Wetlands and springs previously associated with higher groundwater levels in the aquifers are isolated from the aquifer because water levels have declined over the past few decades. This pattern would likely not change under the No Action Alternative; therefore, continued or additional use of the aquifer would not likely affect flows in the Souris River or remaining wetlands overlying the aquifers.

For purposes of comparing the No Action Alternative with the action alternatives, the historical period of record for gages on the Souris River was used to evaluate the without-Project condition.

Figure 4-12 is a flow-duration curve for the USGS gage above Minot that shows every daily flow in the period of record arranged from highest to lowest flows and assigned a percent exceedance on a logarithmic scale. Note that logarithmic scales do not go to zero, so 0.01 cfs represents essentially no flow in the river. The No Action and Missouri River and Groundwater alternatives are both represented by the blue line since neither would withdraw surface water from the Souris River (note that for the Minot gage, the purple line representing the Missouri River and Conjunctive Use Alternative overlaps the blue line for most of the flows). For example, a 75-percent exceedance flow indicates that 75 percent of the flows in the record are higher, and 25 percent are lower. In Figure 4-12, the 75-percent exceedance flow without Project withdrawals (No Action) is about 3 cfs, and the 75-percent exceedance flow under the Groundwater with Recharge Alternative would be zero cfs. Figures 4-13, 4-14, and 4-15 show the flow-duration curves for No Action and action alternatives at the downstream USGS gages near Verendrye, Bantry, and Westhope (see Figure 3-2 in Chapter 3 for the location of the USGS gages on the Souris River).

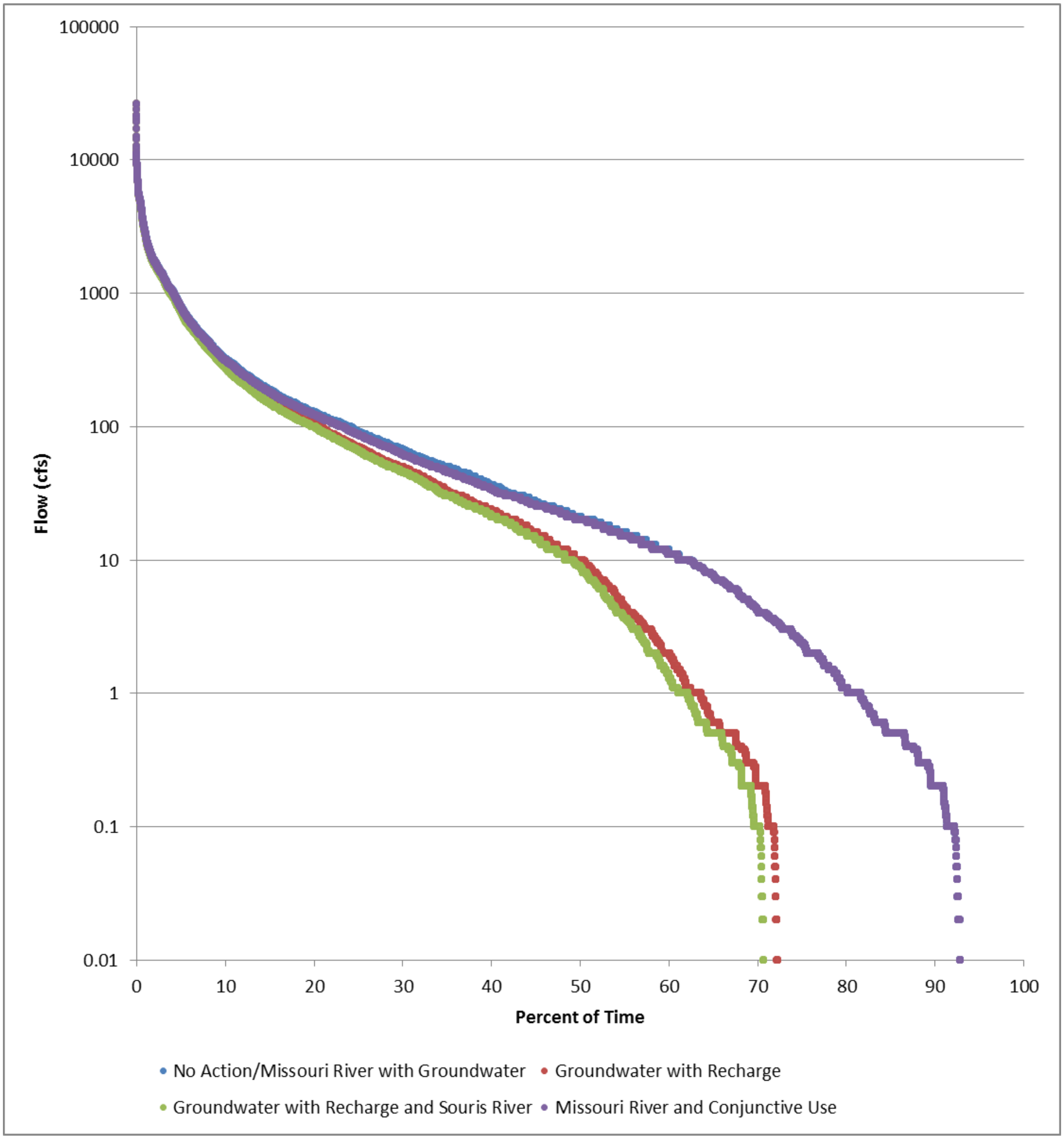

Figure 4-12 Flow Exceedance Curve for Each Alternative Based on the Period of Record for the USGS Gage above Minot

Source: Data from USGS gage 05117500 (2013a)

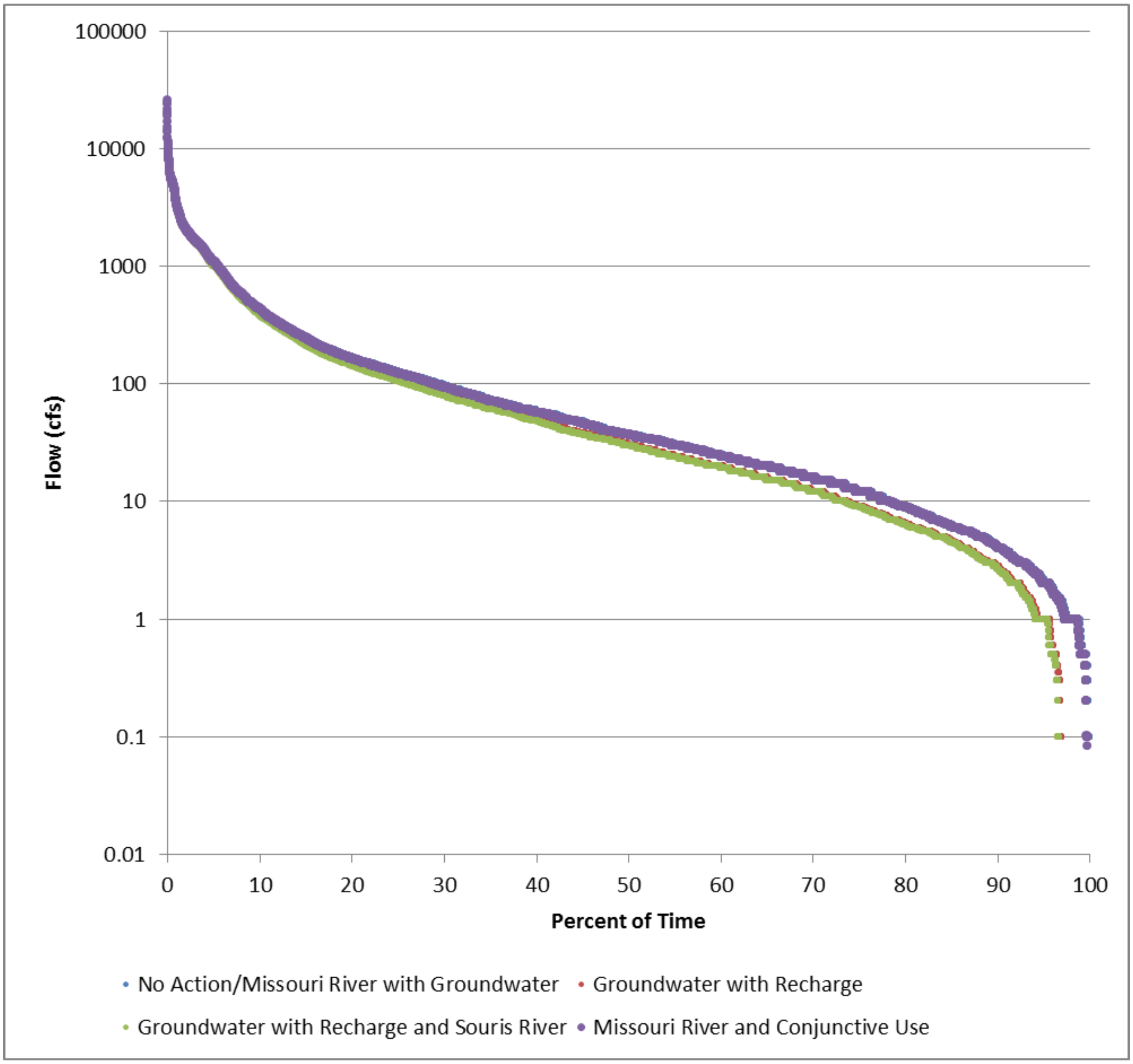

Figure 4-13 Flow Exceedance Curve for Each Alternative Based on the Period of Record for the USGS Gage near Verendrye

Source: Data from USGS gage 05120000 (2013a)

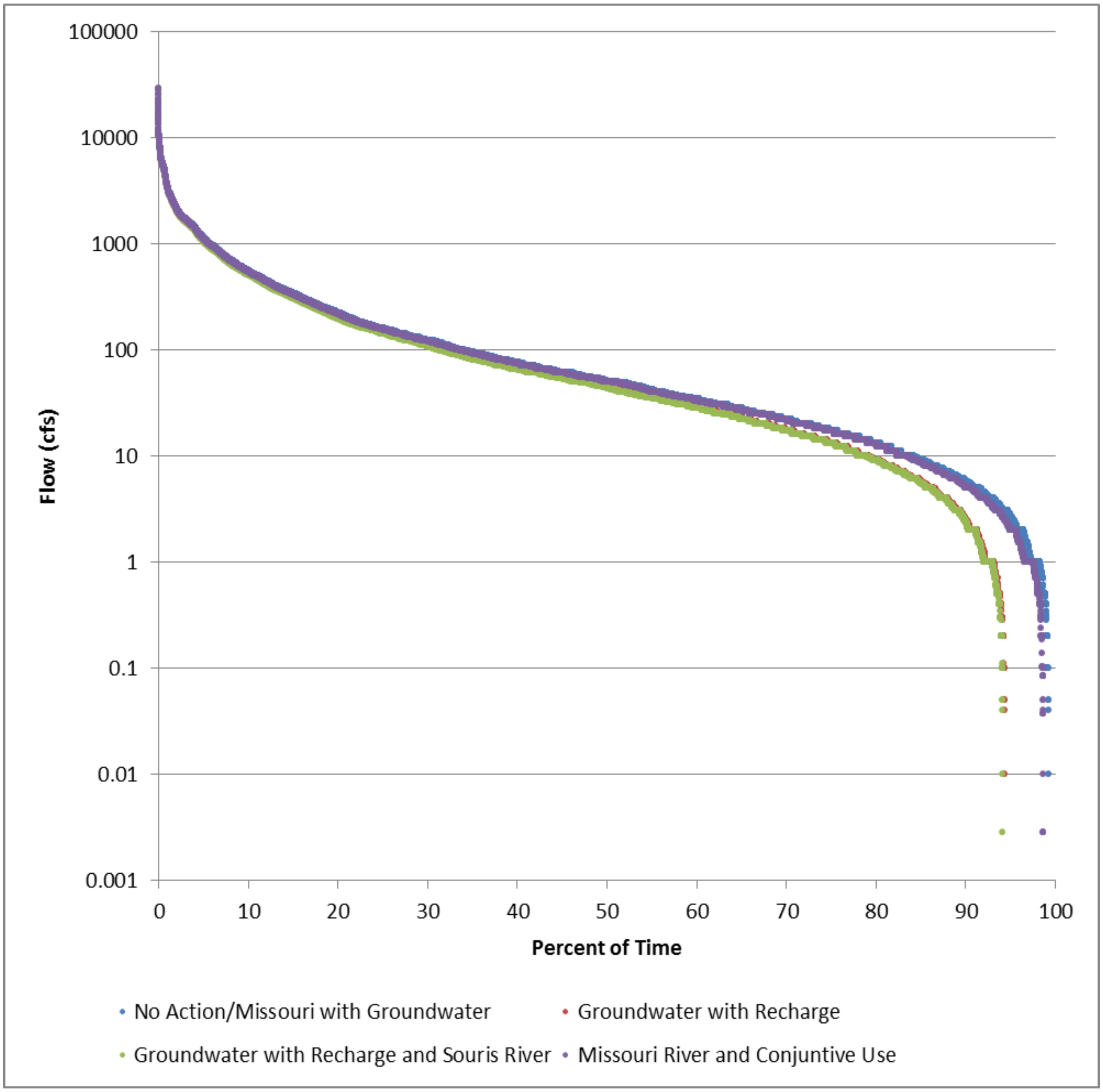

Figure 4-14 Flow Exceedance Curve for Each Alternative Based on the Period of Record for the USGS Gage near Bantry

Source: Data from USGS gage 05122000 (2013a)

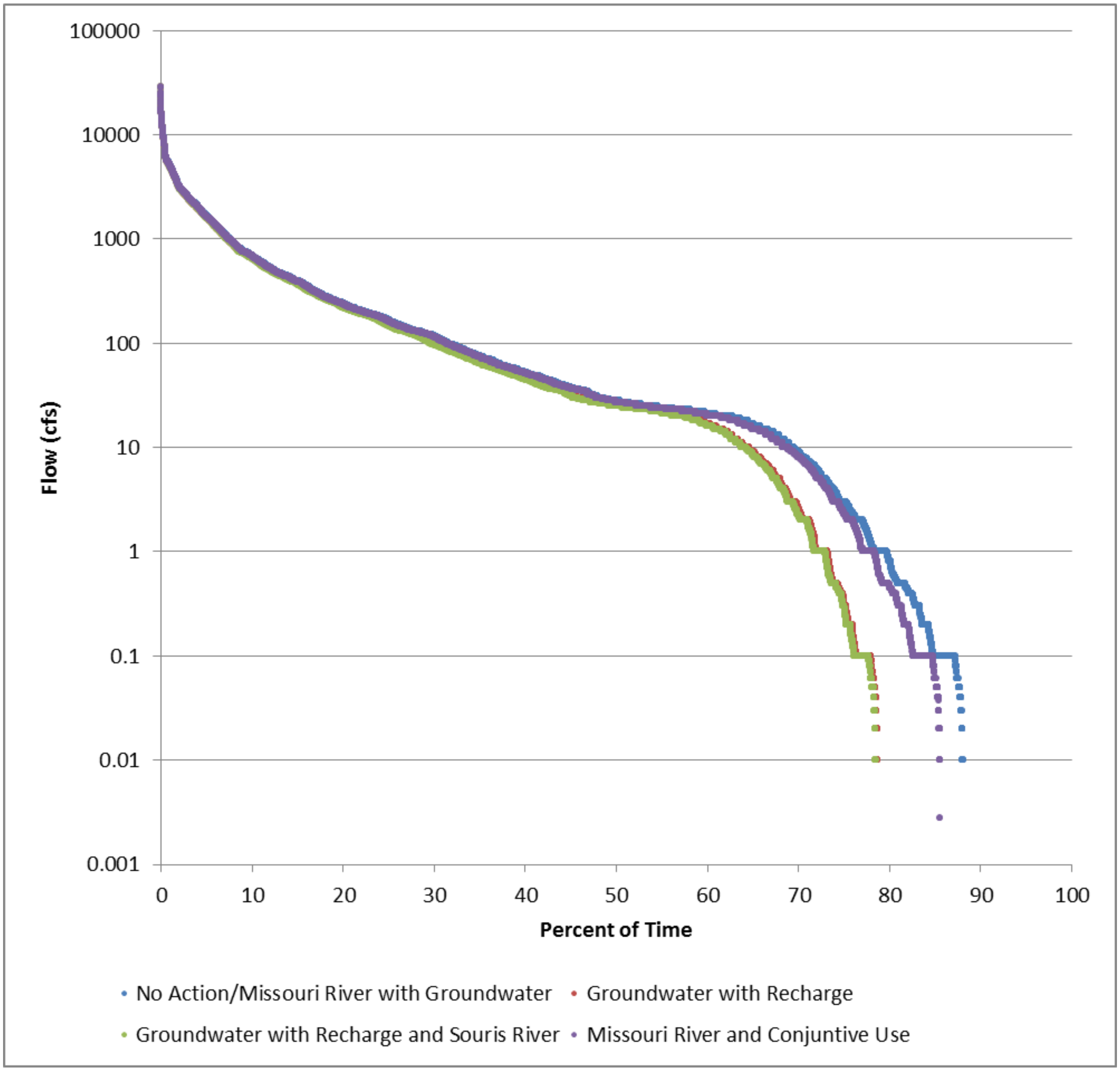

Figure 4-15 Flow Exceedance Curve for Each Alternative Based on the Period of Record for the USGS Gage near Westhope

Source: Data from USGS gage 05124000 (2013a)

Box and whisker diagrams also use the entire period of record, but segregate the data by month to display the range of flows on a monthly basis. Figure 4-16 is the monthly box plot for each alternative for the USGS gage above Minot. The box and whisker diagram represents the 95-percent exceedance flow (bottom whisker representing very low flows), the 75-percent exceedance (bottom of the colored box, representing low flows), the median (line in the box, representing normal flows), the 25-percent exceedance (the top of the box, representing high flows), and the 5-percent exceedance flow (top of the whisker, representing very high flows). Figures 4-17, 4-18, and 4-19 show the monthly box and whisker diagrams for No Action and action alternatives at the downstream USGS gages near Verendrye, Bantry, and Westhope.

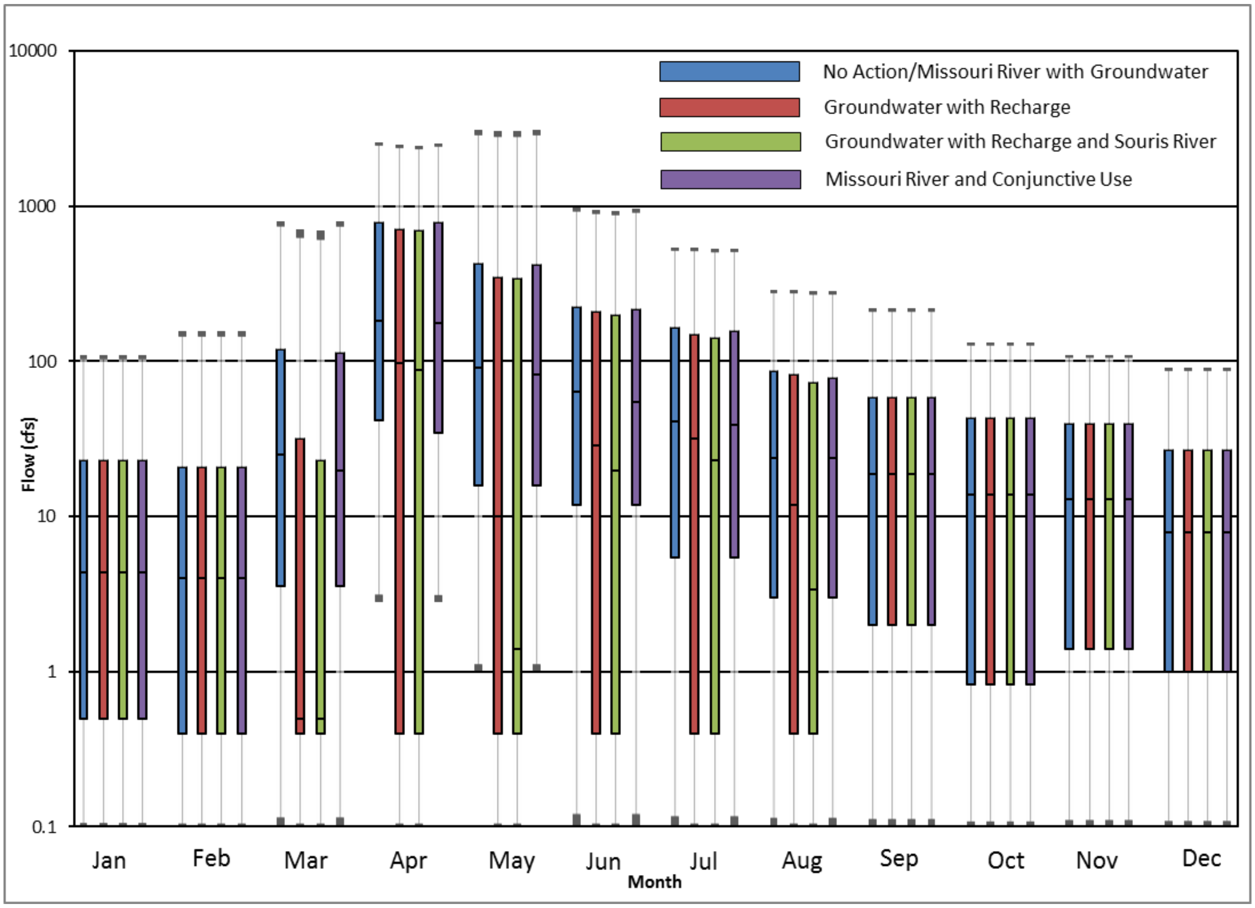

Figure 4-16 Box Plots of Monthly Flows for Each Alternative Based on the Period of Record for the USGS Gage above Minot

Source: Data from USGS gage 05117500 (2013a)

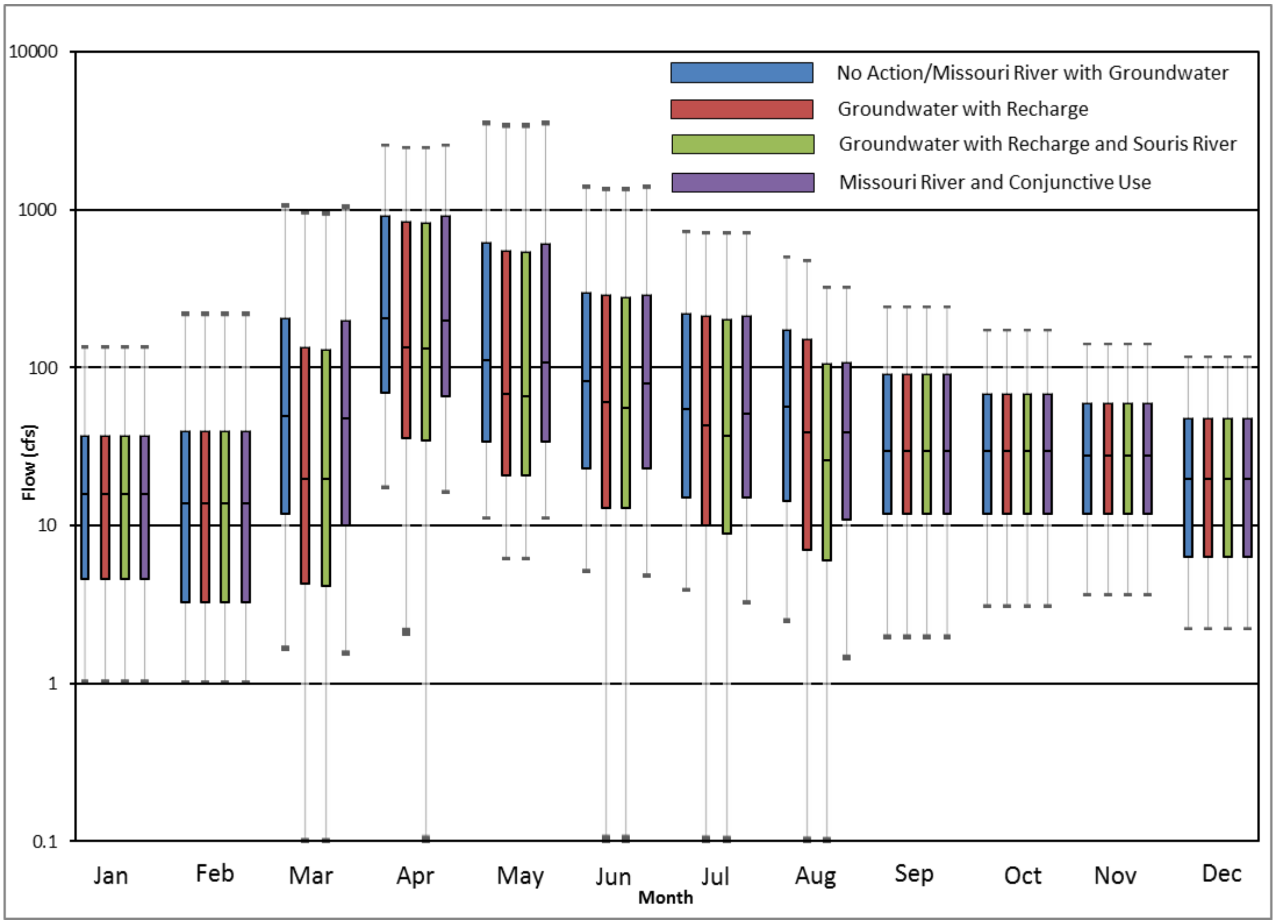

Figure 4-17 Box Plots of Monthly Flows for Each Alternative Based on the Period of Record for the USGS Gage near Verendrye

Source: Data from USGS gage 05120000 (2013a)

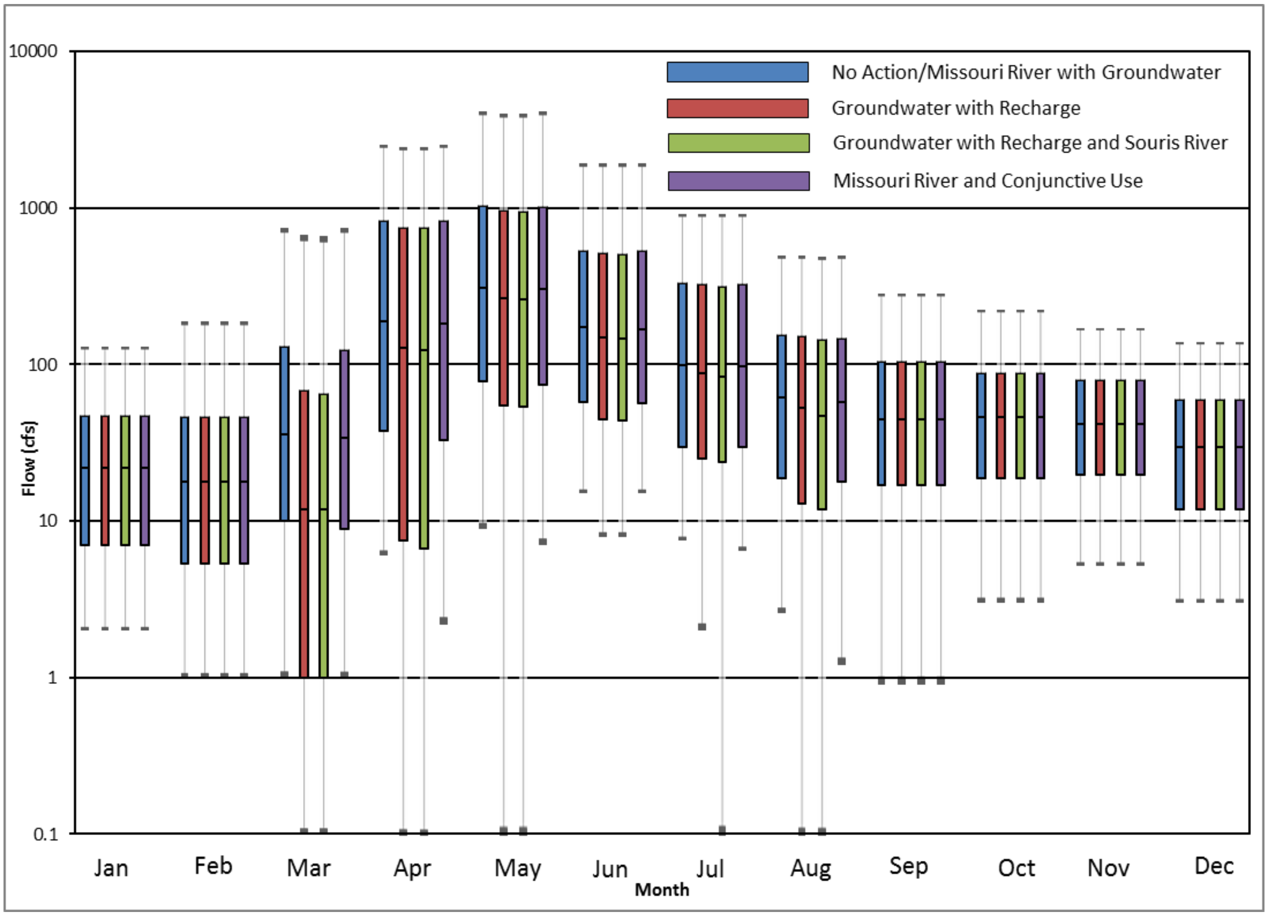

Figure 4-18 Box Plots of Monthly Flows for Each Alternative Based on the Period of Record for the USGS Gage near Bantry

Source: Data from USGS gage 05122000 (2013a)

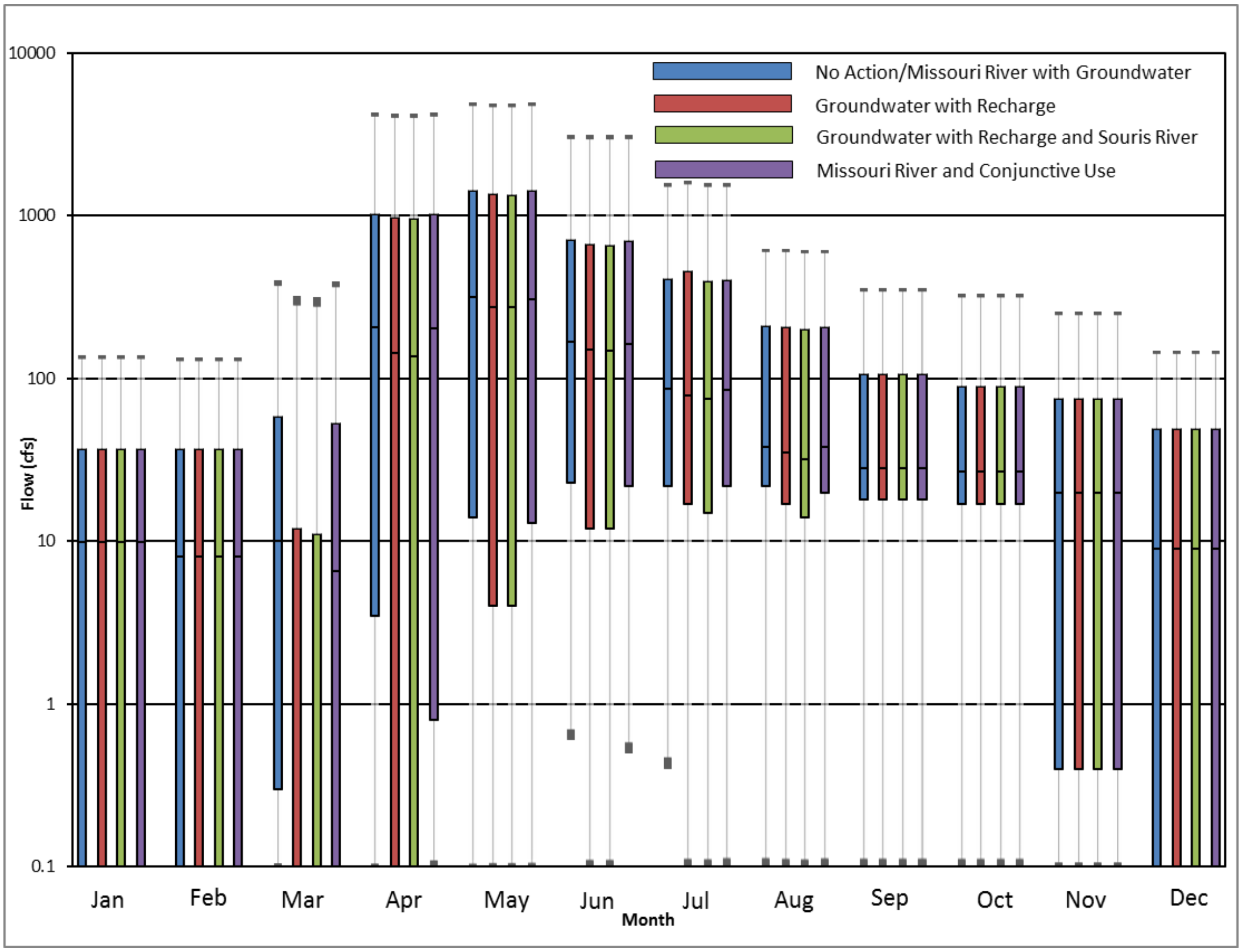

Figure 4-19 Box Plots of Monthly Flows for Each Alternative Based on the Period of Record for the USGS Gage near Westhope

Source: Data from USGS gage 05124000 (2013a)

Changes in Groundwater Recharge, Storage, and Availability near Minot

Under No Action, communities and rural water systems in the Project Area would continue to rely on current water supplies, or their previous water supplies in the case of the communities that currently are receiving water from the City of Minot through interim contracts that expire in 2018. With expected demand increasing from 5.3 mgd in 2010 to 7 mgd in 2060 in the Minot area (Chapter 2), it was assumed that the City of Minot would not be able to continue to supply surrounding communities due to the limitations in available water from the Minot and Sundre aquifers.

Based on a 45-year record of water levels, both the Minot and Sundre aquifers have declined under pumping rates that averaged 2 mgd and 3.1 mgd, respectively (Figures 3-11 and 3-12 in Chapter 3, Water Resources section). The water surface elevation for both aquifers would likely continue to decline into the future at a similar or increased rate (approximately 0.25 feet/year for the Minot aquifer and 1.1 feet/year for the Sundre aquifer) if water use is maintained or increased.

Long-term consequences of continued declines in the Minot and Sundre aquifers include increased pumping costs and the potential for the water level to drop below the screened interval of the existing wells. Water quantity currently available is insufficient to meet local and regional demands. In addition, some communities and rural water systems in the Project Area would have inadequate supplies to meet projected needs (Chapter 2). Due to limited supply to meet its own future demands, it was assumed that the City of Minot would not renew interim water supply contracts with nearby communities, which would lead to additional costs for those communities. (See Chapter 2, Description of the No Action Alternative, for more details.) Groundwater levels may decrease in other aquifers, as well, as communities that currently rely on water provided by the City of Minot through interim contracts return to their groundwater sources to meet their projected water needs through 2060. For some of these communities, the water demand is projected to increase through 2060.

Water Quality

Water quality conditions in the Souris River under the No Action Alternative would continue to be impaired by sedimentation/siltation and by fecal coliform for segments of the river near Minot (Chapter 3). It is anticipated that without water quality improvements within the Souris River basin, water quality would continue to periodically experience impairments of beneficial uses, including support for aquatic life.

Periods of low flow would continue to exhibit more water quality concerns (aside from total suspended solids) than high-flow conditions. It is possible that some improvements to water quality could occur in the future once identified TMDLs are adopted and implemented.

Groundwater quality in the vicinity of Minot under the No Action Alternative would not be expected to change from current conditions and would remain moderately to highly mineralized, with occasional exceedances of primary and secondary drinking water standards.

Geomorphology

Under the No Action Alternative, the geomorphic processes and conditions of the Souris River near Minot (e.g., between Burlington and Velva) would continue to reflect the responses of the river to natural geologic and hydrologic controls along with watershed-scale land use changes, hydrology and sediment loadings, river flow management, flood protection features, and groundwater extraction that have occurred over many decades. As discussed in Chapter 3, the reach of the Souris River through Minot has a channel that is enlarged and has been modified with channel structures and levees to provide flood protection.

The No Action Alternative would not result in the modification of bankfull flows, major floods, peak flows or pulse flows. Continued lowering of groundwater levels would not measurably change these geomorphically important flows. Therefore, the Souris River would be expected to continue to be a low-energy system with relatively fine-grained bed material that periodically has sediment accumulation and vegetation encroachment during years between major flood events. Substantial changes are not expected in the existing streambed or streambank erosion processes.

Action Alternatives

Some temporary construction-related impacts would be identical for all of the action alternatives because they each include the same bulk distribution pipelines, which would cross surface waters and thus could temporarily affect water quality and streamflow during construction. The inbasin alternatives also would require intakes on the Souris River, and the Missouri River alternatives would require an intake at Lake Sakakawea, which also could cause temporary impacts such as erosion and sedimentation during construction.

All other Project components to be constructed would generally avoid surface waters and wetlands. Most construction-related impacts on water resources that could occur would be similar for each action alternative, and the same BMPs and environmental commitments (Appendix F) would be implemented for each action alternative – primarily in the General, Surface Water, Water Quality, Wetland, Aquatic Resources, and Hazardous Materials categories.

Construction impacts would be minimized or avoided by implementation of the BMPs because wetlands, riparian areas, and other sensitive areas would be avoided to the extent practicable, and all actions would be in compliance with Section 404 of the Clean Water Act. In keeping with efforts to avoid impacts on surface water resources, contractors would be required to try to bore under streams and rivers using horizontal directional drilling before using an alternate method of crossing that would result in more disturbance.

Intermittent streams would be crossed only during low-flow periods, preferably when they were dry. Any temporarily disturbed streams would be reestablished following construction by restoring previous elevation contours, compacting trenches sufficiently to prevent drainage along the trench or bottom seepage, salvaging and replacing topsoil, backfilling in a manner such that the stream is not drained, and reestablishing streams to a similar type and function as they were preconstruction. Riparian areas would also be replanted in order to control erosion. Additionally, all construction waste materials and excess fill would be disposed of in upland areas. Details of environmental commitments are included below under Environmental Commitments and in Appendix F.

To protect water quality (Appendix F), a Stormwater Pollution Prevention Plan would be developed before construction that would include erosion control measures to prevent sedimentation and turbidity. Flows would also be maintained if streams were being crossed during construction, and crossings would be routed to minimize disturbance to the extent practicable. If it becomes necessary to disturb the banks and beds of waterways, they would be stabilized to minimize erosion and scour.

Hazardous materials, such as fuels and lubricants, would be used by equipment during construction. Accidental spills of hazardous materials during pipeline construction could affect surface water quality. In order to minimize or avoid impacts on water quality from accidental releases of hazardous materials, a Hazardous Spill Plan or Spill Prevention, Control, and Countermeasures Plan would be in place (Appendix F). This plan would outline the preventative measures to be implemented, including proper placement of refueling facilities, storage, and handling of hazardous materials, and actions that would be taken in the event of a spill, such as clean-up and containment procedures and notification measures. Additionally, all equipment would be maintained in a clean and well-functioning operating condition to avoid or minimize contamination from automotive fluids, and equipment and vehicles would not be refueled within 100 feet of rivers and streams. If onsite fuel tanks are used, approved containment devices would be required.

In addition to impacts from construction activities, impacts on surface water and groundwater hydrology, water quality, and geomorphology could result from Project operations, which involve withdrawals of river water and groundwater. These impacts are different for each alternative because they use different combinations of water supplies and are discussed below.

Groundwater with Recharge Alternative

As described in Chapter 2, this alternative would use groundwater from the Minot and Sundre aquifers and would recharge the aquifers with water from the Souris River. Two surface water intakes would be built in the Souris River to capture water that would be conveyed via feeder lines to two sediment settling facilities and recharge basins located at the Minot and Sundre wellfields. No water from the Missouri River basin would be used.

This alternative would include 7 crossings of perennial streams and 22 crossings of intermittent streams during pipeline construction. Other components such as pump stations, recharge basins, and groundwater wells would be sited to avoid waterbodies. Construction of water intakes in the Souris River would be implemented in accordance with BMPs to minimize any temporary water quality impacts.

Changes in Quantity and Timing of Souris River Flows

Under this alternative, water would be withdrawn from the Souris River to recharge basins through two intakes along the river: one upstream of downtown Minot to recharge the Minot aquifer, and the other a few miles downstream of downtown Minot to recharge the Sundre aquifer (Figures 2-3 and 2-4). Based on the operating assumptions described in Chapter 2, up to 56 mgd (87 cfs) would be withdrawn from the Souris River intakes and sent to the recharge basins from March through August, for up to a total of 4.5 billion gallons per year (bgy). The rate was based on the designed infiltration capacity of the recharge basins and would be split evenly between the two recharge basins. As described in the methods section, this does not take into account potential restrictions from the exercise of senior water rights in the future. Should senior water rights be exercised, the volume of Souris River water withdrawn at Minot could potentially be reduced.

Figure 4-20 shows Souris River flows for the No Action and Groundwater with Recharge Alternatives for 1987, which is an example of the median annual (normal) flow conditions for the Souris River. The vertical axis uses a logarithmic scale because of the wide range of daily flow values plotted. Figures 4-21 and 4-22 show flows for these two alternatives for example dry and wet years, respectively. Dry and wet years are based on the 75^{th}-percentile annual exceedance flow and 25^{th}-percentile annual exceedance flow. Years with flows above the 25^{th}-percentile annual exceedance flow would occur on average about 1 in 4 years, as would flows below the 75^{th} percentile.

For both example normal and dry years (Figures 4-20 and 4-21), withdrawals from the Souris River would result in an increase in the number of days with near-zero flows for the months of May through August downstream of the intakes until tributary or groundwater sources contribute additional flow to the Souris River. There are insufficient streamflow data to determine at what point that would occur under various streamflow conditions.

During the example dry year (Figure 4-21), the peak runoff occurs in April, and although flows would not be reduced to zero during this peak period, a substantial amount of water is withdrawn to send to the aquifer recharge basins, resulting in flows being reduced to zero during the month of March as well as May through August. Under the No Action Alternative, the flow during the example dry year drops to zero for about a month starting in mid-July.

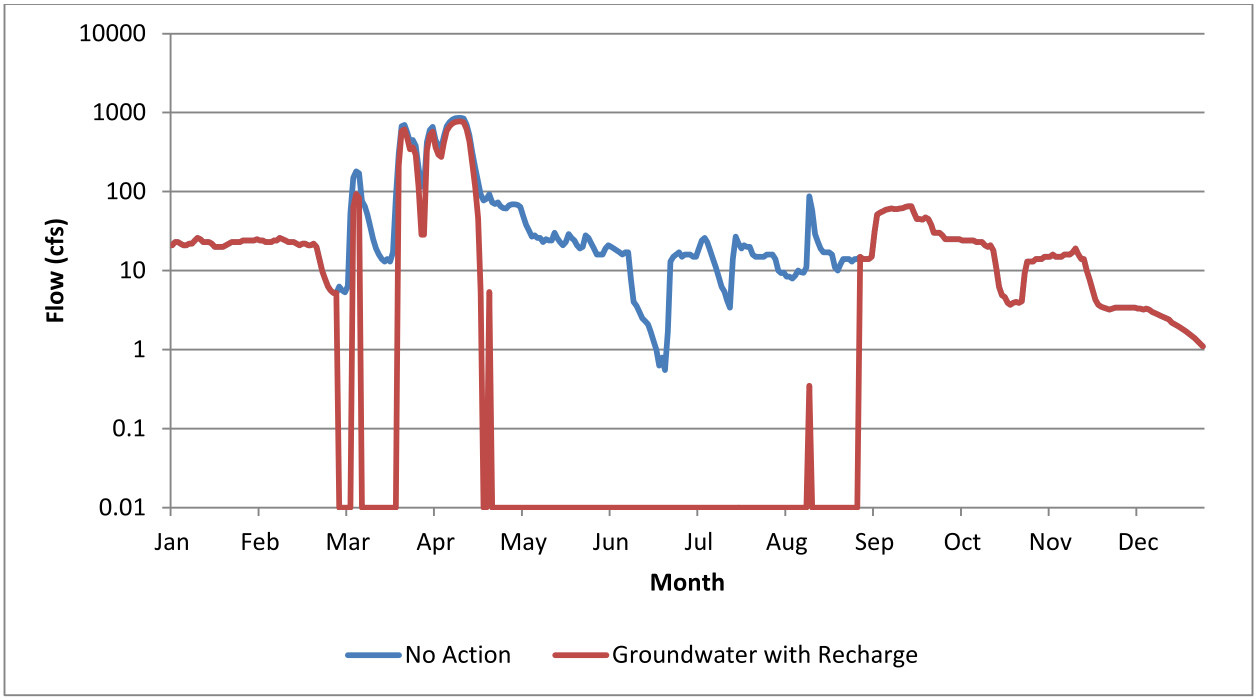

Figure 4-20 Daily Flows for the No Action and Groundwater with Recharge Alternatives for the Example Normal Year (1987) at the USGS Gage above Minot

Source: Data from USGS gage 05117500 (2013a)

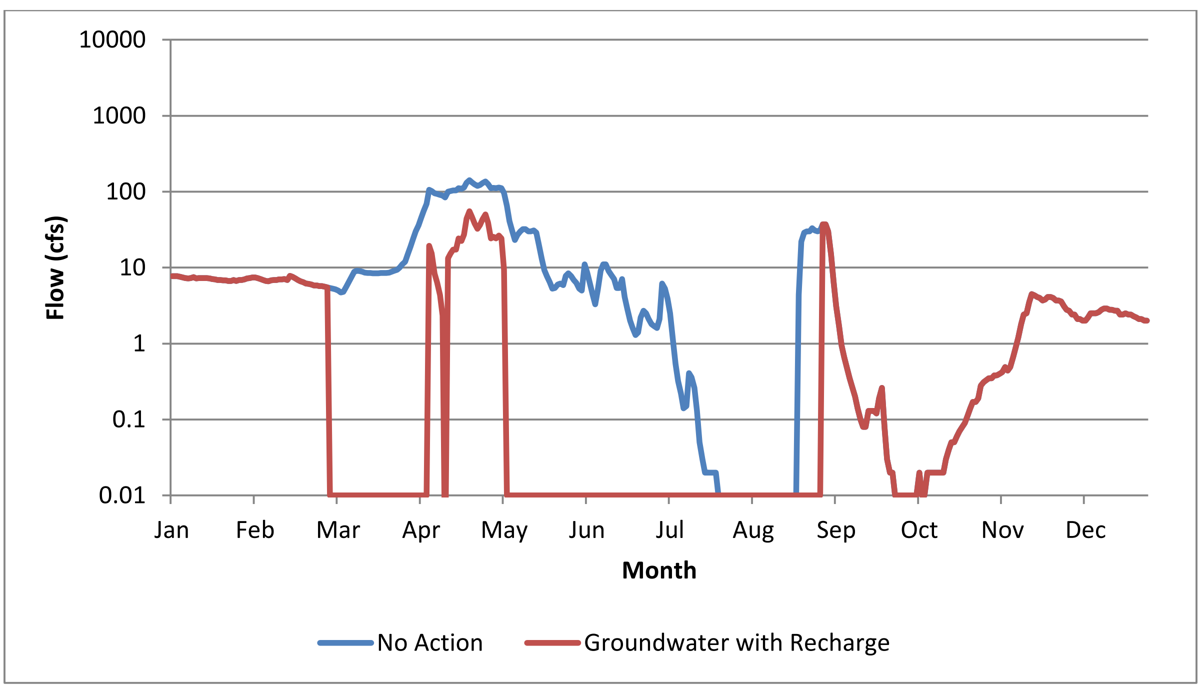

Figure 4-21 Daily Flows for the No Action and Groundwater with Recharge Alternatives for the Example Dry Flow Year (2006) at the USGS Gage above Minot

Source: Data from USGS gage 05117500 (2013a)

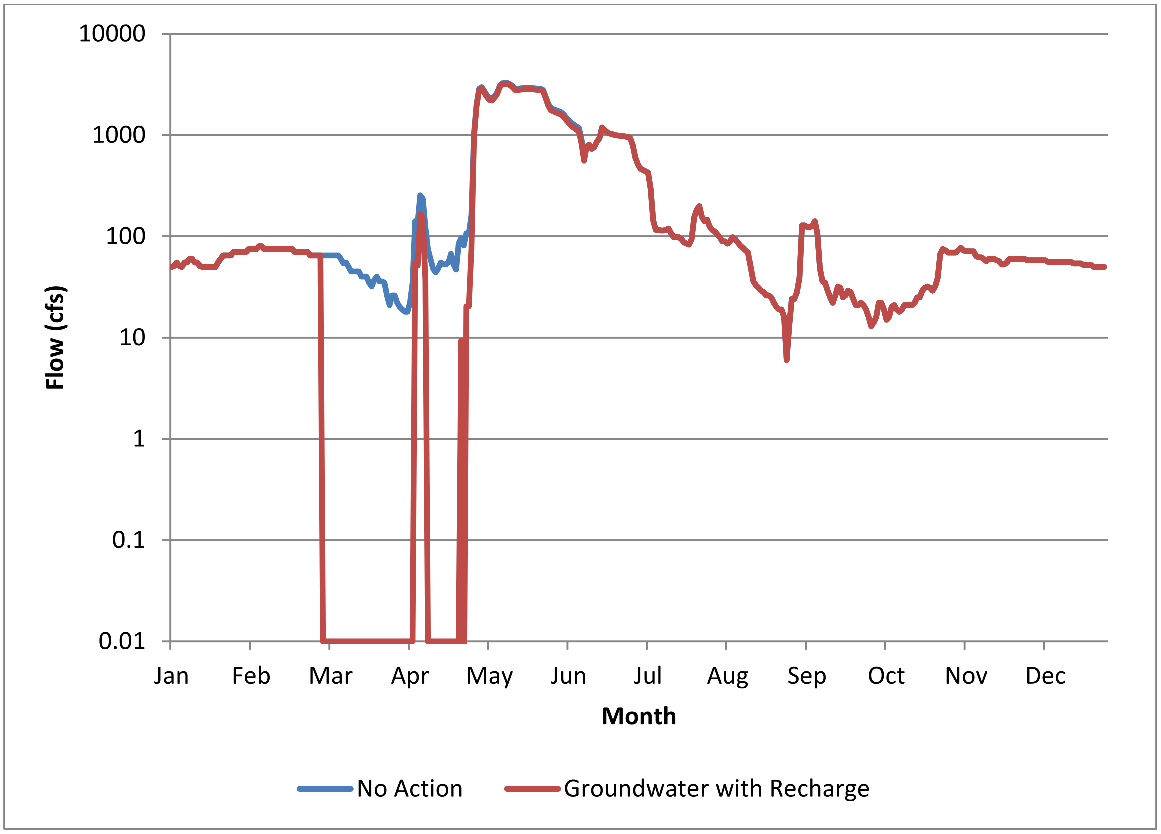

Figure 4-22 Daily Flows for the No Action and Groundwater with Recharge Alternatives for the Example Wet Flow Year (1970) at the USGS Gage above Minot

Source: Data from USGS gage 05117500 (2013a)

For the normal year, the amount withdrawn is a lower proportion of the spring flood flows. From September through February when water is not being withdrawn, flows match the No Action Alternative. The 4.5-bgy withdrawal target for artificial recharge was not achieved for either the example normal year (4.1 billion gallons total) or the example dry year (2.6 billion gallons total) due to insufficient flow in the Souris River to meet the withdrawals under the proposed operating assumptions for this alternative. Withdrawal targets may or may not be met on an annual basis due to the variability of Souris River flows, as described in more detail in the Changes in Groundwater Recharge, Storage, and Availability near Minot section below.

The example wet year has high flows starting in May that last through most of the summer, so the withdrawals for this alternative make up a very small portion of the total flows and are difficult to distinguish in the chart using a logarithmic flow scale (Figure 4-22). The 4.5-billion-gallon withdrawal for artificial recharge was achieved by June 12, and no additional withdrawals occurred the rest of the year. For this example wet year, flows during March and part of April were reduced to zero downstream of the second intake.

The entire period of record was also examined to estimate overall changes in flows on the Souris River. The 50-percent exceedance flow without withdrawals (No Action/Missouri River with Groundwater) was approximately 21 cfs, and the 50-percent exceedance under the Groundwater with Recharge Alternative would be about 10 cfs (Figure 4-12 in the No Action Alternative section in this chapter). Flows less than approximately 10 cfs occur only 38 percent of the time under the No Action Alternative but would occur approximately 50 percent of the time under the Groundwater with Recharge Alternative. The percentage of time that near-zero flows (less than 0.1 cfs) would occur increases from approximately 8 percent of the time to approximately 28 percent of the time. The timing of these low flows would also be extended. Under the No Action Alternative, the typical period of lowest flows would be in the winter months; with the withdrawals from the Groundwater with Recharge Alternative, the lowest flows would continue into March. Higher flows would be comparatively less affected because the proportion of flow withdrawn is smaller relative to the higher flows.

The average number of days per year of near-zero flows would increase from 26 days per year to 103 days per year, based on the 107-year period of record under the Groundwater with Recharge Alternative (Table 4-5). The unaltered flow record, however, is extremely variable; only 29 percent of the years in the 107-year record have any days with near-zero flows, and 42 percent of those years have over 100 days of near-zero flows. Under this alternative, the percentage of years in the record with near-zero flow days would increase from 29 to 94 percent (Table 4-5).

The IHA characterizes the annual low-flow regime for a period of record and summarizes them using the value of the median 1-, 3-, 7-, 30-, and 90-day flows and the number of zero-flow days. As shown in Table 4-5, the Groundwater with Recharge Alternative would decrease the existing median low 1-, 3-, 7-, or 30-day minimum flows to zero. This would be a small change because these flow statistics are already near zero under the existing conditions.

Table 4-5 Souris River Low-Flow Statistics under the No Action and Groundwater with Recharge Alternatives for the Historical Hydrologic Record (1904 – 2010)

Parameter	Units	No Action Alternative	Groundwater with Recharge	Change from No Action
Average Number of Days per Year with Near-Zero Flows [A]	Days	26	103	+77
Percent of Years In 107-Year Record with Near-Zero Flows	Percent	29	94	+65
1-Day Minimum	cfs	0.5	0	-0.5
3-Day Minimum	cfs	0.7	0	-0.7
7-Day Minimum	cfs	0.7	0	-0.7
30-Day Minimum	cfs	1.0	0	-1.0
90-Day Minimum	cfs	4.5	1.0	-3.5

Notes:

cfs = cubic feet per second

The period of record includes several months with data in 1903 and 2011, but only complete years were included in this analysis.

[a] Near-zero flows are less than 0.1 cfs and include periods of no measurable flow (zero cfs).

Figure 4-16 (in the No Action Alternative section) illustrates the monthly flows for the USGS gage above Minot for all of the alternatives for the period of record. The reduced flows can be seen from March through August during the withdrawal period, with the greatest change in median flows during the months of March and May. Under the No Action Alternative, the typical period of lowest flows occurs during the winter months; with the withdrawals from the Groundwater with Recharge Alternative, the period of lowest flows would continue into March.

Higher flows would be comparatively less affected because the proportion of flow withdrawn is smaller relative to the higher flows.

As previously described, flow reductions would be most apparent around and downstream from the proposed Souris River intake associated with the Sundre aquifer recharge facilities. Based on a comparison of hydrographs between Minot and downstream gages at Verendrye and Bantry (Figure 3-7), the Souris River increases in flow in a downstream direction.

The flow exceedance curve for the No Action and Groundwater with Recharge alternatives shows flows below about 5 cfs are much less frequent at the Verendrye gage. Impacts from Project withdrawals at Minot would be considerably muted at the gage 86 miles downstream when compared to the results at the gage above Minot (Figures 4-12 and 4-13).

Figure 4-17 represents the flow data at the Verendrye gage minus the proposed withdrawals at Minot under this alternative. This illustrates the effect of the alternative (compared with No Action) on monthly flows at the Verendrye gage, and similar to the flow exceedance curve, shows reduced impacts of flow withdrawals compared to impacts at the gage above Minot. Median and lower flows are still reduced compared to the No Action Alternative during the months when withdrawals occur, but not to the same extent as with the above-Minot gage (Figure 4-16).

Figures 4-14 and 4-18 illustrate the effects of the proposed withdrawals on flows at the Bantry gage, which lies just upstream of the J. Clark Salyer NWR. Similar to the results for the Verendrye gage, impacts would be reduced when compared to the above-Minot gage, but slightly increased compared to the Verendrye gage at flows below about 10 cfs. Flows below about 10 cfs would occur about 5 percent more frequently (Figure 4-14). Similar to the other gages, the greatest change in median flows would occur in March, and 95 percent exceedance flows would be reduced to near-zero in March, April, May, and August (Figure 4-18).

As illustrated in Figures 4-15 and 4-19, there is a greater effect on low flows from the Groundwater with Recharge Alternative on estimated flows at the Westhope gage than at the Bantry and Verendrye gages. In particular, flows below 20 cfs become more frequent under this alternative, which could impair the ability to maintain the 20 cfs minimum flows at the international border from June through October in compliance with the "Agreement between the Governments of Canada and the United States for Water Supply and Flood Control in the Souris River Basin" (ISRB 2000). The biggest monthly change in median flows occurs in March prior to spring runoff flows, when withdrawals would reduce flows to less than 1 cfs.

Changes in Groundwater Recharge, Storage, and Availability near Minot

Under the Groundwater with Recharge Alternative, up to 4.5 billion gallons of water per year would be withdrawn from the Souris River to recharge the aquifers. Although this alternative proposes to recharge the Minot and Sundre aquifers with 4.5 bgy split evenly between the two aquifers, the variable flows of the Souris River historically would not be sufficient to meet that target in many years. Figure 4-23 is a simulation of the amount of water withdrawn for each year over the period of record. Based on the operational assumptions, the average annual withdrawal rate would be 3.7 billion gallons for the 108 years simulated (1903 to 2011 using incomplete records for the years 1903 and 2011). This is below the projected estimate of demand for the Project of 3.85 bgy in 2060, although demand is expected to ramp up from current levels over that period. By subtracting the amount of groundwater withdrawn daily from the amount artificially recharged to the aquifers, approximately 63 million gallons (averaged over the period of record) more water would be withdrawn than artificially recharged on an annual basis.

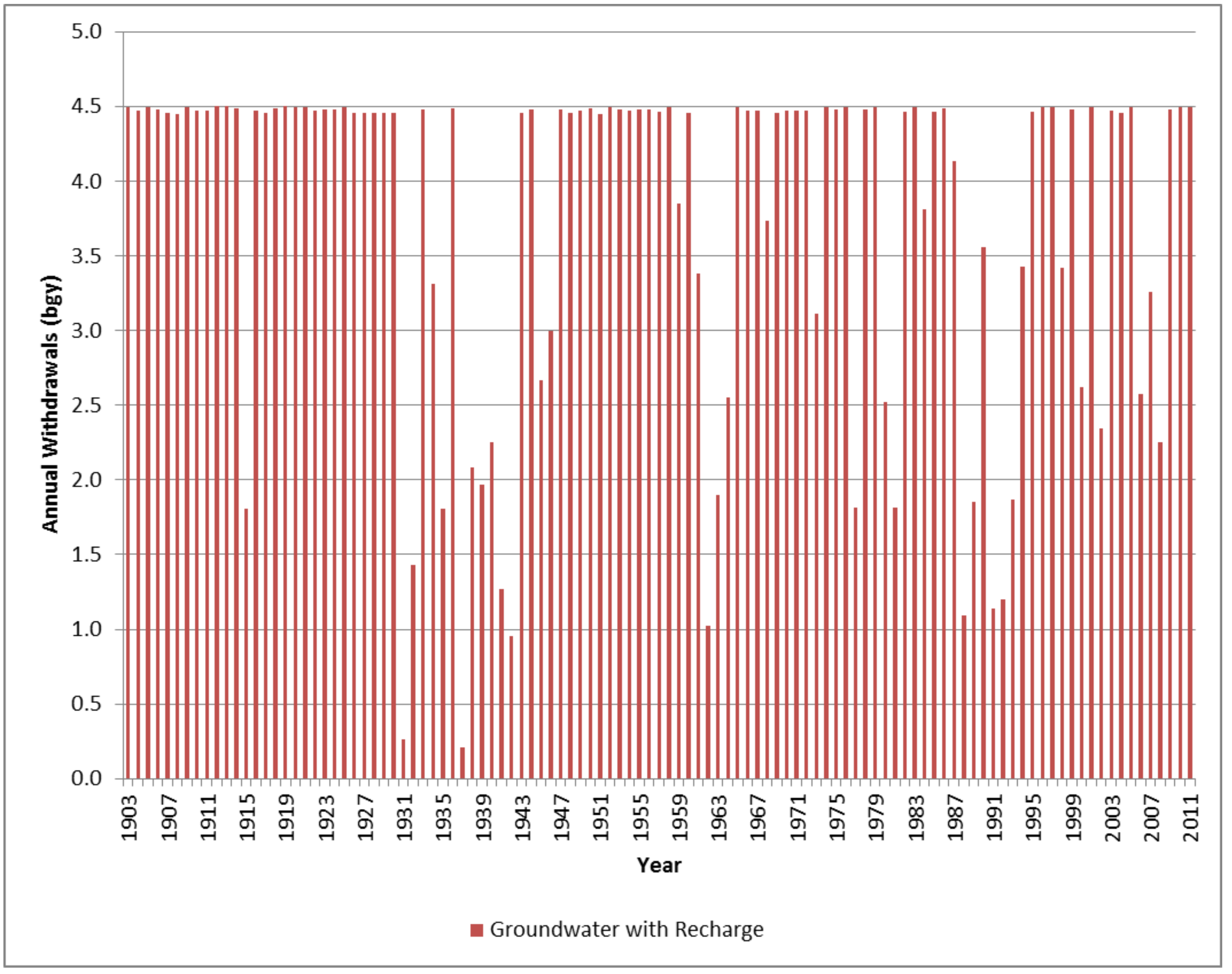

Figure 4-23 Estimate of Annual Withdrawals Based on the Operating Assumptions and Historical Period of Record for the USGS Gage above Minot

Note: bgy = billion gallons per year

Source: Data from USGS gage 05117500 (2013a)

Although more water would be withdrawn from the aquifers than artificially recharged, aquifer levels would be expected to stabilize or increase over the long-term due to augmentation of natural recharge rates with the proposed artificial recharge. Sustainable yields for the Minot and Sundre aquifers have been estimated, but as discussed in Chapter 3, the respective aquifer levels have declined under average pumping rates of 0.73 and 1.13 bgy (1977 to 2010). The 0.063 billion gallon per year average withdrawal deficit proposed under this alternative is about 1/30th of the combined average pumping rate for the aquifers over the past 45 years of 1.86 bgy. Therefore, when net withdrawals from the aquifers are reduced to approximately 1/30 of the historical annual pumping rate, the aquifer levels should stabilize and possibly increase over the long term. Major flood events have also been shown to contribute to aquifer recharge (Figure 3-11 in Chapter 3, Water Resources section), as demonstrated by the flood event of 2011.

During periods of extended drought, aquifer levels would decline. Recharge rates would be reduced while groundwater pumping rates stay the same or increase, resulting in temporary reductions in aquifer water surface levels. There would also likely be localized drawdown around the municipal wells, particularly during peak demand pumping that may not be immediately offset by water from the recharge fields.

Changes in Souris River Water Quality

Because the amount of water that can be withdrawn from the Souris River is limited, higher flows and peak flows would not be substantially affected (Figure 4-12). This alternative would not directly introduce additional pollutants to the Souris River beyond potential short-term impacts associated with construction, but changes in low-flow hydrology (described above) may adversely affect temperature and dissolved oxygen dynamics. Maximum temperatures in the river have occasionally exceeded the State's standard for Class 1A streams in the past during low flows in summer (Table 3-6). The changes in low-flow parameters (Table 4-5) indicate that this alternative could contribute to increased water temperatures (in areas of the river and in isolated pools under extremely low flows) whenever the water temperature is not equilibrated with air temperatures.

Other water quality parameters that are indirectly related to temperature and flows (such as nutrient levels and fecal coliform) may also be adversely affected by reduced flows resulting from this alternative due to a reduced capacity to dilute incoming pollutants and higher productivity with higher temperatures. Impairment of fish and aquatic biota beneficial uses would likely increase under this alternative due to the increase in the number of days with near-zero flows (Table 4-5).

Similarly, the increased occurrence of low-velocity and/or discontinuous surface flows could worsen this river reach's existing poor dilution and downstream movement of pollutants through the reach during low-flow conditions if the low flows exacerbate algal or bacterial growth rates or nutrient dynamics. However, these conditions may already be degraded from naturally occurring low-flow conditions. The incremental worsening cannot be easily determined because the necessary detailed water quality data and their relationship to flow in the Souris River do not exist.

Changes in Groundwater Quality near Minot

Using Souris River water to enhance the recharge of groundwater in the Minot and Sundre aquifers could induce subtle chemical changes in the groundwater over time, changing the chemical state of soluble metals and minerals. This could result in increased concentrations of those metals and minerals and result in changes in water quality. Such reactions could cause mineral and bacterial fouling of the recharge wells that could necessitate enhanced maintenance efforts (e.g., frequent acidification of the recharge wells and pretreatment of Souris River water prior to it being used for aquifer recharge). Some improvement to groundwater quality could occur if Souris River water quality is better than that of the aquifers.

Changes in Geomorphic Processes on the Souris River

The Groundwater with Recharge Alternative would have little effect on primary geomorphic processes controlling the Souris River because high flows would not be reduced enough to measurably affect the ability of the stream to reshape its channel. The overbanking analysis indicates that this alternative would not substantially modify the number or duration of events when streamflow meets or exceeds the natural bankfull capacity, as determined for the reaches upstream and downstream of Minot where bankfull capacity was estimated at between 600 and 1,000 cfs in areas without levees (Table 4-6, Chapter 3). There would be very small reductions (less than 10 percent) in the magnitude of the median annual maximum flow for events with 1-, 3- or 7-day durations (Table 4-7). These two parameters (bankfull capacity and annual maximum flows) are most representative of larger streamflow events, which are considered drivers of geomorphic processes that dominate channel form and dimension and sediment transport. Additionally, there would be no change in the number of high-flow pulse events (defined by IHA as flows over 85 cfs), although their duration would be reduced by 2 days (Table 4-7). This indicates that there would be little effect on sediment mobilization. The Groundwater with Recharge Alternative would not change channel stability relative to streambed or streambank erosion.

Table 4-6 Souris River Overbanking Events under the No Action and Groundwater with Recharge Alternatives for the Historical Hydrologic Record (1903 – 2011)

Parameter	Units	No Action Alternative		Groundwater with Recharge		Change from No Action	
Bankfull Channel Capacity	cfs	600	1,000	600	1,000	600	1,000
Average Number of Days Exceeding Threshold per Year	Days	23	15	21	14	-2	-1
Minimum Duration	Days	1	1	1	1	0	0
Median Duration	Days	10	11	9	11	-1	0
Maximum Duration	Days	178	169	178	135	0	-34
Median First Day of Occurrence	Day	121	122	122	123	+1	+1

Note:

cfs = cubic feet per second

Source: Data from USGS gage 05117500 (2013a)

Table 4-7 Souris River High-Flow Statistics under the No Action and Groundwater with Recharge Alternatives for the Historical Hydrologic Record (1904 – 2010)

Parameter	Units	No Action Alternative	Groundwater with Recharge	Change from No Action
1-Day Maximum	cfs	857	773	-84
3-Day Maximum	cfs	772	763	-9
7-Day Maximum	cfs	712	625	-87
High Pulse Count	n	3	3	0
High Pulse Duration	Days	11	9	-2

Notes:

cfs = cubic feet per second; n =number

The period of record includes several months with data in 1903 and 2011, but only complete years were included in this analysis.

Source: Data from USGS gage 05117500 (2013a)

Reductions in riverine low flows typically have little effect on geomorphology; particularly on systems like the Souris River that already have a wide range of flows, including periods of low to no flow. However, if both low flows and flood flows are reduced for an extended period of time, vegetation could become established in the stream channel, resulting in reduced channel capacity and increased channel roughness, which can increase water elevations during floods. Review of low-flow hydrology effects and toe-of-bank exposure changes (Table 4-8) indicates that the opportunity for in-channel vegetation establishment to alter high-flow hydraulics would not be substantially increased. The number of toe-of-bank exposure events would increase slightly, their durations would not be measurably modified, and the seasonality of events would shift to be slightly sooner, but still in mid-summer. Vegetation encroachment would not be persistent or have roughness effects that could adversely change hydraulics or geomorphic processes during high flows or floods, which, as described above, would be minimally affected under this alternative.

Table 4-8 Souris River Toe-of-Bank Exposure Events under the No Action and Groundwater with Recharge Alternatives for the Historical Hydrologic Record (1903 – 2011)

Parameter	Units	No Action Alternative		Groundwater with Recharge		Change from No Action	
Toe of Bank Exposure	cfs	25	100	25	100	25	100
Average Annual Number of Days below Threshold	Days	127	194	155	206	28	12
Minimum Duration	Days	1	1	1	1	0	0
Median Duration	Days	16	27	17	28	+1	+1
Maximum Duration	Days	275	275	275	275	0	0
Median First Day of Occurrence	Day	229	224	205	216	-24	-8

Source: Data from USGS gage 05117500 (2013a)

Groundwater with Recharge and the Souris River Alternative

This alternative would use Souris River water to recharge the Minot and Sundre aquifers, the Souris River as a direct supply to the Minot WTP, and groundwater to meet the rest of the demand. No water from the Missouri River would be used in this alternative.

The Groundwater with Recharge and the Souris River Alternative would include 7 crossings of perennial streams and 22 crossings of intermittent streams during pipeline construction. Other components such as pump stations, recharge basins, and groundwater wells would be sited to avoid waterbodies. Construction of water intakes in the Souris River would be implemented in accordance with BMPs to minimize any temporary water quality impacts.

Changes in Quantity and Timing of Flows in the Souris River

Under this alternative, water would be withdrawn from the Souris River to supply the Minot WTP from March through August, as well as to recharge basins through two new intakes along the river: one upstream of downtown Minot to recharge the Minot aquifer and the other a few miles downstream of downtown Minot to recharge the Sundre aquifer (Figures 2-3 and 2-4). Based on the operating assumptions described in Chapter 2, up to 56 mgd (87 cfs) would be withdrawn from the Souris River intakes for the recharge basins, and up to 5.75 mgd (8.9 cfs) would be withdrawn for direct delivery to the Minot WTP from March through August. As described in the “Methods” section above, this does not take into account potential restrictions from the full exercise of senior water rights in the future. Should senior water rights be exercised, the volume of Souris River water withdrawn at Minot could potentially be reduced.

Figure 4-24 shows Souris River flows for the No Action and Groundwater with Recharge and the Souris River alternatives for 1987, which represents median annual (normal) flow conditions for the Souris River. Figures 4-25 and 4-26 show flows for these two alternatives for example dry and wet years, respectively.

For both example normal and dry years, withdrawals from the Souris River would result in an increase in the number of days with near-zero flow for the months of May through August downstream of the intakes until tributary or groundwater sources contribute additional flow to the Souris River. There are insufficient streamflow data to determine at what point that would occur under various streamflow conditions. For the normal year, the amount withdrawn is a lower proportion of the spring flood flows (Figure 4-24). From September through February when water is not being withdrawn, flows match the No Action Alternative.

During the example dry year (Figure 4-25), the peak runoff occurs in April, and although the flows would not be reduced to zero during this peak period, a substantial amount would be withdrawn to send to the aquifer recharge basins. The flow during the example dry year would drop to near-zero in May and extend through August.

There was insufficient flow during the March through August withdrawal period to achieve the 4.5-bgy withdrawal target for artificial recharge for either the example normal year (4.1 billion gallons total) or the example dry year (2.6 billion gallons total).

The example wet year has high flows starting in May that last through most of the summer, so the withdrawals for this alternative make up a very small portion of the total flows and are difficult to distinguish in the chart using a logarithmic flow scale (Figure 4-26). The 4.5-billion-gallon withdrawal for artificial recharge was achieved by June 11, although withdrawals for direct delivery continued through the summer – July through August. Flows during March and part of April (and 1 day in August) are reduced to near-zero downstream of the second intake as a result of withdrawals for this alternative.

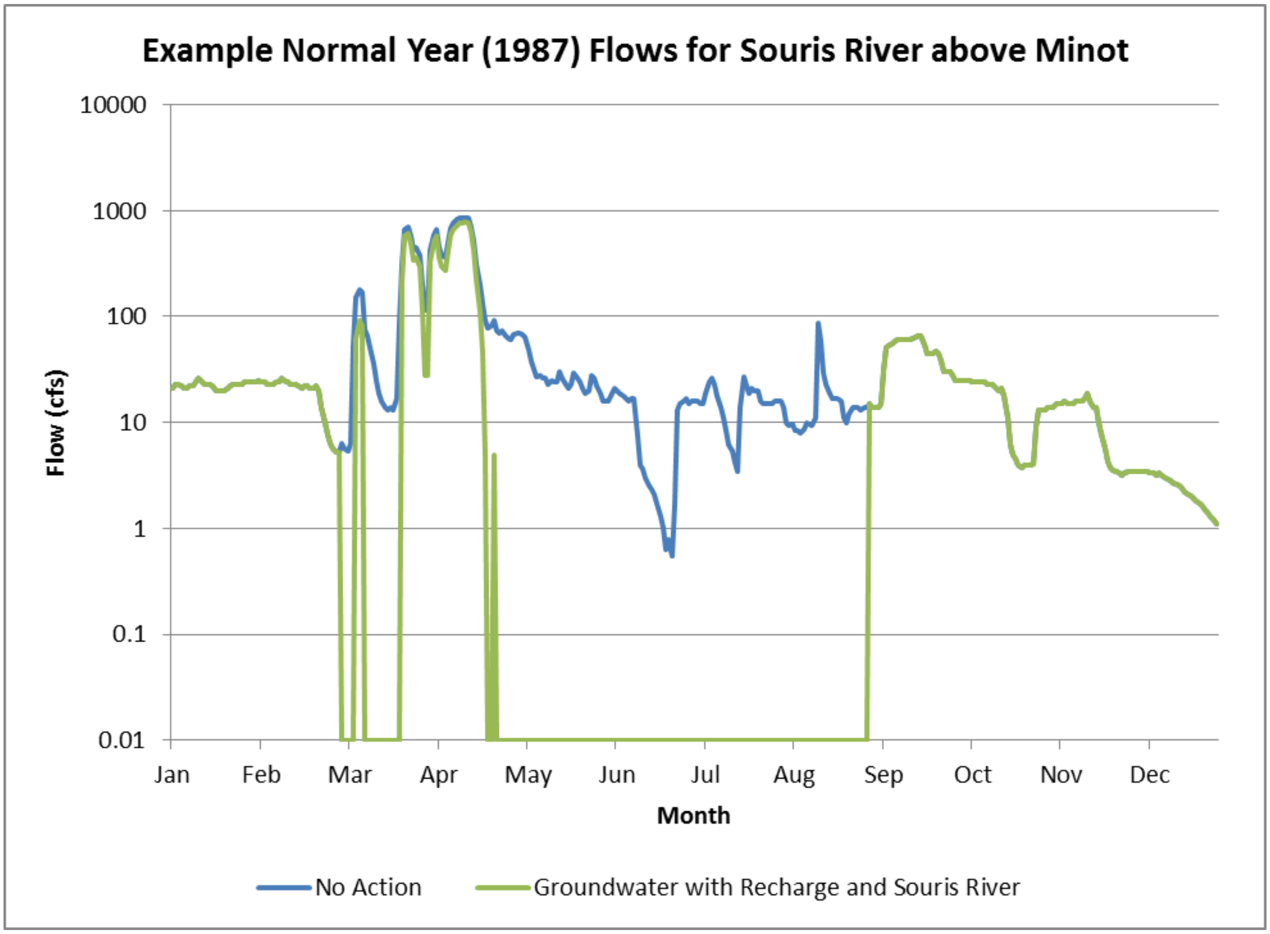

Figure 4-24 Daily Flows for the No Action and Groundwater with Recharge and the Souris River Alternatives for the Example Normal Year (1987) at the USGS Gage above Minot

Source: Data from USGS gage 05117500 (2013a)

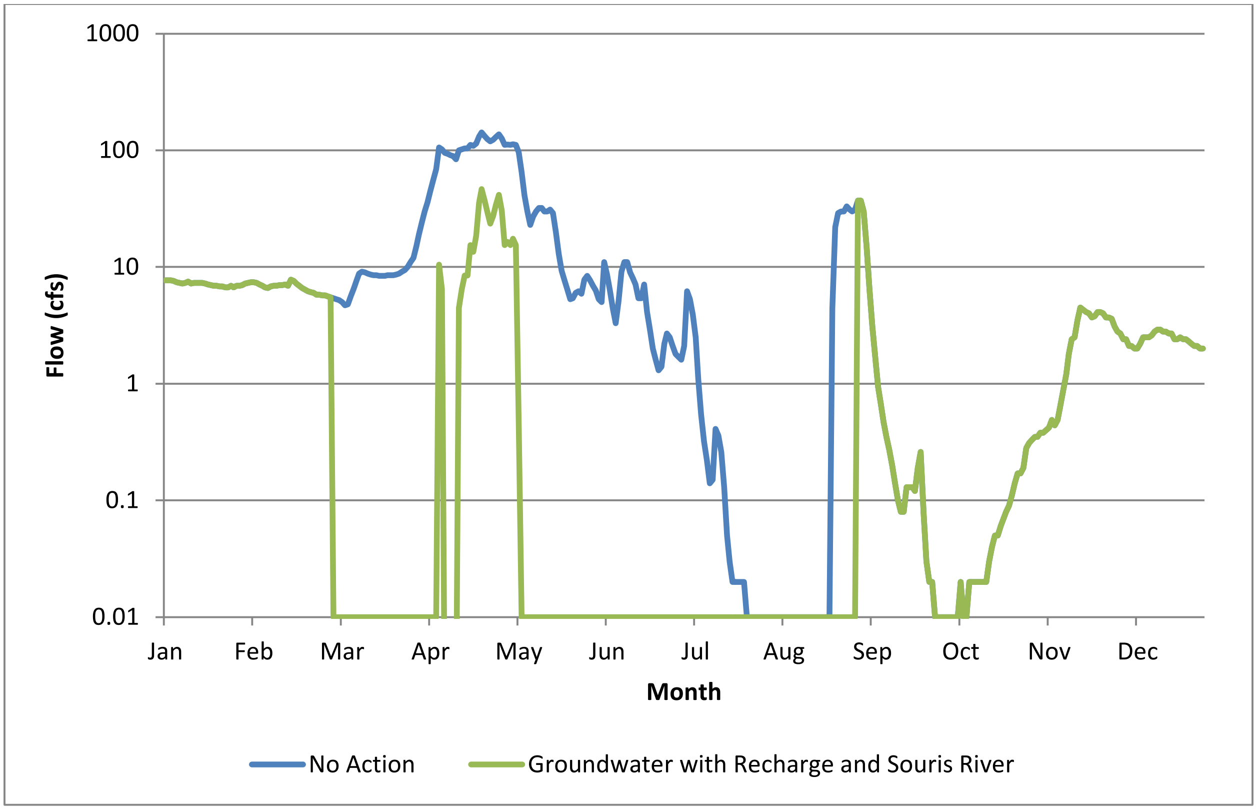

Figure 4-25 Daily Flows for the No Action and Groundwater with Recharge and the Souris River Alternatives for the Example Dry Year (2006) at the USGS Gage above Minot

Source: Data from USGS gage 05117500 (2013a)

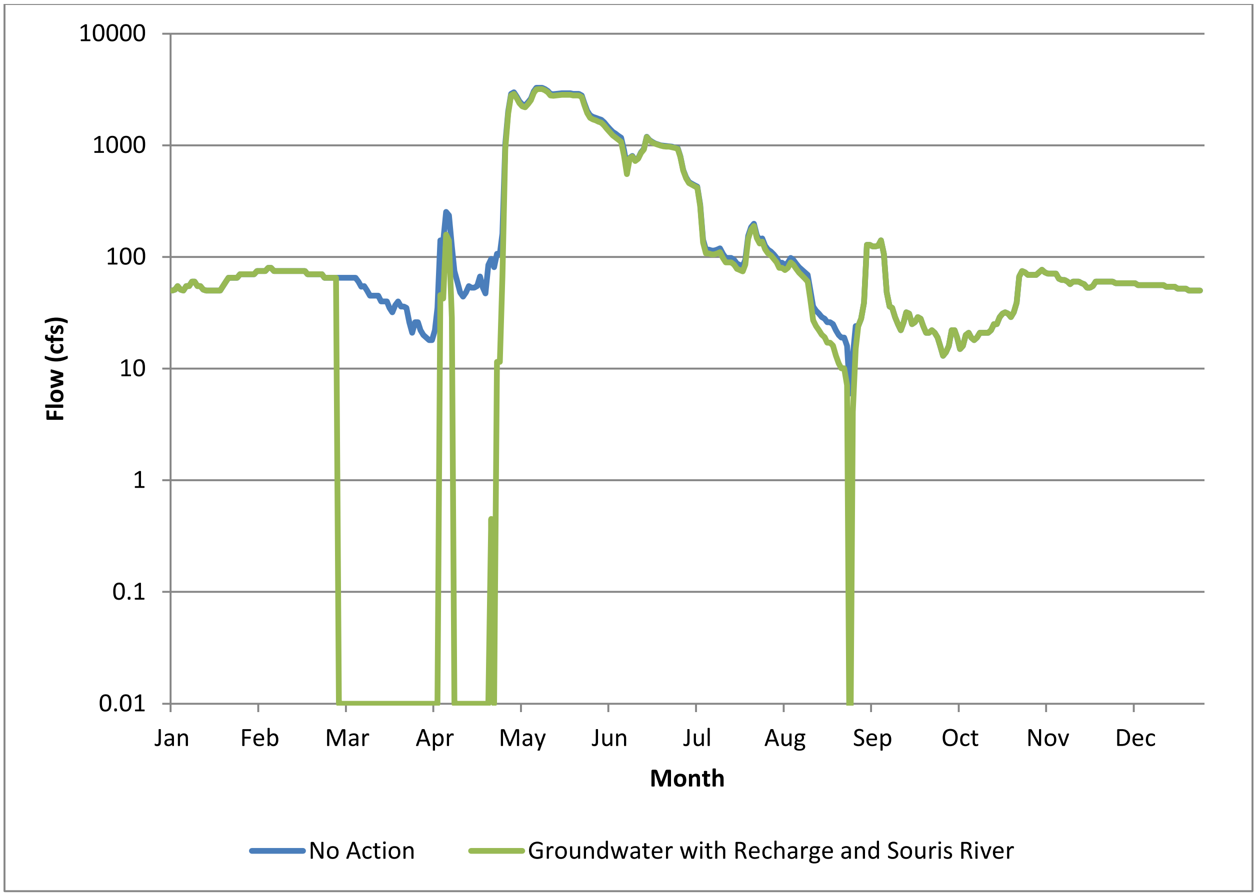

Figure 4-26 Daily Flows for the No Action and Groundwater with Recharge and the Souris River Alternatives for the Example Wet Year (1970) at the USGS Gage above Minot

Source: Data from USGS gage 05117500 (2013a)

The entire period of record was also examined to estimate overall changes in flows on the Souris River. The 50-percent exceedance flow without Project withdrawals (No Action) was approximately 21 cfs, and the 50-percent exceedance flow under the Groundwater with Recharge and the Souris River Alternative would be approximately 9 cfs (Figure 4-12 in the "No Action Alternative" section). For example, flows less than approximately 10 cfs would occur 38 percent of the time under the No Action Alternative but would occur approximately 51 percent of the time under the Groundwater with Recharge and the Souris River Alternative. The percentage of time that near-zero flows (less than 0.1 cfs) would occur increases from approximately 8 percent of the time to approximately 30 percent of the time.

The average number of days per year of near-zero flows would increase from 26 days per year to 108 days per year based on the 107-year period of record under the Groundwater with Recharge and the Souris River Alternative (Table 4-9). The unaltered flow record, however, is extremely variable; only 29 percent of the years in the 107-year record have any days with near-zero flows, and 42 percent of those years have over 100 days of near-zero flows. Under this alternative, the percentage of years in the record with near-zero flow days would increase from 29 to 95 percent (Table 4-9).

The IHA characterizes the annual low-flow regime for a period of record and summarizes them using the value of the median 1-, 3-, 7-, 30-, and 90-day flows and the number of zero-flow days (Table 4-9). The Groundwater with Recharge and the Souris River Alternative would decrease the existing median low 1-, 3-, 7-, or 30-day minimum flows to zero. This would be a small change because these flow statistics are already near zero under the existing conditions.

Table 4-9 Souris River Low-Flow Statistics under the No Action and Groundwater with Recharge and the Souris River Alternatives for the Historical Hydrologic Record (1904 – 2010)

Parameter	Units	No Action Alternative	Groundwater with Recharge and the Souris River	Change from No Action
Average Number of Days per Year with Near-Zero Flows [a]	Days	26	108	+82
Percent of Years in 107-Year Record with Near-Zero Flows	Percent	29	95	+66
1-Day Minimum	cfs	0.5	0	-0.5
3-Day Minimum	cfs	0.7	0	-0.7
7-Day Minimum	cfs	0.7	0	-0.7
30-Day Minimum	cfs	1.0	0	-1.0
90-Day Minimum	cfs	4.5	0.7	-3.8

Notes:

cfs = cubic feet per second

The period of record includes several months with data in 1903 and 2011, but only complete years were included in this analysis.

[a] Near-zero flows are less than 0.1 cfs and include periods of no measurable flow (zero cfs).

Figure 4-16 (in the No Action Alternative section) illustrates changes in monthly flows for the USGS gage above Minot for all of the alternatives using Souris River water. The reduced flows can be seen from March through August during the withdrawal period, with the greatest change in median flows during the months of March and May. Under the No Action Alternative, the typical period of lowest flows occurs during the winter months; with the withdrawals from the Groundwater with Recharge and the Souris River Alternative, the lowest flows would continue into March. Higher flows would be comparatively less affected because the proportion of flow withdrawn is smaller relative to the higher flows.

As previously described, flow reductions would be most apparent around and downstream from the Souris River intake associated with the Sundre aquifer recharge facilities at Minot. Based on a comparison of hydrographs between Minot and downstream gages at Verendrye and Bantry (Figure 3-7), the Souris River increases in flow in a downstream direction. The flow exceedance curve for the No Action and the Groundwater with Recharge and the Souris River alternatives shows that low flows are much less frequent at the Verendrye gage, and that impacts from the withdrawals at Minot would be considerably muted at the gage 86 miles downstream when compared to the results at the Minot gage (Figures 4-12 and 4-13).

Figure 4-17 represents the flow data at the Verendrye gage minus the proposed withdrawals at Minot under this alternative. This illustrates the effect of the alternative (compared to No Action) on monthly flows at the Verendrye gage, and similar to the flow exceedance curve, shows reduced impacts of flow withdrawals compared to the impacts at the gage above Minot. Median and lower flows would still be reduced compared to the No Action Alternative during the months when withdrawals occur, but not to the same extent as with the above-Minot gage (Figure 4-16).

Figures 4-14 and 4-18 illustrate the effects of the proposed withdrawals on flows at the Bantry gage, which lies just upstream of the J. Clark Salyer NWR. The results are very similar to the Groundwater with Recharge Alternative and the results for the Verendrye gage for this alternative. Flows below about 10 cfs would occur about 5 percent more frequently (Figure 4-14). Similar to the other gages, the greatest change in median flows would occur in the month of March; and 95-percent exceedance flows would be reduced to zero in March, April, May, July, and August (Figure 4-18).

As illustrated in Figures 4-15 and 4-19 there is a greater effect on low flows from the Groundwater with Recharge and the Souris River Alternative on estimated flows at the Westhope gage than at the Bantry and Verendrye gages. In particular, flows below 20 cfs become more frequent under this alternative, which could impair the ability to maintain the 20-cfs minimum flows at the international border from June through October in compliance with the "Agreement between the Governments of Canada and the United States for Water Supply and Flood Control in the Souris River Basin" (ISRB 2000). The biggest monthly change in median flows occurs in March prior to spring runoff flows, when withdrawals would reduce flows to less than 1 cfs.

Changes in Groundwater Recharge, Storage, and Availability near Minot

Under the Groundwater with Recharge and the Souris River Alternative, up to 4.5 billion gallons of water per year would be withdrawn from the Souris River for the recharge basins. Although this alternative proposes to withdraw up to 4.5 bgy for aquifer recharge, the variable flows of the Souris River historically would not meet that target in many years. The amount of water withdrawn for each year over the period of record is the same for this alternative as for the Groundwater with Recharge Alternative (Figure 4-23). Based on the operational assumptions, the average quantity of water available for withdrawal from the Souris River would be 3.7 bgy over the past 108 years (1903 to 2011 using incomplete records for the years 1903 and 2011), which is lower than the projected average annual demand through 2060 (3.85 bgy). However, total water demand would be supplemented by an average annual addition of 0.56 billion gallons from direct delivery via the Souris River, which would reduce withdrawals from the aquifers by that amount.

By subtracting the amount of groundwater withdrawn on a daily basis from the amount artificially recharged to the aquifers, there would be approximately 494 million gallons more water artificially recharged than withdrawn on an annual basis when averaged over the period of record. This is due to the additional direct delivery of water from the Souris River replacing some of the groundwater withdrawals.

With the average long-term artificial recharge rates exceeding the average long-term pumping rates, the aquifer levels should stabilize and increase over the long-term. The addition of natural recharge to the aquifer and major flood events would also contribute to aquifer recharge.

During periods of extended drought, aquifer levels would decline. Recharge rates would be reduced while groundwater pumping rates stay the same or increase, resulting in temporary reductions in aquifer water surface levels. There would also likely be localized drawdown around the municipal wells, particularly during peak demand pumping, that may not be immediately offset by water from the recharge fields.

Changes in Souris River Water Quality

Because the amount of water that can be withdrawn from the Souris River is limited, higher flows and peak flows would not be substantially affected (Figure 4-12). This alternative would not directly introduce additional pollutants to the Souris River beyond potential short-term impacts associated with construction, but changes in low-flow hydrology may adversely affect temperature and dissolved oxygen dynamics. Maximum temperatures in the river have occasionally exceeded the State's standard for Class 1A streams in the past (Table 3-6), during low flows in late summer. The changes in low-flow parameters (Table 4-9) indicate that this alternative could contribute to increased water temperatures (in very-low-flow areas of the river and in isolated pools under extremely low flows) whenever the water temperature is not equilibrated with air temperatures.

Other water quality parameters that are indirectly related to temperature and flows (such as nutrient levels and fecal coliform) may also be adversely affected by reduced flows resulting from this alternative due to a reduced capacity to dilute incoming pollutants and higher productivity with higher temperatures. Impairment of fish and aquatic biota beneficial uses would likely increase under this alternative due to the increase in the number of days with near-zero flows (Table 4-9).

Similarly, the increased occurrence of low-velocity and/or discontinuous surface flows could worsen existing poor dispersal patterns and slow transit of pollutants through the Minot reach during low-flow conditions if the low-flows exacerbate algal or bacterial growth rates or nutrient dynamics. However, these conditions may already be degraded from naturally occurring low-flow conditions. No data are available to estimate the incremental change.

Changes in Groundwater Quality near Minot

Under the Groundwater with Recharge and the Souris River Alternative, impacts would be essentially the same as under the Groundwater with Recharge Alternative.

Changes in Geomorphic Processes on the Souris River

The Groundwater with Recharge and the Souris River Alternative would have little effect on primary geomorphic processes controlling the Souris River because high flows would not be reduced enough to measurably affect the ability of the stream to reshape its channel. The overbanking analysis indicates that the average number of days per year when streamflow meets or exceeds the natural bankfull capacity would decrease by 2 days for the 600-cfs event, and by 1 day for the 1,000-cfs event based on the 107-year period of record. The median duration for the 1,000-cfs event would increase by 5 days relative to the No Action Alternative. The project would make small reductions (10 to 15 percent) in the magnitude of the median annual maximum flow for events with 1-, 3- or 7-day durations (Table 4-10). These parameters are most representative of larger streamflow events considered drivers of geomorphic processes that dominate channel form and dimension and sediment transport. Additionally, there would be no change in the number of high-flow pulse events (defined by IHA as flows over 85 cfs), although their duration would be reduced by 3 days (Table 4-10). This indicates that this alternative would have little effect on low-flow sediment mobilization. The Groundwater with Recharge and the Souris River Alternative would not change channel stability relative to streambed or streambank erosion.

Table 4-10 Souris River High-Flow Statistics under the No Action and Groundwater with Recharge and the Souris River Alternatives for the Historical Hydrologic Record (1904 – 2010)

Parameter	Units	No Action Alternative	Groundwater with Recharge and the Souris River	Change from No Action
1-Day Maximum	cfs	857	765	-92
3-Day Maximum	cfs	772	755	-17
7-Day Maximum	cfs	712	616	-95
High Pulse Count	n	3	3	0
High Pulse Duration	Days	11	8	-3

Notes:
cfs = cubic feet per second; n = number
The period of record includes several months with data in 1903 and 2011, but only complete years were included in this analysis.
Source: Data from USGS gage 05117500 (2013a)

Review of low flows and toe-of-bank exposure changes indicate that the opportunity for in-channel vegetation establishment to alter channel hydraulics would not be increased for this alternative. The average annual number of toe-of-bank exposures would increase by 32 days and 15 days for the 25-cfs and 100-cfs flows, respectively, over the period of record; and the median duration would not change for the 25-cfs flow and would increase by 1 day for the 100-cfs flow. The 25-cfs flows would occur almost a month earlier in the year than under the No Action Alternative. Vegetation encroachment would not be persistent or have roughness effects that could adversely change hydraulics or geomorphic processes during high flows or floods.

Missouri River and Conjunctive Use Alternative

This alternative would withdraw Missouri River water from Lake Sakakawea using one of two intake options. It would be treated and conveyed to Minot, where it would be added to and blended with water supplied directly from the Souris River using the City of Minot’s existing intake, along with groundwater from the City’s existing wellfields. Water would be withdrawn from the Souris River for direct delivery (up to the intake’s capacity of 5.75 mgd) when available in March through August at a rate of half the demand whenever the flow is more than twice the monthly average demand. As described in the Methods section above, this does not take into account potential restrictions from the exercise of senior water rights in the future. Should senior water rights be exercised, the volume of Souris River water withdrawn at Minot could potentially be reduced. An average of 1 mgd would be pumped from the Minot and Sundre aquifers from September through May, which would increase to 2.6 mgd for the high-demand months of June through August. Water supplied from the Missouri River would make up the remainder of the demand. Water rights have been obtained for the Project for withdrawals from the Missouri River basin.

Construction impacts specific to this alternative on the 21 intermittent and 2 perennial streams crossed by bulk distribution pipelines would be temporary, and the siting of other components of the bulk distribution system such as pump stations and storage reservoirs would avoid waterbodies as described above for the Groundwater with Recharge Alternative. Construction of a new intake structure in Lake Sakakawea would result in temporary disturbance to the surrounding water over the distance that turbidity and sedimentation occur. Construction of a water intake would be implemented in accordance with BMPs to minimize or avoid water quality impacts.

Changes in Quantity and Timing of Souris River Flow

Under this alternative, water would only be withdrawn from the Souris River and sent to the Minot WTP from March through August, and only if the flows are twice the average monthly demand. Similar to the two inbasin alternatives, figures were developed to compare the withdrawals under the Missouri River and Conjunctive Use Alternative with the No Action Alternative for example normal, dry, and wet flow conditions. Figure 4-27 shows the effect of the alternative's withdrawals compared to the No Action Alternative for an example normal year (1987). The flows would be essentially the same for every month except for a portion of April and May, where the flows would be slightly lower. This pattern is representative of the effect of this alternative—the withdrawal would typically be small compared to the total flows during the spring runoff, although they could reach a maximum of 25 percent of the flow. Figure 4-28 shows the results for an example dry year, which illustrates withdrawals from mid-March through mid-May. Figure 4-29 shows the results for an example wet year (1970), which would have withdrawals in March and April, and some in July because the example wet year flows were higher than normal for that time of year.

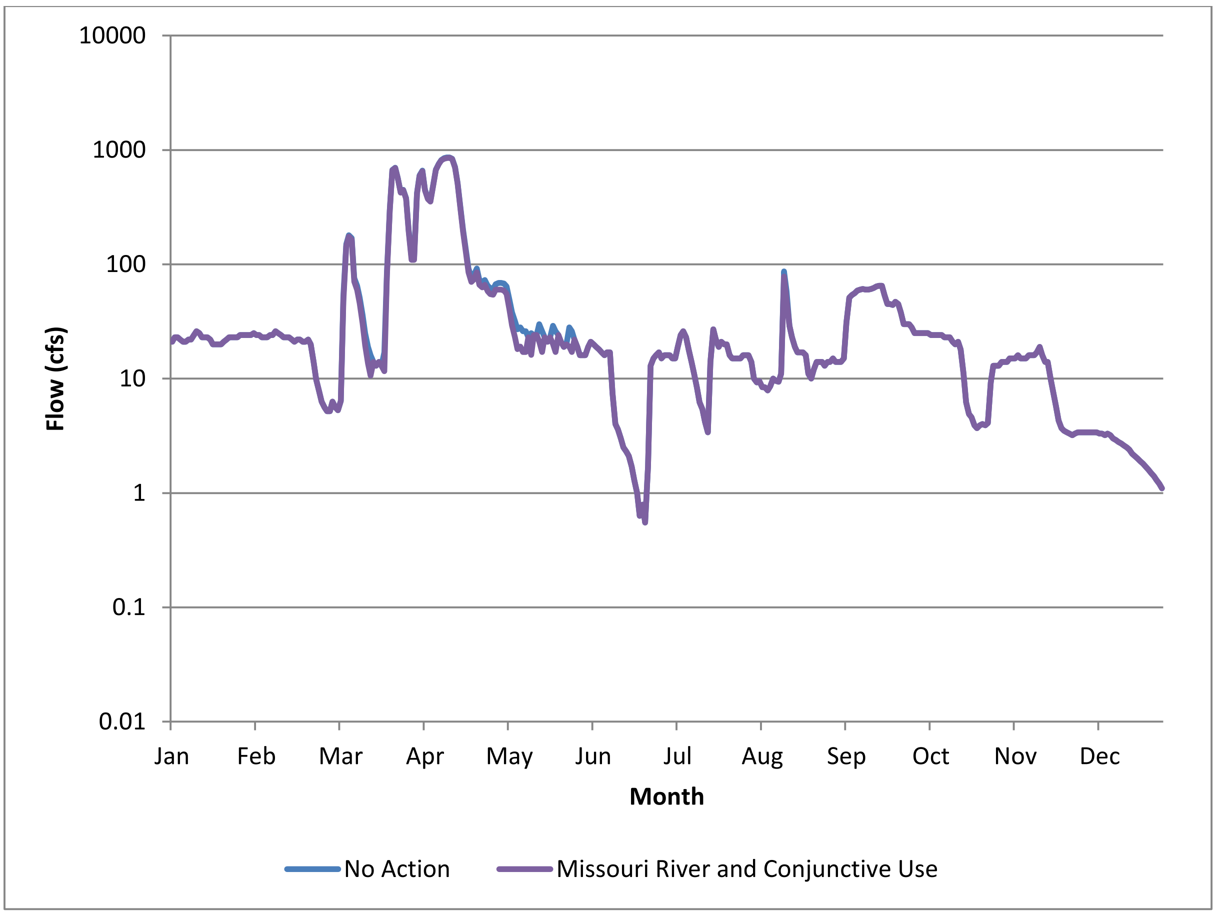

Figure 4-27 Daily Flows for the No Action and Missouri River and Conjunctive Use Alternatives for the Example Normal Year (1987) at the USGS Gage above Minot

Source: Data from USGS gage 05117500 (2013a)

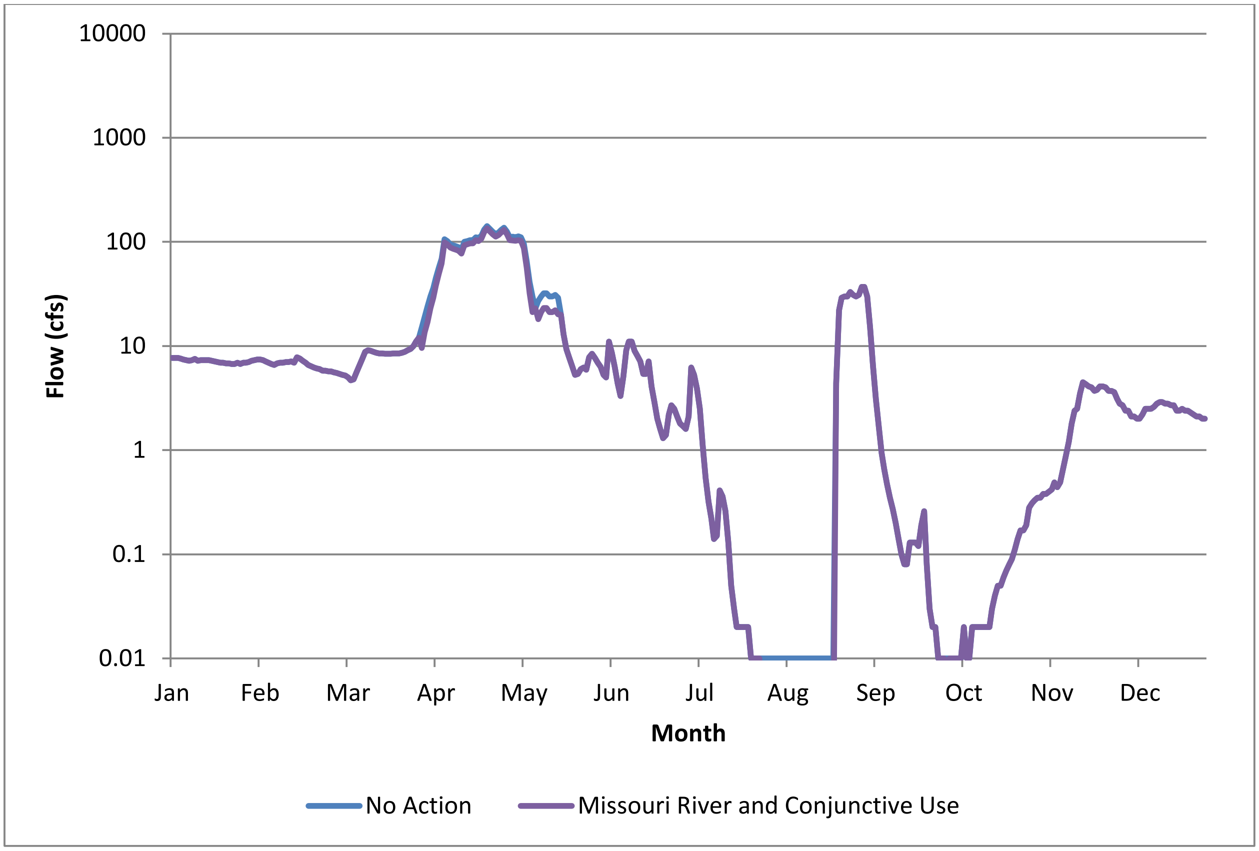

Figure 4-28 Daily Flows for the No Action and Missouri River and Conjunctive Use Alternatives for the Example Dry Flow Year at the USGS Gage above Minot (2006)

Source: Data from USGS gage 05117500 (2013a)

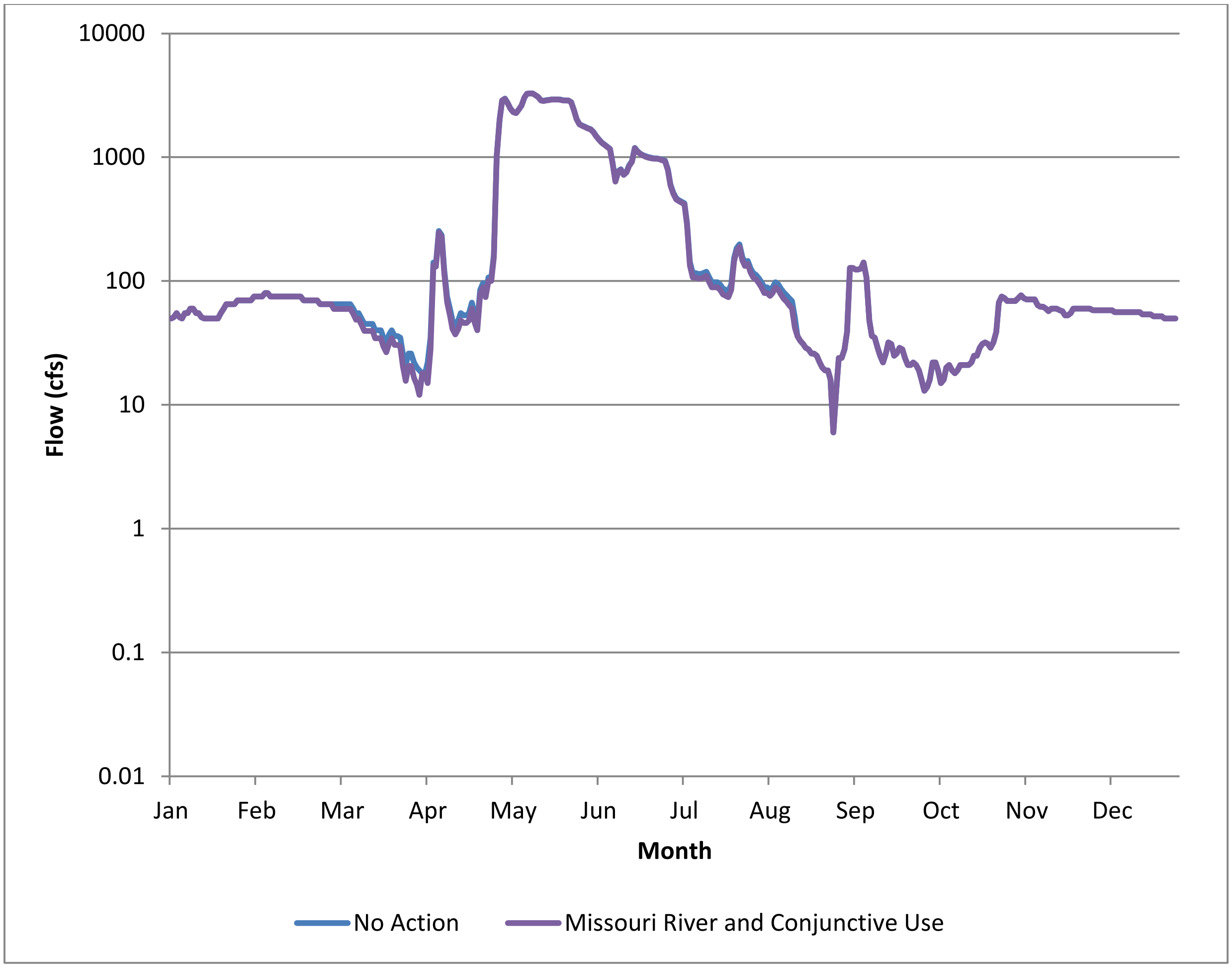

Figure 4-29 Daily Flows for the No Action and Missouri River and Conjunctive Use Alternatives for the Example Wet Year (1970) at the USGS Gage above Minot

Source: Data from USGS gage 05117500 (2013a)

The entire period of record can also be examined to estimate changes in flows on the Souris River. In this case, Figure 4-12 (in the No Action Alternative section) shows that there is a very slight reduction in flows from approximately 16 cfs through approximately 300 cfs (between the 10- and 50-percent exceedance flows). There are no changes at lower flows because water would not be withdrawn from the Souris River at those times, and changes in flows during periods of higher flows would be small relative to the total flows.

Effects on flows from the Missouri River and Conjunctive Use Alternative at the downstream gage at Verendrye are even less distinguishable than the results from the Minot gage and are not presented as figures. However, the withdrawals could have a small effect downstream at the gages near Bantry and Westhope. At the Bantry gage, flows below about 10 cfs would occur about 1 percent more frequently (Figure 4-14), with the slight reductions in flow occurring mainly in the months of April, May, July, and August (Figure 4-18).

At the Westhope gage, flows below about 1 cfs would increase in probability by 1 to 2 percent (Figure 4-15). Based on the box plot analysis, the only months with noticeable differences in low flows are April, June, and July (Figure 4-19).

Reductions in flows up to 25 percent could occur in the vicinity of Minot for short periods of the year, but withdrawals would typically make up a much smaller portion of the total flow. Flow impacts downstream through Verendrye are similarly minor, but low flows (below about 1 cfs) could occur slightly more frequently at the Westhope gage located on the border with Canada.

Changes in Groundwater Recharge, Storage, and Availability near Minot

The average groundwater withdrawal near Minot for this alternative is 1 mgd, and the peak withdrawal is 2.6 mgd during summer months. The annual use would be approximately 549 million gallons per year, a considerable reduction from the average over the past 45 years of almost 1.9 bgy from both the Minot and Sundre aquifers combined. Both aquifers have declined over the period of available data, with average pumping rates of 2 and 3.2 mgd for the Minot and Sundre aquifers, respectively. Prior aquifer studies have indicated that 2 mgd should be a sustainable rate for the Minot aquifer (Chapter 3), but the actual sustainable withdrawal rate is lower because the aquifer has been declining at that pumping rate over the past 45 years. Reducing demand to 1 mgd on average with 2.6-mgd peak withdrawals from the Minot and Sundre aquifers could stabilize and/or reverse the downward trend in water levels over the long term if the new rate of withdrawal is less than the natural recharge rates of the aquifers.

Changes in Souris River Water Quality

The Missouri River and Conjunctive Use Alternative would withdraw up to 25 percent of the Souris River flows during the spring months when flows are higher, but a lower proportion during the highest periods of flow. Reducing the higher flows by up to 25 percent would not measurably affect the water quality in the Souris River. Under this alternative, water would not be withdrawn during lower-flow periods, resulting in no changes in low flows and no further degradation of water quality parameters such as dissolved oxygen, water temperature, or other constituents beyond what is already occurring.

Changes in Groundwater Quality near Minot

Groundwater withdrawals would be reduced under this alternative in comparison to the No Action Alternative. As described above, it is expected that groundwater levels would stabilize or increase over the long term from natural recharge. Increased natural recharge from the Souris River could benefit groundwater quality, although the change is expected to be minor.

Changes in Geomorphic Processes on the Souris River

The Missouri River and Conjunctive Use Alternative would have little effect on primary geomorphic processes controlling the Souris River because the alternative would not take enough water from high-flow events to affect the ability of the stream to reshape its channel. The overbanking analysis indicates that withdrawals from the Souris River would not substantially modify the number or duration of events when streamflow meets or exceeds the natural bankfull capacity. The alternative would make small reductions (less than 5 percent) in the magnitude of the high flow for events with 1-, 3- or 7-day durations. These two parameters are most representative of larger streamflow events and are considered drivers of geomorphic processes that dominate channel form and dimension and sediment transport. Additionally, there would be no change in the number of high-flow pulse events (defined by IHA as flows over 85 cfs). This indicates that this alternative would have little effect on low-magnitude sediment mobilization. This alternative would not change channel stability relative to streambed or streambank erosion.

Review of low flows and toe-of-bank exposure changes indicates that the opportunity for in-channel vegetation establishment to alter channel hydraulics would not be increased. The average annual number of toe-of-bank exposure days would increase by 3 days for both 25-cfs and 100-cfs flows over the period of record, but the median duration would decrease by 1 day for the 25-cfs flow and not change for the 100-cfs flow. The timing of the events would not change. Vegetation encroachment would not be persistent or have roughness effects that could adversely change hydraulics or geomorphic processes during high flows or floods.

Missouri River and Groundwater Alternative

The Missouri River would be the primary water supply source for this alternative. Water would be withdrawn from Lake Sakakawea, treated, and conveyed to the Minot WTP where it would be blended with groundwater from the existing wellfields in the Minot and Sundre aquifers. Groundwater would supplement Missouri River water at a rate of 1 mgd under normal conditions and at 2.6 mgd under peak demand conditions (June through August). This is the same rate as the Missouri River and Conjunctive Use Alternative, and the alternative would draw approximately 549 million gallons per year from groundwater. A water right has been obtained for the Project for withdrawals from the Missouri River. No Souris River water would be used under this alternative.

Construction impacts specific to this alternative on the 21 intermittent and 2 perennial streams crossed by bulk distribution pipelines would be temporary, and the siting of other components of the bulk distribution system such as pump stations and storage reservoirs would avoid waterbodies, as described above for the Groundwater with Recharge Alternative. Impacts of intake construction at Lake Sakakawea would also be the same as described above for the Missouri River and Conjunctive Use Alternative.

Changes in Quantity and Timing of Souris River Flows

This alternative does not use water from the Souris River. As described in the next sections, Minot and Sundre aquifer levels could stabilize or increase over time and eventually return to pre-drawdown levels. As the water levels in the aquifers returned to pre-drawdown levels, the aquifer could more frequently contribute to Souris River flows. However, the extent to which this may occur and the timing cannot be reliably estimated from the currently available information.

Changes in Groundwater Recharge, Storage, and Availability near Minot

Groundwater withdrawals under this alternative would be the same as the Missouri River and Conjunctive Use Alternative, with an average withdrawal of 1 mgd and a peak withdrawal of 2.6 mgd during summer months. Similar to the Missouri River and Conjunctive Use Alternative, reducing demand to 1 mgd on average with 2.6-mgd peak withdrawals from the Minot and Sundre aquifers could stabilize and/or reverse the downward trend in water levels over the long term if the new rate of withdrawal is less than the natural recharge rates of the aquifers.

Changes in Souris River Water Quality

This alternative would not use the Souris River and would not directly affect the water quality of the Souris River. If groundwater levels returned to pre-drawdown levels, flow from the aquifers could augment the Souris River. Increased low flows would reduce impacts from high temperatures and low dissolved oxygen levels, and could reduce stagnation.

Changes in Groundwater Quality near Minot

Groundwater withdrawals would be reduced under this alternative in comparison to the No Action Alternative. As described above, groundwater levels could stabilize or increase over the long term from natural recharge. Increased natural recharge from the Souris River could benefit groundwater quality, although the change would likely be small.

Changes in Geomorphic Processes on the Souris River

This alternative would not use the Souris River and therefore would not result in any reasonably foreseeable effects on the geomorphology.

Environmental Commitments

The following environmental commitments would be implemented during construction if needed (Appendix F).

- When pipeline construction through a stream is unavoidable, existing basin contours would be restored and trenches would be sufficiently compacted to prevent any drainage along the trench or through bottom seepage.
- Where open trench crossing of stream is required, the stream channel would be reestablished following pipe installation.

With implementation of these environmental commitments, no unavoidable adverse impacts associated with construction would occur.

The following environmental commitment would be implemented during operation of the alternatives that use withdrawals from the Souris River if one of them is selected for implementation (Appendix F):

- Reclamation would develop an adaptive management plan, in accordance with the Department of the Interior’s policy guidance (Order 3270) and the report, *Adaptive Management: the U.S. Department of the Interior Technical Guide* (Williams et al. 2007). The plan would be implemented to address Project uncertainty as identified in the SEIS in relation to Souris River water resources and potential impacts to the NWRs.

The environmental commitment would not be expected to fully reduce impacts from changes in Souris River flows; thus, the adverse impacts on flows and water quality would be unavoidable. Adverse impacts on the Souris River and related resources would be much greater for the inbasin alternatives than for the Missouri River and Conjunctive Use Alternative. (See “Land Use” and “Common Wildlife” sections for more details.)

Cumulative Effects

A proposed major flood-reduction project is described in the *Mouse River* [Souris River] *Enhanced Flood Protection Plan Preliminary Engineering Report* (Barr Engineering et al. 2012). This is a preliminary study examining options for flood protection along the Souris River in the Project Area and includes options for various approaches, including levees, floodwalls, bypass channels, and other features. Although a final alternative has not been selected, the goal of the project is to reduce flooding by routing large floods through populated areas while reducing the risk of infrastructure damage from those floods. The flood control project proposes engineered channels and structures that would change the channel shape, size, and length through several populated areas, including Minot. The result would likely reduce the amount of natural aquifer recharge from the Souris River in the Minot area by further reducing the amount of water on the floodplain, reducing channel length, and reducing the travel time for water to flow through the city.

This would have the greatest impact in relation to the No Action Alternative, which relies entirely on naturally recharged groundwater to meet demands. The action alternatives evaluated in this SEIS, on the other hand, rely only partially on naturally recharged groundwater to meet Project demands. The inbasin alternatives would require the most groundwater, withdrawing up to 3.85 bgy from the Minot and Sundre aquifers. These aquifers would, however, be supplemented with artificially recharged water from the Souris River, and with the average long-term aquifer pumping rates less than the average long-term recharge rates, the aquifer levels should stabilize and possibly increase over the long term and from years with high flows or floods. The Missouri River alternatives would not involve artificial recharge of the Minot and Sundre aquifers but would require considerably less groundwater, pumping an average of 1 mgd from September through May, which would increase to 2.6 mgd for the high-demand months of June through August. This could stabilize and/or reverse the downward trend in water levels over the long term if the new rate of withdrawal is less than the natural recharge rates of the aquifers. Because the action alternatives would result in decreased withdrawals from the aquifers near Minot, they would not contribute to an adverse cumulative impact in combination with the flood protection project.

The flood control project would affect the hydrologic conditions associated with higher flows in the Souris River. As discussed above, these flows would be less affected by the three action alternatives using water from this source than by drier or median flows because the proportion of flow withdrawn would be smaller relative to the higher flows; therefore, the action alternatives would have only a minor, incremental contribution to any changes to the hydrology of the river caused by the flood control project**.**

Summary

Most temporary construction-related impacts would be nearly identical for all action alternatives and primarily related to the construction of the bulk distribution pipelines. The number of pipeline-related stream crossings for the action alternatives ranges from 23 to 29. By following established BMPs, none of the action alternatives would be likely to result in erosion, sedimentation, or pollution of waterways during construction of Project components.

Changes in timing and quantities of surface flows for the Souris River would be greatest for the Groundwater with Recharge and Groundwater with Recharge and the Souris River alternatives because they would withdraw the most water from the Souris River to recharge the aquifers and for direct use in the case of the Groundwater with Recharge and the Souris River Alternative. Based on the operating assumptions applied to the period of record, the average number of days per year with near-zero flows below Minot would increase from 26 days under No Action to 103 and 108 days, respectively, for the Groundwater with Recharge and Groundwater with Recharge and the Souris River alternatives. The percent of years in the record with near-zero flows would increase from 29 percent to 94 and 95 percent for each alternative, respectively. High flows would not be affected appreciably because the rate of withdrawal is small compared to peak flows. The Missouri River and Conjunctive Use Alternative would not affect high flows or the lowest flows based on the operations plan that allows withdrawals only when the flows are twice the demand. The Missouri River and Groundwater Alternative does not use water from the Souris River and would have no impact on Souris River flows.

Net groundwater withdrawal rates (withdrawal minus recharge) would be lower for the action alternatives than for the No Action Alternative. Lower net groundwater use could result in groundwater levels stabilizing or starting to rise.

Surface water quality parameters affected by low flows (such as dissolved oxygen and temperature) would be degraded by the Groundwater with Recharge and the Groundwater with Recharge and the Souris River alternatives because they would result in more frequent periods of low and near-zero flows. The Missouri River and Conjunctive Use Alternative would not reduce flows in the Souris River enough to adversely affect water quality.

The Groundwater with Recharge and the Groundwater with Recharge and the Souris River alternatives could improve groundwater quality by increasing the amount of surface water added to the Minot and Sundre aquifers, although the effect would likely be small.

None of the alternatives would be expected to have a measurable effect on the geomorphology of the Souris River compared to the No Action Alternative.

If the selected alternative includes withdrawals from the Souris River, an adaptive management plan would be implemented to address Project uncertainty as identified in the SEIS relative to water resources and potential impacts on the NWRs. (See Land Use and Common Wildlife sections for more details.) This environmental commitment would not fully reduce impacts from changes in Souris River flows; thus, the adverse impacts on flows and water quality would be unavoidable for alternatives that use Souris River water. Adverse impacts on the Souris River and related resources would be much greater for the inbasin alternatives than for the Missouri River and Conjunctive Use Alternative.

Water Resources – Missouri River (including Audubon Lake)

Introduction

Two of the alternatives considered would withdraw water from the Missouri River System. These withdrawals could affect the system's water resources, including system storage, reservoir levels, and dam releases. These water resources impacts are discussed in this section. Potential impacts on other related Missouri River uses and resources impacted by alternatives are discussed in the appropriate resource sections of this chapter. For example, impacts on navigation, flood control, water supply, and hydropower are addressed in the Socioeconomics section. Project water withdrawals from the Missouri River on Lake Sakakawea would affect the amount of water in the Missouri River System. To evaluate this issue, Reclamation partnered with the Corps to complete the study, *Cumulative Impacts to the Missouri River for the Bureau of Reclamation's Northwest Area Water Supply Project* (Corps 2013a), which is discussed in the Water Resources section of Chapter 3 and is included as a supporting document to this SEIS.

> **Missouri River Mainstem Reservoir System** – This term generally describes the Missouri River from the headwaters in Montana to its confluence with the Mississippi River. The system includes six mainstem dams. The proposed Project withdrawals would be on Lake Sakakawea behind Garrison Dam, located in North Dakota.

Four key issues were analyzed for the Missouri River basin:

- Missouri River System storage
- Reservoir levels
- Dam releases
- Water quality

Methods

Removal of water from the Missouri River System would result in varying levels of impacts, depending primarily on the volume of water being removed. In this SEIS, the two Missouri River alternatives were analyzed based on the Project's forecasted annual withdrawal from the Missouri River of 13,600 acre-feet (ac-ft) per year and a theoretical maximum Project withdrawal of 29,100 ac-ft per year. This maximum withdrawal analysis represents the maximum capacity of the main transmission pipeline from Lake Sakakawea to Minot. It should be noted that the transmission pipeline is sized to meet peak daily demands that occur during the summer months; however, the average annual demand would be much lower. Although the transmission pipeline would never be operated at full capacity year-round, this simulation provides an upper bound to the maximum possible Project water withdrawal from the Missouri River System.

Under the Missouri River alternatives, water would be pumped from Lake Sakakawea to meet future water supply needs in the Project area, most of which are located within the Hudson Bay basin. This transbasin diversion of water would result in no return flows to the Missouri River basin. Potential impacts of this transbasin water diversion on Missouri River resources were evaluated using the best available information regarding effects of water withdrawals on system operations.

The Missouri River System is managed by the Corps in compliance with the Master Water Control Manual (Corps 2006). The Corps uses a model (DRM) to simulate changes in operations of the Missouri River System. For evaluations in this SEIS, Reclamation provided estimates of existing and reasonably foreseeable depletions (Reclamation 2012e) and potential Project withdrawals from the Missouri River System to the Corps for input into the DRM. The DRM produces hydrologic, navigation, and hydropower outputs that were used to evaluate the relative impacts of potential changes for each simulation. Results of this analysis are documented in *Cumulative Impacts to the Missouri River for the Bureau of Reclamation's Northwest Area Water Supply Project* (Corps 2013a). Appendix D provides a summary of the step-by-step process followed by Reclamation and the Corps in conducting this analysis. Details on both Reclamation's depletion analysis and the Corps' cumulative impacts analysis of this Project can be found in their respective reports as supporting documents (Reclamation 2012e and Corps 2013a).

Five simulations of the potential changes that affect system regulation were analyzed (Corps 2013a). These simulations include (see Table 4-11):

- **Existing Conditions** – Simulation of Missouri River System operations with existing (2010) level of Missouri River depletions. Necessary for evaluating the consequences of the No Action Alternative (i.e., comparing No Action to existing conditions) and for use in Section 7 consultation under the Endangered Species Act (ESA).
- **Sedimentation 2060 –** To separate out the effects of future sedimentation and future non-Project Missouri River depletions (2010 to 2060), a simulation was run that included the effects of existing depletions and continuing sedimentation in the Missouri River System reservoirs.[2]

[2] The Corps 2060 sedimentation simulation is based on the best available information on recent and long-term changes in reservoir sedimentation that are reported in periodic Corps sediment surveys on the Missouri River reservoirs.

- **No Action** – Simulation of future (through 2060) Missouri River System operations with existing plus reasonably foreseeable future non-Project Missouri River depletions minus decreased storage capacity due to sedimentation. Reasonably foreseeable future non-Project depletions include planned/authorized projects within the basin that could withdraw water from the Missouri River or its tributaries. All action alternatives are compared to No Action as required by NEPA.
- **Average Annual Project Depletions** – Simulation of future (2060) Missouri River System operations, including existing and reasonably foreseeable future non-Project Missouri River depletions plus decreased storage capacity due to sedimentation and the average annual Project Missouri River depletions of 13,600 ac-ft (0.0136 million ac-ft [MAF]).
- **Maximum Possible Project Depletions** – Simulation of future (2060) Missouri River System operations, including existing and reasonably foreseeable future non-Project Missouri River depletions plus decreased storage capacity due to sedimentation and the maximum possible Project Missouri River depletions of 29,100 ac-ft per year (0.0291 MAF).

Table 4-11 Summary of Simulations

Simulations	Depletions and Loss of Storage Capacity
Existing Conditions	12.7 MAF/year of existing depletions
Sedimentation 2060	Existing depletions plus 2.8 MAF of anticipated lost storage capacity in 2060 due to reservoir sedimentation
No Action	13.2 MAF/year (Existing depletions **+** 0.516 MAF of reasonably foreseeable future non-project depletions)minus 2.8 MAF loss of storage capacity due to sedimentation
Average Annual Project Depletions	0.0136 MAF Project depletions **+** No Action depletions (13.2 MAF) minus 2.8 MAF loss of storage capacity due to sedimentation
Maximum Possible Project Depletions	0.0291 MAF Project depletions **+** No Action depletions (13.2 MAF) minus 2.8 MAF loss of storage capacity due to sedimentation

Note:
MAF = million acre-feet

Simulations were analyzed using the DRM and impact models to evaluate the consequences of No Action and impacts of action alternatives. The DRM simulates an 81-year historical period of 1930 through 2010. Daily inflow data for numerous Missouri River mainstem locations are available going back to 1930; therefore, this is the first year of the period for which DRM simulations were conducted. Because 2011 was a record year for runoff in the Missouri River basin, a decision was made to not include 2011 and end the period of record at 2010. Furthermore, the DRM was not developed to handle the high record flows of 2011 and would have to be modified to account for the record flows, which was not possible for this analysis. Therefore, Reclamation and the Corps agreed that the most appropriate period of record for this analysis would be the 1930 to 2010 period. For the Existing Conditions simulation, present-level depletions were used to adjust the historical flows to simulate 2010 level of development in all years. Reservoir sedimentation (i.e., decreased storage capacity), reasonably foreseeable future non-Project depletions, and Project depletions were then incrementally added in the remaining simulations to demonstrate the potential effects of each. For each simulation, the DRM routes the inflows through the Missouri River System following the criteria of the current water control plan, as outlined in the 2006 Master Water Control Manual. The hydrologic analysis (Corps

2013a) used to compare alternatives focused on three variables: *System storage, reservoir levels*, and *dam releases*.

As described in Chapter 3, the volume of water stored in the Missouri River System varies with changes in annual inflows into the Missouri River and the amount of water released from the system to meet its authorized purposes. Daily decisions regarding the operation of the Missouri River System depend on the amount of water stored in the system and the distribution of the water among the upper three, larger reservoirs. Reservoir releases are coordinated in an effort to maintain the desired level in each reservoir and to meet the flow requirements of the authorized purposes on the lower Missouri River downstream from the system. Hence, this analysis evaluates potential hydrologic changes and impacts on water resources in view of integrated system operations.

Results

Sedimentation 2060 Simulation

Reservoir sedimentation is a naturally occurring result of the creation and operations of the Missouri River System. To separate out the effects of sedimentation and reasonably foreseeable future depletions (2010 to 2060), a simulation was run that included only the effects of continuing sedimentation on the system reservoirs. In the Corps analysis (2013a), sedimentation proved to have a larger effect (although relatively minor) on the Missouri River System than future depletions, especially during drought. This small effect is because the continuing deposition of sediments into the system reservoirs would reduce the storage capacity of each reservoir, primarily in the carryover multiple use zone and the permanent pool. This would, in turn, reduce the storage capacity of the total Missouri River System.

Missouri River Storage Zones

Carryover Multiple Use Zone – largest zone, comprising 53 percent of the total storage capacity and designed to serve all project purposes through a severe drought.

Permanent Pool – the bottom 25 percent of the total storage capacity, designed for sediment storage, minimum fisheries and hydropower heads.

Exclusive Flood Control Zone – the top 6 percent of the system storage capacity used only during periods of extreme floods, evacuated as soon as downstream conditions permit.

Annual Flood Control and Multiple Use Zone – occupies 16 percent of the total storage capacity and is the desired operating zone of the system.

System Storage

From 2010 to 2060, sedimentation is projected to reduce Missouri River System storage capacity by 2.8 MAF (Corps 2013a) and reduce the top of the carryover multiple use zone to 53.1 MAF (Figure 4-30). This is a 5-percent reduction in the amount of storage capacity in the carryover multiple use zone of the Missouri River System. This sedimentation would reduce the permanent pool of the Missouri River System by almost 16 percent, resulting in a loss of flexible operating storage and increased reservoir water levels due to displacement of the water by the sediments. In general, future sedimentation would result in lower system storage in about 97 percent of the days during the 81-year period of analysis (Corps 2013a).

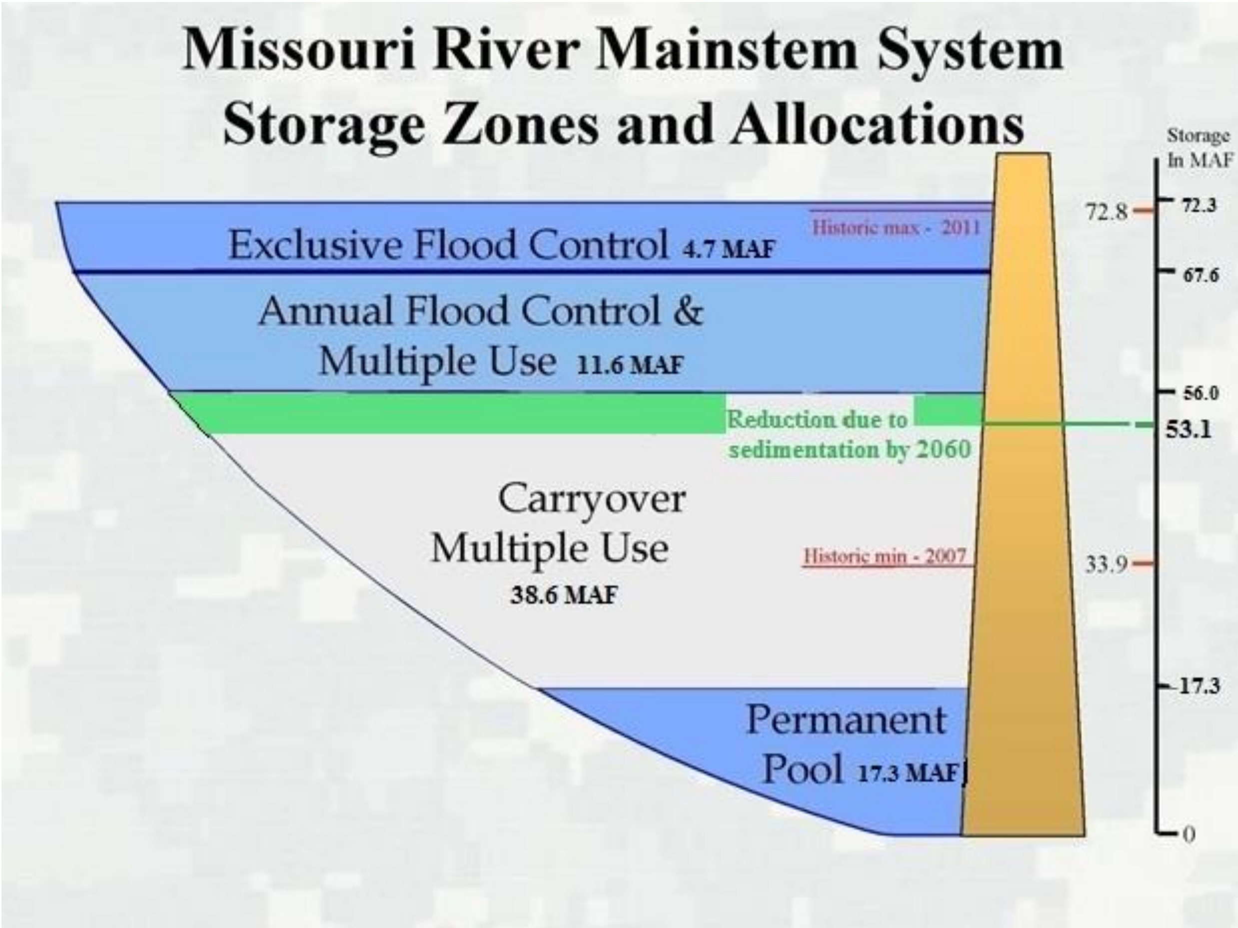

Figure 4-30 Storage Capacity Lost to Sedimentation by 2060

Note: MAF = million acre-feet

Source: Corps 2013a

> **Annual minimum system storage –** is used as a primary factor for determining releases during Corps' System operations and dictates key operating criteria such as navigation service level.

In examining a 1930s-type drought (1933 to 1943), the Corps' analysis (2013a) found that from 1933 to 1939, future sedimentation (projected by 2060) would result in lower annual minimum system storage levels than the existing conditions. This lower storage level results from sediment taking up storage capacity in the reservoirs. However, from 1940 to 1942, the system storage levels would be higher than existing conditions because the additional sedimentation would result in a non-navigation year in 1940 (Figure 4-31). This is because during the latter part of some droughts, navigation service would be suspended due to operating criteria to conserve water during drought. The suspension of navigation flows during drought would mean that these flows would be stored in the reservoirs rather than being released to serve navigation. Therefore, reservoir storage levels would increase with the savings of water.

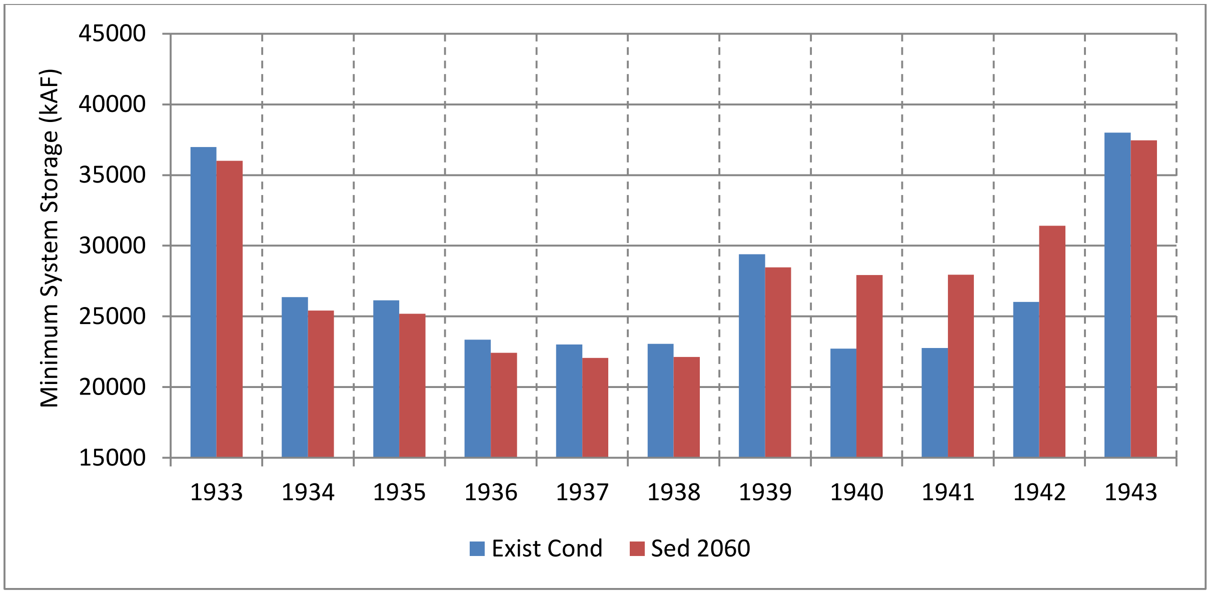

Figure 4-31 Simulated Annual Minimum System Storage Level Changes during a 1930s-Type Drought

Source: Corps (2013a)

During the 2000 to 2010 drought period, future sedimentation would result in lower minimum annual Missouri River System storage levels than the Existing Conditions simulation (Corps 2013a). Figure 4-32 shows simulated minimum annual system storage during the 2000 to 2010drought period. The Sedimentation 2060 simulation showed lower system storage than the Existing Conditions simulation for all years of this drought.

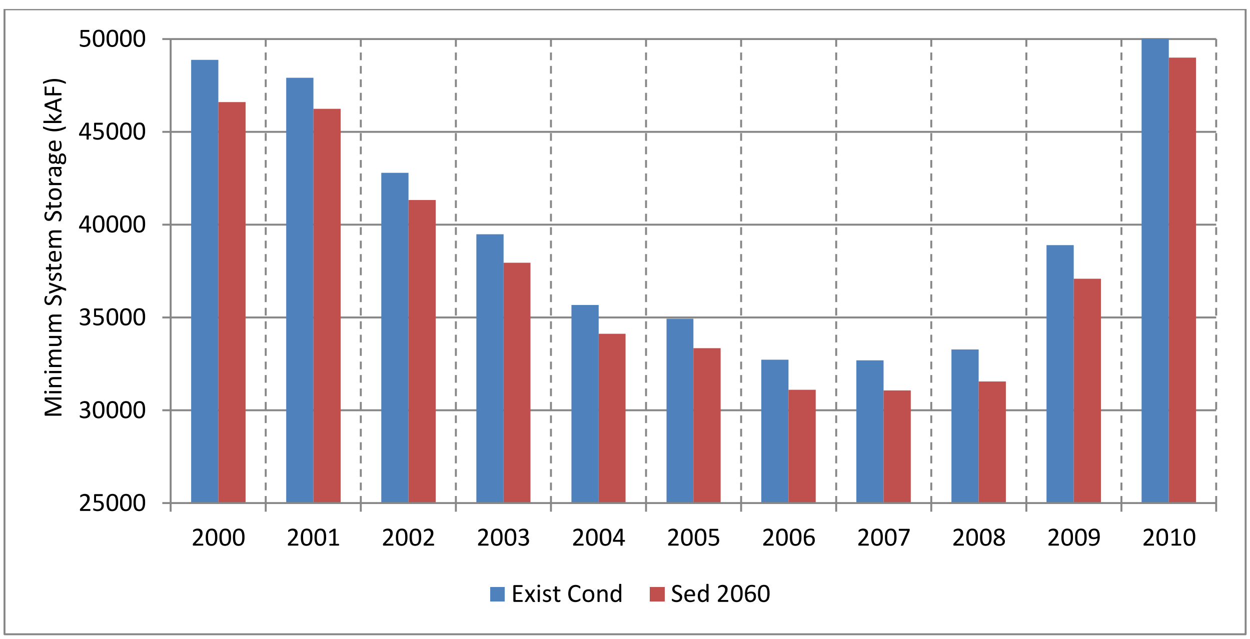

Figure 4-32 Simulated Annual Minimum System Storage Level Changes during a 2000s-Type Drought

Source: Corps (2013a)

Reservoir Levels

As sedimentation continues to cause the storage volume to decrease in the bottom two storage zones in the six reservoirs, the water surface elevations would increase in many years. Additionally, reservoir levels would be higher in some years due to decreased navigation service, because the lower system storage on March 15 (approximately 53.1 MAF in normal years) would be below the top of the service-level navigation guide curve of 54.5 MAF. This means that navigation service would be reduced from full service in more years than it would under existing conditions. This would result in slower drawdown in the April to June timeframe in many years, resulting in higher water surface elevations in Missouri River System reservoirs in those months. These increases would be primarily in the upper three, larger system reservoirs – Fort Peck, Garrison, and Oahe.

Project withdrawals under the two Missouri River alternatives would occur from Lake Sakakawea or Garrison Reservoir. For the period of record (1930 to 2010) the Sedimentation simulation showed higher daily water surface elevations at Garrison Reservoir than the Existing Conditions simulation about 80 percent of the time (Figure 4-33). The most notable differences between the two simulations occurs in the early 1940s, with Sedimentation 2060 having the higher water surface elevation (due to earlier navigation service reductions and delaying a non-navigation year near the end of the 1930s drought). Similar results were shown for Fort Peck and Oahe reservoirs.

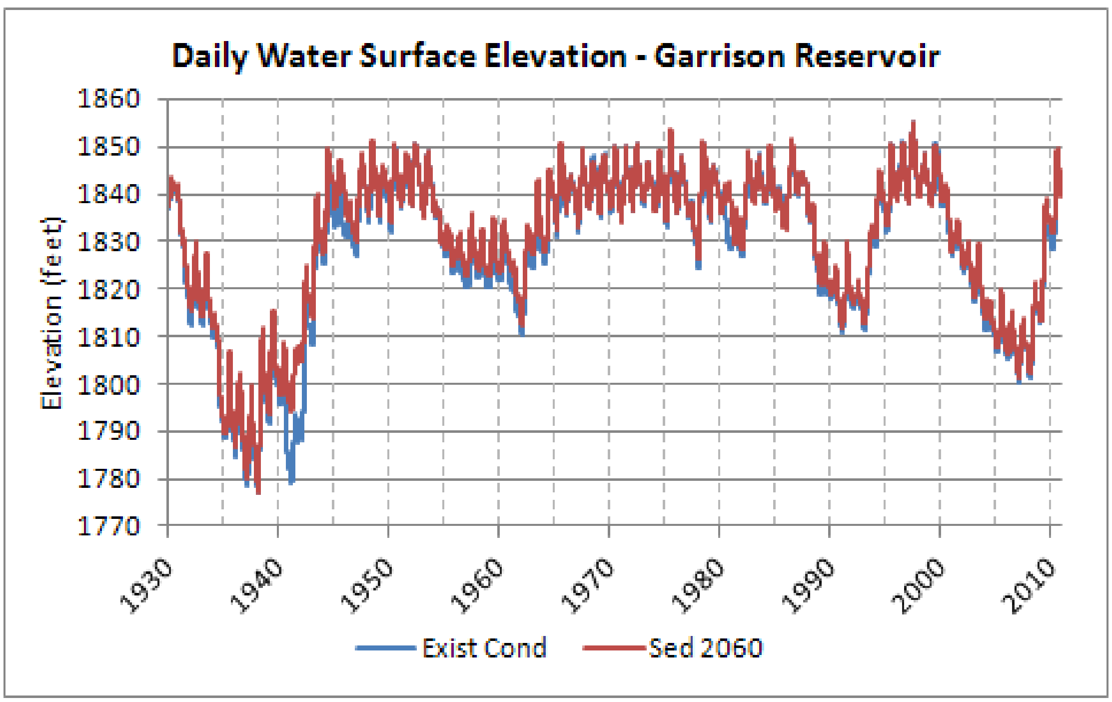

Figure 4-33 Garrison Reservoir Daily Water Surface Elevations for Existing Conditions and Sedimentation 2060 Simulations for 1930 to 2010

Source: Corps (2013a)

Minimum reservoir elevations during drought periods may affect water intakes and boat ramps. The Corps analyzed minimum reservoir levels in the upper three reservoirs during drought periods and the changes in minimum elevations at each reservoir attributable to sedimentation (Corps 2013a). Table 4-12 shows the minimum reservoir elevation differences during droughts when comparing Sedimentation 2060 and Existing Conditions simulations. Sedimentation alone (i.e., without considering the effects of future depletions) would result in higher minimum reservoir levels during droughts.

Table 4-12 Simulated Minimum Water Surface Elevations during Drought Periods (1930 – 2010)

Drought Period	Existing Conditions (ft msl)	Sedimentation 2060 (ft msl)	Difference (ft msl)
Fort Peck Reservoir			
1930s	2,163.6	2,163.7	0.1
1950s	2,201.9	2,206.3	4.4
1990s	2,203.1	2,204.4	1.3
2000s	2,189.4	2,189.4	0.0
Garrison Reservoir			
1930s	1,778.0	1,778.5	0.5
1950s	1,810.3	1,812.3	2.0
1990s	1,810.8	1,812.0	1.2
2000s	1,800.6	1,801.3	0.7
Oahe Reservoir			
1930s	1,546.2	1,546.3	0.1
1950s	1,582.9	1,586.5	3.6
1990s	1,584.9	1,586.8	1.9
2000s	1,572.9	1,574.5	1.6

Notes:

ft msl = feet, mean sea level

Minimum water surface elevation for the upper three, larger Missouri River System reservoirs during the four extended droughts between 1930 and 2010.

Source: Corps (2013a)

Dam Releases

Water releases from the six system dams would be affected by accumulating sediment. For Gavins Point Dam (the most downstream dam), differences in average monthly releases between the Sedimentation 2060 simulation and the Existing Conditions simulation would be small (mostly less than 1 thousand cubic feet per second [kcfs]), ensuring that the water required for meeting downstream navigation and flood control targets would be available (Table 4-13). The difference in average annual releases from Gavins Point Dam would be 0.02 kcfs, or less than 0.1 percent.

Table 4-13 Simulated Monthly Average Gavins Point Dam Releases (1930 – 2010)

Month	Existing Conditions (kcfs)	Sedimentation 2060 (kcfs)	Difference (kcfs)
Jan	15.00	14.53	-0.47
Feb	15.17	14.71	-0.46
Mar	18.12	17.81	-0.31
Apr	22.73	22.50	-0.23
May	27.60	27.48	-0.12
Jun	29.07	29.16	0.09
Jul	31.45	31.45	0.
Aug	33.42	33.56	0.14
Sep	32.39	33.80	1.41
Oct	30.33	31.16	0.83
Nov	24.28	24.17	-0.11
Dec	16.04	15.06	-0.98
Annual Average	**24.63**	**24.62**	**-0.02**

Note:
kcfs = thousand cubic feet per second
Source: Corps (2013a)

Summary

Reservoir storage capacity would be reduced by continuing sedimentation. Reduced storage capacity would generally result in higher reservoir levels. Sedimentation would not affect releases from the system reservoirs in most years because the same volume of water would enter the system reservoirs and would need to be evacuated to the base of flood control in normal to wet years. During droughts, minor differences in system releases would occur because the navigation service level would be reduced in the first 3 months of most drought years due to decreased system storage. Overall, the Corps analysis shows that sedimentation would have a greater effect on the system than would future depletions (see discussions by alternative below).

No Action Alternative

As noted in Chapter 2, the No Action Alternative represents future conditions in 2060 without the Project. Future population growth, irrigated agriculture growth, and additional projects withdrawing water from the Missouri River mainstem and its tributaries would result in future depletions of water in and through the Missouri River System. Missouri River depletions are expected to increase by 2060 due to increasing populations within the Missouri River basin and additional projects that would withdraw water from the Missouri River.

The No Action Alternative includes existing depletions, reasonably foreseeable future non-Project depletions, and future reservoir sedimentation (Table 4-11). The potential consequences of the No Action Alternative were evaluated by comparing the results of the No Action simulation to the results of the Existing Conditions simulation. Appendix D describes the process and analysis Reclamation used to estimate reasonably foreseeable future non-Project depletions that would peak at approximately 516 thousand acre-feet (kAF) or 0.516 MAF per year by 2060.

System Storage

The Corps makes decisions on releases from the Missouri River System based on the amount of water available in system storage. During non-drought periods, the goal each year is to have the volume of water in system storage on March 1 at the base of the flood control storage zone, which is 56 MAF under existing conditions.

Sedimentation (3-MAF decrease in storage capacity) plus reasonably foreseeable future non-Project depletions (0.516-MAF decrease in net system inflows) would result in decreased reservoir storage in the future when compared to existing conditions (Corps 2013a). The simulated average annual storage under No Action is 4.1 percent lower than under existing conditions.

During the history of record, the Missouri River System experienced 4 drought periods, including 1930 – 1940, 1950s, 1990s, and 2000s. These drought periods are identified and discussed in some of the analysis of the alternatives and how operations affect changes during these droughts.

During extended droughts, the amount of water in system storage drops well below the base of the flood control storage zone throughout the year. Minimum system storage level is especially important during drought as it is the primary factor for determining dam releases. These levels dictate key system water control or operational criteria such as navigation service level and season lengths, suspension of navigation in a given year, and effects to recreation and water supply uses on the three upstream reservoirs (see Master Water Control Manual (Corps 2006) for additional information on water control criteria). There are eight non-navigation years for the No Action simulation versus seven non-navigation years for the Existing Conditions simulation.

The Corps' analysis (2013a) found that during a 1930s-type drought (1933 to 1943), the No Action Alternative would result in lower minimum annual system storage levels than would occur under existing conditions from 1933 to 1939 (Figure 4-34). However, from 1940 to 1943, the system storage levels would be higher under No Action than under existing conditions because the loss of storage capacity due to future sedimentation would cause a non-navigation year in 1940.

For the 2000- to 2010-drought period, minimum annual Missouri River System storage was lower under the No Action Alternative than under existing conditions in 8 of 11 years. Figure 4-35 shows simulated minimum annual system storage during this drought period. In comparison, the Sedimentation 2060 simulation (Figure 4-32) showed lower system storage than the Existing Conditions simulation for all years of this drought.

From 2000 to 2007, the No Action simulation results in less Missouri River System storage than the Sedimentation 2060 simulation (Figure 4-32) because the No Action simulation also includes the reasonably foreseeable future non-Project depletions. The No Action simulation includes a non-navigation year in 2007 that does not occur under the Sedimentation 2060 or Existing Conditions simulations. As a result, the No Action simulation shows higher system storage in 2008 to 2010 than the Sedimentation 2060 and Existing Conditions simulations (Figure 4-35). The 1930s and 2000s drought periods were the most severe droughts of record in the Missouri River basin and are shown as examples. Similar results exist for the 1950s and 1990s droughts. (See Corps [2013a] for more detailed information.)

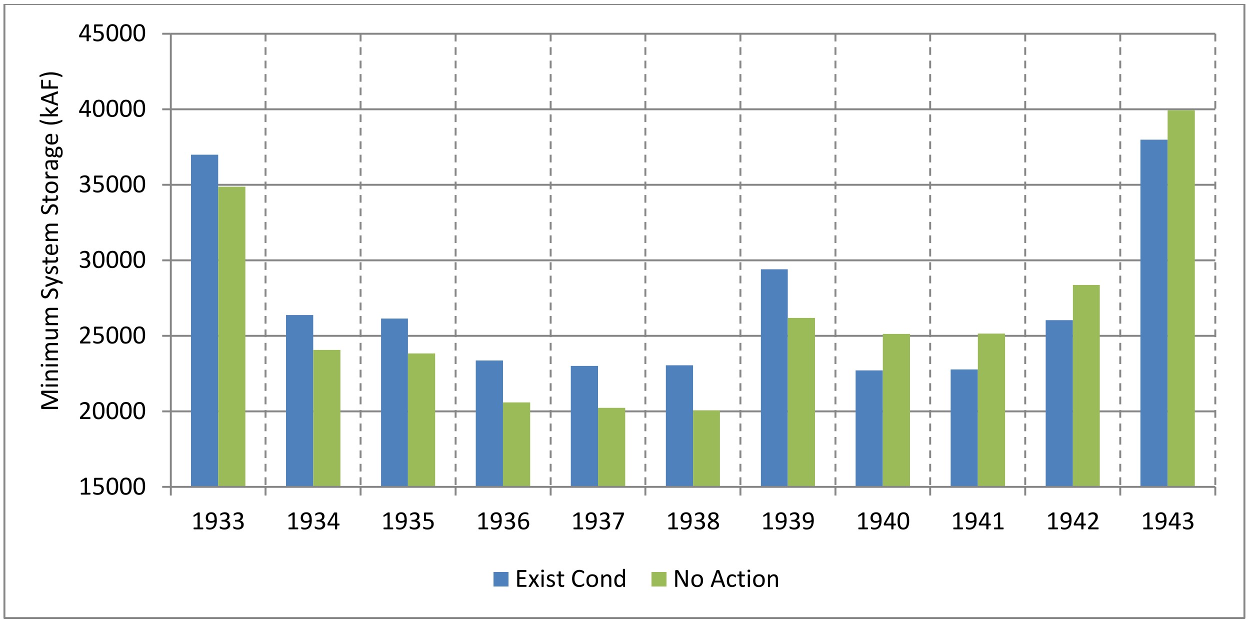

Figure 4-34 Simulated Annual Minimum System Storage Level Changes during a 1930s-Type Drought

Source: Corps (2013a)

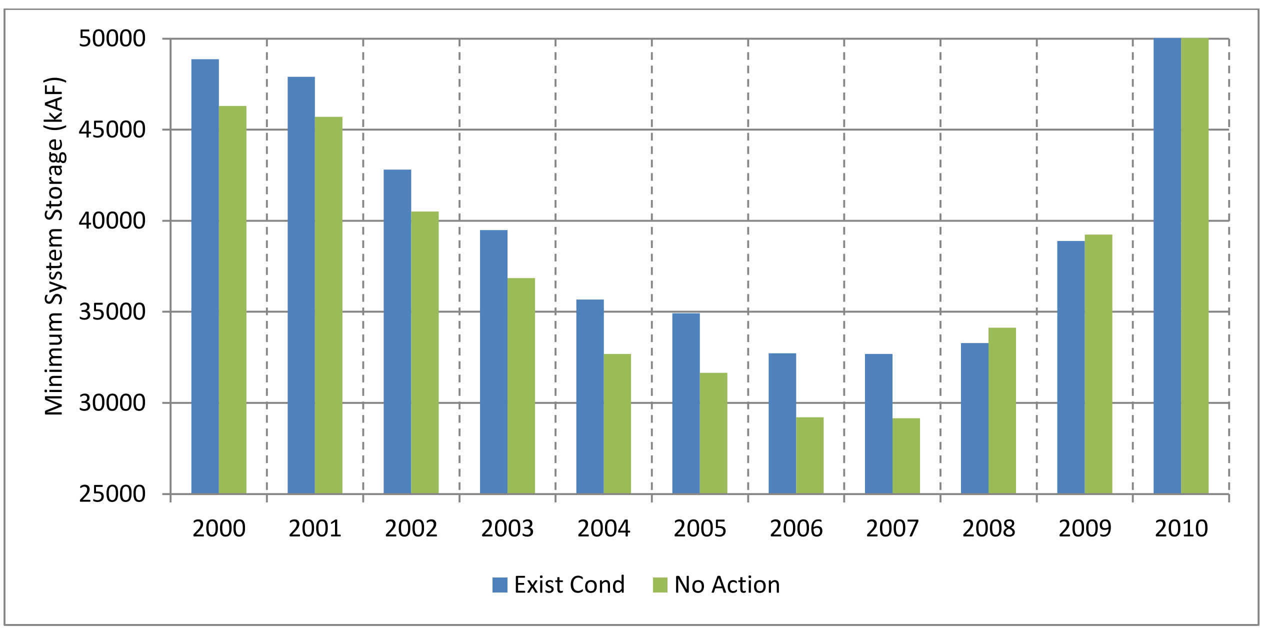

Figure 4-35 Simulated Annual Minimum Missouri River System Storage Level Changes during a 2000s-Type Drought

Source: Corps (2013a)

In summary, simulated minimum Missouri River System storage for No Action decreased by about 3.3 MAF (2.8 MAF from sedimentation and 0.516 MAF from reasonably foreseeable future non-Project depletions) compared to existing conditions. The additional depletions and sedimentation in the No Action Alternative would result in lower system storage than would occur due to sedimentation alone. The differences between the two simulations occur primarily in drought periods when the additional depletions exacerbate the drought effects. However, the incremental effects of sedimentation on system storage are larger than the effects of reasonably foreseeable future non-Project depletions. In other words, the effect of 2.8 MAF of storage loss from sedimentation would be greater than the additional effect of 0.516 MAF of reasonably foreseeable future non-Project depletions.

Reservoir Levels

Future sedimentation on the Missouri River System would generally increase reservoir water levels due to displacement of the water by the sediments. For the upper three Missouri River reservoirs (Fort Peck, Garrison, and Oahe), the daily water surface elevations for the No Action simulation were found to be generally higher (55 to 65 percent of the time) than the Existing Conditions simulation (Corps 2013a). The increase in water surface elevations would be generally less than 5 feet for most of the period of record (85 to 90 percent of the time).

However, as system storage capacity decreases, navigation service would be decreased in more years under the No Action Alternative than under existing conditions (Corps 2013a). This decrease in navigation flows to conserve system storage would result in slower drawdown in the April through July time frames in many years, resulting in higher water surface elevations in those months on the upper three reservoirs. Following drought periods like the 1930s where there would be limited to no navigation service under the No Action Alternative, the water surface elevation increases could be greater than 5 feet compared to existing conditions because additional water would be stored in the reservoirs and not released for navigation during severe drought.

To put these potential water elevation changes under the No Action Alternative in perspective, the average annual reservoir level in Fort Peck Reservoir fluctuates about 10 feet. The Garrison Reservoir water level fluctuates approximately 12 feet, and the reservoir level at Oahe Reservoir fluctuates about 13 feet. Since water surface elevations under No Action are within the range of average pool fluctuations at these reservoirs, consequences of the No Action Alternative compared to existing conditions would generally be negligible.

The Corps’ (2013a) analysis evaluated minimum water surface elevations in the upper three reservoirs during four drought periods. Table 4-14 shows the simulated minimum reservoir elevation differences during droughts when comparing the No Action Alternative to existing conditions. The changes in water elevation (increases and decreases) during drought periods reflect changes in the timing and length of navigation services levels.

Table 4-14 Simulated Upper System Reservoir Changes in Minimum Water Surface Elevations during Extended Droughts

Drought Period	Existing Conditions (ft msl)	No Action Alternative (ft msl)	Difference (ft)
Fort Peck Reservoir			
1930s	2,163.6	2,163.1	-0.5
1950s	2,201.9	2,203.6	1.7
1990s	2,203.1	2,201.6	-1.5
2000s	2,189.4	2,187.5	-1.9
Garrison Reservoir			
1930s	1,778.0	1,777.4	-0.6
1950s	1,810.3	1,810.0	-0.3
1990s	1,810.8	1,809.9	-0.9
2000s	1,800.6	1,797.6	-3.0
Oahe Reservoir			
1930s	1,546.2	1,543.1	-3.1
1950s	1,582.9	1,584.5	1.6
1990s	1,584.9	1,585.5	0.6
2000s	1,572.9	1,571.1	-1.8

Note:
ft msl = feet, mean sea level
Source: Corps (2013a)

Dam Releases

Under No Action, water releases from the six system dams would be affected by accumulating sediment, reasonably foreseeable future depletions, and lower Missouri River tributary inflows. Water releases are needed to meet lower Missouri River navigation and flood control requirements and to meet flood storage evacuation requirements from the system reservoirs as well as flow requirements on the lower river in non-navigation years. For Gavins Point Dam (the most downstream), simulated differences in average monthly releases between the No Action Alternative and existing conditions would be small (mostly less than 1 kcfs), ensuring that the water required for meeting downstream navigation and flood control targets would be available (Table 4-15). The difference in average annual releases from Gavins Point Dam would be -0.37 kcfs, or about a 1.5-percent decrease.

The analysis also found small differences in simulated annual releases from the upper three dams when comparing the No Action Alternative to existing conditions (Corps 2013a). For example, under No Action, average annual releases from Oahe Dam would be reduced by 1.6 percent due to reasonably foreseeable future non-Project depletions and future sedimentation.

Table 4-15 Simulated Monthly Average Gavins Point Dam Releases (1930 – 2010)

Month	Existing Conditions (kcfs)	No Action Alternative (kcfs)	Difference (kcfs)
Jan	15.00	14.48	-0.52
Feb	15.17	14.73	-0.44
Mar	18.12	17.74	-0.38
Apr	22.73	22.26	-0.47
May	27.60	27.21	-0.39
Jun	29.07	28.71	-0.36
Jul	31.45	30.75	-0.70
Aug	33.42	33.01	-0.41
Sep	32.39	33.45	1.06
Oct	30.33	30.55	0.22
Nov	24.28	23.56	-0.72
Dec	16.04	14.69	-1.35
Annual Average	**24.63**	**24.26**	**-0.37**

Note:
kcfs = thousand cubic feet per second
Source: Corps (2013a)

Water Quality

Water quality is one of the authorized purposes of the Missouri River System and is specifically identified in the Master Water Control Manual (Corps 2006). Most water quality impairments in the Missouri River basin result from a combination of pollutant sources and hydrologic conditions throughout the watersheds. The Corps has a water quality monitoring program to ensure that operations of the Missouri River will not contribute to water quality problems. The effects of the regulation of the system on water quality are continuously monitored to ensure that the system regulation enhances water quality to the extent reasonably possible. To the extent possible within their operating criteria (Master Water Control Manual [Corps 2006]), the Corps operates the system to assist in water quality issues that may result from climatic events such as drought. (Refer to Appendix C of the Master Manual for historical system regulation to serve the water quality purpose.) For example, the Corps may set system releases to allow downstream power plants to meet their thermal discharge permit requirements to the extent reasonably possible. Therefore, future system operations are expected, to the extent reasonably possible, to continue to meet the water quality purpose. Because the consequences of No Action on reservoir levels and dam releases would be small (as identified above), water quality is not expected to change measurably as a result of future non-Project depletions nor contribute to existing water quality issues.

Action Alternatives

Groundwater with Recharge and Groundwater with Recharge and the Souris River Alternatives

These alternatives would not use Missouri River water and therefore would not affect water quantity or water quality of the Missouri River System. The effects of these alternatives would be the same as those of No Action.

Missouri River and Conjunctive Use and Missouri River and Groundwater Alternatives

This section covers Missouri River water resource impacts from both of the Missouri River alternatives. As described in Chapter 2, these alternatives would withdraw water from both the Missouri River and Souris River Basins. The Missouri River and Conjunctive Use Alternative would withdraw water from Lake Sakakawea, the Souris River, and the Minot and Sundre aquifers. The Missouri River and Groundwater Alternative would withdraw water from Lake Sakakawea and the Minot and Sundre aquifers.

The Corps analysis (2013a) used two simulations to identify potential Project impacts on the Missouri River System: *Average Annual Project Depletions* (0.0136 MAF/year) and *Maximum Possible Project Depletions* (0.0291 MAF/year), as described in the "Methods" section above. The Corps' hydrologic analysis evaluated changes in the volume of water stored in the Missouri River System, changes in water surface elevations of the three larger system reservoirs (Fort Peck, Garrison, and Oahe), and changes in releases from Gavins Point Dam and the three larger reservoirs.

System Storage

As Missouri River flows are reduced due to depletions, the Missouri River System storage is likely to be further reduced, especially during drought periods. The Corps' analysis (2013a) of reservoir impacts is explained below for the Average Annual Project Depletions and Maximum Possible Project Depletions simulations compared to No Action. The analysis captures the range of potential effects for both Missouri River alternatives.

Average Annual Project Depletions Simulation. Due to the small volume of water (0.0136 MAF/year) for this depletion compared to No Action (13.2 MAF/year), the differences between these two simulations are very small. The 0.0136 MAF/year of Project Missouri River depletions is only 0.1 percent of total future non-Project depletions or 0.02 percent of total system storage capacity (69.4 MAF) anticipated in 2060. Differences between this simulation and No Action are highest during drought periods but are still less than 1 MAF during the 1930s, late 1980s, and early 1990s droughts (Corps 2013a). These droughts had their greatest effect in 1944 and 1998, high inflow years that extended the navigation season resulting in greater drawdowns of storage.

As discussed above, minimum annual storage is a useful metric for evaluating potential drought impacts. For the 1930s drought, the Corps' analysis (2013a) found that average annual Project depletions would have very little effect on minimum storage levels (Figure 4-36).

Maximum Possible Project Depletions Simulation. Due to the small volume of water (0.0291 MAF/year) for this depletion compared to No Action (13.2 MAF/year), the differences between these two simulations are very small. The 0.0291 MAF/year of Project Missouri River depletions used for this simulation is only 0.2 percent of total future non-Project depletions or 0.04 percent of total system storage capacity (69.4 MAF) anticipated in 2060. The differences between system storage for No Action and this simulation are less than 0.3 MAF for two of the four extended droughts in the period of analysis. Slightly larger differences occurred in 1944 and 1998 and the subsequent storage recovery periods, as discussed above for the Average Annual Project Depletions simulation. Overall, differences between this simulated depletion and No Action are negligible (Corps 2013a).

For the 1930s drought, the Corps' analysis (2013a) found very little difference in minimum annual storage between No Action and this simulation (Figure 4-36).

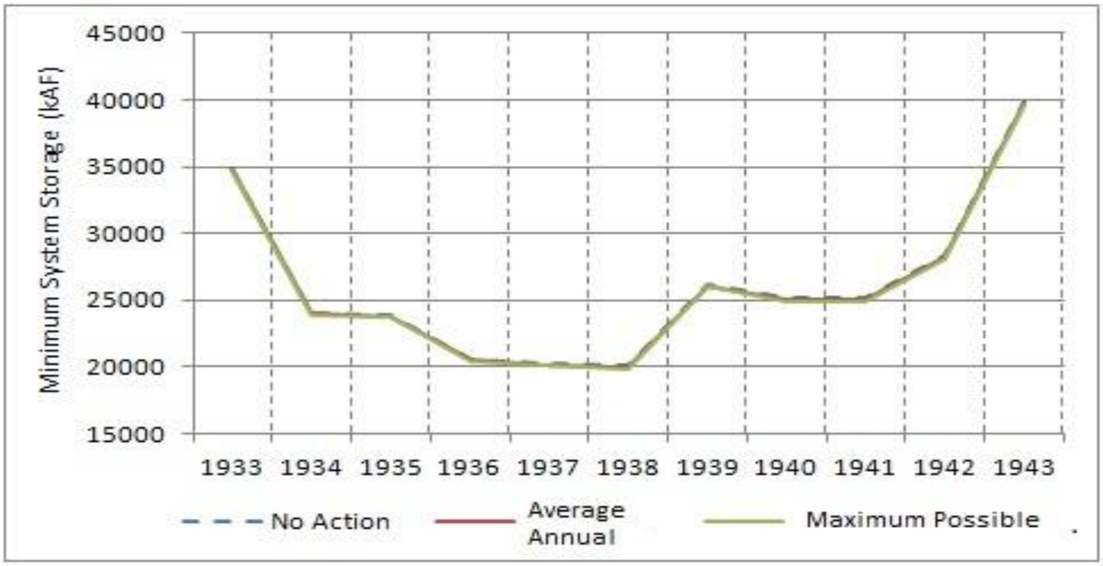

Figure 4-36 Annual Minimum System Storage Levels for the No Action and Action Simulations (1933 – 1943)

Source: Corps (2013a)

Reservoir Levels

Because the Project would withdraw water from Lake Sakakawea and transport it out of the Missouri River basin, each acre-foot of water removed from Lake Sakakawea for the Project would be an acre-foot of depletion. Because Project Missouri River depletions from the alternatives that withdraw water from Missouri River basin would be a very small percentage of total future depletions, effects on reservoir surface elevations would be very small.

Average Annual Project Depletions and Maximum Possible Project Depletions Simulations. For the upper three Missouri River reservoirs (Fort Peck, Garrison, and Oahe), the water surface elevation differences for the two Project simulations and the No Action simulation were small (Corps 2013a). For Garrison Reservoir, the elevation difference was within plus or minus 1 foot for 95 percent of the historical record, with an average difference over the period of analysis of -0.007 ft (less than 0.1 inch) for the Average Annual Project Depletions simulation. Figure 4-37 shows the differences in Garrison Reservoir elevations between the two Project simulations and the No Action simulation.

Dam Releases

The Corps analysis (2013a) demonstrated that Project depletions from the Missouri River alternatives would have very little effect on dam releases. Figure 4-38 shows average monthly Gavins Point Dam releases for No Action and two Project simulations. Differences in average monthly releases are negligible. Similarly, differences in average annual releases from Fort Peck, Garrison, and Oahe dams would all be less than 0.2 percent, again negligible.

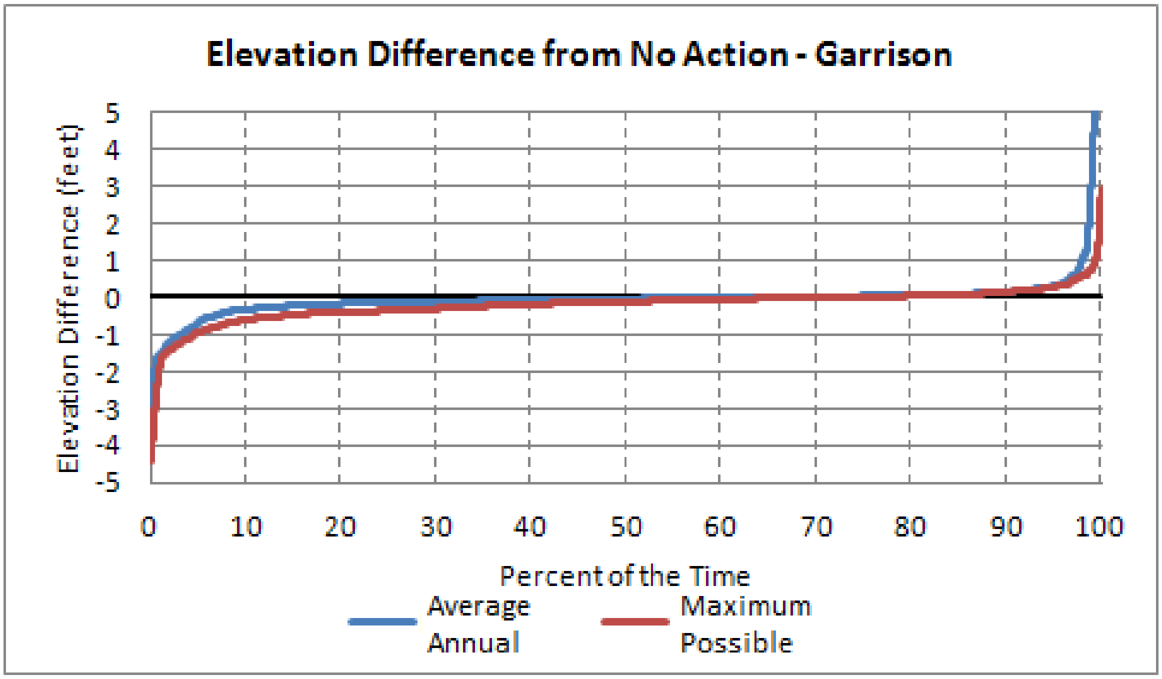

Figure 4-37 Garrison Reservoir Sorted Daily Water Surface Elevation Differences Comparing Missouri River Simulations to No Action

Source: Corps (2013a)

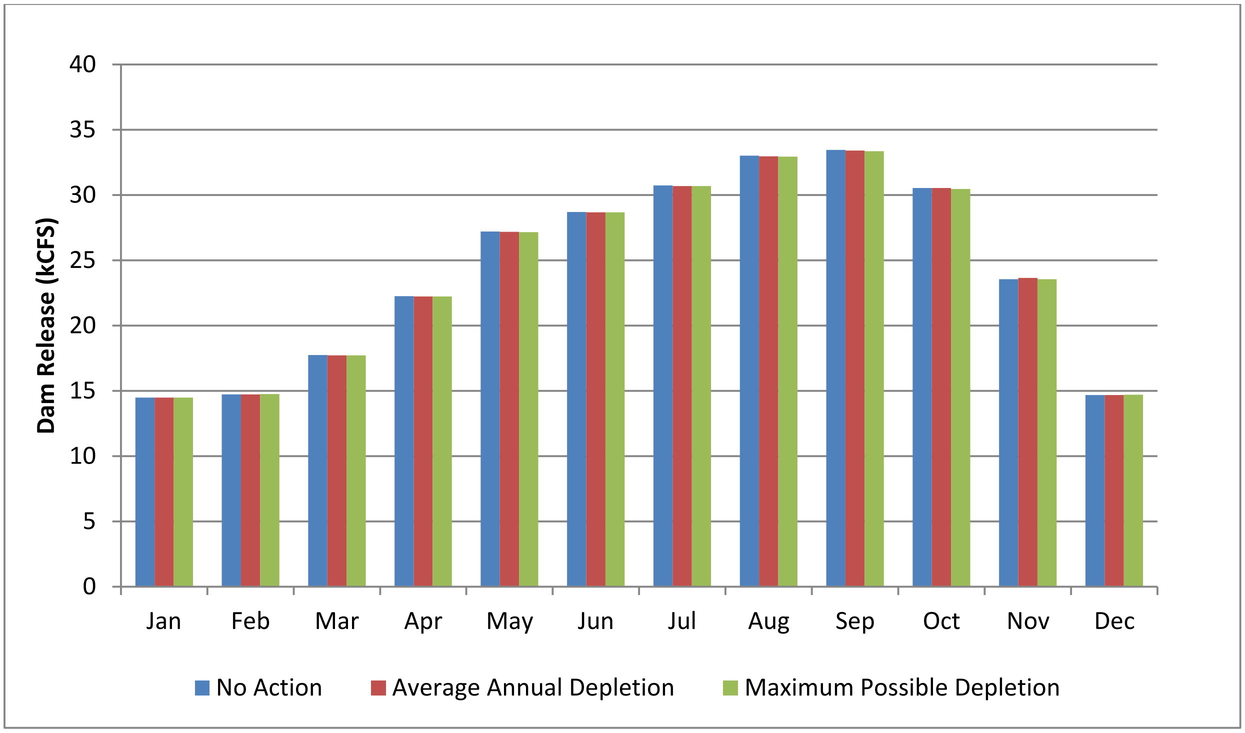

Figure 4-38 Average Monthly Gavins Point Dam Releases for No Action and Two Project Simulations

Source: Corps (2013a)

Water Quality

Water quality is one of the authorized purposes of the Missouri River System and is specifically identified in the Master Water Control Manual (Corps 2006). Most water quality impairments in the Missouri River basin result from a combination of pollutant sources and hydrologic conditions throughout the watersheds. The Corps has a water quality monitoring program to ensure that operations of the Missouri River will not contribute to water quality problems. The effects of the regulation of the system on water quality are continuously monitored to ensure that the system regulation enhances water quality to the extent reasonably possible. To the extent possible, within their operating criteria (Master Water Control Manual [Corps 2006]), the Corps operates to assist in water quality issues that may result from climatic events such as drought. (Refer to Appendix C of this document for historical system regulation to serve the water quality purpose.) For example, the Corps may set system releases to allow downstream power plants to meet their thermal discharge permit requirements to the extent reasonably possible.

It is recognized that Lake Sakakawea can experience algal blooms during low reservoir conditions. Figure 4-39 shows the relationship of No Action and the effects of Project withdrawals for the two Project simulations during a 1930s drought on Garrison Reservoir (Lake Sakakawea) water levels. As shown, the impact of such withdrawals even during drought is very small when compared to No Action. Therefore, future system operations are expected, to the extent reasonably possible, to continue to meet the water quality purpose. Because the impacts of the reservoir levels and dam releases would be small (as identified above) for the two Missouri River simulations evaluated, the water quality for the Missouri River alternatives compared to

No Action is not expected to change measurably as a result of future non-Project depletions or contribute to existing water quality issues.

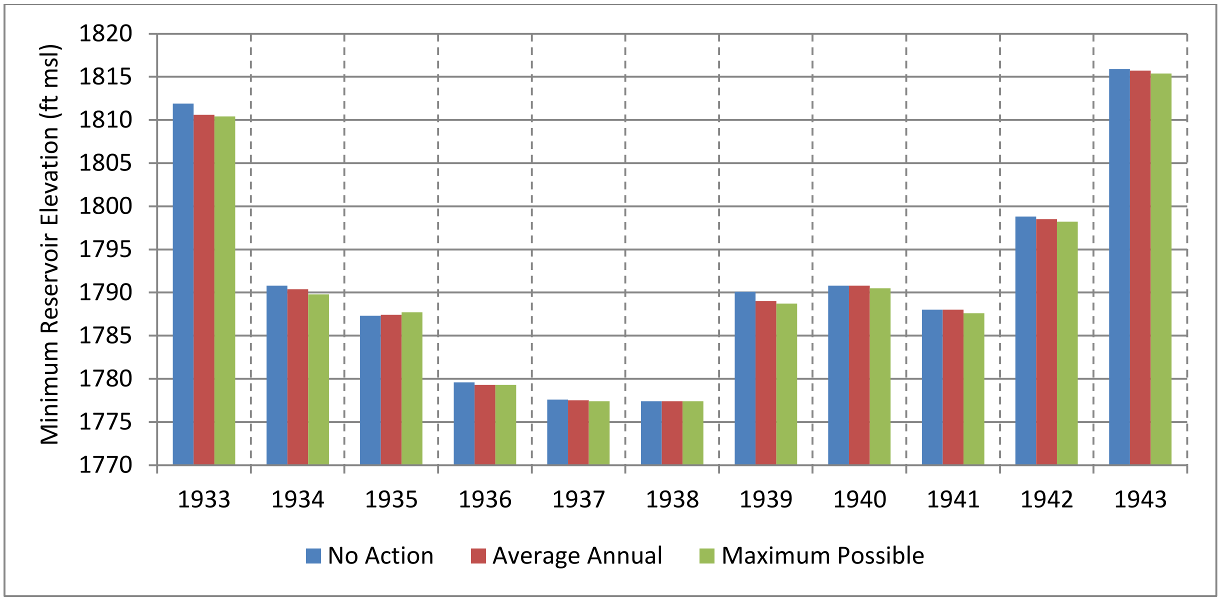

Figure 4-39 Garrison Reservoir (Lake Sakakawea) Minimum Annual Water Levels for No Action and Two Project Simulations during a 1930s Drought

Impacts of intake construction on the water quality of Lake Sakakawea would be temporary and minor. The construction methods selected for this component were chosen, in part, because they eliminate the need for handling and suspension of organic lake sediment in an aquatic environment. Thus, no adverse effects on water quality are expected to occur from the temporary and localized increased turbidity, release of possible contaminants, or release of nutrients.

Audubon Lake

Construction of either intake option could temporarily affect operations of the Snake Creek Pumping Plant (SCPP), which is used to manage Audubon Lake levels. An environmental commitment is noted below and in Appendix F that would avoid construction activity affecting water levels at Audubon Lake.

Environmental Commitments

The following environmental commitment would be implemented during construction if needed (refer to Appendix F for a complete list of environmental commitments):

- Project construction would be coordinated with operation of the SCPP, especially during filling of Audubon Lake.

Cumulative Effects

Cumulative effects were accounted for in the analysis of Missouri River water resources by including existing depletions, reasonably foreseeable future non-Project depletions, and future reservoir sedimentation in the No Action Alternative. Details on this analysis can be found in Appendix D and in the Corps analysis (2013a). The Groundwater with Recharge Alternative and the Groundwater with Recharge and the Souris River Alternative would have no cumulative effects on Missouri River water resources because they do not withdraw any water from the Missouri River. The Missouri River and Conjunctive Use Alternative and the Missouri River and Groundwater Alternative would have negligible effects on Missouri River water resources when compared to No Action. For these alternatives, annual Project Missouri River depletions would be less than 0.2 percent of total future annual depletions.

Climate change could have a cumulative effect on Missouri River System operations by altering the timing and magnitude of runoff. About 75 percent of the climate projections analyzed would result in increased runoff in the Missouri River basin, which would generally increase streamflow and reservoir levels.

Summary

Under the No Action Alternative, continuing deposition of sediments into the Missouri River System reservoirs would reduce the storage capacity of each reservoir, primarily in the carryover and multiple use zone and the permanent pool. This would, in turn, reduce the storage capacity of the total system out to 2060. Sedimentation would have essentially no impact on releases from the system reservoirs in most years because the same volume of water would enter the system reservoirs and would need to be evacuated to the base of flood control in normal to wet years. Future reasonably foreseeable non-Project depletions under the No Action Alternative would reduce inflows to the system reservoirs and the lower Missouri River and are forecasted to reach 0.516 MAF by 2060. These depletions would reduce the amount of water in system storage, especially during extended droughts. This reduction in system storage would generally result in lower water surface elevations during droughts in each of the three, larger system reservoirs (Fort Peck, Garrison, and Oahe) as the depletions continue to accumulate each year. Finally, releases from the system reservoirs would be reduced due to the increase in non-Project depletions, with the amount of release reductions being nearly equivalent to the amount of the cumulative new future depletions above each reservoir.

For the Missouri River and Conjunctive Use and Missouri River and Groundwater alternatives, the amount of potential Project depletions is very small (0.0136 – 0.0291 MAF) compared to existing and reasonably foreseeable future non-Project depletions (13.2 MAF). Consequently, the effect of Project depletions under the two Missouri River alternatives compared to No Action would be negligible. Figure 4-40 provides perspective on the relative size of the Missouri River System compared to potential Project depletions.

Audubon Lake is not a source of water for any of the alternatives; therefore, effects on water quantity would not occur. Because the intake options for the two Missouri River alternatives involve construction activities on Lake Sakakawea, environmental commitments have been designed to minimize any effects of the SCPP operations on Audubon Lake.

Because the effects of Missouri River alternatives on Missouri River water quantity would be negligible, no measurable water quality impacts of proposed Missouri River alternatives would be expected. Impacts on water quality from construction activities would be minimized and/or avoided by the implementation of BMPs identified in Appendix F.

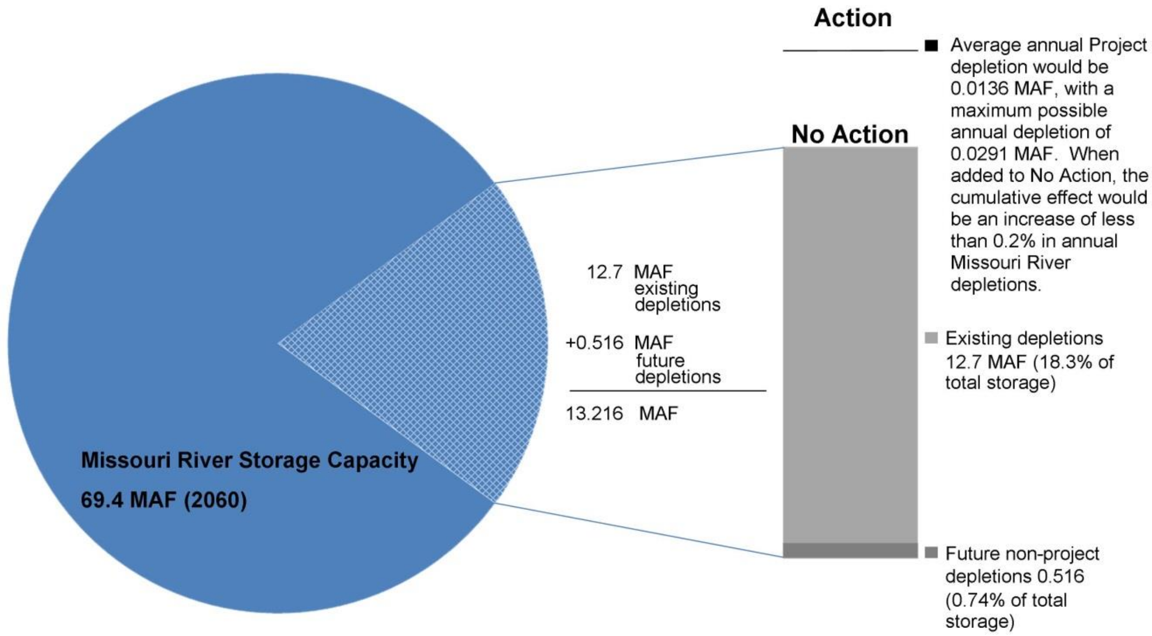

Figure 4-40 Comparison of Potential Project Depletions, Non-Project Depletions, and Missouri River System Storage Capacity

Fisheries and Aquatic Invertebrates

Introduction

This section addresses the potential for temporary and permanent impacts on fish, invertebrates, and their habitat from implementation of the action alternatives, as well as potential consequences for these resources under the No Action Alternative. Temporary impacts could result from construction activities, although the type of impacts that would occur would depend on the types of construction practices used and the proximity of Project components to aquatic resources. For example, construction activities such as installation of new buried pipelines could have temporary impacts on aquatic habitats through runoff of sediments from disturbed soils if they were located near waterbodies, but placement of pipelines under aquatic habitats through use of horizontal directional drilling would have minimal to no effects on the habitat unless an accident occurred. Permanent impacts could result from the construction and operation of intakes on the Souris River or Lake Sakakawea or from changes in river flows, water quality, and aquatic habitat due to water withdrawal. Impacts on wetlands and riparian areas are discussed in the Wetlands and Riparian Areas section in this chapter, but impacts on aquatic species using such areas are addressed in this section. Impacts on all protected species, including aquatic species, are addressed in the Federally Protected Species section. Impacts on fish associated with aquatic invasive species (AIS) are addressed in the “Aquatic Invasive Species” section.

For the Missouri River System, releases are dependent on a variety of factors, including downstream flow targets for flood control, navigation, water supply, water quality, hydropower requirements, recreation, fish and wildlife, and intrasystem balancing for all authorized purposes. The mainstem projects are operated as an integrated system to achieve the multipurpose benefits for which they were authorized. The Master Water Control Manual (Corps 2006) requires the Corps to operate the Missouri River for authorized project purposes, including fish and wildlife. Declining water levels of the reservoirs are a concern to many Missouri River System users interested in the reservoir fishery; however, some fluctuation in the reservoir levels is unavoidable if the reservoirs are to serve all of the authorized purposes. A continuing objective in regulation of the Missouri River System is to minimize changes in reservoir levels from normal, full multipurpose levels to the maximum practical extent consistent with regulation for other authorized project purposes. The maintenance of relatively uniform release rates during certain times of the year is also an environmental objective to benefit certain riverine species during their spawning period. Missouri River System regulation has reduced high flows and supplemented low flows that still naturally occur on the Missouri River. Establishment of minimum releases and steady-to-rising pools during the spring months has been recognized since the 1950s as beneficial for successful fish spawning and hatching. Release rates have been established for Fort Peck, Garrison, Oahe, Fort Randall, and Gavins Point dams for fish management.

Methods

The potential consequences for fish and aquatic invertebrates under the No Action Alternative were assessed qualitatively, based largely on the analysis of potential changes to hydrology, habitats, and water quality presented in the Water Resources and Wetlands and Riparian Areas sections in this chapter.

A GIS analysis was conducted using hydrographic data obtained from the national hydrography dataset (USGS 2013a) to determine which Project components would be constructed within or near streams and lakes. Stream crossings, crossing methods, and construction and operation actions for each alternative were identified to estimate the potential for impacts from these crossings. The footprint of construction areas near aquatic habitats and the footprint of the actual structures in the water also were used to assess impacts on aquatic habitats. The potential for BMPs and environmental commitments listed in Appendix F to minimize or avoid such impacts on aquatic habitats and species using these habitats was then considered.

Impacts on fish and invertebrates were assessed based on the extent and duration of Project effects on rivers, lakes, wetlands, and riparian areas; the timing of these impacts; the species and life stages of fish and aquatic invertebrates likely to inhabit these areas at the time of impact; and studies on responses of these organisms to changes in physical and chemical characteristics of their habitat. Life histories were also reviewed. Life history information was evaluated against habitats known to be present in the Project Area.

For the Missouri River, impacts on fish and aquatic invertebrates were assessed based on the effects of Project depletions on reservoir levels and dam releases. The Corps report, *Cumulative Impacts to the Missouri River for the Bureau of Reclamation's Northwest Area Water Supply*

Project (Corps 2013a), simulated existing operations of the Missouri River System and future operations with and without Project depletions.

Results

No Action Alternative

The extent of potential consequences for fish and aquatic invertebrates from actions taken by Project members under the No Action Alternative cannot be assessed quantitatively, as discussed in the introduction to this chapter. Should construction occur in proximity to waterbodies, impacts could occur, but whether such construction would occur is speculative, as is the location of any such construction and the construction methods that would be followed. Other consequences associated specifically with the Souris River and Missouri River are discussed below.

Souris River Basin

The Souris River is not currently fed by groundwater from the Minot and Sundre aquifers. (See the "Water Resources" section.) Therefore, the wetlands and aquatic habitats in and around the Souris River would not be affected by continued withdrawals and further declines in groundwater levels, and fish and invertebrates relying on these habitats would not be affected. Changes in wetland and riparian communities are further discussed in the Wetlands and Riparian Areas section in this chapter.

Flows and water quality in the Souris River would not be measurably changed under the No Action Alternative, and effects on fish and aquatic invertebrates would continue as has occurred since the aquifer levels declined. Effects of existing low flows on water quality and aquatic organisms, including periodic fish kills, would continue to negatively affect the fish and aquatic resources of the Souris River as they do presently, as described in the Water Resources section. (Refer to the Water Resources and Fisheries and Aquatic Invertebrates sections of Chapter 3 for additional discussion of fish kills.)

Missouri River

The Corps would continue to operate the Missouri River System to meet the fish and wildlife purposes. The No Action Alternative includes existing depletions, reasonably foreseeable future non-Project depletions, and future reservoir sedimentation. (See the Water Resources section.)

Reservoir Levels

The ability of fish to reproduce and develop in the Missouri River System is related to water levels and releases during the spawning period, although a good fish spawn is not necessary each year to maintain the fishery resource in a specific reservoir. Fish managers seek to provide conditions most suitable for fish spawning in all system reservoirs at appropriate times. The Corps generally operates the Missouri River System by maintaining steady-to-rising reservoir levels in the spring with declining reservoir levels after releases of navigation flows. In most years, one of the three upper reservoirs is favored specifically for fish management with no declines during the spawning season. Aquatic invertebrates also may be affected by changes in reservoir levels and dam releases. Declining reservoir levels or dam releases can leave invertebrates buried in substrates high and dry as water levels recede.

For the upper three Missouri River reservoirs (Fort Peck, Garrison, and Oahe), the modeled water surface elevations are generally higher under No Action than existing conditions (Corps

2013a), with an average increase of 0.6 feet to 1.0 feet. Since water surface elevations would be higher under No Action (including sedimentation and potential future depletions) than existing conditions, this would generally benefit fish and aquatic invertebrate management. It also is anticipated that the Corps will continue to manage operations in the reservoirs in cooperation with state game and fish agencies to benefit reservoir fish to the extent practicable under the No Action Alternative.

Dam Releases

The Corps analysis (2013a) comparing No Action to existing conditions found that the differences in annual releases from the upper three dams would be small (mostly less than 1 kcfs). Consequences to fish and aquatic invertebrates therefore would be small and likely not measurable as a result of the small change in dam releases.

Water Quality

In general, water quality on the Missouri River System is good (Corps 2007), with occasional water quality issues attributable to system regulation and other issues that are largely due to non-system pollution sources (e.g., agricultural runoff). Changes to reservoir levels and dam releases due to accumulating sedimentation and future non-Project depletions would be small, as described in the Water Resources section, and would not likely result in water quality changes that would affect fish and aquatic invertebrates. Potential changes in water quality from factors unrelated to system regulation (e.g., agricultural runoff) are unknown.

Action Alternatives

Impacts related to construction and operation of the bulk distribution pipelines, which would cross surface waters and therefore could affect fish and aquatic invertebrates, would be identical for all of the action alternatives. The inbasin alternatives would also require stream crossings during construction of the collector lines and would require two new intakes on the Souris River. The Missouri River alternatives would require a new intake at Lake Sakakawea, which could cause impacts during construction and operation. To minimize impacts on fish from operation of the intakes, the size of the screen openings, intake velocities, and their depths would be designed to meet Service and North Dakota Game and Fish Department (NDGFD) recommendations (Appendix F). All other Project components would avoid surface waters and wetlands.

Project operations that involve the withdrawal of river water have the potential to affect aquatic habitats and aquatic species. The magnitude of these impacts is different for each alternative, and they are discussed below.

Recharging the Minot and Sundre aquifers would not directly affect aquatic habitats, as discussed in the Water Resources and Wetlands and Riparian Areas sections in this chapter, and therefore would not affect the species that use them.

BMPs that would avoid or minimize impacts on aquatic habitats and species are included in the General, Surface Water, Water Quality, Aquatics, Wetlands/Riparian Areas Vegetation, and Land Use categories in Appendix F.

Pipeline Construction

Construction impacts would be avoided where feasible because wetlands, riparian areas, and other sensitive areas would be avoided to the extent practicable. Nonetheless, a total of 29 intermittent and perennial stream crossings would occur for bulk distribution pipeline and connector line upgrade construction under the inbasin alternatives. The number would be reduced to 23 for the Missouri River alternatives. Each of these would be crossed using horizontal directional drilling if feasible, and drilling under these streams would avoid physical disturbance of the stream bed and banks; however, drill fluids (muds and additives) have the potential to enter the water if accidents occur during the drilling process. Drill fluid releases would cause turbidity plumes that settle slowly due to the fine texture of the muds, and chemical additives in the muds may be toxic to aquatic organisms. Fuels, lubricants, and other materials toxic to aquatic organisms would also be used at the stream crossing sites; and accidental spills could reach aquatic habitats, even if no water were present at the time of the spill. However, adverse impacts would be avoided by implementing a hazardous spill plan or spill prevention, control and countermeasures plan, whichever is appropriate, as noted in Appendix F under Hazardous Materials.

Contractors would be required to make least two boring attempts before using an alternate stream or river crossing method, and most, if not all of these, likely would be crossed using horizontal directional drilling. However, open trench methods may be required if the boring attempts are unsuccessful. For streams with water present, trenching would require water diversion and probably dewatering of the trench. This would cause temporary disturbances of the streambed and banks, and some suspension of sediments that would settle out downstream. Sediment deposition could bury benthic (bottom-dwelling) invertebrates, and suspended sediment could affect the gills of fish and invertebrates. Eggs of fish and invertebrates attached to the substrate or submerged vegetation could be smothered by sedimentation or lost due to dewatering if the crossings were made during fish spawning or invertebrate egg-laying times.

Construction and sedimentation effects are expected to be temporary and localized, and would be minimized by the use of BMPs for stream crossings; therefore, no substantial impacts on aquatic organisms would be expected.

Trenching across streams that are dry would temporarily disturb the bed and banks, but no turbidity or sediment deposition would occur at that time. When flow returns to the stream, disturbed sediments could be suspended, with short-term impacts similar to those described above for flowing streams. Instream flows also would be maintained if streams were being crossed by open trench during construction, and crossings would be routed to minimize disturbance to the extent practicable.

Other BMPs would be implemented to further minimize potential impacts on aquatic habitats and species. Intermittent streams would be crossed only during low-flow periods, and preferably when they were dry. In order to avoid impacts on fish, any stream that was identified as a fishery stream by the NDGFD (1978 map) or as Class II or higher waters (NDDH 1999) and that could not be directionally drilled would be avoided from April 15 to June 1. Any temporary disturbances to streams would be repaired following construction by restoring previous elevation contours, compacting trenches sufficiently to prevent drainage along the trench or bottom seepage, salvage and replacement of topsoil, backfill in a manner such that the stream is not drained, and reestablishing streams to a similar type and function as prior to construction. Riparian areas also would be replanted in order to control erosion. Additionally, all construction waste materials and excess fill would be disposed of in upland, non-wetland areas.

In order to protect water quality, which also would protect habitat for aquatic species, a stormwater pollution prevention plan would be developed before construction that would include erosion control measures to prevent sediment runoff and turbidity. If the banks and beds of waterways were required to be disturbed, they would be protected by rock riprap to minimize erosion and scour.

To minimize the potential for impacts from the introduction of AIS, all equipment that previously had been used in a waterbody that was jurisdictional under the Clean Water Act or in a waterbody that was designated as infested by the NDGFD would be disinfected.

Planned Water Releases during Pipeline Construction and Maintenance

The new pipelines would need to be hydrostatically tested and disinfected prior to use for delivery of potable water. The water from the hydrostatic test and disinfection would be released from the pipeline. This could adversely affect aquatic organisms through altered water quality if the release was into existing surface waters; however, such impacts would be minimized because all requirements imposed by permits issued in compliance with the Clean Water Act would be met (Appendix F, General BMPs).

Operation and maintenance of water pipelines also periodically requires draining a portion of the line for inspection and possible repairs to maintain integrity of the pipe. Water is discharged from blowoffs located in topographically low areas, frequently at or near streams. Water treated to drinking water standards contains disinfectants that are toxic to aquatic organisms, and release of treated water into surface waters has the potential to affect fish and invertebrates. Disinfectants are rapidly removed from water that contacts natural stream water containing organic matter so that the effect would be over a small area for a short period of time (duration of release) and would occur infrequently. Moreover, all requirements imposed by permits issued in compliance with the Clean Water Act would be met (Appendix F, General BMPs); thus, adverse impacts on fish and invertebrates would not occur.

Construction and Operation of Intakes

Construction of new intake structures in the Souris River for both of the inbasin alternatives and in Lake Sakakawea for the Missouri River alternatives would result in temporary disturbance of aquatic habitats within the construction area footprint (approximately 1 acre for each of the Souris River intakes and 1 acre or less for the Missouri River intake) and in the surrounding water over the area that turbidity and sedimentation occur. The intake pipe and screen structures would cause a small (less than 1 acre), permanent loss of aquatic habitat at each intake location.

To minimize impacts on fish from operation of the water intakes, the size of the screen openings, intake velocities, and their depths would be designed to meet Service and NDGFD recommendations. Operation of the intakes could entrain fish eggs and larvae, however, as well as aquatic invertebrates that can pass through the intake screens. The Souris River intakes would be operated from March through August, which includes the spawning season for most fish. Since many of the fish species that inhabit the Souris River and Lake Sakakawea have demersal eggs (attached to the bottom or objects in the water column) or spawn in nests, impacts would be expected to be low. However, larval and early juvenile fish have poor swimming abilities and may be entrained with the withdrawn water. Aquatic invertebrates other than zooplankton are primarily benthic; therefore, few would be entrained under most conditions, with minimal effects on productivity or food availability for fish that prey on these organisms.

The magnitude of the potential entrainment effects from operation of the intakes would vary by the amount of water taken in each alternative, although the same types of impacts would occur.

Groundwater with Recharge Alternative

Souris River

Construction impacts on the 22 intermittent and 7 perennial streams crossed by pipelines would be as described above under Action Alternatives. No permanent effects on fish and aquatic invertebrates are expected from pipeline construction and operation. The types of temporary impacts that would result from construction and operation of the intakes on the Souris River would be as described above.

Withdrawal of surface water from the Souris River to recharge the aquifers would, during certain flow levels, have an adverse effect on aquatic habitats and species within the bed and banks of the river downstream of the withdrawal points in Minot. Such impacts would occur primarily during low-flow periods, which can occur within the withdrawal period of March through August, particularly in normal to dry years. Project-related reduced flows would affect aquatic habitat diversity, reduce water velocities, and alter habitat features preferred by certain species. In wet years, withdrawals would have minor effects on flows in the river, and therefore on fish and aquatic resources, from May through August, but could substantially reduce flows in March. (See the Water Resources section.)

In years of normal flow (median flows) or low flow, water withdrawals would reduce flows substantially (up to 100 percent) during much to all of the withdrawal period (March through August). The average number of near-zero flow days per year would increase from 26 days for the No Action Alternative to 103 days for this alternative. (See the Water Resources section in this chapter for more details on flow alterations due to withdrawals.) It should be noted that even though flows do not typically go to zero under average conditions under the No Action Alternative, flows can be very low (less than 1 cfs) for weeks at a time. (See Table 4-5 in the Water Resources section for more details.) An increase in the number of near-zero flow days would increase the potential for fish kills and would reduce the abundance of aquatic invertebrates used as food by fish and birds. If near-zero flow days were interspersed with flow days, invertebrates would have difficulty recolonizing the exposed river bed in the short intervals between near-zero flow events.

Low-flow events occur regularly and periodically under existing conditions with sometimes adverse effects on aquatic habitat structure and quantity as well as water quality. Water withdrawals for this alternative would increase the frequency and duration of these events downstream of the intake locations in March through August.

Reduced flow in the river under dry and normal conditions would expose varying amounts of the riverbed and banks used by aquatic invertebrates and fish for spawning during the warmer, more productive months. For invertebrates that are not very mobile, exposure would increase predation by birds and mortality from desiccation. The amount of suitable habitat remaining would be reduced. Fish and mobile invertebrate species could move to remain in the water, but increasing their density could result in additional stress and reduced carrying capacity of the remaining habitat. Respiration of all aquatic organisms (including aquatic plants) that use dissolved oxygen in excess of that produced by aquatic plants (i.e., primary production) during the day, and particularly at night when no oxygen is being produced by the plants, may further reduce dissolved oxygen below species tolerances and result in mortality. The remaining water would increase in temperature until it equilibrates with atmospheric temperatures as well during the warm summer months, reducing the solubility of oxygen in the water (Najjar et al. 2000 and

Ficke et al. 2007, as cited in Nilsson and Renöfält 2008) and adding heat stress to the aquatic organisms.

As described in the Water Resources section, water quality could be reduced under this alternative, with adverse effects on fish and aquatic invertebrates. Warmer waters with high nutrient levels can increase primary productivity, which adds oxygen during the day but uses it at night, resulting in wide fluctuations in dissolved oxygen concentrations and pH. Increased temperature can also increase toxicity of some pollutants (Langford 1990, as cited in Nilsson and Renöfält 2008). All of these factors would increase the existing stress on fish and aquatic invertebrates.

Effects on aquatic habitats and species would extend downstream of the withdrawal points, until tributary flows augment the mainstem flow.

Missouri River

This alternative would not use Missouri River water; therefore, the Missouri River System would not be affected. The effects of this alternative would be the same as No Action.

Groundwater with Recharge and the Souris River Alternative

Souris River

Construction impacts on the 22 intermittent and 7 perennial streams crossed by pipelines would be as described above under Action Alternatives. No permanent effects on fish and aquatic invertebrates are expected from pipeline construction and operation. The types of impacts that would result from construction and operation of the intakes on the Souris River would be as described above.

Effects on Souris River flows would be the similar to those described for the Groundwater with Recharge Alternative, although a greater amount of water would be withdrawn from the Souris River under this alternative. Flow reductions in March through August would result in an average of 5 more days of near-zero flows per year (108 days total) than for the Groundwater with Recharge Alternative. These flow reductions would have the same type of impacts on aquatic habitats and organisms as described for the Groundwater with Recharge Alternative but of greater magnitude in normal and dry flow years.

Missouri River

This alternative would not use Missouri River water; therefore, the Missouri River System would not be affected. The effects of this alternative would be the same as No Action.

Missouri River and Conjunctive Use Alternative

Construction impacts on the 21 intermittent and 2 perennial streams crossed by pipelines would be as described above under Action Alternatives. No permanent effects on fish and aquatic invertebrates are expected from pipeline construction and operation. Impacts of intake construction and operation at Lake Sakakawea and use of the existing intake on the Souris River would also be as described above under Action Alternatives.

Souris River

Impacts on aquatic habitats and organisms from water withdrawals would be minor under most conditions (i.e., normal, wet, and dry years) because only a relatively small proportion of the total flow (up to 25 percent) in the river would be withdrawn.

Missouri River

Reservoir Levels

Reservoir levels are important to Missouri River fish and aquatic invertebrates, as noted above. For the upper three Missouri River reservoirs (Fort Peck, Garrison, and Oahe), the differences in daily water surface elevations between the two Project simulations (Average Annual Project Depletions and Maximum Possible Project Depletions – refer to the Water Resources section) and No Action simulation were small. The Garrison Reservoir difference was within plus or minus 1 foot for 95 percent of the historical record, with an average difference over the period of analysis of -0.007 feet (less than 0.1 inch) for the Average Annual Project Depletions simulation. Similar results were shown for Fort Peck and Oahe reservoirs (Corps 2013a). With such small changes in reservoir elevations, impacts on fish and aquatic invertebrates would likely not be measurable.

Dam Releases

The Corps' analysis (2013a) comparing No Action to the two Project simulations found that differences in annual releases from Missouri River System dams would be small (mostly less than 1 kcfs), with an average change of less than 0.2 percent at the upper three dams. In addition, this barely detectable decrease would not affect channel and sandbar formation. With these negligible changes in dam releases, impacts on fish and aquatic invertebrates and their habitats would likely not be measurable.

Water Quality

Because the withdrawals of Missouri River water under this alternative would have a negligible effect on reservoir levels and dam releases, no measurable changes in water quality would occur as a result of Project water withdrawals. Therefore, withdrawals under this alternative would not result in any water quality impacts on fish and aquatic invertebrates. Any potential water quality impacts from construction of a Missouri River intake would be minimized and avoided by the implementation of BMPs identified in Appendix F.

Missouri River and Groundwater Alternative

Construction impacts on the 21 intermittent and 2 perennial streams crossed by pipelines would be as described above under Action Alternatives. No permanent effects on fish and aquatic invertebrates are expected from pipeline construction and operation. Impacts of intake construction and operation at Lake Sakakawea would also be the same as described under Action Alternatives.

Souris River

No Souris River withdrawals would occur under this alternative; therefore, no Project-related impacts would occur.

Missouri River

Slightly more water would be withdrawn from the Missouri River under this alternative than under the Missouri River and Conjunctive Use Alternative, but the depletion would still fall within the range covered by the two Project simulations. Impacts on aquatic habitats and organisms caused by changes in reservoir levels, dam releases, or water quality would be negligible, as described above for the Missouri River and Conjunctive Use Alternative.

Environmental Commitments

The following Surface Water environmental commitments would be implemented during construction if needed to further reduce impacts on aquatic habitats and the fish and invertebrate species that use them. A complete list of environmental commitments, including Vegetation and Wetlands, which would minimize impacts on wetlands, is included in Appendix F; they are also discussed in the Wetlands and Riparian Areas section in this chapter.

- When pipeline construction through a stream or wetland basin is unavoidable, existing contours would be restored and trenches would be sufficiently compacted to prevent any drainage along the trench or through bottom seepage.
- Where open trench crossing of a stream is required, the stream channel would be reestablished following pipe installation.
- Project construction would be coordinated with operation of the SCPP, especially during filling of Audubon Lake.

Given the implementation of these environmental commitments, no unavoidable adverse impacts associated with construction would occur.

The following environmental commitment would be implemented during operations under the inbasin alternatives:

- Reclamation would develop an adaptive management plan in accordance with the Department of the Interior's policy guidance (Order 3270) and the report *Adaptive Management: the U.S. Department of the Interior Technical Guide* (Williams et al. 2007). The plan would be implemented to address Project uncertainty as identified in the SEIS in relation to Souris River water resources and potential impacts to the NWRs.

This environmental commitment would not fully reduce impacts from changes in Souris River flows on aquatic habitats and organisms under the inbasin alternatives and the Missouri River and Conjunctive Use Alternative; thus, some adverse impacts would be unavoidable.

Cumulative Effects

Construction of the Mouse River Enhancement Flood Protection Project could occur during construction or operation of the Project. Levee construction could temporarily impact the river banks and add suspended sediment and turbidity to the Souris River. Construction of the Souris River intake for the western recharge basin under both inbasin alternatives could have similar impacts but over a much smaller footprint. Thus, the Project would not result in a substantial additional to a cumulative impact.

Cumulative effects on Missouri River resources were accounted for by including future reservoir sedimentation and reasonably foreseeable future non-Project depletions in simulations of No

Action and Missouri River alternatives (Appendix D and Corps 2013a). Thus, cumulative impacts would be the same as described for the simulations of the Missouri River alternatives.

Summary

The No Action Alternative would not affect aquatic habitats in the Project Area because no construction of new facilities and no new water withdrawals from surface waters would occur. Because the potential changes in Missouri River reservoir levels and dam releases from non-Project sources under the No Action Alternative would be small, minimal consequences on fish and aquatic invertebrates would occur in the Missouri River System.

Effects of pipeline construction and operation on streams crossed would be similar for all action alternatives. Streams would be crossed using horizontal directional drilling if feasible, and drilling under these streams would avoid physical disturbance of the streambed and banks. However, open trench methods may be required if the boring attempts are unsuccessful, which would cause temporary disturbances of the streambed and banks, and some suspension of sediments that would settle out downstream. Construction of new water intake facilities for each of the action alternatives would have temporary impacts on aquatic habitats, while operation of those facilities would result in a small permanent loss of habitat. Implementation of the BMPs and environmental commitments in Appendix F would minimize or avoid aquatic habitat impacts associated with construction of Project components under each of the action alternatives. Thus, no unavoidable adverse impacts would result from construction activities.

Water withdrawal at the intakes would entrain small floating or weakly swimming aquatic organisms in proportion to the amount of water taken, but impacts on aquatic species populations are expected to be minor. Withdrawal of water from the Souris River under both inbasin alternatives, however, would have unavoidable adverse impacts on aquatic habitats that could not be avoided or otherwise mitigated. During normal to dry years, the number of near-zero flow days would be increased compared to the No Action Alternative. Under the Groundwater with Recharge Alternative, the number of near-zero flow days would increase from 26 to 103 days, while under the Groundwater with Recharge and the Souris River Alternative, the number of near-zero flow days would increase to 108. More frequent periods of low to near-zero flow would reduce habitat quality and availability, and could also reduce water quality with adverse effects on fish and aquatic invertebrates.

Under the Missouri River alternatives, Project withdrawals would constitute less than 0.2 percent of Missouri River depletions. The effects of Project withdrawals on reservoir levels, dam releases, and water quality would be negligible. Consequently, the effect of Project depletions on fish and aquatic invertebrates would not likely be measurable.

Aquatic Invasive Species

Introduction

This section describes the *risks* of introducing AIS of concern into the Hudson Bay basin under the No Action Alternative, and the potential for the action alternatives to increase this risk. It also analyzes the impacts that could result from the introduction and establishment of AIS in the Hudson Bay basin, including impacts in Canada. Reclamation has undertaken an evaluation of the potential impact from the Project to the Canadian environment consistent with the court's Order. As described in the Aquatic Invasive Species section in Chapter 3, a variety of non-

Project pathways for potential introduction of AIS are already present, and these would continue under all of the alternatives, including No Action. Both the Missouri River and Conjunctive Use Alternative and the Missouri River and Groundwater Alternative would deliver treated water through a buried transmission pipeline from the Missouri River basin to the Hudson Bay basin and thus could provide a new pathway for the introduction of AIS into the Hudson Bay basin. The alternatives that would not use Missouri River water, the Groundwater with Recharge Alternative and the Groundwater with Recharge and the Souris River Alternative, would not provide a new pathway for the interbasin transfer of AIS because they would only use water sources located within the Hudson Bay basin. As described in Chapter 3, because the majority of AIS are represented by fish pathogens and parasites, this section describes the potential impacts on wild and reared fish populations; natural components of the Hudson Bay basin ecosystems; human health; and economics, including commercial fishing, recreational fishing, and non-fishing recreation.

Methods

The risk assessment is based on the transbasin effects analysis included in Appendix E, *Transbasin Effects Analysis Technical Report* (Transbasin Technical Report). A *Transbasin Effects Analysis Plan of Study* (Reclamation 2011e) was developed and confirmed by the Cooperating Agencies, including the City of Minot, Garrison Diversion Conservancy District, SWC, Corps, and EPA. The Transbasin Technical Report was independently peer reviewed by technical experts in fish pathogens and parasites, water treatment, and ecological risk assessment (Atkins 2012). The peer-reviewers' report is a supporting document to the SEIS. Overall, the reviewers concluded that the study was based on the best available science, and the results and conclusions were supported by that science given the uncertainties inherent in the available data and topic knowledge. The study builds on previous work conducted for the Project, described in the Aquatic Invasive Species section in Chapter 3. In particular, the risk assessment of interbasin biota transfers conducted by the USGS (2007a) in support of the previous Project EIS (Reclamation 2008) provided a foundation for the current study. The USGS report included a failure analysis for components of long-term operation and maintenance associated with the main transmission pipeline infrastructure and water treatment systems.

For this analysis, qualitative and quantitative risk assessment methodologies, available information, and data gaps were reviewed. The lack of comprehensive AIS abundance and distribution data in adjacent hydrologic basins precluded the development of a sensitivity analysis, which would have relied on biota concentration as an integral input variable. Data availability and uncertainty necessitated a qualitative approach to evaluate the risk of AIS interbasin transfer. Qualitative risk assessments are common, acceptable, valid, and considered best practice; and they can be successfully applied when data gaps exist, such as insufficient data on community structure and functioning (Zengeya et al. 2013). The best available science and information were used to make a reasonable final determination, thus complying with the NEPA requirement that an analysis of impacts be supported by credible scientific evidence, not be based on pure conjecture, and be within the rule of reason (40 CFR 1502.22).

The current known North American distribution of representative AIS in the Missouri River basin, Hudson Bay basin, and adjacent and neighboring drainage basins was further documented and is an important component of the current risk analysis. (Refer to Chapter 3 and Attachment 1 of the Transbasin Technical Report [Appendix E].) Distribution information is valuable; however, there is a caveat associated with its use: these hydrologic basins are extremely large "open" systems, and even the most extensive sampling programs would not provide definitive presence/absence and concentration information for AIS. Concentrations of AIS in drainage basins adjacent to the Hudson Bay basin are not available, which would be vital input parameters for a quantitative analysis. The life history characteristics of AIS were further investigated from previous work (USGS 2007a) to assist in evaluating the risk to potential aquatic receptors in the Hudson Bay basin as a result of an introduction through any biota transfer pathway, including both Project and non-Project sources.

Due to the high degree of uncertainty associated with individual effects from infection and the nexus with population-scale effects, potential environmental impacts related to AIS introduction are extremely difficult to estimate or predict. This lack of predictive ability warrants the evaluation of historically observed effects related to biological invasions in aquatic systems other than the Hudson Bay basin. Current and historical scientific literature was examined to gather information regarding observed environmental and economic impacts from documented invasions in other aquatic systems. The identified examples provide a basis to qualitatively describe potential environmental consequences in the Hudson Bay basin. In addition, life histories descriptions were further expanded from previous work to support the evaluation of biota treatment options for the Project, as well as to assist with the effort to estimate potential impacts resulting from an establishment of an AIS in the Hudson Bay basin.

The unintended introduction and establishment of AIS could potentially affect local economies in the Hudson Bay basin, particularly the economies of the communities adjacent to Lake Winnipeg and the greater economy of the Province of Manitoba. Economic sectors most at risk from the introduction of nonindigenous fish pathogens and parasites are recreational and commercial fishing, aquaculture, and nonfishing recreation (e.g., increase in beach closure days). (Refer to Appendix E for additional detail.) The economic impact analysis focuses on the potential *incremental* impacts of AIS introduction in the Hudson Bay basin and Lake Winnipeg. There are currently AIS in Lake Winnipeg and elsewhere in the Hudson Bay basin that could have adverse economic effects. In addition, future invasions through non-Project pathways could also affect economic sectors of the Hudson Bay basin. These effects are part of the No Action Alternative; they would occur even without the Project. Potential influence from the Project is limited to the increased or incremental transfer risk associated with the action alternatives compared to the condition under No Action.

Limited theoretical and empirical literature exists regarding the economic impacts of invasive species establishment (Lovell and Stone 2005). Information is also limited regarding the increased probability of AIS establishment due to the Project. This section therefore identifies and discusses the type and magnitude of potential economic impacts based on a review of the baseline economic conditions within the potentially affected area, focusing on two factors:

- Size of economic sectors (e.g., sector output and employment), with particular focus on the sectors most likely to be directly affected by AIS (recreational and commercial fishing, aquaculture, and nonfishing recreation) or indirectly affected by AIS (such as the fish processing sector, which is linked to the commercial fishing sector). The size of potentially impacted sectors indicates the upper limit of AIS-related adverse impacts, since in a worst-case scenario; the AIS could not impact more than 100 percent of a sector.
- Groups of people participating in potentially affected sectors (e.g., First Nations).

To the extent that information is available, the analysis also discusses the relative likelihood of economic changes based on data regarding the vulnerability of potentially affected sectors to possible AIS introductions (e.g., the degree to which commercially or recreationally important fish species are susceptible to adverse effects from AIS).

Results

Potential Risks of Transferring Aquatic Invasive Species of Concern

This section describes the potential risks of interbasin AIS transfer to the Hudson Bay basin associated with No Action and the action alternatives.

No Action Alternative

As described in Chapter 3, there are a variety of potential pathways through which AIS interbasin transfer can occur. The presence of AIS in adjacent drainage basins (Upper Mississippi region, Pacific Ocean basin, the Great Lakes; see Figure 3-15) suggests that non-Project pathways could introduce AIS to the Missouri River basin and from there to the Hudson Bay basin. The Hudson Bay basin is not a closed system and is therefore connected to other drainage basins by both biotic and abiotic linkages, including water diversions (many without biota treatment), natural interbasin connections, aquatic pathways, animal transport, and weather-related phenomena. These pathways are generally not equipped with controls or other measures and could therefore facilitate direct transport of AIS-laden water or material into Hudson Bay basin waterbodies. See Appendix E for additional discussion of AIS transfer pathways.

Some of these pathways do not require the direct transfer of a volume of water (e.g., piscivorous [fish-eating] birds or mussels attached to boat hulls, fish stocking), while others are entirely dependent on water movement. Birds and mammals can mediate transport across large geographic distances. For many fish parasites and pathogens, including whirling disease, movement of infected fish (including stocking) is the primary mechanism for dispersal and spread (Bartholomew et al. 2005; Bullock and Cipriano 1990; Plumb 1972).

Bait buckets, aquaculture, bilge water/live well releases, fish stocking, and water recreation represent mechanisms with greater inherent risk for facilitating spread between basins than natural pathways, such as animal transport or weather-related phenomena. The successful establishment of invasive organisms via one of these natural non-Project pathways may have a low probability. However, in the long term, even low-probability events, such as AIS establishment, exhibit some probability of eventually occurring. (Refer to Appendix E for additional detail.)

Interbasin water diversions also have the potential to transport invasive species across drainage basins. Most states, including North Dakota, have laws and regulations prohibiting the transport or introduction of known invasives. However, there are no standards for treatment of interbasin water transfers to control invasive species, and the EPA has published a final rule in the Federal Register (73 FR 33694) that generally exempts interbasin water transfers from regulations under the National Pollutant Discharge Elimination System permitting program. Conveyance risk is different for water diversion projects than for the pathways described above. For instance, large, untreated diversions characterized by high flow rates and annual volume transfers are expected to exhibit greater AIS transfer risk than those with lower volumes and equipped with biota treatment facilities and sophisticated control and response systems, such as the Missouri River alternatives being considered in this SEIS.

The successful introduction of AIS in the Hudson Bay basin is much more likely to be caused by a high-probability pathway, such as those that involve relatively large transfers of untreated water or that occur repeatedly (such as the discharge of bilge water or live well contents from recreational and commercial boats). Such discharges may not be currently regulated for some states; however, North Dakota requires that water from bilges, live wells, and motors from recreational boats must be drained prior to leaving a waterbody. The Aquatic Nuisance Species Rule (NDGFD 2012c) also requires that aquatic vegetation be removed from boats, personal watercraft, trailers, and associated equipment; that live aquatic bait not be transported to North Dakota; and that water must be drained from recreational boats before entering the state. The risk of AIS transfer from some of these non-Project pathways can be limited by implementation of appropriate control mechanisms (e.g., boat inspections to control invasive mollusks); however, this would typically require widespread and consistent adoption in neighboring states and Canada.

Uncertainty limits the ability to assign unique transfer risk probabilities to any of these biota transfer pathways. (Refer to the discussion on uncertainty below.) Transfers to the Hudson Bay basin likely have occurred in the past and are likely to continue in the future via existing transfer pathways from adjacent and neighboring hydrologic basins in the absence of the Project. (Refer to Appendix E for additional detail.)

Action Alternatives

Groundwater with Recharge Alternative and Groundwater with Recharge and the Souris River Alternative

These two alternatives would only use inbasin (Hudson Bay basin) source water (groundwater and surface water), and therefore no biota water treatment would be needed. Since these alternatives would not include the Missouri River water as a portion of the water supply, the risk conditions would essentially be the same as those of No Action.

Missouri River and Conjunctive Use and Missouri River and Groundwater Alternatives

Because the Missouri River is the main source of water for these alternatives, the same rigorously engineered system would be implemented for each, with state-of-the-art biota treatment, operation and maintenance practices, and emergency protocols. (Refer to Chapter 2.) The probability of a transfer related to these alternatives and the subsequent establishment of AIS in the Hudson Bay basin would be extremely low because such an episode would require a cascade of highly unlikely events, including, but not limited to a biota treatment interruption coupled with a concomitant pipeline failure within a contributing drainage area, and the release of AIS-containing water. Furthermore, an organism introduced to a subsurface soil (e.g., from a ruptured buried water transmission pipeline that is automatically isolated due to pressure loss) would have to travel through the soil and then through a contributing drainage area (within the Hudson Bay basin) to a surface waterbody in the Hudson Bay basin, find an appropriate host organism, and successfully establish itself in the receiving waters.

Biota Treatment

Water from Lake Sakakawea (the main supply source) would be treated to remove and/or inactivate potential AIS at the Biota WTP, located within the Missouri River basin in Max, before the water was pumped to the Minot WTP for final treatment prior to distribution. Key life history characteristics of AIS, including size and susceptibility to both water treatment and physical removal (Appendix E, Table 3), were considered during the evaluation of biota treatment options for the Missouri River alternatives. Relevant water quality regulations (described in Chapter 2) were also used to identify and develop effective treatment approaches for the removal and/or inactivation of AIS. The following five biota water treatment options are being considered:

- Chlorination
- Chlorination/UV Inactivation
- Enhanced Chlorination/UV Inactivation
- Conventional Treatment
- Microfiltration

The combined log-inactivation or removal for the biota treatment options are presented in Table 4-16. Risk reduction rank scores are provided in Table 4-17. The Conventional Treatment and Microfiltration treatment options exhibit the highest risk reduction score (5 and 6, respectively) because they have the most integrated treatment technologies and are the least likely to fail or to allow a transfer of AIS to the surrounding environment. The addition of the filtration process (particle or media filtration) in these two options provides an additional physical barrier that the other options do not provide. The order of protection provided by the biota treatment options is as follows:

- Microfiltration
- Conventional Treatment
- Enhanced Chlorination/UV Inactivation
- Chlorination/UV Inactivation
- Chlorination

Table 4-16 Combined Log-Inactivation or Removal of Biota Treatment Options

Target Biota	Chlorination	Chlorination/UV Inactivation	Enhanced Chlorination/UV Inactivation	Conventional Treatment	Microfiltration
Giardia	3	> 3	> 3	> 3	> 3
Viruses	> 4	> 4	> 4	> 4	> 4
Cryptosporidium	0	3	> 3	> 3	> 3
Whirling Disease	0	> 4	> 4	> 4	> 4

Note:
UV = ultraviolet

Table 4-17 Risk Reduction Rank Scores for Biota Treatment Options

Option	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Total Rank Score
Chlorination	Chlorination-Chloramination	—	—	—	—	Minot WTP	
Score	1	—	—	—	—	1	**2**
Chlorination/ UV Inactivation	UV	Chlorination-Chloramination	—	—	—	Minot WTP	
Score	1	1	—	—	—	1	**3**
Enhanced Chlorination/ UV Inactivation	Pressure Filtration	UV	Chlorination-Chloramination	—	—	Minot WTP	
Score	1	1	1	—	—	1	**4**
Conventional Treatment	Coagulation-Flocculation/ DAF	—	Media Filtration	UV	Chlorination-Chloramination	Minot WTP	
Score	1	—	1	1	1	1	**5**
Microfiltration	Coagulation-Flocculation	Microfiltration	UV	Chlorination-Chloramination	—	Minot WTP	
Score	1	2	1	1	—	1	**6**

Note:
DAF = dissolved air flotation; UV = ultraviolet; WTP = water treatment plant

Risk Associated with the Missouri River Alternatives

Following treatment at the Biota WTP, Missouri River water would be conveyed by an existing transmission pipeline extending approximately 8 miles northward before reaching the Basin Divide. The pipeline then extends approximately 4 miles to the northern boundary of the Nelson Lake subbasin (Figure 4-41). This is a closed, noncontributing subbasin; therefore, water released from a pipeline failure in this area would not hydraulically connect with tributaries of the Souris River drainage. The distance between the northern boundary of the Nelson Lake subbasin and the Minot WTP is approximately 17 miles.

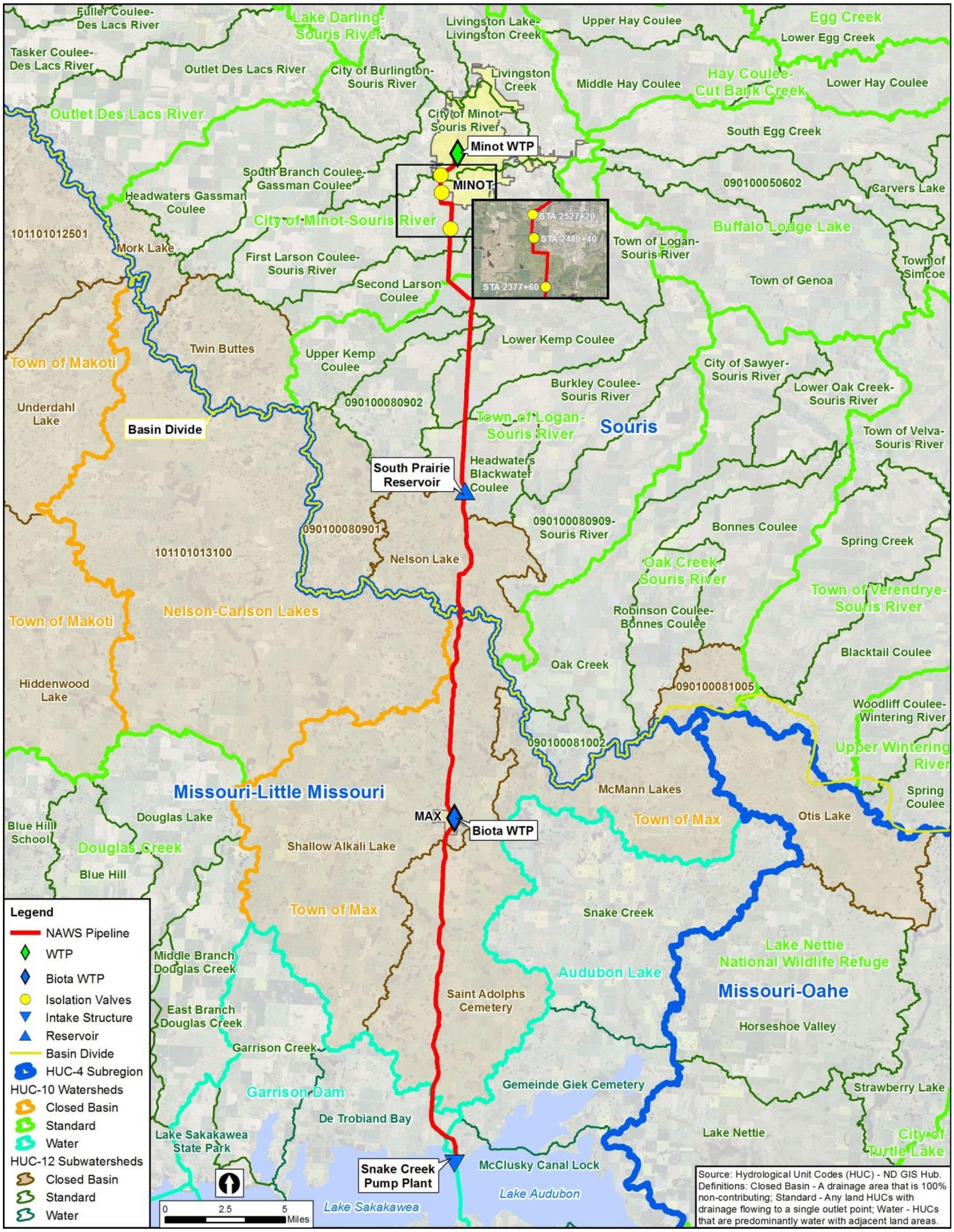

Figure 4-41 Contributing and Non-Contributing Drainages

The transmission pipeline crosses underneath three intermittent streams between Max and Minot. The pipeline was directionally bored beneath the bed of these intermittent streams. Therefore, the risk of pipeline failure due to flood events at these locations would be very low. Additionally, automatic pipeline isolation valves are installed at each of these locations to reduce the volume of water that could be released if a catastrophic failure of the transmission pipeline were to occur.

The main transmission pipeline terminates at the Minot WTP, where Missouri River water (and other water sources) would be filtered and again disinfected prior to distribution. The Minot WTP lies adjacent to the Souris River and thus is potentially vulnerable to flooding during extreme events. The City of Minot plans to construct additional levees at the plant to increase flood protection in the wake of the record flood that occurred in 2011 (Barr Engineering et al. 2012).

The geographically separated components of the proposed water transmission and treatment system would collectively work to reduce risks of interbasin transfer of AIS. Simultaneous failures at the Biota WTP and the main transmission pipeline or Minot WTP would be required for a release of untreated or undertreated water into a contributing drainage in the Hudson Bay basin to occur. Potential failures of these components would likely be independent and uncorrelated. For example, equipment malfunction or power outage at the Biota WTP would not affect the integrity of the transmission pipeline or the operation of the Minot WTP. With multiple independent barriers in the proposed system, risk of release of Missouri River water would be low.

Further, the probability of an organism introduced to a subsurface soil (e.g., from a ruptured transmission pipeline) migrating through a contributing region to the Hudson Bay basin, finding an appropriate host organism, successfully establishing itself in an ecosystem, and causing adverse effects to ecological receptors is also extremely low. Additionally, subsurface soil is an environment characterized by conditions capable of immobilizing and deactivating organisms (Bitton 1999; Buchanan and Flurry 2004).

As stated earlier, movement of infected fish (including stocking) represents the primary mechanism for dispersal and spread of many fish parasites and pathogens (Bartholomew et al. 2005; Bullock and Cipriano 1990; Plumb 1972). Because no fish would be expected to pass through the system, this pathway is not Project-related. However, the risk of transferring infected fish still remains through non-Project pathways.

Uncertainty limits the ability to assign unique transfer risk probabilities to any of these biota transfer pathways. (Refer to the discussion of uncertainty below.) However, based on a qualitative assessment of the basin linkages and competing pathways, the risk of AIS transfer by the Missouri River alternatives is considered to be extremely low compared to non-Project pathways. Figure 4-42 illustrates known pathways that contribute to AIS transfer risk. The Missouri River alternatives represent only one of the potential pathways that could introduce AIS to the Hudson Bay basin, and each pathway's contribution to the overall risk is different for each AIS. Furthermore, the non-Project pathways presented on this figure, which are characterized by lower risk-reduction controls and commitments than would be implemented under the Missouri River alternatives, are only those that have been identified during the analysis. There are likely other pathways that have yet to be identified, which when considered with the pathways in Figure 4-42, would further reduce the contribution of risk probability by the Missouri River alternatives.

Figure 4-42 Pathways Contributing to AIS Transfer Risk

Potential Impacts Associated with Aquatic Invasive Species of Concern

This section describes the potential impacts associated with the introduction and establishment of AIS in the Hudson Bay basin.

When introduced into a new environment, the vast majority of organisms fail to become established, and many that succeed have only minor effects on the newly encountered ecosystem (Williamson and Fitter 1996). However, some nonindigenous species may become invasive, reproducing and spreading rapidly with significant adverse consequences. Nonindigenous species can alter populations, communities, and ecosystem structure and function (Mooney and Drake 1986; Vitousek et al. 1996).

There may be predictable effects for some of the AIS, such as zebra mussels, which have caused ecosystem-level changes in other aquatic systems. It is likely that the impacts from such an organism could result in similar changes to ecosystems and economies in other invaded systems.

However, some fish pathogens and parasites are highly host specific, and therefore may not encounter suitable hosts to infect, preventing them from taking hold and impacting populations of commercially or recreationally valuable fish species (e.g., whirling disease).

No Action Alternative

The No Action Alternative would result in a continuation of the existing conditions described as the affected environment in Chapter 3. It would also include additional consequences related to future invasions through non-Project pathways and the expanded distribution and abundance of AIS already present in the Hudson Bay basin through 2060. For example, zebra mussels were reported in the Red River within the Hudson Bay basin in July 2010 and were confirmed in Lake Winnipeg only 3 years later, in October 2013 (Manitoba Water Stewardship 2012, 2013; USGS 2013b). Therefore, AIS are likely to continue to expand their presence in the Hudson Bay basin in the absence of the Project.

Potential Environmental Consequences

AIS could affect an aquatic ecosystem by infecting native species (a direct impact) or by causing community shifts (an indirect impact). Impacts resulting from the spread and establishment of introduced species may depend on the mode and severity of infection within preferred hosts and the potential for adverse effects on populations.

The impacts of fish pathogens and parasites on individuals and populations are highly dependent on both environmental and biological factors (Hedrick 1998; Lafferty and Kuris 1999). An appropriate combination of host abundance and environmental conditions is required to facilitate the establishment and maintenance of a pathogen or parasite in a newly encountered system (Peeler and Taylor 2011). Environmental factors such as dissolved oxygen, pH, temperature, flow, turbidity, and the presence of toxic contaminants can affect the health of fish populations and cause stress in individuals, enhancing the potential for infection and disease outbreak (Hedrick 1998; Lafferty and Kuris 1999). Many pathogens have the greatest effect on individuals in crowded conditions, such as in fish farms and other aquaculture facilities where infections may be exacerbated by poor water quality and stress (Hedrick 1998; Peeler and Taylor 2011). Wild fish tend to be less susceptible to these types of diseases, although some believe that climate change could lead to temperature-induced susceptibility to pathogens and parasites (Wedekind and Kung 2010).

Case histories of historical aquatic invasions indicate that it is difficult to predict the impacts of species introductions due to site-specific environmental conditions that directly influence the outcomes (Moyle and Light 1996). Historical information does, however, provide observational evidence for the impacts of AIS transfer. Qualitative descriptions of potential environmental impacts are provided herein based on historical observations described in the “Aquatic Invasive Species” section in Chapter 3. Fish viruses tend to have the greatest effect on individuals and populations experiencing stress, such as those reared in aquaculture facilities (Gomez-Casado et al. 2011). Detection of viral infections in rearing facilities usually results in the elimination of contained fish by facility managers; therefore, a single observed infection could result in an effect on a reared population. This would be an example of a human-induced eradication rather than wild population-level effect directly caused by a viral pathogen in the environment.

Viruses are not exclusive to infecting farm-raised fish because viruses such as infectious pancreatic necrosis virus (IPNV), infectious salmon anemia virus (ISAV), and viral hemorrhagic septicemia virus (VHSV) have caused significant mortality of wild fish in natural habitats (Shankar and Yamamoto 1994; ISU 2010; MnDNR 2011). VHSV, in particular, has caused severe impacts in the Great Lakes due to its potential to cause mortality to a variety of host fish species (ISU 2007b). The spread of viruses depends upon a suite of criteria, including host density, habitat features, and virulence (Arkoosh et al. 1998). Infection is generally facilitated by crowding, and susceptibility appears to increase with stress, which is why hatchery fish appear most affected by viral outbreaks. Because no large aquaculture facilities have been identified in the Hudson Bay basin, the spread of viruses via farmed fish would likely be minimal. In addition, catfish are not intensively farmed in Manitoba; therefore, channel catfish virus (CCV) infection, and related consequences, would be unlikely (Statistics Canada 2009).

Bacterial fish pathogens and associated large-scale ecological impacts are not well characterized in the published literature. Information gathered in the Transbasin Technical Report was mainly limited to bacterial AIS already known to be present in the Hudson Bay basin (bacterial kidney disease [BKD] and enteric redmouth disease [ERM]) or ubiquitous in aquatic systems (Strep). Stressful environmental conditions characteristic of impaired waterbodies or aquaculture facilities with poor water quality may compromise immune systems of host fish and facilitate outbreaks (Meyer et al. 1983). Most bacterial infections of fish are spread from fish-to-fish contact, which would be more likely in reared populations than in wild fish in the Hudson Bay basin. In aquaculture settings, impacts of introduced pathogens could include direct mortality of infected individuals or elimination of reared populations as a consequence of standard management actions. Impacts on wild fish, including declines of fish stocks, are possible; however, there is uncertainty regarding the influence of infection on reproduction and recruitment and how that translates to effects at the population level.

Several of the bacterial AIS were found to be present in the Hudson Bay basin (furunculosis, BKD, columnaris disease, *Edwardsiella* spp. infections, and ERM) or widely distributed and ubiquitous in aquatic systems of North America (*P. aeruginosa*, *Mycobacterium* spp. infections, *E. coli*, Legionnaire's disease, and salmonella), and therefore would likely not pose a new risk to potential ecological receptors of the Hudson Bay basin. In addition, bacterial pathogen abundance is often related to environmental factors (e.g., nutrients, sewage); hence, additional transfers would not likely measurably influence abundance in Hudson Bay basin waterbodies.

The primary barrier to whirling disease risk and success in the Hudson Bay basin is the general lack of susceptible salmonid hosts in these receiving waters. Whirling disease is present in the Rocky Mountain region of the western Missouri River basin, which is characterized by cooler, more oxygenated water and abundant wild trout populations, including rainbow, cutthroat, and brown trout. The potential for whirling disease to spread naturally via infected host fish along waterways connecting the current western Missouri River basin to the Project water transfer site (Lake Sakakawea) is thought to be seriously limited by the lack of susceptible hosts and less-than-optimal habitat that lies between the two regions (Holm, pers. comm., 2011; Nehring, pers. comm., 2011). Accidental stocking of infected salmonids in or near Hudson Bay basin waters represents a much more likely scenario of whirling disease transfer. If infected fish or infected *Tubifex* worms (the intermediate host) are present in the eastern Missouri River basin or in the Hudson Bay basin, the potential does exist for whirling disease-related impacts on some wild and farmed trout and char populations in the receiving waters. Population declines of some of the more vulnerable species (e.g., rainbow trout–primarily a farmed species) could result in subsequent increases of other more resilient species (e.g., brown trout) (Granath et al. 2007). However, these types of larger ecosystem-level impacts are not possible to accurately predict.

Ecological receptors of concern that may exhibit at least some vulnerability to whirling disease may include brook trout, brown trout, Chinook salmon, lake trout, lake whitefish, rainbow trout, and shortjaw cisco (Table 3-13). However, studies regarding the sensitivity of lake whitefish and lake trout, two of the most common salmonids in the Hudson Bay basin, have been largely inconclusive. Wild mountain whitefish exhibited some clinical signs of the disease in one study (Pierce et al. 2011), while studies of lake trout and lake whitefish in others have been both contradictory and inconclusive (Hedrick et al. 1999). The lack of evidence for susceptibility of these two species suggests a potentially low likelihood for adverse effects on their wild populations. Whirling disease has the potential to affect wild salmonid populations; however, the general lack of naturally reproducing salmonid populations in the Souris River drainage is a significant limitation to the potential introduction of whirling disease into the Hudson Bay basin through the Souris River.

The animal parasite, *Polypodium*, is rarely lethal to its hosts that inhabit the Hudson Bay basin, including lake sturgeon (Dick et al. 2001). Infection does not appear to result in population-level impacts and is already well established among a variety of fishes in the Missouri River basin, Hudson Bay basin, and throughout North America (Hoffman et al. 1974; Suppes and Meyer 1975; Raikova et al. 1979; Raikova 1994; Dadswell et al. 1984; Choudhury and Dick 1993; Dick et al. 2001; Thomas and Muzzall 2009; Sepúlveda et al. 2010). Because this parasite is currently present in the receiving waters, it does not appear to represent a new threat if additional introductions occurred.

Parasitic copepods (e.g., *Actheres pimelodi, Ergasilus* spp.) are widely distributed in North America, including the Hudson Bay basin (Dick et al. 2001; Bensley et al. 2011). Due to the apparent lack of adverse influence on fish populations, potential impacts to receptors in the Hudson Bay basin are not anticipated.

Other parasites, including *Icelanonchohaptor microcotyle* and *Corallotaenia minutia*, do not appear to be of major concern for potential ecological receptors of concern in the Hudson Bay basin. *C. minutia* has a complicated life cycle, including the requirement of an intermediate host for development prior to its invasion of host tissue. In addition, this parasite has already been detected in North Dakota (Wild Rice River) and in Manitoba (La Salle River) within the Hudson Bay basin (Dick et al. 2001; Rosas-Valdez et al. 2004). *I. microcotyle* has only been found in the Missouri River (Dick et al. 2001), and the effects of this parasite have not been observed in the environment. This parasite has eluded characterization due to its apparent scarcity (both presence throughout and abundance within hydrologic basins). For these reasons, no impacts would be expected as a result of an introduction of this AIS.

Fungal infections are more likely to occur under stressful environmental conditions, such as those characteristic of fish-rearing facilities. In addition, there is considerable uncertainty regarding the potential effects of fungal pathogens on wild fish individuals and populations because they are primarily of interest as pathogens of aquacultural facilities (Durborow et al. 2003; Meyers et al. 2008). Impacts from some fungal AIS, including *Phoma herbarum*, would likely be negligible since they are considered to be only weakly infectious. Potential impacts associated with fungal infection would likely be most severe to farmed fish, where entire populations could be at risk in these controlled systems. However, large rearing facilities have not been identified in the Hudson Bay basin, including Lake Winnipeg.

Native invertebrates such as the mapleleaf mussel could be adversely affected by direct competition from quagga and zebra mussels. Zebra mussels are already present in the Hudson

Bay basin (including Lake Winnipeg), and the distribution of quagga mussels is rapidly expanding (Benson et al. 2012a, 2012b paleontological resources were identified by Hoganson b). Dietary replacement of native mussels with less nutritional invasive mussels could have impacts on Hudson Bay basin. The introduction of quagga mussels could have an effect on plankton biomass and diversity. The presence of mussels could also lead to increased abundance of cyanobacteria, which pose unique challenges to the aquatic environment.

New Zealand mudsnails could cause ecosystem-level disruptions in waterbodies within the greater Hudson Bay basin. Impacts could include direct crowding of, and competition with, native invertebrates such as pulmonate snails (Kerans et al. 2005; Riley et al. 2008). More severe consequences could include fish population declines associated with food web structure alterations. The New Zealand mudsnail is tolerant of a wide range of environments and has been documented in almost all western states of the United States (not in North Dakota), the Great Lakes, and more recently in British Columbia (Proctor et al. 2007; Department of Fisheries and Oceans Canada 2011a). These effects would be site dependent, highly variable, and unpredictable; however, invasive mussels may have the greatest potential of all AIS evaluated to cause adverse environmental impacts in the Hudson Bay basin.

Potential Economic Consequences

This section summarizes the types and potential magnitude of possible incremental adverse economic consequences of unintended introduction of AIS. The descriptive economic analysis characterizes the types of potential economic impacts that may be incurred throughout the Hudson Bay basin, while the quantitative analysis of economic consequences focuses on Manitoba, specifically Lake Winnipeg. Lake Winnipeg is the largest freshwater lake in southern Canada. The Lake Winnipeg watershed includes the Souris River, and any Project-related AIS transfer potentially affecting Canada would occur in the Souris River basin. Because Lake Winnipeg lies downstream of the Project and has high ecological and economic value, the consequences of an AIS transfer would likely be greatest at Lake Winnipeg. Additionally, Lake Winnipeg has high data availability regarding human use and economic significance, and had the highest level of public concern regarding AIS from the proposed Project, based on public comments received during scoping. The types of potential economic impacts felt at Lake Winnipeg may also be felt in in other Hudson Bay basin waterbodies and adjacent communities. The quantitative analysis of Lake Winnipeg serves as a basis for the public, agencies, and decision makers to understand the potential impacts in these other areas of the Hudson Bay basin.

The economic consequences of AIS discussed below focus on the potential effects on commercial and recreational fisheries. However, even for these economic sectors that would be most vulnerable to AIS introduction, the incremental economic impact is likely limited to a small portion of the total economic value of the fishery for the following reasons:

1. Most, if not all, economically important Hudson Bay basin fish stocks are present and fished in the Missouri River Basin, where these fish stocks coexist with several AIS, suggesting that the vulnerability of these fish stocks to AIS present in the Missouri River Basin may be low.

2. There are numerous fish species of recreational and commercial importance in the Hudson Bay basin and since different species are adversely affected by different AIS, potential AIS introduction would likely affect only one or a few fish stocks at a time rather than all fish stocks.

3. Any fish population declines in a commercially or recreationally valuable species may be offset by population increases or increased angling effort in other economically important fisheries that are more resistant to the AIS introduction.

Commercial fishing would be adversely affected if AIS were to result in incremental reduced catch rates (due to changes in fish populations) or incremental reduced fish quality (due to changes in fish appearance or fish size). Reductions in catch rate or quality can translate into several types of economic impacts, including potentially lower revenues and/or profits for fishermen, lower net profits and employment in the seafood product wholesale and distribution industry, and reduced availability/quality and increased price of local fish to consumers (such effects would be mitigated if reductions in any fish populations were offset by increased abundance or quality of other economically valuable species). Reduced profits may cause fishermen to exit from the fishery, reducing fish industry employment. Lake Winnipeg fishermen currently have much higher profits than commercial fishermen elsewhere in Manitoba, suggesting that exit of the fishery due to reduced profits would likely be minimal in this fishery unless AIS effects were severe.

While the risk of AIS introduction and the degree of susceptibility of economically important Hudson Bay basin fish stocks to AIS is not completely understood, the fact that most, if not all, of these fish species are present and fished in the Missouri River basin suggests that there is low probability for incremental consequences in the Hudson Bay basin. In any case, direct consequences on the Manitoba fishery employment would be limited to some portion of the 3,000 total licensed fishers and hired helpers in the Province, while direct consequences on Manitoba commercial fishing income would be limited to some portion of the $40.1 million of total income in the fishery.[3] Likewise, incremental impacts on the Lake Winnipeg fishery employment would be limited to some portion of the 1,000 to 1,100 total Lake Winnipeg licensed fishers and hired helpers, while impacts on Lake Winnipeg fishery income would be limited to some portion of the $25.6 million in total commercial fishing income in that fishery. To put these figures in context, the potentially affected jobs represent approximately 0.3 percent of the estimated 408,700 jobs in the Winnipeg economy.

AIS capable of infecting fish species reared at an *aquaculture* operation could cause significant mortalities within a fish stock for that year. However, the economic consequences of any effects of AIS on the aquaculture industry would be minor in the context of the regional economy. The aquaculture industry in Manitoba is a very small piece of the province’s economy, with gross output value of $31,000 to $95,000 between 2007 and 2009, or an average value of $4,440 per metric tons (Statistics Canada 2009). Consequences of AIS would therefore be limited to some portion of this small value. Reduced availability of trout fingerlings raised in hatcheries (part of the aquacultural industry) could adversely affect aquaculture consumers.

AIS can have two potential types of effects on *recreation and tourism*: effects on the level of enjoyment and value of the experience to the recreators/tourists themselves, and effects on the recreation and tourism economy that may result from changes in the number of non-local visitors and their expenditures. These two types of effects are closely related because the level of visitor enjoyment also affects the number of visitors and their expenditures.

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[3] Annual fishery income figures are based on average annual income per fisher cited in Appendix E, page 106, and as reported by the Manitoba Conservation and Water Stewardship Fisheries Branch.

According to data from the Department of Fisheries and Oceans (Humphries, pers. comm., 2014), fisheries with high recreational visitation in Manitoba include Lake Winnipeg (approximately 162,000 anglers days in 2010), the Red River (approximately 230,000 angler days in 2010), Lac du Bonnet (approximately 130,000 angler days in 2010), and Whiteshell Park (approximately 330,000 angler days in 2010). Other popular recreational fishing destinations include Lake-of-the-Prairies, Winnipeg River, and Nopiming Park. Together, these destinations account for over 50 percent of all angling days in the Province. At all recreational fishing locations, any reduction in the health or abundance of fish species targeted by recreational anglers could adversely affect the level of enjoyment of the angling experience. For example, every 1 percent incremental reduction in catch rates in Lake Winnipeg could potentially reduce the value of the angler experience in the range of $30,000 to $60,000 annually (based on values found from a Great Lakes study [Ontario Ministry of the Environment 2010] and the annual number of fishing days at Lake Winnipeg). Reduced catch rates or reduced health of fish species could also result in consequences for the recreational economy if there are fewer fishing trips and associated tourism expenditures in the Lake Winnipeg or other recreational fishing areas. Such potential consequences would likely be limited to a small portion of the $8 million estimated expenditure associated with Lake Winnipeg fishing trips, or if other waterbodies were affected, a small portion of the total $103 million expenditure associated with all Manitoba fishing trips. (Refer to Table 13 in Appendix E.) As Lake Winnipeg is not particularly attractive as a recreational fishing destination (Brickley, pers. comm., 2012), there may be more local than nonlocal anglers fishing at Lake Winnipeg, which would limit the potential consequences of AIS on tourism expenditures. Similarly, any adverse impacts on recreational spending at the provincial level would likely be limited as approximately 90 percent of angling trips are by residents, who have a lower level of net economic impact than non-resident visitors.[4]For nonfishing recreation, the primary consequences of AIS would likely be an increase in beach closure days (associated with transfer of cyanobacteria or human pathogens), with subsequent consequences for value to recreationists, tourism-related spending, shoreline property values, and tax revenues to shoreline communities. However, these impacts are expected to be limited because concentrations of bacterial pathogens and cyanobacteria are predominantly determined by other water quality factors (e.g., nutrients and water temperature), and additional transfers of these AIS would likely have little influence on concentrations in a Hudson Bay basin waterbody such as Lake Winnipeg.

First Nations communities rely heavily on Lake Winnipeg fisheries and other fisheries in waterbodies elsewhere in the Hudson Bay basin for employment as commercial fishermen, for a subsistence food source, and for cultural value. First Nations treaty rights and entitlements in Manitoba provide for Aboriginal rights to hunt, trap, and fish on ancestral lands (AADNC 2010). With such reliance on Lake Winnipeg fisheries, it is expected that First Nations communities would be affected by AIS consequences on fishery resources. In terms of a subsistence food source, the value of the First Nations subsistence fish harvest may be somewhere in the range of $561,000 to $1.6 million annually. (Refer to the Economic Consequences section in

[4] First, residents spend less per trip than non-residents. Second, while non-residents that are attracted to the Province to fish bring in "new money" that grows the size of the Manitoba economy, resident expenditures in the Province would be expected to be stable even if the Lake Winnipeg fishery, or other Manitoba fisheries, were to change in quality (i.e., resident spending may shift to other types of purchases but would be expected to change little in total value). For this reason, studies of the value of recreation to regional economies do not typically include resident spending (see, for example, methodology as described by Stynes 2005).

Appendix E.) Increased food costs could be a noticeable burden on the First Nations communities around Lake Winnipeg because these communities are low income and have a high unemployment rate.

Action Alternatives

Groundwater with Recharge and Groundwater with Recharge and the Souris River Alternatives

These alternatives would not use Missouri River water; thus, no Project-related impacts would occur, and conditions would essentially be the same as under the No Action Alternative.

Missouri River and Conjunctive Use and Missouri River and Groundwater Alternatives

As discussed above, the implementation of either of these alternatives, which include the use of Missouri River water, would add an additional pathway for AIS to enter the Hudson Bay basin and therefore would increase the risk of these species becoming established in this basin. Each of the biota treatment options would reduce this risk. However, the impacts of implementing these alternatives would be essentially the same as described for the No Action Alternative because AIS pathways already exist, and the impacts of an establishment would vary according to which AIS was involved and not the source of introduction. (Refer to Appendix E for additional detail.) Thus, the Missouri River alternatives would neither cause new types of impacts nor cause more severe impacts than could occur under the existing pathways.

Uncertainty

Biological invasions are extremely complex, and it is difficult to predict which species will become established and compromise control or eradication attempts (Cardno ENTRIX and Cohen 2011; Herborg et al. 2007). While historical accounts of invasive species establishment may assist in predicting future locations of introduction and spread, this approach is not without its challenges. There have been instances in which a species with no invasion history has caused very large impacts, such as the invasion of San Francisco Bay by the Asian or overbite clam, and ensuing large-scale changes in phytoplankton blooms and trophic dynamics (Cardno ENTRIX and Cohen 2011). Conversely, impact predictions made from establishment of a species in one ecosystem may not apply to other ecosystems. For example, predictions made in the 1990s that the green crab would decimate the West Coast shellfish industry, based on its impacts in New England and elsewhere, have not materialized (Cardno ENTRIX and Cohen 2011).

The impact potential of parasites and pathogens is highly uncertain, as well. For example, the impact from the introduction of whirling disease has varied greatly. Water temperature (seasonal range and variation), host size and availability, turbidity, flow rate, elevation, substrate, and land use all affect the relative success of the whirling disease parasite (Elwell et al. 2009). The wide range of variables involved makes it difficult to predict with certainty where, when, and under what circumstances the impact of whirling disease might be significant and where it might be benign (Nehring 2006).

Aquatic systems are complex and local conditions are variable, which confounds the ability to identify responsible invasive species introduction pathways. Further, little empirical information exists on the time lapse between introduction and establishment for a specific invasive species in a particular location. For example, quagga mussels are believed to have been first introduced into the Great Lakes in 1986, although they were not detected until 1988. Time lapses may be affected by climate. For instance, duration for some species to take hold and establish in a new environment could be longer in cold climates and shorter in warm environments.

The geographic ranges of species provide some insight into the potential for movement into neighboring areas, including aquatic systems within adjacent drainage basins. However, comprehensive data and information regarding the distribution of mostly single-celled AIS in the Hudson Bay basin and surrounding basins are lacking. There have been few systematic surveys for the majority of these AIS, with a few exceptions including the Devils Lake study (Bensley et al. 2011). Most of the available data on presence/absence and distribution in publicly accessible databases and published literature are largely anecdotal. The lack of comprehensive species distribution information represents an uncertainty that reduces the ability to identify the most likely sources of introduction, characterize the risks of these transfer mechanisms, and predict potential impacts associated with AIS establishment.

In addition, the lack of abundance information for AIS in the Missouri River basin and other adjacent drainage basins precluded the development of a sensitivity analysis, which would have relied on biota concentration as an integral input variable. Because comprehensive abundance and distribution data are largely absent, a qualitative approach was used in the Transbasin Technical Report (Appendix E).

The lack of well-documented impacts of AIS, and related or similar organisms in other aquatic systems, also contributes to uncertainty. Relatively few studies have adequately described the incidence of disease at the individual level and how those effects translated to the population level; and population-level studies tend to be cost-prohibitive (Peeler and Taylor 2011). Ecologists also struggle with the uncertainty related to the question of whether mortality and reduced fertility can lead to recruitment loss and associated declines in populations (Peeler and Taylor 2011).

During the previous risk study associated with the Final EIS (Reclamation 2008), USGS (2007a) described uncertainty related to several components of its analysis of the potential for the Project to result in the introduction of invasive species including, but not limited to:

- Control system operation
- Biota treatment and water transmission pipeline
- Infrastructure materials, installation, and system aging
- Preliminary failure analysis and system designs
- Competing interbasin biota transfer pathways
- Potential system failures and associated risks of biota transfer

USGS concluded that risk of AIS transfer could be reduced by treatment of intake water at the source within the Missouri River basin and transmission through a closed conveyance system (buried pipeline) and delivery to the Hudson Bay basin, consistent with the Red River Valley Water Supply Project (USGS 2005a).

Uncertainty associated with random events was the primary focus of the USGS analysis due to its relevance to mediate failure of individual elements that could result in a system failure and introduction of AIS to the Hudson Bay basin. System failure analysis is complicated by the relationship of factors linked to the interaction among components, as well as the components themselves (USGS 2007a). Stochastic events that can physically damage or compromise a system, no matter how unlikely (e.g., earthquakes) should be considered in design features and within the context of uncertainty. In addition, it is conservative to assume that a system failure would result in a release of AIS-containing water, a transfer of this AIS-containing water to the Hudson Bay basin, and successful establishment of a sustainable population of an AIS in the Hudson Bay basin. However, the actual likelihood of a system failure is highly unlikely, and the probability of an associated transfer of water containing AIS is even more unlikely. The transfer of AIS to the Hudson Bay basin would not guarantee success of that organism in the receiving waters and the resulting potential to infect hosts and cause impacts. Specific spatial and temporal conditions in the Hudson Bay basin may be required for successful AIS establishment, but the precise conditions are not well understood and, therefore, contribute additional uncertainty to an impact analysis.

Biota treatment is integral to the water diversion under the Missouri River alternatives to reduce the risk of AIS transfer to the Hudson Bay basin. Treatment options, including physical removal and disinfection, have been identified for source water from the Missouri River; however, each step of the treatment process exhibits varying levels of uncertainty. In addition, construction materials and the operation and maintenance of transmission and treatment systems have characteristic uncertainties related to system failures and associated biota transfers (USGS 2007a). Some pipe materials may be more supportive of microbial growth, influenced by organic matter in a system, or susceptible to corrosion by certain water chemistry variables both internally and externally (USGS 2007a). The long-term operation and maintenance of a water diversion, including withdrawal, treatment, and transmission, is also characterized by uncertainty, which reduces an accurate estimation of the potential for system failures capable of facilitating biota release and transfer (USGS 2007a).

According to the Council on Environmental Quality Regulations for Implementing NEPA (40 CFR 1502.22), when foreseeable significant adverse effects are being addressed in an EIS, the lack of complete or available information shall be clearly discussed. Thorough research and data acquisition efforts for this Project revealed that the available data were captured during the analysis. There were no discoveries of further cost-prohibitive material acquisitions that would have embellished or strengthened the analysis. Sufficient information was obtained to support sound scientific analysis, even in the absence of additional information that could have reduced uncertainty. The available information supported the ability to draw informed conclusions regarding the risks of AIS introduction and the evaluation of potential impacts of an establishment in the Hudson Bay basin.

Environmental Commitments

Chapter 2 describes design features and management actions that would be used as preventive controls to reduce the risk of interbasin transfer by the Missouri River alternatives. In addition, Reclamation would implement the environmental commitments described in Appendix F to further reduce the potential for risks related to the implementation of a Missouri River alternative. These include consulting with the EPA and other stakeholders as appropriate to develop an adaptive management plan to assess control system efficacy and make modifications to the control system if the risk changes significantly. The adaptive management plan would be developed in accordance with the Department of the Interior’s policy guidance (Order 3270) and technical guidance provided by Williams et al. (2007).

As noted previously, a Project-related invasion would require a series of extremely low-probability events, beginning with an AIS-containing water release from the underground transmission pipeline. Implementation of the adaptive management plan would further reduce the already low potential for the Missouri River alternatives to result in AIS transfer and establishment in the Hudson Bay basin, but this potential cannot be completely eliminated. As noted above, however, although the *risk* of an AIS transfer could increase, *impacts* would be comparable to those of No Action because numerous pathways already exist, and the Missouri River alternatives would not create new or more severe impacts. Thus, no unavoidable adverse impacts would result from their implementation.

Cumulative Effects

AIS biota transfer pathways associated with the Missouri River alternatives would contribute to the existing and reasonably foreseeable non-Project biota transfer pathways to result in a potential cumulative risk of transferring AIS between the Missouri River and Hudson Bay basins. Current non-Project and reasonably foreseeable pathways pose a combined risk in the absence of the Project alternatives. In comparison to the non-Project pathways, the risk contributed by the Missouri River alternatives is very low considering the built-in engineering and management controls that would be implemented, and the cumulative risk posed by the Project would be negligible. Moreover, the biota treatment options have been designed to treat a broad range of AIS life history categories to further minimize the potential risks. Additionally, an adaptive management plan would be implemented that would monitor the effectiveness of the control system and include provisions for modifying the control system if the risk changed significantly.

Although both the non-Project pathways and the Missouri River alternatives would contribute to the total cumulative transfer risk, the existing risk, reasonably foreseeable risk from the Missouri River alternatives, and cumulative risk all would have the same effects if an establishment of AIS were to occur in the Hudson Bay basin. A biological invasion may be attributable to a single transfer pathway, the identity of which would more than likely be unknown. The biological invasion could also be attributable to multiple pathways with effects in the same location. However, the impacts associated with that invasion could be associated with a specific introduction source or multiple disparate sources, and therefore would not be cumulative. As described previously, the potential impacts associated with an AIS establishment would be independent of the introduction source. The impacts would only vary in accordance with the AIS introduced and the location of the introduction, such as within an area that supports susceptible host species for pathogens and/or parasites.

Summary

The *risk* of AIS introduction to the Hudson Bay basin could be slightly increased if one of the Missouri River alternatives were implemented because they would add one, very-low-probability pathway to the already wide variety of pathways that currently exist. The probability of a release of water from the implementation of one of these alternatives that would result in the potential transfer of AIS and subsequent establishment in the Hudson Bay basin would be minimal, however, because of the controls included in the design of each of these alternatives and management actions that would be undertaken to minimize the potential risk. An adaptive management plan would also be implemented, which would further minimize the potential risks. Conversely, the numerous and diverse non-Project pathways that are already present and would continue under the No Action Alternative exhibit a far greater risk for introducing AIS (which are present in adjacent drainage basins) to the Hudson Bay basin. For example, birds, fish, and mammals can transport AIS across large geographic distances. Constructed interbasin water diversions also have the potential to transport invasive species across drainage basins, and there are no standards for treatment of interbasin water transfers to control invasive species.

The potential *impacts* from Project-related AIS introductions and establishment in the Hudson Bay basin would be comparable to those that would occur under the No Action Alternative because numerous pathways for AIS transfer already exist, and these alternatives would not create new types of impacts or increase the severity of impacts that could result from AIS transfer under the current pathways.

Paleontological Resources

Introduction

This section addresses potential consequences to paleontological resources that could result from the No Action Alternative and impacts from construction and implementation of the action alternatives. As noted in Chapter 3, the term "paleontological resource" means any fossilized remains, traces, or imprints of organisms preserved in or on the Earth's crust that are of paleontological interest and provide information about the history of life on earth. Issues considered include the potential for temporary disturbance or loss of paleontological resources from the construction of Project components.

Methods

The areas that could be affected by Project construction and that could contain paleontological resources were identified by Hoganson (pers. comm., 1996) for the Project Environmental Assessment (Reclamation 2001). Records from previous construction of Project components, which occurred in the same geographic area and thus would be expected to have similar impacts, also were considered (Hoganson 2007; Hoganson, pers. comm., 2013). The analysis also considered BMPs (Appendix F) that are part of the Project description:

- All previously recorded paleontological resources and paleontologically sensitive zones within the path of the alternative selected in the Record of Decision would be inspected in the field by a qualified paleontologist. Avoidance measures would be developed to avoid significant resources.
- Reclamation would consult with the North Dakota Geological Survey to identify areas for paleontological survey where significant fossils are likely. Paleontological surveys would be completed prior to construction. Based upon survey data, Reclamation would consult with a qualified paleontologist about revising routes to avoid damaging significant fossil locations.

Results

No Action Alternative

The extent of potential consequences for paleontological resources under the No Action Alternative cannot be assessed quantitatively, as discussed in the introduction to this chapter. Because it is not known what Project members would do in the absence of the Project, the potential impacts are unknown.

Inbasin Alternatives

Paleontological resources generally have not been identified in the Project Area. Through the implementation of BMPs, surveys prior to construction, and avoidance of significant paleontological resources, no adverse impacts on paleontological resources are anticipated.

Missouri River Alternatives

One of two intake options would be constructed at Lake Sakakawea under the Missouri River alternatives. This area has been identified as a location where paleontological resources could potentially occur. BMPs require consultation with the North Dakota Geological Survey and surveys prior to construction, as well as avoidance of significant paleontological resources; therefore, no adverse impacts on paleontological resources are anticipated.

Environmental Commitments

No impacts on paleontological resources are anticipated; therefore, no environmental commitments are identified.

Cumulative Effects

The action alternatives are not expected to affect paleontological resources within the Project Area; therefore, no cumulative effects would occur.

Summary

Due to the lack of significant paleontological resources within the Project Area and implementation of BMPs, no impacts on these resources are anticipated under any of the alternatives.

Land Use

Introduction

This section addresses the potential impacts on land use, recreation, and farmland from construction and operation of the Project components associated with each action alternative. Potential consequences associated with the No Action Alternative are also considered.

Potential impacts analyzed in this section include:

- Short-term disturbance and long-term conversions of existing land use.
- Temporary and long-term conflicts with existing or proposed land use.
- Consistency/inconsistency with local land use plans and zoning.
- Short-term disturbance/interruption and long-term impacts on recreational activities in or near the potential construction areas and adjacent to the Souris River. Recreation impacts associated with the withdrawal of water from the Missouri River are discussed in the "Socioeconomics" section in this chapter.
- Short-term and long-term impacts on protected lands, including an NWR, Waterfowl Production Areas (WPAs), Wildlife Management Areas (WMAs), and wetland and grassland easements, including recreational activities on these lands.

- Short-term disturbance of farmland and potential long-term conversion of farmland, as defined by the National Resources Conservation Service (NRCS) and the Farmland Protection Policy Act.

Methods

Consequences of the No Action Alternative are described qualitatively because specific information regarding the actions Project members might take in the absence of a Project are uncertain, as explained in Chapter 2 and in the introduction to this chapter.

The impact analysis presented below was conducted using information in the ALD Report (Appendix J). As indicated in Chapter 2, the general locations of Project components identified in the appraisal-level design would be refined during the final design of any of the action alternatives. The general locations where Project components would be located are based on the current design, and this impact analysis was conducted within the designated corridors and footprints associated with each component.

Potential impacts were identified by comparing the size and proposed location of the various Project components (including estimates of temporary and permanent surface disturbance based on the current design) to the appropriate GIS mapping layers (i.e., existing land use, NWRs and WPAs, wetland and grassland easements, WMAs, recreational lands, and farmland), and satellite imagery to determine the type, magnitude, and duration of potential impacts on land use, recreation, and farmland from construction and operation of each action alternatives. An economic model was used to evaluate potential Missouri River depletion impacts on land uses, including recreation. These impacts are discussed in detail in the “Socioeconomics” section in this chapter.

GIS mapping information was obtained from a variety of sources and includes general land cover type information from the USGS 2010 Gap Analysis Program (GAP) (USGS 2010), wetland mapping from the NWI (Service 2012h), and information on specific types of farmland from the NRCS North Dakota Soils Map (NRCS 2013). Land use and recreation information also was obtained from satellite imagery available on Google Earth and from a variety of publically accessible websites.

The GAP land cover categories used in this analysis are based on the same data used in the vegetation and wildlife analyses and include cultivated cropland; developed land; developed, open space; mixed-grass prairie; and shrubland. Because the mapping detail for these categories is relatively coarse in scale, the GAP data are useful for a broad identification of existing land cover conditions but become less accurate the larger the scale of analysis (i.e., when showing smaller areas in greater detail).

Results

No Action Alternative

The extent of potential consequences for land use, recreation, and farmland under the No Action Alternative cannot be quantified or fully defined, as discussed in the introduction to this chapter. Some development may occur in the future in order to meet the water quality and water supply needs of Project members if the Project is not implemented, but no information is available regarding the types of development that might be implemented. Given this lack of information regarding future plans, it is not possible to determine whether land use impacts would occur under No Action.

Action Alternatives

Construction and operation of each action alternative would temporarily disturb existing land uses and/or permanently convert existing land uses to Project-related facilities and uses. As shown in Table 4-18, most impacts would be temporary. Many of the land use impacts of the action alternatives would be the same because they share many of the same Project components, including bulk distribution pipelines, storage reservoirs, pump stations, and upgrades to the Minot WTP.

Because the two inbasin alternatives would have the same recharge facilities, peaking wells, and upgraded collector lines, the land use impacts from construction and operation of those Project components would be the same for both alternatives. Similarly, because the Missouri River alternatives would have the same intake and pump station options, Biota WTP and Pump Station options, and South Prairie Storage Reservoir location, the impacts from construction and operation of those components would be the same for both of these alternatives.

One notable difference between action alternatives, however, is the potential effect that reduced flows in the Souris River could have on recreational resources and activities occurring along the river and on the functions of the J. Clark Salyer NWR. The potential for these types of effects is associated with the two inbasin alternatives and the Missouri River and Conjunctive Use Alternative, and these effects are described below under each of these alternatives.

The following discussions describe the potential land use impacts from construction and operation of the Project components common to all action alternatives. Separate discussions are presented for potential impacts on protected lands, including wetland easements, grassland easements, and WPAs; recreation; and farmland because they could be affected by multiple components.

Bulk Distribution Pipelines. The bulk distribution pipeline segments common to all action alternatives (including meter and control valves and other pipeline appurtenances) would be installed within a 110-foot-wide construction corridor. Most of the distribution pipeline segments would be installed immediately adjacent to existing roadways. Construction of the Glenburn to Renville Corner, Westhope and ASWUD System III, and Souris and ASWUD System I pipeline segments in Bottineau County would temporarily disturb approximately 1,057 acres along their collective approximately 58-mile length. Permanent land use impacts from meters, control valves, and other pipeline appurtenances would be less than 1 acre.

Most of the land affected by construction of the Glenburn to Renville Corner, Westhope and ASWUD System III, and Souris and ASWUD System I pipeline segments in Bottineau County would be agricultural land, including land categorized as Developed, Open Space in Table 4-18. Numerous farm houses, outbuildings, and silos are located along the proposed pipeline segment adjacent to major roadways. This pipeline segment could cross the J. Clark Salyer NWR and access roads to two U.S. Air Force missile sites off of U.S. Highway 83. Use of horizontal directional drilling techniques and/or installing the new pipeline within the existing right-of-way of State Highway 5 would be used for the 0.8-mile crossing of the refuge. These construction methods and the BMPs in Appendix F would avoid direct impacts on the refuge and/or access to those lands. Coordination with refuge managers would occur consistent with the BMPs in Appendix F. As with other distribution pipeline segments, impacts on intersecting access roads and driveways would be temporary, and alternative access to affected properties would be provided if necessary.

Table 4-18 Potential Temporary and Permanent Land Cover Impacts by Alternative (approximate acres)

Land Cover	Groundwater with Recharge		Groundwater with Recharge & the Souris River		Missouri River & Conjunctive Use				Missouri River & Groundwater			
					Upgraded SCPP Intake and Pump Station		Intake and Pump Station Adjacent to SCPP		Upgraded SCPP Intake and Pump Station		Intake and Pump Station Adjacent to SCPP	
	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.
Vegetation Land Cover Type												
Cultivated Cropland	126	49	126	49	106	10	106	10	106	10	106	10
Pasture/Hay	15	1	15	1	5	1	5	1	5	1	5	1
Northwestern Great Plains Mixed-Grass Prairie	2	1	2	1	2	1	2	1	2	1	2	1
Northwestern Great Plains Shrubland	20	14	20	14	5	0	5	0	5	0	5	0
Northwestern Great Plains Tallgrass Prairie	0	0	0	0	0	0	0	0	0	0	0	0
Total Vegetation Acres	**163**	**65**	**163**	**65**	**118**	**12**	**118**	**12**	**118**	**12**	**118**	**12**
Other Land Cover Types												
NWI Wetlands	19	<1	19	<1	17	1	17	1	17	1	17	1
Developed Land	182	12	182	12	172	3	172	3	173	3	173	3
Developed, Open Space [a]	767	1	767	1	758	1	758	1	757	1	757	1
Total Disturbance	**1,131**	**79**	**1,131**	**79**	**1,065**	**17**	**1,065**	**17**	**1,065**	**17**	**1,065**	**17**

Land Cover	Groundwater with Recharge		Groundwater with Recharge & the Souris River		Missouri River & Conjunctive Use				Missouri River & Groundwater			
					Upgraded SCPP Intake and Pump Station		Intake and Pump Station Adjacent to SCPP		Upgraded SCPP Intake and Pump Station		Intake and Pump Station Adjacent to SCPP	
	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.

Notes:

NWI = National Wetland Inventory

[a] The USGS has characterized Developed, Open Space areas as containing small amounts of impervious surface (less than 20 percent) and large amounts of vegetation (primarily grasses planted for erosion control, aesthetic purposes, or recreation). A review of aerial photos indicates that the vegetated areas are most likely in agricultural use.

Sources: USGS 2010; Service 2012h

Impacts on homes, businesses, and military facilities during construction of the bulk distribution system would be short term, lasting no more than a few days as construction moved along the corridor. All areas disturbed during pipeline construction would be restored to original contours; and any structures affected by pipeline construction would be replaced, repaired, or restored to original condition as described under General BMPs in Appendix F.

In areas where the bulk distribution pipeline would cross agricultural lands, disturbed areas would be restored with topsoil to the same depth, quality, grade, and relative density as the original surface, consistent with the BMPs in Appendix F. To the extent feasible, construction activities on irrigated lands would be avoided during the growing season.

Bottineau County and many of the small towns potentially affected by the bulk distribution line (i.e., Maxbass and Souris) do not have formal zoning. Two exceptions are the towns of Westhope and Bottineau. Both have formal zoning ordinances that consider water supply-related infrastructure, including pumping stations and water storage reservoirs, as "special uses" subject to City Council approval.

Pump Stations. Construction of the six underground pump stations would temporarily disturb approximately 1 acre or less at each of the proposed pump station sites. Once completed, the permanent footprint at each pump station site would range from less than 0.5 acre to just over 1 acre. All of the proposed pump station sites would be located on undeveloped agricultural land adjacent to existing roadways. Construction and operation of these facilities would not be expected to result in notable land use impacts. Pump stations would either be permitted outright in areas with no formal zoning ordinance or allowed as a conditional or special use subject to local approval.

Storage Reservoirs. The Lansford Storage Reservoir would be located near the intersection of U.S. Highway 83 and 84th Street in Bottineau County. Construction of the reservoir would temporarily disturb 3 acres and could permanently occupy 2 acres of agricultural land. The circular steel reservoir would be compatible with the size and scale of existing buildings and agriculture-related facilities in the area.

The Bottineau Storage Reservoir would be located on a 1-acre site in or near the town of Bottineau. The exact site of the Bottineau Reservoir would be refined during the final design phase to minimize impacts on other land uses, and it would be located on land with compatible zoning consistent with the BMPs in Appendix F.

Minot WTP Upgrades. All of the proposed upgrades to the Minot WTP under the action alternatives would occur within the existing boundaries of the WTP and would not result in land use impacts outside of those boundaries.

Recreation. Construction and operation of the bulk distribution pipelines, storage reservoirs, and pump stations would not have a notable impact on recreation. Most of these facilities would be located in rural agricultural areas, and recreational activities that typically occur on such lands, such as birding and hunting, are allowed on lands throughout the Project Area, except where posted. Thus, ample opportunities for these recreational activities are available, and the temporary disturbance from construction would not preclude the public from participating in these activities. Snowmobiling may be allowed in road rights-of-way, where pipeline construction could occur; however, construction is expected to be limited during the winter, minimizing the potential for impacts. Additionally, only a portion of the pipeline route would be under construction at any given time, which would also minimize the potential for restrictions. If visitors were present in the areas near J. Clark Salyer NWR where horizontal directional drilling techniques may be used or where the new pipeline would be installed within existing highway right-of-way, the presence and operation of heavy machinery nearby could adversely affect recreational activities occurring on refuge lands, including hunting and birding activities. However, because construction activity would be temporary, the additional disturbance from this activity would be negligible, particularly since recreational opportunities are available elsewhere.

Protected Lands. In addition to crossing the NWR described above, construction of the proposed bulk distribution line and two pump stations, as currently designed, could be located on 19 wetland easements affecting approximately 167 acres and one WPA affecting approximately 0.4 acre. During operation, these same Project components could permanently displace approximately 0.4 acre of one wetland easement and approximately 0.003 acre of one WPA. During final design, however, modifications to the pipeline route would be made to avoid wetland and grassland easements and WPAs consistent with the BMPs in Appendix F. Alternatively, horizontal directional drilling construction techniques could be used to avoid surface disturbance in these sensitive areas. If impacts on Service lands, such as grassland easements and WPAs, could not be avoided, the appropriate approval mechanism would be determined based on the extent of the impact and the type of lands affected; such a mechanism could include a refuge compatibility determination consistent with the BMPs in Appendix F. If these Service lands cannot be avoided, then mitigation would be determined in coordination and in agreement with the Impact Mitigation Assessment Team including pertinent regulatory agencies consistent with the environmental commitments for wildlife in Appendix F.

Farmland. Construction of the Project components common to all action alternatives, including bulk distribution pipelines, storage reservoirs, pump stations, and upgrades to the Minot WTP, could temporarily disturb approximately 732 acres of prime farmland and approximately 89 acres of farmland of statewide or local importance (NRCS 2013). Operation of these same Project components could permanently convert approximately 3 acres of prime farmland and approximately 1 acre of farmland of statewide or local importance to Project-related uses. Once final engineering design was complete, NRCS would be contacted concerning the potential to convert prime farmland to non-agricultural use. For areas where prime farmland would be permanently converted to non-agricultural uses, Reclamation would complete and submit a Farmland Conversion Form (AD-1006) to the NRCS in compliance with the Farmland Protection Policy Act. This would be consistent with the BMPs in Appendix F. All temporarily disturbed farmland would be restored with topsoil to the same depth, quality, grade, and relative density as the original surface. To the extent feasible, construction activities on irrigated lands would be avoided during the growing season. Because most impacts on prime farmland and farmland of statewide and local importance would occur only during the construction period, and impacts on farmland would be reduced or avoided through use of BMPs, the overall impact on this resource would be negligible.

Groundwater with Recharge Alternative

In addition to the components common to all action alternatives, the Groundwater with Recharge Alternative includes new recharge facilities, peaking wells, and collector lines. Impacts from these components would be in addition to the impacts described above for all action alternatives. Construction of the additional components associated with this alternative would temporarily impact approximately 75 acres and permanently impact approximately 74 acres. The predominant land uses affected by temporary impacts include developed and undeveloped lands in the City of Minot and agricultural lands and public lands outside the city limits in Ward County.

Construction of the Minot aquifer recharge facility, including the new intake structure, underground feeder line, sediment settling facility, and aquifer recharge basin (with recharge wells, access roads, and other facilities) would temporarily disturb approximately 49 acres and permanently convert approximately 36 acres of land to Project-related facilities; this includes the 35-acre recharge facility plus the 1-acre intake structure. Approximately half the 2,500-foot long feeder line would be installed adjacent to and within the same right-of-way as an existing segment of the bulk distribution pipeline located adjacent to U.S. Highway 83. Above-ground structures would not be allowed within the right-of-way of the new feeder line. The remainder of the feeder line and the recharge basin as currently planned would be constructed on land currently occupied by an active gravel quarry operated by Gravel Products, Inc. of Minot, North Dakota. The quarry is located just west of the Minot city limits in unincorporated Ward County and is currently zoned agricultural (AG). Quarries are permitted uses in the AG zone (Ward County 2010).

The existing Ward County zoning ordinance identifies pumping or booster stations along a pipe line as a permitted use in the AG zone but does not specifically mention sediment settling facilities or aquifer recharge basins. These Project components would likely be considered “special uses” subject to review and approval by the Board of County Commissioners (Ward County 2010).

Construction of the Sundre aquifer recharge facility, including the new intake structure, underground feeder line, sediment settling facility, and recharge basin with recharge wells, access roads, and other facilities would temporarily disturb approximately 44 acres and permanently convert approximately 36 acres of land to Project-related facilities. This includes the 35-acre recharge facility plus the 1-acre intake structure.

The land affected by the Sundre aquifer recharge facility is located in unincorporated Ward County on land zoned AG. While the intake structure would be located within the right-of-way of an existing high-voltage transmission line, the construction and operation of the intake structure would not interfere with operation or maintenance of the existing transmission line, or substantially affect the existing transmission line right-of-way.

The proposed 2,700-foot-long feeder line from the intake structure to the recharge basin would follow the north side of an existing access road. Above-ground structures would not be allowed within the right-of-way of the new feeder line. Both the feeder line and the recharge basin would be constructed near several inactive gravel quarries. The recharge basin could convert approximately 14 acres of an active agricultural field to non-agricultural use. As with the Project components proposed for the Minot aquifer recharge facility, the Project components associated with the Sundre aquifer recharge facility would be considered “special uses” subject to review and approval by the Board of County Commissioners (Ward County 2010). The location of the proposed recharge facility would be reviewed during the final design phase, and its location may be adjusted to minimize impacts on agricultural land consistent with the BMPs in Appendix F.

The four new peaking wells that would draw water from the Minot aquifer would each occupy an approximately 5,400-square-foot site in the City of Minot. The precise location of the peaking wells would be determined during final design; and they would be sited to minimize conflicts with residential development, parks, and businesses, and other land uses in the general area, consistent with the BMPs included in Appendix F. As currently designed, the peaking well sites are located in areas zoned for other purposes and therefore would be subject to approval as "special uses" by the Minot City Council (City of Minot 2004). The two peaking wells drawing water from the Sundre aquifer would each be developed on an approximately 6,500-square-foot site in the City of Minot. As currently proposed, both wells would be located within the Bison Plant Trails open space area, which is owned by the Minot Park District and includes an unpaved 3.1-mile hiking and biking trail that parallels the Souris River and loops around several oxbow lakes. Construction of these wells would also be subject to approval as "special uses" by the Minot City Council (City of Minot 2004). The final location of the peaking wells would be determined during the final engineering design phase, and they would be sited in an area that either avoided the open space area or minimized impacts on the open space area consistent with the BMPs in Appendix F.

Water lines connecting each peaking well to the upgraded collector lines would be installed within existing street rights-of-way in most areas to avoid additional land use impacts. Installation of these lines would cause temporary traffic disruptions in the immediate vicinity of construction activities (refer to Appendix I - Other Minor Issues).

The upgraded collector lines that would convey water from the peaking wells to the Minot WTP would be installed adjacent and parallel to existing collector lines and would be co-located within the same easements. The existing collector lines run parallel to existing roads and railways and across land in the City of Minot and unincorporated Ward County zoned single-family residential, manufactured residential, light industrial, heavy industrial, general commercial, agricultural, and public (i.e., parks and open space). Installation of the upgraded collector lines would temporarily disturb up to 56 acres within a 110-foot-wide construction corridor. All areas disturbed during pipeline construction would be restored to original contours; and any structures affected by pipeline construction would be replaced, repaired, or restored to their original condition, as described under General BMPs in Appendix F. The upgraded collector lines would be subject to approval as "special uses" by the Minot City Council and the Ward County Board of County Commissioners depending on their location (City of Minot 2004; Ward County 2010).

Recreation. Construction of the two proposed peaking wells within the Bison Plant Trails open space area may cause temporary construction noise and access restrictions that could affect recreation activities within the Bison Plant Trails open space area, although as noted above, the peaking wells would be sited in an area that either avoided or minimized impacts on this area. Construction of other Project components associated with this alternative would not have notable effects on recreation activities or facilities. During operation, withdrawal of water from the Souris River to recharge the Minot and Sundre aquifers could adversely affect recreational activities in areas where river flows would be substantially reduced compared to normal or expected flow conditions. For example, the "Water Resources" section in this chapter shows substantially reduced flows from March through August, with an increase in the number of near-zero flow days from an average of 26 per year under the No Action Alternative to 103 days per year under this alternative. The reduced river flows could discourage sport fisherman, hikers, bicyclists, and other visitors from using fishing piers, parks, and recreational trails along the Souris River during these times of year. Potentially affected recreation resources could include parks and trails in the City of Minot such as Dakota Bark Park, the Souris Valley Golf Course, Wee Links Golf Park, Moose Park, Oak Park, Nubbin Park, Riverside Park, Via-View Park, Roosevelt Park, and Green Valley Park. Additional downstream recreation areas potentially affected by reduced flows include the Bison Plant Trails open space area and J. Clark Salyer NWR.

Protected Lands. Construction and operation of the new recharge facilities, peaking wells, and collector lines proposed under this alternative would not impact any known wetland easements, grassland easements or WPAs. Construction impacts on the NWR are discussed above under Action Alternatives. In addition, operation of this alternative would involve reduced flows in the Souris River from March through August, including 103 days with near zero-flow conditions in the area downstream of Minot. As discussed in the Water Resources section in this chapter, the effects of water withdrawals would diminish farther downstream because tributaries contribute flow to the Souris River. Therefore, the removal of water from the Souris River near Minot would not result in the same low flows at the J. Clark Salyer NWR as it would in the immediate vicinity of Minot. As discussed in the Common Wildlife section in this chapter, however, the Service has expressed concern that a flow reduction could further stress the species using the refuge. Flow reductions also could affect recreational use of the NWR, as described under Recreation above.

Such adverse impacts may not be consistent with the provisions of the National Wildlife Refuge System Improvement Act of 1997, which establishes the overall management framework for the NWR, as discussed in the Land Use section of Chapter 3, because they could affect the biological integrity, diversity, and environmental health of the J. Clark Salyer NWR, as well as wildlife-dependent recreational uses at the refuge. The BMPs listed in Appendix F include conducting a refuge compatibility determination if any impacts on the NWR would occur and to ensure that the goals of the refuge would not be compromised.

Farmland. In addition to the impacts from construction and operation of the components common to all action alternatives described above, construction of the new recharge facilities, peaking well facilities, and collector lines associated with this alternative could temporarily disturb approximately 47 additional acres of prime farmland and approximately 4 additional acres of farmland of statewide or local importance. Operation of these same Project components could permanently convert approximately 16 additional acres of prime farmland and 19 additional acres of farmland of statewide or local importance to Project-related uses. Long-term effects on prime farmland would be avoided to the extent feasible, and all disturbed farmland would be restored with topsoil to the same depth, quality, grade, and relative density as the original surface, consistent with the BMPs in Appendix F. To the extent feasible, construction activities on irrigated lands would be avoided during the growing season. For areas where prime farmland would be permanently converted to non-agricultural uses, Reclamation would complete and submit a Farmland Conversion Form (AD-1006) to the NRCS in compliance with the Farmland Protection Policy Act, as also described in Appendix F. Because most impacts on prime farmland would occur during the construction period, and impacts on farmland would be avoided or minimized using BMPs, the overall impact on this resource would be negligible.

Groundwater with Recharge and the Souris River Alternative

Impacts on land use, recreation, and farmland from construction of the Groundwater with Recharge and the Souris River Alternative would be similar to those described above for the

Groundwater with Recharge Alternative because both alternatives share the same proposed components.

The only differences between the two inbasin alternatives would be related to changes in Souris River flows. For example, the Groundwater with Recharge and the Souris River Alternative would have 5 more near zero-flow days per year than the Groundwater with Recharge Alternative (i.e., 108 days vs. 103 days, respectively). This suggests that the Groundwater with Recharge and the Souris River Alternative would have a slightly greater impact on the wildlife and recreators at the J. Clark Salyer NWR, as well as recreators and sport fisherman using parks, trails, fishing piers, and other facilities adjacent to the river, assuming that the recreational behavior of those recreators would be adversely affected by lower flows. (See the Water Resources section for additional information on changes in Souris River flows.)

Missouri River and Conjunctive Use Alternative

In addition to the Project components common to all action alternatives, the Missouri River and Conjunctive Use Alternative includes two new intake/pump station options at Lake Sakakawea, a Biota WTP and pump station, and the South Prairie Storage Reservoir. Impacts from these components would be in addition to the impacts described above for all action alternatives.

Two options are currently being considered for the new intake and pump station on Lake Sakakawea. One would involve modifying the existing SCPP to include new pumps and a new pipeline connection to the southern terminus of the existing transmission pipeline located approximately 2,000 feet north of the SCPP. The second would be a new intake and pump station structure located immediately north of the SCPP. A similar but shorter new pipeline would connect the pump station to the southern terminus of the existing transmission pipeline under the second option.

Modifications at the existing SCPP and construction of the new pipeline connection would temporarily disturb approximately 7 acres of land owned by the Corps along U.S. Highway 83 between Lake Sakakawea and Audubon Lake. Construction of the new pipeline connection to the existing transmission line would require a 125-foot trenchless crossing of U.S. Highway 83, which would be conducted using the jack and bore (also referred to as “pipe ramming”) construction technique to avoid traffic disruptions on the highway.

Construction of a new intake and pump station structure immediately north of the existing pumping plant would temporarily disturb approximately 11 acres of land owned by the Corps.

Construction of the new Biota WTP and pump station (under any of the five potential treatment options) would temporarily disturb up to 11 acres and permanently convert up to 9 acres on an undeveloped 41-acre site in the town of Max. The site is bounded by the Canadian Pacific Railway on the north, by U.S. Highway 83 on the west, by State Route 53 on the south, and by agricultural land on the east. The property was purchased by the State of North Dakota from a private landowner for Project purposes. Historically, the site has been used for agriculture, and satellite imagery shows evidence of recent cultivation. The site of the proposed Biota WTP and pump station is located within the town of Max and would therefore be subject to review and approval by the Max City Council. However, because the site is already owned by the State of North Dakota, and no sensitive land uses are located on or adjacent to the site, no notable direct or indirect land use impacts would be expected from construction and operation of the Biota WTP and pump station.

The proposed South Prairie Storage Reservoir would be a new circular, 105-foot-diameter, 50-foot-high steel tank constructed on a 1-acre site near the junction of U.S. Highway 83 and 205th Avenue in Ward County. An alternative design for the reservoir would be a circular concrete design constructed above ground or partially buried. The proposed reservoir site and surrounding area is primarily agricultural land. The temporary disturbance of 2 acres and the permanent conversion of 1 acre of agricultural land to non-agricultural use in this area would have a negligible impact on crop production and surrounding land use. The proposed reservoir would be a "special use" in this agricultural area, subject to review and approval by the Board of County Commissioners (Ward County 2010).

Recreation. Construction of the new pipeline connection between the SCPP plant or a new intake and pump station on Lake Sakakawea and the existing transmission pipeline would not interfere with vehicle access to the East Totten Trail Campground or the Totten Trail boat ramp located east of U.S. Highway 83. However, during pipeline installation, construction activity and the presence of heavy equipment may temporarily affect the serenity and recreational enjoyment of the area. Construction of other Project components associated with this alternative would have no effect on recreation activities or facilities. The relatively small amount of Souris River water used in the operations of this alternative would not have a noticeable effect on river flows and therefore would not adversely affect sports fishing or recreational activities along the river (See the "Water Resources" section for details regarding changes in flows from this alternative).

Protected Lands. Construction and operation of either intake/pump station option, the Biota WTP and pump station, and the South Prairie Storage Reservoir under this alternative would not impact any known wetland easements, grassland easements, or WPAs. This alternative includes the use of water from the Souris River from March through August, which would reduce the amount of water available at the J. Clark Salyer NWR; but changes would be substantially less than described for the inbasin alternatives because less water would be withdrawn from the river. There would be a slight increase (1 percent) in flows below 10 cfs at the Bantry gage near the NWR and no increase in the number of near zero-flow days downstream of Minot compared to the No Action Alternative. A detailed discussion of water availability for this alternative is included in the "Water Resources" section in this chapter. A refuge compatibility determination also would be conducted for this alternative to ensure that the goals of the refuge would not be compromised.

Farmland. Construction of the Biota WTP and pump station would temporarily disturb up to 11 acres and permanently convert up to 9 acres on a 41-acre site in the town of Max that has historically been used for agriculture. Because the property is currently owned by the State of North Dakota for the purpose of developing a future Biota WTP, development of the site would not represent an impact on farmland. However, in addition to the impacts from construction and operation of the components common to all action alternatives, construction of the South Prairie Storage Reservoir could temporarily and permanently impact approximately 1 additional acre of farmland of statewide or local importance. Disturbed farmland in this location not required for operation of the reservoir would be restored with topsoil to the same depth, quality, grade, and relative density as the original surface, consistent with the BMPs in Appendix F.

Missouri River and Groundwater Alternative

Impacts on land use, recreation, and farmland from construction and operation of the Missouri River and Groundwater Alternative would be similar to those described above for the Missouri

River and Conjunctive Use Alternative because both alternatives share almost the same Project components. Because this alternative does not involve withdrawals from the Souris River, no impacts associated with the Souris River recreation or protected lands within that watershed would occur.

Environmental Commitments

Given the implementation of the BMPs and environmental commitments in Appendix F as described in this section, no additional mitigation would be required for construction impacts, and no unavoidable adverse impacts would occur.

In order to address adverse impacts on the J. Clark Salyer NWR from flow-related changes resulting from the two inbasin alternatives and the Missouri River and Conjunctive Use Alternative, Reclamation would develop and implement an adaptive management plan, in accordance with the Department of the Interior's policy guidance (Order 3270) and the report *Adaptive Management: the U.S. Department of the Interior Technical Guide* (Williams et al. 2007). It is possible, however, that impacts on the wildlife and recreators using the J. Clark Salyer NWR from reductions in water availability at the refuge may be unavoidable, particularly from implementation of the inbasin alternatives.

Cumulative Effects

No projects have been identified that would result in cumulative impacts on land use, recreation, or farmland, including the proposed Mouse River Enhanced Flood Protection Project. Therefore, no cumulative impacts on land use, recreation, or farmland are expected.

Summary

Information is not available regarding future plans in the communities that would be served by the Project if it were not implemented; therefore, it is not possible to determine whether land use impacts would occur under No Action.

All four action alternatives would have similar impacts on land use, recreation, and farmland from construction and operation of the Project components they have in common. These include the bulk distribution pipelines, storage reservoirs, pump stations, and upgrades at the Minot WTP. Together, these Project components would temporarily impact approximately 1,056 acres of land during construction, but the permanent impacts from operation of these components would only be an estimated 5 acres. Both the inbasin alternatives and the Missouri River alternatives would require additional components that would result in different temporary and permanent impacts. The additional temporary and permanent impacts of the inbasin alternatives would be approximately 75 acres and 74 acres, respectively. These estimations are substantially greater than the approximate additional impact acreages for the Missouri River alternatives, which are 9 acres and 12 acres, respectively. Furthermore, most of the land use, recreation, and farmland impacts associated with the inbasin alternatives would result from construction and operation of the new recharge facilities, peaking wells, and collector lines that would be built in and around the City of Minot.

The inbasin alternatives would result in adverse impacts on the J. Clark Salyer NWR due to the reduction in Souris River flows, which could affect both wildlife and recreators. This may not be consistent with the provisions of the National Wildlife Refuge System Improvement Act of 1997 and the impacts may be unavoidable. Impacts would be greatest from the Groundwater with

Recharge and the Souris River Alternative, followed by the Groundwater with Recharge Alternative. The Missouri River and Conjunctive Use Alternative also would withdraw water from the Souris River and could affect the refuge, but impacts would be substantially lessened in comparison to the inbasin alternatives because considerably less water would be withdrawn. The greater magnitude of the impacts from the inbasin alternative component, as well as the negative effects of the seasonally reduced flows in the Souris River from these alternatives, would affect a much larger number of land owners, residents, and recreators than the Missouri River alternatives, and in particular, the Missouri River and Groundwater Alternative, which does not require water to be withdrawn from the Souris River.

Vegetation

Introduction

This section addresses expected changes to upland vegetation that may result from the No Action Alternative or implementation of the action alternatives. The vegetation types that could be affected primarily are agricultural lands, including cultivated cropland, pasture, and hay vegetation types; Northwestern Great Plains mixed-grass prairie; and Northwestern Great Plains shrubland (USGS 2010). Impacts on wetlands, although noted here, are fully addressed in the Wetlands and Riparian Areas section in this chapter. Impacts on developed lands also are noted here but are addressed in greater detail in the previous Land Use section. Developed land includes a mix of residential, commercial, and industrial land uses. The USGS (2010) has characterized lands classified as developed, open space since it includes small amounts of impervious surface (less than 20 percent) and large amounts of vegetation (primarily grasses planted for erosion control, aesthetic purposes, or recreation). A review of aerial photos, however, indicates that the impervious surfaces are likely roads and that the vegetated areas are most likely in agricultural use. Implementation of the action alternatives may temporarily or permanently affect vegetation. Temporary impacts are generally associated with buried pipeline construction or the use of staging areas, after which the land would be restored to its previous condition. Permanent impacts on vegetation are associated with construction of above-ground permanent facilities, such as the Biota WTP and storage reservoirs.

Methods

Consequences of the No Action Alternative are described qualitatively because specifics regarding the types of changes that might occur are not available, as discussed in the introduction to this chapter. The extent and description of existing vegetation was derived from the USGS's 2010 GAP GIS dataset (USGS 2010). The 2010 GAP GIS dataset was based on data prepared in 2005 using 30-meter pixel satellite imagery collected in 1998. Mapped vegetation was compared to the location of proposed components, based on the current design of the action alternatives described in the appraisal-level design (Appendix J), using a GIS analysis. The GIS analysis identified the types and quantities of vegetation that could be temporarily affected within the construction footprint (identified in Chapter 2) and within the footprint of permanent facilities. This analysis calculated vegetation removal and disturbance in the absence of BMPs. The ability of the BMPs and environmental commitments, if required, to minimize or avoid impacts was then considered.

Results

No Action Alternative

The extent of potential consequences on vegetation under the No Action Alternative cannot be quantified; however, consequences could result from the continued operation of water infrastructure. In particular, some vegetative communities are dependent on groundwater, and if groundwater sources were over-used without sufficient natural recharge, vegetative species composition could shift toward drought- or salt-tolerant species. The vegetative communities potentially most affected by changes in depth to the groundwater would include wetland and riparian communities (Le Maitre et al. 1999), which are discussed in the Wetlands and Riparian Areas section in this chapter. Other vegetation communities would be less likely to be affected because average groundwater levels in the areas that would otherwise be served by the Project are below the shallow root zones of the cultivated fields, pasturelands, grasses, and shrublands that are generally present in the area. The average depth to groundwater ranges from 8 feet below ground surface near the City of Mohall to 125 feet below ground surface in the areas served by the North Central Rural Water Consortium. In most areas, the average depth to groundwater is more than 20 feet below ground surface (SWC 2013a).

Action Alternatives

Vegetation could be temporarily disturbed or permanently removed under each action alternative as a result of construction and the use of staging areas, as shown in Table 4-18.[5] This table shows the types of vegetation that could be affected, along with wetlands, developed land, and land classified as developed, open space by the USGS (2010) to provide a complete overview of the types of areas where construction would occur. As indicated in this table, most impacts would be temporary. Some impacts of the action alternatives would be the same because they share a number of common components, including bulk distribution pipelines, storage reservoirs, and pump stations. (Note that some facilities, such as pump stations, as currently designed would be located partially on developed land and partially on vegetated land.) For all action alternatives, the Minot WTP upgrades would be constructed on developed land. Other impacts would be the same for the inbasin alternatives because they have the same components, including recharge facilities, peaking wells, and upgraded collector lines, some of which would be constructed on developed land. Impacts that would be common to the Missouri River alternatives include those associated with components such as the intake and pump station at Lake Sakakawea, Biota WTP and Pump Station, and South Prairie Storage Reservoir. The specific amount and types of vegetation potentially affected would vary between the alternatives due to the differences in components, as shown in Table 4-18. However, the types of impacts that could occur would be similar because the same BMPs, described in Appendix F, would be implemented for each action alternative and because similar types of vegetation would be affected.

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[5] National Wetland Inventory (NWI) (Service 2012h) GIS data are used to define wetland areas in the “Wetland and Riparian Areas” section in this chapter. The Gap Analysis Program (GAP) GIS data (USGS 2010) used for the vegetation analysis also classify some areas as wetland vegetation types, such as depressional wetlands and wet meadow or prairie. NWI data are considered more accurate for the wetland analysis than the GAP data. For that reason, areas classified as a wetland vegetation type in the GAP data but not classified as a wetland in the NWI data are not considered wetlands. These areas are included in the “Vegetation” section grouped with their corresponding upland vegetation type. For example, areas classified by the GAP data as wet meadow or prairie that are not also classified as wetlands in the NWI data are considered prairie herein.

Implementation of the BMPs described in Appendix F under the General and Vegetation and Land Use categories would minimize or avoid impacts on vegetation. During construction, native prairie and shrub vegetation would be avoided to the extent practicable, and forested lands would be entirely avoided; topsoil would be salvaged, stored, and replaced; disturbed areas would be revegetated with species appropriate to ecological conditions of the surrounding area (except for cropland); and coordination with the NRCS would be conducted in compliance with the Farmland Protection Policy Act, if required.

Other general construction BMPs would also avoid or minimize impacts on vegetation by requiring that federal, state, and local wildlife areas and refuges and designated critical habitats be avoided to the extent practicable. Construction limits would be clearly marked with stakes or fencing prior to beginning ground-disturbing activities, with disturbance prohibited beyond marked limits except for nondestructive protection measures for erosion/sediment control. Material and equipment storage would be limited to designated staging areas situated outside of vegetated areas. BMPs would minimize the potential for permanent vegetation impacts because components would be sited to avoid vegetated areas to the extent practicable. Environmental commitments would be implemented under each action alternative if required to mitigate impacts that could not otherwise be avoided.

Groundwater with Recharge Alternative

Approximately 163 acres of vegetation could be temporarily disturbed during construction of the buried bulk distribution system pipelines, most of which (78 percent of temporary vegetation impacts) would be cultivated cropland, as shown in Table 4-18. Other vegetation that could be temporarily disturbed includes shrublands (12 percent), pasture/hay (9 percent), and prairie (1 percent). Table 4-18 also identifies other land cover types, as classified by the USGS (2010), that would be temporarily disturbed. A review of aerial photographs was conducted for lands identified as developed, open space; this review indicated this land is currently in agricultural use. Approximately 767 acres of such land would be temporarily disturbed. Temporary impacts would be minimized or avoided by implementation of BMPs, as described above; thus, impacts are expected to be negligible upon their implementation.

This alternative could also result in the permanent loss of approximately 65 acres of vegetation, most of which would be cultivated cropland (75 percent of permanent impacts), as shown in Table 4-18. Impacts would also occur to shrublands (21 percent), pasture/hay (2 percent), and prairie (2 percent); approximately 1 acre of developed, open space also could be permanently affected. These permanent impacts would result from construction of the Minot and Sundre aquifer recharge facilities, six peaking well facilities, upgraded collector lines, and six new pump stations, as shown in Figures 2-2 and 2-3 and described in Chapter 2. Upgrades to the Minot WTP would occur entirely on developed land and would not affect vegetation. If permanent impacts on 14 acres of shrublands and 1 acre of prairie cannot be avoided by the siting of Project components, measures to address the impacts would be provided, as described in the Environmental Commitments discussion below.

Groundwater with Recharge and the Souris River Alternative

Vegetation impacts of this alternative would be the same as those of the Groundwater with Recharge Alternative, as shown in Table 4-18, because this alternative would result in the same amount of ground disturbance in the same locations.

Missouri River and Conjunctive Use Alternative

Approximately 118 acres of vegetation could be temporarily disturbed during construction of the bulk distribution pipelines, most of which (90 percent) would be cultivated cropland, as shown in Table 4-18. Other temporary disturbances would occur to shrublands (4 percent), prairie (2 percent), and pasture/hay (4 percent); 758 acres of developed, open space also would be disturbed. Two intake options at Lake Sakakawea are being considered for this alternative; the overall acreage affected by each option would be the same, but the option involving upgrades to the existing facility would affect more developed land. Temporary impacts would be minimized or avoided by the implementation of BMPs, as described above. The temporary vegetation impacts of this alternative are expected to be negligible upon implementation of the BMPs.

This alternative could result in the permanent loss of approximately 12 acres of vegetation from construction of components common to all alternatives, as well as from the Biota WTP and pump station, South Prairie Storage Reservoir, the intake and pump station at Lake Sakakawea, storage reservoirs near Lansford and Bottineau, and six pump stations (Table 4-18). Most of the affected areas would be cultivated cropland (83 percent), although approximately 1 acre each of pasture/hay and prairie would be lost (approximately 8 percent of each; totals do not add up to 100 percent due to rounding). Approximately 1 acre of developed, open space also could be permanently affected. No shrublands would be permanently disturbed under this alternative. If unanticipated permanent impacts on the 1 acre of prairie cannot be avoided by the siting of Project components, mitigation would be provided as described in the Environmental Commitments discussion below.

Missouri River and Groundwater Alternative

Vegetation impacts of this alternative would be the same as those of the Missouri River and Conjunctive Use Alternative, as shown in Table 4-18, because this alternative would result in the same amount of ground disturbance in the same locations.

Environmental Commitments

If impacts on native prairie cannot be avoided during construction of the action alternatives, the following environmental commitment would be implemented:

- Native prairie would be mitigated acre for acre.

Once the final Project design was complete, the Impact Mitigation Assessment Team would evaluate the potential for impacts on shrublands to determine whether impacts could be avoided by the siting of Project components, or they would provide guidance for appropriate mitigation at that time. Such guidance would likely include restoring an appropriate amount of shrublands elsewhere.

Although this analysis has shown that no impacts on woodlands would occur, the following environmental commitment would be implemented if unanticipated impacts on woodlands were identified either prior to or during construction:

- Woodlands would be mitigated at a ratio of 2:1 acres.

Given the implementation of the BMPs and the above environmental commitments, no unavoidable adverse impacts would occur. A complete description of BMPs and environmental commitments is included in Appendix F.

Cumulative Effects

No projects that would result in a cumulative impact on vegetation have been identified, including the Mouse River Flood Protection Project; thus, no cumulative impacts would occur.

Summary

Consequences of the No Action Alternative cannot be quantified but could include changes in groundwater levels leading to a change in species composition. Under all the action alternatives, most impacts would occur in cultivated areas, with lesser impacts on shrublands, pasture/hay, and Northwestern Great Plains prairie. Forested areas are not expected to be affected. Most impacts would be temporary because disturbed areas, including those associated with buried pipelines, would be restored after construction was completed in accordance with the BMPs identified in Appendix F.

Each of the inbasin alternatives could result in the temporary disturbance of approximately 163 acres of vegetation (78 percent cultivated cropland, 12 percent shrublands, 9 percent pasture/hay, and 1 percent prairie). Additionally, 767 acres of developed, open space could be disturbed, most of which is currently in agricultural use. These alternatives could result in the permanent disturbance of approximately 65 acres of vegetation (75 percent cultivated cropland, 21 percent shrublands, 2 percent pasture/hay, and 2 percent prairie). Additionally, 1 acre of developed, open space could be permanently disturbed. The Missouri River alternatives would result in similar temporary impacts, potentially affecting approximately 118 acres of vegetation (90 percent cultivated cropland, 4 percent shrublands, 2 percent prairie, and 4 percent pasture/hay) and 758 acres of developed, open space. Permanent impacts would be much less, with only approximately 12 acres of vegetation affected (83 percent cultivated cropland and approximately 8 percent each of pasture/hay and prairie; totals do not add up to 100 percent due to rounding). One acre of developed, open space could also be permanently affected.

BMPs would be implemented to minimize or avoid impacts on vegetation, and environmental commitments would be implemented as needed to further reduce impacts resulting from construction. Thus, the temporary vegetation impacts of each alternative are expected to be negligible upon implementation of the BMPs. No unavoidable adverse permanent impacts would occur.

Wetlands and Riparian Areas

Introduction

This section addresses changes to wetlands and riparian habitats that may result from the No Action Alternative or implementation of the action alternatives. Issues considered include the potential for temporary or permanent disturbance or loss of wetlands and riparian vegetation from the construction of Project components, as well as the potential for effects of water withdrawal from the Souris River and Missouri River on the amount of water available to wetland and riparian areas.

The wetland types that could be affected include riverine, lacustrine, and palustrine. Riverine wetlands are subdivided into perennial, intermittent, and ephemeral streams. Lacustrine wetlands are lakes. Palustrine wetlands include prairie potholes, which are influenced mainly by isolated groundwater or local surface runoff. Riparian areas are defined as vegetation that occurs along and is influenced by streams and rivers. Riparian habitats are typically dominated by plant species dependent upon a hydrological regime of the adjacent waterbody. Riparian vegetation may be herbaceous, scrub-shrub, or forested.

Methods

Consequences of the No Action Alternative were assessed qualitatively for the Souris River basin because detailed information is not available regarding the changes that could occur. For the Missouri River basin, the consequences of the No Action Alternative and impacts of the action alternatives were assessed by simulating the effects of future non-Project depletions, reservoir sedimentation, and Project depletions on Missouri River System operations. As discussed in the Water Resources section in this chapter, a study was initiated with the Corps to analyze effects of non-Project and Project water withdrawals from the Missouri River. This study, *Cumulative Impacts to the Missouri River for the Bureau of Reclamation's Northwest Area Water Supply Project* (Corps 2013a), assessed the effects of these depletions using a hydrologic analysis that addressed potential changes in reservoir levels and dam releases. This hydrologic information, which is discussed in depth in the Water Resources section in this chapter, was then used to evaluate the consequences of No Action and impacts of action alternatives on Missouri River wetland and riparian resources.

For the Souris River basin, the proposed construction footprint and the changes in surface water and groundwater hydrology described in the Water Resources section were used to assess impacts of the action alternatives on wetland and riparian resources.

The analysis of the action alternatives included the following steps:

- Assess the amount of wetlands that potentially could be temporarily and permanently affected by construction of Project components. The assessment was conducted by overlaying all areas that could be directly affected by Project construction over wetland mapping from the NWI GIS dataset (Service 2012a). The description of potential impacts was based on the extent of each wetland type estimated to be present within the construction and facilities footprint before the application of BMPs.
- Conduct a GIS analysis to determine which Project components would be constructed within or near streams, where riparian vegetation could be present, using hydrographic data obtained from the national hydrography dataset (USGS 2013e). Identification of the riparian vegetation types present at stream crossings was interpreted from 2010 aerial photography (ESRI 2013).
- Consider the ability of the BMPs and environmental commitments to minimize or avoid construction-related impacts.
- Qualitatively assess the potential effects of surface water withdrawal on surface water-influenced wetlands and riparian habitat occurring within the Souris River floodplain, downstream of the withdrawal point, during Project operations. (This is applicable only to the two inbasin alternatives and the Missouri River and Conjunctive Use Alternative.) This analysis includes downstream effects on the J. Clark Salyer NWR. Effects of withdrawals on wetlands and riparian areas on the river banks and in the meandering channels also were evaluated qualitatively, as were impacts on wetlands from changes in the groundwater levels of the Minot and Sundre aquifers under each of the action alternatives. This analysis draws on information provided in the Water Resources sections in Chapters 3 and 4 and is based on

changes in river flows at different times of the year, as well as the interactions of the Souris River and the Minot and Sundre aquifers.

The following data limitations are associated with the analysis described above:

- Wetland data used for this analysis are from the NWI, which is based on USGS topographic maps, soil survey maps, and remote sensing data. These data are intended to provide a regional description of wetlands but are not necessarily accurate for fine-scale use. The NWI data have not been ground-truthed or field delineated. These data were used to quantitatively analyze the potential for impacts due to construction of the action alternatives. However, any potential changes in surface water level affecting these wetlands could be within the margin of error of the existing data; thus, all discussions of effects from surface water and groundwater withdrawal and aquifer recharge are qualitative.
- Characterization of riparian vegetation is based on interpretation of 2012 aerial photography using GIS software and professional judgment.

Analysis and discussions relating to potential impacts from changes in flows downstream of Minot are qualitative due to limited information available regarding flows between gages and the natural variability in flows from year to year. Future Project withdrawals would also be subject to operational constraints and changes, such as senior water rights and adaptive management.

Results

No Action Alternative

The extent of changes in wetlands and riparian areas that would occur under the No Action Alternative cannot be quantified, as discussed in the introduction to this chapter. Continued groundwater withdrawal from the Minot and Sundre aquifers would be unlikely to affect wetlands overlaying them because groundwater levels have already declined to a level where they do not feed these wetlands. (See the Water Resources section.) Riparian areas generally are located along rivers and streams, which serve as their primary water supply; thus, continued withdrawals from deeper aquifers are not expected to affect riparian vegetation.

Project Area communities have not identified plans to use Missouri River water under the No Action Alternative. Reasonably foreseeable non-Project withdrawals from the Missouri River that could occur between 2010 and 2060 have been identified (Appendix D). The effect of reservoir sedimentation from 2010 to 2060 was an additional factor that was considered. This section describes the consequences of No Action in relation to reservoir water levels and dam releases that have the potential to affect Missouri River wetland and riparian areas. When considering Missouri River wetland and riparian areas the discussion focuses on lacustrine wetlands in the reservoirs and riparian areas and riverine wetlands in the areas below the dams.

From the Corps analysis (2013a) for the upper three Missouri River reservoirs (Fort Peck, Garrison, and Oahe), the daily water surface elevations for No Action (including sedimentation and potential future depletions) were found to be generally higher than existing conditions, with the difference less than 5 feet for most of the period of record (85 to 90 percent of the time). The average elevation for the upper three reservoirs would increase 0.6 to 1.0 foot under No Action. However, as water system storage decreases, navigation service could be decreased in more years than under existing conditions. This decrease in navigation flows to conserve Missouri

River System water would result in slower drawdown in the April through July timeframes in many years, resulting in higher water surface elevations in those months on the upper three reservoirs. Following drought years like the 1930s, where there is limited to no navigation service, water surface elevation could increase more than 5 feet over existing conditions. Because reservoir levels would generally be higher under No Action than under existing conditions, lacustrine wetland areas would likely expand due to higher reservoir elevations.

To put these potential elevation changes under the No Action Alternative in perspective, the average annual pool fluctuation at Fort Peck reservoir is about 10 feet, Garrison reservoir is about 12 feet, and Oahe reservoir is about 13 feet. Changes in reservoir levels would be within the normal range of annual reservoir level fluctuation, with the overall effects of No Action on lacustrine wetland resources being slightly beneficial.

Dam release information can be used to evaluate potential consequences to riparian areas and riverine wetlands below the dams. Releases from the upper three reservoirs are based on the need to balance the effects of depletions, sedimentation, and flood storage evacuation while ensuring that the Gavins Point Dam releases are sufficient to meet downstream navigation and flood control targets. Under No Action, average annual releases from these dams would decrease slightly (less than 2 percent) compared to existing conditions (Corps 2013a), with the decrease nearly equal to the reasonably foreseeable future non-Project depletions. (See the Water Resources section for more detail.) Therefore, consequences to riparian areas and riverine resources would be small and include changes over existing conditions that are not likely measurable.

Action Alternatives

Temporary and permanent impacts on wetlands and riparian habitats have the potential to occur as a result of Project construction. Most potential construction-related impacts would be identical for all of the action alternatives because they each include the same bulk distribution pipelines, which would be located in proximity to wetlands and riparian areas. Although the specific amount and types of wetlands and riparian areas potentially affected would vary slightly between the inbasin and Missouri River alternatives due to the differences in components, as shown in Tables 4-19 and 4-20, the types of impacts that could occur as a result of Project component construction would be similar because the same BMPs and environmental commitments (Appendix F and the Environmental Commitments section below) would be implemented for each action alternative.

The BMPs included in the General, Surface Water, Water Quality, Wetlands/Riparian Areas, and Vegetation and Land Use categories in Table F-1 (Appendix F) would minimize or avoid impacts on wetlands and riparian areas from construction. Due to the implementation of these BMPs, temporary construction impacts would be minimized by avoiding wetlands and riparian areas to the extent practicable. An example of wetland avoidance is shown in Figure 4-43. The top photograph shows the initial proposed pipeline route (in red), the middle photograph shows the actual alignment during construction (curving line), and the bottom photograph shows the same location 1 year after construction.

If wetlands could not be avoided during construction, they would be reestablished after construction by restoring previous elevation contours, compacting trenches sufficiently to prevent drainage along the trench or bottom seepage, salvaging and replacing topsoil, backfilling in a way that did not drain the wetland, and reestablishing the wetland so it was a similar type and had a similar function as it had before construction. Additionally, erosion control measures would be implemented where appropriate, including at all stream crossings, which would minimize the impacts. Figure 4-44 illustrates a wetland before and after a temporary construction disturbance. The figure on the left shows a wetland that could not be avoided prior to construction. The wetland was pumped dry to bury the pipeline and then allowed to refill naturally. The figure on the right shows the same location 1 year following construction.

Wetlands also would be protected from the spread of invasive species by ensuring that any equipment previously used in wetlands or areas with non-native invasive species infestations would be cleaned before being used for Project construction.

In addition to protection and restoration measures described above, any permanent wetland impacts would be mitigated acre-for-acre as required by the Project's authorizing legislation. Environmental commitments are described below and also in Appendix F.

Riparian areas also would be protected because pipeline construction at stream crossings would be achieved by boring underneath them wherever possible, and existing trees along the streambanks also would be preserved where feasible, thus protecting riparian habitats and streambank stability. Streambeds and embankments that are disturbed would be stabilized, restored, and revegetated as soon as construction was complete. Streambeds and embankments would be maintained until they were stable, thus further minimizing impacts. If riparian vegetation were disturbed, it would be replanted in a way that maintained the ecological characteristics of the site, preserving the shading characteristics of the watercourse and the aesthetic nature of the streambank.

Impacts on wetlands and riparian areas specific to each action alternative are described below. In addition to impacts from construction activities, impacts could result from operations, which involve the use of river water and groundwater and are different for each alternative.

Table 4-19 Potential Temporary and Permanent Wetland Impacts from Construction (acres)

	Groundwater with Recharge		Groundwater with Recharge & the Souris River		Missouri River & Conjunctive Use				Missouri River & Groundwater			
					Upgraded SCPP Intake and Pump Station		Intake and Pump Station Adjacent to SCPP		Upgraded SCPP Intake and Pump Station		Intake and Pump Station Adjacent to SCPP	
Wetland Type	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**
Riverine Wetlands	1	<1	1	<1	0	0	0	0	0	0	0	0
Lacustrine Wetlands	2	0	2	0	2	<1	2	<1	2	<1	2	<1
Palustrine Wetlands	—	—	—	—	—	—	—	—	—	—	—	—
Intermittently Exposed	<1	0	<1	0	<1	0	<1	0	<1	0	<1	0
Seasonally Flooded	5	0	5	0	4	0	4	0	4	0	4	0
Semipermanently Flooded	5	0	5	0	5	0	5	0	5	0	5	0
Temporary Flooded	6	0	6	0	6	0	6	0	6	0	6	0
Total	**19**	**<1**	**19**	**<1**	**17**	**<1**	**17**	**<1**	**17**	**<1**	**17**	**<1**

Note:

The acreages listed here are approximate.

Source: Service 2012a

Table 4-20 Riparian Areas Affected by Stream Crossings

Riparian Type	Number of Crossings			
	Groundwater with Recharge	**Groundwater with Recharge & the Souris River**	**Missouri River & Conjunctive Use**	**Missouri River & Groundwater**
Perennial Streams				
Forested	1	1	0	0
Scrub-Shrub	2	2	0	0
Herbaceous	4	4	2	2
Perennial Total	*7*	*7*	*2*	*2*
Intermittent Streams and Ditches				
Forested	0	0	0	0
Scrub-Shrub	0	0	0	0
Herbaceous	22	22	21	21
Intermittent Total	*22*	*22*	*21*	*21*
Total	**29**	**29**	**23**	**23**

Source: USGS 2013a

Figure 4-43 Wetland Avoidance

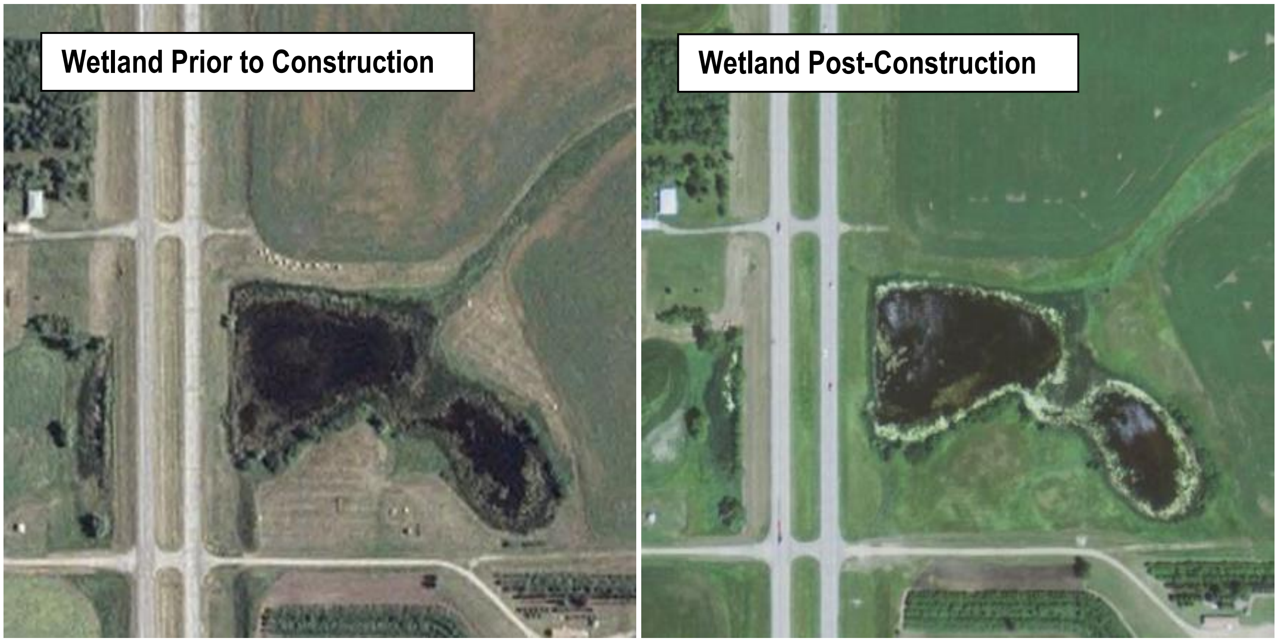

Figure 4-44 Temporary Wetland Disturbance

Groundwater with Recharge Alternative

This alternative is estimated to result in the temporary disturbance of 19 acres of wetlands, most of which (16 acres) would be palustrine, as shown in Table 4-19. Implementation of this alternative also would require 29 stream crossings during pipeline construction, potentially affecting the types of riparian vegetation shown in Table 4-20. As discussed above, impacts would either be minimized or avoided by the implementation of BMPs; impacts not avoided by the BMPs would be mitigated to compensate for the impact, as discussed in Appendix F and the "Environmental Commitments" discussion below.

This alternative could also result in the permanent loss of less than 1 acre of riverine wetlands from construction of each new intake structure on the Souris River at Minot. If this impact could not be avoided by relocating the structure, which may not be feasible because it must be located at the Souris River, environmental commitments would be implemented to compensate for the impact, as discussed below and in Appendix F.

Operation of this alternative would result in the withdrawal of Souris River water between March and August, which would reduce flows in the river downstream of Minot during these months; details regarding changes in river flow are described in Chapter 2 and in the Water Resources section in this chapter. As discussed in the Water Resources section in Chapter 3, construction of the flood protection levees near Minot (Barr Engineering et al. 201; Barr Engineering 2013) has resulted in decreased opportunities for river water to overbank onto the floodplain. Downstream of the levees, overbanking can also occur during high flows with recharge of shallow groundwater that supports wetlands and riparian areas within the floodplain. During dry and normal conditions, overbanking does not occur; therefore, under these conditions, reduction of river flow would not directly affect wetlands or riparian areas within the floodplain outside and downstream of the levees. Overbanking can occur during high flows (i.e., floods), and while this can affect wetlands and riparian areas, the Groundwater with Recharge Alternative would not have a perceptible effect on high flows when compared to the No Action Alternative. Therefore, this alternative would have a negligible effect on wetlands outside the levees but within the floodplain and within the floodplain downstream of the levees.

The reduced Souris River flows as a result of this alternative would periodically result in a slightly narrower wetted cross section of the river and more frequent exposure of the toe of the river bank during spring and summer, as discussed in the Water Resources section in this chapter. In dry conditions, this would allow herbaceous and fast-growing scrub-shrub wetland and riparian vegetation to grow farther downslope, toward the water in the river channel. Since the change in the range of flows from this alternative is within the natural range of flows that already occurs and would continue to occur under No Action, the increased narrowing of the channel under some flow conditions could temporarily alter the extent of wetland/riparian vegetation but would not have an impact on the composition or integrity of wetland and riparian species in the affected areas.

Impacts on established wetlands and riparian areas along the river bank or within the meandering channel could occur, however, due to the lowering of the water level in the river and the change in pattern of the flows in the Souris River under dry or normal conditions. Wetlands and riparian vegetation along the upper banks could be reduced temporarily in localized areas, but as described in the Water Resources section, the Souris River is already highly variable and both wetland and riparian vegetation are adapted to this highly variable environment. Shrubs and herbaceous vegetation would be least likely to experience long-term effects since they can more rapidly react to changes in water availability; trees would experience the greatest stress during dry periods. In particular, lower river levels during the spring and summer (growing season) could cause at least partial lowering of the shallow groundwater draining from bank areas along the river, potentially affecting the root systems of trees in localized areas. During high flows, any change would be imperceptible. Impacts specific to the J. Clark Salyer NWR are addressed in the Water Resources, Common Wildlife, and Land Use sections of this chapter.

Water in the Souris River is a source of recharge to the regional groundwater aquifers via infiltration. (Refer to the Water Resources section in Chapter 3.) This alternative would decrease river flows yet increase the rate of overall recharge to the Minot and Sundre aquifers through the use of new recharge basins, which could result in an increase in groundwater levels. Since the wetlands overlying the Minot and Sundre aquifers are no longer hydrologically connected to the aquifers, any changes in groundwater levels from aquifer recharge would not adversely affect wetlands and could be beneficial in the long term if aquifer levels return to near-surface levels. (Refer to the Water Resources section in this chapter for further discussion.)

No change in Missouri River hydrology would occur because this alternative does not use Missouri River water; therefore, no impacts on wetlands or riparian vegetation in the Missouri River System would occur.

Groundwater with Recharge and the Souris River Alternative

Impacts on wetlands and riparian vegetation from construction of this alternative would be as described for the Groundwater with Recharge Alternative because both alternatives include the same components, and the same BMPs and environmental commitments would be implemented if needed.

Effects on floodplain wetlands and riparian vegetation due to water withdrawals from the Souris River during operation of this alternative would be similar in nature to but slightly greater than those described for the Groundwater with Recharge Alternative because water would continue to be withdrawn for direct delivery after the annual quota of 4.5 bgy for aquifer recharge is reached. (Refer to the Water Resources section in this chapter for details.) Since water withdrawn would only constitute a fraction of the total flow during high-flow events under this alternative, operation would not substantively affect the number of overbank flow events, nor would it affect the seasonal timing or duration of these events. Thus, this alternative would not have measurable effects on the recharge of wetlands or the hydration of riparian areas within the floodplain but outside or downstream of the levees. Wetlands and riparian areas along the river bank or within the meandering channel would be affected by the lowering of the water level and the change in flow pattern in the Souris River in dry or normal conditions, similar to the Groundwater with Recharge Alternative, although the impacts would be increased slightly due to the greater volume of water that would be withdrawn through the summer.

Like the Groundwater with Recharge Alternative, this alternative is expected to result in stable or increasing groundwater levels of the Minot and Sundre aquifers by artificially recharging the aquifers. As described for that alternative, the wetlands overlying the Minot and Sundre aquifers are no longer hydrologically connected to the aquifers; therefore, any changes in groundwater levels from aquifer recharge would not adversely affect wetlands and could be beneficial in the long term if aquifer levels return to near-surface levels. No change in Missouri River hydrology would occur because this alternative does not use Missouri River water; therefore, no impacts on wetlands or riparian vegetation in the Missouri River system would occur.

Missouri River and Conjunctive Use Alternative

This alternative could result in the temporary disturbance of an estimated 17 acres of wetlands, most of which (15 acres) would be palustrine, as shown in Table 4-19. Implementation of this alternative would also require 23 stream crossings, potentially affecting the types of riparian vegetation shown in Table 4-20. As discussed above, impacts would either be minimized or avoided by the implementation of BMPs.

This alternative also could result in the permanent loss of less than 1 acre within Lake Sakakawea, a lacustrine wetland, from construction associated with the Upgraded SCPP Intake and Pump Station option and up to 1 acre from construction of the inlet and channel associated with the Intake and Pump Station Adjacent to SCPP option. Impacts from these options could not be avoided because these components must be located at Lake Sakakawea; therefore, environmental commitments would be implemented to compensate for any impact, as discussed below and in Appendix F.

Effects on floodplain wetlands and riparian vegetation due to water withdrawals from the Souris River during operation of this alternative would be similar to but substantially less than those described for the Groundwater with Recharge or Groundwater with Recharge and the Souris River alternatives because less water would be withdrawn from the Souris River. Therefore, impacts on wetlands and riparian areas located along the river banks and meandering channels would be correspondingly reduced. As described for the Groundwater with Recharge Alternative, Project operations would not have measurable effects on the recharge of floodplain wetlands or hydration of riparian areas by the surface water flows of the Souris River.

This alternative does not include artificial recharging of the Minot and Sundre aquifers. However, less water would be withdrawn from the aquifers than would occur under No Action, which could result in stabilization or long-term increase in the water levels of these aquifers.

This would not adversely affect wetlands overlying the Minot and Sundre aquifers and could be beneficial in the long term if aquifer levels return to near-surface levels.

Missouri River

For the Missouri River System, dam releases are dependent on a variety of factors, including reservoir pool elevations, downstream flow targets for flood control, navigation, water supply, water quality, hydropower requirements, recreation, fish and wildlife, and intrasystem balancing for all authorized purposes. The mainstem projects are operated as an integrated system to achieve the multipurpose benefits for which they were authorized. Regulation of the Missouri River System follows a repetitive annual cycle that is described in detail in the Master Water Control Manual (Corps 2006).

Reservoir Impacts

For the upper three Missouri River reservoirs (Fort Peck, Garrison, and Oahe), the difference in daily water surface elevation between No Action and both Average Annual Project Depletions and Maximum Possible Project Depletions simulations would generally be very small. For example, the difference in simulated elevations at Lake Sakakawea would be within approximately 1 foot 95 percent of the time over the period of record, with a mean difference of 0.007 feet, or less than 0.1 inch. By comparison, the average annual water level fluctuation at Lake Sakakawea is 11.5 feet. Potential changes in reservoir levels would be well within the range of normal variation and would not have adverse impacts on lacustrine wetlands.

> **From Water Resources Section**
>
> **Average Annual Project Depletions –** Simulation of future (2060) Missouri River System operations, including existing and reasonably foreseeable future non-Project depletions plus decreased storage capacity due to sedimentation, and the average annual Project depletions of 0.0136 million acre-feet (MAF).
>
> **Maximum Possible Project Depletions –** Simulation of future (2060) Missouri River System operations, including existing and reasonably foreseeable future non-Project depletions plus decreased storage capacity due to sedimentation, and the maximum possible Project depletions of 0.0291 MAF.

Dam Release Impacts

Changes in dam releases could affect downstream riparian areas and riverine wetlands. The Corps' analysis (2013a) found differences in mean annual releases from Missouri River System dams between the Average Annual Project Depletion and Maximum Possible Project Depletion simulations and No Action would likely be undetectable. For example, the difference in the mean annual release from Garrison Dam would be 20 cfs (-0.1 percent), and the difference at Gavins Point Dam would be 15 cfs (-0.06 percent). These very small decreases would not adversely affect Missouri River riparian areas and riverine wetlands.

Missouri River and Groundwater Alternative

Impacts on wetlands and riparian vegetation from construction of this alternative would be as described for the Missouri River and Conjunctive Use Alternative because both alternatives include the same components, and the same BMPs and environmental commitments would be implemented if needed.

No Project-related impacts on wetlands and riparian vegetation located along the Souris River would occur because no Souris River water would be used. The discussion of groundwater in the

Minot and Sundre aquifers under the Missouri River and Conjunctive Use Alternative is applicable to this alternative, although less groundwater would be used.

Changes in Missouri River hydrology and resulting impacts on wetlands and riparian vegetation are the same as discussed above for the Missouri River and Conjunctive Use Alternative.

Environmental Commitments

BMPs and environmental commitments are fully described in Appendix F. In the event that wetlands could not be avoided during construction of any of the action alternatives, the following environmental commitments would be implemented:

- When pipeline construction through a stream or wetland basin is unavoidable, existing basin contours would be restored and trenches would be sufficiently compacted to prevent any drainage along the trench or through bottom seepage.
- Where open trench crossing of a stream is required, the stream channel would be reestablished following pipe installation.
- Where any wetlands are disturbed during construction, topsoil would be salvaged before construction and replaced. Revegetation plans would be would be specifically designed for these areas to ensure reestablishment of a similar type and quantity of native wetland vegetation.
- Any effects on jurisdictional waters of the United States would occur only with authorization from the Corps, and a compensatory mitigation plan would be prepared if required.
- Permanent wetland impacts would be mitigated acre for acre with ecologically equivalent habitat, as required by the Project's authorizing legislation.

Given the implementation of these environmental commitments, no unavoidable adverse impacts would occur from construction of Project components. Impacts associated with reduced Souris River flows would be unavoidable. Impacts on wetlands and riparian areas associated with Missouri River withdrawals would likely be undetectable and would not require additional mitigation.

Cumulative Effects

The results of a preliminary wetland impact analysis for the Mouse River Enhanced Flood Protection Project show that approximately 6 acres of forested wetlands and 39 acres of non-forested wetlands could be affected by the construction of flood risk reduction features on the Mouse River (Barr Engineering et al. 2012). As discussed above, the inbasin alternatives could result in the permanent loss of less than 1 acre of riverine wetlands, and the Missouri River alternatives could result in the permanent loss of 1 acre or less of lacustrine wetlands, depending on the intake option. Given the limited acreage involved, the action alternatives would not result in a substantive contribution to a cumulative impact on wetlands; moreover, any loss of wetlands associated with the inbasin or Missouri River alternatives would be fully mitigated, as described in the Environmental Commitments section. Thus, after mitigation, no cumulative impacts would occur.

Cumulative effects on Missouri River flows and reservoir levels, including sedimentation, existing depletions, and reasonably foreseeable non-Project depletions, were accounted for in the Corps' Missouri River DRM simulations. Details on these analyses can be found in Appendix D and the Corps analysis (2013a). Cumulative effects of the action alternatives on Missouri River hydrology and thus associated wetland and riparian areas would be very small and likely undetectable.

Summary

Consequences of the No Action Alternative cannot be quantified but could include changes in local groundwater levels that are not expected to affect wetlands. Changes in riparian vegetation are not expected. Impacts of the inbasin and Missouri River alternatives from construction of Project components would be similar; they could result in temporary impacts on 19 and 17 acres of wetlands, respectively. The inbasin alternatives would require 29 stream crossings, and the Missouri River alternatives would require 23 stream crossings during pipeline construction, which could affect riparian vegetation. BMPs would be implemented, however, that would minimize or avoid impacts on wetlands and riparian areas from construction. The inbasin alternatives could result in the permanent loss of less than 1 acre of riverine wetlands, and the Missouri River alternatives could result in the permanent loss of 1 acre or less of lacustrine wetlands, depending on the intake option. These impacts would be fully mitigated, as would any temporary construction impacts not avoided by BMPs; therefore, no unavoidable adverse impacts associated with the construction of Project components would occur under any of the action alternatives.

Each of the inbasin alternatives plus the Missouri River and Conjunctive Use Alternative would involve withdrawals of water from the Souris River between March and August, which could have localized effects on wetlands and riparian areas on the banks of the river and in the meandering channels during dry and normal conditions. The greatest impacts would occur under the Groundwater with Recharge and the Souris River Alternative because the most water would be withdrawn. The least impacts would occur under the Missouri River and Conjunctive Use Alternative because the smallest amount of water would be withdrawn. Changes would be most pronounced during dry and normal flows; under wet conditions, impacts from the flow reductions would not result in a perceptible change due to the high volume of water present.

Each of the three alternatives using Souris River water could result in the narrowing of the river channel due to reduced flows between March and August, especially during dry periods. In dry conditions, this would allow herbaceous and fast-growing scrub-shrub wetland and riparian vegetation to grow farther downslope, toward the water in the river channel. Riparian areas along the Souris River are adapted to naturally occurring highly variable flows. Since the change in the range of flows from this alternative is within the natural variability of flows that already occurs and would continue to occur under No Action, the increased narrowing of the channel under some flow conditions would not have an impact on the composition or integrity of wetland and riparian species in the affected areas.

Impacts on wetlands and riparian areas along the river bank or within the meandering channel may occur, however, due to lowering of water levels in the river and the change in flow pattern in the Souris River in dry or normal conditions. Wetlands and riparian vegetation along the upper banks could be reduced temporarily in localized areas, but the Souris River is already highly variable, and both wetland and riparian vegetation are adapted to this highly variable environment. Shrubs and herbaceous vegetation would be least likely to experience long-term effects since they are more ephemeral; trees would experience the greatest stress during dry periods. In particular, lower river levels during the summer (growing season) could at least cause lowering of the shallow groundwater draining from bank areas along the river, affecting the root systems of trees in localized areas. During high flows, any change would be imperceptible.

Withdrawal of water from the Souris River under the inbasin alternatives and the Missouri River and Conjunctive Use Alternative would not affect wetlands located within the floodplain, outside of the levees and downstream of the levees, because overbanking does not occur near and downstream of Minot under dry and normal conditions; therefore, these conditions would be unchanged. Given the large volume of water present under high flows, the amount of water withdrawn from the Souris River under these alternatives would not result in a perceptible change.

The stabilization and potential increase in groundwater levels in the Minot and Sundre aquifers due to artificial recharge under the inbasin alternatives or decreased withdrawals under the Missouri River alternatives is not expected to result in an impact on wetlands given the current groundwater depth below the land surface but could be beneficial in the long term if aquifer levels return to near-surface levels.

No change in Missouri River hydrology would occur as a result of the inbasin alternatives because they do not use Missouri River water; therefore, no impacts on wetlands or riparian vegetation in the Missouri River system would occur.

Potential changes in Missouri River reservoir levels and dam releases under the No Action Alternative compared to existing conditions are predicted to be small to negligible, as identified in the Water Resources section. Therefore, consequences of No Action on Missouri River wetlands and riparian areas would be very small and not likely measurable.

For the Missouri River and Conjunctive Use and Missouri River and Groundwater alternatives, the potential changes in Missouri River reservoir levels and dam releases relative to No Action would be negligible, as identified in the Water Resources section. Therefore, impacts on wetlands and riparian areas would very small and likely not measurable.

Common Wildlife

Introduction

This section addresses changes that might result from No Action or the implementation of the action alternatives on common terrestrial wildlife species. The types of impacts considered include disturbance of wildlife by construction activities, temporary and permanent losses of habitat from the installation of new components, effects on wildlife from the presence of Project components, and changes to wildlife habitats from alteration of the Souris and Missouri rivers' flow regimes and changes in groundwater levels. Wildlife conservation habitats are discussed in the Land Use section, although impacts on species that use those habitats are addressed in this section.

Implementation of the action alternatives may affect wildlife habitats, either temporarily or permanently. Temporary impacts generally are associated with buried pipeline construction or the use of staging areas, after which the land would revert to its previous use. Permanent impacts are associated with construction of above-ground permanent components, such as the Biota WTP and storage reservoirs. Permanent impacts could also result from changes in groundwater availability and river flows, which would affect wetland and riparian areas as discussed in more detail in the Wetland and Riparian Areas section, and the associated wildlife species that use these areas.

Methods

The types of construction equipment and general construction practices that would be used were considered in analyzing disturbances to wildlife. Impacts on wildlife habitats were determined based on the types of habitats that are present in the proposed construction areas and footprint of Project components. The analysis then considered the implementation of BMPs when assessing the potential for temporary and permanent impacts.

To determine the amount of habitat potentially affected, the proposed Project components and construction areas were overlaid onto wildlife habitat maps using GIS. The acreage of each habitat type affected was quantified and compared to the total amount present in the Project Area. The description and extent of habitat that could be affected was based on data from the USGS 2010 GAP GIS dataset (USGS 2010). The potential for Project power lines to result in injury or mortality of avian species, or to serve as a barrier to wildlife movement also was evaluated based on the best available literature information and scientific judgment.

The conclusions of the Wetland and Riparian Areas and Water Resources sections were used to evaluate how changes in groundwater availability and surface water flows could affect wildlife using wetland and riparian habitats.

Results

No Action Alternative

The extent of potential consequences for wildlife under the No Action Alternative cannot be quantified, as discussed in the introduction to this chapter. Some vegetative communities supporting wildlife can be dependent on groundwater, such as riparian areas, and if groundwater sources were over-used without sufficient natural recharge, vegetative species composition could shift and the wetland and riparian areas directly connected to the aquifers could be affected. (See the Wetlands and Riparian Areas and Vegetation sections in this chapter.) Wetlands and riparian areas provide important habitat for fish and wildlife (USGS 2013c) and also supply food and water for a large diversity of animals (USGS 2013d). (See Table G2-3 in Appendix G for a list of representative wildlife and the habitats they use.) Alteration or loss of these habitats could reduce the abundance of wildlife present or change the wildlife community structure.

Action Alternatives

This section summarizes the general types of impacts that would result from implementation of each of the action alternatives.

Disturbance, Injury, or Mortality from Construction Activities. Construction impacts on individuals from different wildlife species include the potential for injury or mortality from contact with equipment and hazardous materials, as well as disturbance from noise and human presence. These impacts would be similar under all action alternatives because they would use similar construction equipment and methods, and similar types of wildlife and wildlife habitat would be affected.

Construction equipment and vehicles would emit noise that could affect wildlife in or adjacent to the work area. Wildlife would likely move away from areas with human activity and noise, however, and return after Project completion. Nonetheless, during pipeline installation or upgrades, open trenches could trap small mammals, amphibians, and reptiles and could cause injury to large mammals. Heavy machinery and stockpiles of materials, open trenches, and pipeline sections stored along the construction right-of-way prior to burial also could block movements of animals across the construction area. Large equipment would move slowly through the area, which would prevent collision with large and more mobile animals, but small animals that are unable to escape may be harmed through direct contact with equipment and vehicles. Impacts would occur only in the areas directly affected by construction activities and while individuals could be affected, entire populations would not.

The potential for impacts would also be minimized by the implementation of general construction BMPs (Appendix F), which require that, to the extent possible, construction would avoid wetlands; federal, state, and local wildlife areas and refuges; designated critical habitats; and migratory bird habitat during the critical nesting and brood-rearing season. Thus, construction activities would be located away from areas most likely to attract wildlife and would be timed to avoid impacts when migratory birds were nesting and breeding. Wildlife BMPs include similar measures to minimize the potential for construction impacts, including selecting sites to minimize potential for environmental impacts on nesting migratory birds and timing construction around wildlife habitats to avoid migratory bird nesting and wildlife parturition dates. Impacts on lands under the jurisdiction of the Service also would be avoided where feasible. If impacts on NWRs and WPAs could not be avoided, the local refuge manager would be consulted concerning the issuance of a special use permit or if a refuge compatibility determination would be necessary.

Some wildlife also may be harmed from exposure to hazardous materials, but such impacts would be minimized by Hazardous Materials BMPs (Appendix F) that require material and equipment to be stored within well defined, designated staging areas placed outside of wetlands and other sensitive areas. A Hazardous Spill Plan or a Spill Prevention, Control and Countermeasures Plan, whichever is appropriate, also would be in place, describing preventive measures and the actions that would be taken in the event of a spill.

Temporary and Permanent Loss of Habitat. Temporary disturbance and permanent loss of wildlife habitats could occur under each action alternative from construction of Project components and from the use of staging areas. Common components of the action alternatives include the bulk distribution pipelines, upgrades to the Minot WTP, certain storage reservoirs, and pump stations. For the inbasin alternatives, common components include the recharge facilities, peaking wells, and upgraded collector lines. Components common to the Missouri River alternatives include the intake and pump station options at Lake Sakakawea, Biota WTP and Pump Station, and South Prairie Storage Reservoir. The types of impacts that could result from common components would be the same because the same types of habitats would be affected and the same BMPs would be implemented for each action alternative. The quantity of habitat affected, however, would be different. Table 4-18 shows the acreages of habitat types that could be temporarily and permanently affected by the action alternatives. Loss of habitat would cause wildlife to seek similar habitat elsewhere. As discussed in Chapter 3 (in the Common Wildlife and Land Use sections), however, considerable acreages of different habitat types are available in the Project Area and thus could accommodate the displaced wildlife, particularly since the permanent loss of habitat would be very small.

As shown in Table 4-18, most construction would occur on lands designated as developed, open space (USGS 2010). These lands are characterized as containing small amounts of impervious surface (less than 20 percent) and large amounts of vegetation (primarily grasses planted for erosion control, aesthetic purposes, or recreation). A review of aerial photos indicates that the impervious surfaces are likely roads and that the vegetated areas are most likely in agricultural use. Regardless, the vegetation in this area appears to be non-native and may be mowed or otherwise maintained given its use for recreation and other purposes. These factors diminish the value of such lands for wildlife (the value of agricultural lands as wildlife habitat is discussed further below).

Developed land is the second-most common land use type that would be affected by the action alternatives; it includes a mix of residential, commercial, and industrial land uses. Project activities in this land use type would have limited impacts on wildlife because developed areas generally have lower species diversity than more natural areas (Johnson and O'Neil 2001). Wildlife most closely associated with developed land includes exotic species such as house sparrow and European starling.

Slightly less construction would occur on agricultural lands, including cultivated cropland and pasture/hay, which have low value for wildlife. Wildlife using agricultural habitats are typically either seasonal migrants or use these areas in conjunction with other habitat types (Johnson and O'Neil 2001). Agricultural land in the Project Area may be used by migrating waterfowl during spring and fall migrations because of waste grain in crop fields, and harvested agricultural fields in the Prairie Potholes Region of North Dakota are known to be important stopover habitats for granivorous (grain-eating) spring-migrating birds (Galle et al. 2009). Agricultural habitats also are regularly used by game birds, such as wild turkey and ring-necked pheasant, and by other common wildlife species, such as mule deer and American crow. Agricultural land is not generally considered to be highly valuable wildlife habitat, however, due to regular land disturbance (Johnson and O'Neil 2001) and uniform vegetation stands. In some areas, regional cropland is being converted to native prairie in an effort to restore and enhance wildlife habitat, which illustrates the poorer quality of agricultural land for wildlife. Under the North Dakota Partners for Fish and Wildlife Program, the Service and private land owners work together to develop new wildlife habitat and to initiate conservation-oriented agricultural practices that benefit wildlife. As of July 2013, 225 square miles of private land in the state has been restored, created, or enhanced to benefit wildlife species (Service 2013a).

Wetland and riparian areas also could be affected by construction activities and often support high concentrations of animals, including mammals, birds, fish and invertebrates, and in particular reptiles and amphibians such as garter snakes and northern leopard frogs. The BMPs included in Appendix F under Wetlands and Riparian Areas require that wetlands and riparian areas should be avoided to the extent practicable, thereby avoiding temporary and permanent impacts on the species that use them.

Each of the action alternatives also could affect mixed-grass prairie and shrublands, which have a diverse vegetative species composition that supports numerous wildlife species, including common mammals such as coyote and American badger, birds such as burrowing owl and lark bunting, and reptiles and amphibians such as short-horned lizard and bufonid toads. To the extent practicable, however, construction would avoid impacts on wildlife species by avoiding native prairie. All affected grassland areas would be revegetated as described under the BMPs for

Vegetation and Land Use (Appendix F). Thus, temporary and permanent impacts on these habitats and the wildlife that use them would be minimized by the implementation of BMPs.

The wildlife habitats described above include certain protected habitats, such as NWRs, WPAs, wetland and grassland easements, and WMAs. Protected habitats are important feeding and resting areas for many species, particularly migrating and breeding waterfowl. As discussed in greater detail in the Land Use section in this chapter, as currently designed, pipeline construction could temporarily affect such areas, but any impacts would be of short duration and generally would be avoided by Wildlife BMPs, which require avoidance of such areas where feasible. Any impacts on NWRs or WPAs would require coordination with the local refuge manager and potentially a refuge compatibility determination. No permanent above-ground Project components are proposed to be located on NWRs, and BMPs call for avoidance of other sensitive areas, as well; therefore, no permanent impacts on these protected wildlife habitats are expected to occur under any of the action alternatives.

Additionally, the Impact Mitigation Assessment Team would review designs for all Project components prior to construction. If necessary, components would be realigned to avoid sensitive wildlife habitat, or appropriate mitigation would be developed in coordination with the appropriate state and federal agencies. Environmental commitments that would be implemented are described below under Environmental Commitments and in Appendix F.

Impacts of Permanent Facilities. Pipelines would be buried and thus would not have permanent impacts on wildlife. Upgrades to the Minot WTP would not result in any additional impacts on wildlife since no additional land would be used for the upgrades and it is located in a developed area. The storage reservoirs included in each action alternative would be fully enclosed structures that would not be accessible to wildlife. During operations, the pump stations may emit some noise but would be unlikely to affect wildlife species since they would be buried underground.

New power lines would be necessary to power pump stations along the pipeline and for other components under each action alternative. Above-ground power lines and any supporting guy wires could increase collision potential for migrating and foraging birds; power poles could be used as vantage perches by raptors, which facilitates predation on ground-nesting birds; and the location of poles across grassland habitats can reduce habitat suitability for ground-nesting birds (Avian Power Line Interaction Committee and Service 2005). The determination of whether the power lines would be above ground or buried, as well as their specific locations, would be resolved in a future design phase. The BMP included in Appendix F identifies the steps that would be taken to minimize or avoid wildlife impacts.

Groundwater with Recharge Alternative

This alternative includes new recharge facilities, peaking well facilities, and collector lines in addition to the Project components common to all alternatives. Impacts from components common to all action alternatives would be as described above, and impacts of constructing the additional components would be similar but additive to those. As shown in Table 4-18, approximately 141 acres of agricultural land, which includes both cultivated cropland and pasture/hay, and approximately 767 acres of land designated as developed, open space, could be temporarily disturbed during construction. Approximately 50 acres of agricultural land and 1 acre of developed, open space could be permanently converted to developed uses under this alternative. As discussed above, these areas have low value for wildlife, and ample similar habitat is present in the Project Area.

Approximately 182 acres of developed land could be temporarily affected by construction, and approximately 12 acres could be permanently occupied by Project components under this alternative. Developed land has limited value for wildlife, however. Wetland habitats could experience approximately 18 acres of temporary disturbance under this alternative and approximately 1 acre of permanent loss. Approximately 22 acres of mixed-grass prairie and shrublands habitats could be disturbed temporarily, and approximately 1 acre of mixed-grass prairie could be permanently affected. Such areas have value as wildlife habitat, but impacts would either be avoided or minimized by the implementation of BMPs (Appendix F); moreover, ample areas of similar habitat are present in the Project Area.

Under this alternative, one recharge basin would be located at an existing quarry and the other would be located in agricultural land. Standing water in the recharge basins (from March to June) may have the potential to attract waterfowl during migrations that occur during that time. However, the recharge basins are not likely to attract breeding birds due to noise and human disturbance. The sediment settling facilities would be open to the air so birds and animals could come and go; however, the whole area (including the sediment settling facilities and recharge basins) would be fenced to prevent larger wildlife from entering. The sediment settling facilities would have no standing water – only flowing water for a few months of the year – and would be made of concrete. When added to noise and human disturbance, this area would not be attractive to most wildlife.

Use of water from the Souris River from March through August may affect the J. Clark Salyer NWR by reducing the amount of water available at the refuge. High flows would not be substantially modified, but median flows would be moderately reduced during the withdrawal period, reducing the total amount of water flowing to the refuge. During dry years, when refuge operations are already likely to be affected by low flows, a greater proportion of the reduced Souris River flows would be withdrawn for Project needs. Additionally, some of the releases from the upstream Lake Darling reservoir to provide additional water to the J. Clark Salyer NWR during periods of low flow could be withdrawn by the Project in Minot, thus reducing flows to the downstream refuge. (Refer to the Water Resources section in Chapter 3 for additional discussion of Lake Darling releases.) The refuge contains diverse wildlife habitats, including upland and lowland grasses and wetlands. Water depth determines the diversity of wetland plant species which, in turn, influence the wildlife species that use the area (Service 2013a). Water levels vary naturally from year to year, which influences seasonal vegetation composition, and in successive wet or dry years, wetlands may undergo significant changes (Service 2011c). Over time, water use in the surrounding area has resulted in substantial changes to the hydroperiod of the refuge wetlands (the length of time and portion of year the wetland holds ponded water), requiring adaptations by the waterfowl and other wildlife species using the refuge (Estep, pers. comm. 2013). Further changes to the hydroperiod, particularly by reducing the amount of water available, would further stress the species using the refuge. A reduction in the amount of water reaching the refuge may also lead to increases of botulism from decomposing vegetation (Estep, pers. comm. 2013), which would increase mortality of waterfowl using the area. However, as described in the Wildlife BMPs, any impacts on NWRs or WPAs would have to go through a refuge compatibility determination to ensure that the goals of the refuge would not be compromised.

As explained in the Wetlands and Riparian Areas section, this alternative is not expected to have measurable effects on recharge of floodplain wetlands or hydration of riparian areas by the surface water flows of the Souris River, or recharge of the Souris Valley aquifer and wetlands connected to the surficial aquifer. Therefore, wildlife would not be measurably affected in these habitats. Effects from withdrawals of Souris River water include encroachment of riparian species toward the center of the Souris River channel during dry years where flows are reduced for the duration of the growing season, which may be beneficial to wildlife dependent on riparian areas by providing additional habitat.

Groundwater with Recharge and the Souris River Alternative

Wildlife impacts of this alternative would be similar to those of the Groundwater with Recharge Alternative, as shown in Table 4-18, because the same components are included in each, the same amount of wildlife habitat would be affected, and the same BMPs would be implemented.

This alternative includes the use of more water from the Souris River from March through August than under the Groundwater with Recharge Alternative. Similar types of impacts would occur as described above, but impacts would likely be slightly greater due to the increased volume of water that would be withdrawn from the river, particularly during the summer months of July and August, as discussed in the Water Resources section in this chapter. Effects on floodplain wetlands and riparian areas due to water withdrawals during operations of this alternative would be similar to those of the Groundwater with Recharge Alternative. Beneficial impacts on wildlife dependent on riparian areas from aquifer recharge would also be similar under this alternative.

Missouri River and Conjunctive Use Alternative

This alternative includes two intake/pump station options at Lake Sakakawea, a Biota WTP and pump station, and the South Prairie Storage Reservoir in addition to the Project components common to all alternatives. Impacts from components common to all action alternatives would be as described above, and impacts of constructing the additional components would be similar but additive to those. BMPs also would be implemented as described above. As shown in Table 4-18, approximately 111 acres of agricultural land, which includes both cultivated cropland and pasture/hay, and approximately 758 acres of developed, open space could be temporarily disturbed during construction. Approximately 11 acres of agricultural land and approximately 1 acre of developed open space could be permanently occupied by Project components under this alternative. Such land has low value for wildlife, and ample similar habitat is available elsewhere in the Project Area.

Approximately 172 acres of developed land could be temporarily affected by construction, and approximately 3 acres could be permanently occupied by Project components under this alternative. This land has low value for wildlife. Wetland habitats could experience approximately 16 acres of temporary disturbance under this alternative, and approximately 1 acre of permanent disturbance. Approximately 7 acres of mixed-grass prairie and shrublands habitats could be disturbed temporarily, and approximately 1 acre of mixed-grass prairie could be permanently affected. Such areas have value as wildlife habitat, but impacts on wildlife from habitat changes would either be avoided or minimized by the implementation of BMPs; moreover, ample areas of similar habitat are present in the Project Area.

Two intake options at Lake Sakakawea are being considered for this alternative; the overall acreage affected by each option would be the same, but the option involving upgrades to the existing facility would affect more developed land because more road would be constructed.

However, impacts on wildlife habitats are the same with either intake option; as noted above, developed land is not valuable as wildlife habitat. Modifications to the existing SCPP would not result in disturbance of any wildlife habitats since it would be constructed within the footprint of the existing facility. The new discharge pipe would be 0.5-mile long and constructed in developed land and mixed-grass prairie. The latter has value as wildlife habitat, and if this area could not be avoided through siting, appropriate mitigation would be implemented, as described in the Environmental Commitments section below. In the appraisal-level design, approximately 2.5 miles of overhead electrical line would be installed in accordance with BMPs from the substation to the intake site, all likely to be placed in developed land. If the intake were located adjacent to the SCPP, construction of a new intake building and discharge pipe, along with two power poles and a power transformer, would cause some additional temporary construction impacts; but the affected area would consist of developed, open space and developed land, and therefore would not affect valuable habitat.

The Biota WTP and pump station in Max would be constructed on a 41-acre site, all of which is cultivated cropland and has low value as wildlife habitat. The Biota WTP has a design footprint of approximately 9 acres, with an additional 2 acres required for construction.

This alternative includes the use of water from the Souris River from March through August, which would reduce the amount of water available at the J. Clark Salyer NWR particularly during periods of low flow, but changes would be substantially less than described for the inbasin alternatives because less water would be withdrawn from the river. (See the “Water Resources” section for details.) However, although high and low flows would not be changed under this alternative, the total amount flowing to the refuge would be reduced, which could adversely affect refuge operations by reducing the amount of water available for management purposes, particularly during periods of drought.

Missouri River and Groundwater Alternative

Wildlife impacts from construction activities associated with this alternative would be similar to those of the Missouri River and Conjunctive Use Alternative, as shown in Table 4-18 because similar components are proposed in each and a similar amount of wildlife habitat would be affected. The same BMPs would be implemented to minimize or avoid impacts. The Souris River is not used as a water supply source in this alternative; therefore, the types of impacts discussed under the Missouri River and Conjunctive Use Alternative associated with use of this water supply would not occur. Environmental commitments that would be implemented are described below and in Appendix F.

Environmental Commitments

Environmental commitments have been identified to minimize or avoid adverse effects associated with Project construction on wildlife remaining after implementation of the BMPs:

- Pipelines, WTPs, and pump station facilities would be realigned, where feasible, to avoid sensitive wildlife habitat. If sensitive wildlife habitat cannot be avoided, then mitigation would be determined in coordination and agreement with the Impact Mitigation Assessment Team including pertinent regulatory agencies.
- Preconstruction surveys with the Impact Mitigation Assessment Team would identify sensitive habitats and wildlife use before construction to allow implementing BMPs and environmental commitments.

Given the implementation of these environmental commitments, no unavoidable adverse impacts associated with construction would occur. The following environmental commitment would be implemented in order to address impacts associated with changes in Souris River flows on the J. Clark Salyer NWR:

- Reclamation would develop an adaptive management plan, in accordance with the Department of the Interior's policy guidance (Order 3270) and the report *Adaptive Management: the U.S. Department of the Interior Technical Guide* (Williams et al. 2007). The plan would be implemented to address Project uncertainty as identified in the SEIS in relation to water resources and potential impacts on the NWRs.

However, it is possible that this adaptive management plan may not be able to completely eliminate impacts on wildlife using the J. Clark Salyer NWR from changes in Souris River flows associated with operation of the two inbasin alternatives. Thus, these adverse impacts from reduced Souris River flows from implementation of these alternatives are expected to be permanent and unavoidable.

Cumulative Effects

The results of a preliminary wetland impact analysis show that approximately 6.0 acres of forested wetlands and 39.0 acres of non-forested wetlands could be affected by the construction of the flood risk reduction features for the Mouse River Enhanced Flood Protection Project, which would also affect wildlife using these wetlands. The Project alternatives could affect wetlands, and thus the wildlife that use them, during construction; however, all impacts would either be avoided or appropriately mitigated through BMPs and environmental commitments. It also is anticipated that the Mouse River Project would be required to mitigate any loss of wetlands resulting from project implementation, which also would reduce the potential for cumulative impacts. Any impacts from operation of the inbasin alternatives and the Missouri River and Conjunctive Use Alternative on wetlands associated with the Souris River would be localized and minor. (Refer to the Wetlands and Riparian Areas section for more detail.) Therefore, no adverse cumulative impacts on wildlife are anticipated.

Summary

The No Action Alternative would likely cause the least consequence to wildlife habitats since no construction would occur, although wildlife could be affected if changes in groundwater levels affected vegetation species composition. The action alternatives would all result in similar types of impacts from construction of the proposed components. Construction could injure or kill individuals from different wildlife species from contact with equipment and hazardous materials, and could cause disturbance from noise and human presence. Construction of each of the alternatives would affect similar types of wildlife habitats both temporarily and permanently. The inbasin alternatives could affect the most acres temporarily and permanently (1,131 acres and 79 acres, respectively), as opposed to the Missouri River alternatives, which could affect 1,065 acres and 17 acres, respectively. Most construction would affect agricultural land or developed land or land classified as developed, open space, which has low value as wildlife habitat and which is plentiful in the Project Area. No permanent structures would be built within protected lands, and only 1 acre each of wetlands and mixed-grass prairie could be permanently affected by the action alternatives. Implementation of the BMPs and environmental commitments identified in Appendix F would minimize or avoid wildlife and wildlife habitat impacts associated with the construction of Project components under each of the action alternatives. Thus, unavoidable adverse impacts on wildlife and their habitats would not result from construction and operation of proposed components.

Effects from withdrawals of Souris River water under the inbasin alternatives include encroachment of riparian species toward the center of the Souris River channel during dry years, where flows are reduced for the duration of the growing season, which may be beneficial to wildlife dependent on riparian areas by providing additional habitat. Such benefits would be lessened under the Missouri River and Conjunctive Use Alternative because less water would be withdrawn from the river. None of these alternatives is expected to have measurable effects on recharge of floodplain wetlands or hydration of riparian areas by the surface water flows of the Souris River, or recharge of the Souris Valley aquifer and wetlands connected to the surficial aquifer. Therefore, wildlife would not be measurably affected in these habitats. However, withdrawals of Souris River water would reduce the amount of water available at the J. Clark Salyer NWR, which would have detrimental impacts on wildlife, and waterfowl in particular. Impacts would be greatest under the inbasin alternatives, but also could occur under the Missouri River and Conjunctive Use Alternative. Changes to the hydroperiod have already required adaptations by the species using the refuge, and a reduction in water during some months of the year may lead to increases of botulism and mortality of waterfowl. Impacts would be greater during dry and normal years than in wet years. Although an adaptive management plan would be implemented, these adverse impacts from operation of the inbasin alternatives and the Missouri River and Conjunctive Use Alternative may be permanent and unavoidable.

Federally Protected Species

Introduction

Assessing impacts under the federal ESA is different than under NEPA. Section 7 of the ESA implementing regulations (50 CFR 402) states that the effects of a proposed action are added to the environmental baseline to determine whether the species likely would be jeopardized by a proposed action. The environmental baseline includes the past and present impacts of all federal, state, or private actions, and other human activities in the action area. It also includes anticipated impacts of all proposed federal actions in the action area that have already undergone formal or early Section 7 consultation and the impact of state and private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline is a “snapshot” of a species health at a specified point in time. Usually, this is the current condition. The ESA requires consultation with the Service on discretionary federal actions that may affect federally listed threatened and endangered species or designated critical habitat. As part of this consultation, Reclamation prepared a biological assessment, which is an ESA analysis of the proposed action compared to current conditions. This biological assessment is included in Appendix L.

For the purposes of NEPA analysis, any potential impacts on federally listed species are evaluated similar to the other resources discussed in this chapter by comparing the action alternatives to what is expected to occur under the No Action Alternative. The potential consequences associated with the No Action Alternative are described to the extent reasonable without being speculative.

Methods

Analysis of potential impacts on federally protected species was based on descriptions of the affected environment in Chapter 3 and analyses of impacts on related resources (e.g., water quantity, water quality, groundwater, fisheries and aquatic ecology, vegetation, wetlands, and wildlife) in this chapter. The resource analyses took into account applicable environmental commitments, including BMPs and environmental commitments (Appendix F). Additionally, federal and state lists and databases were searched to determine the distribution and occurrence of these species within the Project Area. Federally threatened, endangered, and candidate species potentially in the Project Area are discussed in Chapter 3 and are listed in Table 4-21 by alternative. Candidate species are included because there is a potential for these species to be listed prior to construction of the Project.

Life histories were also reviewed for all species. Life history information was evaluated against potential habitat in the Project Area. Much of this habitat information was obtained during analysis of impacts on other resources, as noted above.

Table 4-21 Federally Listed Species That May Be Present in the Project Area

Species	Critical Habitat	Federal Status	Groundwater with Recharge	Groundwater with Recharge & the Souris River	Missouri River & Conjunctive Use	Missouri River & Ground-water
Gray Wolf		E	X	X	X	X
Northern Long-Eared Bat		PE	X	X	X	X
Interior Least Tern		E			X	X
Piping Plover	X	T	X	X	X	X
Whooping Crane		E	X	X	X	X
Sprague's Pipit		C	X	X	X	X
Red Knot		T	X	X	X	X
Dakota Skipper	P	T	X	X	X	X
Pallid Sturgeon		E			X	X

Note:
E= endangered, T = threatened, C = candidate, P=Proposed

Evaluation of potential impacts on Missouri River protected species, including the least tern, piping plover, and pallid sturgeon, also used information and results from the Corps report, *Cumulative Impacts to the Missouri River for the Bureau of Reclamation's Northwest Area Water Supply Project* (2013a), as well as information in other sections of this chapter. The hydrologic effects analysis from the Corps' report (2013a) was used to address potential changes in Missouri River System storage, reservoir water levels, and dam releases. The Corps analyzed five simulations of the potential changes that affect Missouri River System regulation. These simulations include Existing Conditions, the Sedimentation 2060 simulation, No Action, Average Annual Project Depletions, and Maximum Possible Project Depletions. These simulations and the resulting hydrologic effects, as described earlier in this chapter, were then used to address any life history or habitat concerns with the protected species.

Regulation of the Missouri River System follows an annual cycle that is described in detail in the Master Water Control Manual (Corps 2006) and summarized in the Water Resources section in Chapter 3. The Master Water Control Manual requires the Corps to operate the Missouri River System to minimize take of least terns and piping plovers during the nesting season (approximately May 1 to August 15). Since 1986, flow releases from all Missouri River mainstem dams except Oahe and Big Bend have been modified to accommodate least tern and piping plover nesting. Daily hydropower peaking patterns are developed prior to nest initiation in early to mid-May. Generally, dam releases are set during the nesting season to ensure steady flows in areas containing the bird's habitat. During drought, water conservation measures are initiated, and releases are made on a peaking cycle of 2 days down and 1 day up, usually during the last two-thirds of May to keep birds from nesting at low elevations.

The Corps has established spring pulse criteria for the benefit of the pallid sturgeon. Included in the technical criteria for each spring pulse is a Missouri River System storage drought preclude level, below which the corresponding pulse would be foregone that year. Currently, the Missouri River System storage drought preclude level for the March pulse is 36.5 MAF, and the drought preclude level for the May pulse is 40.0 MAF. The magnitude of the spring pulses is constrained by flood control flow limits downstream of Gavins Point Dam. The Master Water Control Manual also contains provisions for Fort Peck flow modification tests to benefit pallid sturgeon and other native river fish. These tests involve a combination of Fort Peck spillway and power plant releases during the early-June timeframe.

Direct impacts on federally listed species could include direct and indirect mortality or temporary displacement of species caused by construction activities (habitat destruction and habitat disturbance). For Missouri River alternatives, this could be habitat losses associated with Missouri River depletions in combination with Missouri River System operations. Most potential impacts would likely be temporary; allowing species to return after habitat is restored.

Under the ESA, four types of effects on federally listed species are considered: is not likely to adversely affect, discountable effects, insignificant effects, and take. Definitions for these terms are found in the text box. The analysis below takes into consideration the full implementation of the BMPs and environmental commitments.

Effects

Is Not Likely to Adversely Affect – The appropriate conclusion when effects on listed species are expected to be discountable, insignificant, or completely beneficial.

Discountable Effects – Those extremely unlikely to occur.

Insignificant Effects – Relate to the size of the impact and should never reach the scale where take occurs.

Take – To harass, harm, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct.

BMPs would include those identified in habitat chapters (those from this chapter's Vegetation and Wetlands and Riparian Areas sections). BMPs specific to federally listed or proposed species include:

- Avoiding potential habitats of federally listed or proposed species.
- Prohibiting construction within 1/4 mile of least tern and piping plover nesting sites during the breeding season (April 15 to August 31).

- Ceasing construction if a federally listed or proposed species appears on site until consultation is made between Reclamation and the Service.
- Burying power lines or power line marking to avoid conflicts with whooping cranes.
- Intake screening requirements for pallid sturgeon.
- Assessing forested habitat for potential northern long-eared bat habitat.

Environmental commitments are identified near the end of this section and in Appendix F.

Results

Impacts that may impact federally listed, proposed, and candidate species (Table 4-21) were identified for construction and operation activities associated with action alternatives. BMPs and environmental commitments (Appendix F) would be incorporated into all the action alternatives to avoid potential adverse effects. Examples include conducting preconstruction surveys, seasonal restrictions, intake screens, and avoiding these species' habitats. Because BMPs and environmental commitments would be incorporated to avoid potential adverse impacts, and any potential adverse impacts would not result in take and would be extremely unlikely to occur, no adverse impacts are anticipated for federally listed, proposed, or candidate species. Effects associated with each alternative are discussed below.

No Action Alternative

General Consequences. If Project members continued with their present water sources, there could be effects on groundwater sources or changes in the Souris River flows, as described in the Water Resources section. However, none of the federally listed, proposed, or candidate species are known to occur in the groundwater source areas or in the Souris River, or have only been documented infrequently. Therefore, continued use of existing water sources under the No Action Alternative would have no adverse consequences to these species.

Missouri River System. Increasing populations and additional federal projects on the Missouri River could increase withdrawals of Missouri River water by the year 2060. Appendix D describes an analysis of the reasonably foreseeable non-Project depletions of approximately 0.516 MAF over current conditions by 2060. Reasonably foreseeable future non-Project depletions and sedimentation may have consequences to terns, plovers, red knot, northern long-eared bat, and pallid sturgeon as discussed below. Because the gray wolf, whooping crane (those using habitat outside Missouri River reservoirs), Sprague's pipit, and Dakota skipper are not generally associated with Missouri River habitats, no adverse consequences have been identified for these species. Whooping cranes have been documented to occur on roosting sites adjacent to the Missouri River and resting areas associated with sand islands and peninsulas of reservoirs. However, this use of reservoir habitat is opportunistic and usually limited to drier times or when islands, flats, and peninsulas on reservoirs are exposed. Potential consequences to reservoir whooping crane habitats are addressed below. Red knots may use Missouri River sandbars, but because their occurrence is so rare, no adverse consequences have been identified. Northern long-eared bats have been identified in riparian and forested habitats adjacent to the Missouri River, but in habitats that would not likely be affected by depletions or sedimentation. No adverse consequences to this species are anticipated.

The Corps analysis (2013a) simulated potential consequences of the No Action Alternative to the Missouri River System relative to current conditions. The No Action simulation included forecasted reservoir sedimentation and reasonably foreseeable future non-Project depletions out to 2060.

Under the No Action Alternative, reasonably foreseeable future non-Project depletions have a lower incremental consequence on Missouri River System operations than sedimentation (Corps 2013a). For example, sedimentation alone would result in Missouri River System storage capacity loss of 2.8 MAF.

To put this in perspective, the storage capacity of the entire Missouri River System is 73.1 MAF in 2013 and is projected to be 69.4 MAF by 2060. Sedimentation through 2060 is projected to cause a loss of almost 4 percent of total storage capacity. By comparison, reasonably foreseeable future non-Project depletions of 0.516 MAF are equivalent to 0.7 percent of total storage capacity.

Continued accumulation of sediments in the Missouri River System would cause the reservoirs' water surface elevation to rise while the sediments would reduce the capacity for water storage. In general, future sedimentation would result in decreased system storage in about 97 percent of the days during the 81-year period of analysis (Corps 2013a). Lost storage capacity reduces the flexibility in Missouri River System operations.

Reservoir Elevations. With the influence of sedimentation on the Missouri River System, there is a subsequent increase in reservoir water levels due to displacement of the water by the sediments. For the upper three Missouri River reservoirs (Fort Peck, Garrison, and Oahe), the daily water surface elevations for the No Action simulation were found to be generally higher (55 to 65 percent of the time) than the existing conditions simulation (Corps 2013a). Higher water surface elevations would be generally less than 5 feet for most of the period of record (85 to 90 percent of the time).

Since water surface elevations under No Action are within the average pool fluctuations at these reservoirs, consequences of the No Action Alternative compared to existing conditions would be considered negligible. Reservoir level fluctuations would not have consequences to pallid sturgeon because the reservoirs are not generally used by the fish that normally occupy natural river reaches below mainstem dams. Changing reservoir levels could have consequences to available reservoir habitat for least terns and piping plover during the nesting season, which generally occurs from May 15 to August 15. Normal operations of the Missouri River System have steady-to-rising reservoir levels in the spring, with declining reservoir levels subsequent to releases of navigation flows, which can start as early as March 23. In wet years, the upper three reservoirs would store water to maximize flood control during the tern and plover nesting season. During drought, the reservoirs may drop considerably during the birds' nesting season to meet navigation targets downstream.

During the nesting season, reservoir levels usually rise from June to July with melting snowpack and decline from July to August as reservoirs are called on to support downstream navigation targets. Mean reservoir levels vary by 4 feet on Fort Peck, 6 feet at Garrison, and 2 feet at Oahe (Corps 1999). The potential for higher reservoir levels during the nesting season is within the range of normal reservoir variation and is not likely to have adverse consequences to least terns and piping plovers or their critical habitat.

Whooping cranes and red knots may use islands, peninsulas, or flats to rest or eat during spring migration from April to May and fall migration from August to September. Mean reservoir elevations potentially used by the cranes during these months varied at Fort Peck by 1 to 1.3 feet, 0.7 to 1.5 feet at Garrison, and 0 to 0.7 feet at Oahe (Corps 1999). These changes in reservoir levels would be within the normal reservoir level variation. The potential for higher reservoir levels during spring migration and lower levels during fall migrations is not likely to have adverse consequences to the whooping crane or red knot, considering the small changes in reservoir levels, their opportunistic use of these habitats, the infrequency of sightings, and the good availability of habitat adjacent to the reservoirs.

These reservoirs can also support a large portion of the nesting tern and plover population during drought years. The changes in reservoir levels as described here would be within the normal reservoir level variation during the nesting season. Usually, tern and plover habitats will increase as water levels drop during the beginning of a drought and decline with vegetative advancement over the course of the drought period.

When compared to existing conditions, the fluctuation of reservoir storage and elevation levels found in the Corps' analysis (2013a) of the No Action Alternative, including sedimentation and reasonably foreseeable future projects impacts, is not likely to have adverse consequences to pallid sturgeons, whooping cranes, red knots, least terns, or piping plovers or their habitats.

Dam Releases. Dam release information can be useful in looking at potential consequences to pallid sturgeon, red knots, least tern, and piping plover and their habitats. Whooping cranes are not considered here as they are not likely to occur in areas below the dams. The dam releases most important to pallid sturgeon, least terns, and piping plovers are the releases from Fort Peck, Garrison, Fort Randall, and Gavins Point dams. For the No Action Alternative, the Corps' analysis (2013a) found that differences in annual releases from these dams would be small to negligible (Water Resources section) when compared to existing conditions. For Gavins Point Dam, the monthly difference in releases between No Action and existing conditions is mostly less than 1 kcfs. (September is the only exception and is slightly greater than 1 kcfs.). This small decrease is not likely to have adverse consequences on channel and sandbar formation and therefore should not have adverse consequences on red knots, least terns, piping plovers, pallid sturgeon, or their habitats. Although decreases in flows may allow more exposure of sandbar habitats, it would not likely be noticed during the nesting season because the Corps generally operates with steady flows during the nesting season to avoid impacts on terns and plovers and their habitats. The Biological Opinion on the Missouri River (Service 2000) notes a 1.5- to 2.5-inch rise of water levels on sandbars in the Gavins Point reach for every 1-kcfs increase (confirmed by Svendsen, pers. comm., 2013). Therefore, if decreases in releases are less than 1kcfs, any additional exposure of sandbar habitat would be less than 1.5 to 2.5 inches.

Fort Randall releases generally mirror Gavins Point releases. The 1.2- to 2.5-inch rise of water levels on sandbars for each increase in 1 kcfs at Gavins Point also applies to Fort Randall (Svendsen, pers. comm., 2013); thus, consequences to red knots, least terns, and piping plovers and their habitats would be similar to those from Gavins Point releases. At Garrison Dam, the trend is around 2 to 3 inches per 1 kcfs (Svendsen, pers. comm., 2013). Because the Corps' analysis (2013a) found that differences in annual releases from this dam would be relatively small when comparing existing conditions to the No Action Alternative, consequences to terns and plovers and their habitats in this reach would be discountable. Furthermore, the Corps manages system operations to protect terns and plovers and their habitats during the nesting season in accordance with the Biological Opinion on the Missouri River Master Water Control Manual (Service 2000); thus, no adverse consequences are anticipated for negligible changes in dam releases when comparing No Action to existing conditions.

Overall, the consequences of future sedimentation on water storage and water surface elevations are far greater than the consequences of reasonably foreseeable future non-Project depletions. Future federal projects or new intakes would likely undergo future project-specific NEPA analysis and Section 7 consultations. Consequences for the interior pallid sturgeon, red knot, least tern, whooping crane, and piping plover are negligible when the No Action Alternative is compared to current conditions.

Groundwater with Recharge Alternative

This alternative would not affect listed species associated with the Missouri River, including the interior least tern, piping plover, red knot, whooping crane, and pallid sturgeon because no Missouri River water is involved with this alternative. Because it is an infrequent visitor to the Project Area, and because of the absence of secluded habitat in the Project Area, no adverse impacts on the gray wolf are anticipated for this alternative.

Direct construction impacts on other federally listed species, including those shown in Table 4-21, would be avoided or minimized because BMPs and environmental commitments, including preconstruction surveys (Appendix F), would avoid potential adverse impacts. Piping plover critical habitat occurs in the Project Area, but no construction or facilities are being planned in those areas. Lake Darling on the Souris River has designated piping plover critical habitat, but it is upstream of any of the effects of water withdrawal on the Souris River. (See Chapter 4, Water Resources – Souris River.)

The Central Flyway Whooping Crane Corridor (Figure 3-20) suggests that there may be a high probability of encountering whooping cranes in the vicinity of the proposed bulk distribution pipeline and pump stations in Burke County and the very northwest tip of Ward County. However, because of BMPs and environmental commitments, including preconstruction surveys and power line requirements (Appendix F), adverse impacts on this species would be avoided.

Candidate and proposed species, including the Dakota skipper, Sprague's pipit, and northern long-eared bat, are considered because they may be listed prior to project construction. These species may occur in the Project Area (Chapter 3). No known records of occurrence for any of these species were found in any area where construction is proposed with the exception of one historical occurrence of Dakota skipper (record from 1979; Duttenhefner, pers. comm., 2012) found just east of Bottineau along the proposed pipeline construction route. Direct construction impacts on these candidate species would be avoided or minimized through BMPs, including avoidance of native prairie habitats, and environmental commitments, including preconstruction surveys (Appendix F). Additionally, pipeline construction would generally occur along existing rights-of-way, which are usually mowed and not likely to contain habitat for these species.

No federally listed, proposed, or candidate species or critical habitat would be affected by the use of Souris River water for aquifer recharge because none of these species occupy habitat associated with the Souris River or affected by its flows.

Individually, and when compared to No Action, no potential adverse impacts on federally listed, proposed, and candidate species, nor critical habitat have been identified. This alternative would not result in take of federally listed, proposed, or candidate species; and no adverse modification to piping plover critical habitat nor proposed Dakota skipper critical habitat would occur.

Groundwater with Recharge and the Souris River Alternative

Construction impacts would be the same as described for the Groundwater with Recharge Alternative, but this alternative would also use the existing Souris River intake to divert Souris River water to the Minot WTP. This alternative would have similar impacts on federally listed, proposed, and candidate species (Table 4-21) as described for the Groundwater with Recharge Alternative. In other words, either the species are not present in areas proposed to be affected for this alternative or BMPs would avoid any potential impacts. Additionally, no federally listed, proposed, or candidate species would be affected by the use of Souris River water for aquifer recharge or direct delivery as none of these species occupy habitat associated with the Souris River or affected by its flows. No potential adverse impacts on federally listed, proposed, and candidate species nor critical habitat have been identified. This alternative would not result in take of federally listed, proposed, and candidate species; and no adverse modification to piping plover critical habitat or proposed Dakota skipper habitat would occur.

Missouri River and Conjunctive Use Alternative

In the Project area, impacts of this alternative on federally listed, proposed, and candidate species and critical habitat during operation would be similar to No Action because it would use the existing wellfields in the Minot and Sundre aquifers and the existing surface water intake for the Souris River as a supplement to Missouri River water. However, the level of use of aquifers and the Souris River would be greatly reduced. No adverse impacts on federally listed, proposed or candidate species occur under present-day operations of these wellfields and intakes; and no impacts are anticipated under the reduced use associated with this alternative. This alternative involves similar construction components to the inbasin alternatives, including bulk distribution pipelines, upgrades to the Minot WTP, storage reservoirs at Lansford and Bottineau, pump stations, and use of the Souris River. No adverse impacts on federally listed, proposed, or candidate species nor critical habitat have been identified for these components.

The use of Missouri River water for this alternative could affect federally listed species using the Missouri River, including the interior least tern, piping plover, whooping crane, and pallid sturgeon. Red knots may use Missouri River sandbars but because their occurrence is so rare, no adverse impacts are expected. Northern long-eared bats have been identified in riparian and forested habitats adjacent to the Missouri River but in habitats that would not likely be affected by depletions; therefore, no adverse impacts are anticipated.

Impacts could also result from additional construction activities at proposed Missouri River intake sites and the associated buried pipelines, Biota WTP, and South Prairie storage reservoir. The proposed intake construction is not likely to adversely affect pallid sturgeon because screening is provided at the intake to prevent any potential but highly unlikely entrainment of sturgeon. It is also not likely that pallid sturgeon would be found in or near the intake site as this is not preferred sturgeon habitat. Associated construction of a buried pipeline, the Biota WTP, and the South Prairie storage reservoir are not likely to adversely affect the least tern, piping plover, whooping crane, Sprague’s pipit, red knot, northern long-eared bat, or Dakota skipper because their occurrence in any of the areas of construction would be highly unlikely or BMPs and environmental commitments are in place to avoid potential impacts.

Missouri River Impacts. The Corps analyzed potential impacts associated with the withdrawal of water from the Missouri River (Corps 2013a). The Corps evaluated two Missouri River simulations to evaluate the Missouri River action alternatives. The first simulation is referred to as the "Average Annual Project Depletions" simulation, which represents the forecasted average monthly water use of the Project totaling 0.0136 MAF per year. It consists of the average monthly water use in the service area plus 20 percent for losses that may be experienced during Biota WTP operations. The second simulation is referred to as the "Maximum Possible Project Depletions" simulation, which corresponds to the maximum capacity of the main transmission pipeline (0.0291 MAF per year). It should be noted that the transmission pipeline is sized to meet peak daily demands that occur during the summer months; however, the average annual demand would be much lower. Although the transmission pipeline would never be operated at full capacity year-round, this simulation provides an upper bound to the maximum possible Project water withdrawal from the Missouri River System.

The Corps analysis (2013a) used these two simulations to identify the potential Missouri River System impacts of this alternative compared to the No Action Alternative. These potential hydrologic impacts were used to address any life history or habitat concerns with federally listed Missouri River species, including the least tern, piping plover, whooping crane, and pallid sturgeon. Red knots may use Missouri River sandbars, but because their occurrence is so rare, no adverse impacts are expected.

Comparison of this alternative with the No Action Alternative showed that the effects of Project Missouri River depletions would be very small. This is expected, as even the maximum possible Project depletion (0.0291 MAF/year) is only 0.2 percent of total future non-Project depletions, or 0.04 percent of total system storage capacity (69.4 MAF) anticipated in 2060. Small differences are noted during the four extended droughts on record, since the Missouri River System is managed to conserve water during droughts.

Reservoir Storage and Elevation. For the upper three Missouri River reservoirs (Fort Peck, Garrison, and Oahe), the differences in water surface elevations between the No Action simulation and the two Project simulations was very small. For example, Fort Peck and Garrison dams would be within a plus or minus 1-foot difference in water surface elevation range (comparing the Maximum Possible Project Depletions simulation to No Action) 95 percent of the time over the period of record, while Oahe Dam would have water levels within this range 92 percent of the time. As stated previously, during the least tern and piping plover nesting season (May to August), mean historical reservoir levels vary by almost 4 feet at Fort Peck Dam, almost 6 feet at Garrison Dam, and 2 feet at Oahe Dam. A 1-foot change in water levels over the historical record for a large majority of the time (92 to 95 percent) is relatively small considering current reservoir level fluctuations during the time the birds are nesting. These potential reservoir level changes during the nesting season are within the range of normal reservoir variation and are not likely to have adverse impacts on least terns, piping plovers, or their critical habitat.

Likewise, the small potential changes in reservoir levels during spring and fall migrations are not likely to have adverse impacts on the whooping crane considering their opportunistic use of these habitats, the infrequency of sightings, and the good availability of habitat adjacent to the reservoirs.

The Corps' analysis (2013a) also evaluated the potential Project effects on annual minimum Missouri River System storage, as this is the primary factor for determining releases to the lower

Missouri River. Because minimum storage is most important during droughts, the Corps looked at the two greatest droughts of record in the Missouri River basin – the 1930s and 2000s. The differences in minimum Missouri River System storage between No Action and the Maximum Possible Project Depletion simulation are less than 3 MAF during the extended droughts of record. These relatively small differences in system storage are not likely to adversely affect least terns and piping plovers. Changes in reservoir levels as noted above would be within the normal reservoir level variation during the nesting season. Usually, these birds' habitats will increase as water levels drop during the beginning of a drought and decline with vegetative advancement over the course of the drought period.

Small changes in reservoir storage during whooping crane migration seasons are not likely to have adverse impacts on this species considering their opportunistic use of these habitats, the infrequency of sightings, and good availability of alternative habitat adjacent to the reservoirs. Reservoir level fluctuations would not adversely affect pallid sturgeon because the reservoirs are not generally used by pallid sturgeon.

In summary, fluctuations in reservoir storage and reservoir levels found in the Corps' analysis (2013a) of the Average Annual Project Depletion and Maximum Possible Project Depletion simulations when compared to the No Action Alternative are not likely to have adverse impacts on whooping cranes, least terns, piping plovers, or pallid sturgeon nor their habitats including critical habitat. Because red knots use the same type of habitat as least terns and piping plovers and occur infrequently on reservoirs, this alternative is not likely have adverse impacts on this species.

Dam Releases. Changes in dam releases could impact pallid sturgeon, least tern, and piping plover and their habitats. Whooping cranes and red knots would not be affected because they are not likely to occur in areas below the dams. The Corps analyzed releases at Fort Peck, Garrison, Oahe, and Gavins Point dams (Corps 2013a) as these releases have the potential to affect to pallid sturgeon, least tern, and piping plover and their habitats. Fort Randall Dam releases were not specifically addressed in the Corps' analysis (2013a), as these releases mirror releases out of Gavins Point Dam. Results of the analysis show the differences between Average Annual Project Depletion and Maximum Possible Project Depletion simulations and No Action in annual releases from these dams to be so small that they are barely detectable.

This negligible decrease is not likely to have adverse impacts on channel and sandbar formation and therefore should not have adverse impacts on terns, plovers, or pallid sturgeon and their habitats. Although decreases in flows may allow more exposure of sandbar habitats, it would not likely be noticed during the nesting season. Furthermore, the Corps generally operates during the nesting season with steady flows to avoid impacts on terns and plovers and their habitats.

Overall, when comparing the impacts of the range of water withdrawals for Average Annual Project Depletion and Maximum Possible Project Depletion simulations, no potential adverse impacts on federally listed, proposed, or candidate species nor their critical habitat have been identified. This alternative would not result in take of federally listed, proposed, or candidate species; and there would be no adverse modification to piping plover critical habitat.

Missouri River and Groundwater Alternative

When compared to the No Action Alternative, this alternative would have similar impacts on federally listed and candidate species (Table 4-21) as those described for the Missouri River and

Conjunctive Use Alternative. Because the use of Missouri River water and groundwater and construction impacts are the same for this alternative as for the Missouri River and Conjunctive Use alternative, no potential adverse impacts have been identified. This alternative would not result in take of federally listed, proposed, or candidate species; and there would be no adverse modification to piping plover critical habitat.

Environmental Commitments

Details on the BMPs and environmental commitments are found in Appendix F. The following BMPs and environmental commitments address federally listed, proposed, and candidate species and their habitats:

- Where construction cannot avoid:
  - Wetlands,
  - Federal, state, and local wildlife areas and refuges, and
  - Native prairie.

  Mitigation would occur acre for acre, with ecological equivalency in accordance with Project authorizing legislation. If these areas are disturbed during pipeline construction, topsoil would be replaced and revegetation plans would be specifically designed for these areas to ensure reestablishment of a similar type and quality of native vegetation recommended by local NRCS office and approved by the landowner.
- Pipelines, WTPs, and pump station facilities would be realigned, where feasible, to avoid sensitive wildlife habitat. If sensitive wildlife habitat cannot be avoided, mitigation would be determined in coordination and agreement with the Impact Mitigation Team, including pertinent regulatory agencies.
- Preconstruction surveys would be conducted with the Impact Mitigation Team to identify sensitive habitats and wildlife use before construction to allow implementing BMPs and environmental commitments.
- If forested habitat is identified prior to construction activities, the Impact Mitigation Assessment team would determine whether bat surveys are required. If any tree (with a diameter of greater than 3 inches) removal activities cannot be avoided between April and September, northern long-eared bat surveys would be conducted to confirm absence of the species. If any suitable roost sites, possible hibernacula, or the species are observed during the surveys, steps taken to avoid and minimize disturbance of this habitat would be documented.

Cumulative Effects

Because the No Action Alternative looks at the future out to 2060 without the action, cumulative effects from future reasonably foreseeable Missouri River System depletions and sedimentation were included in this impact analysis. Impacts on federally listed, proposed, and candidate species were not found. There are no known present or reasonably foreseeable non-Project future actions in the Project Area that would change this determination.

Summary

The No Action Alternative was found to have no adverse consequences on federally listed species, as identified in Table 4-21. None of the action alternatives was found to adversely affect any federally listed species or critical habitat as identified in Table 4-21.

Historic Properties

Introduction

This section compares the effects of the alternatives on historic properties. Historic properties are prehistoric or historic districts, sites, buildings, structures, or objects included in, or eligible for inclusion in, the National Register of Historic Places. When evaluating a federal action, only properties that meet eligibility and integrity criteria for listing in the National Register of Historic Places are taken into consideration by federal agencies under the National Historic Preservation Act (NHPA).

Methods

Historic properties were identified through a Class I file and literature review (Burns 2013) described in the Historic Properties section in Chapter 3. GIS data collected by the Class I review were used to identify properties that intersect pipeline corridors and facility locations. The analysis area for the Class I survey covers 1 mile on either side of proposed pipelines or facilities and 1 mile on either side of the Souris River. The area of analysis is wider than the area that would be directly impacted, which allows flexibility in rerouting pipelines or relocating Project facilities to avoid historic properties during Project design. Most of the area of potential effects (APE) has not been surveyed to identify historic properties; very few cultural resource compliance inventories have been completed to date. Results presented in the Water Resources section in this chapter, including discussions on geomorphology, were used to determine that the Project would not change flows in a way that would result in increased erosion that potentially could affect historic properties along the Souris River.

Area of Potential Effects is the portion of the Project Area where the Project may have direct or indirect impacts on the character or use of historic properties.

As addressed in the Water Resources section in this chapter, a study was initiated with the Missouri River Basin Water Management Division under the Northwestern Division of the Corps to analyze impacts from a proposed transfer of water from the Missouri River to the Project Area. This study, *Cumulative Impacts to the Missouri River for the Bureau of Reclamation's Northwest Area Water Supply Project* (Corps 2013a), assessed the effects of Project depletions using a hydrologic analysis of projected surface water reservoir levels and dam releases. This hydrologic information from the "Water Resources" section was used to address potential impacts on historic properties along the Missouri River and reservoirs.

Reclamation recognizes that the Corps is responsible for the operation and maintenance of the Missouri River System and continued consultation with Missouri River Basin Tribes regarding effects on historic properties. Under the terms of Stipulation 18 of the March 2004 "Programmatic Agreement for the Operation and Management of the Missouri River Main Stem System for Compliance with the National Historic Preservation Act, as amended," the Corps has agreed to consult/meet with the affected tribes and Tribal Historic Preservation Officers, State Historic Preservation Officers, the Advisory Council on Historic Preservation, and other parties on development of an annual operating plan for the Missouri River System. Reclamation does not anticipate that this proposed Project would change the way the Corps operates the Missouri River or how cultural and tribal issues are addressed by the Corps.

The analysis also takes into consideration full implementation of the BMPs in Appendix F.

Results

No Action Alternative

As discussed in the introduction to this chapter, the extent of potential consequences on historic properties under the No Action Alternative cannot be quantified in regard to activities within the Souris River basin. Because there would be no federal involvement in No Action, it is not a federal undertaking. Under the No Action Alternative, no new pipelines or Project facilities would be constructed; therefore, no historic properties would be affected within the Souris River basin.

The analysis of potential consequences of the No Action Alternative on Missouri River resources (Corps 2013a) does not include future depletions by the Project. Therefore, under No Action, only the estimated reasonably foreseeable future non-Project depletions were analyzed (see Appendix D).

Missouri River Reservoir Consequences

As discussed in the Water Resources section in this chapter, daily water surface elevations of the upper three Missouri River reservoirs (Fort Peck, Garrison, and Oahe) for No Action were found to be generally higher than existing conditions. Along Missouri River reservoirs, the consequences of No Action to historic properties would be beneficial or barely detectable.

Missouri River Dam Release Consequences

The Corps' analysis (2013a) also evaluated dam releases. Information on dam release can be useful in looking at potential consequences on historic properties below the dams. Releases from the upper three reservoirs are based on the need to balance the effects of depletions, sedimentation, and flood storage evacuation while ensuring water to meet downstream navigation and flood control targets is stored in Gavins Point Reservoir.

The Corps analysis (2013a) found that differences in annual releases from these dams would be relatively small when compared to the average daily releases for the No Action Alternative and are nearly equal to the non-Project depletions. (See the Water Resources section for more detail.) Flow changes would be negligible, and no additional riverbank erosion would occur that could affect historic properties. Therefore, consequences on historic properties are expected to be negligible compared to existing conditions. Additionally, the Corps would continue to manage for historic properties in accordance with the Master Water Control Manual (Corps 2006) and annual operating plans.

Action Alternatives

Tables 4-22 and Table 4-23 compare the effects of the action alternatives on historic properties to the consequences of No Action. Table 4-22 quantifies the number of properties recorded in the analysis area of each alternative. The area evaluated in the Class I survey is larger than the area that would be affected if an action alternative would be implemented. Table 4-23 quantifies recorded properties in a smaller area, limited to the APE of each alternative.

Table 4-22 Number of Recorded Properties within Historic Properties Analysis Area

National Register Eligibility	No Action Alternative	Groundwater with Recharge	Groundwater with Recharge and the Souris River	Missouri River and Conjunctive Use	Missouri River and Groundwater
Eligible	Unknown	29	29	27	3
Unevaluated	Unknown	345	345	266	47
Ineligible	Unknown	96	96	84	10
Isolated Find	Unknown	43	43	30	8
Total	**Unknown**	**513**	**513**	**407**	**68**

Notes:
National Register eligibility is based upon investigator recommendations and not formal determinations of eligibility.
Analysis area includes 1 mile on either side of pipeline, facility, or Souris River.

Table 4-23 Number of Recorded Properties within Project Corridor

National Register Eligibility	No Action Alternative	Groundwater with Recharge	Groundwater with Recharge and the Souris River	Missouri River and Conjunctive Use	Missouri River and Groundwater
Eligible	Unknown	2	2	2	2
Unevaluated	Unknown	49	49	8	8
Ineligible	Unknown	1	1	1	1
Isolated Find	Unknown	2	2	2	2
Total	**Unknown**	**54**	**54**	**13**	**13**

Notes:
National Register eligibility is based upon investigator recommendations and not formal determinations of eligibility.
Recorded properties within the Project corridor are limited to the area of potential effects of each alternative.

The NHPA requires federal agencies to take into account the effects of their undertakings only on historic properties. The first column on both tables presents the eligibility status of the recorded properties. In most cases, eligibility status reflects the recommendation of the investigator who recorded the property rather than a determination by the federal agency in consultation with the State Historic Preservation Office or Tribal Historic Preservation Office.

If an action alternative is selected in the Record of Decision, formal determinations of eligibility would be completed for all resources identified within the APE. Until then, data presented in these tables are the best available and useful for comparing alternatives.

Groundwater with Recharge and Groundwater with Recharge and the Souris River Alternatives

Of the action alternatives, the inbasin alternatives have the greatest number of properties recorded in their analysis areas (Table 4-22). Impacts would be associated with construction of pipelines, pump stations, reservoirs, recharge basins, and other engineering components. Hydrology and geomorphology analyses discussed in the Water Resources section determined that use of Souris River water would not increase erosion along the Souris River because of previously implemented flood control measures. Therefore, no impacts were identified for historic properties along the Souris River. The number of recorded properties within the APE of both inbasin alternatives is the same, with 2 eligible properties, 49 unevaluated properties, 1 ineligible property, and 2 isolated finds (Table 4-23).

Missouri River and Conjunctive Use Alternative

The Missouri River and Conjunctive Use Alternative does not have recharge basins; therefore, there are fewer properties in the Souris River basin analysis area than under the inbasin alternatives. This alternative has 407 properties, compared to 513 for the inbasin alternatives. In the APE of the Missouri River and Conjunctive Use Alternative, there are 2 eligible properties, 8 unevaluated properties, 1 ineligible property, and 2 isolated finds (Table 4-23).

The effect of Project depletions on historic properties on Missouri River reservoir shorelines would be relatively small, as demonstrated in the Water Resources section. The data show generally higher water levels on the reservoirs. Small differences in reservoir levels would occur during extended droughts because the Missouri River System is managed to conserve water during droughts. Details are in the Water Resources section and in the Corps analysis (Corps 2013a).

The potential reservoir level changes are within the range of normal reservoir variation and are not likely to adversely affect historic properties beyond effects under existing conditions or No Action. The fluctuation of reservoir storage and reservoir levels found in the Corps analysis of the Project simulations (2013a) is generally not likely to adversely affect historic properties in comparison to No Action.

Dam Release Impacts. The Corps' analysis (2013a) also evaluated water releases from dams within the Missouri River System, as described for the No Action Alternative above. The analysis included releases from Fort Peck, Garrison, Oahe, and Gavins' Point dams because these releases could potentially affect historic properties along riverbanks. Fort Randall Dam releases were not specifically addressed in the analysis because these mirror releases from Gavins Point Dam. Comparison of the No Action simulation to the Project simulations showed that differences in annual releases from these dams are so small as to be barely detectable or nearly equal. This barely detectable decrease is not likely to increase bank erosion; therefore, it should not adversely affect historic properties.

Missouri River and Groundwater Alternative

Like the Missouri River and Conjunctive Use Alternative, this alternative has fewer recorded properties in the analysis area than the inbasin alternatives (Table 4-22). Impacts in the APE would be the same — 2 eligible properties, 8 unevaluated properties, 1 ineligible property, and 2 isolated finds (Table 4-23).

The effects of Project depletions on historic properties on Missouri River reservoir shorelines and shorelines below the dams would be the same as described above for the Missouri River Conjunctive Use Alternative.

Environmental Commitments

The following mitigation measures would be implemented during construction (see Appendix F).

- Reclamation will continue complying with stipulations in the Programmatic Agreement between the Bureau of Reclamation, The Advisory Council on Historic Preservation, and the

North Dakota State Historic Preservation Officer for the Implementation of Reclamation Undertakings in North Dakota for the life of the Project and in consultation with tribes.

- Avoidance would be the preferred method for treating historic properties. However, should that not be possible, the Programmatic Agreement identifies standards to be used in developing mitigation plans.
- Reclamation would consult under Section 106 of the NHPA with appropriate Indian tribes regarding the locations of and potential impacts on properties of traditional religious and cultural importance. If any such properties cannot be avoided and must be mitigated, Reclamation would invite the appropriate tribes to participate in development of an appropriate treatment plan.
- All gravel, fill, and rock materials would be obtained from a source approved by Reclamation to ensure compliance with Section 106 of the NHPA.

Cumulative Effects

A cumulative action was identified in the Souris River basin. A preliminary plan for additional flood protection along the Souris River from Burlington to Velva and Mouse River Park has been developed. Because the Project would not affect historic properties along the Souris River due to extensive existing flood protection, no cumulative effects from enhancing this flood protection would occur.

Cumulative effects through 2060 were accounted for in the Missouri River impacts analysis, including sedimentation in the Missouri River mainstem system and non-Project depletions. Details on this analysis can be found in Appendix D and in the Corps analysis (2013a). The action alternatives would have no or very small cumulative effects on Missouri River hydrologic resources and, thus, cultural resources when compared to No Action.

Summary

The consequences of No Action on historic properties are unknown. The Missouri River and Conjunctive Use and Missouri River and Groundwater Alternatives would affect fewer properties than the inbasin alternatives, as illustrated in Figure 4-45. There are 54 resources within the APE that could be affected by the inbasin alternatives but only 13 within the APE of the Missouri River alternatives.

Project depletions from the Missouri River alternatives would be relatively small. The resulting changes in reservoir levels would be within normal reservoir fluctuations. Negligible changes in dam releases would not likely affect historic properties within the APE beyond what is already occurring under existing conditions.

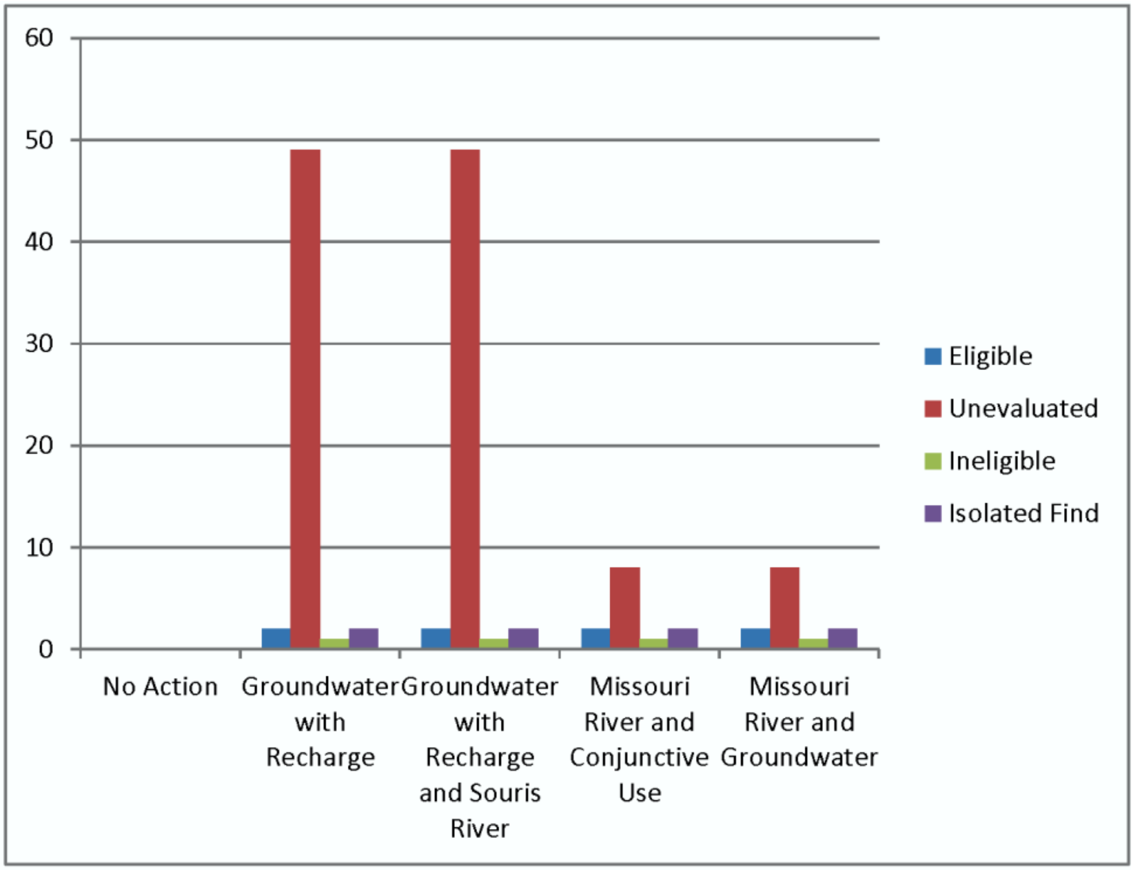

Figure 4-45 Comparison of the Number of Recorded Properties within the Area of Potential Effects of the Alternatives

Indian Trust Assets

Introduction

This section discusses the consequences of the No Action Alternative and the effects of the action alternatives on Indian Trust Assets (ITAs). As documented in Chapter 3, three categories of ITAs were identified that potentially could be affected by the Project. These ITA categories are:

- Trust lands
- Hunting, fishing, and gathering rights
- Indian water rights

Potential effects of the Project on historic properties, such as traditional cultural properties, are addressed in the Historic Properties section, and the potential effects of the Project on tribal communities are discussed in the Environmental Justice section.

Methods

In August 2010, Reclamation contacted 27 individual tribes seeking assistance in identifying ITAs or other issues of concern and to assess potential impacts, as discussed in Chapter 5. The same tribes were consulted in February 2012 and January 2014. In response, the Sisseton-Wahpeton Oyate of Lake Traverse Reservation, Standing Rock Sioux Tribe, and Yankton Sioux Tribe requested further information on the Project, which was provided, but no ITAs have been identified by any of the 27 tribes to date. Project-related information was sent to the tribes throughout the SEIS process, and representatives were invited to meet with Reclamation to discuss possible impacts on potentially affected ITAs.

To identify potential impacts on trust lands, the areas of potential effects for the Project alternatives were compared to the distribution of tribal lands. To identify hunting, gathering, and fishing rights, Royce (1899) was used to determine the geographical boundaries of different treaties. The terms of those treaties and pertinent Supreme Court decisions relative to treaty rights, such as *Winters v. United States* (1908) were considered.

Results

No Action Alternative

This alternative would not have consequences associated with any trust lands; hunting, fishing, and gathering rights; or water rights. This does not imply that tribal persons living in the Project Area may not experience consequences from not implementing the Project, but such consequences are discussed in the Environmental Justice section.

Action Alternatives

Groundwater with Recharge and Groundwater with Recharge and the Souris River Alternatives

Since all facilities would be located outside of Indian reservations, no trust lands would be affected. Furthermore, this alternative would not affect water rights or hunting and gathering rights over the long term.

Missouri River and Conjunctive Use and Missouri River and Groundwater Alternatives

Since all facilities would be located outside of Indian reservations, no trust lands would be affected. Furthermore, this alternative would not affect water rights or any hunting and gathering rights over the long term. With respect to water rights, if tribes quantified their reserved water rights and put the water to beneficial use, the volume of water available for other users in the basin may be affected. The Corps (2006) has stated, "[u]ntil such time as the Tribes quantify their water rights and consumptively withdraw their water from the Mainstem Reservoir System, the water is in the system." The Corps intends to operate the Missouri River using the water currently in the system.

In its depletion analysis of Missouri River resources, Reclamation included all future tribal depletions documented in written plans, such as municipal, rural, and industrial needs assessments and tribal reserved water rights that have been quantified (as identified in Chapter 3). These depletion data are in Appendix D. Some depletions result from water rights settlements, while others do not. Both depletion simulations estimated for this Project should not affect reserved tribal water rights settlements.

Environmental Commitments

No environmental commitments have been identified to mitigate effects because none of the action alternatives would adversely affect ITAs.

Cumulative Effects

The analyses have not identified direct or indirect effects on ITAs; therefore, no cumulative effects would occur. All proposed permanent components would be outside of Indian reservations and are not proposed on any trust lands; therefore, no impacts on these ITAs are anticipated. Furthermore, the action alternatives would not affect water rights or any hunting and gathering rights over the long term, as described in the analyses above.

Summary

The No Action Alternative would not have consequences for any trust lands; hunting, fishing, and gathering rights; or water rights. Because all proposed Project components would be located outside of Indian reservations and trust lands, no impacts on these ITAs are anticipated. To date, the 27 tribes consulted by Reclamation have not identified any ITAs or effects on these assets from the action alternatives. Furthermore, none of the action alternatives would affect water rights or any hunting and gathering rights over the long term.

Socioeconomics

Introduction

This section examines the potential consequences of No Action and the effects of the action alternatives on social and economic characteristics in the Project Area. Effects on water supplies, including water quality and quantity and water rates, are discussed along with area economic impacts, including temporary construction and permanent operation impacts associated with employment, materials, and supply costs, maintenance costs, and housing demand for the workforce. Potential disruption to agricultural activities and property taxes are also described. Impacts on agricultural activities are based on the analysis in the Land Use section in this chapter.

As described in Chapter 1, the Project would be constructed under the North Dakota State Municipal, Rural, and Industrial (MR&I) Program, which includes a non-federal cost share requirement of at least 25 percent of the Project costs. In 1998, the citizens of the City of Minot implemented a 1-percent sales tax in their community to fund the local cost share requirement for the Project. Today, that specific sales tax for the Project no longer exists because the City of Minot has determined that the full local cost share requirement has been met. It is anticipated that the operation and maintenance costs of the Project would be funded through water assessments on water bills.

This section is organized slightly differently than the other sections in this chapter. The discussions of methods, results, environmental commitments, cumulative effects, and the summary that immediately follow this introduction focus on the impacts associated with construction and operation of the Project components throughout the entire Project Area, as well as issues associated with water quality and quantity and water rates. These discussions are followed by another impact analysis that focuses specifically on socioeconomic issues associated with the use of water from the Missouri River as part of the two Missouri River alternatives.

Project Area Impacts

Methods

Impacts associated with water quality and quantity were addressed qualitatively based on information provided by the Project Area communities, which is summarized under the No Action Alternative in Chapter 2 and in Appendix B. Impacts associated with potential changes in water rates for Project Area communities are described qualitatively based on information regarding existing rates provided by individual communities, percentage of typical household budgets, and costs that could be incurred in response to poor water quality (e.g., higher energy costs and costs to replace appliances).

The direct, indirect, and induced socioeconomic effects of construction and operations primarily were assessed using the U.S. Department of Commerce's Bureau of Economic Analysis (BEA) Regional Input-Output Modeling System (RIMS II) statewide final-demand multipliers for employment, earnings, and output (BEA 2013). RIMS II is an economic model used to estimate the economy-wide impacts of change in economic activity from the Project. These statewide multipliers are based on 2010 regional data for construction and operation of water, sewage, and other systems. The total average annual costs to complete construction and the total costs for operation are multiplied by these industry multipliers to estimate direct, indirect, and induced employment, wages, and output resulting from each Project alternative.

Direct effects are associated with constructing and operating the Project components. Examples of direct jobs are those that would be generated by construction of the distribution pipeline and operation of the Biota WTP. Direct labor income is the income earned by construction and operation workers, including contract workers. Direct economic output is associated with initial purchases of materials and supplies needed to construct and operate the Project.

Indirect effects are the jobs, income, and economic output generated by businesses that would supply goods and services needed to construct and operate the Project. Indirect jobs, for example, would include those at a company that produced pipe for the Project. Indirect labor income includes the income earned by people working at indirect jobs. Indirect output includes the total sales volume related to the supply of goods and services to suppliers of goods and services.

Induced effects are the result of spending of the wages and salaries of the direct and indirect employees on items such as food, housing, transportation, and medical services. This spending creates induced employment in nearly all sectors of the economy, especially service sectors.

These effects were compared to the population, housing, employment, and economic data identified in Chapter 3 to show relative levels of impacts. Potential temporary or permanent disruptions to cultivated cropland and hay/pasture were assessed based on the analysis performed for the "Land Use" section in this chapter and on potential property tax losses for above-ground facilities in Ward and McLean Counties, which are presented in Appendix H (Table H-5).

Results

No Action Alternative

Project Area communities are primarily supplied by groundwater, which in many cases is currently characterized by water quality that does not meet secondary drinking water standards. Under the No Action Alternative, most Project Area communities would continue to have water that did not meet secondary drinking water standards, and some water quality would be worse than at present because after 2018 (or sooner), water would no longer be provided by the City of Minot to the cities of Berthold, Burlington, Deering, Kenmare, Mohall, and Sherwood. As shown in Table 4-24, of the 18 communities and rural water systems that are Project members, only the communities of Mohall and Rugby have local water supplies that meet secondary water quality standards.

Additionally, Kenmare's local water supply exceeds the primary standard for arsenic, although by law Kenmare would be required to provide water that did not exceed this standard. The City of Kenmare previously evaluated two alternative ways of treating its water to meet the arsenic standard but has indicated that it does not have the funds available to develop such a treatment plant and also has expressed concerns that the skill level required to operate such a WTP is above what the City of Kenmare could reasonably attain, given the extremely high demand for skilled labor within the region (Ness, pers. comm., 2011).

Table 4-24 Community Water Quality Concerns without the Project

Community/Rural Water District	Water Quality Issues	Meets Primary Standards?	Meets Secondary Standards?
All Seasons Water Users District	TDS, iron, manganese, sodium, color	Yes	No
Berthold	TDS, sodium	Yes	No
Bottineau	TDS, sodium, uranium, and sulfate	Yes	No
Burlington	Sulfate, TDS, manganese	Yes	No
Deering	Sulfate, TDS, manganese, sodium	Yes	No
Des Lacs	TDS, iron, manganese, sodium, sulfate	Yes	No
Kenmare [a]	Arsenic, TDS, sodium	No	No
Maxbass	TDS, iron, manganese, sodium	Yes	No
Minot	TDS, iron, manganese	Yes	No
Mohall	None	Yes	Yes
North Central Rural Water Consortium	TDS, iron, manganese, sodium, sulfates	Yes	No
Rugby	None	Yes	Yes
Sherwood	TDS, manganese, sodium	Yes	No
Souris	TDS, iron, manganese, sulfate	Yes	No
Upham	TDS, elevated iron, manganese, sodium, color	Yes	No
Upper Souris Water Users District	TDS, iron, salinity, arsenic, lead, copper, manganese	Yes	No
Westhope	TDS, manganese, sodium	Yes	No
Willow City	TDS, elevated iron, manganese, sodium, color	Yes	No

Notes:

TDS = total dissolved solids

[a] Kenmare currently meets the primary water quality standard for arsenic through an interim contract with Minot that expires in 2018 and that would not be renewed. Source: Appendix B, "Community/Water Systems Data"

Water quality concerns include total dissolved solids (TDS), iron, manganese, sodium, sulfate concentrations, sodium bicarbonate, sodium sulfate, calcium bicarbonate, arsenic, salinity, lead, copper, and color. Given the concentrations of these constituents present in water supplies, some Project Area communities would experience water with undesirable taste, odor, and color and some also experience economic burdens. Table 4-25 outlines the aesthetic, cosmetic, and technical effects identified by the EPA for the concentrations present in the Project Area and potential community concerns. Commenters during the scoping meetings also reiterated the need for the Project because of current water quality conditions and raised concerns about taste, odor, and color; and the economic burdens of fixing appliances, stained clothes, and purchasing water supplies and water services (Reclamation 2011c).

Table 4-25 Concerns Associated with Exceeding Secondary Water Quality Standards

Water Quality Secondary Standards Category	Category Explanation	Water Quality Issues in Project Area	Potential Project Area Community Concerns
Aesthetic Effects	Undesirable taste, odors, and color	Color, copper, iron, manganese, sulfate, TDS	Preference for water supplies that do not contain undesirable taste, odor, and color.
Cosmetic Effects	Undesirable effects including skin and teeth discoloration	None	None
Technical Effects	Damage to equipment, including corrosion, sedimentation, scaling, and staining	Copper, iron, manganese, TDS	Staining of laundry, limited effectiveness of soaps and detergents; higher energy use for corroded pipes; water loss and leaking in pipes and appliances; cost of replacing appliances, including water heaters, washing machines, and dishwashers more frequently.

Note:
TDS = total dissolved solids
Source: EPA 2013a

While economic impacts from poor-quality water supplies were not specifically quantified for the No Action Alternative, other studies can be used as general indicators of potential impacts for the Project Area. For example, a study in the Rio Grande basin assessed the appliance depreciation costs (i.e., water heaters, faucets, garbage disposals, clothes washers, dish washers, and evaporative coolers) and non-appliance costs (i.e., bottled water and water softeners) associated with poor water quality. This study showed that the City of El Paso, with approximately 160,500 households, was estimated to have annual appliance depreciation costs of $31.78 per household and non-appliance costs of $13.60 per household (Rio Grande Salinity Management Coalition 2009) due to poor water quality. Although the exact depreciation costs have not been calculated for the Project Area, using the El Paso study as a generalized guide shows that the estimated 51,000 housing units in the Project Area in 2010 (U.S. Census Bureau 2012a) could incur annual appliance and non-appliance costs due to poor water quality. Additionally, some residents might rely on supplemental water supplies, such as bottled water, and water services, such as laundromats, in response to poor-quality water, both of which would have economic impacts.

Some communities also would have water supplies that were inadequate to meet future demands through 2060, including those served by the All Seasons Water Users District and the North Central Rural Water Consortium and the cities of Berthold, Bottineau, Des Lacs, Kenmare, and Mohall. (See Chapter 2 and Appendix B for potential community and system water shortage details.) The current water source for the City of Minot has been declining for a long time (refer to Figures 3-11 and 3-12 in Chapter 3, which show groundwater declining since the 1960s), and they would need to limit water or suffer shortages in the future. Costs could be associated with implementing water conservation measures, and businesses dependent on reliable water supplies might experience financial hardships or limited ability to expand.

Current water rates and annual costs for selected Project Area communities, based on readily available information, are depicted in Table 4-26; annual costs are based on the assumption that an average family household of four uses 400 gallons per day (EPA 2013c). The cost per 1,000 gallons of water use was the highest in Kenmare ($5.00) and the lowest in Sherwood ($2.00). Similarly, the percentage of household income an average family of four might be expected to spend per year ranges from 0.8 to 2.0 percent for Project Area communities. Minot residents, which comprise 84 percent of the Project Area community population in Table 4-26, spend 1.7 percent of household income on current water costs (U.S. Census Bureau 2012a).

Table 4-26 2013 Water System Rates for Selected Project Area Communities

Community	2010 Population	Base Rate	$ per 1,000 Gallons	Cost per Year per Household	Median Household Income (2011)	Percent of Income per Household
Bottineau	2,211	$12.50	$2.25	$425	$42,167	1.0
Burlington	1,060	$0.00	$2.92	$426	$55,515	0.8
Kenmare	1,096	$30.00	$5.00	$970	$48,527	2.0
Minot	40,888	$9.96	$4.65	$798	$46,687	1.7
Rugby	2,785	$9.00	$3.00	$510	$32,428	1.6
Sherwood	242	$20.00	$2.00	$508	$46,042	1.1
Westhope	429	$10.00	$4.00	$656	$72,344	0.9

Sources: City of Bottineau 2013; City of Burlington 2013; City of Kenmare 2010; City of Minot 2013; City of Rugby 2013; City of Sherwood 2012; City of Westhope 2013; EPA 2013c; U.S. Census Bureau 2012a, 2013

The No Action Alternative could potentially result in smaller community water rates increasing over time to meet primary and secondary water quality standards. If no regional system allows the costs to be pooled and partially federally funded, communities might need to make localized changes to their system requiring additional funding, or they might rely on higher water rates set by larger communities or systems for their future demand. Existing area economic conditions, employment, housing, agricultural activities, and property tax revenue levels would continue, as described in Chapter 3, under the No Action Alternative.

Action Alternatives

Water quality, quantity, and rates are described in this section by alternative and in comparison to No Action. Potential construction impacts for each action alternative include total construction costs, annual construction costs for the 10-year construction period, temporary employment, housing demand for the workforce, local and non-local purchases of materials and supplies, and potential disruption of agricultural activities. Operation impacts for each alternative include permanent employment, potential need for permanent housing, maintenance costs and expenditures, and property taxes on permanent easements.

As described under No Action and in Table 4-24, Project Area communities have water quality and quantity issues that might cause undesirable taste, odor, and color in addition to economic burdens. The action alternatives described in Chapter 2 would provide sufficient water supplies to meet future population growth and improve water quality, although the benefits would be greater under the Missouri River alternatives because water would be treated to meet both primary and secondary drinking water standards. Under the inbasin alternatives described in Chapter 2, the treated water would meet primary standards but would meet only some secondary standards; the proposed treatment process would not result in full compliance with secondary standards for TDS, sulfate, and chloride.

There is a potential for water rates to increase as a result of the Project, although the exact extent of the increase is not quantified. The costs of the Project would be spread throughout a large number of Project Area communities, and a percentage of overall cost would be partially offset by federal funding (up to 75 percent), which would minimize the potential for increases. Currently, the funding necessary for the local cost share has already been collected by area residents for construction costs. Operation costs would need to be collected by water users once construction is complete. Additionally, as discussed under the No Action Alternative, costs are associated with poor water quality, and these would be minimized as a result of the Project alternatives, particularly the Missouri River alternatives. Any water rate increases associated with the alternatives would be expected to be at least partially offset by an improvement in water quality and quantity for residents.

Total construction costs and proposed construction costs to complete by action alternatives are shown in Table 4-27. Additional information about the construction costs of each alternative is provided in Chapter 2, and additional details are included in Appendix J. Proposed construction costs to complete each of the action alternatives are estimated to range from $95.2 to $166.5 million. Based on past levels of federal funding, a 10-year construction schedule was assumed for annual costs by alternative. Average annual completion costs during construction are estimated to range from $9.5 to $16.7 million. Total cost estimates included in Appendix J were completed at a 30% design level. Due to the preliminary nature of these estimates, this socioeconomic analysis does not break out costs for specific categories including labor, land and easement acquisitions, capital facility equipment, rental equipment, materials and supplies, and other expenditures.

The economic benefits (i.e., employment, wages, spending on goods and services, and taxes) of this construction would be realized not only by the 10-county Project Area but also the remainder of North Dakota, and potentially by surrounding states. It is expected that local purchases of materials and supplies could include concrete and that non-local purchasing (i.e., in North Dakota and surrounding states) might include more specialized equipment for the Minot WTP and piping for the Project, which is not manufactured locally.

Table 4-27 Construction Costs by Alternative

Alternative	Total Construction Costs ($ million)	Proposed Construction Costs to Complete Alternative ($ million)	Average Annual Costs ($ million)
Groundwater with Recharge	$216.6	$106.1	$10.6
Groundwater with Recharge and the Souris River	$217.1	$106.7	$10.7
Missouri River and Conjunctive Use	$205.6 – 276.8	$95.3 – $166.3	$9.5 – $16.6
Missouri River and Groundwater	$205.5 – 276.8	$95.2 – $166.5	$9.5 – $16.7

Source: Appendix J, *Appraisal-Level Design Report*

Table 4-28 provides the BEA RIMS II analyses for direct, indirect, and induced impacts, indicating the additional jobs, employment income, and economic output that would be generated statewide by each action alternative per year on average for the 10-year construction schedule. The statewide Project benefits would include the creation of between 132 and 231 average annual jobs during the 10-year construction schedule. As described in the Socioeconomics section in Chapter 3, there were 1,648 unemployed people in the Project Area in 2011, 910 of which are in Ward County (U.S. Census Bureau 2013).

Table 4-28 Statewide Average Annual Construction Impacts by Alternative

Alternative	Average Annual Construction Costs ($ million)	Average Annual Employment	Average Annual Wages ($ million)	Average Annual Output ($ million)
Groundwater with Recharge	$10.6	147	$5.7	$18.7
Groundwater with Recharge and the Souris River	$10.7	148	$5.8	$18.8
Missouri River and Conjunctive Use	$9.5 – $16.6	132 – 231	$5.1 – $9.0	$16.8 – $29.3
Missouri River and Groundwater	$9.5 – $16.7	132 – 231	$5.1 – $9.0	$16.7 – $29.3

Source: BEA 2013

Although housing demand has escalated with the Bakken oil boom, many of the Project temporary construction workers would likely be locally hired and already reside in housing in the Project Area. As described in the Socioeconomics section in Chapter 3, 9,448 unoccupied housing units were present in the Project Area in 2010, of which 4,384 were seasonal, recreation, and temporary use units; thus, adequate temporary housing should be available for workers currently residing outside the Project Area (U.S. Census Bureau 2012a). The statewide Project benefits would include the creation of between $5.1 and $9.0 million in average annual wages and between $16.7 and $29.3 million in average annual economic output during the 10-year construction schedule.

As discussed in the Land Use section in this chapter, a number of Project components would be constructed on farm land used for agricultural purposes. Impacts on agricultural activities would be minimized by the implementation of BMPs. To the extent feasible, construction activities on irrigated lands would be avoided during the growing season. In areas where above-ground components for the Project would not allow agricultural activities to continue, landowners would be compensated for the permanent impacts.

Total annual operation costs by alternative are shown in Table 4-29. Operation costs are estimated to range from $8.8 million for the inbasin alternatives to $10.8 million for the Missouri River alternatives. Additional information about the operation costs of each alternative is included in Appendix J. These total costs include labor, capital facility equipment, rental equipment, materials and supplies, and other expenditures. The economic benefits of this operation would be realized not only by the 10-county Project Area but also the remainder of North Dakota, and potentially by surrounding states.

Table 4-29 Annual Operation Costs by Alternative

Alternative	Annual Operation Costs ($ million)
Groundwater with Recharge	$8.8
Groundwater with Recharge and the Souris River	$8.8
Missouri River and Conjunctive Use	$9.5 – $10.8
Missouri River and Groundwater	$9.5 – $10.8

Source: Appendix J, *Appraisal-Level Design Report*

Table 4-30 provides the BEA RIMS II analysis for direct, indirect, and induced impacts indicating the additional jobs, employment income, and economic output that would be generated by operation of each alternative. The statewide Project benefits would include the creation of between 105 and 129 annual operation jobs that would be located primarily at the Minot WTP and other major components. It is anticipated that these permanent operation workers would be locally hired and already reside in housing in the Project Area. The statewide Project benefits would include the creation of between $4.0 and $4.9 million in annual wages and between $14.3 and $17.6 million in annual economic output during operation.

The property tax base would likely decrease for some counties and communities in the Project Area. While this would not change as a result of temporary easements required for the action alternatives, some property tax base could be lost where an alternative requires permanent right-of-way for above-ground facilities. The State already owns the land for the Biota WTP in McLean County, which would be a Project component for the Missouri River alternatives, but other land acquisition surrounding Minot in Ward County would be required for the inbasin alternatives.

Table 4-30 Statewide Annual Operation Impacts by Alternative

Alternative	Annual Operation Costs ($ million)	Annual Employment	Annual Wages ($ million)	Annual Output ($ million)
Groundwater with Recharge	$8.8	105	$4.0	$14.3
Groundwater with Recharge and the Souris River	$8.8	105	$4.0	$14.3
Missouri River and Conjunctive Use	$9.5 – $10.8	113 – 129	$4.3 – $4.9	$15.5 – $17.6
Missouri River and Groundwater	$9.5 – $10.8	113 – 129	$4.3 – $4.9	$15.5 – $17.6

Source: BEA 2013

Groundwater with Recharge Alternative

This alternative would not meet all secondary water quality standards; however, the improvement in quality and quantity compared to the No Action Alternative would likely be substantial. Any water rate increases associated with this alternative would likely be partially offset by an improvement in water quality and quantity.

The average annual construction costs for the Groundwater with Recharge Alternative would be $10.6 million during the 10-year schedule. Results of the BEA RIMS II analysis for direct, indirect, and induced construction impacts are shown in Table 4-28. The average annual employment for this alternative would be 147, and the average annual wages would be $5.7 million. The average annual economic output from this alternative during construction would be $18.7 million.

During Project operation for this alternative, the annual costs would be $8.8 million. As shown in Table 4-30, the BEA RIMS II analysis found direct, indirect, and induced operation impacts of 105 annual jobs and annual wages of $4.0 million. The annual economic output from this alternative during operation would be $14.3 million.

Many above-ground components, such as the recharge facilities, would require permanently purchasing and converting the land used from agricultural purposes, which would result in property tax losses. Most of the permanent effects would occur in Ward County, including 49.4 acres of cultivated cropland, resulting in $15.60 in foregone property taxes annually and 0.2 acre of hay/pasture, resulting in $0.03 in foregone property taxes annually (Appendix H, Table H-5).

Groundwater with Recharge and the Souris River Alternative

The water quality and quantity and agricultural impacts would be the same as those described for the Groundwater with Recharge Alternative because the same Project components are included in each alternative. The use of water from the Souris River for this alternative, resulting in more days of no-flow conditions during a typical year, is not expected to change the social and economic effects from those of the Groundwater with Recharge Alternative.

The average annual construction costs to complete the Groundwater with Recharge and the Souris River Alternative would be $10.7 million during the 10-year schedule. Results of the BEA RIMS II analysis for direct, indirect, and induced construction impacts are shown in Table 4-28.

The average annual employment for this alternative would be 148, and the average annual wages would be $5.8 million. The average annual economic output from this alternative during construction would be $18.8 million.

During Project operation for this alternative, the annual costs would be $8.8 million. As shown in Table 4-30, the BEA RIMS II analysis found direct, indirect, and induced operation impacts of 105 annual jobs and annual wages of $4.0 million. The annual economic output from this alternative during operation would be $14.3 million.

Missouri River and Conjunctive Use Alternative

Because this alternative would meet primary and secondary water quality standards, it would improve undesirable taste, odor, and color of the water and reduce economic burdens to a considerable degree. Any water rate increases associated with this alternative would likely be partially offset by an improvement in water quality and quantity.

The average annual construction costs to complete the Missouri River and Conjunctive Use Alternative would range between $9.5 and $16.6 million during the 10-year schedule. Results of the BEA RIMS II analysis for direct, indirect, and induced construction impacts are shown in Table 4-28. The average annual employment for this alternative would range between 132 and 231, and the average annual wages would range between $5.1 and $9.0 million. The average annual economic output from this alternative during construction would range between $16.8 and $29.3 million.

During Project operation for this alternative, the annual costs would range between $9.5 and $10.8 million. As shown in Table 4-30, the BEA RIMS II analysis found direct, indirect, and induced operation impacts of between 113 and 129 annual jobs, and annual wages of between $4.3 and $4.9 million. The annual economic output from this alternative during operation would range between $15.5 and $17.6 million.

Many above-ground components, such as storage reservoirs, would require permanently purchasing and converting the land used from agricultural purposes, which would result in property tax losses. Most of the permanent effects would occur in McLean County, including 8.8 acres of cultivated cropland for the Biota WTP, which would result in $2.20 in foregone property taxes annually (Appendix H, Table H-5).

Missouri River and Groundwater Alternative

The water quality and quantity and agricultural impacts would be the same as those described above for the Missouri River and Conjunctive Use Alternative because the same Project components are included in each alternative.

The average annual construction costs to complete the Missouri River and Groundwater Alternative would range between $9.5 and $16.7 million during the 10-year schedule. Results of the BEA RIMS II analysis for direct, indirect, and induced construction impacts are shown in Table 4-28. The average annual employment for this alternative would range between 132 and 231, and the average annual wages would range between $5.1 and $9.0 million. The average annual economic output from this alternative during construction would range between $16.7 and $29.3 million.

During Project operation for this alternative, the annual costs would range between $9.5 and $10.8 million. As shown in Table 4-30, the BEA RIMS II analysis found direct, indirect, and induced operation impacts of between 113 and 129 annual jobs, and annual wages of between $4.3 and $4.9 million. The annual economic output from this alternative during operation would range between $15.5 and $17.6 million.

Environmental Commitments

No environmental commitments would be required because impacts would either be beneficial or minimized by the implementation of BMPs; no unavoidable adverse impacts would occur to socioeconomic characteristics.

Cumulative Effects

No projects that would result in an adverse cumulative socioeconomic impact in combination with this Project have been identified. Although still in the planning stages, it is anticipated that the Mouse River Flood Protection Project would result in beneficial impacts due to the creation of construction jobs and flood protection benefits; therefore, no adverse cumulative socioeconomic effects would occur.

Summary

Under the No Action Alternative, most Project Area communities (except Mohall and Rugby) would continue to have water that did not meet secondary drinking water standards, and Kenmare would not meet the primary standard for arsenic after its interim contract ended with Minot in 2018. Given the specific concentrations present in their water supplies and public comments, Project Area communities experience water with undesirable taste, odor, and color (Reclamation 2011c). Poor-quality water supplies also cause economic burdens, as exemplified by residents of El Paso where the annual appliance depreciation cost and non-appliance cost totaled $45.38 per household (Rio Grande Salinity Management Coalition 2009). In communities with insufficient water supplies, there also would be costs for implementing water conservation measures, and businesses dependent on reliable water supplies might experience financial hardships or limited ability to expand.

There is a potential for water rates to increase under the action alternatives, although the costs of the Project would be spread throughout a large number of Project Area communities and a percentage of the Project would be federally funded, which would minimize the potential for rate increases in any given community. The exact increase is not known, but any water rate increases associated with the Project would be expected to be partially offset by an improvement in water quality and quantity for residents, especially in communities and rural water systems not meeting primary or secondary water quality standards or facing short- or long-term water shortages. The action alternatives are not expected to have adverse effects on the socioeconomic characteristics of the Project Area. Improved water quality and quantity would be a benefit for Project Area communities. The Missouri River alternatives would meet primary and secondary water quality standards, while the inbasin alternatives would meet primary water quality standards. It is expected that all alternatives would improve the taste, odor, and color of the water and reduce economic burdens compared to the No Action Alternative.

In addition, the economic direct, indirect, and induced impacts, including employment, income, and output, likely would be a benefit for Project Area residents and North Dakota overall during construction and operation, as described above under each alternative.

Permanent effects on agricultural land would result in minor foregone property taxes annually in Ward and McLean counties on cultivated cropland and hay/pasture. The permanent right-of-way or acquisition of land for all alternatives would not affect the overall tax base in the Project Area due to the extremely small reduction involved.

Missouri River Impacts

Introduction

Changes in Missouri River reservoir levels and dam releases could have economic effects. This section describes the consequences of No Action and the impacts of action alternatives on Missouri River System economic indicators, including flood control, hydropower production, navigation benefits, water supply, and recreation.

Methods

As part of the *Missouri River Master Control Manual March Review and Update EIS* (Corps 2004a), models were developed to evaluate economic impacts of changes in Missouri River System operations. The economic impact models compute absolute economic values. The models were originally developed between 1993 and 2002 and have not been subsequently updated with more recent economic data. To ensure that the use of these models was still appropriate, Reclamation initiated an independent consultant's review of the suitability of the Corps' Missouri River economic models for use in the SEIS. The review determined that these economic impact models, designed specifically for the Missouri River System, are the best available tools for use in this impact analysis. The models have been approved through the Corps' internal model review process and used successfully in other NEPA analyses to provide a relative comparison of alternatives.

The methodology for this analysis is documented in *Cumulative Impacts to the Missouri River for the Bureau of Reclamation's Northwest Area Water Supply Project* (Corps 2013a) and is summarized in Appendix D. The analysis included the same five simulations as discussed in the Water Resources section in this chapter. These simulations are described in detail in the Water Resources section and are discussed separately.

Table 4-31 lists the Missouri River economic uses and resource categories for which effects were computed in this analysis. A description of each use and resource category is provided in Chapter 3.

Table 4-31 Missouri River Economic Uses Evaluated Cumulative Impacts

Use/Resource Category	Abbreviation	Unit
Flood Control	FC	$ million
Missouri River Navigation	NAV	$ million
Hydropower	HYD	$ million
Water Supply	WS	$ million
Recreation	REC	$ million
Total Economics	TOT	$ million

Results

No Action Alternative

As noted in Chapter 2, the No Action Alternative is future reasonably foreseeable conditions through 2060 without further Reclamation funding for the Project. Future conditions through 2060 include predicted reservoir sedimentation and reasonably foreseeable non-Project depletions.

The consequences of No Action compared to existing conditions are described below for each economic value. Again, sedimentation effects are broken out so the consequences of sedimentation can be separated from the consequences of reasonably foreseeable future depletions.

Flood Control

Table 4-32 presents the average annual flood control benefits under the No Action Alternative compared to existing conditions. Existing conditions are a simulation of Missouri River System operations from 1930 to 2010 with the existing (2010) level of depletions. Table 4-32 shows that continuing deposition of sediments into the Missouri River System reservoirs would cause flood control benefits to drop slightly (by 0.13 percent) between now and 2060. Future depletion of flows into the Missouri River mainstem would eliminate this loss of benefits and make the net change positive by 0.02 percent (net change of 0.15 percent). Overall, the change in flood control benefits due to the combined forecasted sedimentation and reasonably foreseeable future depletions are negligible (0.02 percent).

Table 4-32 Average Annual Flood Control Benefits

Simulation	Total Benefits ($ million)	Percent Change from Existing Conditions	Reach Benefits ($ million)		
			Reservoirs	Upper River	Lower River
Existing Conditions	$393.78	—	-$0.52	$81.24	$313.06
Sedimentation 2060	$393.29	-0.13%	-$0.55	$81.25	$312.59
No Action	$393.86	0.02%	-$0.55	$81.31	$313.11

Missouri River Navigation

Operation of the Missouri River System is directly affected by the navigation requirements for the lower Missouri River, flood storage evacuation requirements in high inflow years, and other authorized requirements when navigation is suspended in extended droughts. Future sediment deposition and depletions would have an effect on the navigation service (service level and season length) on the Missouri River, and these changes would have an effect on the navigation economic benefits provided by the Missouri River System.

Table 4-33 shows the average annual navigation benefits on the Missouri River for the No Action Alternative compared to existing conditions. The changes from existing conditions are relatively large at about -15 percent, with most of the change attributable to sedimentation. The loss in navigation benefits is distributed among all of the four reaches.

Table 4-33 Average Annual Missouri River Navigation Benefits

Simulation	Total Benefits ($ million)	Percent Change from Existing Conditions	Reach Benefits ($ million)			
			Sioux City	Omaha	Nebraska City	Kansas City
Existing Conditions	$6.753	—	$0.870	$0.657	$0.414	$4.812
Sedimentation 2060	$5.872	-13.05%	$0.710	$0.535	$0.261	$4.366
No Action	$5.708	-15.48%	$0.694	$0.520	$0.275	$4.220

To help understand the navigation economic effects, DRM navigation results for service level are presented in Figure 4-46. The Corps analysis (2013a) found that the greatest difference is the change in the number of years at full service for the addition of sediment deposition into the reservoirs between existing conditions and 2060. The loss of 8 out of 81 years in the period of analysis is about a 10-percent reduction. The additional 0.516 MAF of reasonably foreseeable non-Project depletions under the No Action simulation results in a loss of 2 more full-service years.

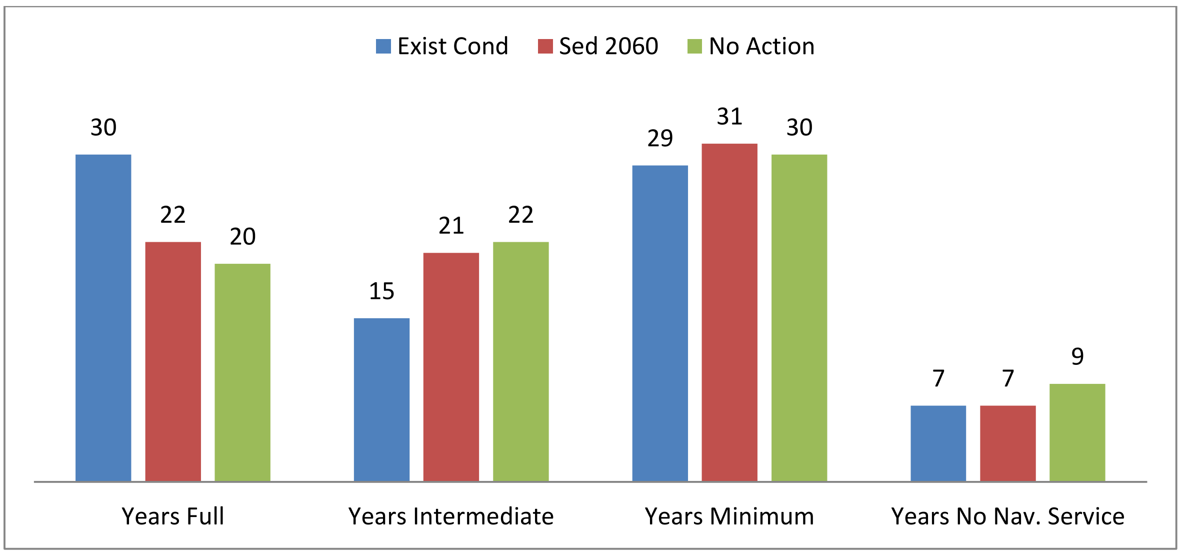

Figure 4-46 Navigation Service Level Based on March 15 System Storage Check

Source: Corps 2013a

Hydropower

The total capacity of all six Missouri River System dam hydropower units is 2,501 megawatts, averaging about 10 million megawatt-hours (MWh) of electricity annually. The amount of energy generated varies with the amount of "head" (height of water above the units) and with the amount of water moving through the units. In general, hydropower generation decreases during drought periods and increases during wet periods.

Benefits are computed by the hydropower economic impacts model using the monthly hydropower results from the DRM. Table 4-34 summarizes these benefits on a reach and total basis as average annual benefits over the period of analysis. The Sedimentation 2060 simulation has the highest average annual total hydropower benefits. Under No Action, the additional reasonably foreseeable future non-Project depletions result in lower heads and releases, and thus a slight decrease in hydropower benefits (-0.43 percent) compared to existing conditions.

Table 4-34 Average Annual Hydropower Benefits

Simulation	Total Benefits ($ million)	Percent Change from Existing Conditions	Reach Benefits ($ million)					
			Fort Peck	Garrison	Oahe	Big Bend	Fort Randall	Gavins Point
Existing Conditions	$628.84	—	$60.39	$126.30	$184.36	$111.40	$108.01	$38.37
Sedimentation 2060	$632.74	0.62%	$60.87	$128.75	$186.34	$111.33	$107.36	$38.09
No Action	$626.17	-0.43%	$60.25	$126.33	$184.18	$110.68	$106.86	$37.88

Water Supply

The water supply economic impacts model computes benefits not only for those relying on the river as a source of water but also for water quality issues for the power plants along the river that discharge their heated water after running through the cooling units of the generators to the river. These benefits are summarized in Table 4-35. Typically, the costs increase for water supply when reservoir levels drop and river flows are reduced. Under No Action, reasonably foreseeable future non-Project depletions would generally result in lower reservoir levels and releases, causing a slight reduction (-0.28 percent) in water supply benefits.

Table 4-35 Average Annual Water Supply Benefits

Simulation	Total Benefits ($ million)	Percent Change from Existing Conditions	Reach Benefits ($ million)		
			Reservoirs	Upper River	Lower River
Existing Conditions	$607.77	—	$19.69	$95.81	$492.27
Sedimentation 2060	$607.81	0.01%	$20.06	$95.80	$491.95
No Action	$606.07	-0.28%	$19.83	$95.32	$490.93

Recreation

Recreation use occurs on all reaches of the Missouri River. The economic benefits of recreation are distributed among all of the reaches; however, changes in recreation benefits on the upper three larger reservoirs have been related to fluctuations in water levels on these large storage reservoirs, which vary greatly according to climatic condition and authorized purposes served. Reservoir levels on the lower three reservoirs are relatively stable because they are flow-through reservoirs with stable water levels. Table 4-36 summarizes the average annual benefits over the 81-year period of analysis on a reach and total basis.

Table 4-36 Average Annual Recreation Benefits

Simulation	Total Benefits ($ million)	Percent Change from Existing Conditions	Reach Benefits ($ million)			
			Upper Three Reservoirs	Lower Three Reservoirs	Upper River	Lower River
Existing Conditions	$82.37	—	$29.40	$29.01	$4.50	$19.47
Sedimentation 2060	$83.97	1.94%	$31.07	$29.03	$4.48	$19.38
No Action	$83.61	1.50%	$30.78	$29.04	$4.47	$19.32

The change in benefits in the lower three reservoirs is near zero. Simulations show small changes in the upper three larger reservoirs, and these are reflected in the changes of the total recreation benefits. The difference between existing conditions and No Action is 1.5 percent. Continuing sedimentation results in higher water levels in the upper three reservoirs. Under No Action, the recreation benefits would increase in the reservoirs and on a total basis in response to the higher levels.

Total National Economic Development Benefits

Summation of the flood control, navigation, hydropower, water supply, and recreation benefits for the Missouri River System provides some perspective on the total benefits to the nation on an average annual basis. These benefits can also be split between those provided within the Missouri River System and those provided to the lower Missouri River. Table 4-37 presents the total national economic development (NED) benefits and the breakdown in these benefits for those that are within the system and those that are along the lower Missouri River for Existing Conditions, Sedimentation 2060, and No Action.

Table 4-37 Total National Economic Development Benefits

Simulation	Total ($ million)	Percent Change From Existing Conditions	Within System ($ million)	Lower River ($ million)
Existing Conditions	$1,719.52	—	$636.44	$1,083.09
Sedimentation 2060	$1,723.68	0.24%	$640.79	$1,082.89
No Action	$1,715.42	-0.24%	$635.89	$1,079.54

Sedimentation generally increases reservoir levels, resulting in increased total NED benefits. Reasonably foreseeable future non-Project depletions would generally result in lower reservoir levels and dam releases, which would decrease total NED benefits. The net result of these two factors is a very small decrease (-0.24 percent) in total NED benefits for No Action relative to existing conditions, with most of the decrease on the lower river.

Action Alternatives

Groundwater with Recharge and Groundwater with Recharge and the Souris River Alternatives

Neither of these alternatives would use Missouri River water; therefore, the Missouri River system would not be affected. The effects of these alternatives would be the same as No Action.

Missouri River and Conjunctive Use and Missouri River and Groundwater Alternatives

The potential impacts of these alternatives were identified using the economic models and comparing the result to the results of No Action. As described in the “Water Resources” section in this chapter, two simulations were used to evaluate the Missouri River alternatives. These simulations, Average Annual Project Depletions and Maximum Possible Project Depletions, represent a range of depletions: 0.0136 MAF per year and 0.0291 MAF per year, respectively.

Flood Control

Table 4-38 presents the average annual flood control benefits for No Action and the two Project simulations for comparison purposes. Neither of the Missouri River alternatives would have an effect on the flood control benefits, as the differences are practically zero.

Table 4-38 Average Annual Flood Control Benefits

Simulation	Total Benefits ($ million)	Percent Change from No Action	Reach Benefits ($ million)		
			Reservoirs	Upper River	Lower River
No Action	$393.86	—	-$0.55	$81.31	$313.11
Average Annual Project Depletions	$393.84	-0.01%	-$0.54	$81.29	$313.09
Maximum Possible Project Depletions	$393.85	0.00%	-$0.54	$81.28	$313.11

Missouri River Navigation

Table 4-39 presents the average annual navigation benefits on the Missouri River comparing No Action to the two Project simulations. The changes from No Action for the two Project simulations are relatively small, at 0.07 percent for the Average Annual Project Depletion simulation and -0.14 percent for the Maximum Possible Project Depletion simulation. As the anticipated depletion for these two alternatives would be less than or equal to the Average Annual Project Depletion simulation, the Missouri River alternatives would have generally negligible effects on navigation benefits.

To help understand the navigation economic effects, DRM navigation results on navigation service level are presented in Figure 4-47. Navigation service levels can be defined as “full service,” “intermediate service,” “minimal service,” or “no service.” For example, full service is provided in normal runoff years, providing flows to fill the 9-foot navigation channel with 8.5-foot draft, while minimal service provides only 7.5 feet of draft and conserves water in the system during drought. Adding the effects of Project simulations to No Action effects adds one more year in which full service would not be provided in a repeat of the 1930 to 2010 period of record. The change would be 1 more year of intermediate service instead of full service.

Table 4-39 Average Annual Missouri River Navigation Benefits

Simulation	Total Benefits ($ million)	Percent Change from No Action	Reach Benefits ($ million)			
			Sioux City	Omaha	Nebraska City	Kansas City
No Action Alternative	$5.708	—	$0.694	$0.520	$0.275	$4.220
Average Annual Project Depletions	$5.712	0.07%	$0.693	$0.520	$0.273	$4.227
Maximum Possible Project Depletions	$5.700	-0.14%	$0.691	$0.518	$0.271	$4.221

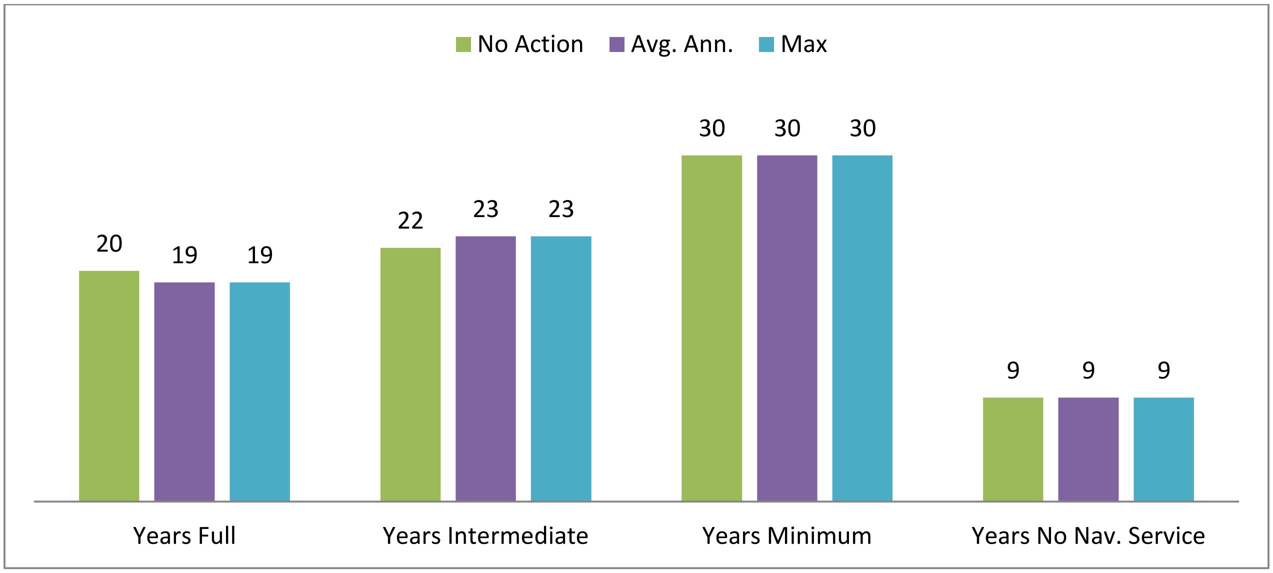

Figure 4-47 Navigation Service Level Based on the March 15 System Storage Check

Source: Corps 2013a

Hydropower

Benefits are computed for both capability and generation by the hydropower economic impacts model using the monthly hydropower results from the DRM. Table 4-40 summarizes these benefits for the different Missouri River reaches as well as the total benefit based on the average annual benefits over the 1930 to 2010 period of analysis. The relative difference between the two Project depletion simulations and No Action regarding the average annual hydropower benefits is in the range of -0.06 to -0.12 percent.

Table 4-40 Average Annual Hydropower Benefits

Simulation	Total Benefits ($ million)	Percent Change from No Action	Reach Benefits ($ million)					
			Fort Peck	Garrison	Oahe	Big Bend	Fort Randall	Gavins Point
No Action	$626.17	—	$60.25	$126.33	$184.18	$110.68	$106.86	$37.88
Average Annual Project Depletions	$625.79	-0.06%	$60.24	$126.24	$183.92	$110.70	$106.83	$37.87
Maximum Possible Project Depletions	$625.40	-0.12%	$60.21	$125.89	$183.96	$110.65	$106.82	$37.86

Water Supply

Water supply benefits are summarized in Table 4-41, which includes the total and reach benefits broken down into three categories: upper and lower Missouri River reaches and reservoir reaches. Additional depletions associated with the two Project simulations resulted in an -0.8-percent change compared to the No Action simulation. This loss basically occurs in the reach downstream from Garrison Dam, which includes three power plants. Detailed investigation of the data associated with the flows and water supply economics could not identify the reason for the lost benefits (Corps 2013a). The No Action simulation, which includes 0.516 MAF per year of reasonably foreseeable non-Project depletions, did not have a similar loss of water supply benefits. At a loss of about 0.8 percent, this Project simulation (0.0136 MAF per year depletion) does not appear to be reasonable when a loss of 0.516 MAF per year for non-Project depletions resulted in a loss of benefits of only 0.29 percent. However, there is some expectation that operational nuances in the Garrison reach may cause some discrepancies in the results. In spite of this apparent anomaly in the data, the Missouri River alternatives would still have a less than 1-percent change on water supply benefits.

Table 4-41 Average Annual Water Supply Benefits

Simulation	Total Benefits ($ million)	Percent Change from No Action	Reach Benefits ($ million)		
			Reservoirs	Upper River	Lower River
No Action	$606.07	—	$19.83	$95.32	$490.93
Average Annual Project Depletions	$601.20	-0.80%	$19.84	$90.44	$490.93
Maximum Possible Project Depletions	$601.19	-0.81%	$19.82	$90.43	$490.93

Recreation

As noted above, recreation use occurs on all reaches of the Missouri River. The economic benefits of recreation are distributed among all of the reaches; however, changes in recreation benefits on the upper three, larger reservoirs has been a longstanding issue related to fluctuations in water levels on these large storage reservoirs which vary greatly according to climatic conditions and authorized purposes served. Reservoir levels on the lower three reservoirs are relatively stable because they are flow-through reservoirs, making their water levels more stable in contrast to the storage purposes of the upper three reservoirs. This is evident in results presented in Table 4-42, which summarizes the average annual benefits over the 81-year period of analysis on a reach and total basis. The lower three reservoirs show no change in recreation benefits, while the upper three reservoirs show a less than 1-percent change.

Table 4-42 Average Annual Recreation Benefits

Simulation	Total Benefits ($ million)	Percent Change from No Action	Reach Benefits ($ million)			
			Upper Three Reservoirs	Lower Three Reservoirs	Upper River	Lower River
No Action	$83.61	—	$30.78	$29.04	$4.47	$19.32
Average Annual Project Depletions	$83.38	-0.28%	$30.54	$29.04	$4.47	$19.32
Maximum Possible Project Depletions	$82.97	-0.77%	$30.13	$29.04	$4.47	$19.32

The relative differences in total recreation benefits between the two Project simulations and No Action are -0.28 percent for the Average Annual Project Depletions simulation and -0.77 percent for the Maximum Possible Project Depletions simulation, with all of the differences occurring in the upper three reservoirs Project depletions, although very small, would likely result in slightly decreased benefits, especially during drought. Overall, the Missouri River alternatives would have a less than 1-percent effect on recreational benefits.

Total National Economic Development Benefits

Summation of the flood control, navigation, hydropower, water supply, and recreation benefits for the Missouri River System provides some perspective on the total benefits to the nation on an average annual basis. Table 4-43 shows the total NED benefits and the breakdown of these benefits into those that are within the Missouri River System and those that are along the lower Missouri River. When comparing No Action to the Project simulations, there is a difference of -0.3 to -0.4 percent. Overall, the Missouri River alternatives would have a less than 1-percent effect on total NED.

Table 4-43 Total National Economic Development Benefits

Simulation	Total ($ million)	Percent Change from No Action	Within Missouri River System ($ million)	Lower River ($ million)
No Action	$1,715.42	—	$635.89	$1,079.54
Average Annual Project Depletions	$1,709.92	-0.32%	$630.55	$1,079.37
Maximum Possible Project Depletions	$1,709.10	-0.37%	$629.87	$1,079.23

Environmental Commitments

No environmental commitments have been identified to offset or mitigate effects because the action alternatives would have minimal impacts on Missouri River economic resources.

Cumulative Effects

Cumulative effects were accounted for by including future reservoir sedimentation, existing depletions, and reasonably foreseeable future non-Project depletions in simulations of the No Action and Missouri River alternatives. Project depletions under the Missouri River alternatives would add less than 0.2 percent to the total forecasted Missouri River depletions in 2060. The Missouri River alternatives are not expected to have cumulative effects on Missouri River economic resources.

Summary

Under No Action, reservoir sedimentation and reasonably foreseeable future non-Project depletions would affect economic benefits of the Missouri River System. The primary economic consequence of No Action would be a reduction in navigation benefits, primarily because of the continuing sedimentation in the reservoirs and that factor's effect on Missouri River System releases. The loss of navigation benefits under No Action would be approximately 15 percent, and the majority of this loss is attributed to future sedimentation (Table 4-43). For all of the other economic benefits calculated, differences between No Action and existing conditions would be less than 2 percent.

Project withdrawals from Lake Sakakawea under the two Missouri River alternatives would have very little effect on Missouri River System economic benefits. Overall, the relative impacts of Project depletions in terms of percent changes in economic benefits from No Action would be less than 1 percent (Table 4-44). In fact, with the exception of water supply and recreation, the impacts on Missouri River economic indicators would be less than or equal to 0.2 percent.

Table 4-44 Percent Change in Economic Benefits of Project Simulations from the No Action Alternative Simulation

Simulation	Flood Control	Navigation	Hydropower	Water Supply	Recreation	Total NED Benefit
Average Annual Project Depletions	-0.01%	-0.07%	-0.06%	-0.80%	-0.28%	-0.32%
Maximum Possible Project Depletions	0.00%	-0.14%	-0.12%	-0.81%	-0.77%	-0.37%

Note:
NED = national economic development

Environmental Justice

Introduction

This section examines the potential consequences of the No Action Alternative and the effects of the action alternatives on low-income or minority communities in the Project Area (those exceeding the 50 percent and meaningfully greater [120 percent] criteria for minority and low-income populations described in the Environmental Justice section in Chapter 3). Adverse effects on human health or the environment within communities of concern present an environmental justice problem when those effects are disproportionately high resulting from federal government programs, policies, or actions (Executive Order 12898).

For environmental justice issues, a "community of concern" is one that has a greater than 50 percent minority or low-income population, or a population with a composition of minority or low-income populations meaningfully greater than statewide averages.

This analysis focuses on water supplies and drinking water quality, changes to water rates, and economic issues (increased employment opportunities, wages, and output). As documented in Appendix I, it was previously determined that the action alternatives would have only minor construction and operation impacts on issues such as air quality, hazardous materials, traffic, and noise; thus, these are not issues for environmental justice and are not discussed in this section.

Methods

As described in Chapter 3, the Project Area communities' most recent census data was reviewed to determine whether they should be identified as a community of interest based on either minority or low-income population. The result of that determination is found in Table 3-31. In order to determine whether the alternatives implicate environmental justice impacts, each alternative was considered in its entirety rather than on a component-by-component basis. Two questions were asked: first, are anticipated impacts adverse and high, and if so, are the anticipated impacts disproportionately falling on a community of concern?

Impacts associated with drinking water quality and quantity were addressed qualitatively based on information provided by the Project Area communities. This is summarized in the Socioeconomics section in this chapter and in Appendix B. Impacts associated with potential changes in water rates are described qualitatively based on information regarding existing rates provided by Project Area communities, percentage of typical household budgets, and costs that could be incurred in response to poor water quality (e.g., higher energy costs and costs to replace appliances). The economic discussion is based on the impact analysis performed for the Socioeconomics section.

Results

No Action Alternative

Under the No Action Alternative, most Project Area communities, including the nine identified communities of concern listed in Table 4-45, would continue to have water that would not meet secondary drinking water standards, and some water quality would be worse than at present because water would no longer be provided by the City of Minot to the communities of Burlington, Deering, or Kenmare after their interim contracts expire. In the absence of water provided by the City of Minot, Kenmare's water supply also would not meet the primary standard for arsenic. As shown in Table 4-45, of the nine communities of concern in the Project

Area, only Rugby has water that meets secondary water quality standards. Some communities would also have water supplies that were inadequate to meet future demands through 2060, including those served by Bottineau and Kenmare.

Table 4-45 Water Quality Issues in Identified Communities of Concern without the Project

Community	Communities of Concern Population(s)	Meets Primary Standards? [a]	Meets Secondary Standards? [a]
Bottineau	Minority	Yes	No
Burlington	Minority	Yes	No
Deering	Minority and low-income	Yes	No
Kenmare	Minority	No	No
Maxbass	Minority and low-income	Yes	No
Minot	Minority	Yes	No
Rugby	Minority	Yes	Yes
Westhope	Minority	Yes	No
Willow City	Low-income	Yes	No

Note:

[a] Kenmare currently meets the primary water quality standard for arsenic through an interim contract with Minot that expires in 2018 and that would not be renewed.

Source: Appendix B, "Community/Water Systems Data"

As discussed in the Socioeconomics section above, water rates in smaller communities could potentially increase over time as they invest in additional water supply infrastructure to meet secondary water quality standards, and in the case of Kenmare, primary water quality standards. Costs associated with appliance depreciation from poor water quality also would continue. Some households might experience a financial burden should they rely on additional water supplies delivered by water trucks to household storage tanks, use bottled water, or use water services such as laundromats. Costs also may be associated with implementing water conservation measures in communities with inadequate water supplies, and businesses dependent on reliable water supplies might experience financial hardships or limited ability to expand.

The identified communities of concern would continue to have poor drinking water and associated costs, and in some cases, inadequate water supplies. These conditions have socioeconomic implications but do not create or lead to environmental justice issues. Under No Action, these effects do not cause an environmental justice issue, because it is not the federal government's policies or programs which have caused those conditions. There are no pollution or environmental hazards for the communities of concern relative to this analysis; therefore, there are no environmental justice consequences.

Action Alternatives

Effects in each of the communities of concern would not vary significantly by alternative because each includes the same counties and communities. Each of the action alternatives would provide sufficient water supplies to meet future population growth and improved water quality for all Project members, including the communities of concern. The water quality benefits would be somewhat greater under the Missouri River alternatives, however, because water would be treated to meet both primary and secondary drinking water standards. Under the inbasin alternatives, the treated water would meet primary standards but would not meet some secondary standards. The proposed treatment process would not result in full compliance with secondary standards for TDS, sulfate, and chloride.

There is a potential for water rates to increase as a result of the Project, although the exact extent of the increase has not been determined. Any water rate increases associated with the alternatives likely would be at least partially offset by an improvement in water quality and quantity for all communities served by the Project, including the communities of concern.

As shown in Tables 4-27 to 4-30 in the Socioeconomics section, the action alternatives would result in increased employment, wages, and output and would have overall economic benefits in the Project Area during construction and operation.

While the benefits associated with improved water supplies and economic activity, as well as potential water rate increases, would affect communities of concern, they would not be disproportionately high and adverse.

Groundwater with Recharge Alternative

The Groundwater with Recharge Alternative would meet primary water quality standards but not all secondary water quality standards. The improvement in quality and quantity compared to the No Action Alternative would likely still be substantial for the communities of concern. Other impacts would be as described above.

Groundwater with Recharge and the Souris River Alternative

Impacts would be the same as described for the Groundwater with Recharge Alternative.

Missouri River and Conjunctive Use Alternative

This alternative would meet both primary and secondary water quality standards. Other impacts would be as described for the Groundwater with Recharge Alternative.

Missouri River and Groundwater Alternative

Impacts would be the same as described for the Missouri River and Conjunctive Use Alternative.

Environmental Commitments

Because no disproportionately high and adverse impacts on low-income and minority populations would occur, no environmental commitments are proposed.

Cumulative Effects

No Project-specific disproportionately high and adverse impacts on low-income and minority populations would occur; thus, the Project alternatives would not contribute to a cumulative impact.

Summary

Under the No Action Alternative, some communities of concern in the Project Area would continue to have water supply or water quality concerns which could cause economic burdens for Project Area residents; however, there would be no environmental justice issues or impacts as a result. There would be no pollution or environmental hazards for the communities of concern resulting from the Project.

Improvements in water quality and quantity would occur under all action alternatives, although the Missouri River alternatives would have greater benefits because they would treat water to meet both primary and secondary standards, and the inbasin alternatives would provide treatment that only meets the primary standards. Water rate increases might occur under all alternatives, but would likely be partially offset by an improvement in water quality and quantity, particularly under the Missouri River alternatives. The action alternatives would result in beneficial economic impacts, including employment opportunities and increased income. No disproportionately high and adverse human health or environmental impacts on the communities of concern are anticipated within the Project Area as a result of the action alternatives.

Chapter Five – Consultation and Coordination

Introduction

This chapter describes Reclamation's consultation and coordination activities during the preparation of this SEIS. Detailed below are the public involvement activities, methods for distributing information, and coordination activities with government and tribal agencies.

Public Involvement Plan

Reclamation developed a Public Involvement Plan to establish a process for engaging the public in the development of the SEIS. It is intended to ensure that members of the public and interested agencies have an opportunity to communicate their concerns about the Project to Reclamation and review key environmental documents before a final decision is made regarding the proposed action. The initial public involvement efforts included distribution of a scoping notice, public scoping meetings, and other efforts to make information readily available to individuals; Indian tribes; and federal, state, and local agencies interested in or potentially affected by the Project.

This section describes the specific activities and techniques Reclamation used to engage the public in the SEIS process in order to ensure that interested parties had sufficient information to understand the potential impacts of the Project alternatives. Public involvement actions and outcomes are described herein.

Notice of Intent

The Notice of Intent to prepare this SEIS was published in the Federal Register on August 12, 2010. The Notice of Intent summarized previous environmental documentation prepared for the Project and subsequent litigation; it also described the purpose and need for the Project, the proposed action, geographic scope of the SEIS, and the SEIS process. The Notice of Intent also provided times and locations of public scoping meetings and contact information for Reclamation.

Public Scoping Meetings

Public scoping is a formal process required by NEPA to gather early public input in an open process in order to determine the scope of issues to be addressed in an environmental document and to identify the significant issues related to a proposed action. In addition to the Federal Register notice, the public was notified of the scoping meetings through news releases, information posted on the Project website, and a newsletter circulated to all entities on the Project mailing list. The scoping notification process was used to solicit initial comments on the Project. Below is a list of the dates and locations of the scoping meetings held for the Project:

- September 13, 2010, Bottineau, North Dakota
- September 14, 2010, Minot, North Dakota
- September 15, 2010, New Town, North Dakota

- September 16, 2010, Bismarck, North Dakota

Each meeting began with an introductory presentation by Reclamation staff to share information about the NEPA work that had been completed to date and how Reclamation proposed to address new and existing issues in the SEIS. Following the presentation, the public was invited to participate by sharing information, comments, concerns, and ideas relating to the proposed Project and the SEIS. Approximately 60 people attended the scoping meetings.

Project Website

Reclamation's website is used to post Project information for viewing by the public. The web address is http://www.usbr.gov/gp/dkao/naws. Material posted on the Project website includes information regarding the preparation of this SEIS, in addition to information and reports on the previous NEPA analyses completed for the Project.

Project Newsletters

Two Project newsletters have been prepared and distributed to the public via the Project website and the Project mailing list of over 300 interested parties. The first newsletter, issued in August 2010, announced Reclamation's intention to prepare the SEIS and also discussed the Project need, goals, and Project planning activities to date. The dates and locations of upcoming scoping meetings were also listed in the newsletter. The second newsletter, issued in December 2011, introduced the public to the consulting team of Cardno ENTRIX and the Cooperating Agency Team members. A brief description of the water needs and supply assessment, alternatives being considered, resources to be analyzed, the transbasin effects study, and the Missouri River depletion analysis was also included. No further newsletters are planned for the Project at this time.

Public Hearing

In June 2014, Reclamation released the Draft SEIS for public review and comment. A notice of availability for the Draft SEIS was published on June 27, 2014, in the *Federal Register* (79 FR 36556). Reclamation granted a 30-day extension for the public review period, which was originally established for 45 days. The public was notified of this extension through a notice published in the *Federal Register* (79 FR 45459) on August 5, 2014. The public was encouraged to provide written comments or participate in a public hearing hosted by Reclamation during the public review period.

On July 23, 2014, Reclamation hosted a public hearing in Minot, North Dakota. The purpose of the hearing was to provide a forum for members of the public to provide oral and/or written comments on the Draft SEIS. A summary of the testimony recorded at the public hearing is included in Appendix K, along with the responses to these comments.

Cooperating Agencies

Reclamation invited other governmental agencies and entities to assist with the preparation of the 2008 EIS. Reclamation reconvened this Cooperating Agency Team for the SEIS so they could continue to provide data and contribute to the preparation of the SEIS, including through review of draft chapters. Governmental agencies invited to participate as members of this team were chosen because they have jurisdiction by law or have special expertise with respect to the Project. Reclamation has entered into Memoranda of Agreement with each Cooperating Agency to formalize roles and responsibilities. The Cooperating Agency Team includes the following federal, state, and local governmental agencies:

- U.S. Army Corps of Engineers (Corps)
- U.S. Environmental Protection Agency (EPA)
- North Dakota State Water Commission (SWC)
- City of Minot
- Garrison Diversion Conservancy District

The SWC represents the interests of the state of North Dakota, including the North Dakota Department of Health and the North Dakota Game and Fish Department. The Standing Rock Sioux Tribe and the Three Affiliated Tribes were invited to participate as Cooperating Agencies, but did not respond. The U.S. Fish and Wildlife Service (Service) also was invited to be a Cooperating Agency but respectfully declined. The Service is involved with the Project as a member of the Impact Mitigation Assessment Team, as described in the introduction to Chapter 4. Representatives of the Service have reviewed sections of the SEIS and participated in teleconferences held to share information regarding the Project and impacts of the action alternatives.

Members of the Cooperating Agency Team were involved in meetings throughout the development of the SEIS, providing data and input relative to the analyses being conducted. The dates and locations of the Cooperating Agency Team meetings are listed below.

- November 23, 2010 Bismarck, North Dakota
- September 14, 2011 Bismarck, North Dakota
- December 5, 2011 Bismarck, North Dakota
- March 7, 2012 Bismarck, North Dakota
- July 18, 2012 Webinar/Bismarck, North Dakota
- January 9, 2013 Webinar/Bismarck, North Dakota
- December 4, 2013 Conference call
- January 29, 2014 Webinar/Bismarck, North Dakota
- April 16, 2014 Webinar/Bismarck, North Dakota
- February 24, 2015 Webinar/Bismarck, North Dakota

U.S. Environmental Protection Agency Consultation

The EPA is a member of the Cooperating Agency Team and actively participated in all of the Cooperating Agency Team meetings described above. The EPA has several important roles and responsibilities in the development of an EIS. One of its roles is to provide guidance to federal agencies on filing an EIS, including draft, final, and supplemental EISs, as required by NEPA and Council on Environmental Quality regulations. The EPA also performs substantive reviews of EISs pursuant to NEPA and Section 309 of the Clean Air Act.

Endangered Species Act Consultation

Federal agencies are required to consult with the Service under Section 7 of the Endangered Species Act when federally listed species may be affected by an agency action. Reclamation started the process by obtaining a list of federally protected species from the Service that may be found in the Project Area and potentially affected. Informal consultation with the Service continued throughout the preparation of this SEIS. The SEIS analyzes Project impacts on federally listed species in Chapter 4. A biological assessment has been prepared for the preferred alternative in consultation with the Service. The biological assessment is included as Appendix L.

Native American Consultation

In accordance with Secretarial Order 3206, NEPA, and related laws, regulations, and policies, Reclamation initiated consultation with tribes within the Missouri River and Souris River basins regarding federal-tribal trust and Indian Trust Asset (ITA) responsibilities. The purpose of this consultation was to identify tribal issues and concerns about the proposed action and consider how to address them. Comments from the tribes were solicited during the scoping process. Reclamation requested that the tribes identify any ITAs that could be affected by the proposed alternatives and invited them to meet and consult regarding impacts on any potentially affected ITAs. Table 5-1 details the tribal coordination performed for this SEIS to date.

Table 5-1 Tribal Coordination

Topic	Tribe(s)	Date	Method or Location
Notification of SEIS Preparation	All Missouri River Basin Tribes[1]	08/27/2010	Letter
Invitation to participate as SEIS Cooperating Agency	Three Affiliated Tribes (Mandan, Hidatsa, Arikara) and Standing Rock Sioux Tribe	08/27/2010 05/26/2011	Letter Letter
Project information and coordination	All Missouri River Basin Tribes	10/2011	Newsletter
Invitation for ITA consultation regarding the Missouri River basin	All Missouri River Basin Tribes	02/03/2012	Letter
Project information and coordination	Yankton Sioux Tribe	02/27/2012 05/03/2012	Telephone and email Telephone
Project information and coordination	Sisseton Wahpeton Oyate	05/04/2012	Telephone
THPO coordination	Standing Rock	05/23/2012	Email
THPO coordination	Standing Rock	05/25/2012	Email
THPO coordination	Standing Rock	06/13/2012	Email
THPO coordination	Standing Rock	07/03/2012	Email
Project information and coordination	Sisseton Wahpeton Oyate	08/14/2012	Telephone and email
Project information and coordination	Sisseton Wahpeton Oyate	08/23/2012	Telephone
Project information and coordination	Sisseton Wahpeton Oyate	08/27/12	Telephone
Project information and coordination	Sisseton Wahpeton Oyate	08/30/2012	Telephone
Coordination and invitation to meeting in Pierre, South Dakota	Sisseton Wahpeton Oyate, Standing Rock, Yankton Sioux	08/31/2012	Email
THPO coordination	Standing Rock	9/6/2012	Telephone
Project information and coordination	Sisseton Wahpeton Oyate, Standing Rock, Yankton Sioux	10/3/2012	Email
Project information and coordination	No tribes attended	10/16/2012	Meeting in Pierre, South Dakota
Project information and coordination	Sisseton Wahpeton Oyate, Standing Rock, Yankton Sioux	10/17/2012	Email
Invitation for ITA consultation regarding the Souris River basin	Souris River Basin Tribes	01/31/2014	Letter
Project information and coordination	Lower Brule Sioux Tribe	03/24/2014	Meeting in Lower Brule, South Dakota
Project Information	Missouri River Basin Tribes and Souris River Basin Tribes	06/20/2014	Letter and Draft SEIS

Notes:
ITA = Indian Trust Asset; THPO = Tribal Historic Preservation Office
Missouri River basin tribes are shown in Figure 3-33 in Chapter 3.

Cultural Resources Consultation

As a part of the identification of cultural properties under Section 106 of the National Historic Preservation Act, Reclamation consulted with the State Historic Preservation Office (SHPO) and Tribal Historic Preservation Office (THPO) during the preparation of the Final Environmental Assessment (EA) and Finding of No Significant Impact (FONSI). Reclamation also has been conducting additional consultation on specific Project facilities that already have been constructed where appropriate (construction has been underway since 2002). These consultations are being completed in compliance with environmental commitments established for the Project in the FONSI.

Resource Meetings

The meetings listed in Table 5-2 were held to discuss resources issues of interest to the Corps and Service.

Table 5-2 List of Resource Meetings

Topic	Attendees	Date	Location/Method
Missouri River impact analysis	Reclamation, Corps, and Cardno ENTRIX	February 24, 2012	Conference Call
Missouri River impact analysis	Reclamation, Corps, and Cardno ENTRIX	February 27, 2012	Conference Call
Missouri River impact analysis	Reclamation and Corps	March 1, 2012	Conference call
Missouri River impact analysis	Reclamation, Corps, and Cardno ENTRIX	March 1, 2012	Conference Call
Tern and plover models	Corps, Service, Cardno ENTRIX	March 8, 2012	Conference Call
Potential effects on the Souris River	Reclamation, Service, and Cardno ENTRIX	June 13, 2013	Conference call
Potential effects on the Souris River	Reclamation, Service, and Cardno ENTRIX	July 24, 2013	Conference call
Biological Assessment	Reclamation and Service	August 2014	Emails
Biological Assessment	Reclamation and Service	February 10, 2015	Meeting in Bismarck
Biological Assessment	Reclamation and Service	March 5, 2015	Meeting in Bismarck
Biological Assessment	Reclamation and Service	March 10, 2015	Meeting in Bismarck

Coordination and Compliance with other Applicable Laws, Regulations, and Policies

Analysis and implementation of the Project require consistency, coordination, and compliance with multiple federal and state laws, regulations, executive orders, and policies. The following have known application to the Project.

Federal Laws and Regulations

- Antiquities Act of 1906
- Archaeological Resources Protection Act of 1979
- Boundary Waters Treaty of 1909
- Clean Water Act of 1977 (as amended)
- Endangered Species Act of 1973
- Farmland Protection Policy Act (a subtitle of the Agriculture and Food Act of 1981 [P.L. 97-98]; final rules and regulations were published in 1994)
- Fish and Wildlife Coordination Act of 1934 (as amended)
- Migratory Bird Treaty Act of 1918 (as amended)
- National Historic Preservation Act of 1966 (as amended)
- National Invasive Species Act of 1996
- National Wildlife Refuge System Administration Act of 1966
- Native American Graves Protection and Repatriation Act of 1990 (P.L. 101-601)
- Rivers and Harbors Appropriation Act of 1899
- Safe Drinking Water Act of 1974 (as amended)

Executive Orders

- 11988, Floodplain Management
- 11990, Protection of Wetlands
- 12114, Environmental Effects Abroad of Major Federal Actions
- 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- 13007, Indian Sacred Sites
- 13112, Invasive Species
- 13186, Responsibilities of Federal Agencies To Protect Migratory Birds
- 13514, Federal Leadership in Environmental, Energy, and Economic Performance

Other Federal and State Laws, Regulations, and Plans

- Water Rights
- North Dakota Air Pollution Control Rules
- North Dakota Game and Fish Department Wildlife Action Plan
- North Dakota State Burial Laws
- North Dakota Century Code 23-06-27
- North Dakota Century Code 55-02-7

- North Dakota Century Code 55-03-01
- North Dakota Administrative Code 40-02-03
- North Dakota Century Code 61-24-08
- Cooperative Agreement between the United States of America and the Garrison Diversion Conservancy District 6-FC-60-00210, 1986.
- Cooperative Agreement between Reclamation and Garrison Diversion R12AC6014, 2012.
- *Missouri River Mainstem Reservoir System Master Water Control Manual*. 2006. Department of Army Corps of Engineers Northwestern Division.

Distribution List

Reclamation has maintained and periodically updated a list of individuals and entities with an interest in the Project. This list was used to distribute Project information, including newsletters and the Draft and Final SEIS. The entities listed below received a printed copy of the Draft and Final SEIS or an Executive Summary with a compact disc of the SEIS.

U.S. Federal Agencies

Army Corps of Engineers
Daniel Cimarosti – Bismarck Regulatory
Larry Janis – Omaha District
Eric Laux – Omaha District
Todd Lindquist – Garrison Project Office

Bureau of Indian Affairs
Fort Berthold Agency

Bureau of Land Management
Dakotas District Office

Department of Agriculture, Rural Development
Rod Beck

Department of Agriculture, Natural Resources Conservation Service
Donald Felch

Department of State
Jenna Purl – Office of Canadian Affairs
Elise Mellinger - Office of Canadian Affairs
Danielle Monosson - Office of Canadian Affairs

Environmental Protection Agency
Phillip Strobel – Region 8
Shaun McGrath – Region 8
Maggie Pierce – Region 8

Federal Highway Administration
J. Michael Bowen – Division Administrator

Fish and Wildlife Service
Frank Durbian, Souris River Basin National Wildlife Refuge Complex
Meg Estep, Region 6 Office
Kevin Shelley – North Dakota Ecological Services Field Office

Geological Survey
Bismarck District Office

North Dakota Congressional Delegation
Honorable Kevin Cramer – Representative
Honorable Heidi Hietkamp – Senator
Honorable John Hoeven – Senator

State Agencies and Local Officials

North Dakota

Louella Anderson – McHenry County Commission
Eric Bless – Department of Health
Don Baasch – North Dakota Wildlife Federation
John Bluemle – North Dakota Geological Survey
Greg Boschee – Mountrail County Commission
Bottineau City Hall
Brent Svangstu – Divide County Commission
Bradley Brandt– City of Glenburn
Kenneth Brist –Department of Transportation
James Burbidge – Renville County Water Resource District
Dave Caroline – Bottineau County Economic Development Corporation
Jack Dalrymple – Governor of North Dakota
Michael Ell – Department of Health
Tim Freije – State Water Commission
L. David Glatt – Department of Health
Jerome Gruenberg – City of Burlington
Trudy Roland – Mountrail County Water Resource District
John Hanzel – Mountrail County Rural Water, Inc.
Cindy Hemphill – Director of Finance, City of Minot
John Hoganson – Geological Survey
Dan Jonasson – Minot Public Works Director
Dan Kalil, Chairman – Williams County Commission
Wayne Kern – Department of Health
Michelle Klose – State Water Commission
Bruce Kreft – Game & Fish Department
Steve Lee – McLean County Commission
Kevin Levi – Department of Transportation
Robert Markhouse – Department of Health, Division of Municipal Facilities
Mary Massad – Southwest Water Authority
Mayor, City of Berthold
Mayor, City of Bottineau
Mayor, City of Bowbells
Mayor, City of Columbus
Mayor, City of Grenora
Mayor, City of Kenmare
Mayor, City of Minot
Mayor, City of Mohall
Mayor, City of Noonan
Mayor, City of Rugby
Mayor, City of Sherwood
Mayor, City of Souris
Mayor, City of Westhope
Mayor, City of Wildrose
Mayor, City of Willow City
Shawn McKenna –Executive Director, North Dakota Wildlife Federation
Terry Nelson – Burke County Commission
Merlan Paaverud – State Historical Society of North Dakota
Keith Skaare – Williams County Water Resource District
Terry Steinwand – Game & Fish Department
Douglas Vosper – State Water Commission
Darlene Watne – Chairman, Ward County Commission
Francis Ziegler – Department of Transportation
Mark Zimmerman –Director, Parks and Recreation Department

Missouri

Bob Bacon – Department of Natural Resources
Sara Parker Pauley – Department of Natural Resources

Minnesota

Steve Colvin – Department of Natural Resources
Kent Lokkesmoe – Director, Department of Natural Resources

Tribal Agencies and Officials

Tribal Chair – Three Affiliated Tribes
Tribal Chair – Assiniboine & Sioux Tribes
Tribal Chair – Blackfeet TribeTribal Chair – Cheyenne River Sioux
Tribal Chair – Chippewa Cree Rocky Boy Reservation
Tribal Chair – Crow Creek Sioux Tribe
Tribal Chair – Crow Nations
Tribal Chair – Three Affiliated Tribes
Tribal Chair – Eastern Shoshone Tribe
Tribal President – Flandreau Santee Sioux
Tribal President – Fort Belknap Indian Community
Indian Affairs Commission
Tribal Chair – Iowa Tribe of Kansas
Tribal Chair – Kickapoo Tribe
Tribal Chair – Lower Brule Sioux Tribe
Tribal Chair – Northern Arapaho Business Council
Tribal President – Northern Cheyenne Tribe
Tribal President – Oglala Sioux Tribe
Byron Olson – Tribal Archeologist, Standing Rock Sioux Tribe
Tribal Chair – Omaha Tribe of Nebraska
Tribal Chair – Ponca Tribe of Nebraska
Tribal Chair – Prairie Band of the Potawatami Nation
Tribal Chair – Rosebud Sioux Tribe
Tribal Chair – Sac and Fox Nation of Missouri
Tribal Chair – Santee Sioux Nation
Tribal Chair – Sisseton-Wahpeton Oyate of the Lake Traverse Reservation
Tribal Chair – Standing Rock Sioux Tribe
Tribal Historic Preservation Officer – Standing Rock Sioux Tribe
Randaz Bailey – Standing Rock Water System
Tribal Chair – Three Affiliated Tribes
Tribal Historic Preservation Officer – Three Affiliated Tribes
Tribal Chair – Trenton Indian Service Area
Tribal Chair – Turtle Mountain Band of Chippewa Indians
Tribal Chair – Winnebago Tribe of Nebraska
Tribal Chair – Yankton Sioux Tribe
Frank White-Calfe - NAWS Advisory Committee, Three Affiliated Tribes

Organizations

All Seasons Water Users District
George Azure – Belcourt Public Utilities
Brent Bogar – NAWS Advisory Committee
David Conrad – National Wildlife Federation
Caroline Downs – The Kenmare News
Mike Dwyer – North Dakota Water Users Association
Maurice Foley – Ward County Water Resource
Joseph Genareo – Renville County Commission
Roger Hagen – Houston Engineering, Inc.
Gary Hager – NAWS Advisory Committee
Myron Hahn – Oak Creek Water Resource District
Darrell Hournbuckle – Interstate Engineering Inc.
Clifford Issendorf – NAWS Advisory Committee
David Koland – Garrison Diversion Conservancy District
Alan Lee – NAWS Advisory Committee
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The Nature Conservancy, North Dakota Field Office
Lynn Oberg – McLean-Sheridan Rural Water
Lynn Oberg – McLean County Water Resource District
Rick Olson – Williams Rural Water Association
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Thelma Paulson – Peterson Coulee Outlet Association
Gary Pearson – National Wildlife Federation

Kenny Rogers – NAWS Advisory Committee
Martin Dahl – Garrison Rural Water Association
Dan Schaefer – All Seasons Water Users Association
Jean Schafer – North Dakota Water Coalition
Bob Schempp – NAWS Advisory Committee
Jill Schramm – Minot Daily News
Nick Schroeck – Great Lakes Environmental Law Center
Ervin Schultz – Burke County Water Resource District
Gene Siercks – Chair, Boundary Creek Water Resource District
Sierra Club
Genevieve Thompson – Audubon Dakota
Henry Vanoffelen – Minnesota Center for Environmental Advocacy
Charlie Vein – Advanced Engineering & Environmental Services
Henry David Venema – International Institute for Sustainable Development
Eric Volk – North Dakota Rural Water Systems Association
Alan Walter - NAWS Advisory Committee, Ackerman Estvold Engineering
Vernon & Barbara Wenger – Max (Rural)
West River Water
The Wildlife Society, North Dakota Chapter

Individuals

Linda Aas
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Theodora Bird Bear
Paul Christianson
John Coughlin
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James Hatlelid
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Pat Lauer
J. McElwain
Shannon McIver
Jim Myers
Jon Nelson
Tammy Rodman
Jason Sorenson
Neil Stessman
F. Bruce Walker
Kim Yale
Leo Walker

Libraries

North Dakota
Bismarck Public Library
Minot Public Library
Mohall Public Library
North Dakota State Library
Bureau of Reclamation, Denver Office Library
Natural Resources Library, U.S. Department of the Interior

Canadian Agencies, Officials, Organizations, Individuals, and Libraries

Nicole Armstrong – Manitoba Conservation and Water Stewardship
Wayne Dybvig – Transboundary Waters Unit
David Henry – Environment Canada, Americas Directorate
Glen Koroluk – Manitoba Eco-Network
Jenna Mackay-Alie – Environment Canada Americas Directorate
Kim Perry Butler – Director General, North American Bureau, Foreign Affairs and International Trade Canada
Don Norquay – Assistant Deputy Minister of Transportation, Winnipeg

Tobias Nussbaum – Director U.S. Relations Division Foreign Affairs and INTL Trade Canada
Robert Oleson
Beatrice Olivastri – Friends of the Earth Canada
Jim Petsnik – Manitoba Water Conservation and Stewardship
Tom Selinger – Canadian Consulate General
Joel Wessman – Canadian Consulate General
Winnipeg Public Library System

List of Preparers

U.S. Department of the Interior, Bureau of Reclamation

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Project Role: Water Needs and Supply, Alternatives Analysis, and Engineering
Education: M.S. Civil/Environmental Engineering, B.S. Environmental Engineering
Experience: 10 years of experience with Reclamation

Greg Hiemenz, Environmental Specialist, Reclamation
Project Role: Climate Change, Invasive Species Transfer, and Natural Resources
Education: M.S. Zoology, B.S. Biology
Experience: 28 years of experience with Reclamation

Elizabeth (Nell) McPhillips, Natural Resource Specialist, Reclamation
Project Role: Missouri River, Natural Resources, and Federally Listed Species
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Experience: 19 years of experience with the U.S. Fish and Wildlife Service and 11 years with Reclamation

Alicia Waters, Project Manager and Program Analyst, Reclamation
Project Role: Team Leader
Education: B.S. Math and Natural Sciences
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Cardno ENTRIX Consulting Team

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Project Role: Land Use and Recreation
Education: M.A. Urban Planning, B.A. Urban Planning
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Brandon Ashby, Senior Project Scientist, Cardno ENTRIX
Project Role: Water Resources
Education: B.S. Geology
Experience: 16 years of experience in hydrogeologic investigations, water quality analysis, water supply planning and vulnerability analyses, and environmental site/contamination assessments.

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Project Role: Aquatic Invasive Species and Transbasin Effects Analysis
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Project Role: GIS, Environmental Justice, Socioeconomics
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Experience: 9 years of experience with NEPA and Geographic Information Systems (GIS).

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Project Role: Water Resources, Climate Change
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Experience: 14 years of experience in natural resource management, including hydrology, soils, geomorphology, cumulative effects analysis, and NEPA analysis and documentation.

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Project Role: Project Management and Water Resources
Education: M.S. Fisheries Science/Statistics, B.S. Aquatic Science/Biology
Experience: 30 years of experience in managing a wide variety of water resource and NEPA compliance projects.

Virginia Mahacek, Senior Geomorphologist, Cardno ENTRIX
Project Role: Geomorphology and Climate Change
Education: M.A. Physical Geography, B.A. Physical Geography
Experience: 25 years as a technical specialist and project manager for numerous stream and wetland restoration projects.

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Project Role: Socioeconomics and Environmental Justice
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Experience: 30 years of experience in managing and conducting analyses for NEPA and State Environmental Policy Act (SEPA) environmental assessments throughout the United States.

Sandy Slayton, Senior Staff Scientist, Cardno ENTRIX
Project Role: Vegetation, Wetlands, Fish and Aquatic Invertebrates
Education: M.A. Ecology, B.A. Environmental Science
Experience: 11 years of experience in performing environmental assessments pertaining to water resources, wetlands, and biological sciences.

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Project Role: Fish and Aquatic Invertebrates, Wetlands, Wildlife
Education: Ph.D. Marine Biology, B.A. Zoology
Experience: 40 years of experience in studying aquatic (both marine and freshwater) ecology, with extensive experience in aquatic habitats and endemic fishes.

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Experience: 9 years of experience in environmental analysis, project management, and permitting, with an emphasis on terrestrial biology.

Lorraine Woodman, Ph.D., Senior Consultant, Cardno ENTRIX
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Education: Ph.D. Anthropology, M.A. Anthropology, B.A. Anthropology
Experience: 30 years of experience in managing environmental impacts analyses, with an emphasis on water resources projects.

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Chapter Six – References

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