FINAL REPORT

US Army Corps of Engineers
St. Paul District
Mississippi Valley Division

Feasibility Report and Environmental Assessment

Marsh Lake Ecosystem Restoration Project

Minnesota River

Big Stone, Lac qui Parle, and Swift Counties, Minnesota

Photo by Ron Bolduan

Completed in conjunction with the Minnesota Department of Natural Resources

July 2011

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Summary

Introduction

This report was prepared in response to the study authorization contained in a Resolution of the Committee on Public Works of the U.S. House of Representatives, May 10, 1962. The resolution reads as follows:

"Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the report of the Chief of Engineers on the Minnesota River, Minnesota, published as House Document 230, 74th Congress, First Session and other pertinent reports, with a view to determining the advisability of further improvements in the Minnesota River Basin for navigation, flood control, recreation, low flow augmentation, and other related water and land resources."

In response to the study authority the reconnaissance phase of the study was completed in December 2004 (USACE 2004) and approved in January 2005. The reconnaissance study resulted in the finding of Federal interest in and potential solutions to several existing water resources problems that warrant feasibility studies, including ecosystem restoration at Marsh Lake.

The Minnesota Department of Natural Resources (DNR) as the non-Federal sponsor, and the U.S. Army Corps of Engineers, St. Paul District (Corps) initiated the feasibility phase of the study on February 2, 2006. The feasibility phase study cost was shared equally between the Corps and the sponsor.

This summary is intended to describe the major factors which were considered in the investigation and influenced the decisions and recommendations documented in this report.

Planning Process and NEPA

Starting in November 2000 through 2002, the DNR conducted a planning process with interagency coordination and public participation to identify ways to restore the Marsh Lake ecosystem.

In collaboration with the DNR and making use of the information generated from the DNR's earlier planning for Marsh Lake, we identified the problems and opportunities, set project objectives, identified and evaluated a number of alternative measures for Marsh Lake ecosystem restoration, formulated alternative plans, assessed the costs, benefits, environmental and social impacts of the alternative plans, coordinated with agencies and the public, recommended a plan and documented this planning process in this draft integrated Feasibility Report and Environmental Assessment (FR/EA).

This FR/EA has been prepared to meet Corps of Engineers planning guidance and National Environmental Policy Act (NEPA) requirements. Following agency and public review, a final FR/EA will be prepared. The St. Paul District Commander will consider signing a Finding of No Significant Impact for the Marsh Lake Ecosystem Restoration Project to conclude the National Environmental Policy Act (NEPA) process.

This planning process has been subject to Value Engineering Review, Agency Technical Review; review by interested agencies and the public, and review by the Corps of Engineers Mississippi Valley Division and by Corps Headquarters.

Major Conclusions and Findings

Planning Objectives

The investigation of the problems and opportunities led to the establishment of the following planning goals and objectives for ecosystem restoration in the Marsh Lake study area.

Goal: A return of the Marsh Lake area ecosystem to a less degraded and more natural and functional condition

Objectives:

1. Reduced sediment loading to Marsh Lake over the 50-year period of analysis

2. Restored natural fluctuations to the hydrologic regime of Marsh Lake over the 50-year period of analysis

3. Restored geomorphic and floodplain processes to the Pomme de Terre River over the 50-year period of analysis

4. Reduced sediment resuspension within Marsh Lake over the 50-year period of analysis

5. Increased extent, diversity and abundance of emergent and submersed aquatic plants within Marsh Lake over the 50-year period of analysis

6. Increased availability of waterfowl habitat within Marsh Lake over the 50-year period of analysis

7. Restored aquatic habitat connectivity between Marsh Lake, the Pomme de Terre River and Lac Qui Parle over the 50-year period of analysis

8. Reduced abundance of aquatic invasive fish species within Marsh Lake over the 50-year period of analysis

9. Increased diversity and abundance of native fish within Marsh Lake and the Pomme de Terre River over the 50-year period of analysis

Alternatives

A wide range of alternative measures were identified to address the planning objectives. Alternative plans were formulated. Alternative measures evaluated as a part of this study are as follows:

- Modifications to the Marsh Lake Dam to enable passive and active water level management.
- Provide for fish passage between Lac qui Parle Lake and Marsh Lake and the Pomme de Terre River. Restore the Pomme de Terre River to its former channel near its confluence with the Minnesota River. Construct a bridge over the Pomme de Terre River to maintain access to the Marsh Lake Dam.
- Construct rock wave-break islands in Marsh Lake to reduce wind fetch, wave action, and sediment resuspension to restore aquatic vegetation.

- Reconnect the abandoned fish rearing pond next to the Marsh Lake Dam with the upper end of Lac qui Parle.
- Install gated culverts in the Louisburg Grade Road to enable water level management in upper Marsh Lake.
- Modify the Reservoir Regulation Plan for the Lac qui Parle Flood Control Project to include growing season drawdowns of Marsh Lake as needed to restore aquatic vegetation in years when river discharge allows.
- Construct recreational and educational features including a trail bridge over Marsh Lake Dam to connect with the Minnesota State Trail, fishing access on Marsh Lake, canoe access on the Pomme de Terre River, and an improved recreation area at Marsh Lake Dam.
- Monitor the ecological effectiveness of the Marsh Lake ecosystem restoration features to provide information for future adaptive ecosystem management.

Local Support

The non-Federal sponsor, the Minnesota Department of Natural Resources, has expressed the desire for implementing ecosystem restoration and sponsoring project construction in accordance with the items of local cooperation that are set forth in this report. The financial analysis indicates that the non-Federal sponsor is financially capable of participating in the project.

Recommended Plan

The Recommended Plan recommended for implementation is Alternative Plan 4 which consists of the following:

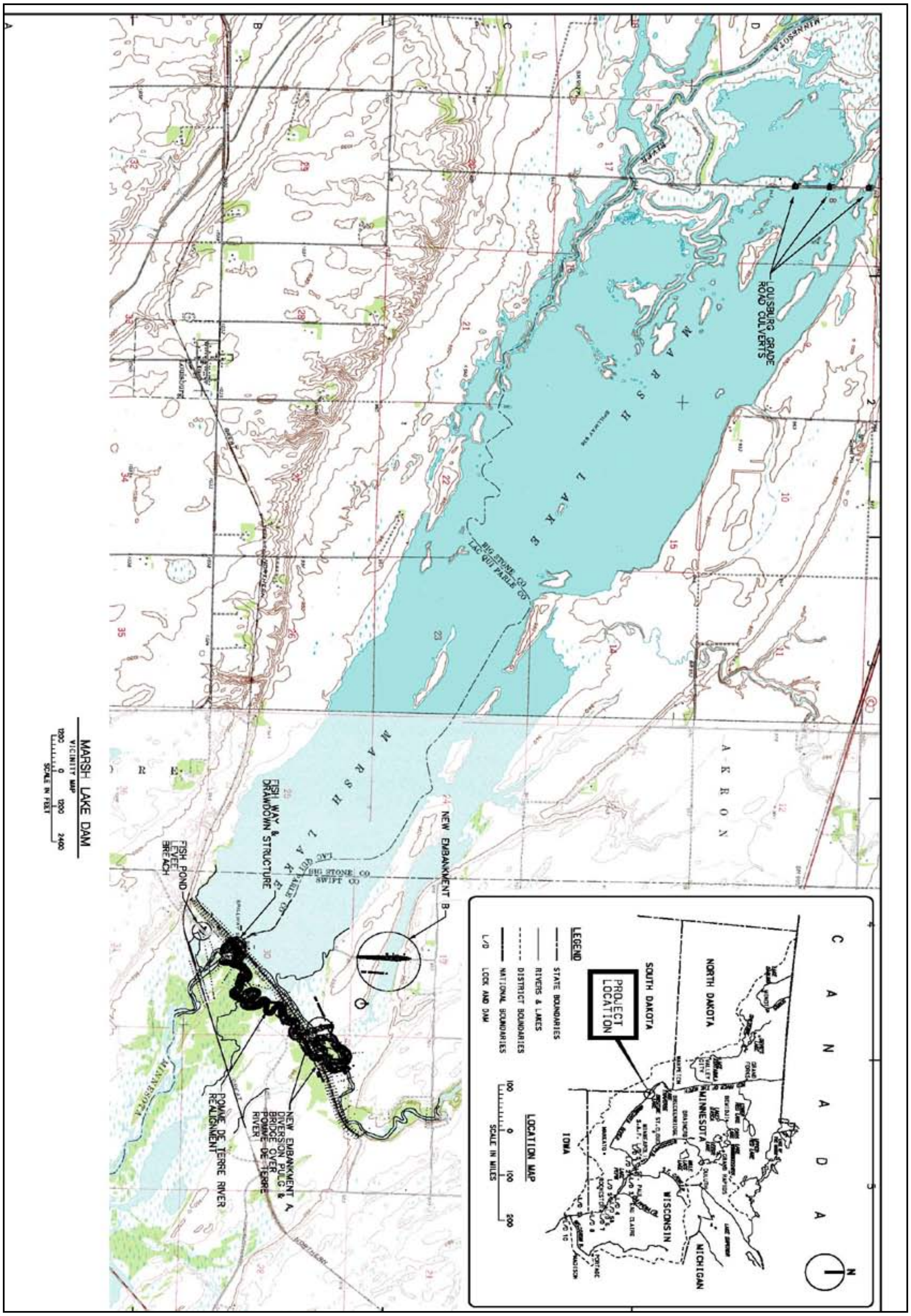
- Restore the Pomme de Terre River to its historic channel
- Breach dike at abandoned fish pond
- Construct drawdown structure
- Construct Louisburg Grade Road gated culverts
- Modify the Marsh Lake Dam, construct fishway

Through the planning process outlined in this report, it was determined that Alternative Plan 4, consisting of the measures noted above, provided the greatest increase in benefits, addressing each planning objective, at the least cost. The Recommended Plan will provide an increase of approximately 8400 Habitat Units at an average annual cost of $474,000. In addition, a number of recreation features will be constructed (highlighted in Section 7.2) that will provide approximately $225,000 of economic benefit at an 8.6 benefit-cost ratio with an average annual cost of $26,000. The total project costs of the ecosystem and recreation features equals $9,967,000 with an annualized cost of $500,000. The costs and benefits of the Recommended Plan are summarized below:

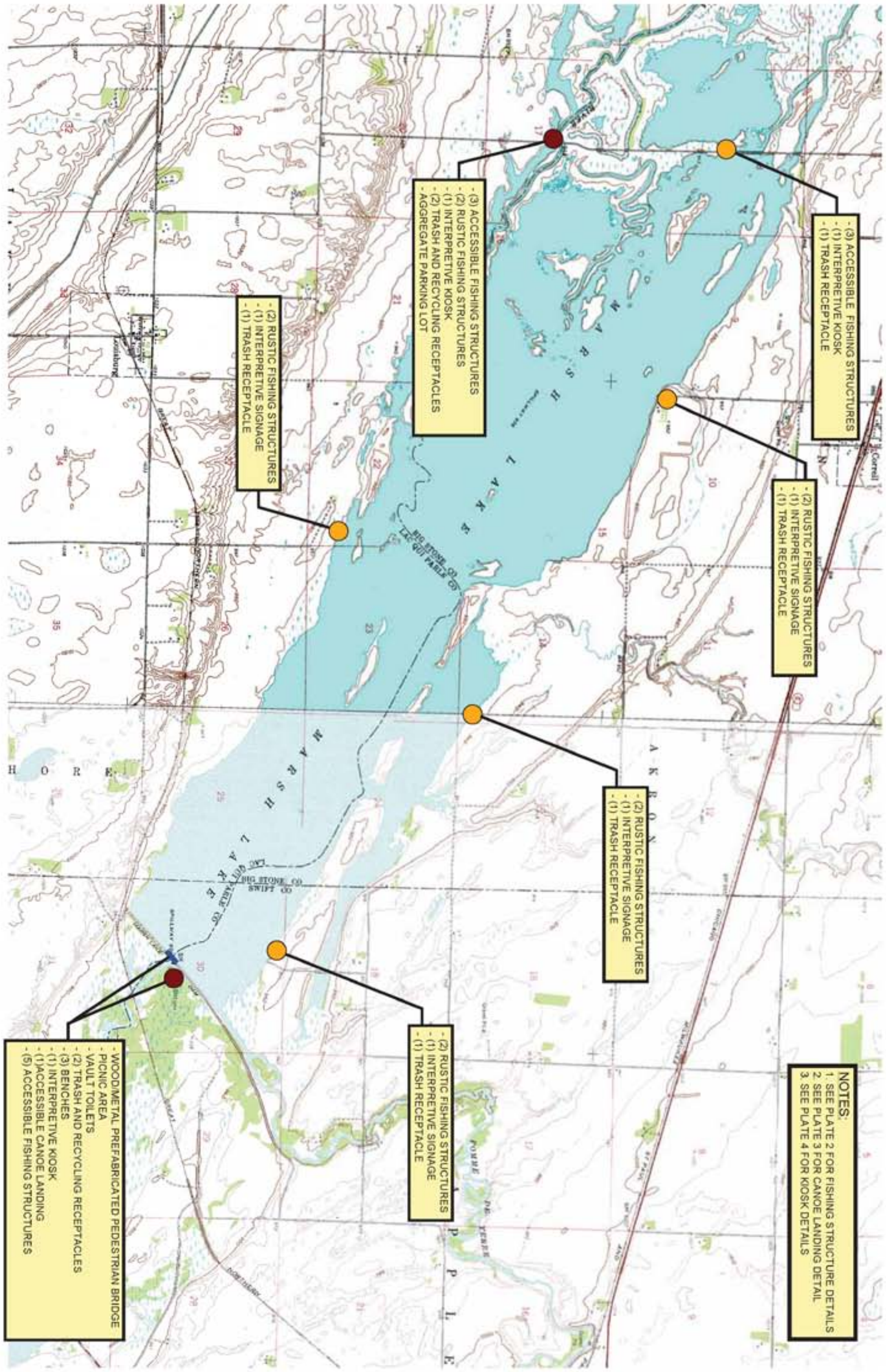
Breakout of Total Project Costs and Benefits
Marsh Lake Ecosystem Restoration - Recommended Plan

	Ecosystem Restoration
Total Project First Costs	$ 9,967,000
Interest During Construction (4.125%)	$ 214,000
Present Worth of Investment	**$ 10,181,000**
Annualized Total Project Costs	$ 500,000
Annual Operations and Maintenance Costs	$ 35,000
Total Annual Benefits (Habitat Units)	8400
Total Annual Benefits (Recreation)	$ 225,000

Rounded to nearest $1000



Ecosystem Restoration Features of the Recommended Plan



Recreation Features of the Recommended Plan

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1. Introduction

1.1 Purpose of Report

The purpose of this Feasibility Report and Environmental Assessment is to document the planning process for ecosystem restoration of the Marsh Lake area on the Minnesota River, to provide opportunity for participation in the planning process for river management partners and the public, to meet Corps of Engineers planning guidance and to meet National Environmental Policy Act (NEPA) requirements.

1.2 Study Authority

The Marsh Lake feasibility study was authorized by a Resolution of the Committee on Public Works of the U.S. House of Representatives, May 10, 1962. The resolution reads as follows:

> "Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the report of the Chief of Engineers on the Minnesota River, Minnesota, published as House Document 230, 74th Congress, First Session and other pertinent reports, with a view to determining the advisability of further improvements in the Minnesota River Basin for navigation, flood control, recreation, low flow augmentation, and other related water and land resources."

1.3 Minnesota River Basin Reconnaissance Study

Funds were appropriated in Federal fiscal year 2003 to initiate the reconnaissance study. The reconnaissance study was completed in December 2004 (USACE 2004) and approved by the Corps Mississippi Valley Division in January 2005. The purpose of the reconnaissance study was to evaluate the potential for Federal interest in implementing solutions to flooding, navigation, low flow augmentation, recreation, ecosystem restoration, and other related water resource problems and opportunities in the Minnesota River Basin (MRB) in Minnesota, South Dakota, North Dakota, and Iowa.

The reconnaissance investigation was conducted in close coordination with the many agencies active in land and water resources management in the MRB, including the U.S. Fish and Wildlife Service (USFWS); Natural Resources Conservation Service (USDA); U.S. Geological Survey (USGS); Minnesota Department of Natural Resources (DNR); Minnesota Pollution Control Agency (MPCA); Minnesota Board of Water and Soil Resources (BWSR); University of Minnesota; Minnesota State University at Mankato; MRB Joint Powers Board; Metropolitan Council of the Twin Cities; local watershed districts; Clean Up the River Environment (CURE); Ducks Unlimited; and The Nature Conservancy. These agencies are committed to a Basin-wide watershed framework to address water resources problems and needs in the MRB. An electronic copy of the reconnaissance study report can be found at the following location:

http://www.mvp.usace.army.mil/environment/default.asp?pageid=93

The reconnaissance study resulted in the finding of Federal interest in and potential solutions to several existing water resources problems that warrant feasibility studies including this Marsh Lake Ecosystem Restoration Project, the Blue Earth River Ecosystem Restoration Project, and an Integrated Watershed, Water Quality and Ecosystem Restoration Analysis for the MRB. The Blue Earth River Watershed is located a considerable distance downstream from the Marsh Lake area and is unrelated to the Marsh Lake Ecosystem Restoration Project. The Minnesota River Integrated Watershed Study will provide a comprehensive evaluation of existing watershed conditions and may result in implementation measures that could further enhance ecosystem conditions at Marsh Lake. The Minnesota River Integrated Watershed Study is currently scheduled for completion in 2015.

The geographic scope of this project was negotiated between the sponsor and the Corps and includes Marsh Lake, adjoining floodplain and shorelines, the confluence of the Pomme de Terre River, Marsh Lake Dam and Lac qui Parle reservoir (Figure 1-2). A Project Management Plan (PMP) was developed in coordination with study partners and stakeholders for the Marsh Lake Ecosystem Restoration Project (Appendix A). A Feasibility Cost Sharing Agreement was signed in May 2007 with the DNR to conduct this study (Appendix B).

1.4 Purpose of the Marsh Lake Ecosystem Restoration Project

The purpose of this project is to restore the aquatic and riparian ecosystems in the Marsh Lake project area. Impoundment of Lac qui Parle and Marsh Lake, diversion of the Pomme de Terre River into Lac qui Parle, and river regulation have significantly altered the ecosystem state.

Aquatic ecosystem restoration is a primary mission of the Corps' Civil Works program, and is defined as achieving a "return of natural areas or ecosystems to a close approximation of their conditions prior to disturbance, or to less degraded, more natural conditions"(EP 1165-2-502.)

In some circumstances, as at Marsh Lake, a return to pre-disturbance conditions may not be feasible. In those instances, "the goal is to partially or fully reestablish the attributes of a naturally functioning and self regulating system." The goal of this project is to return the Marsh Lake area ecosystem to less degraded, more natural conditions by restoring natural functions and processes.

The original construction of the Marsh Lake Dam was intended to serve as a flood damage reduction measure as well as a recreational feature to the region, primarily through the creation of a static pool on the river. The intended flood damage reduction benefits provided by the Marsh Lake Dam are minor due to effectiveness of the Lac qui Parle Dam downstream. Marsh Lake is a popular recreation destination in the region as shown by visitor numbers. As with many projects constructed at the time, a full understanding of the ecology of the system was not of primary concern.

Since impoundment, Marsh Lake has undergone significant degradation of aquatic habitat due to a number of stressors including high sediment and nutrient loading, a fixed crest dam that prevents low seasonal water levels, high turbidity from wind-driven sediment resuspension, and abundant common carp that increase turbidity and graze off submersed aquatic vegetation and macroinvertebrates. Although Marsh Lake provides an open water area for migratory waterfowl to rest and islands for nesting colonial waterbirds, degradation of the aquatic ecosystem there limits habitat suitability for many species of fish and wildlife.

The underlying purpose and need for this project is to restore the degraded Marsh Lake ecosystem.

The stated goal of Marsh Lake Ecosystem Restoration Project is to "return the Marsh Lake area ecosystem to a less degraded and more natural condition by restoring ecosystem structure and functions." The intent of the Marsh Lake ecosystem restoration project is to increase variability in ecosystem processes, restore a more natural water level regime, aquatic habitat connectivity, and a vegetated lake ecosystem state.

1.5 Project Scope

1.5.1 Location

Marsh Lake Dam is located on the Minnesota River in western Minnesota (Figure 1-1). Lac qui Parle and Marsh Lake Reservoirs form boundaries for Lac qui Parle, Swift, and Big Stone Counties.

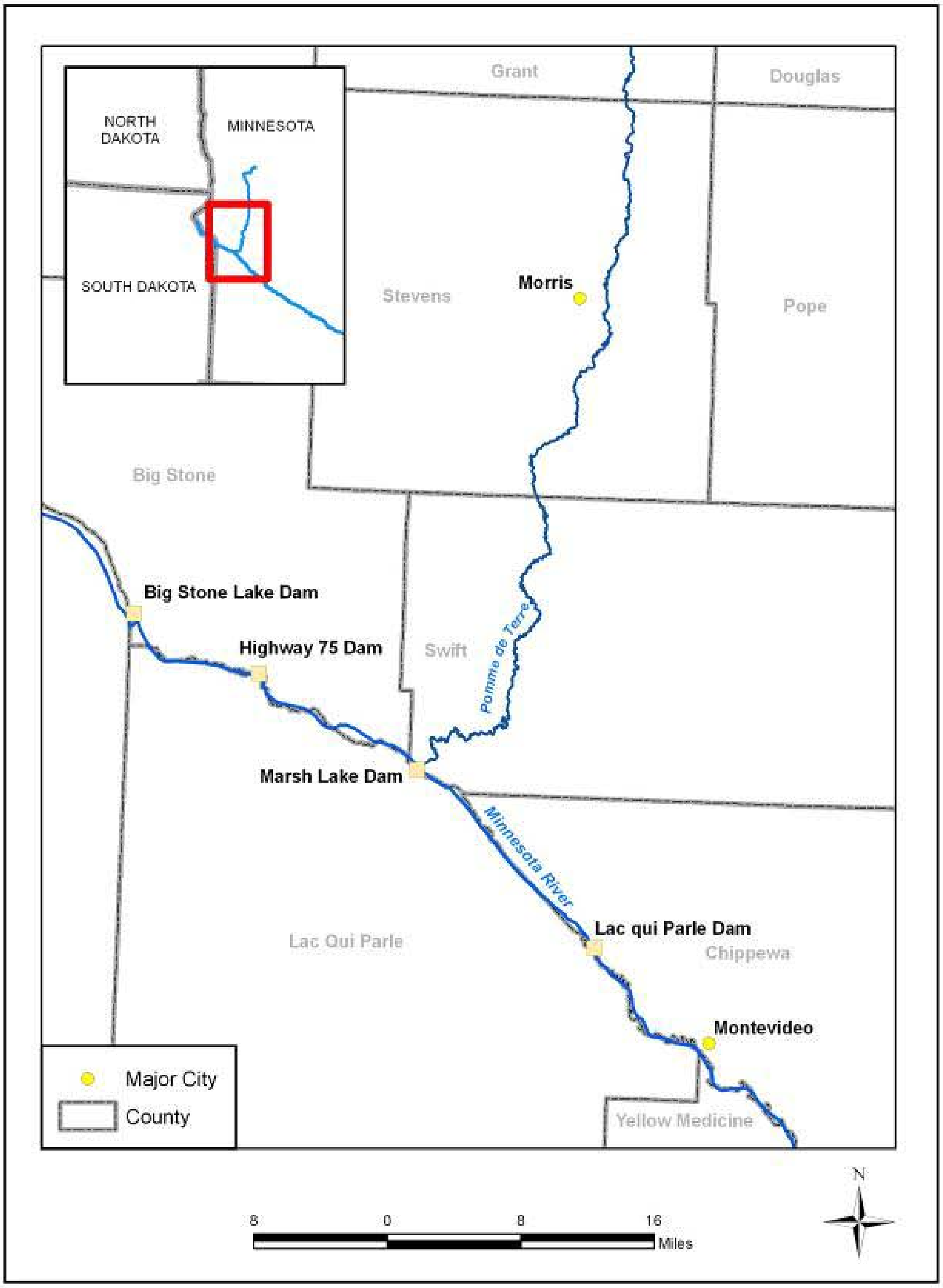


Figure 1-1. Location of Marsh Lake and the Lac qui Parle Flood Control and Water Conservation Project in the Upper Minnesota River Basin.

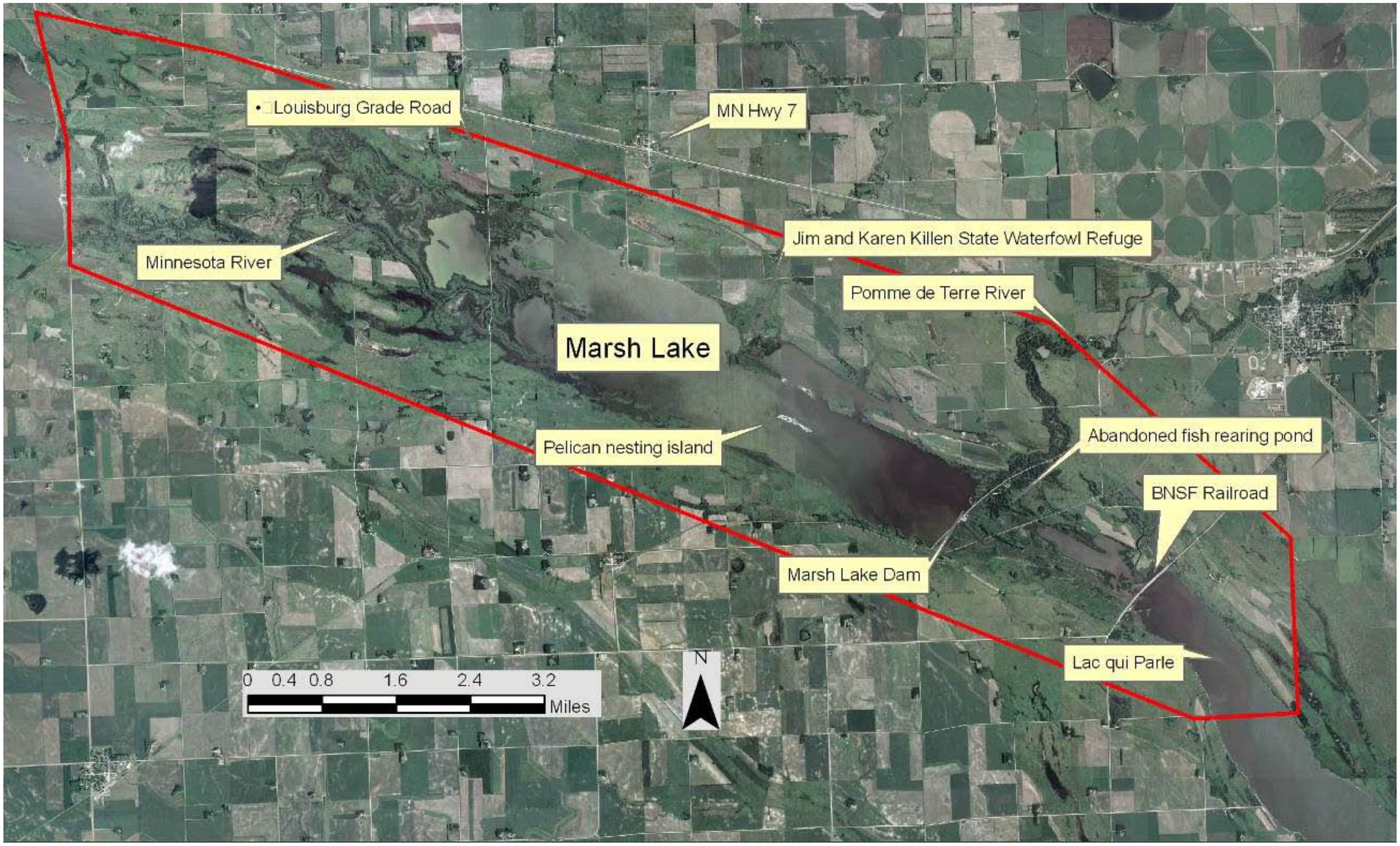


Figure 1-2. Marsh Lake project area boundary. Minnesota River flowing left to right. Marsh Lake Dam at right center. Pomme de Terre River entering from upper right. Farm Service Agency 2003 photo.

1.5.2 Geographic Scope

The geographic scope of this project includes Marsh Lake, adjoining floodplain and shorelines, the confluence of the Pomme de Terre River, Marsh Lake Dam and Lac qui Parle reservoir (Figure 1-2). There are many opportunities for ecosystem restoration present in the study area. The DNR is the non-Federal cost share sponsor for this study. The DNR has authority, funding and staff for ecosystem restoration and management of the Lac qui Parle Wildlife Management Area.

Because the condition of the Minnesota River ecosystems affects migratory birds and a flyway of international importance, the geographic scope of the project extends in effect to the range of the many species of migratory birds that breed in, migrate through and that stop to feed and rest in the Marsh Lake area. The project area is important to many species of migratory waterfowl with effects that extend beyond the immediate project area.

Condition of the Marsh Lake area ecosystems are greatly affected by land use in the upper Minnesota River Basin. Modification of the hydrology and land use in the Minnesota River Basin has been profound, converting former prairie, streams and wetlands into an extensively drained agricultural landscape dominated by row crops. This report does not address watershed and water quality management in the upper Minnesota River Basin. As documented in the Minnesota River Basin Reconnaissance Study report (USACE 2004), we recognize that many of the problems in the Marsh Lake area ecosystem are symptoms of larger watershed issues. Opportunities to further restore and contribute to the sustainability of Marsh Lake area ecosystems through actions in the greater watershed are being explored in the ongoing Minnesota River Basin Watershed, Water Quality and Ecosystem Restoration Study as recommended in the Minnesota River Basin Reconnaissance Report (USACE 2004). A feasibility cost share agreement for the Minnesota River Basin Watershed, Water Quality, and Ecosystem Restoration Study was signed by the Corps and the Minnesota River Environmental Quality Board in February 2009. That watershed study is currently under way and will identify ecologically and cost-effective alternatives for watershed improvement, water quality management, and ecosystem restoration throughout the Minnesota River Basin.

As a result of the reconnaissance study, the Lac qui Parle Wildlife Management Area (WMA) became the original geographic focus of the Feasibility Study due to the presence of Corps owned and operated structures at Lac qui Parle and Marsh Lake, ownership by the DNR over the WMA lands, and the willingness of the DNR to serve as the non-Federal Sponsor on the study. As the Feasibility Study progressed and alternative measures were screened (see Section 4), the scope of the study was further limited to a smaller geographic area within the WMA where a series of measures could be implemented that would improve the aquatic and riparian conditions primarily in and around Marsh Lake (Figure 1-2). This geographic area is referred to throughout the report as the Marsh Lake project area, which includes Marsh Lake, the Pomme de Terre River outlet, the Marsh Lake Dam, and the upper portion of the Lac qui Parle reservoir. While the Feasibility Study utilizes a watershed approach, additional measures to reduce sediment loading from sources within the watershed are being investigated as a part of the Minnesota River Basin Integrated Watershed Study.

1.5.3 Temporal Scope

The temporal scope of the project is a period of analysis of 50 years.

1.6 Project Planning

The Marsh Lake Ecosystem Restoration Project is being planned following the standard Corps of Engineers six-step planning process:

1. Identify problems, opportunities and constraints.
2. Inventory existing conditions and forecast future conditions.
3. Formulate alternatives.
4. Evaluate alternatives.
5. Compare alternatives.
6. Select a recommended plan.

This study has also been drafted to comply with NEPA, with an integrated environmental assessment.

1.7 Existing Water Projects, Prior Studies and Reports

1.7.1 Existing Projects

Lac qui Parle Flood Control and Water Conservation Project

The Marsh Lake Dam was built in the late 1930's by the State of Minnesota and the Federal Works Progress Administration as part of the multi-purpose Lac qui Parle Water Control Project. The project was authorized by the Flood Control Act of 1936, Public Law 74-738 and was partially constructed by the Works Progress Administration. The Corps of Engineers completed project construction between 1941 and 1951. Operation of the project was transferred from the State of Minnesota to the Corps of Engineers in 1950.

Components of the Lac qui Parle project include the Lac qui Parle Dam (Figure 1-4), the Chippewa River Diversion (Figure 1-5), and the Marsh Lake Dam (Figure 1-6). An overview of the project components is included below in Figure 1-3.

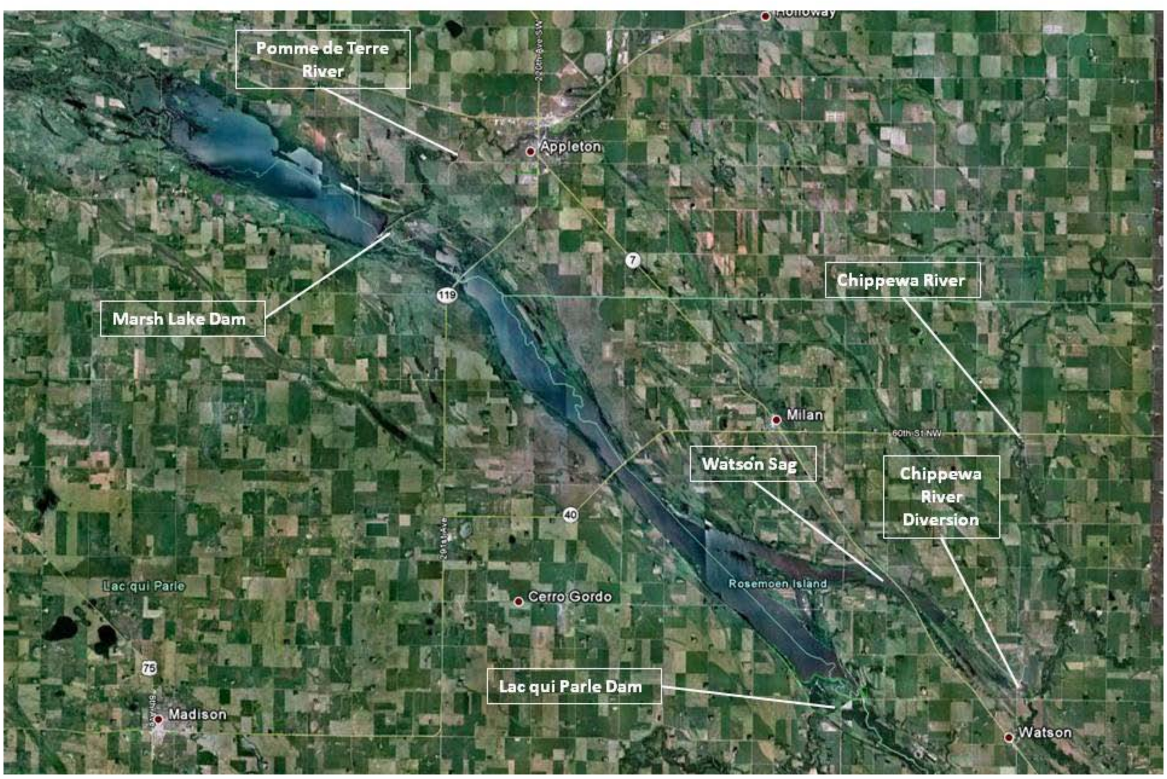


Figure 1-3. Overview of Lac qui Parle Project Components

The Lac qui Parle Dam impounds the natural Lac qui Parle formed on the Minnesota River by the delta of the Lac qui Parle River. The Chippewa River Diversion reduces downstream Minnesota River flood flows at Montevideo, Minnesota, by diverting a portion of the Chippewa River floodwaters into Lac qui Parle through the Watson Sag (a former channel of the Glacial River Warren, now a shallow bay of Lac qui Parle).

Marsh Lake Dam is a fixed-crest dam constructed to hold a conservation pool in the upper portion of the Lac qui Parle. An abandoned fish rearing pond is located on the downstream side of the Marsh Lake dam embankment.

The Minnesota DNR's Lac qui Parle Wildlife Management Area surrounds both Lac qui Parle Lake and Marsh Lake.

Figure 1-4. Lac qui Parle Dam on the Minnesota River, looking upstream.

Figure 1-5. Chippewa River Diversion on the Chippewa River near Watson, Minnesota. Diversion structure is under bridge at center, Watson Sag Channel at upper left.

Figure 1-6. Marsh Lake Dam on the Minnesota River. Abandoned fish rearing pond at upper right on downstream side of dam.

Table 1-1. Pertinent data about Lac qui Parle and Marsh Lake.

Lac qui Parle Dam	Concrete dam 237 ft long with 4 17 ft-wide bays: Bay 2 with 3 4 ft x 4 ft vertical lift gates for low flow regulation. Bays 1, 3, 4 with 2 6 ft x 8 ft vertical lift gates. Spillway with crest at 934.2 ft and 8 17-ft wide bays. Bays 5, 6, and 7 are uncontrolled. Bays 8 through 12 have moveable steel bulkheads. Dam is 32 ft high. Emergency spillway 2500 ft long surfaced roadway
Lac qui Parle	Conservation pool elevation 933.0 ft in summer, 934.0 in fall and winter.
	Full pool elevation 941.1 ft
	Reservoir area at conservation pool 7700 acres Maximum depth 17 ft
Marsh Lake Dam	11,800 ft-long rolled earth dam
	112 ft – long concrete overflow spillway crest elevation 937.6 ft (not an operable spillway)
	2 ft x 2 ft vertical lift gate low flow outlet sill at 932.6 ft
	90 ft long emergency spillway with crest at 940.0 ft
Marsh Lake Reservoir	Conservation pool elevation 937.6 ft
	Full pool elevation 941.5 ft
	Reservoir area at conservation pool 5,000 acres

Modifications to River Regulation at the Lac qui Parle Project

The water control plan (USACE 1995) for the Lac qui Parle Project describes low flow, routine, and flood control regulation of the project. The water control plan provides a history of river regulation at the project.

Following completion of the Lac qui Parle dam in 1939, the conservation pool was set at 934.2 feet year-round. The State of Minnesota lowered the conservation pool elevation to 932.0 ft in 1946 in an effort to provide more flood water storage. Following meetings with stakeholders the conservation pool elevation was reset to 932.1 ft that same year.

The project was transferred to the Corps of Engineers in 1950 and a spring drawdown to 926.0 ft was adopted. Starting in 1968, the pool was raised in the fall to 934.2 ft from 15 October to 15 November and held there over winter to help prevent fish kills. The spring drawdowns to 931.2 ft or lower were done between 15 January and 15 March. In 1970 the regulation plan was changed to start the fall pool rise on 1 August.

In 1979 the summer conservation pool elevation was changed to a band between 932.75 and 933.0 ft. In 1982 the spring drawdown period was changed to 21 February to 10 March.

Following completion of a Reservoir Operating Plan Evaluation (USACE 1989), the regulation plan for the Lac qui Parle project was changed to reduce the duration of high stages on the reservoir and to reduce flood damages downstream. The current plan has a summer conservation pool elevation of 933+/- 0.2 ft and a fall and winter pool level of 934.0 +/- 0.2 ft. The spring drawdown occurs from 1 March to 15 March.

The Marsh Lake dam does not have an operable spillway. It is a fixed-crest dam with a crest elevation of 937.6 ft. A two-foot gated box culvert low flow outlet has a sill elevation of 932.6 ft.

Existing Projects Upstream on the Minnesota River

Big Stone Lake

Big Stone Lake is a 26-mile-long 12,610-acre natural floodplain lake at the headwaters of the Minnesota River formed by the delta of the Whetstone River. A stoplog water control structure was built by the State of Minnesota in the mid-1930s to control the level of Big Stone Lake. The Whetstone River was diverted to discharge into the Minnesota River between Big Stone Lake and the water control structure. The State ceased operating the water control structure in 1947. The Big Stone Lake-Whetstone

River Modification Project was authorized by the Flood Control Act approved 27 October 1965. The Big Stone Dam was replaced by the Corps of Engineers as part of the Big Stone Lake-Whetstone River Flood Control Project. The new dam and channel modifications were completed in 1985. The Upper Minnesota River Watershed District owns and operates Big Stone Dam.

Highway 75 Dam

Highway 75 Dam was constructed by the Corps of Engineers as part of the Big Stone Lake-Whetstone River Flood Control Project and was completed in 1974 (Figure 1-7). The authorized project purposes are flood damage reduction and water conservation. The Highway 75 Dam impounds approximately 5,000 acres of water. A water control structure was included in the dam to allow manipulation of water levels in the large wetland impoundment. Lands for the project were initially acquired by the Corps of Engineers in 1971, and were then transferred to the U.S. Fish and Wildlife Service in 1975. All the lands (11,115 acres) acquired by the Fish and Wildlife Service were incorporated into the land base for Big Stone National Wildlife Refuge. The Corps of Engineers operates and maintains the Highway 75 Dam

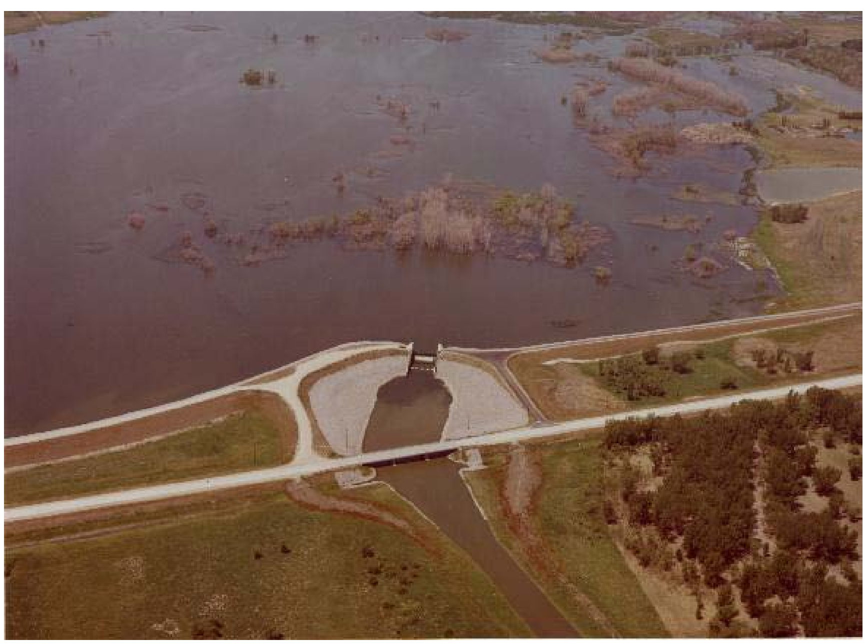


Figure 1-7. Highway 75 Dam on the Minnesota River.

1.7.2 Prior Studies and Reports

Reports pertinent to the Marsh Lake ecosystem restoration project include those listed in the References section below. The Corps conducted a number of studies to identify solutions for reducing flood damages on the upper Minnesota River that led to the Big Stone Lake – Whetstone River Project and the Lac qui Parle Project (USACE 1950, 1960, 1961, 1966). The Corps conducted a Reservoir Operating Plan Evaluation (ROPE) study of the Lac qui Parle project and produced a report (USACE 1989) that led to modifications of the reservoir operating plan. The Minnesota River Basin Reconnaissance Study report (USACE 2004) was completed in December 2004 and approved in January 2005. The Marsh Lake Ecosystem Restoration feasibility study was recommended in that report.

This feasibility study and environmental assessment is not a supplement to an earlier action. There have been only three National Environmental Policy Act (NEPA) environmental assessments prepared about the Lac qui Parle project in recent years:

- Reservoir Operating Plan Evaluation (ROPE) Environmental Assessment, 1989.

- Long-Term Maintenance Dredging Plan of the Chippewa River and Chippewa River Diversion Channel Environmental Assessment, December, 2004

- Watson Sag Diversion Channel Levee Repair Environmental Assessment, September 2005.

There have been many studies of the hydrology, sediment movement, water quality and aquatic habitat conditions in the Minnesota River Basin including USACE (1969), Southern Minnesota Rivers Basin Commission (1977), Van Alstine (1987), MPCA (1994), James and Barko (1995). A compilation of Minnesota River Basin data, information, and reports is maintained by the Minnesota River Basin Data Center at Mankato State University: http://mrbdc.mnsu.edu/

2. Existing and Future Without-Project Conditions

This section presents a summary of existing conditions in the Marsh Lake project area followed by a forecast of future conditions without a project to restore the Marsh Lake area ecosystem.

2.1 Marsh Lake

Marsh Lake is a river floodplain lake originally created by the delta formed where the Pomme de Terre River joins the Minnesota River. Marsh Lake once was a shallow lake surrounded by seasonally-flooded floodplain forest, prairie and wetland habitat.

Today Marsh Lake is an approximately 5,000-acre shallow reservoir (Figure 2-1). The fixed-crest Marsh Lake Dam was constructed to hold a conservation pool in the upper part of the Lac qui Parle. The Works Progress Administration constructed the Marsh Lake Dam and rerouted the Pomme de Terre River into Marsh Lake between 1936 and 1939. The reservoir was first filled in the spring of 1939. The Corps of Engineers improved the dam between 1941 and 1951 as part of the Lac qui Parle Project. The project was operated by the State of Minnesota until 1950, when operation and maintenance responsibilities were transferred to the Corps of Engineers.

The upper end of Marsh Lake is divided by the Louisburg Grade Road (Figure 2-1). There are three sets of culverts under the road connecting the north part with the main body of the lake. The culverts do not have gates or other control structures. The Louisburg Grade Road crosses the Minnesota River on a bridge.

A fish rearing pond (now abandoned) is located on the downstream side of the Marsh Lake Dam (Figure 2-1). The water control inlet and outlet structures (gated culverts) for the fish rearing pond no longer function.

The Jim and Karen Killen State Waterfowl Refuge on the north side of Marsh Lake (Figure 2-1) has a 110-acre sub-impoundment on a local drainage way and a system for pumping water to control water levels in the refuge. The Killen refuge area is managed as a moist-soil unit to provide food for migrating waterfowl.

Average annual water level on Marsh Lake is 938.3 ft. The crest elevation of the fixed crest spillway in the Marsh Lake Dam is 937.6 ft. Approximately 3,000 of the 5,000 acres of Marsh Lake are less than 3 feet deep when the lake is at the level of the fixed crest spillway (Figure 2-2).

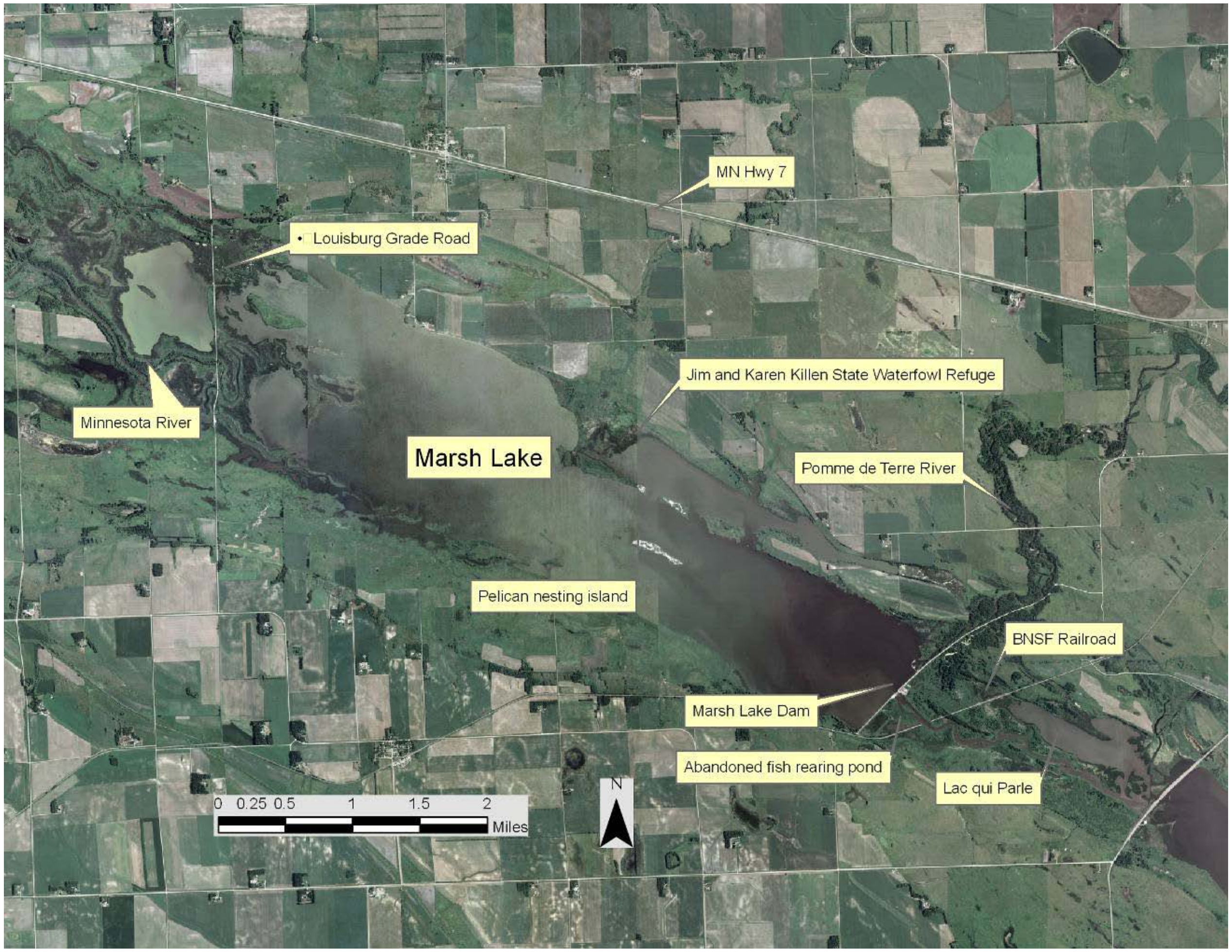


Figure 2-1. Marsh Lake. Minnesota River flowing left to right. Marsh Lake Dam at lower right. Pomme de Terre River entering from middle right. Farm Service Agency 2003 photo.

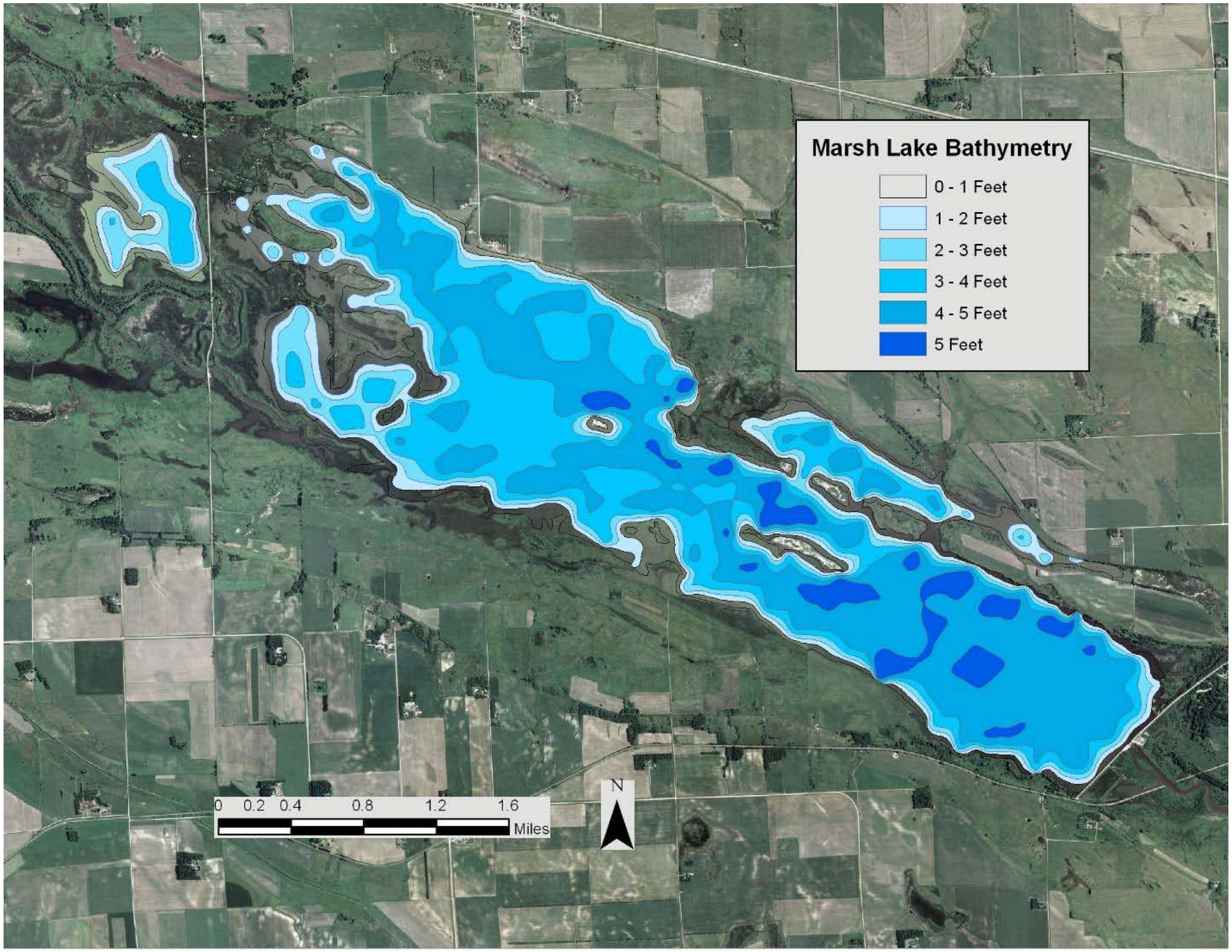


Figure 2-2. Marsh Lake bathymetry (from 2003 DNR survey data).

2.1.1 Marsh Lake Dam

The Marsh Lake Dam is an earth-fill structure 11,800 feet long with an average top elevation of 950.0 feet (Figure 2-1). The service spillway is a concrete fixed-crest overflow section 112 feet wide with a crest elevation of 937.6 feet. A grouted riprap emergency spillway immediately southwest of the service spillway is 90 feet wide with a crest elevation of 940.0 feet. The dam also has a 2-foot-square gated low flow outlet conduit with a sill elevation of 923.6. Unlike the Lac qui Parle Dam downstream, the Marsh Lake Dam cannot be operated to manage water levels in Marsh Lake (Figure 2-2).

Figure 2-3. Marsh Lake Dam.

2.2 Hydrology

The hydrologic regime of the Upper Minnesota River Basin has been changed markedly by conversion of prairie to cropland, extensive drainage of wetlands, expansion of the artificial drainage network for agriculture with ditches and subsurface drains, and by impoundment and river regulation.

2.2.1 Minnesota River Hydrology

The Minnesota River originates at the outlet of Big Stone Lake, flows through the Highway 75 impoundment and then into Marsh Lake and Lac qui Parle Reservoir, draining an area of 4050 mi^2. The mean annual flow rate at the gage just downstream of the Lac qui Parle Dam is 766 cfs. Peak flow of 30,100 cfs occurred on April 14, 2001. The hydrologic regime of the Minnesota River today is flashy with high discharge during spring runoff events and summer thunderstorms, and very low flows near zero during extended summer dry periods and in winter (Figure 2-4).

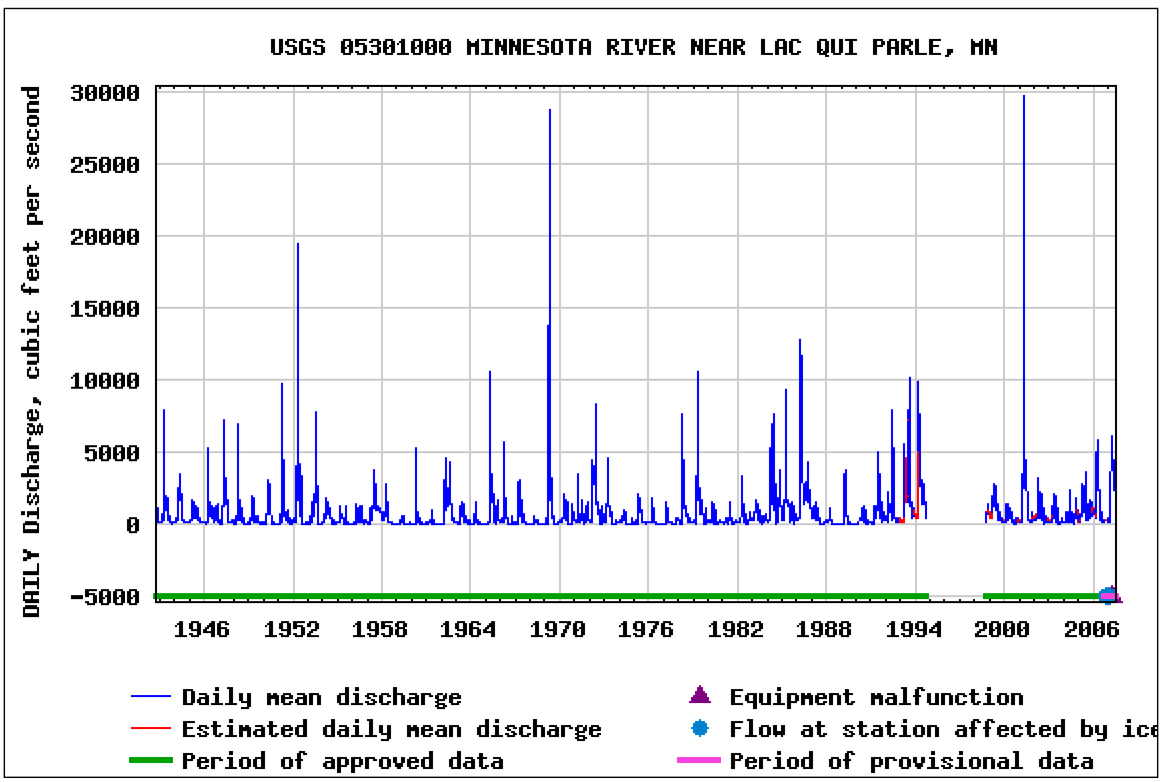


Figure 2-4. Minnesota River daily mean discharge 1946 – 2007.

2.2.2 Pomme de Terre River Hydrology

The Pomme de Terre River is a tributary of the Minnesota River. The Pomme de Terre River originates in western Otter Tail County and flows 106 miles southward through the cities of Barrett, Morris and Appleton to its confluence with the Minnesota River southwest of Appleton in Swift County. Most of the 875 mi^2 watershed was formerly prairie, but now row crop agriculture is the predominant land use on 81 percent of the watershed. Many of the former wetlands and non-contributing areas in the watershed have been drained. The total length of the stream network is 751 miles of which 616 miles are intermittent streams and 134.6 miles are perennial streams. There are a number of small dams in the watershed including a dam on the Pomme de Terre River in Morris.

Table 2-1. Streams in the Pomme de Terre River watershed (USGS data).

Stream Name	Total Stream Miles	Total Perennial Stream Miles	Total Intermittent Stream Miles
Artichoke Creek	2.7	0.0	2.7
Dry Wood Creek	10.1	3.2	6.9
Muddy Creek	31.5	11.1	20.4
Pelican Creek	12.4	12.4	0.0
Pomme de Terre River	105.9	105.9	0.0
Total Named Streams	162.6	132.6	30
Total Major Watershed Streams	750.7	134.6	616.1

The annual mean flow rate at Appleton during the 1936 – 2006 period of record was 134 cfs. The highest flow rate was 8,890 cfs on April 7, 1997, and occurred in part due to a dam failure at Appleton. Peak flows occur during spring runoff. Groundwater base flow maintains river discharge at about 100 cfs much of the time. The river flow occasionally ceases in winter and during extended periods of dry weather.

The lower part of the Pomme de Terre River was diverted into Marsh Lake when the Marsh Lake Dam was constructed.

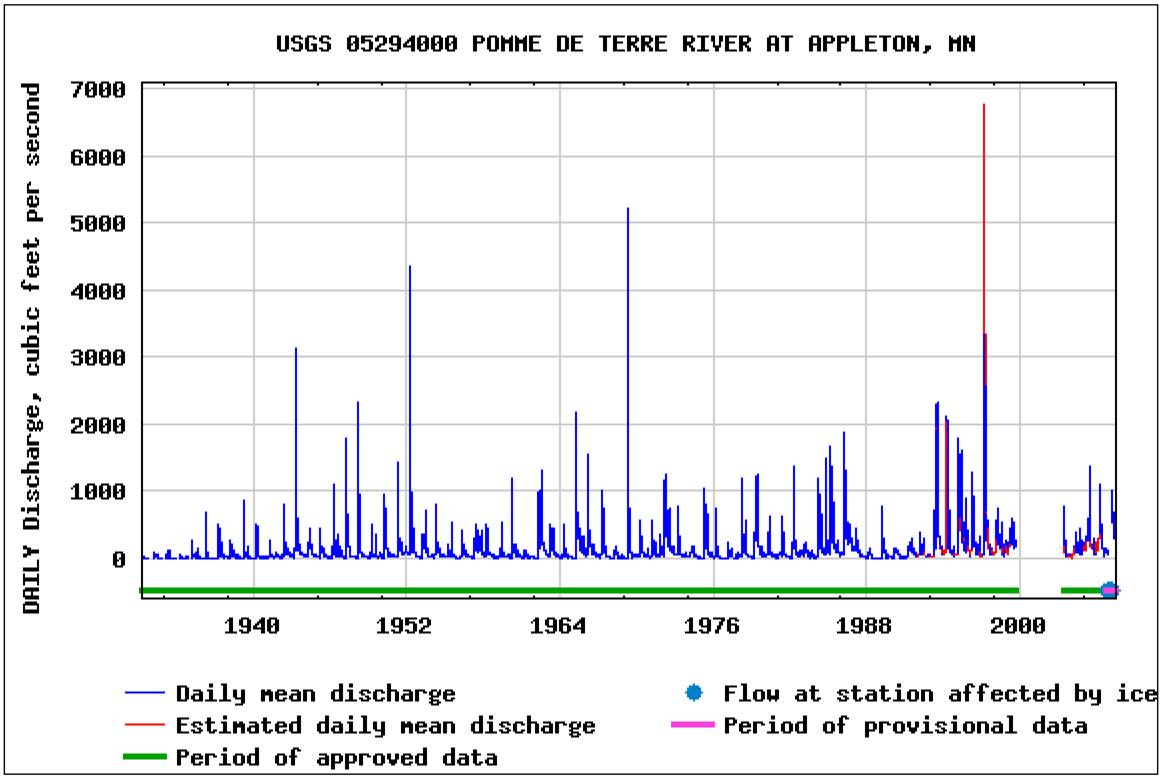


Figure 2-5. Pomme de Terre daily mean discharge at Appleton 1936 – 2007.

2.2.3 Marsh Lake Hydrology

Marsh Lake (Figure 2-2) covers approximately 5000 acres at the project pool elevation. The minimum project pool elevation, set by the fixed-crest Marsh Lake Dam, is 937.6 ft. At the average annual water level of 938.3, Marsh Lake covers 6100 acres. Water levels on Marsh Lake are characterized by rapid rises during spring runoff and thunderstorm events (Figure 2-6).

Marsh Lake provides flood water storage. The stage on Marsh Lake is dependent on inflow and outflow from the reservoir. The pool rises when inflow is higher than outflow. High pool elevations in Lac qui Parle Reservoir can affect stages in Marsh Lake by reducing the rate of outflow from Marsh Lake Dam.

Marsh Lake provides some flood damage reduction benefit because of the head loss across the Marsh Lake Dam during high water events. Head losses through the

Marsh Lake Dam during floods are quite variable but commonly about two feet. Head losses of 4.7 and 1.2 feet were observed for the large 1997 and 2001 floods respectively. The variability in head loss between Marsh Lake and Lac qui Parle is due to the timing and magnitude of discharge from the inflowing rivers (Minnesota River, Pomme de Terre River and Lac qui Parle River). The pool elevation of Marsh Lake is always higher than on Lac qui Parle. The floodwater storage in Marsh Lake provides some flood damage reduction benefits to downstream areas.

Because of the fixed crest Marsh Lake Dam, there is no 'normal pool' elevation. The pool level is typically around elevation 938.3 feet with a tailwater of around 934.0 feet during normal non-flood conditions.

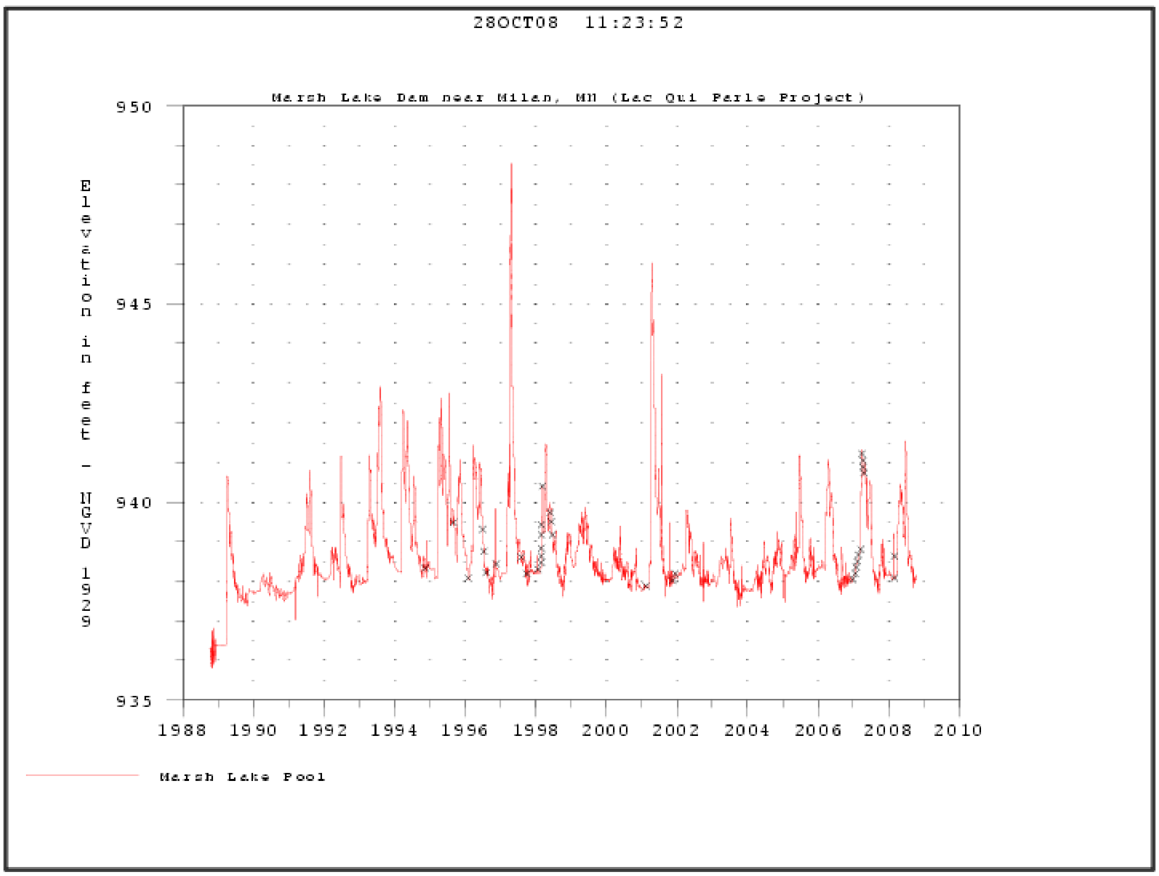


Figure 2-6. Marsh Lake stage hydrograph October 1, 1988 to October 1, 2008.

2.2.4 Lac qui Parle Hydrology

Lac qui Parle reservoir covers approximately 7,700 acres at the conservation pool elevation of 933.0 ft. As described for Marsh Lake, the stage hydrograph of Lac qui Parle is flashy, with periods of high water during spring runoff and summer thunderstorm events (Figure 2-7). The water control plan specifies discharge as necessary starting March 1 to achieve a drawdown to elevation 933.0 ft by March 15. From March 16 through May 15, discharge inflow and hold pool elevation at 933.0 +/- 0.2 ft or discharge the minimum flow of 20 cfs whichever is greater. From May 16 through August 31, discharge inflow to hold the pool at 933.0 ft +/- 0.2 ft. Starting on September 1, raise the pool to elevation 934.0 ft, and then hold this pool elevation through February.

During non-flood periods, the maximum release from Lac qui Parle Dam is 2500 cfs. During times when inflows are greater, the pool level rises. Maximum flood control storage when Lac qui Parle is at 941.1 ft and Marsh Lake is at 941.5 ft is 162,000 acre-feet.

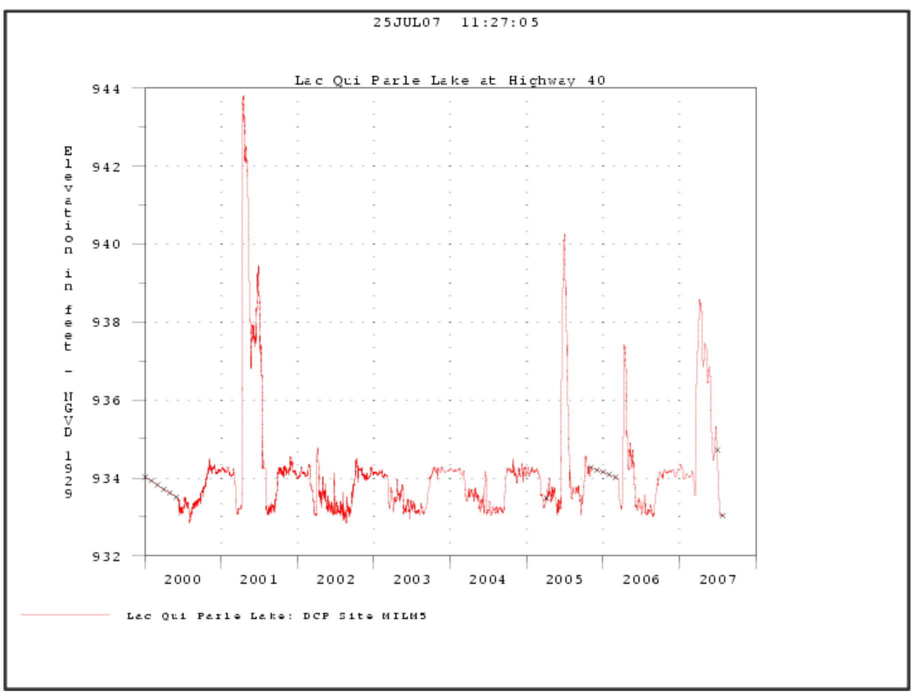


Figure 2-7. Stage hydrograph of Lac qui Parle January 2000 through July 2007. Note the summer water levels at elevation 934 and March drawdowns to elevation 933.0.

2.3 Sediment Loading to Marsh Lake

Loadings of seston (suspended sediment and particulate organic matter) to Marsh Lake generally increase in conjunction with higher Minnesota River flow. During high inflow periods, the Minnesota River exhibited higher loading rates of suspended sediment than the Pomme de Terre River (James and Barko 1995). During the 1991-1992 June – September period studied by James and Barko (1995), the Minnesota and the Pomme de Terre Rivers each contributed about 50 percent of the average daily seston load to Marsh Lake. During the June-September period monitored in 1991, the Minnesota River contributed 439,200 kg (473 tons) of seston and the Pomme de Terre River contributed 378,200 kg (306 tons) of seston to Marsh Lake.

Based on suspended sediment monitored on the Chippewa River by the U.S. Geological Survey (USGS) and adjusted for drainage area, the Pomme de Terre is estimated to yield 19,161 tons/year, or 8.2 acre-feet of suspended sediment annually. Under existing conditions, the Pomme de Terre River delivers its entire sediment load to the Marsh Lake reservoir, where the bed load settles out and forms the delta at the mouth of the river (Figure 2-8). A dam failure event on the Pomme de Terre River at Appleton in 1997 mobilized a large volume of sediment, contributing to the delta in Marsh Lake. Most of the suspended sediment delivered by the Pomme de Terre River flows from the delta area along Marsh Lake Dam to the overflow spillway, where it enters the Minnesota River at the upper end of Lac qui Parle.

The Minnesota River delivers little bed load sediment into Marsh Lake because of the trapping effect of the Highway 75 impoundment upstream. Rates of total (bed load and suspended) sediment loading and sediment accumulation in Marsh Lake have not been measured.

Figure 2-8. Pomme de Terre River delta where it enters Marsh Lake. Looking north from the Marsh Lake Dam.

2.4 Wind-generated Waves and Sediment Resuspension on Marsh Lake

Marsh Lake is a 7-mile long lake oriented southeast to northwest in a windy area. Wind fetch is the length of open water in the direction that the wind is blowing. Wind-driven wave action on Marsh Lake can be powerful, resuspending bottom sediment and causing shoreline erosion (James and Barko 1995)

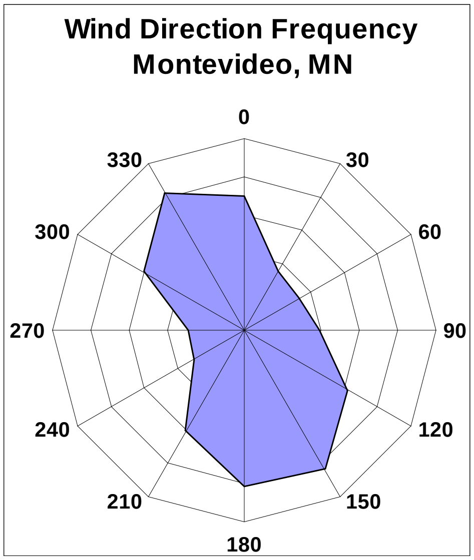
James and Barko (1995) found that sediment resuspension was low in Marsh Lake in 1991 when submersed aquatic vegetation was densely established. In 1992, vegetation was almost completely absent and sediment was readily resuspended by wind-driven wave action.

Storm inflows during the summer of 1991 and 1992 caused increases in the pool elevation and thus the wave length required to resuspend the sediment surface. Mean daily wind velocities were generally lower during June through August, further reducing the potential for sediment resuspension. In contrast, mean daily wind velocities and sediment resuspension were generally greatest in Marsh Lake during the late spring (i.e., May and early June) and the autumn (i.e., late August and September) of both years.

Measurements taken by Barko and James (1995) indicated that high wind velocities greater than 12 km/hr (7.5 mph) from any direction caused sediment resuspension in Marsh Lake when it was unvegetated in 1992 (Table 2-2). In 1991 when the lake was vegetated, the critical wind speed for sediment resuspension was 20 km/hr (12.5 mph).

Export of resuspended sediment from Marsh Lake to Lac qui Parle Lake occurred primarily when winds were blowing from the northwest toward the dam, with maximums of around 150,000 kg/d (165 T/d). Wind set-up raises water level at the dam, contributing to discharge of water and sediment over the fixed-crest dam. While sediment resuspension occurred relatively frequently in Marsh Lake during 1992 (i.e., 32 percent of the time during the April through July growing season), discharge of resuspended sediment occurred much less frequently (i.e., 15 percent) in 1991, due to the role of wind direction and vegetation in regulating sediment resuspension and discharges (Barko and James 1995).

A wind fetch model (Rhoweder et al. 2008) was applied to Marsh Lake to simulate wind-driven waves and potential for sediment resuspension (Appendix J) The wind fetch model incorporates the wind speed and direction data (Figure 2 – 8) and simulates threshold wind speeds for sediment resuspension for different fetch lengths and water depths. The wind fetch model simulates the shear force exerted on the lake bed from rotational wave currents. Sediment is resuspended at relatively low wind speeds when the wind direction is on the long axis of the lake, either from the northwest or from the southeast (Figure 2-10).



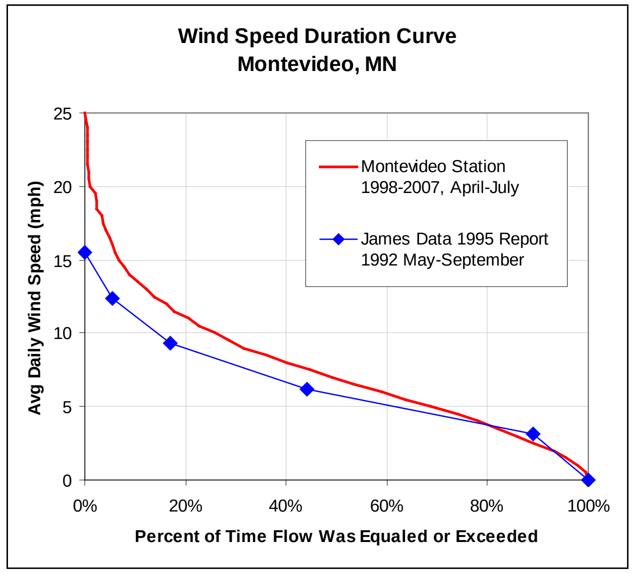


Figure 2-9. Wind direction and speed at Montevideo, Minnesota during April through July 1998 – 2007.

Table 2-2. Estimated percent of the Marsh Lake bed disturbed by wave action at various wind speeds and directions in 1992 when Marsh Lake was unvegetated (from James and Barko 1995).

Wind Speed		**Wind Direction**		
km/h	**NE**	**SE**	**SW**	**NW**
5	22	22	17	17
10	49	67	37	75
15	86	95	81	100
20	100	100	100	100

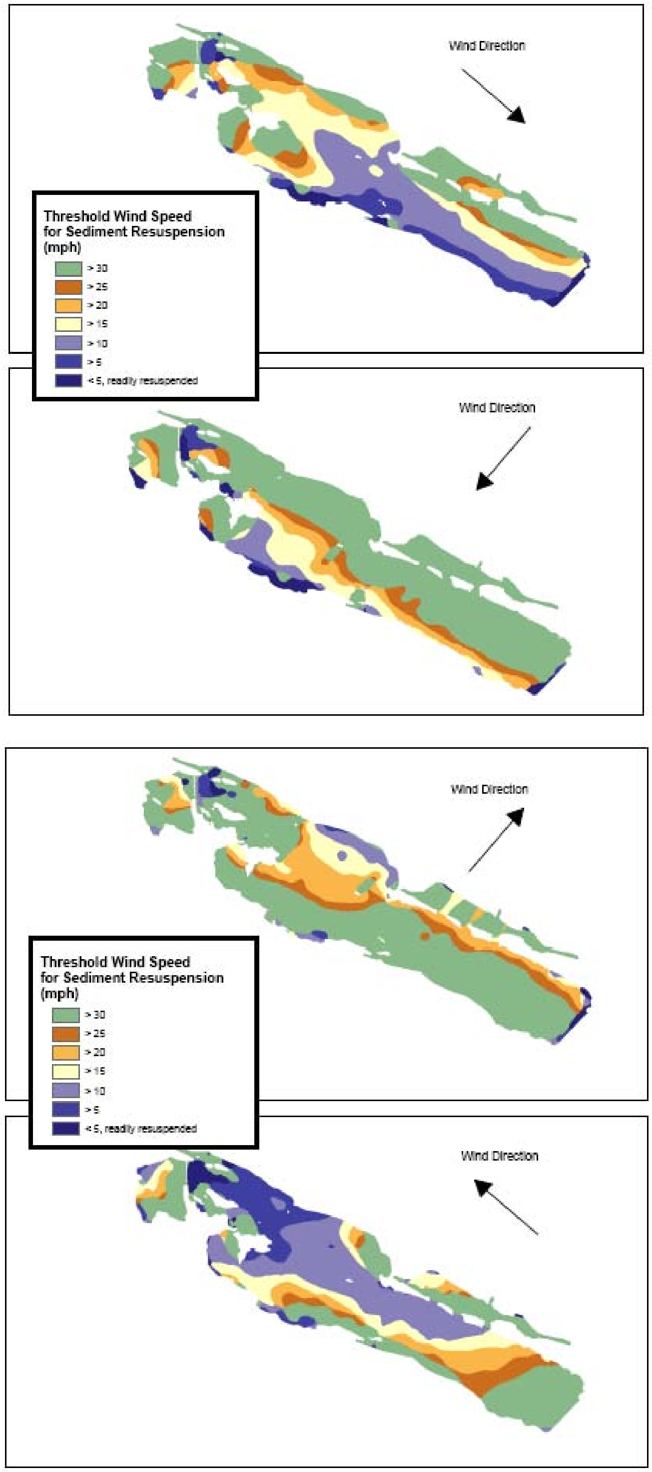


Figure 2 – 10. Threshold wind speeds for sediment resuspension in Marsh Lake.

2.5 Shoreline Erosion on Marsh Lake

Wind-driven wave action has eroded islands and shorelines on Marsh Lake. The eroding shorelines are mostly in the northern part of the lake where wind fetch is the greatest and where emergent plants are not present along the shoreline (Figure 2 - 11). Several islands that were present following impoundment have been eroded away. The large island used by nesting American pelicans has also been eroded. The rates of shoreline erosion have not been measured.

On an October 2008 site visit, we examined many of the eroding shoreline areas (Figures 2-12, 2-13). Marsh Lake has an abundance of large boulders in the lake bed, a legacy from the Glacial River Warren and the granite outcroppings in the area. Wave action and ice push has, over time, effectively rip-rapped and stabilized the eroding shoreline areas. It does not appear that shoreline erosion on Marsh Lake will continue.

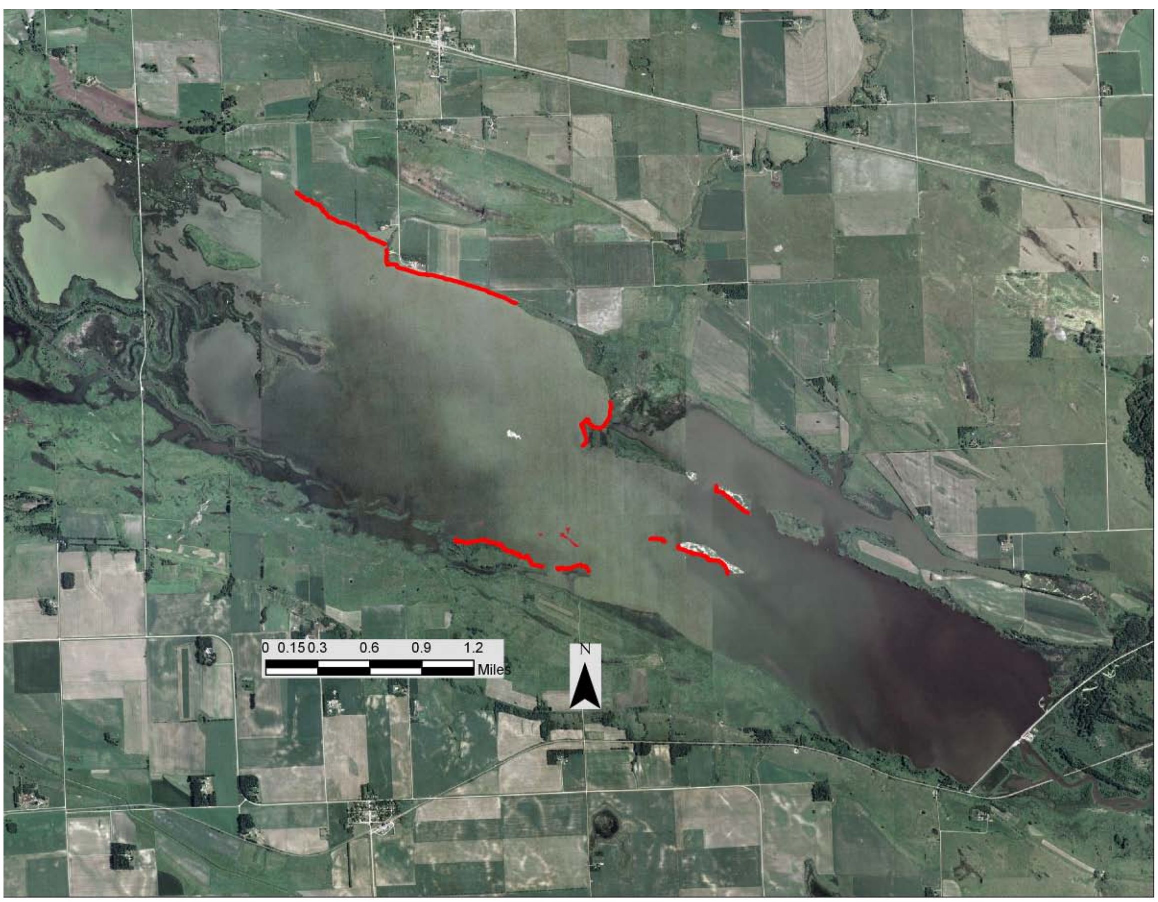


Figure 2 - 11. Eroding shorelines on Marsh Lake shown in red. The red dots in the center are the locations where islands have eroded away.

Figure 2-12. Eroding shoreline along the north side of Marsh Lake armored by native boulders. October 9, 2008 photo.

Figure 2-13. Eroding shoreline on an island in Marsh Lake armored by native boulders. October 9, 2008 photo.

2.6 Water Quality

The Minnesota River, Marsh Lake and the Pomme de Terre River are usually turbid with suspended sediment. Secchi disc transparency is typically less than one foot.

According to accounts of early explorers, when the watersheds of the upper Minnesota and Pomme de Terre Rivers were mostly covered with prairie, the rivers were vegetated and ran clear (Waters 1977).

Today, the system receives considerable loading of sediments and the plant nutrients nitrogen and phosphorus from the intensively row-cropped watershed. Alteration of the stream drainage network by subsurface drain tiles, ditching and stream channelization has altered the hydrology of tributaries to the Minnesota River, making them more flashy and caused sediment to be mobilized from the bed and banks of the tributaries.

The upper Minnesota River is alkaline, with total alkalinity generally over 250 mg/L. Sulfate concentrations are high, generally over 150 mg/L. These alkaline conditions are characteristic of prairie water bodies in the region and influence the species of plants and zooplankton that can grow in Marsh Lake.

The Minnesota River in Marsh Lake and Lac qui Parle are on the Minnesota Pollution Control Agency's (MPCA) Section 303(d) Clean Water Act list of impaired waters. The impairment shown on the 2006 list is for mercury, which prompted a fish consumption advisory for walleye of not more than 1 meal per week for the general population and not more than 1 meal per week of carp, northern pike, yellow perch and walleye for women who are or may become pregnant and for children under 15 years of age (Minnesota Department of Health 2008).

The Pomme de Terre River is on the MPCA's 2006 impaired waters list with impairments by fecal coliform bacteria, fish IBI (index of biological integrity), mercury and turbidity.

The Minnesota Department of Health (2008) has issued fish consumption advisories for the Minnesota River and the Pomme de Terre River because of mercury contamination in fish. The current advisory cautions the general population to eat no more than one meal per week of walleye and not more than 1 meal per week of carp, northern pike, yellow perch and walleye for women who are or may become pregnant and for children under 15 years of age.

Dissolved oxygen in the Minnesota River, the Pomme de Terre River and Marsh Lake is usually higher than the standard of 5 mg/l for protection of aquatic life. In the winter during ice and snow cover, Marsh Lake becomes hypoxic with low dissolved oxygen levels. The low winter dissolved oxygen levels are a significant stressor on fish in Marsh Lake. The Pomme de Terre River may provide dissolved oxygen refugia for fish in Marsh Lake during winter. Winter fish kills occurred historically in Marsh Lake prior to impoundment (Moyle 1941). There have not been significant fish kills in Marsh Lake since one winter in the early 1990's when large numbers of common carp were killed (Chris Domeier, DNR Fisheries, Ortonville, MN, personal communication December 2010).

Chlorophyll a concentration is a measure of active green plant pigment that indicates the biomass of algae in fresh water. Chlorophyll a is essential to photosynthesis and is the primary basis for primary production by algae. Primary production in most lake ecosystems is dominated by planktonic algae. Benthic (attached to the bottom) algae, submersed and emergent aquatic plants and terrestrial vegetation also contribute organic matter to lake ecosystems. High concentrations of chlorophyll a in lake water indicates high planktonic algal biomass and eutrophic conditions. Many lakes and rivers in the Minnesota River Basin are eutrophic with high concentrations of chlorophyll a due to phosphorous loading from non-point sources.

The combination of algae, non-living particulate organic matter, dissolved solids and inorganic suspended sediment reduces light penetration into the water and primary production by submersed aquatic plants and benthic algae.

James and Barko (1995) reported that algal biomass in Marsh Lake represented by chlorophyll a concentrations appeared to be affected by high wind velocities during both 1991 and 1992. Chlorophyll a concentrations increased substantially (i.e., > 50 ug/L) during high winds in September of both years, coinciding with concomitant increases in total phosphorus (P) concentrations in the water column. In contrast, chlorophyll a concentrations were lower, less than 50 ug/L during the calmer summer months of both years.

Available Corps of Engineers water quality monitoring records for Marsh Lake documented chlorophyll a concentrations (Figure 2-14) ranging from approximately 0.015 to 0.1 mg/l (15 to 100 ug/l) during summer conditions in 2000 through 2003. Most of the measured chlorophyll a concentrations in Marsh Lake during that time were within the 25th to 75th percentile range for lakes in the Western Corn Belt Plains ecoregion (Berry and German 1999).

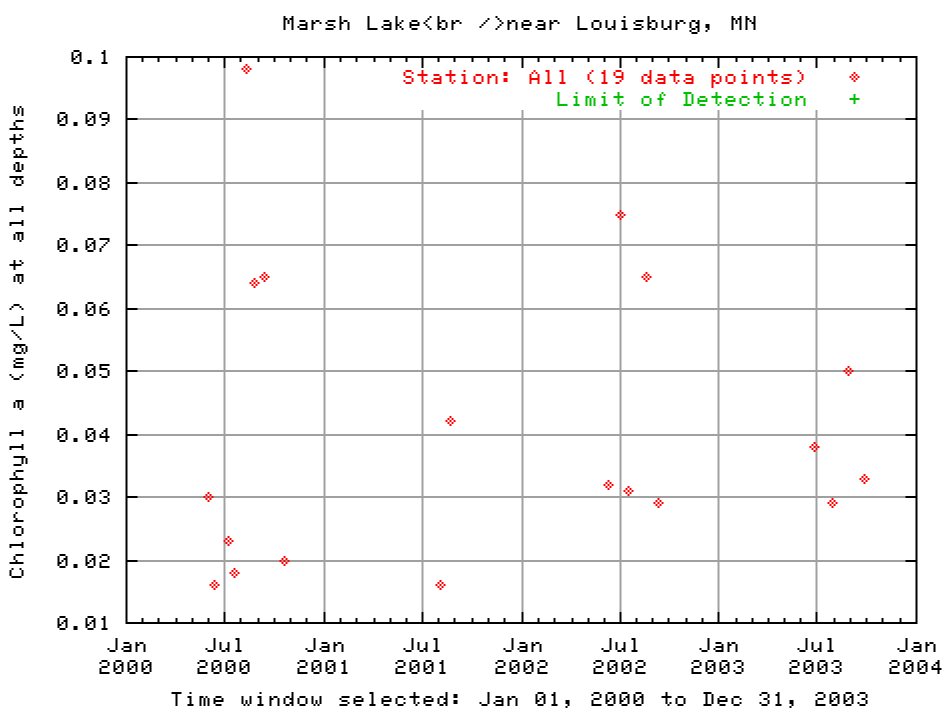


Figure 2-14. Chlorophyll a concentrations in Marsh Lake during the summers of 2000 through 2003. U.S. Army Corps of Engineers water quality monitoring data.

2.7 Historic and Cultural Resources

Previous cultural resources investigations at Marsh Lake include a 1993 survey of Corps fee title and leased lands at Marsh Lake Dam (Ollendorf and Mooers 1994a), a 1993 survey of one potential bank protection area on the north side of Marsh Lake (Ollendorf and Mooers 1994b), a 1998 survey of flowage easement lands along the south side of Marsh Lake between Marsh Lake Dam and the Louisburg Grade Road (Kolb et al. 1999), and a 1999 survey of Marsh Lake flowage easement lands between Louisburg Grade Road and Highway 75 Dam (Harrison 2000).

Minnesota Department of Natural Resources (DNR) archeologists conducted cultural resources surveys of small areas of DNR-administered lands (Marsh Lake Wild Management Area) surrounding Marsh Lake in 1996 and 2002 to 2008 (Emerson and Magner 2002:71-73; 2003:33-36; 2004:107-110; 2005:33-35; Magner et al. 2007:94-97; Magner and Allan 2008:133-138; Skaar 1997).

In 2008, Minnesota Department of Natural Resources archeologists conducted a Phase I cultural resources survey of areas specifically connected with the proposed Marsh Lake ecosystem restoration project along the pre-dam Pomme de Terre River channel both above and below the Marsh Lake dam embankment, at three proposed cutoff dike locations above the dam embankment; and at six potential lakeshore and island shoreline reaches where bank protection was proposed (Magner 2008). The proposed bank protection measures have since been dropped from the ecosystem restoration project due to natural armoring of the shorelines with rocks and cobbles that have eroded out of the soils in these areas.

Known cultural resources sites at Marsh Lake include the Marsh Lake Dam itself (SW-APT-003), as well as two prehistoric archeological sites (21LP33, 21BS67) and one prehistoric and historic archeological site (21BS35) between Marsh Lake Dam and the Louisburg Grade Road, and six prehistoric archeological sites (21BS41, 21BS43, 21BS44, 21BS45, 21BS46, 21LP36), one prehistoric and historic archeological site (21BS47), and two historic archeological sites (21BS42 and Area J Granite Quarry) between the Louisburg Grade Road and the Highway 75 Dam upstream. Sites 21BS41, 21BS42, 21BS43, 21BS44, 21BS45, and 21BS46 have been determined not eligible to the National Register of Historic Places (Minnesota SHPO letter dated January 16, 2002). Sites 21LP33, 21LP36, 21BS47, 21BS67 and the Area J Granite Quarry need further testing and research to determine their National Register eligibility.

Marsh Lake Dam (SW-APT-003) was determined individually eligible to the National Register of Historic Places in 1994 as part of the Lac qui Parle Flood Control Project, a flood control and water conservation system consisting of the Lac qui Parle Dam, the Marsh Lake Dam, and the Chippewa River Diversion. The Lac qui Parle Project was constructed as a Works Progress Administration (WPA) project under the sponsorship of the State of Minnesota beginning in 1936. It was one of the most extensive work projects of its kind undertaken by the State and the largest flood control project at the time of construction. Marsh Lake Dam is eligible for inclusion on the National Register under Criterion A for its association as a WPA project of the Federal Relief Programs following the Great Depression of 1929. Marsh Lake Dam consists of three contributing structures and one contributing object: the 1939 dam and embankment with a concrete fixed-crest main spillway and a grouted-riprap auxiliary spillway, two 1939 concrete stage recorder houses on the downstream side of the northeast embankment and the upstream side of the southwest embankment, and a rock with a plaque describing the intentions of the entire Lac qui Parle Flood Control Project. Marsh Lake Dam retains its integrity of original location, design, setting, materials, workmanship, feeling and association. While the Corps has added a metal structure to the upstream side of the northeast embankment in the 1970s and made emergency repairs to the grouted riprap overflow spillway in 1999, these minor repairs do not impact on the integrity of the structure.

2.8 Natural Resources

2.8.1 Climate

The climate is continental, with cold dry winters and warm wet summers. Average annual precipitation is 24 to 26 inches with two thirds normally falling in the five months from May through September. Average annual runoff is estimated at 1-2 inches. Average monthly temperatures recorded at Madison range from 12.40 F in Jan., to 68.80 F in July.

2.8.2 Land Use and Land Cover

Land use in the study area is primarily agricultural use and state-owned wildlife management area. Land cover within the study area is primarily emergent wetland vegetation, open water, agricultural cropland, pasture and hay, grassland, woody wetlands and deciduous forest (Figure 2-15, Table 2-3). The emergent wetland vegetation is largely single-species stands of reed canary grass (Phalaris arundinacea) and cattail (Typhus spp.) except in the upper end of Marsh Lake west of the Louisburg Grade Road.

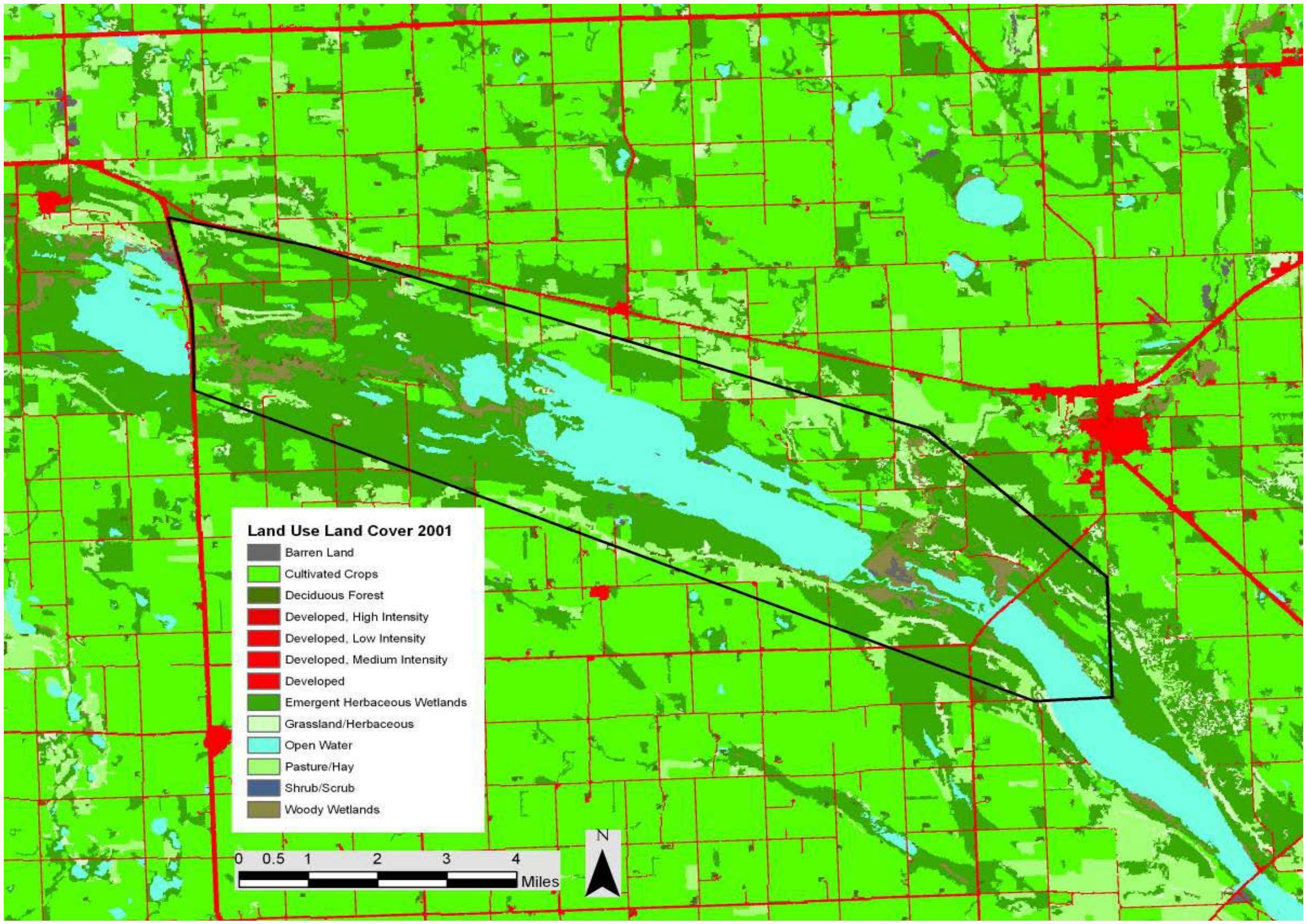


Figure 2 -15. Land cover and land use in the Marsh Lake project area (Minnesota DNR 2001 data). Dark line is the study area boundary.

Table 2-3. Land use and land cover classes within the Marsh Lake study area.

Acres	Land Use/Land Cover Class
5584	Open Water
475	Developed, Open Space
22	Developed, Low Intensity
6	Developed, Medium Intensity
82	Barren Land
217	Deciduous Forest
636	Grassland/Herbaceous
1891	Pasture/Hay
4288	Cultivated Crops
1325	Woody Wetlands
12391	Emergent Herbaceous Wetlands

2.8.3 Marsh Lake Ecosystem State

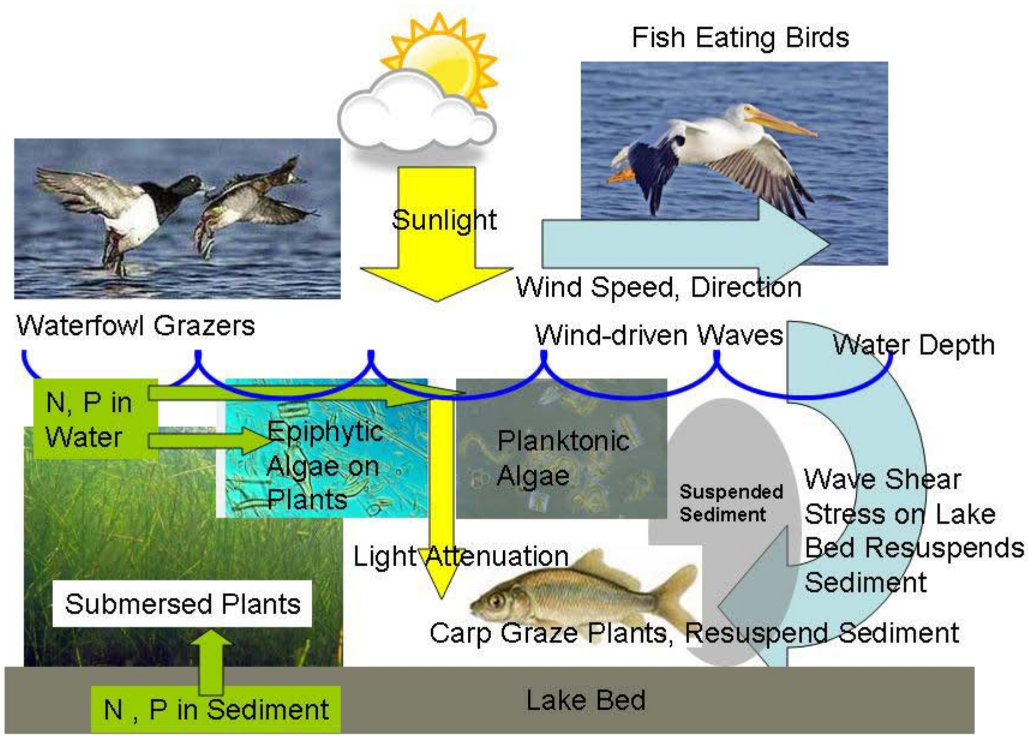


Figure 2-16. Conceptual model of the Marsh Lake ecosystem.

Shallow freshwater lakes are complex ecosystems. The ecosystem state of shallow lakes can shift from vegetated with clearer water and a mixed fish community to a turbid un-vegetated state dominated by blue-green algae blooms and bottom-feeding fish (Scheffer, 1998).

Figure 2-16 is an illustrative conceptual model of the Marsh Lake ecosystem. In a clear-water, vegetated state in the lake (on left in Figure 2-16), submersed aquatic plants dominate, providing food for migratory waterfowl, sheltering zooplankton and supporting a diverse fish community. The clearer water conditions and a diverse fish community support fish eating birds that rely on sight to prey on fish. White pelicans nest on islands in Marsh Lake where they are protected from predators and they forage widely for fish.

With increased loading of nutrients (nitrogen, phosphorus; N and P at left in the conceptual model), excessive algae grows on the leaves of submersed aquatic plants and limits their growth. Increased nutrient loading also supports planktonic algae blooms that limit light penetration into the water and further reduce submersed aquatic plants. As submersed aquatic plants become sparse, they no longer suppress wave action, allowing wind-generated waves to resuspend bottom sediment, further reducing light penetration into the water. Common carp thrive in turbid lakes and further reduce submersed aquatic plants by grazing and resuspending sediment. The turbid ecosystem state can persist for many years.

Drivers that can shift the ecosystem state back to the clear water vegetated condition include lower lake levels, reduced sediment loading, reduced nutrient loading, reduced wind fetch, sediment resuspension, and reduced carp populations.

Further explanation of historic, existing and forecasted future ecosystem conditions in Marsh Lake are provided in the sections that follow.

2.8.4 Historic and Recent Conditions in Marsh Lake

Immediately after construction of the Marsh Lake Dam, Marsh Lake had good habitat with extensive stands of submersed and emergent aquatic vegetation (Moyle 1941), but the aquatic and riparian ecosystems have degraded over the last 68 years.

Today Marsh Lake is a shallow, turbid environment (about 3,000 of 5,000 acres are less than 3 feet deep). Because the Marsh Lake Dam has a fixed crest and is not operable, the continuous minimum water surface has disrupted natural flooding and drying cycles. As a result, emergent aquatic plants that require exposed mudflat conditions to germinate from seed have declined in the lake. Reduced stands of emergent plants have increased the wind fetch. Wind induced wave action and non-native carp resuspend sediments, blocking sunlight and reducing opportunity for submersed aquatic plant growth (Figure 2-16). Wave action has eroded the shoreline, islands and points where emergent plants used to grow.

Aquatic plants and many other life forms in floodplain rivers like the Minnesota River are adapted to characteristic annual changes in flow and water levels (Junk et al. 1989, Bayley 1995).

2.8.5 Aquatic Vegetation

Aquatic plants are important components of the river ecosystem. Aquatic plants provide food and habitat for macroinvertebrates, fish and wildlife. They are a major source of primary production in the river system. Epiphytic algae grow on aquatic plants, providing another important source of primary production. Aquatic plants provide food for furbearers and food and habitat for macroinvertebrates, which in turn provide food for fish and birds. Aquatic plants cycle nutrients between the sediment and the water. Aquatic plants remove suspended sediment from the water, anchor substrate, attenuate wave action and reduce sediment resuspension. Aquatic plants remove nitrogen from the water and promote denitrification (conversion of nitrate and nitrite to nitrogen gas). Aquatic plants inhibit growth of planktonic algae, resulting in clearer water that favors sight-feeding fishes. Aquatic plants form patches of different habitat types needed by many fish and wildlife species. Aquatic plants provide a major source of food for migrating waterfowl. Aquatic plants contribute to the scenic beauty of the river.

Perennial Emergent Aquatic Plants

Perennial emergent aquatic plants like arrowhead, bulrush, cattail, and rice cutgrass can grow vegetatively for years from their root systems. Extended periods of high water, grazing by muskrats and waterfowl, ice and wind-driven wave action reduce the abundance of perennial emergent aquatic plants over time. In years with low summer water levels, perennial emergent aquatic plants have opportunity to germinate from seed in dewatered mud flats. The new plants grow to full size over the course of a couple growing seasons. Extensive stands of emergent aquatic plants are re-established and can persist for years.

Prior to impoundment, the Marsh Lake area was a frequently inundated and dewatered low floodplain with perennial smartweed (*Polygonum* sp.), reed canary grass (*Phalaris arundinacea*) and slough grass (*Spartina pectinata*). Following impoundment in 1937, in 1941 the emergent perennial plants around Marsh Lake included river bulrush (*Scirpus fluviatalis*), common cattail (*Typha latifolia*), narrow-leafed cattail (*Typha angustifolia*), wild millet (*Echinochloa crusgalli*), bur reed (*Sparganium urycarpum*), slough grass (*Spartina pectinata*), softstem bulrush (*Scirpus validus*), and giant reed grass (*Phragmites australis*) (Moyle 1941).

Historic aerial photography was interpreted by the Minnesota DNR to quantify the extent of emergent aquatic vegetation in Marsh Lake. The 1988-1989 droughts caused low water levels in Marsh Lake that enabled emergent aquatic plants to germinate in the dewatered areas of the lake bed. In 1991 there were 1574 acres of emergent aquatic plants around the periphery of Marsh Lake (Figure 2-17). After a number of years of stable and higher water levels and the flood year of 1998 when Marsh Lake water levels were very high, the extent of emergent aquatic plants on Marsh Lake declined to 1032 acres (Figure 2-18).

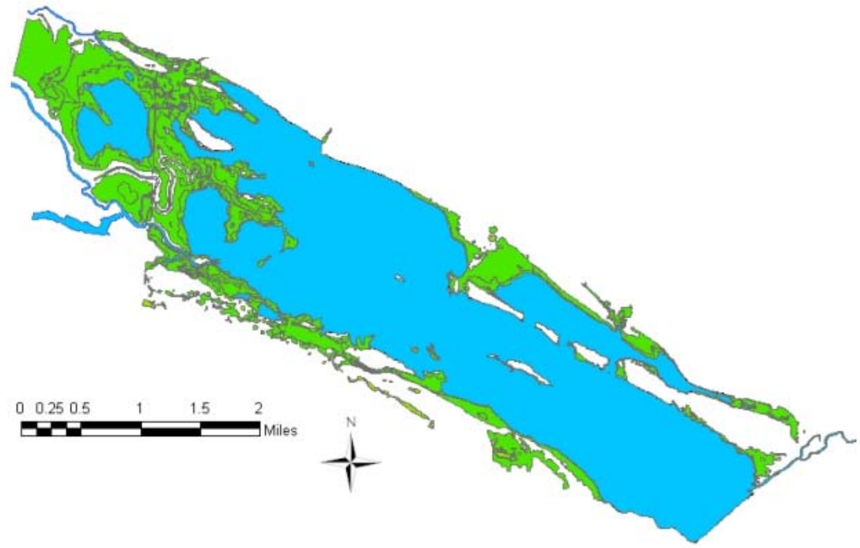


Figure 2-17. Emergent aquatic vegetation covering 1571 acres in Marsh Lake in 1991, interpreted from aerial photography by the Minnesota DNR.

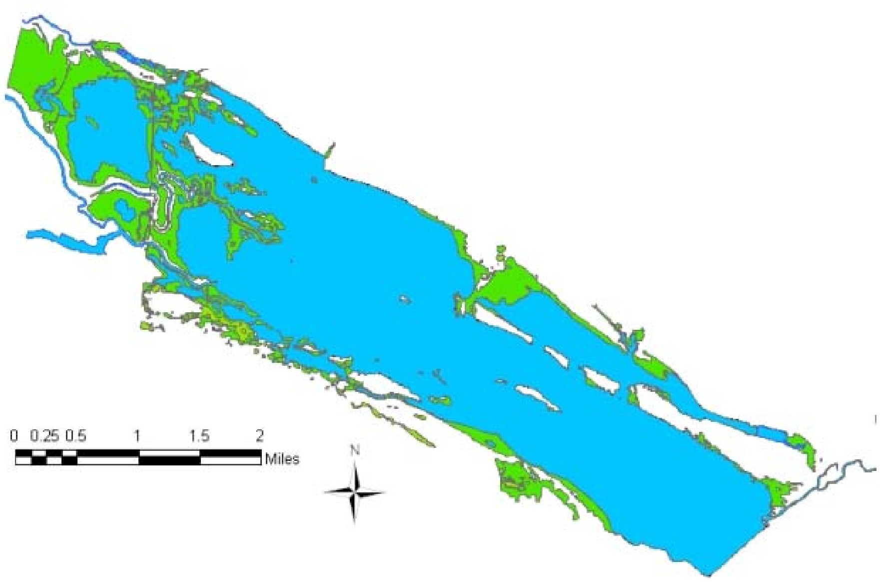


Figure 2-18. Emergent aquatic vegetation in Marsh Lake covering 1032 acres in 1999, interpreted from aerial photography by the Minnesota DNR.

Years of maintaining a minimum water level on Marsh Lake has caused emergent perennial aquatic plants to decline in extent, diversity and abundance. Today, the perennial emergent plant community is dominated by a narrow band of hybrid cattail with occasional river bulrush with a band of dense reed canary grass on the landward side around the periphery of the lake.

Submersed Aquatic Plants

Submersed aquatic plants require underwater light to thrive. In years of extended high water and turbid conditions, the submersed aquatic plants in Marsh Lake are nearly absent. In rare years with lower spring and summer water levels and little wind-driven sediment resuspension, more light reaches the bottom and submersed aquatic plants have the opportunity to grow.

Low summer water levels dewater sand bars and mud flats, oxidizing and consolidating sediment. Upon reflooding, the consolidated sediment is more resistant to resuspension by wind-driven wave action. Decomposition of organic matter in dewatered sediment releases nutrients for plant growth.

Submersed aquatic plants in Marsh Lake have varied markedly in abundance from one year to another. Following impoundment, Moyle (1941) reported that in 1941, approximately 10 percent of the area of Marsh Lake had submersed aquatic plants. Sago pondweed (*Stuckenia pectinatus*) and coontail (*Ceratophyllum demersum*) were the most common species. In 1991, Marsh Lake had near-complete coverage with sago pondweed, but it was not present in 1992 (James and Barko 1995).

Sago pondweed is the dominant submersed plant (Table 2-4) in Marsh Lake due primarily to its ability to withstand a wide range of turbidity levels compared to other submersed macrophytes (Stuckey 1971). Sago pondweed produces tubers that are an important food source for migrating diving ducks and geese in the fall. Sago pondweed frequency of occurrence in Marsh Lake can vary markedly. In 2002, 72.2% of the stations sampled (n=277) recorded sago pondweed whereas in 2007, only 11.5% (n=165) recorded sago pondweed (Table 2-4).

When sago pondweed is abundant (e.g. 2002, Fig. 2-19), plant distribution is throughout the entire lake even in the deepest water zones. In years of limited abundance (e.g. 2007, Fig. 2-20), plant distribution is restricted to protected bays and shallow water zones on Marsh Lake. James and Barko (1995) documented the positive role sago pondweed can have on reducing sediment resuspension by dampening wave action on Marsh Lake.

Aside from sago pondweed, submersed aquatic plant diversity is extremely low and other species were limited to a few individual plants found only in the most protected bays and shallow water zones on Marsh Lake (Table 2-2, Fig. 2-20). The primary factors limiting overall submersed aquatic plant abundance in Marsh Lake appears to be high spring and summer water levels, abnormal timing and magnitude of water level fluctuations, wind-driven wave-induced sediment resuspension limiting underwater light and grazing by common carp.

A bioenergetics plant growth model (POTAM) for sago pondweed was used to simulate existing and with-project conditions for submersed aquatic plant growth in Marsh Lake (Appendix J). Using information on wind speed, wind direction, water depth, experiments to determine the critical shear stress for Marsh Lake sediment resuspension, and application of the POTAM plant growth model indicate that current conditions in Marsh Lake do not allow the persistence of sago pondweed. The availability of underwater light is the primary limiting factor.

Table 2-4. Frequency of occurrence of submersed aquatic plants in Marsh Lake, 1962-2007. MN-DNR Wildlife Lake Habitat and Game Lake Survey Reports.

Species	Frequency of Occurrence %				
	1962	1968	2002	2004	2007
Sago pondweed	46.0	37.0	72.2	22.4	11.5
Coontail (*Ceratophyllum demersum*)	4.0	1.0	3.6	0.6	1.2
Greater bladderwort (*Utricularia vulgaris*)					0.6
Leafy pondweed (*Potamogeton foliosus*)	9.0				
Illinois pondweed (*P. illinoensis*)	2.0				
Narrowleaf pondweed (*P. strictifolius*)	2.0				
Narrowleaf pondweed group (*P. NL spp.*)			0.7		0.6

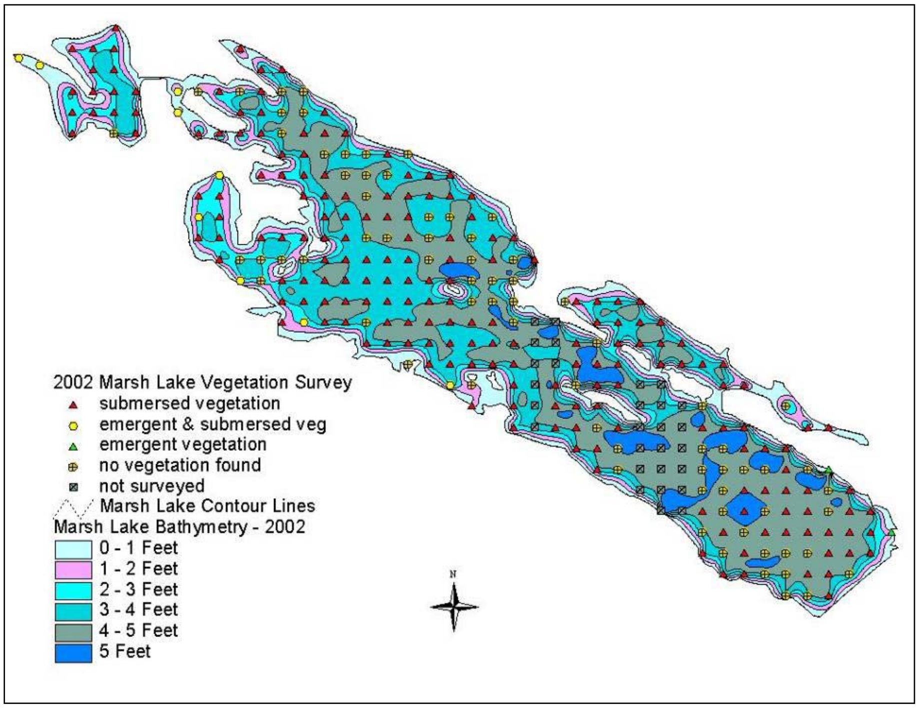


Figure 2-19. Distribution of submersed vegetation in Marsh Lake, 2002. Minnesota DNR survey data.

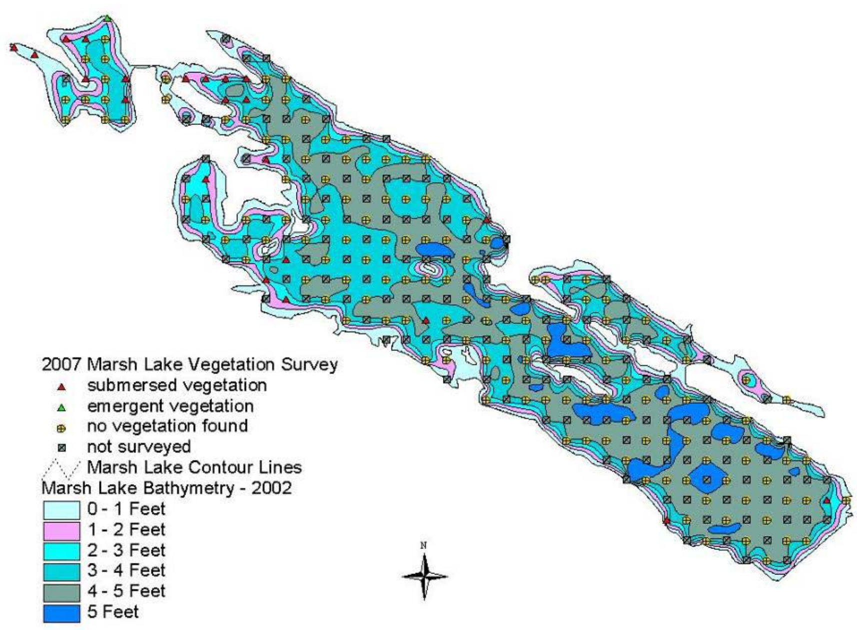


Figure 2-20. Distribution of submersed vegetation in Marsh Lake, 2007. Minnesota DNR survey data.

Annual Emergent Aquatic Plants

Annual emergent aquatic plants also germinate from seed in mudflats dewatered during low water periods during the growing season. These plants grow rapidly, provide food and shelter for wildlife, and then die at the end of the growing season. The senescent plants provide an abundance of organic matter for zooplankton, which in turn provide food for small fish.

Prior to impoundment, the frequently inundated low floodplain that became Marsh Lake supported extensive areas of "rank herbaceous vegetation" of annual emergent aquatic plants, including smartweed (*Polygonum* spp.), nut grass (*Cyperus* spp.) and sticktight (*Bidens* spp.) (Moyle 1941). Following impoundment in 1937, Moyle (1941) reported that because of little fluctuation in water levels, the margin of Marsh Lake was taken over with mostly perennial emergent aquatic plants.

Today, sparse annual emergent aquatic plants occur around the edges of Marsh Lake. Their extent and abundance varies with water level fluctuations during the growing season.

2.8.6 Fish Community

The Minnesota River and its tributaries support a diverse native fish community. The DNR found 25 fish species during a 2006 survey of Marsh Lake, using gill nets and trap nets for adult fish, and fine mesh trap nets for young-of-year and small fish (Minnesota DNR 2006).

Common carp are the most abundant fish in Marsh Lake, dominating the community by both numbers and biomass (Tables 2-5 and 2-6). Common carp were brought from Europe to the U.S. in 1831 and invaded the Minnesota River by the late 1800s. Carp have fluctuated in abundance between 62 per 24-hour gill net set in 2000 to a low of 3.7 per gill net in 1997. The 2006 catch was 28.5 carp per gill net. These catch rates for carp are considerably higher than in other similar lakes in Minnesota.

Table 2-5. Results of DNR 2006 gill net survey on Marsh Lake

Fish Species	No. Fish 6 Gill Net Sets	Community Composition (%) by Number	Total Weight (lbs) 6 Gill Net Sets	Community Composition (%) by Weight
Bigmouth Buffalo	33	6.8	47	5.1
Black Bullhead	39	8.0	9	1.0
Black Crappie	27	5.5	7	0.8
Brown Bullhead	24	4.9	16	1.7
Channel Catfish	15	3.1	40	4.3
Common Carp	171	35.0	629	67.9
Freshwater Drum	16	3.3	16	1.7
Northern Pike	30	6.1	30	3.2
Shorthead Redhorse	9	1.8	9	1.0
Walleye	62	12.7	62	6.7
White Bass	38	7.8	38	4.1
White Sucker	19	3.9	19	2.0
Yellow Bullhead	1	0.2	1	0.1
Yellow Perch	4	0.8	4	0.4

Table 2-6. Results of DNR 2006 trap net survey on Marsh Lake.

Fish Species	No. Fish 15 Trap Net Sets	Community Composition (%) by Number	Total Weight (lbs) 15 Trap Net Sets	Community Composition (%) by Weight
Bigmouth Buffalo	3	0.8	17.6	2.0
Black Bullhead	31	7.8	3.3	0.4
Black Crappie	35	8.8	14.8	1.7
Bluegill	1	0.3	0.1	0.0
Brown Bullhead	8	2.0	6.8	0.8
Channel Catfish	2	0.5	2.2	0.3
Common Carp	96	24.2	619.5	71.9
Common Shiner	1	0.3	0.1	0.0
Freshwater Drum	103	26.0	37.6	4.4
Green Sunfish	1	0.3	0.1	0.0
Northern Pike	22	5.6	80.6	9.3
Orangespotted Sunfish	1	0.3	0.1	0.0
Quillback	1	0.3	0.4	0.0
Shorthead Redhorse	14	3.5	29.2	3.4
Walleye	20	5.1	18.3	2.1
White Bass	43	10.9	20.4	2.4
White Sucker	3	0.8	6.1	0.7
Yellow Bullhead	8	2.0	3.3	0.4
Yellow Perch	3	0.8	1.7	0.2

Northern pike are moderately abundant, similar to other shallow lakes in Minnesota. Some natural reproduction of northern pike in Marsh Lake was evident with young-of-year in the fine mesh trap samples. Northern pike spawn in the upstream end of Marsh Lake, in the extensive areas of emergent aquatic plants above the Louisburg Grade Road.

One and two-year-old walleye constituted most of the walleye catch. Previous stocking studies using oxytetracycline tracer indicated that downstream migration of walleyes stocked in Big Stone Lake contribute substantially (50 percent of the 2006 year class) to the walleye population in Marsh Lake. Other game fish are low in abundance.

Yellow perch grow fast in Marsh Lake, reaching quality size for the sport fishery (10 to 11 inches long) in three years. They have been historically abundant in Marsh Lake but were not in 2006.

<u>Habitat Connectivity and Fish Migrations</u>

Lac qui Parle provides good habitat for native walleyes, northern pike, white bass and white suckers but the Marsh Lake Dam prevents their access to prime spawning areas in the Pomme de Terre River (walleyes, white bass, white suckers) and in the upper end of Marsh Lake (northern pike) (Figure 2-21). The dam also prevents the transport of native mussel glochidia (small larval stage mussels that temporarily parasitize fish by attaching to their gills) from Lac qui Parle to the Pomme de Terre River.

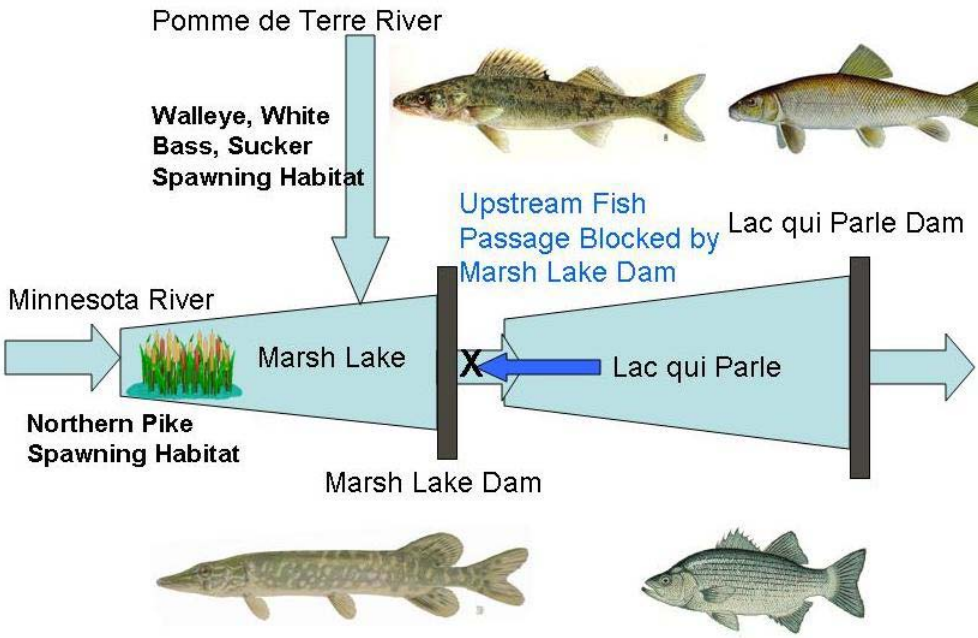


Figure 2-21. Conceptual model of blocked fish migration routes from Lac qui Parle into Marsh Lake and the Pomme de Terre River.

Fish persist in Marsh Lake despite hypoxic (low dissolved oxygen concentration < 5 mg/l) conditions in winter and high turbidity and high water temperatures in summer. In winters with little or no inflow from the Minnesota River and with ice and snow cover preventing photosynthesis by algae, inflowing Pomme de Terre River water may provide oxygen refugia for carp. Winterkill of fish historically occurred in Marsh Lake (Moyle 1941). Winter dissolved oxygen monitoring by the DNR has found periods of hypoxia, but the last winter fish kill in Marsh Lake occurred in the early 1990s when dead carp were found (Chris Dohmeier, DNR Fisheries, Ortonville MN, personal communication, December 2010). The winter aquatic habitat conditions created by the diversion of the Pomme de Terre River into Marsh Lake favors non-native carp over native northern pike. Northern pike are more tolerant of hypoxic conditions than are carp.

2.8.7 Macroinvertebrates

The benthic macroinvertebrate community in Marsh Lake in 1990 was dominated by chironomid and ceratopogonid midge larvae with some mayflies, caddisflies and dragonflies (Montz 1990). Fingernail mussels (*Sphaeriidae*) are an important food for fish and waterfowl. They were not present in Marsh Lake in 1990. A 1989 survey of the Minnesota River Basin (Zischke et al. 1990) found that the macroinvertebrate community in the Minnesota River downstream of Lac qui Parle dam was dominated by amphipods. Very few insects were present.

The Pomme de Terre River supports a diverse macroinvertebrate community. Invertebrates were collected by the Minnesota DNR from the Pomme de Terre River over the period of June 25-July 1, 1991 using a kick-net. Samples were not quantified, but invertebrates were identified and presence noted. Fingernail clams (order Pelecypoda) were found at all stations and were the only invertebrates found at Station 6, located 32.8 miles from the mouth. In contrast, sampling of stations 2 and 7 found the presence of six different insect orders. Insect larvae were most abundant in areas with coarser substrates such as gravel or rubble. Additional species collected from the river outside of specific sampling stations included a snail from the genus *Ferrissia*, the leech *Placobdella parasitcia*, and a stonefly from the family Pteronarcidae. The most abundant insect larvae were mayflies (order Ephemeroptera.)

2.8.8 Mussels

The Minnesota DNR conducted mussel surveys of Marsh Lake and the Pomme de Terre River in 2007 and 2010. A detailed report of the DNR mussel surveys is provided in Appendix Q. Only one live mussel was found in Marsh Lake, a pink heelsplitter (*Potamilus alatus*), a species adapted to living in soft substrate.

A diverse and abundant mussel community was found in the lower Pomme de Terre River. The river mussel community there is dominated by threeridge (Amblema plicata). The survey results suggest the river has a regionally significant assemblage of freshwater mussels as compared to the Minnesota River Basin as a whole. Abundance of mussels in the Pomme de Terre River, in terms of qualitative search catch per unit effort (CPUE, mussels/hour), was substantially higher than in the Minnesota River main stem or elsewhere in the entire Minnesota River Basin. The Pomme de Terre River also has regionally significant populations of elktoe (*Alasmidonta marginata* - MN Threatened), black sandshell (*Ligumia recta* - MN Special Concern) (Figure 2-22), three ridge (*Amblema plicata*), and Wabash pigtoe (*Fusconaia flava*), as these are the largest populations of these species in the entire Minnesota River system, based on statewide mussel survey data collected to date. The highest densities of mussels were found at stations in the diverted reach of the lower Pomme de Terre River just upstream of Marsh Lake.

No invasive zebra mussels (*Dreissena polymorpha*) have been found the project area.

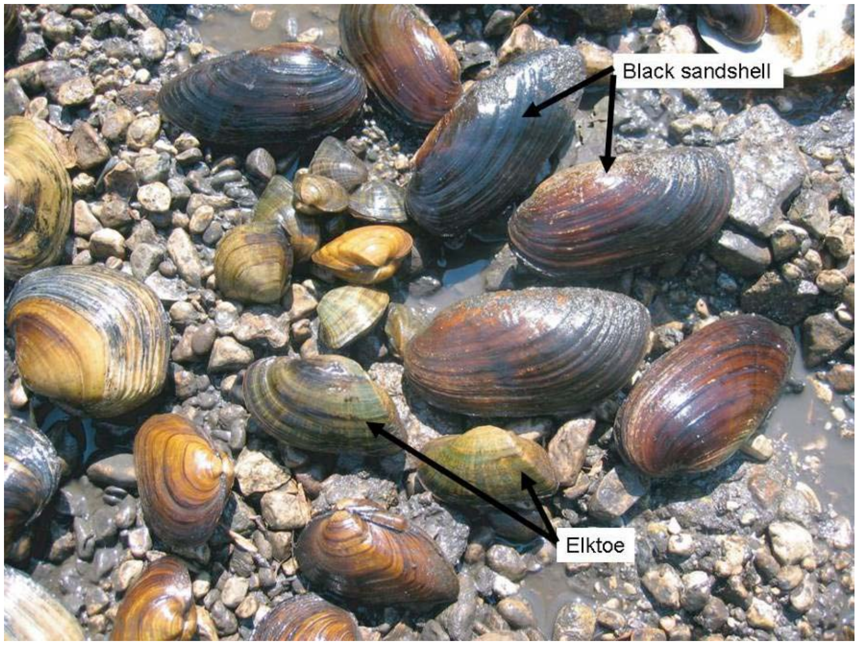


Figure 2-22. State-listed mussels from the lower Pomme de Terre River, August 2007. Minnesota DNR photo.

Table 2-7. Mussels found in Marsh Lake and the Lower Pomme de Terre River during an August 2007 survey. Minnesota DNR data.

				Lower Pomme de Terre River						
				Diversion Reach		Upstream of Diversion Reach				
Species	Common Name	MN Listing Status	Marsh Lake	2136	2137	3042	3034	2138	2135	3035
Alasmidonta marginata	**elktoe**	**threatened**						2	2	
Amblema plicata	threeridge	unclassified		461	153	63	46	7	14	1
Fusconaia flava	Wabash pigtoe	unclassified		26	14	17	1	2	7	
Lampsilis cardium	plain pocketbook	unclassified		39	49	147	76	25	20	3
Lampsilis siliquoidea	fat mucket	unclassified			52	3	30	7	15	1
Lasmigona complanata	white heelsplitter	unclassified		4	8	2	2	1	5	1
Leptodea fragilis	fragile papershell	unclassified		5	5	5	2	8	4	1
Ligumia recta	**black sandshell**	**special concern**		9	4	28	9	5	13	
Potamilus alatus	pink heelsplitter	unclassified	1	9	4	4	6	7	9	
Pyganodon grandis	giant floater	unclassified		2				1	1	
Quadrula quadrula	mapleleaf	unclassified						1		
Strophitus undulatus	creeper	unclassified		1	1		6	1	1	1
Truncilla truncata	deertoe	unclassified		53	41	23	9	104	9	2
Total number live mussels			1	609	331	292	187	171	100	10
Number of sites sampled			3	1	1	1	1	1	1	1
Avg. CPUE (mussels/hr)			0.7	365.4	220.7	116.8	83.1	60.4	44.4	6.7

2.8.9 Wildlife

The Marsh Lake project area lies within the 32,990-acre Lac qui Parle Wildlife Management Area, managed by the Minnesota DNR. The adjacent 11,521-acre Big Stone National Wildlife Refuge is upstream and is managed by the U.S. Fish and Wildlife Service. The Nature Conservancy owns two preserves adjacent to the Lac qui Parle Wildlife Management Area totaling 2,436 acres. Together these three natural areas provide over 46,000 acres of protected wildlife habitats in the upper Minnesota River valley.

The habitat is a diverse mixture of shallow lakes, prairie potholes, cattail marshes, native prairie grasslands - some of the largest remaining in west-central Minnesota – restored grasslands, old field habitats, floodplain forests, rock outcrops, and cropland. This habitat diversity supports a rich assemblage of animal species.

<u>Birds</u>

The Audubon Society has recognized the Lac qui Parle – Marsh Lake – Bigstone Refuge area as an Important Bird Area of national significance. The upper Minnesota River valley is located in one of the most heavily traveled duck migration corridors in the United States (Bellrose 1976). Most migrants originate from Alberta, Manitoba, North Dakota, and Minnesota, but others come from subarctic and arctic-nesting grounds in western Canada and Alaska.

<u>Waterfowl (Geese)</u> – the Lac qui Parle Wildlife Management Area has the largest concentration of migrating Canada geese in the state. In November, as many as 120,000 to 150,000 Canada geese use the State Game Refuge at one time, accounting for over 800,000 goose-use days (September – December; MN-DNR, unpublished data). Canada goose use of Marsh Lake peaks at around 5,000 to 10,000 during this time period. Approximately 65% of these geese are from the Eastern Prairie Population, which nests near the southwestern shore of Hudson Bay and traditionally wintered on or near Swan Lake National Wildlife Refuge in Missouri. The Canada geese are accompanied by smaller flocks of snow, cackling, and white-fronted geese. Ross's geese are uncommon visitors.

<u>Waterfowl (Ducks)</u> – Blue-winged teal, mallard, and wood duck are the most abundant breeding ducks. The ruddy duck is the most common nesting diving duck, but secure nests sites are limited due to fluctuating water levels. Blue-winged teal, green-winged teal, mallard,

and wood duck are the most common puddle ducks early in the fall migration. American wigeon, gadwall, northern shoveler, and pintail are common but tend to be less abundant.

Mallard numbers build as the fall progresses reaching a peak in mid-November while other puddle duck numbers decline. Counts of peak mallard numbers normally range between 40,000 to 80,000+ between the Lac qui Parle Wildlife Management Area and Big Stone National Wildlife Refuge. This large concentration of migratory waterfowl lasts for a week or two and is not related to food resources within the Big Stone National Wildlife Refuge, Marsh or Lac qui Parle Lakes, but is due to the security from predators that these large water bodies provide. The large flocks of migratory waterfowl feed on waste grain in surrounding agricultural fields and roost at night on the lakes. This fact is further borne out by weekly waterfowl surveys on Marsh Lake held in October 2006 and 2007, which documented mallard and teal numbers averaging <500 birds each. However, on an adjacent moist-soil unit with abundant native aquatic plant food resources, puddle ducks numbered in the thousands (David Trauba, personal communication).

Diving duck-use, primarily ring-necked duck, redhead, and lesser scaup, is very low on Marsh and Lac qui Parle Lakes. It is well documented that heavy diving duck-use is related to the amount of aquatic food resources available. Marsh Lake in its present form, with its turbid waters and correspondingly low plant diversity and abundance, is not attractive diving duck habitat.

<u>Shorebirds</u> – Thousands of shorebirds migrate through the Marsh Lake area in the spring and late summer. The Big Stone National Wildlife Refuge with its managed pools is a focal point and in 2004 over 100,000 individual shorebirds were counted within the boundaries of the Lac qui Parle – Big Stone Important Bird Area. Marsh Lake with its stable water regime receives limited shorebird use.

Colonial Waterbirds – Marsh Lake contains the largest breeding colony of American pelicans in North America. In 2006, waterbirds nested on 5 islands and one peninsula in Marsh Lake. The following numbers were estimated from aerial photography (DiMatteo and Wollenberg, unpublished data):

American pelicans: 19,396 breeding pairs
Double-crested cormorant: 1,550 breeding pairs
Ring-billed gulls: 4,083 breeding pairs
Great egret: 212 breeding pairs

Forster's terns, black crowned night herons, great blue herons, and occasionally cattle egrets are also associated with these nesting islands.

Bird Species Diversity – Over 250 species of birds are recorded on an annual basis within the upper Minnesota River valley. Grassland birds associated with our native prairie tracts include: northern harrier, short-eared owl, greater prairie chicken (restoration), sharp-tailed grouse, upland sandpiper, marbled godwit, eastern kingbird, clay-colored sparrow, savannah sparrow, Henslow's sparrow, Le Conte's sparrow, bobolink, western meadowlark, loggerhead shrike, Brewer's blackbird, and the exotic ring-necked pheasant. Neotropical songbirds such as warblers and vireos use the floodplain forests. American bitterns, sora, red-winged and yellow-headed blackbirds are found along the cattail zone on Marsh Lake; western grebes previously nested on Marsh Lake but have been absent in recent years. As many as 50 bald eagles use the area during the spring and fall migration and 5-8 pairs nest here. Golden eagles are uncommon.

Mammals

Fifty-two mammal species are known to or probably occur within the upper Minnesota River valley. Mule deer, pronghorn antelope, and elk are rare visitors today but were present prior to European settlement. Sightings of moose, which are mostly transient animals, occur almost every year. The large herds of bison are gone.

White-tailed deer, eastern cottontail, white-tailed jackrabbit, gray and fox squirrels are common and hunted during authorized seasons. Beaver, muskrat, mink, raccoon, short and longtail weasels, badger, striped skunk, red fox, coyote, and opossum are common furbearers; river otters were successfully reintroduced and are now common.

Because small mammals are inconspicuous, their distribution and abundance is difficult to assess. The most common small mammals include: white-footed mouse, deer mouse, short-tailed shrew, meadow jumping mouse, meadow vole, prairie vole, masked shrew, and redbacked vole.

Reptiles and Amphibians

Rocky outcropping and other dry areas provide habitat for reptiles, while in the wetlands a variety of amphibians can be found. The following is a list of reptiles and amphibians that may be observed in the upper Minnesota River valley spring through fall:

Spiny soft-shell turtle	Fox snake
Snapping turtle	Mudpuppy
Western painted turtle	Eastern tiger salamander
Prairie Skink	American toad
Red-bellied snake	Great Plains toad
Red-sided garter snake	Canadian toad
Plains garter snake	Cope's gray tree frog
Bull snake	Northern leopard frog
Western hog-nosed snake	Western chorus frog

Butterflies and Insects

Several rare butterfly species are known to be inhabitants of our native prairie plant communities that still exist in the upper Minnesota River valley. These species include: Dakota skipper, poweshiek skipper, arogos skipper, pawnee skipper, and the regal fritillary, one of the state's showiest butterflies. One record exists of the ottoe skipper in Big Stone County.

There is much less information about moths than about butterflies, but there are also prairie-restricted moths, perhaps a large number. Examples are the under wing moths *Catocala abbreviatella* and *C. whitneyi*, and the small *Noctuid schinia lucens*. All of these feed on leadplant as larvae. Other important orders that are known to contribute elsewhere to a distinctive prairie fauna are beetles (*Coleoptera*) and the leafhoppers (*Homoptera*). The grasshoppers and crickets (*Orthoptera*) may also have a few highly restricted representatives in prairie remnants.

Open sedge meadow wetlands that have not suffered much disturbance also support some restricted butterflies (and probably members of other orders) such as the mulberry wing, the broad-winged skipper, and the dion skipper. However, there are no records from the vicinity.

Aquatic habitats are prominent features of the upper Minnesota River valley. Major aquatic insect orders should be well represented, including stoneflies (*Plecotpera*), mayflies (*Ephemeroptera*), caddisflies (*Trichoptera*), and dragonflies (*Odonata*). Other orders that contribute significantly to the aquatic and shoreline fauna are beetles, flies (*Diptera*), and true bugs (*Hemiptera*). The highly disturbed character of aquatic habitats probably means that there are no rare or narrow habitat specialists present. There are several small calcareous seepage fens present in the river valley that might harbor some rare specialists.

2.8.10 Endangered and Threatened Species

No Federally-listed threatened or endangered species occur in the Marsh Lake project area. Bald eagles nest and feed in the area. They are no longer listed as a Federal endangered species, but they are still protected.

The bald eagle is a state-listed threatened species. The Dakota skipper is a rare prairie butterfly that is a candidate for state listing that occurs in the project area. The Pomme de Terre River has regionally significant populations of elktoe mussels (*Alasmidonta marginata* - MN Threatened) and black sandshell (*Ligumia recta* - MN Special Concern).

2.8.11 Contaminants, Hazardous, Toxic and Radioactive Waste

A Phase 1 HTRW Assessment has been conducted in areas potentially affected by construction of a project. The Phase 1 HTRW is a stand-alone document included in Appendix F. No known issues related to HTRW are present at the site.

2.9 Social and Economic Conditions

2.9.1 Land Use

Big Stone County covers approximately 528 square miles (338,281 acres). According to the Minnesota database of land use statistics (January 2000), Big Stone County's largest single land use category is cultivated land with 74.6 percent of the total, followed by hay/pasture/grassland at 11.6 percent. Lac qui Parle County covers approximately 778 square miles (498,324 acres). Lac qui Parle County's largest single land use category was also cultivated land with 82.5 percent of the total, followed by hay/pasture/grassland at 9.9 percent. Swift County covers approximately 752 square miles (481,439 acres). Swift County's largest single land use category was also cultivated land with 83.4 percent of the total, followed by hay/pasture/grassland at 8.7 percent. Table 2-8 provides total land use and cover statistics by county.

Table 2 - 8. Land use and cover statistics by County

Land use/cover categories	Big Stone	Lac qui Parle	Swift
Urban and rural development	1.4%	1.7%	1.6%
Cultivated land	74.6	82.5	83.4
Hay/pasture/grassland	11.6	9.9	8.7
Brush land	0.2	0.2	0.3
Forested	2.7	2.7	2.8
Water	5.7	1.7	1.4
Bog/marsh/fen	3.7	1.3	1.7
Mining	0.1	0.1	0.1

Source: Minnesota Land Management Information Center – Database of land use statistics, January 2000

2.9.2 Transportation

Major highways in Big Stone County include U.S. Highway 12, which goes east-west through the County connecting Ortonville to Minneapolis/St. Paul located 175 miles to the east, and U.S. Highway 75 which goes north-south through the County connecting Ortonville to Fargo/Moorhead located 110 miles to the north. Major highways in Lac qui Parle County include U.S. Highway 212, which goes east-west through the County, and U.S. Highway 75 which goes north-south through the County connecting Madison to Fargo/Moorhead located approximately 137 miles to the north. Major highways in Swift County include U.S. Highway 12, which goes primarily east-west through the County connecting Benson to Minneapolis/St. Paul located 110 miles to the east, and U.S. Highway 59 which goes north-south through the County.

There are two active rail lines in Big Stone County. Burlington Northern/Santa Fe (BNSF) operates a class two rail line that runs along the northern edge of the County, along the northern side of State Highway 28 through the communities of Johnson, Graceville, Barry and Beardsley. The other rail line in Big Stone County is operated by Twin Cities & Western Railroad

Co. (TC&W). The TC&W line is a class three line that runs parallel to State Highway 7 on the southern edge of the County to Ortonville. It runs through the communities of Correll, Odessa, and Ortonville. Madison, the county seat for Lac qui Parle County, is served weekly by BNSF. It is 38 miles to the main line. There are two active rail lines in Swift County, the BNSF and TC&W. The BNSF runs through the communities of Benson, Clontarf, Danvers, DeGraff, Holloway, Kerkoven, and Murdock. The city of Appleton is served by the TC&W.

Big Stone County has one airport located in Ortonville. It has a 3,418 foot-long lighted and paved runway. Lac Qui Parle County has airports located in Madison and Dawson. The airport in Madison has a 3,300 foot-long lighted and paved runway. The Dawson airport closed on October 30, 1990. Swift County has airports located in Appleton, Benson, and Murdock. The airport in Appleton has a 3,500 foot-long paved runway. The airport in Benson has a 4,000 foot-long paved runway. The airport in Murdock has a 3,415 foot-long turf runway and is closed in the winter.

2.9.3 Regional Economy

The top industries in Minnesota are tourism, agriculture, computers and services, healthcare and medical equipment, forest and forestry products and printing and publishing (www.state.mn.us). Within the study are, livestock and crop farming are the mainstays of the local economy (www.appletonmn.com). Table 2-9 represents the major non-agricultural industries in the area.

Table 2 - 9 Employment By Industry-Swift County	Number of employed
Government	1,009
Trade, Transportation and Utilities	782
Manufacturing	623
Professional and Business Services	400
Education and Health Services	303
Leisure and Hospitality	204
Financial Activities	163
Other Services	111
Information	38

Source (www.appletonmn.com) - 2008 data

2.9.4 Employment

Big Stone County's labor force totaled 2,859 in March 2005, with an unemployment rate of 6.6 percent, compared to 5.0 percent (unadjusted) for the State of Minnesota and 5.4 percent (unadjusted) for the United States. Lac qui Parle County's labor force totaled 4,273 in March 2005, with an unemployment rate of 5.1 percent. Swift County's labor force totaled 5,525 in March 2005, with an unemployment rate of 6.1 percent

2.9.5 Income

Median household income is the mid-point at which one half of the households earn more and one half earn less. According to information from the U.S. Census Bureau, the 1999 median household money income for Big Stone County was $30,721, for Lac qui Parle County it was $32,626, and for Swift County it was $34,820. This compares to $47,111 for the State of Minnesota and $41,994 for the United States.

Per capita income represents total income divided by the population to derive a per person income estimate. According to 2000 census figures, per capita income (1999 dollars) for Big Stone County was $15,708, for Lac qui Parle County it was $17,399, and for Swift County it was $16,360. This compares to $23,198 for the State of Minnesota and $21,587 for the United States.

Families and persons are classified as below poverty level if their total family or unrelated individual income was less than the poverty threshold specified for the applicable family size, age of householder, and number of children under 18 present. The Census Bureau uses the Federal government's official poverty definition. For example, the poverty threshold in 1999 for a family of four with two children less than 18 years of age was $16,895.

According to 2000 census figures, in Big Stone County, 12.0 percent of the population was below the poverty level, for Lac qui Parle County it was 8.5 percent, and for Swift County it was 8.4 percent. This compares to the state average of 7.9 and the national average of 12.4 percent.

2.9.6 Demography

Table 2-10 describes the population of the study area.

Table 2-10 Demographics of Study Area	Study Area	U.S.
Total population	35,979	304,059,724
White persons, percent, 2008 (a)	95.19%	79.80%
Black persons, percent, 2008 (a)	1.34%	12.80%
American Indian and Alaska Native persons, percent, 2008 (a)	0.85%	1.00%
Asian persons, percent, 2008 (a)	0.83%	4.50%
Native Hawaiian and Other Pacific Islander, percent, 2008 (a)	0.61%	0.20%
Persons reporting two or more races, percent, 2008	1.25%	1.70%
Persons of Hispanic or Latino origin, percent, 2008 (b)	3.01%	15.40%
White persons not Hispanic, percent, 2008	92.43%	65.60%
Female persons, percent, 2008	48.37%	50.70%

Source - US Census Bureau State and County Quick Facts 2008

Population totals for the study area are presented in table 2-11.

Table 2-11 Study Area Population

	Swift	Lac Qui Parle	Big Stone	Chippewa	Study Area Total
2000	11956	8067	5820	13088	38931
2008	11035	7165	5365	12414	35979
% Change	-7.70%	-11.18%	-7.82%	-5.15%	-7.58%

Source - US Census Bureau State and County Quick Facts 2008, Census 2000

It is estimated that the four-county area lost between .1% and 9.9% of its population from 1990 to 2000 (US census- Population Change and Distribution).

2.9.7 Education

Among persons 25 years and over, 79.0 percent of Big Stone County's population has achieved high school or higher educational attainment, for Lac qui Parle County it was 80.8 percent, and for Swift County it was 80.4 percent. This compares to 87.9 percent for the State of Minnesota, and 80.4 percent for the United States (U.S. Census Bureau 2000).

Of Big Stone County's population, approximately 11.4 percent of the adults 25 years and over possess bachelor's degrees or higher, for Lac qui Parle County it was 13.0 percent, and for Swift County it was 14.0 percent. This compares with 27.4 percent for the State of Minnesota and 24.4 percent for the United States (U.S. Census Bureau 2000).

While there is no institution of post-secondary education in Big Stone, Lac qui Parle, or Swift Counties, Minnesota West Community and Technical College is located 26 miles away from Madison in Canby, Minnesota. Ridgewater Community and Technical College is located 30 miles away from Benson with facilities in Hutchinson and Willmar, Minnesota. The University of Minnesota, Morris is an undergraduate liberal arts campus of the University of Minnesota and is located 25 miles away from Benson and 50 miles from Ortonville.

2.9.8 Housing

According to 2000 census figures, there are a total of 3,171 housing units in Big Stone County. There were 2,022 owner-occupied (63.8 percent), 355 renter-occupied (11.2 percent), and 794 (25.0 percent) vacant housing units. The vacancy rate for single-family housing units was 5.3% and 20.4% for rental housing units. The median value of owner-occupied housing units is $41,900. Median rent totaled $231 and the median mortgage is $580.

According to 2000 census figures, there are a total of 3,774 housing units in Lac qui Parle County. There were 2,683 owner-occupied (71.1 percent), 633 renter-occupied (16.8 percent), and 458 (12.1 percent) vacant housing units. The vacancy rate for single-family housing units was 3.6% and 9.7% for rental housing units. The median value of owner-occupied housing units is $43,100. Median rent totaled $348 and the median mortgage is $572.

According to 2000 census figures, there are a total of 4,821 housing units in Swift County. There were 3,353 owner-occupied (69.6 percent), 1,000 renter-occupied (20.7 percent), and 468 (9.7 percent) vacant housing units. The vacancy rate for single-family housing units was 2.6% and 13.1% for rental housing units. The median value of owner-occupied housing units is $58,200. Median rent totaled $362 and the median mortgage is $632.

2.9.9 Recreation

The Minnesota River corridor is rich in history, culture, natural and scenic beauty offering exceptional recreational opportunities for outdoor enthusiasts of all ages. The Marsh Lake project area supports a variety of recreational activities including

Photos by Ron Bolduan

canoeing, kayaking, fishing, hunting, wildlife viewing, boating, bicycling and cross-country skiing.

Improving the area around Marsh Lake improves the recreational connectivity of the upper portion of the Minnesota River corridor—from Big Stone Lake near Ortonville to Marsh Lake to Lac qui Parle Reservoir near Montevideo. This corridor is approximately 47 miles long and includes Lac qui Parle, Swift, Big Stone, and Chippewa Counties with an approximate combined population of 35,979 *(US Census Bureau, 2008 estimates)*.

There are 12 municipalities in the project region of which the cities of Ortonville and Appleton are the largest, about 5,000 people. Tourism dollars provide an important contribution to the local economy but regional recreation opportunities also help to sustain a high quality of life to residents in the area.

	Activities in Minnesota by Residents and Nonresidents	Activities in Minnesota by Nonresidents
Fishing		
Anglers	**1,427,000**	**319,000**
Days of fishing	24,382,000	2,077,000
Average days per angler	17	7
Total expenditures	$2,725,366,000	$466,292,000
Trip-related	$859,657,000	$165,039,000
Equipment and other	$1,865,709,000	$301,253,000
Average per angler	$1,843	$1,462
Average trip expenditure per day	$35	$79
Hunting		
Hunters	**535,000**	**26,000**
Days of hunting	6,492,000	145,000
Average days per hunter	12	6
Total expenditures	$494,149,000	$34,490,000
Trip-related	$166,577,000	$15,197,000
Equipment and other	$327,572,000	$19,293,000
Average per hunter	$889	$1,321
Average trip expenditure per day	$26	$105
Wildlife Watching		
Total wildlife-watching participants	**2,093,000**	**146,000**
Away-from-home participants	641,000	146,000
Around-the-home participants	1,908,000	(X)
Days of participation away from home	8,040,000	625,000
Average days of participation away from home	13	4
Total expenditures	$698,889,000	$119,593,000
Trip-related	$271,493,000	$103,313,000
Equipment and other	$427,396,000	$16,280,000
Average per participant	$330	$784
Average trip expenditure per day	$34	$165

(X) Not applicable.

**2006 National Survey of Fishing, Hunting and Wildlife Associated Recreation – Minnesota. U.S. Fish & Wildlife Service*

<u>Fishing</u>

Most angling on Marsh Lake occurs through the ice in winter and in the spring. Anglers primarily fish for walleye and northern pike. Winter creel surveys were conducted by the Minnesota DNR in 2002 and 2004. Anglers and spear-fishermen (for northern pike) spent an estimated 2112 hours in the winter of 2002 to catch 531 fish of which most were yellow perch and walleye and 22 were northern pike. During the winter of 2004, anglers spent an estimated 1681 hours to catch 229 walleye and yellow perch. No northern pike were observed caught.

Lac qui Parle supports a popular sport fishery, primarily for walleyes and northern pike. Angler effort has varied over the years, mostly due to weather, lake level and fish abundance (Table 2-12).

Table 2-12. Lac qui Parle Sport Fishing (Minnesota DNR data).

Date	Open water angler hours (one SE)	Ice angler hours (one SE)[c]	Number of fish harvested (one SE)	Pounds of fish harvested (two SE)	Non-fishing recreation hours (one SE)[b]
May 13-Oct. 24, 1989	100,734 (7,869)[a]		21,302 (1,060)[a]	31,617 (1,822)	2,932
Dec. 9, 1989-Feb. 15, 1990	165 (74)[a]	38,814	2,226	5,872	
May 14-Oct. 31, 1994	75,285 (16,543)[a]		18,016 (7,059)[a]	25,649	
Dec. 1, 1994-Feb. 19, 1995		73,618 (17,356)[a]	16,706 (6,752)[a]	23,621	
May 13-Oct. 31, 1995	81,787 (8,684)		22,449 (4,157)	40,819	58 (35)
Dec. 1, 1995-Feb. 18, 1996		40,054 (6,962)	3,813 (948)	5,210	
May 12-Oct. 31, 2001	59,871 (5,999)		9,070 (1,062)	18,025	1,951 (399)
Dec. 1, 2001-Feb. 17, 2002		28,493 (3,391)	1,951 (319)	3,551	
May 10-Oct. 31, 2003	56,565 (5,615)		6,577 (717)	11,026	1,742 (332)
Dec. 1, 2003-Feb. 15, 2004		30,872 (5,385)	2,451 (691)	4,471	

[a]Measure of variability was calculated as two standard errors.
[b]Non-fishing recreation activities consisted of swimming, water-skiing, canoeing, pleasure boating, sailing, jet skiing, and waterfowl hunting.
[c]Ice fishing estimates include spearers.

<u>Hunting</u>

Minnesota wildlife management areas are used for public hunting, trapping, fishing, wildlife viewing and other activities compatible with wildlife and fish management. Hunting has always accounted for the largest share of public use on the Lac qui Parle Wildlife Management Area, but the area is also used for fishing, wildlife viewing, cooperative farming, cooperative grazing and haying, rough fish harvest and environmental education.

The Lac qui Parle area is considered a “major destination point” for wildlife related activities due to the area’s large public land-base and proximity to the Twin Cities metropolitan area. Beyond Canada goose hunting, the economic impact of wildlife related recreation has not been measured for the Lac qui Parle Wildlife Management Area specifically.

The U.S. Fish and Wildlife Service (2005) estimated Waterfowl Production Areas in Minnesota generated $19.8 million in spending by all visitors in 2004. The Morris Wetland Management District, which includes counties in the Upper Minnesota River Valley, generated the most spending by waterfowl hunters in the state at $8.7 million. In 2001, Minnesota ranked first in the nation for the number of waterfowl hunters, generating an economic impact of $132.5 million for the state of Minnesota (Henderson 2005). In 2006, 87.5 million U.S. residents 16 years old and older participated in wildlife-related recreation. During that year, 30.0 million people fished, 12.5 million hunted, and 71.1 million participated in wildlife viewing spending an estimated $122.3 billion on their activities (U.S. Department of Interior 2006).

Hunters pursue various wildlife species at Lac qui Parle. Foremost are Canada geese, waterfowl, deer, and pheasants. The pursuit of rabbits, squirrels, turkeys, and furbearers also provides important recreational opportunity.

Visitor-use records spanning an entire hunting season do not exist, except for Canada goose hunters. The visitor information for ducks and pheasants is for opening day only on the Lac qui Parle Wildlife Management Area. Deer hunting estimates are taken from MN-DNR 2006 Deer Harvest Report.

<u>Canada Goose Hunting</u> - The Lac qui Parle Wildlife Management Area lies within Minnesota's West Central Goose Zone. For a five-year period (1990-1994) all goose hunters in the West Central Goose Zone were required to purchase a permit before hunting. A postseason survey of randomly selected permit holders was then conducted to determine Canada goose harvest, hunter activity, and success. In addition, hunters using state blinds at the Lac qui Parle Refuge are required to register in person to use a blind, and report their success at the completion of their hunt. Based on the West Central Goose Zone survey in 1994, it was determined that 11,121 persons spent a total of 60,581 hunter-use days pursuing Canada geese. The state blinds accounted for 4,271 hunters-use days – an average of 142 hunters/day. Of the state blind hunters, 603 were under 18 years of age. Most hunters (39.1%) were from the southern portion of Minnesota, with 22.5% from the Twin Cities and 10.7% from the West Central Goose Zone.

The total economic value of the goose hunt was estimated at $2.2 million in 1985 with over half the goose hunter expenditures ($1.2 million) being made in the local area (Hiller & Kelly 1987). Private land hunters paid nearly $410,000 to property owners for hunting privileges that same year. It is important to note that the above figures are based on an estimate of 5,446 hunters or 30,546 goose-hunting days in the Lac qui Parle Zone. From the 1990-94 West Central Goose Zone permit, it was determined that 7,500-10,600 hunters spend 30,500-43,200 goose-hunting days in the Lac qui Parle Goose Zone. Based on permit data, it appears the 1987 report, although the numbers are substantial, underestimated the economic impact of the goose hunt.

Duck Hunting - Marsh Lake is the focal point for duck hunting, especially the western half (motorized zone). From 1997-2006, the opening day car count has averaged 183 vehicles or an estimated 371 hunters. The peak opening day car count occurred in 1998 with 262 vehicles for an estimated 547 hunters. Hunting pressure remains heavy on the weekends throughout the waterfowl season, but is light to moderate during the week. Eighty percent of the opening day duck hunters were from the Twin Cities metropolitan area.

Pheasant Hunting - From 1998-2007, the opening day car count has averaged 166 vehicles for an estimated 352 hunters. The peak opening day car count occurred in 2006 with 254 vehicles for an estimated 519 hunters. Sixty percent of the opening day pheasant hunters were from the Twin Cities metropolitan area.

Deer Hunting - The Lac qui Parle Wildlife Management Area lies within Permit Area 433, which is 402 square miles in size. In 2006, 2,526 firearm hunters were estimated to have hunted in Permit Area 433 for 6.3 hunters per square mile. Although not specifically measured, wildlife personnel believe much of this pressure occurred between the Lac qui Parle Wildlife Management Area and Big Stone National Wildlife Refuge. This hunter density estimate is slightly higher than the statewide average of 5.6 hunters per square mile. Hunter density estimates do not exist for archery or muzzleloader hunters but we do know archery and muzzleloader hunters harvested 108 and 229 deer, respectively, in 2006.

Trapping - Trappers are required to receive a trapping permit from the resident manager, and provide an annual harvest report. Fur prices are the driving force behind trapper numbers and for the past 3 years trapping permits have ranged from 7 to 15. This is down from an average of 26 trapping permits, 1965-75.

Wildlife Viewing - No estimate has been made for wildlife viewing visitation rates. These activities are year-round, dispersed, and very difficult to monitor. In 2006, an estimated 1.9 million Minnesota residents 16 years and older, or 48% of the total population, took part in wildlife-watching activities spending $698 million on equipment and trip related expenses within Minnesota (U.S. Department of Interior 2006).

The upper Minnesota River Valley is a popular destination for wildlife watchers because of the abundance and diversity of wildlife that can be seen. A number of specific sites provide wildlife viewing opportunities. The Lac qui Parle Management Area and the Marsh Lake Dam site are popular wildlife viewing areas located within the geographic scope of the study. Wetland and prairie species can be observed in the Lac qui Parle Wildlife Management Area. A diversity of migratory waterfowl can be observed in the fall. The Marsh Lake Dam is a popular spot for birdwatching.

There are other sites that provide wildlife viewing opportunities within the Minnesota River corridor in Big Stone, Swift, Lac qui Parle and Chippewa counties. The Minnesota River Valley Birding Trail maps existing roads, paths and bike trails to link 132 birding sites within the Minnesota River Watershed. Recommended routes and sites are mapped for birders to follow. A variety of wildlife including, prairie chickens, upland sandpipers, and marbled godwits can be observed at Plover Prairie, a 655 acre wet prairie owned by The Nature Conservancy. The 1,143 acre Chippewa Prairie is a mesic prairie. Some species that can be observed here include migrating flocks of geese, ducks, sandpipers, godwits and other shorebirds; upland sandpiper, short-earred owl, and marbled godwit.

Wildlife watching is one of the most popular activities at the Big Stone National Wildlife Refuge. Seventeen species of ducks and 23 species of shorebirds can be observed during spring and fall. Mallards, blue-winged teal, northern shoveler, and Canada geese can be seen. Shorebirds include least and semipalmated sandpipers, and lesser yellow legs. It is also home to a diversity of seasonal, resident wildlife including great-blue heron, common egrets, and several species of ducks. A population of reintroduced river otters can be observed. The refuge serves as an important wintering area for white-tailed deer. In 2006, an estimated 22,050 visits were for wildlife watching and 14,300 visits in 2007. Visits were lower in 2007 due to the fact the auto tour loop was closed, which is a primary facility that visitors use to view wildlife.

<u>Boating</u>

The boating resources are Big Stone Lake, Marsh Lake, and Lac qui Parle. The vast majority of the boating activity in the area is associated with hunting and angling. There are 5 boat accesses within the geographic scope of the project. A 2007 visitation estimate recorded by the Corps of Engineers for Boyd Landing on Marsh Lake was 1,800.

<u>Canoeing</u>

The Minnesota River is designated as a Canoe and Boating route between Ortonville and Fort Snelling. The Pomme de Terre River, tributary of the Minnesota River, is also a designated Canoe and Boating Route. The Department of Natural Resources publishes canoe maps with descriptions of river segments, location of public access points, campsites, rest areas, navigational features and river miles.

The Minnesota River, Marsh Lake and Lac qui Parle are located within the geographic scope of this project and are a segment of the designated canoe route. Approximately five miles of the Pomme de Terre Canoe Route is also within the geographic scope of this project. Within the geographic scope of the project there are five canoe accesses on the Minnesota River and Marsh Lake and one on the Pomme de Terre. There are no use estimates for canoeing.

Hiking/Bicycling Trails

While there are no existing bicycle trails within the geographic scope of the project, there are several existing bicycle trails within the Minnesota River Valley corridor in Big Stone, Lac qui Parle and Swift Counties. The Marsh Lake area holds the potential to be integrated into a broad regional network of existing natural areas, recreational opportunities, and educational amenities through links between present and future trail systems.

Nearby Natural Areas with Recreational Opportunities

- Big Stone National Wildlife Refuge
- Big Stone State Park
- Lac qui Parle WMA
- Lac qui Parle State Park
- Lac qui Parle County Park
- Plover Prairie Preserve
- Fort Renville State Historic Park
- Upper Sioux Agency State Park

Present (P) and Future (F) Trail Systems

- MN State Bike Trail System (P, F)
- MN River Canoe Trail (P)
- National Scenic Byways MN River Valley Auto Tour (P)
- Audubon Society MN River Valley Birding Trail (P)
- Appleton Community Bike Trail (P)
- Watchable Wildlife Sites (P)
- Historic/Cultural/Heritage Trail (F)

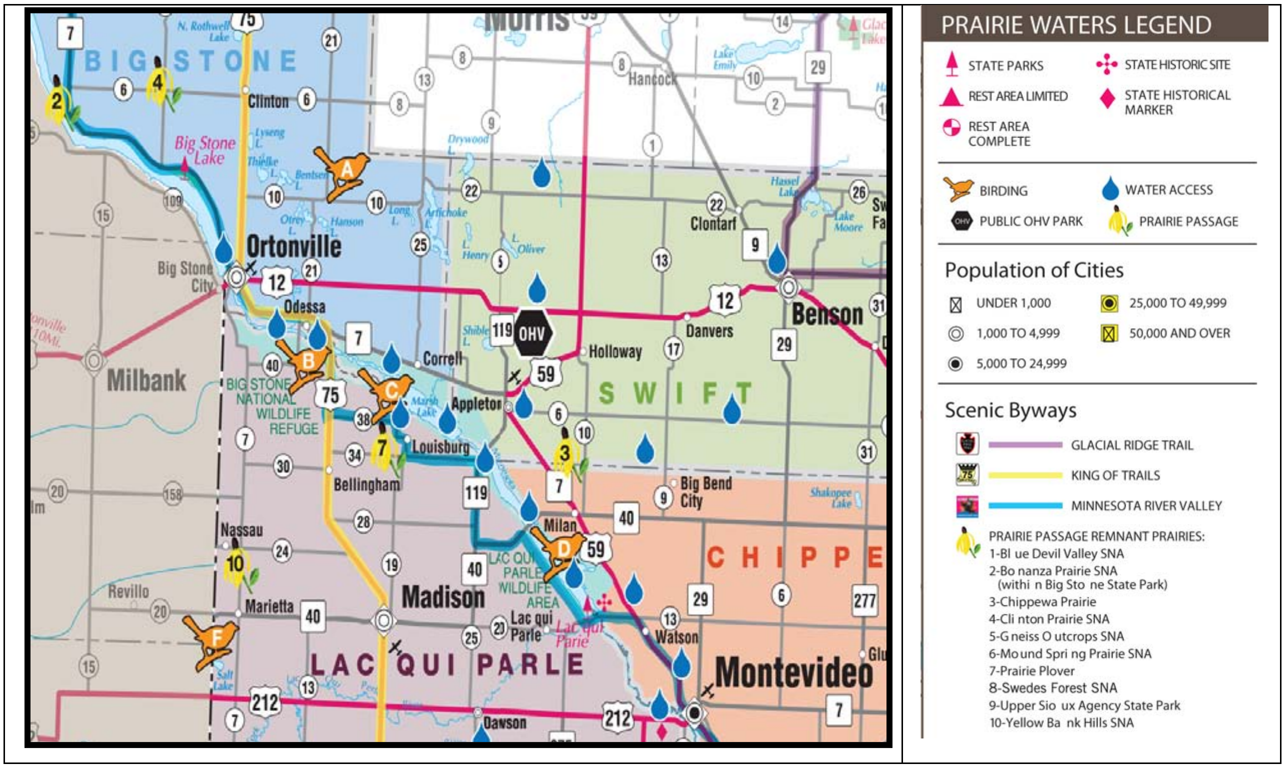


Figure 2-24. Official Trails and recreational opportunities in the project area.

Various area trails include:

<u>Milan to Milan Beach</u>

This 3 mile paved trail connects Milan Beach Resort on Lac qui Parle to Milan. It is envisioned that in the future, this segment would be part of the Minnesota River State Trail. There are no use statistics available for this trail.

Appleton community trail system

A 1.5 mile paved trail starts at Riverside Park and follows the banks of the mill pond, past the Appleton Athletic Field, hospital and nursing home and assisted living complex on the east end of town and connects back into town west to TH 7 via Reuss Avenue.

County 32 adjacent to Lac qui Parle State Park

Paved shoulders along County 32 connect the upper and lower portions of the park and can be used for biking.

Ortonville to Big Stone National Wildlife Refuge

A segment of the legislatively authorized Minnesota River State Trail was completed in the spring of 2008. This trail begins at the ouitlet of Big Stone Lake and travels through the southern part of Ortonville. It crosses the Minnesota River and exits the community in the southeastern corner. The trail parallels TH 75 until it connects with the Big Stone Refuge's 5.5 mile auto tour route.

There are no use estimates available for these bicycle trails, which are also used for hiking and skiing.

Cross-country Skiing

There are no groomed cross-country ski trails within the geographic scope of this project. However there are some trails within the Minnesota River Valley Corridor in Big Stone, Swift, and Lac qui Parle counties. Cross-country skiing is allowed in the Big Stone National Wildlife Refuge, although no trails are designated and managed for this use. Lac qui Parle State Park has 5 miles of cross-country ski trails.

Horseback Riding

Lac qui Parle State Park has 5 miles of horseback riding trails. Lac qui Parle County Park has horseback riding trails.

Snowmobiling

There are 460 miles of Grant In Aide snowmobile trails in Big Stone (122 miles), Lac qui Parle (184), and Swift (154) Counties. These trails are developed and maintained by local snowmobile clubs with the support of grants provided by Minnesota DNR through the local unit of government.

Off highway vehicle riding

The Appleton Off-Highway Vehicle Area provides recreation opportunities for off-highway vehicle riders. There are 10 miles of off-road vehicle trails, 15 miles of all terrain vehicle/off-highway motorcycle trails, 1.5 miles of off-highway motorcycle tracks and 3 enduro tracks.

Visiting Historic Sites

The history of the area also attracts recreationists to the area. Three significant sites visited are:

Fort Renville Site – location of Joseph Renville's fur trading post established in 1822 at a Wahpeton Dakota village

Lac qui Parle Mission State Historic Site

Big Stone County Museum -- displays from the area's past including a historic boat that traveled Big Stone Lake.

Recreation User Data

Use data for the recreational activities described above is limited. Several recreational facilities keep visitor data that serve as an indicator of the recreational activity in the area of the project. Data from Big Stone National Wildlife Refuge, Big Stone and Lac qui Parle state parks, and Corps of Engineers is displayed in Tables 2- 13 through 2-16.

Table 2-13. Lac qui Parle State Park attendance history.

Year	Total Attendance	Overnight Visits
2006	115,525	7,697
2005	111,835	7,678
2004	64,610	5,900
2003	69,426	5,477
2002	71,600	5,638
2001	48,786	2,998
2000	71,396	6,169
1999	68,965	5,908
1998	64,273	5,623
1997	71,942	3,765

Table 2-14. Big Stone Lake State Park attendance history

Year	Total Attendance	Overnight Visits
2006	53,663	3,266
2005	55707	3,531
2004	52,946	2,933
2003	52,444	2,870
2002	32,545	2,832
2001	29,079	3,188
2000	35,268	3,261
1999	36,559	3,730
1998	33,748	3,335
1997	28,581	3,432

Table 2-15. Big Stone National Wildlife Refuge user data

Activity	**2006 Visits**
Hunting	3,000
Fishing	1,000
Wildlife observation	22,050
Photography	150
Environmental Education	270
Interpretive programs	800
Other	1,450

Activity	**2007 Visits**
Hunting	2,700
Fishing	1,000
Wildlife Observation	14,300
Photography	150
Environmental Education	180
Interpretive Programs	1,350
Other	1,450

Table 2-16. Visitation data for the Marsh Lake Dam Recreation Area in 2009.

	Visitor Hours	Visitors
Sep 09	2037	1818
Aug 09	3231	2885
July 09	1144	1022
June 09	1529	1365
May 09	2334	2084
Apr 09	1115	995
Mar 09	930	578
Feb 09	205	183
Jan 09	626	559
Dec 08	666	595
Nov 08	1542	1049
Oct 08	2314	1574
FY Total	17673	14707

The Corps of Engineers maintains a recreation area at Marsh Lake Dam consisting of a parking area, picnic tables, rest rooms and a fishing platform.

Minnesota River State Trail

The Marsh Lake Dam is a vital connection for the alignment of the Minnesota River State Trail. The Minnesota River State Trail is a legislatively authorized state trail that will connect Big Stone Lake State Park to Le Sueur (Minnesota Statutes, Chapter 85.015, Subd. 22). The Draft Master Plan for the Minnesota River State Trail identifies a corridor that parallels Marsh Lake and the Lac qui Parle Management Area on the south, veering north at the location of the Marsh Lake Dam to connect into Appleton. The best alternative for crossing the river north into Appleton is the Marsh Lake Dam, due to the constraints of surrounding land ownership patterns and geography. In addition to providing an opportunity for a trail alignment, a crossing at this location also provides trail users access to the natural and cultural resources at this location.

2.10 Future Conditions Without an Ecosystem Restoration Project

The forecasted future conditions provide a baseline by which alternative plans are evaluated. The planning period of analysis for this project is 50 years and for the purposes of this report, the base year is defined as the year of proposed project completion, scheduled in 2014. Implementation of ecosystem improvements within the Marsh Lake project area by others was considered as a part of the future conditions, however, no known plans exist which would significantly alter future conditions from the assessment below.

2.10.1 Future Social and Economic Conditions

From 1990 to 2000, the population of the study area decreased by up to 10%. From 2000 to 2008 the study area lost 7.58% of its population. The most likely explanation for the overall decline in population in the study area is migration from rural to urban communities. This trend will presumably persist to some degree in the coming years as nearby metropolitan areas such as the Twin Cities and Fargo-Moorhead continue to draw rural populations.

2.10.2 Future Land Use and Land Cover

Terrestrial land use and vegetative cover on private land in the project area is expected to remain much in its present condition, dominated by annual row-crop agriculture, primarily corn and soybeans. The land use within the Minnesota River Watershed upstream of the project site is over 90% agricultural. The productivity of Minnesota agriculture is highly dependent on the hydrologic alteration that permits drainage of agricultural lands to maintain ideal agronomic growing conditions. While much of the drainage system within the basin was completed over the last 100 years, drainage improvements continue today. Professional experience within the basin and work with agriculture experts on the Minnesota River Integrated Watershed Study has shown that drainage improvements are on-going. These alterations have a substantial effect on the hydrology of the watershed and are often performed at a large scale._Future watershed change based on the amount of perennial cover on the landscape will depend on national Farm Bill policy. Provided the Conservation Reserve Program is reauthorized, and a market for perennial-based biomass emerges, it is possible the amount of perennial cover (e.g., native warm season grasses) on private land may increase. For the purposes of this Feasibility Study, however, existing land use is assumed to remain dominated by row crop agricultural.

That portion of the project area located on the state-owned Lac qui Parle Wildlife Management Area will continue to be managed to provide diverse wildlife habitats, healthy wildlife populations, and outdoor recreation. Land cover is diverse: open water, emergent wetlands, grassland, pasture and hayland, agricultural cropland, and deciduous floodplain forests. No major changes in land cover are anticipated.

As recommended by the Minnesota River Reconnaissance Study, a Minnesota River Integrated Watershed Study is currently being conducted by the Corps in conjunction with State and Federal study partners. This study will examine the root of problems related to hydrology, sediment transport, nutrient loading and flooding throughout the basin and recommend comprehensive solutions for implementation. The study is currently in its initial stages and it is not possible at this time to speculate how the outcome of this study may impact future watershed conditions. The Integrated Watershed Study is scheduled to be completed in 2015.

2.10.3 Future Hydrology

Climate change is expected to cause hotter, dryer summers and warmer winters in western Minnesota (Union of Concerned Scientists 2009). Climate change is forecast to result in shorter duration of ice cover, less snow, higher winter river discharge, more intense summer thunderstorm events, hotter summer temperatures, and generally more variable hydrology in the upper Minnesota River Basin. Inflows to Marsh Lake will probably decline and summer lake stages may be lower. Climate change is expected to bring about more extreme precipitation events, leading to larger floods and longer droughts.

2.10.4 Future Hydraulic Condition of Marsh Lake and Pomme de Terre River and Lac Qui Parle

The delta at the mouth of the Pomme de Terre River in Marsh Lake is expected to increase in area with time. Wind-driven sediment resuspension in Marsh Lake should maintain the same approximate geometry and volume of the lake, balanced between sediment inflows and export. The former channel of the Pomme de Terre River that was re-routed when the Marsh Lake Dam was constructed will probably accumulate sediment and rise slightly in elevation over time. Sediment from Marsh Lake will continue to accumulate in Lac qui Parle, primarily in the upper end of the lake.

The Marsh Lake Dam will continue to be operated over time as with passive discharge, in the same manner it is today. Recreational activity around the dam does pose a risk to public safety, as evidenced by a drowning death at the site in 1991.

The dam will continue to provide a conservation pool for boaters, which does provide a recreational benefit at the site. In its current condition, however, the dam provides little flood damage reduction benefit to downstream communities. Hydraulic modeling of the river shows that the dam itself is partially inundated with a 1% chance flood event (947.4’). The consequences of failure at Marsh Lake Dam are relatively minor as it lies above the Lac qui Parle Reservoir, which contains more storage than Marsh Lake. A flowage easement up to elevation 945 exists for the Lac qui Parle Reservoir, and there is no population below that elevation. Detailed modeling results are provided in Appendix J of this report.

2.10.5 Future Ecosystem State

Emergent aquatic plants have declined to a limited band of hybrid cattails, sparse river bulrush and dense reed canary grass on the periphery of Marsh Lake. This extent of emergent aquatic plants is expected to continue in the future, covering approximately 1032 acres as in 1999 (Figure 2-18 above).

In rare years when conditions allow, such as occurred in 1991, submersed aquatic vegetation can grow in Marsh Lake. In most years however, water levels and turbid conditions caused by wind-driven sediment resuspension and by carp will prevent growth of submersed aquatic plants. The abundant carp in Marsh Lake will also graze back submersed aquatic plants. The frequency of occurrence of submersed aquatic plants in Marsh Lake is expected to be less than 15 percent as was found in the 2007 survey (Table 2-7).

Biomass of the most abundant submersed aquatic plant, Sago pondweed, is expected to remain low and therefore existing and without-project future conditions are assumed to be equivalent. Application of a wind fetch model (Rohweder et al. 2008) and a bioenergetics plant growth model, POTAM for sago pondweed (Best and Boyd 2003) provided an estimate of existing and future without-project sago pondweed shoot and tuber biomass production in Marsh Lake (Appendix J, Table 2-17).

Table 2-17. Simulated production of sago pondweed in Marsh Lake under existing and without-project future conditions (existing and future-without assumed to be equivalent).

Depth Class (m)	Average Wind Fetch (m)	Area in Depth Class (acres)	Peak Biomass (lb/ac)		Lakewide Peak Biommass (Tons)	
			Shoots	Tubers	Shoots	Tubers
0.5 (0 - 0.75)	751	1364	1071	204	731	139
1 (0.75 - 1.25)	1371	2541	840	173	1067	220
1.5 (1.25 - 1.75)	1430	502	371	171	93	43
				Total	1891	401

Vegetation in the abandoned channel area of the Pomme de Terre River downstream of the Marsh Lake Dam is expected to shift toward flood-tolerant woody vegetation as sediment accumulates there, including sandbar willow, black willow, cottonwood and silver maple.

Conditions of the Lac qui Parle ecosystem are not expected to change in the future. It is assumed the Lac qui Parle pool is similar in ecosystem condition to that of Marsh Lake with high susceptibility to wind and wave driven sediment resuspension resulting in a turbid environment with low levels of submersed aquatic vegetation.

2.10.6 Future Water Quality

Climate change will probably result in less ice cover, better winter dissolved oxygen concentrations and warmer summer water temperatures. Continued row crop agriculture and further expansion of the agricultural drainage network in the watershed will cause the future hydrologic regime to become flashier with more rapid increases in tributary discharge during runoff events. Loadings of sediment and plant nutrients to Marsh Lake are expected to remain the same or increase.

If a change in the agricultural economy and associated land use shifts toward increased perennial cover crops, infiltration of water on the land would increase and loadings of sediment, nitrogen and phosphorus would be significantly reduced, leading to improved water quality conditions in the project area.

Without restoration, Marsh Lake is expected to continue to accumulate sediment that is later transported via the Minnesota River to Lac qui Parle Lake during wind-driven resuspension events. Low primary production will continue because of high turbidity and a lack of aquatic plants.

2.10.7 Future Fish Community

The expected future water quality conditions described above are conducive to fish communities dominated by non-native fish, primarily common carp and freshwater drum. The absence of submersed aquatic plants will continue to limit spawning success and juvenile growth of northern pike and other native fish. Low numbers of large predatory fish will allow non-native species, especially common carp, to remain abundant. In addition, the lack of sufficient resources from primary production and larger sized zooplankton will continue to limit the survival of young-of-year native fish.

Without restoration of the Pomme de Terre River and fish passage through Marsh Lake Dam, fish habitat will continue to be fragmented. Native fish from Lac qui Parle such as walleye and northern pike will continue to be excluded from the Pomme de Terre River and its high-quality spawning habitat. Likewise, fish from the Pomme de Terre River will continue to be excluded from the winter refugia in the Minnesota River and Lac qui Parle.

Overall, without restoration of the Marsh Lake ecosystem, the future fish community will consist primarily of non-game species that are expected to maintain or increase in abundance. However, conditions will continue to be less favorable for popular game fish species, and their abundance will stay the same or decline. The result will be a declining fishery resource that is unattractive and undesirable to users of the area.

2.10.8 Future Wildlife

Without restoration, Marsh Lake will continue to exist in its turbid water state. Emergent vegetation will be dominated by a narrow band of hybrid cattail with reed canary grass on the periphery. Submersed vegetation will consist of only one species, sago pondweed, and in most years be limited to a few plants (<15% frequency of occurrence) found in sheltered bays. Overall future aquatic vegetation in Marsh Lake will provide only limited food and cover for wildlife.

Waterfowl numbers are expected to remain low. In certain years field-feeding mallard and Canada goose numbers will be impressive, but their numbers are related to the security the lake provides for resting and not the waterfowl food present. Most species of waterfowl, especially diving ducks, will pass through quickly spending at most a day or two on the lake. This rapid turn-over in numbers is directly related to the lack of waterfowl foods, primarily sago pondweed, low species diversity in the perennial emergent zone and few annual emergent aquatic plants due to static water levels.

Colonial waterbird numbers and diversity are expected to remain stable. Long term population fluctuations are more related to region-wide environmental conditions, meta-population dynamics, and not conditions in the lake itself. American pelicans, cormorants, and gulls are attracted to Marsh Lake due to lack of human disturbance and the security of the nesting islands, not water quality. Western grebes previously nested on Marsh Lake but have been absent in recent years. Without restoration, it is doubtful western grebes will return to Marsh Lake.

Shorebird numbers are expected to remain very low. Shorebird numbers and food availability are directly related to the quantity and quality of available mud flat habitats. Climate change may result in hotter, dryer summers, lower lake stages and hence mud flats, but extreme precipitation events will most likely negate this potential benefit for shorebirds. Agricultural drainage is expected to continue in the watershed and will result in the hydrologic regime to become even flashier with increased episodic tributary inflows. Without restoration, mud flat conditions are expected to be rare and confined to only those years of extreme drought throughout the growing season.

Furbearer numbers are expected to remain similar with no major changes in species composition. Furbearer numbers fluctuate based on broad environmental conditions, disease, and in-lake water levels fluctuations. For example, successive years of stable water levels allow muskrat numbers to increase with a corresponding increase in mink numbers a few years later (predator prey relationship). Conversely, widely fluctuating water levels should result in a gradual decline in muskrat and hence mink numbers in the Marsh Lake basin. Climate change complicates these relationships but again no major population changes expected.

2.11 Planning Assumptions

Planning assumptions underlie the logic of the planning process. Although these states of nature and anticipated human activities are not certain, they are assumed to apply in the future:

1. The Lac qui Parle Flood Control Project (including the Marsh Lake Dam) will continue to be operated and maintained by the Corps of Engineers for the foreseeable future.

2. The hydrologic regime of the Minnesota and Pomme de Terre Rivers will remain within historic seasonal ranges of flow.

3. The Lac qui Parle Wildlife Management Area will continue to be maintained and managed by the DNR.

4. The beneficial uses of the Marsh Lake ecosystem (flood damage reduction, fish and wildlife management, recreation) will continue to provide benefit to the public.

5. The value of flood damage reduction to downstream urban and agricultural areas will continue or increase in the future.

6. Loss of habitat over time within the watershed will increase the value of Marsh Lake and Lac qui Parle as a protected area for wildlife.

7. The value of the project area for recreation and frequency of use is expected to be maintained over time.

3. Problems and Opportunities

One of the critical steps in the initial planning process is the identification of problems and opportunities associated within the geographic scope of the project area. Problem statements are concise characterizations of the broad issue that will be addressed with the project. Opportunity statements follow each problem and consist of an array of opportunities presented by the virtue of planning and construction activities occurring at the site of the problem. Opportunities can be directly related to solving the problem at hand, but can also be ancillary to the identified problem. From the list of opportunities, objectives for the project are drafted. The success of the project planning is determined by the fulfillment of the objectives through identified alternative measures (Sections 4-Section 6).

Because ecosystem restoration authority is the guiding authority for the Marsh Lake Ecosystem Restoration Project, objectives drafted for this study are primarily related to ecosystem outputs. As noted in the preceding Sections, construction of the Marsh Lake Dam in 1939 inundated natural floodplain habitats, increased reservoir fish and wildlife habitat and created new colonial water bird nesting habitat by creating islands. However, it also disrupted natural river functions and processes, affecting sediment movement and floodplain function, blocking fish movements, and reducing river and floodplain habitats. Natural flooding and drying cycles were disrupted, reducing emergent aquatic plants and associated fish and wildlife habitats found in the area prior to the impoundment. Taking the existing and forecasted future conditions into consideration, the following problems were identified:

- Degraded Marsh Lake Ecosystem State
- Low-Diversity Fish Community
- Degraded Pomme de Terre River Ecosystem State

Each problem is elaborated upon in the sections below.

3.1 Problem: Degraded Marsh Lake Ecosystem State

Marsh Lake has been subject to long-term degradation. Rapid delivery of water, sediment, and nutrients into the system due to land use changes in the watershed led to higher and faster fluctuations in water levels and degraded water quality. The current degraded ecosystem state is primarily influenced by the following stressors:

- Altered hydrologic regime
- Sediment loading
- Sediment resuspension
- Invasive species
- Loss of ecosystem connectivity

The sedimentation rate over the last 60 years has been estimated at approximately 60 acre-feet (97,000 cubic yards) per year from both the Minnesota and Pomme de Terre Rivers. The lake appears to have reached equilibrium with sediment loading and export to Lac qui Parle. Wind and wave action resuspends sediments that have accumulated in the reservoir. The suspended sediment blocks sunlight and limits the growth of aquatic plants, which affects the quality of fish and wildlife habitat. Much of the resuspended material and associated phosphorus passes downstream where it affects water quality and promotes algal growth in Lac qui Parle. Carp thrive in the lake, grazing on aquatic vegetation, resuspending sediment and further degrading habitat for other fish and wildlife.

The lack of aquatic plants has limited food available for migrating waterfowl. Over time, the lake has developed into a shallow, turbid unvegetated ecosystem state, and its habitat quality has declined.

After spring runoff, water levels remain relatively stable due to the dam’s fixed-crest design. The lake is very shallow, with more than 3,000 of its 5,000 acres less than 3 feet deep when the lake is at the spillway elevation. Lake levels tend to fluctuate between 938 and 942 in normal conditions however due to hydrologic alteration in the watershed, peak stages tend to consist of short-duration, flashy peaks followed by stabilization of pool elevation at the crest elevation of 937.6'. As evidenced by the 20-year period of record (Figure 2-6), the lake seldom drops below the spillway crest elevation of 937.6' for substantial periods of time. This regime is in stark contrast to natural riverine conditions which fluctuated with climate conditions and allowed for periodic drought and low water conditions in the lake prior to impoundment. Emergent aquatic plants require dewatered mud flat conditions to germinate from seed. Stable growing season water levels have prevented re-establishment of emergent aquatic plants in Marsh Lake.

Opportunity: Restore Marsh Lake Aquatic Ecosystem Processes and Connectivity

A key to restoring freshwater aquatic ecosystems is restoring a more natural hydrologic regime. On a river lake like Marsh Lake, a more natural hydrologic regime includes lower lake levels in some years to enable aquatic vegetation to re-establish. Growing season drawdowns to naturalize the hydrologic regime of shallow lakes and reservoirs have been conducted on Upper Mississippi River Pools 5, 8, 13, 24, 25, and 26, on Mud Lake at the Lake Traverse Flood Control Project on the Bois de Sioux River along the Minnesota-South Dakota border, at Swan Lake in south-central Minnesota, and on many other shallow lakes in the region. These drawdowns have resulted in increased extent, diversity, and abundance of aquatic vegetation, increased food for waterfowl, and improved water quality conditions, providing significant ecological benefits. Figure 3-1 illustrates the change in ecosystem state that a growing season drawdown, reduced wind-driven sediment resuspension, and reduced abundance of carp can produce.

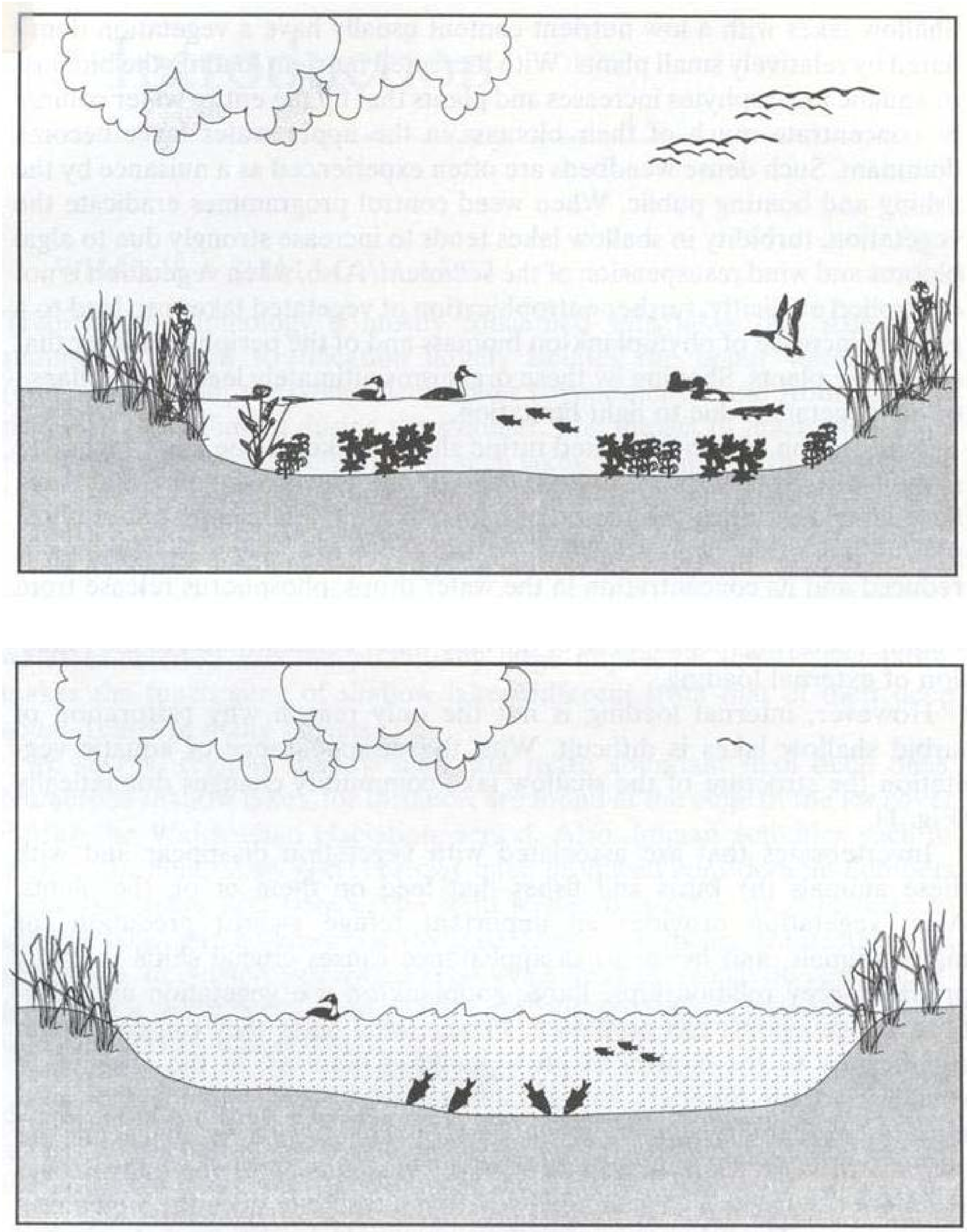


Figure 3-1. Schematic representation of a shallow lake in a vegetation-dominated clear state (upper panel) and in a turbid phytoplankton dominated state (lower panel) in which submersed aquatic plants are largely absent and where bottom-feeding fish and wind-driven waves resuspend the sediments. With permission from Martin Scheffer; (Scheffer 1998).

Low water levels during the growing season can contribute to a shift in ecosystem state of shallow lakes and reservoirs from turbid conditions with dense blue-green algal blooms dominated by plankton and detritus-feeding fish to clearer water condition with aquatic plants and game fish (Sheffer 1998, Strange 2007). Marsh Lake has exhibited such shifts in the past when in some years, lower water levels and ambient turbidity allowed aquatic plants to grow, dampening wave action and sediment resuspension. However, in most years, Marsh Lake has been in the turbid state without much aquatic vegetation (Figure 3-1 bottom panel), and a fish community dominated by common carp.

Opportunity exists to change the ecosystem state of Marsh Lake by naturalizing the water level regime, reducing wind fetch, reducing the abundance of common carp and by restoring aquatic vegetation. This can be done through modifying the dam to allow water level management, constructing islands to reduce wind fetch and by restoring the Pomme de Terre River to its former channel.

Opportunity exists for water level management that would simulate a more natural hydrologic regime through modification of the Marsh Lake Dam, the abandoned fish rearing pond area, and the Louisburg Grade Road culverts.

Marsh Lake has the potential to again be an important migration and feeding stop for many species of migratory waterfowl including ducks, geese, swans and shorebirds. With an increase in water clarity to levels experienced in 1991, Marsh Lake has the potential to grow significantly more sago pondweed tubers (Best and Boyd 2007) that are the preferred food for many waterfowl species during fall migration.

Opportunity: Enhance recreational opportunities in and around Marsh Lake

As noted in Section 2.9.9, Big Stone State Park, Lac qui Parle State Park and the Wildlife Management Area adjacent to Marsh Lake provide numerous opportunities for hunting, angling, active and passive recreation. The opportunity exists to enhance existing recreational opportunities with an ecosystem restoration project through three primary means:

1. Increase connectivity between recreational areas
2. Upgrade existing facilities and create new facilities where needed
3. Provide interpretation and education to visitors to the site

A detailed plan for improvement and enhancement of recreation facilities is included in Section 7.2 and has also been included in the overall cost estimates for the project.

Opportunity: Reduce public safety risks at Marsh Lake Dam

The Marsh Lake Dam has an ogee crest spillway with a strong hydraulic back-roller on the downstream end. Many people visit the Marsh Lake Dam and fish there. A drowning death occurred at the Marsh Lake Dam in July 1991. Alterations to the ogee crest spillway with measures to reduce the slope would eliminate the hydraulic roller and the public safety hazard in the immediate tailwater. The opportunity to address public safety risks is not in and of itself justification for the project, however, consideration towards addressing and minimizing the public safety risks is an opportunity presented if ecosystem restoration features are to be implemented at the site.

3.2 Problem: Low-Diversity Fish Community

The fish community in Marsh Lake is dominated by non-native common carp. Over two thirds of the biomass of fish in Marsh Lake is carp. Native game fishes like yellow perch, walleye, white bass, black crappies, and northern pike occur but in relatively low abundance.

Carp exacerbate the turbidity problem in Marsh Lake by bioturbation of sediment. Carp graze submersed aquatic plants, helping maintain an unvegetated and turbid ecosystem state in the lake.

Winter conditions in Marsh Lake favor carp. Water from the Pomme de Terre River maintains an oxygen refugia for carp during the winter. Northern pike are more tolerant of low dissolved oxygen than are carp. The fish community in the Pomme de Terre River is limited by access to suitable winter habitat in Lac qui Parle.

Diversion of the Pomme de Terre River has blocked fish migrations between Lac qui Parle and the Pomme de Terre River. Because Marsh Lake is shallow and has low winter dissolved oxygen conditions, fish in the Pomme de Terre River are denied access to suitable winter habitat.

Walleye and northern pike in Lac qui Parle do not have access to high quality spawning habitat because their historic migration pathways to Marsh Lake and the Pomme de Terre River have been blocked by the Marsh Lake Dam.

Opportunity: Restore the Native Fish Community

Opportunity exists to restore the native fish community by changing the ecosystem state of Marsh Lake toward a condition with clearer water and more aquatic plants. This would favor native fishes over the non-native common carp. Increased abundance of northern pike and walleyes in Marsh Lake would increase predation on common carp, contributing to improved water quality conditions.

Restoring the Pomme de Terre River to its former channel would provide walleyes and white suckers from Lac qui Parle access to rock and gravel spawning habitat in the Pomme de Terre River, eliminate the winter oxygen refugia for carp in Marsh Lake, reduce their abundance through winterkill, and would favor northern pike. Fish from the Pomme de Terre River would have access to suitable winter habitat in Lac qui Parle.

Restoring connectivity at the Marsh Lake Dam would enable fish from Lac qui Parle to migrate to high quality spawning areas (Figure 3-2). Northern pike would make use of the extensive marshes in upper Marsh Lake, and walleyes would migrate up the Pomme de Terre River to spawning areas with rock and gravel substrate. Restoring connectivity of habitats in river systems has been shown to be effective in increasing the abundance and spatial distribution of many species of native fishes (Hart et al. 2002).

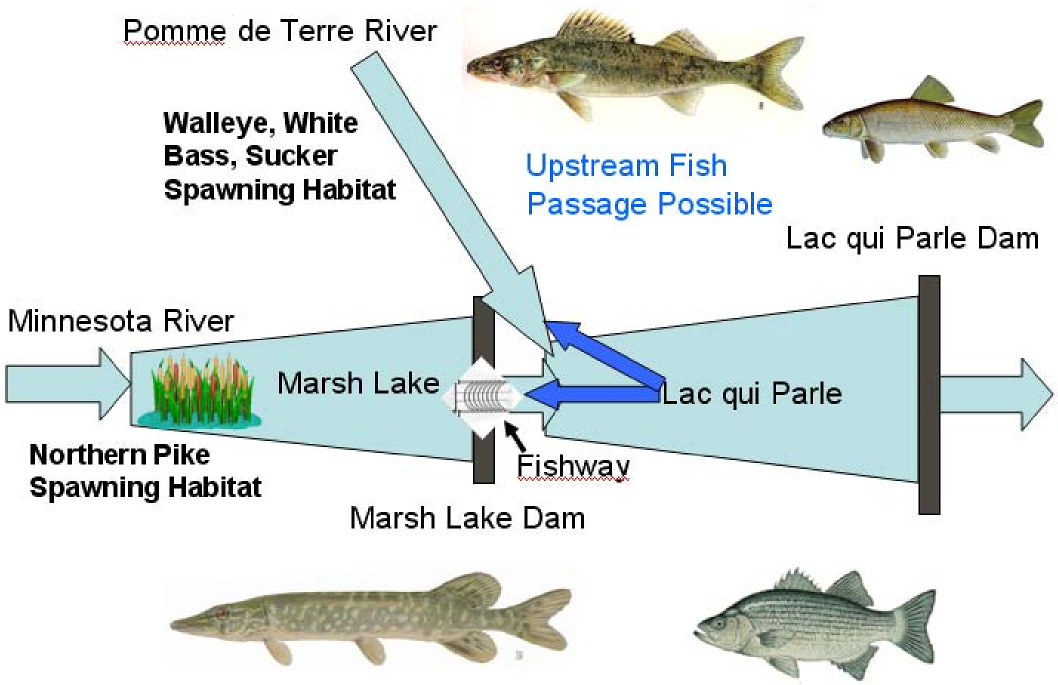


Figure 3-2. Conceptual model of fish migration routes restored from Lac qui Parle into the Pomme de Terre River and with a fishway at Marsh Lake Dam.

The U.S. Commission on Fish and Fisheries (1895) noted that a fishway was needed at the Appleton dam on the Pomme de Terre River. That dam failed and was replaced with a rock ramp fishway in 1996. Opportunity exists to restore fish migrations from Lac Qui Parle back into the Pomme de Terre River system, with 56 miles of river up to the dam at Marshall, Minnesota.

With improved fish passage, the native mussel community in Marsh Lake, Lac qui Parle and the Pomme de Terre River should receive benefits from the presence of their glochidial (larval stage) host fish species.

3.3 Problem: Degraded Pomme de Terre River Ecosystem State

The Pomme de Terre River was diverted into Marsh Lake when the dam was built in the 1930's. The river diversion was intended to conserve water in Marsh Lake. Water and suspended sediment from the Pomme de Terre River short circuits to the Marsh Lake Dam. Sediment from the Pomme de Terre has been depositing to form a delta in Marsh Lake rather than replenishing the floodplain at its confluence with the Minnesota River at the upper end of Lac qui Parle.

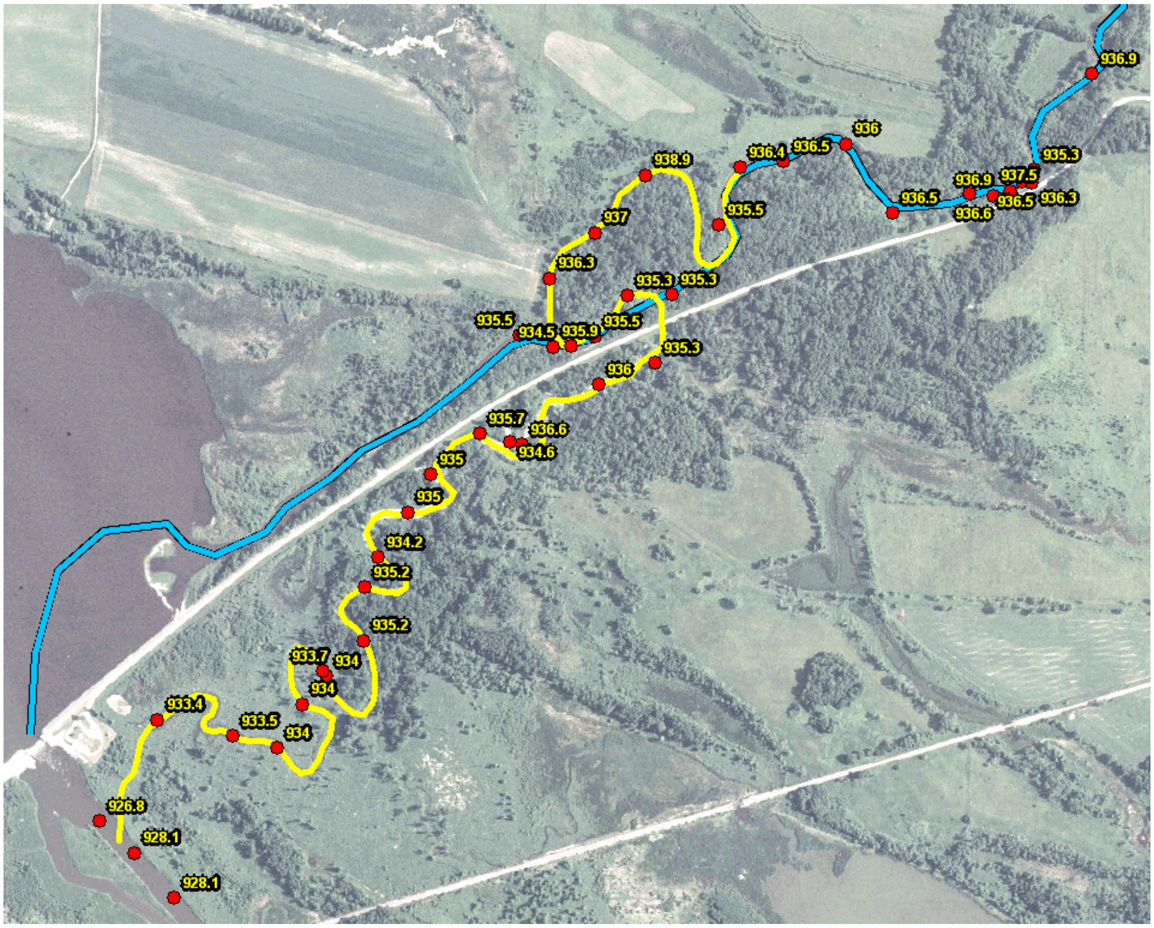


Figure 3-3. Former Pomme de Terre River channel (yellow). Re-routed Pomme de Terre River channel (blue).

Diversion of the Pomme de Terre River altered the floodplain and riparian habitat along the river. Sediment has accumulated in the former river channel. The channel and riparian area no longer receives flushing flows, new sediment deposition, and transport of organic material. The Pomme de Terre River provides carp in Marsh Lake a winter refugia with dissolved oxygen in some years. Diversion of the Pomme de Terre River eliminated 11,500 feet of river and its associated mussel community. It also resulted in a portage over the Marsh Lake Dam for canoeists to travel from the river into Lac qui Parle.

Opportunity: Restore Pomme de Terre River ecosystem processes and connectivity

Restoring river ecosystems by returning rivers to their former channels has proven to be ecologically effective worldwide. Opportunity exists to restore the Pomme de Terre River to its former channel and to restore its floodplain and riparian habitat in the upper end of Lac qui Parle. Restoring the Pomme de Terre River to its former channel would contribute to winter hypoxia in Marsh Lake, which would help reduce the abundance of carp, sediment resuspension and grazing on aquatic plants. Walleyes and white suckers from Lac qui Parle would have access to rock and gravel spawning habitat in the Pomme de Terre River. Fish in the Pomme de Terre River would have access to winter refugia in Lac qui Parle. A restored Pomme de Terre River would provide a canoe route linking the Pomme de Terre River with Lac qui Parle.

Opportunity: Enhance recreational opportunities on the Pomme de Terre River

Restoring the Pomme de Terre River to its former channel would enable canoeists and kayakers to follow the river to its confluence with the Minnesota River at the upper end of Lac qui Parle without having to portage over Marsh Lake Dam. Recreational use of the Pomme de Terre River within the project area is primarily by anglers and canoeists. A series of existing canoe launches and landings extends up the Pomme de Terre for open access and use. The opportunity exists to enhance the existing access to the river, particularly near the outlet with the Minnesota River, a primary takeout point for canoeists.

Table 3-1: Summary of Problems and Opportunities

Goal	Problem	Stressors	Opportunity
A return of the Marsh Lake area ecosystem to a less degraded, more natural and functional condition.	Degraded Marsh Lake Ecosystem State	Sediment Loading	1. Restore Marsh Lake ecosystem function, processes and connectivity 2. Enhance recreational opportunities in and around Marsh Lake 3. Reduce public safety risks at the Marsh Lake Dam
		Sediment Resuspension	
		Altered Hydrologic Regime	
		Ecosystem Connectivity	
	Low-Diversity Fish Community	Invasive Species	1. Restore native fish community 2. Enhance recreational fishing opportunities in and around Marsh Lake
		Ecosystem Connectivity	
	Degraded Pomme de Terre Ecosystem State	Sediment Deposition	1. Restore Pomme de Terre ecosystem function, processes and connectivity 2. Enhance recreational opportunities on the Pomme de Terre River
		Ecosystem Connectivity	

3.4 Project Goals and Objectives

The Marsh Lake Ecosystem Restoration Project study team considered the initial DNR goal and objectives and the team worked closely with the DNR to identify the following goal and objectives for the Marsh Lake Ecosystem Restoration Project:

Goal: A return of the Marsh Lake area ecosystem to a less degraded and more natural and functional condition.

Objectives:

1. Reduced sediment loading to Marsh Lake over the 50-year period of analysis

2. Restored natural fluctuations to the hydrologic regime of Marsh Lake over the 50-year period of analysis

3. Restored geomorphic and floodplain processes to the Pomme de Terre River over the 50-year period of analysis

4. Reduced sediment resuspension within Marsh Lake over the 50-year period of analysis

5. Increased extent, diversity and abundance of emergent and submersed aquatic plants within Marsh Lake over the 50-year period of analysis

6. Increased availability of waterfowl habitat within Marsh Lake over the 50-year period of analysis

7. Restored aquatic habitat connectivity between Marsh Lake, the Pomme de Terre River and Lac Qui Parle over the 50-year period of analysis

8. Reduced abundance of aquatic invasive fish species within Marsh Lake over the 50-year period of analysis

9. Increased diversity and abundance of native fish within Marsh Lake and the Pomme de Terre River over the 50-year period of analysis

While improving public safety, the recreation experience and public education at the Marsh Lake are not ecosystem restoration objectives and are therefore not included in the list above. They are, however, additional planning objectives to be considered in conjunction with the ecosystem restoration objectives.

3.5 Planning Constraints

Planning constraints are temporary or permanent limits imposed on the scope of the planning process and choice of solutions and include ecological, economic, engineering, legal, and administrative constraints. Some are states of nature; some are based on the design of built structures and other engineering considerations. Legislation and policy-making impose other constraints. The human-imposed constraints are possible to change. Following are the planning constraints identified in this study:

1. The planning process must be consistent with all applicable Federal laws, Executive Orders, Agency Regulations and other applicable policy.

2. The formulation of alternative measures should avoid, to the greatest extent possible, the reduction of the flood damage reduction benefits provided by the dams.

3. In its existing condition, Marsh Lake and the Pomme de Terre River provide functional habitat for a number of species. A universal constraint in the planning of ecosystem restoration projects is the maxim that the restoration activities should not

degrade, but rather seek to improve, the existing function of the ecosystem from its current state. Consideration of the potential adverse impacts to species within the project area therefore imposes constraints on the development of alternative measures. Specific biotic considerations include:

a. American Pelicans – a colony of nesting and breeding pelicans inhabits Marsh Lake during the summer months. Pelicans seek refuge on islands in the lake. Changes to water levels within the lake should minimize the impact on the isolation of these islands.
b. Mussels – A diverse mussel community exists within the lower reaches of the Pomme de Terre River. Consideration of project alternatives should minimize the impacts to this community and its future viability.
c. Fish Community – while the community is primarily dominated by common carp (an invasive species), Lac qui Parle and Marsh Lake also support communities of native fish. Changes to water levels resulting from alternative measures must minimize negative impacts on the native fish community, particularly valuable northern pike spawning habitat in the upper end of Marsh Lake.

3.6 Significance of Resources and Significance of Ecosystem Outputs

The criteria for determining the significance of resources are provided in the Federal Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (Water Resources Council 1983) and Corps planning guidance ER 1105-2-100. Protecting and restoring significant resources is in the national interest. The significance and the relative scarcity of the resources helps determine the Federal interest in the project.

Significant resources in the project area include natural and cultural resources that are recognized as significant by institutions and the public. For ecosystem restoration projects, the significance of resources is based on both monetary and non-monetary values. Monetary value is based on the contribution of the resources to the Nation's economy. Non-monetary value is based on technical, institutional or public recognition of the ecological, cultural, and aesthetic attributes of resources in the study area. The scientific community and natural resources management agencies recognize the technical significance of resources.

Through discussion with stakeholders and study participants, significant resources in the study area were identified.

Significant infrastructure features in the project area include the following:

- Lac qui Parle Dam
- Marsh Lake Dam
- Chippewa River Diversion
- Lac qui Parle State Park
- Lac qui Parle State Wildlife Management Area
- Fish rearing pond below the Marsh Lake Dam
- Jim and Karen Killen State Waterfowl Refuge
- Highway 75 Dam and low flow structure
- Big Stone National Wildlife Refuge
- Burlington Northern Santa Fe railroad track, embankment and bridge
- Minnesota State Highways 75, 119 and 7
- Louisburg Grade Road (Township road) and culverts
- Northern Natural Gas pipeline

Significant ecological and cultural resources in the project area include the following:

- Scenic beauty of the river
- Native American cultural resources in the floodplain
- Floodplain forest wetlands
- Emergent marsh wetlands
- Fish populations and a popular sport fishery supported by northern pike and walleyes
- Freshwater mussels in the Pomme de Terre River
- Migratory birds that use the Lac qui Parle Wildlife Management Area including ducks, Canada geese, swans, American pelicans, warblers, raptors, colonial-nesting pelicans, cormorants, herons and egrets
- Native prairie
- Bald eagles

Significance of ecosystem outputs are evaluated by institutional, technical and public criteria as provided in ER 1105-2-100 Appendix E-37. This guidance assists in addressing the challenge of dealing with non-monetized benefits associated with ecosystem restoration and provides context for the selection of the recommended plan.

Institutional Recognition Criteria: Constitutes significance of an environmental resource as acknowledged by laws, adopted plans and other policy statements of public agencies, tribes, or private groups. For the Marsh Lake Ecosystem Restoration Project, institutionally-recognized significant resources include the following:

A. Minnesota Department of Natural Resources (DNR): The State of Minnesota has made on-going investments in managing the Lac qui Parle State Park and the Lac qui Parle Wildlife Management Area. Marsh Lake is also one of the primary sites of the DNR Shallow Lakes long term evaluation and monitoring program. In addition, the DNR has also contributed to the development of several statewide conservation plans which address wildlife management broadly, but specifically focus on the loss of quantity and quality of shallow lakes for wildlife management. These include:
    1. Minnesota Statewide Conservation and Preservation Plan
    2. A Fifty-Year Vision – Minnesota Campaign for Conservation
    3. Tomorrow’s Habitat for the Wild and Rare
    4. The Minnesota Department of Natural Resources Long-Range Duck Recovery Plan

    The DNR serves as the non-Federal Sponsor for the study and its input as a team is provided with deference to the plans noted above. It is assumed that improvement to the ecosystem function of Marsh Lake will assist the DNR in meeting the goals of its multiple planning efforts.

B. The Minnesota State Historic Preservation Office (SHPO) considers the Marsh Lake Dam to be a significant resource eligible for listing on the National Register of Historic Places in connection with the Lac qui Parle Flood Control Project. The Dam typifies the type of design implemented under Works Progress Administration efforts. Coordination with SHPO is on-going throughout the Feasibility phase and overall project development.

C. The U.S. Fish and Wildlife Service (USFWS) recognizes the significance of the ecological resources in the project area, in particular migratory birds and their habitats. The project area is an important migration stop on a major flyway for waterfowl as well as part of a corridor for neotropical migrating songbirds. The study area is internationally significant as an important migratory bird resting and feeding area on the Mississippi flyway as recognized in the North American Waterfowl Management Plan by the Office of Migratory Bird Management. Many migratory species noted in Section 2.8.9 are also listed in the Office of Migratory Bird Management's official list. Coordination with USFWS is on-going throughout the Feasibility phase and overall project development.

D. The National Audubon Society recognizes the project area as part of a nationally significant Important Bird Area (IBA). IBA extends from Montevideo in Chippewa County along the Minnesota River northwest through Lac qui Parle Lake, Marsh Lake, Big Stone Lake, Lake Traverse, and Mud Lake. It extends to the east to include almost all of Big Stone County and the southwest portion of Traverse County. Included within this IBA are Lac qui Parle Wildlife Management Area, Chippewa Prairie Wildlife Management Area, Big Stone National Wildlife Refuge, Big Stone Lake State Park, Lac qui Parle State Park, and Bonanza Prairie State Natural Area. The habitat in the Minnesota River IBA is a diverse mixture of lakes, prairie potholes, prairie grasslands, river bottom lakes, riparian woodlands, cattail marshes, rocky pastures and cropland. This IBA includes large waterbird nesting areas and some of the highest quality tallgrass prairie in the Midwest. This has resulted in a rich diversity of species including some of Minnesota's largest concentrations of Canada Geese and other waterfowl, the world's largest American American pelican breeding colony, and other waterbirds, shorebirds and grassland songbirds. Ecosystem outputs associated with restoration efforts within the project area will presumably enhance the values noted by the IBA through increased habitat suitability.

E. The Nature Conservancy has also provided technical and institutional recognition of the Minnesota River, including the Marsh Lake project area, as a conservation priority area (The Nature Conservancy 2003). While recognizing the highly altered ecosystems in the Minnesota River Basin, The Nature Conservancy notes that there are still areas of high biological diversity and habitat quality, largely confined to the main-stem floodplain and lower portions of tributaries. These areas harbor a large variety of remnant terrestrial and semi-aquatic communities, including prairies, upland and lowland hardwood forests, marshes, fens, seepage wetlands and other unique natural features. Ecosystem outputs associated with restoration efforts will complement the recognition of the conservation priority area by improving the quality of resources and habitat suitability.

F. Ducks Unlimited Inc. (DU) works to restore habitat conditions for waterfowl in Minnesota through its Living Lakes Initiative (LLI). The LLI recognizes the project area as a critical migratory stop-over for waterfowl and has utilized public and private funds to help restore 110-acres of wetland around Marsh Lake itself. DU has contributed feedback on the Feasibility Report through the Minnesota DNR and is supportive of ecosystem restoration of Marsh Lake.

In addition to institutional recognition, the public recognizes the significance of certain environmental resources. Public recognition of the significance of a resource may involve membership in a conservation organization, financial contributions to resource-related efforts, providing volunteer labor, and correspondence regarding the importance of the resource. As noted above, several non-profit organizations have indicated interest in improving the ecosystem quality and function of the Marsh Lake and Lac qui Parle (Audubon, The Nature Conservancy, DU). Several citizens groups have also formed around improving conditions on the Minnesota River as well as within the project area including:

A. Clean Up the River Environment (CURE)
B. Friends of the Minnesota Valley
C. Coalition for a Clean Minnesota River
D. Minnesota River Board; consisting of delegates from each of the Counties within the Minnesota River Basin

Coordination with the general public and non-profit groups active within the project study area will occur during public review of the Feasibility Report.

In addition to institutional and public recognition of significant resources, technical recognition means that a resource qualifies as significant based on its merits, which are based on scientific knowledge or judgment of critical resource characteristics. Some technical reasons that resources in the study area are considered significant include:

A. Status and Trends – 90% of Minnesota prairie wetlands have been lost due to hydrologic alteration of the landscape, primarily for agricultural use. Those wetlands that remain are often larger basins that were more difficult to drain. Given the reduced storage capacity within watersheds, the remaining wetlands in the project area are under increasing stress from runoff carrying sediments, nutrients and other contaminants which impact overall water quality and ecosystem health.

B. Connectivity – Marsh Lake and Lac qui Parle are artificially constructed impoundments on the main stem of the Minnesota River. Given their direct hydrologic connection to upstream and downstream river reaches as well as tributaries such as the Pomme de Terre, the project area serves a critical connective function for aquatic fauna such as fish and amphibians, particularly for reproduction and forage. As noted in previous sections of the report, the project study area is a critical stopover for both ducks and geese. Peak numbers of 150,000 Canada geese and 20,000 mallards have been recorded within the Wildlife Management Area which in part is managed as a Migratory Feeding and Resting Area (DNR). Ecosystem restoration features are targeted at improving connectivity and function of the system for aquatic species and birds.

C. Limiting Habitat – There are relatively few remaining wetland and shallow lake habitat areas in western Minnesota. Marsh Lake and Lac qui Parle provide habitat for an active breeding colony of white pelicans, one of only two in the entire state. White pelicans, in addition to 30 other identified species within the study area, are listed as a species of special concern by the Minnesota Department of Natural Resources.

D. Biodiversity – Even with the presence of invasive species such as common carp, the project area supports a rich and diverse abundance of wildlife, detailed in Section 2.8.8. A number of the stated project objectives relate to increasing the diversity and impact of invasive species through the implementation of identified measures. Invasive species have thrived in the project study area primarily due to the human-induced conditions. Restoration of the natural form and function of the ecosystem will tend to favor habitat conditions and production of native species and natural biodiversity.

4. Alternative Measures

Alternative measures are management actions that singly or in combination may contribute to attaining the project objectives. Each project objective has a set of potential management actions (Table 4-1). Most of the potential alternative measures listed in Table 4-1 were considered in the 2000 – 2002 DNR Marsh Lake planning process. Some management actions would contribute to attaining more than one objective.

Table 4-1. Alternative measures that could contribute to attaining project objectives.

Goal	Problem	Sub-Category	Objective	Output	Alternatives
A return of the Marsh Lake ecosystem to a less degraded, more natural and functional condition	Marsh Lake Ecosystem State	Sediment Loading	Reduced sediment loading to Marsh Lake over the 50-year period of analysis	1. Reduced turbidity 2. Increased aquatic plan growth 3. Increased availability of forage for waterfowl	• Watershed BMPs • Wetland restorations in watershed • Stream bank stabilization in watershed • Reroute lower Pomme de Terre River to its former channel
		Sediment Resuspension	1. Reduced sediment loading to Marsh Lake over the 50-year period of analysis 2. Increased extent, diversity and abundance of emergent and submersed aquatic plants within Marsh Lake over the 50-year period of analysis 3. Reduced sediment resuspension within Marsh Lake over the 50-year period of analysis 4. Increased availability of waterfowl habitat within Marsh Lake over the 50-year period of analysis	1. Reduced turbidity 2. Increased aquatic plan growth 3. Increased availability of forage for waterfowl	• Growing season drawdowns to restore emergent aquatic plants • Construct islands to reduce wind fetch • Construct exclosures to prevent grazing and plant submersed aquatic vegetation
		Lake Level Variability	1. Restored natural fluctuations to the hydrologic regime of Marsh Lake over the 50-year period of analysis 2. Increased extent, diversity and abundance of emergent and submersed aquatic plants within Marsh Lake over the 50-year period of analysis	1. Increase light attenuation 2. Increase frequency of consolidation of bottom sediments 3. Increase frequency of germination of aquatic plant seedbed 4. Increased aquatic plant abundance and diversity 5. Increased availability of forage for waterfowl	• Modify Marsh Lake Dam to attain target water levels • Growing season drawdowns to restore emergent aquatic plants • Winter drawdowns to reduce carp abundance • Install gated culverts in the Louisburg Grade Road to manage water levels in upper Marsh Lake • Install gated culverts in abandoned fish pond to manage water levels • Breach dike in abandoned fish pond • Breach or remove the Marsh Lake Dam
		Ecosystem Connectivity	Restored aquatic habitat connectivity between Marsh Lake, the Pomme de Terre River and Lac Qui Parle over the 50-year period of analysis	1. Increase the frequency of immigration of native fish between Lac qui Parle and Marsh Lake 2. Increase quality of habitat for piscivores	• Construct a fishway in the Marsh Lake Dam • Restore the lower Pomme de Terre River to its former channel • Breach dike in abandoned fish pond • Breach or remove the Marsh Lake Dam
	Low-Diversity Fish Community	Invasive Species	1. Reduced abundance of aquatic invasive fish species within Marsh Lake over the 50-year period of analysis 2. Increased diversity and abundance of native fish within Marsh Lake and the Pomme de Terre River over the 50-year period of analysis	1. Increase availability of spawning habitat for northern pike 2. Increase availability of spawning habitat for walleye 3. Reduce abundance of invasive fish species	• Construct a fishway in the Marsh Lake Dam • Restore the lower Pomme de Terre River to its former channel • Winter drawdowns to reduce carp abundance
		Ecosystem Connectivity	Restored aquatic habitat connectivity between Marsh Lake, the Pomme de Terre River and Lac Qui Parle over the 50-year period of analysis		
	Degraded Pomme de Terre Ecosystem State	Sediment Deposition	Reduced sediment loading to Marsh Lake over the 50-year period of analysis	1. Reduced turbidity 2. Increased aquatic plan growth 3. Increased availability of forage for waterfowl	• Watershed BMPs • Wetland restorations in watershed • Stream bank stabilization in watershed • Reroute lower Pomme de Terre River to its former channel
		Ecosystem Connectivity	1. Increase the diversity and abundance of native fish in the Pomme de Terre River 2. Restored geomorphic and floodplain processes to the Pomme de Terre River over the 50-year period of analysis 3. Restored aquatic habitat connectivity between Marsh Lake, the Pomme de Terre River and Lac Qui Parle over the 50-year period of analysis	1. Increase the frequency of immigration of native fish between Lac qui Parle and Marsh Lake 2. Increase availability of spawning habitat for walleye	• Reroute lower Pomme de Terre River to its former channel

4.1 Description of Alternative Ecosystem Restoration Measures

4.1.1 Watershed Best Management Practices (BMPs)

A variety of watershed BMPs can be implemented to reduce sediment and nutrient loading to Marsh Lake and Lac qui Parle. These include nutrient management on farms, installation of grassed waterways and buffer strips along streams, conservation tillage, and conversion of row crop land to perennial cover. Watershed BMPs are implemented by landowners with cost share assistance from state and USDA soil and water conservation programs.

4.1.2 Wetland Restorations in Watershed

Restoration of wetlands that have been drained for agriculture can be very effective at restoring the hydrologic regime, reducing loading of sediment and nutrients, and providing habitat for wildlife. Restorations of drained wetlands are implemented by landowners with cost share assistance from the U.S. Fish and Wildlife Service and from state and USDA soil and water conservation programs.

4.1.3 Stream Bank Stabilization in Watershed

Agricultural drainage and ditching has altered the stream drainage network in the Upper Minnesota River watershed and tilling perennial grasslands has led to destabilization of stream channels. Measures to restore the hydrologic regime and to stabilize stream channels can reduce loading of sediment and nutrients to Marsh Lake and Lac Qui Parle. Restorations of stream channels are implemented by landowners with cost share assistance from state and USDA programs.

4.1.4 Restore the Lower Pomme de Terre River to its Former Channel

Currently, the channelized lower Pomme de Terre River flows into Marsh Lake and short circuits to the overflow spillway at Marsh Lake Dam. The bed sediment has been depositing a delta in Marsh Lake, and the suspended sediment flows toward the Marsh Lake Dam and on into Lac qui Parle. Rerouting the lower Pomme de Terre River to its former channel and floodplain at the confluence with the Minnesota River downstream of Marsh Lake Dam (Figure 4-1) would restore natural floodplain processes. Sediment from the Pomme de Terre River would be deposited overbank in the floodplain during higher discharge events. The sediment in the former river channel is currently about 0.5 feet of silt over the former sand/gravel substrate. This fine material would be scoured out in the first year following restoring flow to the former channel therefore no excavation will be required to reestablish the historic channel.

The Pomme de Terre River would be re-routed into its former channel in a meander loop upstream of Marsh Lake Dam and into the longer former channel downstream of the Marsh Lake Dam by constructing three earthen cut-off dikes (Figure 4-1). The total length of river channel that would be restored would be 11,500 feet. With an average 80-ft wide channel, approximately 21 acres of river channel would be restored. This would restore floodplain processes to the Pomme de Terre River delta downstream of the Marsh Lake Dam, a 293-acre area.

The upstream cut-off dike would be armored with rock on the upstream side to withstand river currents. The top of the upstream cut-off dike would be about one foot higher than the surrounding floodplain, allowing it to be overtopped during floods. The top of the downstream cut-off dike and the west cut-off dike would be at the same elevation as the Marsh Lake Dam embankment, at 950 ft. The west cut-off dike would involve raising a township road, also to 950 ft. The downstream and west cut-off dikes would effectively become part of the Marsh Lake Dam embankment. A total of 39,800 cubic yards of earth fill would be used to construct the cut-off dikes.

Clay material to construct the cut-off dikes would be borrowed from the field northwest of the downstream cut-off dike within the Lac Qui Parle Wildlife Management Area. The borrow area would be approximately 5.7 acres, excavated to a depth of 4 feet. Lake bed material excavated from the approach to the drawdown structure in Marsh Lake Dam would be used to partially fill and top dress the borrow area. The borrow area would be planted to native grasses following construction.

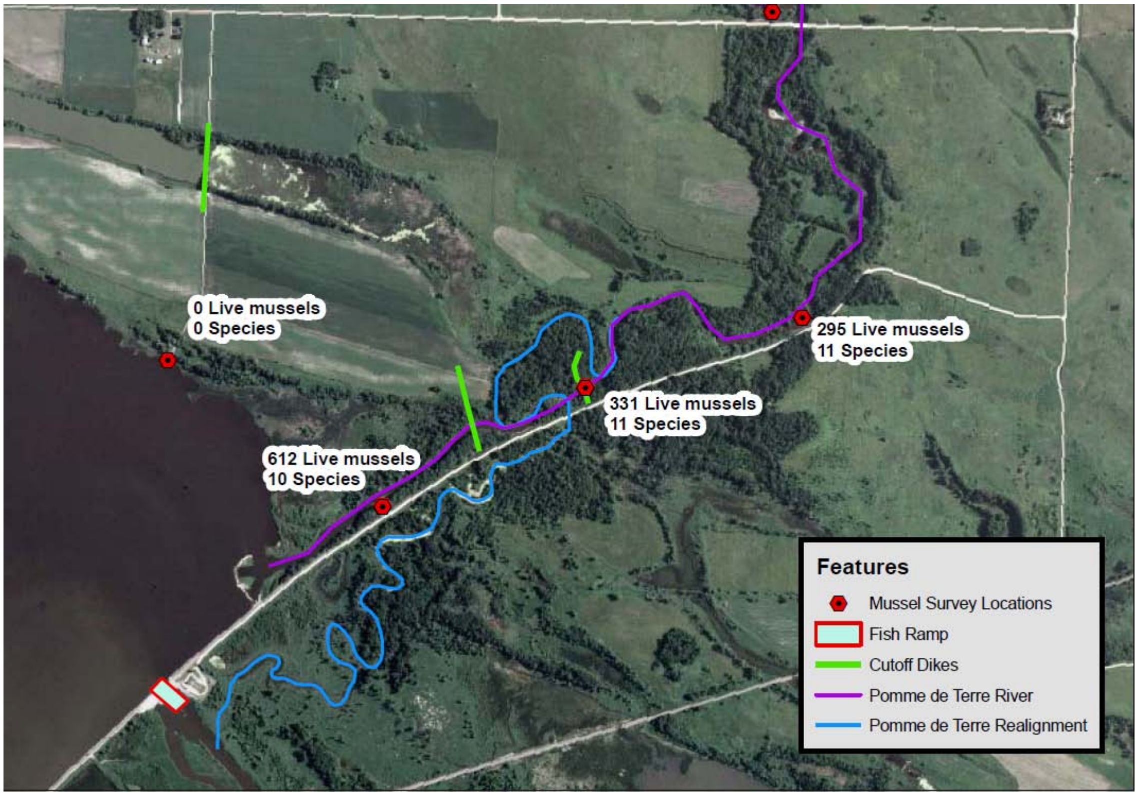


Figure 4-1. Pomme de Terre River existing channel (purple), realignment into former channel (blue), earthen cut-off dikes (green), 2007 mussel sampling locations (red).

The lower Pomme de Terre River supports an abundant and diverse mussel community with two state-listed species (See Section 2.8.7 above). Mussels in the lower reach of the channelized Pomme de Terre River below the lower cut-off dike would no longer be in a flowing river and would probably die. Mussels in the locations of the cut-off dikes would be buried.

Based on discussions with the DNR, this alternative measure would include a survey of the existing mussel community in the lower Pomme de Terre River and monitoring the recolonization of the restored river channel as part of the Marsh Lake project. There is not a Federal interest in a large-scale mussel relocation effort for a native mussel community containing no Federally-listed endangered or threatened species.

If the DNR chooses to do so, the DNR may harvest mussels from the impact area in the lower Pomme de Terre River and temporarily relocate the mussels to selected areas in the Pomme de Terre River upstream. PIT (passive integrated transponder) tags could be attached to relocated mussels and then used to find them later. Following a year or two of flow through the restored channel to allow the fine-grained sediment to be scoured down to the underlying sand-gravel substrate, the mussels in the temporary relocation sites could be removed and stocked into the restored river channel above and downstream of the Marsh Lake Dam. Parts of the restored channel would not receive relocated mussels and would serve as a control to enable monitoring of mussel recruitment and recolonization. A reference reach of the Pomme de Terre River upstream of the impact area was surveyed for mussels in 2010 (Appendix Q).

Survey of the Existing Lower Pomme de Terre River and Mussel Community

A systematic survey of the impact area of the lower Pomme de Terre River was done in 2010 by collecting 0.25 m^2 randomly located quadrat samples (Appendix Q). Additional sites not sampled in the 2007 survey were sampled by qualitative timed searches to better assess the species richness of the mussel community. From these data a population estimate, population demographics and community composition descriptors were generated and will be used as perspective when characterizing the recruitment of mussels into the restored channel over time. A map of the river showing the density of mussels, number of mussels <3 years old, and number of species found at each collection site was generated (Appendix Q).

A cursory survey of several sites within the old channel consisting of wading and snorkeling where needed will be done to support or refute the assumption that there are no live mussels currently in the former Pomme de Terre River channel to be restored. The former Pomme de Terre River channel to be restored has had six or more inches of silt deposited there since the river was diverted when the Marsh Lake Dam was built. Mussels are unlikely to occur there now. Following three years of flow through the restored areas above and below the Marsh Lake Dam, biologists will survey the restored river channel using qualitative timed searches at a minimum of 5 sites to assist in finding all species present and systematic quantitative sampling similar to that used within the impact area. At least 100 0.25 m^2 quadrat samples will be collected as described above to allow for a population estimate of mussels that may have been recruited since restoration of flows. Mussels collected during this sampling will be identified to species, measured (TL) and growth arrest lines counted. Qualitative information on the substrate types represented at each sample will be estimated and recorded as a percent among 7 substrate categories:

Woody debris, Organic Detritus, Silt, Sand, Gravel, Cobble, or Boulder. A map of the river showing the density of mussels, number of mussels <3years old, and number of species found at each collection site will be generated.

Consideration (assessment of the existing and monitoring to assess reestablishment in restored channel) of the existing mussels, their habitat, and the ecosystem services they provide is an important part of this project to the DNR. Approaches to accomplish that, to the best of existing knowledge, are currently being worked on are partially listed above. These may include: organism identification, enumeration, and valuation using American Fisheries Society (AFS) replacement numbers; habitat mapping and valuation, and ecosystem service identification and valuation. The DNR's involvement in accomplishing this aspect of the project can be assumed. A more complete experimental design will be developed in the detailed design phase of the project.

Estimated cost for the lower Pomme de Terre pre-project survey and three years of post-project monitoring was provided by the Minnesota DNR (Table 4-2). The estimated total cost of $128,000 includes data analysis and reporting.

Table 4-2. Estimated cost of Pomme de Terre River survey and monitoring mussel recolonization in the restored Pomme de Terre River channel.

Tasks	Days	# Crews	Per Day/one crew	Report	Total
Est. Current Channel Pop & Reference site	6	2	$ 2,000.00	$ 2,000.00	$ 26,000.00
Evaluate New Channel	1	2	$ 2,000.00	$ 2,000.00	$ 6,000.00
Cutoff Channel Mussel Salvage	2	2	$ 2,000.00	$ 1,000.00	$ 9,000.00
Yr3 Monit; New Channel/Reference site	6	2	$ 2,000.00	$ 5,000.00	$ 29,000.00
Yr6 Monit; New Channel/Reference site	6	2	$ 2,000.00	$ 5,000.00	$ 29,000.00
Yr10 Monit; New Channel/Reference site	6	2	$ 2,000.00	$ 5,000.00	$ 29,000.00
				Total	$ 128,000.00

Bridge Over the Pomme de Terre River

A bridge over the re-routed Pomme de Terre River channel would be constructed to maintain access to Marsh Lake Dam (Figure 4-2). The bridge would be 450 feet long with 5 spans and be constructed of 46" deep concrete I-girders. The bridge would be designed to carry cars, trucks, materials and equipment needed to provide continued public access and to maintain the Marsh Lake Dam. The deck of the bridge would be 40 feet wide to carry two lanes of traffic.

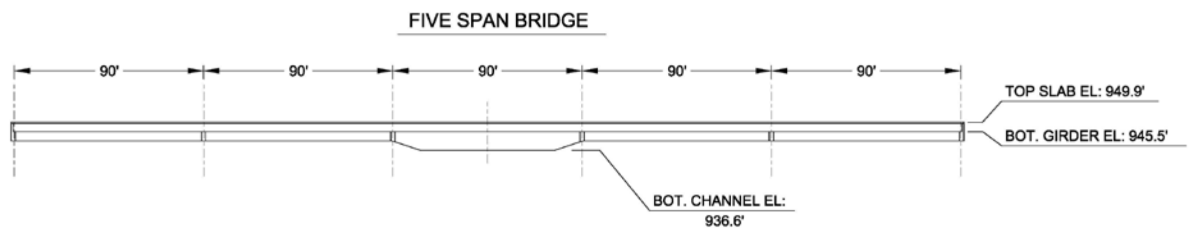


Figure 4-2. Conceptual design of a bridge over the re-routed Pomme de Terre River.

4.1.5 Modify Marsh Lake Dam to Attain Target Water Levels and Construct a Fishway (Passive water level management)

Marsh Lake Dam could be modified with a fishway structure to provide a passive weir that would increase water level variability on Marsh Lake, attain the target water level regime and to allow year-round fish passage (Figure 4-4). The fishway would be constructed in the existing fixed crest spillway in Marsh Lake Dam. The fishway was designed by comparing a number of alternatives to optimize the time that the lake is in the target range of water levels (Objective 2) and to have suitable velocities within the fishway to allow upstream fish passage to provide habitat connectivity for fish through the Marsh Lake Dam (Objective 7). In order to maintain desired pool elevations for protection of nesting waterfowl, through discussions with the DNR, the average September Marsh Lake water level of 937.7 ft was selected as the target water level elevation (Figure 4-5).

Nature-like fishways are effective in re-establishing fish migration routes past dams and other hydraulic obstacles. Nature-like fishways simulate natural river channels and the hydraulic conditions that fish have evolved to swim through. Nature-like fishways can be simple rock ramps that look like natural rapids or bypass channels with riffles and pools. Many nature-like fishways have been constructed in Minnesota and have been very effective in restoring migratory fishes to stream networks (Figure 4-3) (L. Aadland, Minnesota DNR, personal communication).

Figure 4-3. Rock ramp fishway at a lake outlet. Minnesota DNR photo.

The fishway would be constructed in the location of the existing fixed ogee crest spillway in the Marsh Lake Dam. The fishway would have a series of arched rock riffles (Figure 4-4). This would concentrate flow toward the middle of the fishway. Shallow areas on the sides would have slower current velocities and would allow upstream passage by smaller and weaker-swimming fish. The riffles would be made of boulders imbedded into smaller rock, with pools of deeper water between the riffles. Water would flow between the boulders in the riffles at velocities that fish could still swim through. Each riffle would produce a head loss of approximately 0.8 ft.

The fishway would be constructed with a rock fill base at a 4% slope, nine boulder weir “steps” of 0.8-ft head each, 20-ft spacing between the boulder weirs, a 30-ft wide notch in the existing spillway from 937.6 ft down to 935.5 ft, a 30-ft wide V-notch in base rock, with invert of 936.0 ft.

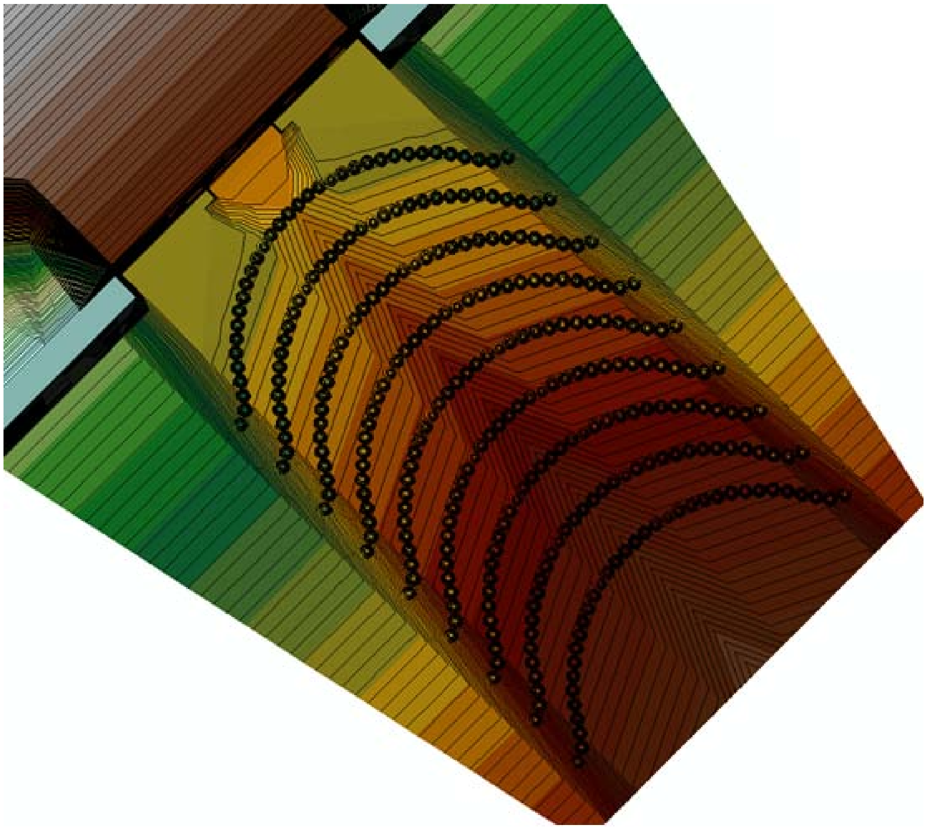


Figure 4-4. Conceptual design of a Marsh Lake fishway. Flow from upper left to lower right.

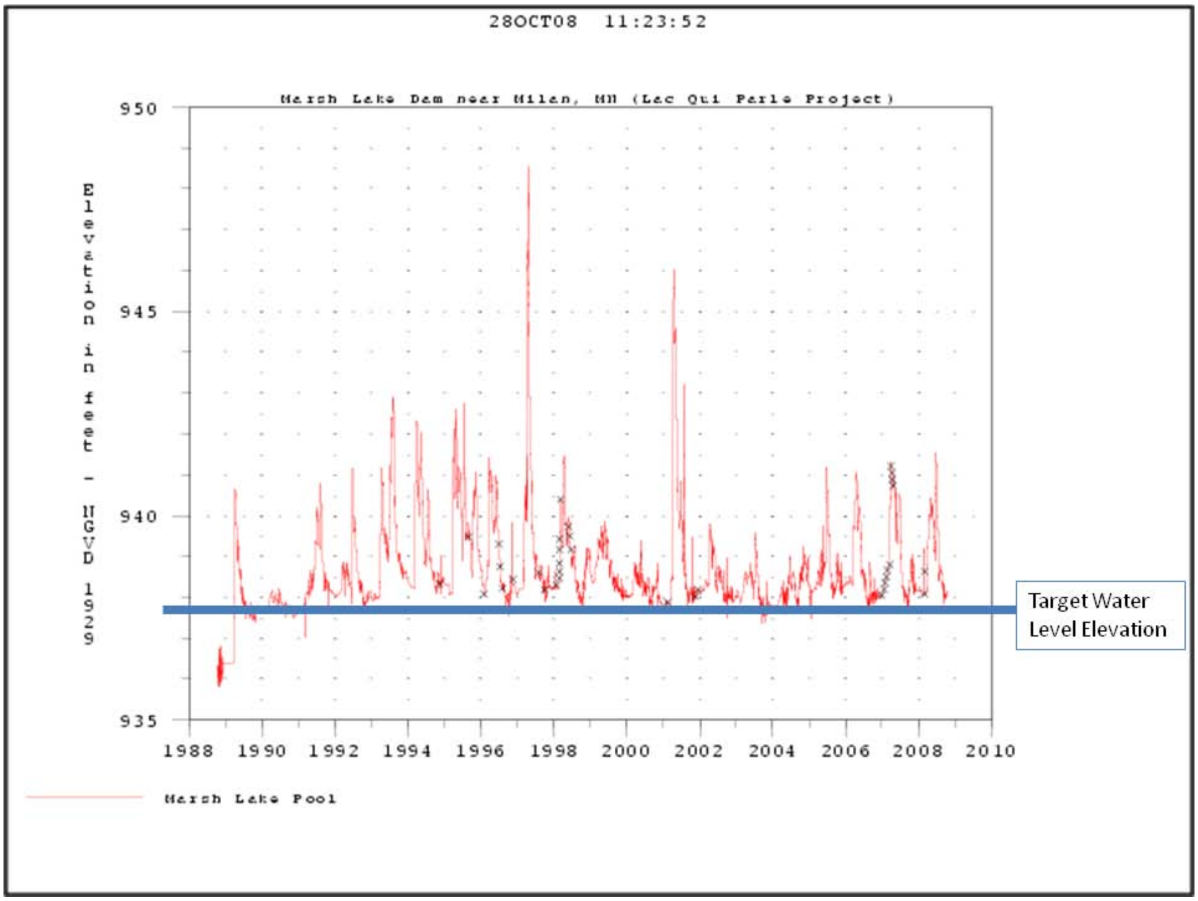


Figure 4-5. Historic Marsh Lake water levels and the 437.7 ft September target water level elevation.

4.1.6 Construct Water Level Control Structure to Allow Drawdowns to Restore Emergent Aquatic Plants and Reduce Carp Abundance (Active Water Level Management)

Growing season drawdowns are effective in providing dewatered mud flat conditions that emergent aquatic plants need to germinate from seed (Figure 4-6).

Figure 4-6. Seedling arrowhead and other emergent aquatic plants on exposed mud flats in Pool 8, Mississippi River, during a 2005 growing season drawdown.

Growing season drawdowns are typically conducted following spring high water into September when plants go senescent. Growing season drawdowns can be done in two consecutive growing seasons to allow plants germinated in the first year to grow to full size before flooding to normal water levels. Once established, perennial aquatic plants can persist for years, providing valuable food and habitat for fish and wildlife.

Drawdowns on Marsh Lake would require modifications to the Marsh Lake Dam to allow active water level management. A water control structure would be built in the existing overflow spillway area to provide controlled discharge capacity to enable a drawdown. The ability to maintain the pool in a drawdown condition with less than one week of high water following a runoff event is needed to prevent "drowning" of newly germinated emergent aquatic plants. This was used as design criteria for the water control structure (Figure 4-7).

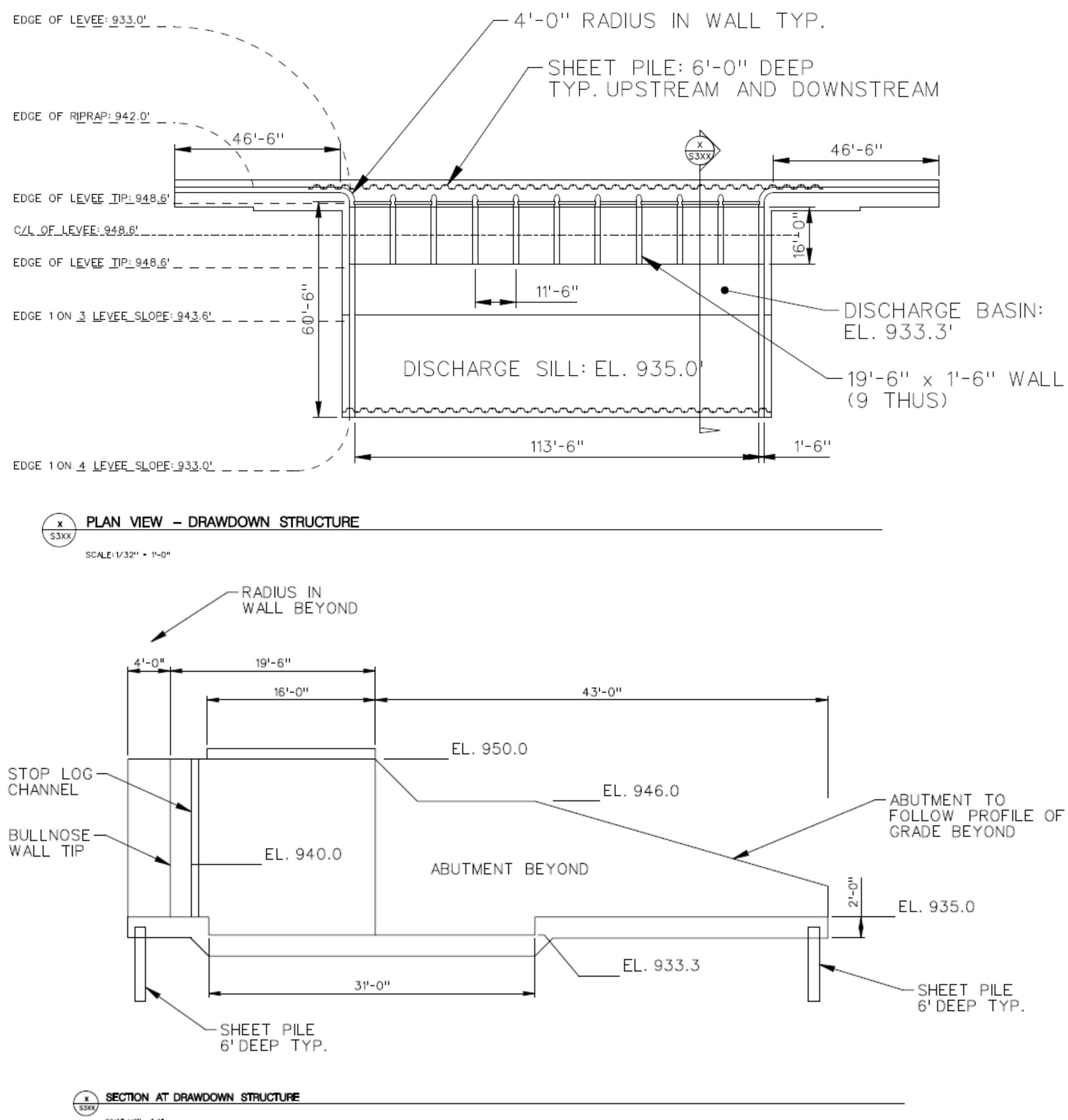


Figure 4-7. Conceptual design of a drawdown water control structure for the Marsh Lake Dam.

The drawdown structure would be 113.5-feet wide with 10 bays. The water control structure would have a 16-ft wide walkway across the top that could serve a secondary purpose as part of a trail across the dam in the future.

The structure would enable drawdown of approximately 90 percent of the lake to elevation 935 ft for winter drawdowns, dewatering approximately 3,569 acres of lake bed (Figure 4-8).

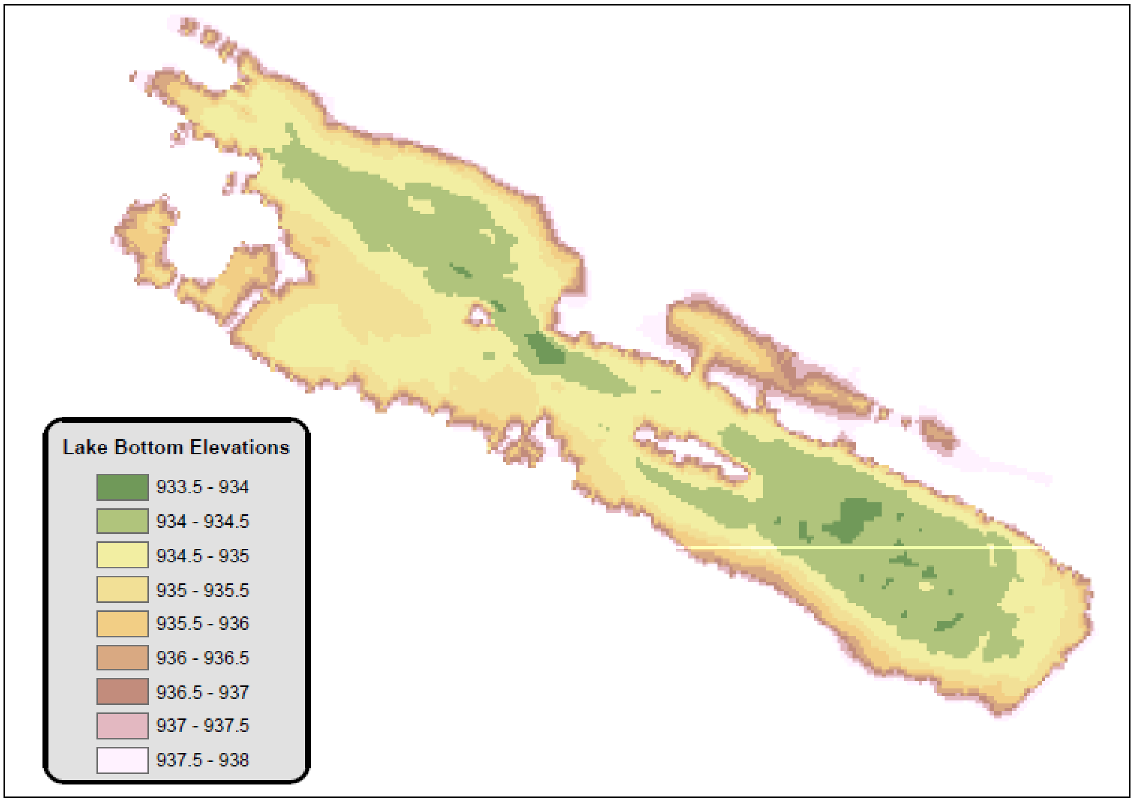


Figure 4-8. Marsh Lake flooded area outline at different water surface elevations.

Growing season drawdowns of the Marsh Lake pool should maintain a minimum elevation of 936.0 ft to prevent mainland predators from accessing the colonial bird nesting islands. Growing season drawdowns would expose 2625 acres of lake bed, allowing germination of emergent aquatic plants.

The frequency of drawdowns would be based on the extent of emergent aquatic vegetation. When the area of emergent aquatic vegetation in Marsh Lake falls below 1500 acres (see Objective 5 above), a growing season drawdown would be conducted the next year if river discharge allows.

Winter Drawdowns to Reduce Carp Abundance

Winter drawdowns would reduce the volume of water in Marsh Lake and the amount of available dissolved oxygen, imposing hypoxia stress and winterkill on carp. Winter drawdowns would stress other fish species and would kill most submersed aquatic plants except sago pondweed, which is the most common submersed aquatic plant in Marsh Lake and the target species for structural enhancement to the ecosystem. Sago pondweed is resistant to freezing if snow covers the dewatered sediment. Winter drawdowns on Marsh Lake would also require a water control structure in the Marsh Lake Dam to allow active water level management as described above. Winter drawdowns would be implemented following growing season drawdowns or separately as needed to limit carp abundance in Marsh Lake and meet project Objective 8. As noted above, winter drawdowns will stress the existing fish community, primarily dominated by invasive carp, but will allow native fish to reestablish within the lake in the following spring, ultimately shifting the dominance from invasive species to the native community. Winter drawdowns would be to the sill elevation of the stoplog control structure, 935.0 ft, leaving 2425 acres of water in Marsh Lake, most of which would freeze to the bottom.

4.1.7 Install Gated Culverts on Louisburg Grade Road

The existing culverts under the Louisburg Grade Road (Figures 4-9, 4-10) drain water from the upper end of Marsh Lake. The Louisburg Grade Road is owned and maintained by Akron Township of Big Stone County. The culverts are deteriorating and should be replaced. A natural river levee of higher ground exists along the Minnesota River upstream of the Louisburg Grade Road. New culverts with stoplogs would allow active management of water levels in the upper end of Marsh Lake.

Water levels in the upper part of Marsh Lake could be managed separately from the main body of the lake. For example, high water levels could be maintained for a time in early spring to provide flooded marsh habitat upstream of the Louisburg Grade Road for spawning northern pike and to improve survival of young-of-year fish. The stop logs could then be removed to allow the fish to return to Marsh Lake.

Figure 4-9. Culverts under the Louisburg Grade Road at the upper end of Marsh Lake.

Figure 4-10. Location of culverts under the Louisburg Grade Road at the upper end of Marsh Lake.

Water levels in the upper part of Marsh Lake could also be managed separately from the main body of the lake to provide deeper marsh habitat during years when growing season drawdowns are implemented on Marsh Lake. This would provide habitat for nesting waterfowl and furbearers when much of the rest of Marsh Lake is dewatered.

4.1.8 Install Gated Culverts and Pump System on Abandoned Fish Pond

The abandoned fish pond on the downstream side of the Marsh Lake Dam (Figure 4-11) currently is shallow un-vegetated aquatic habitat without connection to Lac qui Parle. If the existing inlet and outlet structures were rehabilitated or new ones installed, the abandoned fish pond could be operated as a moist soil management area to produce food for shorebirds and waterfowl, and/or to provide spawning habitat for northern pike. If it were to be operated as a moist soil management unit, a pump would be needed to maintain low water levels for emergent plant germination.

4.1.9 Breach Dike on Abandoned Fish Pond

Breaching the dike in one or more places on the abandoned fish pond would allow water levels within it to be the same as in the upper end of Lac qui Parle, and would allow fish access to the area. The shallow abandoned fish pond area would also provide shorebird habitat during times when Lac qui Parle water level is low.

Figure 4-11. Marsh Lake Dam with abandoned fish rearing pond at upper right.

4.1.10 Breach or Remove Marsh Lake Dam

The Marsh Lake dam would be removed or breached in several locations, allowing free flow of the Minnesota River into Lac Qui Parle.

4.1.11 Construct Islands in Marsh Lake

Islands can be constructed to break up wind fetch, reduce sediment resuspension, encourage the growth of submersed aquatic vegetation, provide protected areas for fish and waterfowl, and to provide loafing habitat for colonial waterbirds (Figures 4-12 and 4-13). The size, layout and number of islands that would most effectively reduce wind fetch and wave action on Marsh Lake was designed using a wind fetch model (Rohweder et al. 2008) (See Section 2.4).

Additional considerations were applied to the island design by the DNR to avoid public use, and navigation problems. A variety of island designs were considered, ranging from simple rock breakwaters to islands that incorporate mud flats and ponds within them. Given the adequate number of existing islands for nesting colonial waterbirds on Marsh Lake, no additional islands are needed for bird nesting.

This alternative measure consists of simple rock islands that break wave action. Islands of this type also shelter areas allowing submersed aquatic plants to grow and they also provide sheltered feeding and resting areas for birds.

Figure 4-12. Constructed rock island sheltering aquatic vegetation. Pool 9, Mississippi River.

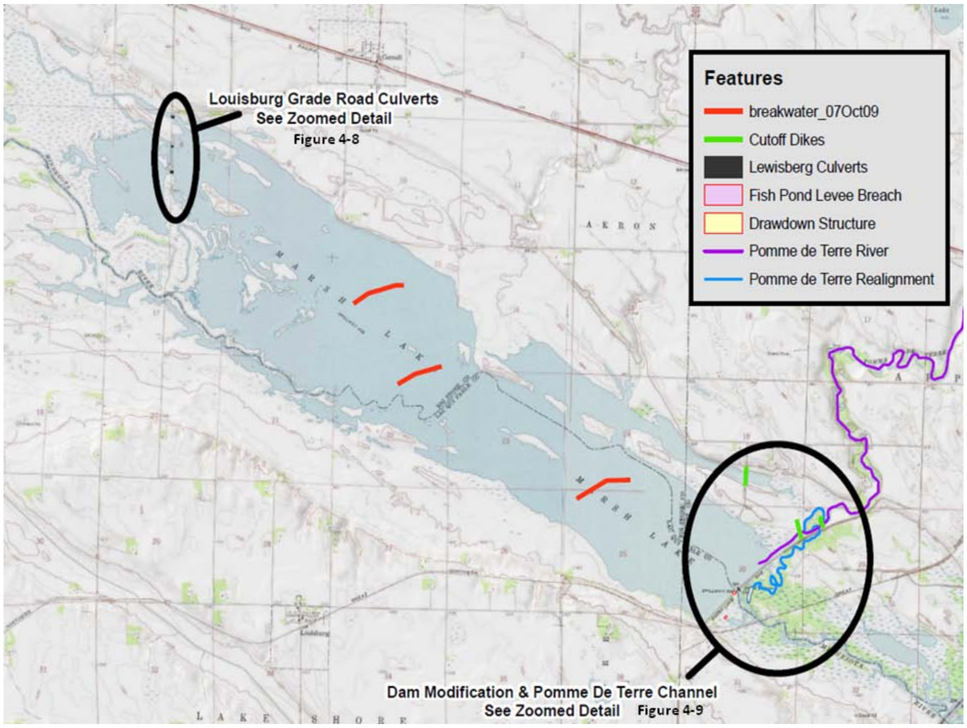


Figure 4-13. Location of potential rock breakwater islands (red) in Marsh Lake.

The rock islands would be constructed of local rock (quarry scrap and from farm fieldstone piles, not "mined" from native prairie areas). The rock islands would likely be built during winter when the lake is drawn down. The rock islands would be built to a top elevation of 940.3 ft, with a top width of 5 ft and side slopes of 3 to 1. Breakwater A (northernmost) would be 2647 ft long. Breakwater B (middle) would be 2153 feet long, and Breakwater C (southernmost) would be 2466 feet long. A total of 41,045 cubic yards of rock would be used to construct the breakwater islands.

4.1.12 Construct Exclosures to Prevent Grazing and Plant Submersed Aquatic Vegetation

Submersed aquatic vegetation can be planted in shallow lakes where the seed bank is exhausted or propagules are scarce. Seeds and propagules can be obtained from commercial nurseries or harvested from the wild. After seeds and propagules have been planted, they require protection from grazing. Exclosures are typically netting suspended from stakes to exclude carp. Once sufficient area of submersed aquatic vegetation is established, the exclosures can be removed and the vegetation cover may expand.

4.2 Screening of the Alternative Measures

Identified alternative measures must be evaluated in their effectiveness in achieving planning objectives while simultaneously complying with administrative, policy, legal and environmental constraints. From Section 3, objectives and constraints were identified as follows:

<table>
<tr><th>Objectives</th><th></th><th>Constraints</th></tr>
<tr><td>1. Reduced sediment loading to Marsh Lake over the 50-year period of analysis</td><td rowspan="9"></td><td rowspan="2">1. The planning process must be consistent with all applicable Federal laws, Executive Orders, Agency Regulations and other applicable policy.</td></tr>
<tr><td>2. Restored natural fluctuations to the hydrologic regime of Marsh Lake over the 50-year period of analysis</td></tr>
<tr><td>3. Restored geomorphic and floodplain processes to the Pomme de Terre River over the 50-year period of analysis</td><td rowspan="2">2. The formulation of alternative measures should avoid, to the greatest extent possible, the reduction of the flood damage reduction benefits provided by the dams.</td></tr>
<tr><td>4. Reduced sediment resuspension within Marsh Lake over the 50-year period of analysis</td></tr>
<tr><td>5. Increased extent, diversity and abundance of emergent and submersed aquatic plants within Marsh Lake over the 50-year period of analysis</td><td rowspan="5">3. In its existing condition, Marsh Lake and the Pomme de Terre River provide functional habitat for a number of species. A universal constraint in the planning of ecosystem restoration projects is the maxim that the restoration activities should not degrade, but rather seek to improve, the existing function of the ecosystem from its current state. Consideration of the potential adverse impacts to species within the project area therefore imposes constraints on the development of alternative measures. Specific biotic considerations include:

a. American Pelicans – a colony of nesting and breeding pelicans inhabits Marsh Lake during the summer months. Pelicans seek refuge on islands in the lake. Changes to water levels within the lake should minimize the impact on the isolation of these islands.

b. Mussels – A diverse mussel community exists within the lower reaches of the Pomme de Terre River. Consideration of project alternatives should minimize the impacts to this community and its future viability.

c. Fish Community – while the community is primarily dominated by common carp (an invasive species), Lac qui Parle and Marsh Lake also support communities of native fish. Changes to water levels resulting from alternative measures must minimize the negative impact on the native fish community, particularly valuable northern pike spawning habitat in the upper end of Marsh Lake.</td></tr>
<tr><td>6. Increased availability of waterfowl habitat within Marsh Lake over the 50-year period of analysis</td></tr>
<tr><td>7. Restored aquatic habitat connectivity between Marsh Lake, the Pomme de Terre River and Lac Qui Parle over the 50-year period of analysis</td></tr>
<tr><td>8. Reduced abundance of aquatic invasive fish species within Marsh Lake over the 50-year period of analysis</td></tr>
<tr><td>9. Increased diversity and abundance of native fish within Marsh Lake and the Pomme de Terre River over the 50-year period of analysis</td></tr>
</table>

Not all the potential alternative measures identified can or should be implemented in the Marsh Lake Ecosystem Restoration project. In addition to the objectives and constraints, three screening criteria were used to identify the alternative management measures retained for further consideration:

1) Could the management action be implemented as part of the Marsh Lake Project?
2) Would the management action be ecologically effective?
3) Would the management action be practicable from an engineering perspective?

Table 4-2 Assessment of the viability of the alternative measures.

Alternative Measures	Can be Implemented as part of Marsh Lake Project?	Ecologically Effective?	Practicable from Engineering Perspective?	Retain for Further Consideration?
No Action	Yes	No	Yes	Yes (for comparison with other alternatives)
Watershed BMPs	No	Yes	Yes	No
Wetland restorations in watershed	No	Yes	Yes	No
Streambank stabilization in watershed	No	Yes	Yes	No
Restore Pomme de Terre River to its former channel	Yes	Yes	Yes	Yes
Modify Marsh Lake Dam to attain target water levels/construct fishway	Yes	Yes	Yes	Yes
Drawdowns to restore emergent aquatic plants, control carp, modify Marsh Lake Dam	Yes	Yes	Yes	Yes
Install gated culverts Louisburg Grade Road	Yes	Yes	Yes	Yes
Install gated culverts and pump system in abandoned fish pond	Yes	No	No	No
Breach dike on abandoned fish pond	Yes	Yes	Yes	Yes
Breach or remove Marsh Lake Dam	Yes	Yes	No	No
Construct islands in Marsh Lake	Yes	Yes	Yes	Yes
Construct exclosures, plant submersed aquatic plants	Yes	Potentially	No	No

No action to restore the Marsh Lake ecosystem continues to impose unnaturally high water levels with only passive water level variability, relying on droughts to reduce inflows to zero and lower water level in Marsh Lake below the level of the fixed crest weir. This alternative measure would not meet the project objectives. It will be retained for further consideration because it is part of the without-project future baseline condition.

A variety of watershed BMPs can be implemented to moderate the hydrologic regime and reduce sediment and nutrient loading to Marsh Lake and Lac qui Parle. These are all actions that can and hopefully will be implemented by private landowners, other agencies and organizations under other programs. These alternative measures are being evaluated in the Minnesota River Basin Integrated Watershed Study. These alternative measures will not be retained for further consideration in the Marsh Lake project. They are actions that extend throughout the Upper Minnesota River Basin and are beyond the scope of the Marsh Lake project.

Lowering the water level within the abandoned fish pond area to below the level of Lac qui Parle would require pumping. Given the small size (10 acres) of this area, lack of DNR interest in active water level management in this area and the relatively high cost of pumps and operation and maintenance, this alternative measure has been dropped from further consideration.

Removing Marsh Lake dam would continuously lower the water level of Marsh Lake, allowing it to fluctuate along with the water level in Lac qui Parle reservoir. Much of Marsh Lake would become dewatered, reverting to wet meadow and marsh with the Minnesota River channel running through it. The potential for extensive areas of emergent and submersed aquatic vegetation providing food for migratory waterfowl would be significantly reduced. The colonial waterbird nesting islands would become vulnerable to predation and the colonial waterbirds would have restricted foraging area. In its current state, the Marsh Lake Dam does provide a minor benefit to flood damage reduction by storing the head of minor flooding in the upstream portion of the reservoir. Removing the hydraulic constriction of the Marsh Lake dam would reduce the head and storage upstream and would have the potential to increase the risk of downstream flooding damages. For these reasons, this alternative measure was dropped from further consideration.

Constructing exclosures to prevent carp grazing and planting submersed aquatic plants would be difficult in Marsh Lake due to fluctuating water levels and the wind and wave conditions that occur there. A sufficiently abundant seed and propagule bank for sago pondweed is present that allows abundant growth in years when growing conditions permit, so the seed bank is not a problem. For these reasons, this alternative measure was dropped from further consideration.

The alternative measures retained for further consideration (Table 4-3) derive from the ecosystem objectives for the project and are considered promising for implementation; potentially ecologically effective and practicable from an engineering perspective. Estimated costs of these alternative measures are provided in Table 4-3 and in Appendix G. The alternative measures will be combined into the alternative plans.

Table 4-2. Alternative measures retained for further consideration.

1) No Action
2) Restore Pomme de Terre River to its former channel
3) Modify Marsh Lake Dam to attain target water levels, construct fishway
4) Construct a drawdown water control structure to enable water level drawdowns and restore aquatic plants
5) Install gated culverts in Louisburg Grade Road
6) Breach dike at abandoned fish pond
7) Construct islands in Marsh Lake

Table 4-3. Costs of the alternative measures.

Alternative Measure Number	Alternative Measures	Net Benefit (AAHU)	First Costs of Construction	O&M Cost	Planning, Engineering & Design (PED)	Construction Management (CM)	Total First Project Costs	Average Annual Costs
1	No Action	0	$ -	$ -	$ -	$ -	$ -	$ -
2	Restore Pomme de Terre River to its former channel	6567	$ 3,448,212	$ 11,508	$ 387,945	$ 193,973	$ 4,030,130	$ 203,588
3	Modify Marsh Lake Dam to attain target	483	$ 1,399,695	$ 7,245	$ 154,433	$ 77,216	$ 1,631,344	$ 85,382
4	Construct drawdown water control structure	725	$ 2,594,217	$ 13,503	$ 278,993	$ 139,496	$ 3,012,706	$ 157,782
5	Install gated culverts in Louisburg Grade Road	610	$ 448,902	$ 800	$ 52,815	$ 26,408	$ 528,125	$ 26,105
6	Breach dike at abandoned fish pond	5	$ 6,426	$ 50	$ 870	$ 435	$ 7,731	$ 421
7	Construct islands in Marsh Lake	239	$ 4,006,254	$ 20,376	$ 448,875	$ 224,438	$ 4,679,567	$ 244,535

4.3 Alternative Plans

Alternative plans are combinations of alternative measures that would contribute to attaining the planning objectives. A stand alone measure is an alternative measure that can be implemented independently of others, resulting in some positive amount of ecosystem restoration output. Optional measures are those measures that would have limited utility by themselves, but can be implemented with other measures.

4.3.1 Stand Alone Measures

Measure 1 – No Action

The Corps is required to consider the option of “No Action” as one of the alternatives. With the No Action plan, which is synonymous with the “Without Project Condition,” we assume that no project would be implemented by the Federal Government or by local interests to achieve the planning objectives. The No Action plan forms the basis from which all other alternative plans are measured.

Measure 2 – Restore the Pomme de Terre River to its former channel

This is a stand-alone measure that could be implemented independently of other restoration alternatives. Earthen berms would be constructed to re-route the river into its former channel both upstream and downstream of the Marsh Lake Dam access road embankment. This alternative would include a bridge over the river to maintain access to the Marsh Lake Dam and monitoring of the mussel community as described in Section 4.1.4 above.

Measure 3 - Modify Marsh Lake Dam to attain target water levels, construct fishway

This is a stand-alone measure that could be implemented independently of other restoration alternatives. Marsh Lake Dam would be modified with a fixed-crest weir fishway that would allow passive attainment of target water levels in most years and also allow continuous fish passage between Lac qui Parle and Marsh Lake.

Measure 4 – Construct a drawdown water control structure in Marsh Lake Dam

This is a stand-alone measure that could be implemented independently of other restoration alternatives. Marsh Lake Dam would have to be modified with a water control structure to enable water level management. Growing season drawdowns to elevation 936.0 ft would be done to encourage reestablishment of emergent aquatic plants and to increase the extent of submersed aquatic plants, particularly sago pondweed, an important source of forage for waterfowl. Following growing season drawdowns, winter drawdowns to elevation 935.0 ft could be implemented to reduce carp abundance.

Measure 5 – Install gated culverts in Louisburg Grade Road

. Installing stoplog control structures on the Louisburg Grade Road culverts would enable holding water in upper Marsh Lake in years when a growing season drawdown was conducted, allowing northern pike to successfully spawn in the flooded marsh vegetation and the young to grow into juveniles. Implementation of this measure is dependent on the construction of a drawdown structure and would only be effective in drawdown years on the lake. The measure is considered stand alone, but will only be combined with Alternative Plan combinations that include the drawdown structure for the purpose of plan formulation.

Measure 6 – Breach dike at abandoned fish pond

This is a stand-alone measure that could be implemented independently of other restoration alternatives. Breaching the fish pond dike on the downstream side of the Marsh Lake Dam would provide connectivity between the fish pond area and the upper end of Lac qui Parle, allowing native floodplain vegetation to become established and providing seasonally variable habitat for fish and shorebirds.

Measure 7 – Construct islands in Marsh Lake

This is a stand-alone measure that could be implemented independently. Constructing islands to break up wave action and reduce sediment resuspension would improve conditions for submersed aquatic plant growth. Although this is a stand-alone measure, it would be best to construct islands in Marsh Lake in conjunction with growing season and winter drawdowns (Measure 4) and modifying Marsh Lake Dam to attain target water levels (Measure 3). Growing season drawdowns would consolidate lake bed sediment, reducing sediment resuspension. Winter drawdowns would reduce carp abundance and grazing on submersed aquatic plants.

5. Optimization and Best Buy Analysis

Environmental plan evaluation consists of a comparison of the environmental outputs and the economic costs of alternative plans. The cost effectiveness and incremental cost analysis procedures provide a framework to assist in environmental plan evaluation. The following analysis was accomplished using the planning methodology incorporated in the Institute of Water Resources Cost Effectiveness and Incremental Cost Analysis program (IWR-PLAN). Combinations of solutions were derived and a total cost and total output is calculated for each combination. The program then conducts cost effectiveness analysis; first identifying the least cost combination for every possible level of output, and then identifying the cost effective set of combinations by screening out plans where more output could be provided by another combination at the same or less cost. Once the cost effective set of combinations is identified, the program calculates the incremental cost and incremental output of moving from each combination to the next larger combination. The program also identifies the subset of the cost effective set which is the most efficient in production, or “best-buys”, as scale increases from the smallest to the largest combination.

Alternatives evaluated include the no action alternative and various combinations of restoration measures. The ecosystem output variable is stated in average annual habitat units (AAHU). Project outputs were determined by estimating the additional amount of enhanced Marsh Lake aquatic habitat, Marsh Lake emergent marsh habitat, Pomme de Terre River aquatic habitat, and floodplain wetland habitat that would be provided by each alternative using a Habitat Evaluation Procedures (HEP) analysis (Appendix E).

Representative species and guilds used in the HEP analysis were diving ducks for Marsh Lake aquatic habitat, walleye for Lac qui Parle and Pomme de Terre River aquatic habitat, northern pike for Lac qui Parle and upper Marsh Lake aquatic habitat and great blue heron for the abandoned fish pond wetland habitat. U.S. Fish and Wildlife Service "Blue Book" models and an Upper Mississippi River diving duck habitat model were used in the HEP analysis No relative value weighting of the habitat type areas potentially affected by the Marsh Lake project was conducted. Details of the HEP analysis are provided in Appendix E.

Cost estimates for the alternative plans were based on October 2011 price levels. Details of the cost estimate are provided in Appendix G. The first costs of implementation include detailed design, contracting, construction, planting, and monitoring. Recurring operation and maintenance activities following construction and habitat restoration were estimated over the 50-year project life and included in the cost estimate. Average annual costs were calculated by multiplying the first costs with operation and maintenance (OMRR&R) costs by an Interest and Amortization Factor for 4 1/8 percent (0.04125) over the 50 year period of analysis.

Plan formulation through IWR-Plan generated 48 alternative plans. Table 5 -1 presents the alternative plan combinations and Table 5-2 presents individual alternative measure average annual cost estimates at March 2011 price levels, as well as the estimated benefits (in average annual habitat units, AAHU'S). Alternative plans range from the no action alternative with no costs and no benefits to the 48th combination (identified as Alternative Plan 5) that has an average annual cost of $717,831with benefits of 8,508 AAHU's.

Table 5-1. Alternative plans with average annual benefits and average annual costs

No.	Restore Pomme de Terre	Modify Marsh Lake Dam	Drawdown Structure	Louisburg Grade Road Gated Culverts	Modify Abandoned Fish Pond	Construct Islands in Marsh Lake		Average Annual Habitat Units (AAHU)		Average Annual Costs		Average Costs per AAHU	Best Buy Plan
1								0		$ -		$ -	*
2					x			5		$ 421		$ 84.20	
3						x		239		$ 244,535		$ 1,023.16	
4					x	x		244		$ 244,956		$ 1,003.92	
5		x						483		$ 85,382		$ 176.77	
6		x			x			488		$ 85,803		$ 175.83	
7		x				x		722		$ 329,917		$ 456.95	
8			x					725		$ 157,782		$ 217.63	
9		x			x	x		727		$ 330,338		$ 454.39	
10			x		x			730		$ 158,203		$ 216.72	
11			x			x		964		$ 402,317		$ 417.34	
12			x		x	x		969		$ 402,738		$ 415.62	
13		x	x					1208		$ 243,164		$ 201.29	
14		x	x		x			1213		$ 243,585		$ 200.81	
15		x	x			x		1326		$ 487,699		$ 367.80	
16		x	x		x	x		1331		$ 488,120		$ 366.73	
17			x	x				1335		$ 183,887		$ 137.74	
18			x	x	x			1340		$ 184,308		$ 137.54	
19			x	x		x		1574		$ 428,422		$ 272.19	
20			x	x	x	x		1579		$ 428,843		$ 271.59	
21		x	x	x				1818		$ 269,269		$ 148.11	
22		x	x	x	x			1823		$ 269,690		$ 147.94	
23		x	x	x		x		1936		$ 513,804		$ 265.39	
24		x	x	x	x	x		1941		$ 514,225		$ 264.93	
25	x							6567		$ 203,588		$ 31.00	*
26	x				x			6572		$ 204,009		$ 31.04	*
27	x					x		6806		$ 448,123		$ 65.84	
28	x				x	x		6811		$ 448,544		$ 65.86	
29	x	x						7050		$ 288,970		$ 40.99	
30	x	x			x			7055		$ 289,391		$ 41.02	
31	x	x				x		7289		$ 533,505		$ 73.19	
32	x		x					7292		$ 361,370		$ 49.56	
33	x	x			x	x		7294		$ 533,926		$ 73.20	
34	x		x		x			7297		$ 361,791		$ 49.58	
35	x		x			x		7531		$ 605,905		$ 80.45	
36	x		x		x	x		7536		$ 606,326		$ 80.46	
37	x	x	x					7775		$ 446,752		$ 57.46	
38	x	x	x		x			7780		$ 447,173		$ 57.48	
39	x	x	x			x		7893		$ 691,287		$ 87.58	
40	x	x	x		x	x		7898		$ 691,708		$ 87.58	
41	x		x	x				7902		$ 387,475		$ 49.04	
42	x		x	x	x			7907		$ 387,896		$ 49.06	*
43	x		x	x		x		8141		$ 632,010		$ 77.63	
44	x		x	x	x	x		8146		$ 632,431		$ 77.64	
45	x	x	x	x				8385		$ 472,857		$ 56.39	
46	x	x	x	x	x			8390		$ 473,278		$ 56.41	*
47	x	x	x	x		x		8503		$ 717,392		$ 84.37	
48	x	x	x	x	x	x		8508		$ 717,813		$ 84.37	*

Table 5-2. Cost and benefits (Average Annual Habitat Units) of alternative measures (October 2011 price levels).

Alternative Measure Number	Alternative Measures	Net Benefit (AAHU)	Total First Project Costs	Average Annual Costs	Annualized Cost (per AAHU)
1	No Action	0	$ -	$ -	$ -
2	Restore Pomme de Terre River to its former channel	6567	$ 4,030,130	$ 203,588	$ 31
3	Modify Marsh Lake Dam to attain target water levels, construct fishway	483	$ 1,631,344	$ 85,382	$ 177
4	Construct drawdown water control structure	725	$ 3,012,706	$ 157,782	$ 218
5	Install gated culverts in Louisburg Grade Road	610	$ 528,125	$ 26,105	$ 43
6	Breach dike at abandoned fish pond	5	$ 7,731	$ 421	$ 84
7	Construct islands in Marsh Lake	239	$ 4,679,567	$ 244,535	$ 1,023

Interest and Amoritization on Factor for 4-1/8% interest (0.04125) over the 50 year payment period.

To further refine the number of alternative plans remaining, criteria to distinguish the cost effectiveness of each alternative were established. The screening for cost effectiveness included the following:

- The same output level could be produced by another plan at less cost;
- A larger output level could be produced at the same cost; or
  A larger output level could be produced at less cost.

Five alternative plans (including the "No Action" alternative) emerged as cost-effective and were identified as "Best Buy" plans through incremental and cost effectiveness analysis using the Corps of Engineers IWR Planning Suite (Table 5-1, Figure 5-1). In the figure below, a blue best-fit straight line is included to identify the trend in cost-effective plans, while a red best-fit curve is included to illustrate the array of best buy plans within chart.

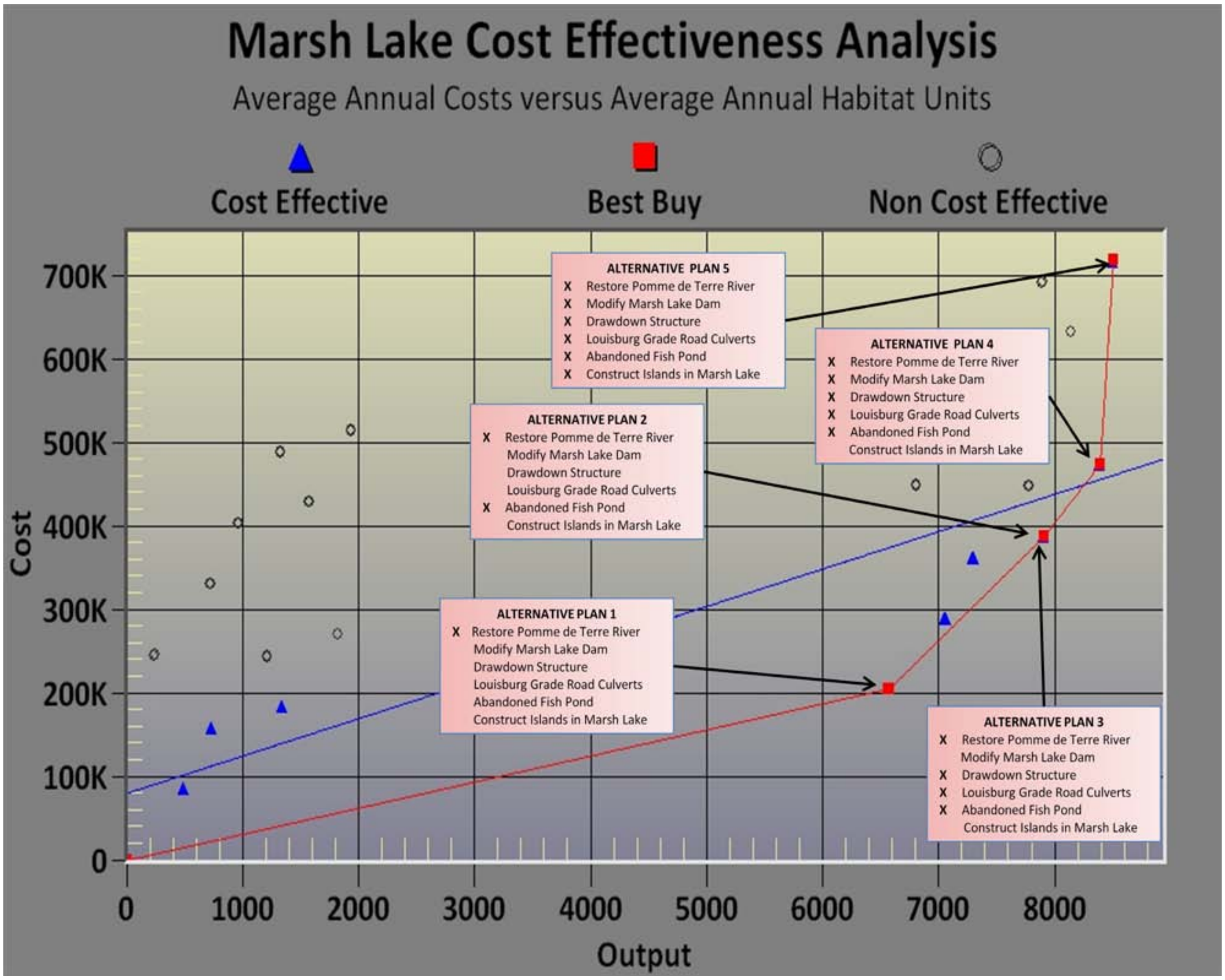


Figure 5-1 Results of incremental and cost effectiveness analysis of the alternative plans. Average annual costs (y-axis costs) versus average annual habitat units (x-axis benefits)

Figure 5-15 further highlights information included in Table 5-1 by illustrating the average annual cost per unit (cost of one AAHU) for each plan contrasted with the corresponding cumulative ecosystem benefits of each plan. Best Buy/Alternative Plans are specifically identified within the graph.

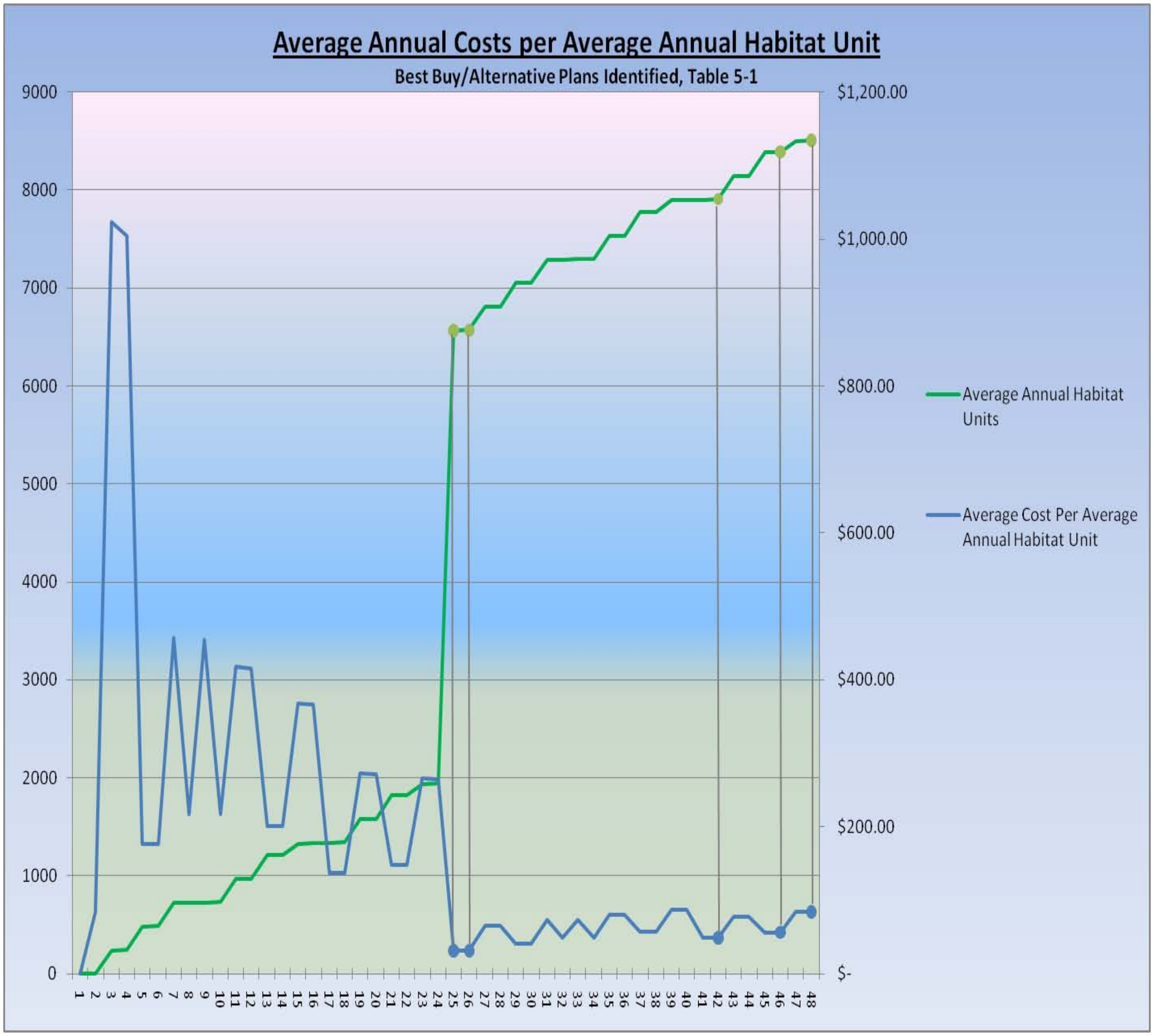


Figure 5-2 Average annual costs per average annual habitat units (Best Buy Plans Identified)

A best buy plan is a cost effective plan that has the greatest increase in output or benefit for the least increase in cost. Each cost effective plan was first compared to the no action alternative and ranked. This ranking provided the first best buy plan. From here, each remaining plan was compared to the first best buy plan and ranked. This analysis yielded the second best buy and so on. There can be multiple best buy plans and any of them can be chosen as the preferred alternative.

6. Evaluation and Comparison of Alternative Plans

6.1 Alternative Plans

The five best buy plans and the no action alternative are carried forward in the analysis and further described as alternative plans.

<u>Alternative Plan 0 (IWR Formulated Plan #1): No Action</u>

The no action alternative assumes that no project would be implemented by either the Corps or local interests to achieve the planning objectives. The no action alternative is synonymous with the without-project future condition.

<u>Alternative Plan 1 (IWR Formulated Plan #25)</u>

Alternative Plan 1 is the restoration of the Pomme de Terre River to its historic channel. The average annual cost of this plan is $203,588 and would result in 6,567 AAHU over 50 years.

<u>Alternative Plan 2 (IWR Formulated Plan #26)</u>

Alternative Plan 2 is a combination of restoration of the Pomme de Terre River described in Alternative Plan 1 with the addition of breaching the dike at the Abandoned Fish Pond in order to connect this area to the downstream area of Lac qui Parle. The average annual cost of this plan is $204,009 (average and would result in 6,572 AAHU over 50 years.

<u>Alternative Plan 3 (IWR Formulated Plan #42)</u>

Alternative Plan 3 is a combination of the restoration measures included in Alternative Plan 2 with the addition of a drawdown structure to lower lake levels periodically and construction of culverts with stoplogs at Louisburg Grade Road. The average annual cost of this plan is $387,896 and would result in 7,907 AAHU over 50 years.

<u>Alternative Plan 4 (IWR Formulated Plan #46)</u>

Alternative Plan 4 is a combination of Alternative 3 with the addition of modifying Marsh Lake Dam to meet target water levels and construct a fishway. The average annual cost of this plan is $473,278 and would result in 8,390 AAHU over 50 years.

Alternative Plan 5 (IWR Formulated Plan #48)

Alternative Plan 5 is a combination of all the alternative measures including constructing islands in Marsh Lake. The average annual cost of this plan is $717,813 and would result in 8508 AAHU over 50 years.

6.2 Evaluation of the Alternative Plans

The alternative plans are evaluated for their potential to contribute to achieving project objectives:

1. Reduced sediment loading to Marsh Lake over the 50-year period of analysis
2. Restored natural fluctuations to the hydrologic regime of Marsh Lake over the 50-year period of analysis
3. Restored geomorphic and floodplain processes to the Pomme de Terre River over the 50-year period of analysis
4. Reduced sediment resuspension within Marsh Lake over the 50-year period of analysis
5. Increased extent, diversity and abundance of emergent and submersed aquatic plants within Marsh Lake over the 50-year period of analysis
6. Increased availability of waterfowl habitat within Marsh Lake over the 50-year period of analysis
7. Restored aquatic habitat connectivity between Marsh Lake, the Pomme de Terre River and Lac Qui Parle over the 50-year period of analysis
8. Reduced abundance of aquatic invasive fish species within Marsh Lake over the 50-year period of analysis
9. Increased diversity and abundance of native fish within Marsh Lake and the Pomme de Terre River over the 50-year period of analysis

The narrative below discusses the degree to which the alternative plans would contribute to attaining the project objectives.

Objective 1: Reduced sediment and nutrient loading to Marsh Lake

Alternative Plan 0: No Action

The no-action plan would not meet this objective. Sediment and nutrient loading to Marsh Lake and Lac qui Parle would continue at high rates.

<u>Alternative Plan 1: Restore the Pomme de Terre River to its Historic Channel</u>

This alternative plan would significantly reduce sediment and nutrient loading to Marsh Lake. Sediment and nutrients conveyed by the Pomme de Terre River would enter the upper end of Lac qui Parle via the historic Pomme de Terre River delta. Much of the sediment and nutrient load would be retained in overbank areas in the floodplain, contributing to natural floodplain processes and reducing sediment and nutrient loading to Lac qui Parle.

<u>Alternative Plan 2: Restore Pomme de Terre River to its Historic Channel + Breach Dike at Abandoned Fish Pond</u>

This alternative plan would significantly reduce sediment and nutrient loading to Marsh Lake as described for Alternative Plan 1. In addition, breaching the abandoned fish pond dike would reconnect the fish pond area to the upper end of Lac qui Parle, providing the opportunity for retaining sediment and processing nutrients within the fish pond area.

<u>Alternative Plan 3: Alternative Plan 2 + Drawdown Structure + Gated Culverts at Louisburg Grade Road</u>

This alternative plan would significantly reduce sediment and nutrient loading to Marsh Lake as described for Alternative Plan 2. The drawdown structure would enable drawdowns on Marsh Lake to restore aquatic vegetation. Increased extent of aquatic vegetation would retain sediments and nutrients in Marsh Lake, reducing sediment and nutrient loading to Lac qui Parle. Stoplog structures under the Louisburg Grade Road would only be operated during years when Marsh Lake is drawn down to enable successful spawning by northern pike in upper Marsh Lake. This would have a minor positive contribution to Objective 1 by retaining sediment and nutrients in upper Marsh Lake during the years when Marsh Lake is drawn down.

<u>Alternative Plan 4 – Alternative Plan 3 + Modify Marsh Lake Dam to Attain Target Water Levels and Construct Fishway</u>

This alternative plan would significantly reduce sediment and nutrient loading to Marsh Lake as described for Alternative Plan 3. In addition, Modifying Marsh Lake Dam with a fishway would result in lower late summer and winter water levels in Marsh Lake. This would encourage aquatic vegetation in Marsh Lake, trapping sediment and nutrients in Marsh Lake, thereby reducing sediment and nutrient loading to Lac qui Parle.

Alternative Plan 5 – Alternative 4 + Construct Islands in Marsh Lake (All alternative measures)

This alternative plan would significantly reduce sediment and nutrient loading to Marsh Lake as described for Alternatives 4. Constructing islands in Marsh Lake would further promote aquatic vegetation in Marsh Lake, trapping sediment and nutrients in Marsh Lake, thereby reducing sediment and nutrient loading to Lac qui Parle.

Objective 2: Restored natural fluctuations the water level regime in Marsh Lake

Alternative Plan 0: No Action

The no action plan would not meet the objective of restoring a more natural water level regime in Marsh Lake.

Alternative Plan 1: Restore Pomme de Terre River to its Historic Channel

Restoring the Pomme de Terre River to its former channel would help restore a more natural water level regime in Marsh Lake by moderating water level fluctuations induced by storm runoff events in the Pomme de Terre River watershed. This would be a minor but positive effect. The fixed crest Marsh Lake Dam would continue to limit the low side of the water level regime in Marsh Lake.

Alternative Plan 2: Restore Pomme de Terre River to its Historic Channel + Breach Dike at Abandoned Fish Pond

This alternative plan would help restore a more natural water level regime in Marsh Lake as described for Alternative Plan 1. Breaching the dike on the abandoned fish pond would have no effect on the water level regime in Marsh Lake.

Alternative Plan 3: Alternative Plan 2 + Drawdown Structure + Gated Culverts at Louisburg Grade Road

This alternative would meet the objective of restoring a more natural water level regime in Marsh Lake by enabling drawdowns of Marsh Lake to consolidate sediment and restore emergent aquatic plants. The drawdowns would simulate natural low water events that occurred on Marsh Lake prior to impoundment. The gated culverts at the Louisburg Grade Road would allow successful spawning of northern pike in upper Marsh Lake in years when Marsh Lake is drawn down. Northern pike spawn in flooded emergent marsh vegetation.

Alternative Plan 4 – Alternative Plan 3 + Modify Marsh Lake Dam to Attain Target Water Levels and Construct Fishway

This Alternative Plan would meet the objective of restoring a more natural water level regime as described for Alternative Plan 3. In addition, modifying Marsh Lake Dam with a fishway would result more natural lower late summer and winter water levels in Marsh Lake nearly every year through passive water level management.

Alternative Plan 5 – Alternative 4 + Construct Islands in Marsh Lake (All alternative measures)

This Alternative Plan would meet the objective of restoring a more natural water level regime as described for Alternative Plan 4 above. Constructing islands would have no effect on the Marsh Lake water level regime, however islands would be effective in reducing wind-driven waves and sediment resuspension, thereby promoting growth of submersed aquatic plants (Objectives 4 and 5).

Objective 3: Restored natural geomorphic and floodplain processes in Pomme de Terre River

Alternative Plan 0: No Action

The no-action plan would not restore geomorphic and floodplain processes in the Pomme de Terre River.

Alternative Plan 1: Restore Pomme de Terre River to its Historic Channel

This alternative plan would restore geomorphic and floodplain processes in the Pomme de Terre River and its delta at its historic confluence with the Minnesota River in upper Lac qui Parle. The Pomme de Terre River would flow through its former channel in its confluence with the Minnesota River, resuming the fluvial processes that form the complex channel and floodplain habitats in that area. Sediment conveyed by the river would be deposited overbank in the delta area during higher discharge events, enriching floodplain soils, enhancing floodplain habitats and reducing sediment and nutrient loading into Lac qui Parle.

Alternative Plan 2: Restore Pomme de Terre River to its Historic Channel + Breach Dike at Abandoned Fish Pond

This alternative plan would restore geomorphic and floodplain processes as described for Alternative Plan 1. In addition, breaching the dike at the abandoned fish pond would reconnect the fish pond area with the upper end of Lac qui Parle, enabling movement of water, materials and organisms between that area and the rest of the floodplain. Although not directly contributing to restoring geomorphic and floodplain processes in the Pomme de Terre River, it would restore floodplain processes in upper Lac qui Parle across the Minnesota River from the Pomme de Terre River confluence.

Alternative Plan 3: Alternative Plan 2 + Drawdown Structure + Gated Culverts at Louisburg Grade Road

This alternative plan would also restore geomorphic and floodplain processes in the Pomme de Terre River and its delta as described for Alternative Plan 2.

Alternative Plan 4 – Alternative Plan 3 + Modify Marsh Lake Dam to Attain Target Water Levels and Construct Fishway

This alternative plan would also restore geomorphic and floodplain processes in the Pomme de Terre River and its delta as described for Alternative Plan 2.

Alternative Plan 5 – Alternative 4 + Construct Islands in Marsh Lake (All alternative measures)

This alternative plan would also restore geomorphic and floodplain processes in the Pomme de Terre River and its delta as described for Alternative Plan 2.

Objective 4: Reduced sediment resuspension in Marsh Lake

Alternative Plan 0: No Action

The no action alternative would not meet the objective for reduced sediment resuspension in Marsh Lake.

Alternative Plan 1: Restore Pomme de Terre River to its Historic Channel

Alternative Plan 1 would not meet the objective for reduced sediment resuspension in Marsh Lake.

<u>Alternative Plan 2: Restore Pomme de Terre River to its Historic Channel + Breach Dike at Abandoned Fish Pond</u>

Alternative Plan 2 would not meet the objective for reduced sediment resuspension in Marsh Lake.

<u>Alternative Plan 3: Alternative Plan 2 + Drawdown Structure + Gated Culverts at Louisburg Grade Road</u>

Alternative Plan 3 would contribute to achieving reduced sediment resuspension in Marsh Lake. Drawdowns would consolidate sediment and encourage the reestablishment of emergent aquatic vegetation which upon return to normal water levels would greatly reduce wind fetch and sediment resuspension in Marsh Lake.

<u>Alternative Plan 4 – Alternative Plan 3 + Modify Marsh Lake Dam to Attain Target Water Levels and Construct Fishway</u>

Alternative Plan 4 would also contribute to achieving reduced sediment resuspension as described for Alternative Plan 3. In addition, modifying Marsh Lake Dam with a fishway would result more natural lower late summer and winter water levels in Marsh Lake nearly every year through passive water level management. This would encourage the establishment and persistence of emergent aquatic vegetation that would reduce wind fetch and sediment resuspension.

<u>Alternative Plan 5 – Alternative 4 + Construct Islands in Marsh Lake (All alternative measures)</u>

This alternative plan would greatly contribute to reducing sediment resuspension as described for Alternative Plan 4. In addition, rock wave barrier islands are very effective in reducing wind fetch, wave action and sediment resuspension and have been designed to optimally reduce wind fetch and wave action on Marsh Lake.

Objective 5: Increased extent, diversity and abundance of emergent and submersed aquatic plants in Marsh Lake

Alternative Plan 0: No Action

The no action plan would not meet this objective. Submersed aquatic plants would remain sparse and emergent vegetation would be limited to a narrow fringe around the shores.

Alternative Plan 1: Restore Pomme de Terre River to its Historic Channel

This alternative plan would contribute to increased submersed aquatic vegetation in Marsh Lake by reducing sediment loading from the Pomme de Terre River and by moderating the water level regime in Marsh Lake. Reduced sediment loading would reduce turbidity, allowing more underwater light necessary for submersed aquatic plant growth. A more natural water level regime would reduce periods of high water, also contributing to submersed aquatic plant growth.

Alternative Plan 2: Restore Pomme de Terre River to its Historic Channel + Breach Dike at Abandoned Fish Pond

Like Alternative Plan 1, this alternative plan would contribute to increased submersed aquatic vegetation in Marsh Lake. Breaching the dike in the abandoned fish pond may increase submersed aquatic plant growth in that area.

Alternative Plan 3: Alternative Plan 2 + Drawdown Structure + Gated Culverts at Louisburg Grade Road

Alternative Plan 3 would greatly contribute to increased aquatic vegetation in Marsh Lake. In addition to the positive effects of re-routing the Pomme de Terre River on submersed aquatic plants in Marsh Lake as described for Alternative Plan 2, drawdowns would enable reestablishment of emergent aquatic plants. Drawdowns consolidate bottom sediment, reducing sediment resuspension and allowing the seeds of emergent aquatic plants to germinate in the dewatered area. Upon return to normal water levels, the increased extent of emergent aquatic plants would reduce wind fetch and sediment resuspension, allowing more submersed aquatic plant growth. Winter drawdowns would reduce abundance of common carp that graze on submersed aquatic plants.

Alternative Plan 4 – Alternative Plan 3 + Modify Marsh Lake Dam to Attain Target Water Levels and Construct Fishway

Alternative Plan 4 would increase the extent and abundance of aquatic vegetation in Marsh Lake as described for Alternative Plan 3. In addition, modifying Marsh Lake Dam with a fishway would result in more natural lower late summer and winter water levels in Marsh Lake nearly every year through passive water level management. This would encourage the establishment and persistence of emergent aquatic vegetation.

Alternative Plan 5 – Alternative 4 + Construct Islands in Marsh Lake (All alternative measures)

This alternative plan would increase the extent and abundance of aquatic vegetation as described for Alternative Plan 4. In addition, the rock wave barrier islands would physically reduce wind fetch, wind-driven wave action and sediment resuspension over much of Marsh Lake, greatly contributing to growth of submersed aquatic plants.

Objective 6: Increased availability of waterfowl habitat within Marsh Lake

Alternative Plan 0: No Action

The no action plan would not contribute to increased waterfowl habitat in Marsh Lake.

Alternative Plan 1: Restore Pomme de Terre River to its Historic Channel

This alternative plan would contribute to increased availability of waterfowl habitat by increasing submersed aquatic vegetation needed by fall migrating waterfowl. Submersed aquatic vegetation would increase due to reduced sediment loading from the Pomme de Terre River and a moderated the water level regime in Marsh Lake.

Alternative Plan 2: Restore Pomme de Terre River to its Historic Channel + Breach Dike at Abandoned Fish Pond

This alternative plan would contribute to increased availability of waterfowl habitat as described for Alternative Plan 1. In addition, breaching the dike on the abandoned fish pond would restore habitat connectivity with the rest of Lac qui Parle, providing a shallow foraging area for fish-eating waterfowl.

Alternative Plan 3: Alternative Plan 2 + Drawdown Structure + Gated Culverts at Louisburg Grade Road

This alternative plan would greatly contribute to increased availability of waterfowl habitat as described for Alternative Plan 2. In addition, drawdowns would enable reestablishment of emergent aquatic plants. Increased extent of emergent aquatic plants would provide sheltered shallow water for nesting waterfowl and for migrating waterfowl. Drawdowns consolidate bottom sediment, reducing sediment resuspension and allowing more submersed aquatic plant growth. Increased submersed aquatic vegetation like sago pondweed and water celery would provide important food for fall migrating waterfowl.

Alternative Plan 4 – Combination of Alternative Plan 3 + Modify Marsh Lake Dam to Attain Target Water Levels and Construct Fishway

This alternative plan would greatly contribute to increased availability of waterfowl habitat as described for Alternative Plan 3. In addition, modifying Marsh Lake Dam with a fishway would result in more natural lower late summer and winter water levels in Marsh Lake nearly every year through passive water level management. This would encourage the establishment and persistence of emergent aquatic vegetation, providing increased habitat and food for waterfowl.

Alternative Plan 5 – Alternative 4 + Construct Islands in Marsh Lake (All alternative measures)

This would be the most ecologically effective plan for restoring waterfowl habitat in Marsh Lake. In addition to the benefits of Alternative Plan 4, the rock wave barrier islands would allow more consistent growth of submersed aquatic vegetation and would provide wave-sheltered areas for resting migrating waterfowl.

Objective 7: Restored habitat connectivity for fish to migrate between Marsh Lake, the Pomme de Terre River and Lac Qui Parle

Alternative Plan 0: No Action

The no action plan would not improve habitat connectivity for fish.

Alternative Plan 1: Restore Pomme de Terre River to its Historic Channel

Alternative Plan 1 would significantly improve habitat connectivity for fish between Lac qui Parle and the Pomme de Terre River. Walleye, white bass, white suckers, shorthead redhorse and many other species would be able to migrate up the Pomme de Terre River to high quality spawning and nursery habitat. This alternative plan would not improve aquatic habitat connectivity between Lac qui Parle and Marsh Lake.

Alternative Plan 2: Restore Pomme de Terre River to its Historic Channel + Breach Dike at Abandoned Fish Pond

As with Alternative Plan 1, this alternative plan would improve habitat connectivity for fish between Lac qui Parle and the Pomme de Terre River, but it would not improve fish passage opportunity between Lac qui Parle and Marsh Lake. Breaching the dike on the abandoned fish pond would allow fish access into the abandoned fish pond from Lac qui Parle.

Alternative Plan 3: Alternative Plan 2 + Drawdown Structure + Gated Culverts at Louisburg Grade Road

Alternative Plan 3 would significantly improve habitat connectivity for fish between Lac qui Parle and the Pomme de Terre River as described for Alternative Plan 2. In addition, the gated culverts at the Louisburg Grade Road would allow northern pike in Marsh Lake to successfully spawn in upper Marsh Lake in years when the lake is drawn down.

Alternative Plan 4 – Combination of Alternative Plan 3 + Modify Marsh Lake Dam to Attain Target Water Levels and Construct Fishway

Alternative Plan 4 would significantly improve habitat connectivity for fish between Lac qui Parle, the Pomme de Terre River and Marsh Lake. The fishway in the Marsh Lake Dam would provide year-round aquatic habitat connectivity between Lac qui Parle and Marsh Lake.

Alternative Plan 5 – Alternative 4 + Construct Islands in Marsh Lake (All alternative measures)

This alternative plan would significantly improve fish habitat connectivity as described for Alternative Plan 4. The rock wave barrier islands in Marsh Lake would not impede fish movements.

Objective 8: Reduced abundance of aquatic invasive fish species in Marsh Lake

Alternative Plan 0: No Action

The no action plan would not contribute to increased abundance of native fish in Marsh Lake. Common carp would remain abundant.

Alternative Plan 1: Restore Pomme de Terre River to its Historic Channel

Alternative Plan 1 would contribute to increased abundance of native fish and reduced abundance of common carp in Marsh Lake. Reduced sediment loading would improve water clarity in Marsh Lake to the benefit of native fish. Diverting the Pomme de Terre River would reduce winter dissolved oxygen in Marsh Lake, reducing over-winter survival of common carp. Native fish like northern pike are better adapted to winter hypoxic conditions than are carp.

Alternative Plan 2: Restore Pomme de Terre River to its Historic Channel + Breach Dike at Abandoned Fish Pond

Alternative Plan 2 would contribute to increased abundance of native fish and reduced abundance of common carp as described for Alternative Plan 1. In addition, breaching the dike in the abandoned fish pond would add 15 acres of shallow aquatic habitat accessible by fish in Lac qui Parle.

Alternative Plan 3: Alternative Plan 2 + Drawdown Structure + Gated Culverts at Louisburg Grade Road

Alternative Plan 3 would contribute to increased abundance of native fish and reduced abundance of common carp as described for Alternative Plan 2. In addition, Marsh Lake drawdowns would restore aquatic vegetation and reduce carp abundance in Marsh Lake, increasing water clarity and providing increased food and cover for native fish. Winter drawdowns would be very effective in reducing the abundance of carp in Marsh Lake. The gated culverts under the Louisburg Grade Road would enable successful spawning by northern pike in upper Marsh Lake in years when the lake is drawn down.

Alternative Plan 4 – Combination of Alternative Plan 3 + Modify Marsh Lake Dam to Attain Target Water Levels and Construct Fishway

Alternative Plan 4 would contribute to increased abundance of native fish and reduced abundance of common carp as described for Alternative Plan 3. In addition, the fishway in the Marsh Lake Dam would provide year-round aquatic habitat connectivity between Lac qui Parle and Marsh Lake to the benefit of native fish populations.

Alternative Plan 5 – Alternative 4 + Construct Islands in Marsh Lake (All alternative measures)

Alternative Plan 5 would contribute to increased abundance of native fish and reduced abundance of common carp as described for Alternative Plan 4. The rock wave barrier islands would not impede fish movement in Marsh Lake and would provide hard substrate for macroinvertebrates that fish prey upon.

Objective 9: Increased diversity and abundance of native fish within Marsh Lake the Pomme de Terre River

Alternative Plan 0: No Action

The no action plan would not contribute to increased abundance of native fish in Marsh Lake or the Pomme de Terre River.

Alternative Plan 1: Restore Pomme de Terre River to its Historic Channel

Alternative Plan 1 would increase the diversity and abundance of native fish in the Pomme de Terre River. Walleye, white bass, white suckers, shorthead redhorse and many other species would be able to migrate up the Pomme de Terre River to high quality spawning and nursery habitat. Reliable access to high quality spawning habitat should improve reproductive success and contribute to increased migratory fish populations.

Alternative Plan 2: Restore Pomme de Terre River to its Historic Channel + Breach Dike at Abandoned Fish Pond

This alternative measure would increase diversity and abundance of fish in the Pomme de Terre River as described for Alternative 1. Breaching the dike at the abandoned fish pond would provide fish access to that area from Lac qui Parle.

Alternative Plan 3: Alternative Plan 2 + Drawdown Structure + Gated Culverts at Louisburg Grade Road

Alternative Plan 3 would increase the diversity and abundance of native fish in the Pomme de Terre River as described for Alternative Plan 2.

Alternative Plan 4 – Alternative Plan 3 + Modify Marsh Lake Dam to Attain Target Water Levels and Construct Fishway

Alternative Plan 4 would increase the diversity and abundance of native fish in the Pomme de Terre River as described for Alternative Plan 2. Construction of a fishway in the Marsh Lake Dam would effectively expand the area of aquatic habitat accessible to Pomme de Terre River fish, contributing to more optimal foraging, growth, survival and population sizes.

Alternative Plan 5 – Alternative 4 + Construct Islands in Marsh Lake (All alternative measures)

Alternative Plan 5 would contribute to increased abundance of native fish in the Pomme de Terre River as described for Alternative Plan 4. The rock wave barrier islands would not impede fish movements and would provide hard substrate for macroinvertebrates that fish prey upon.

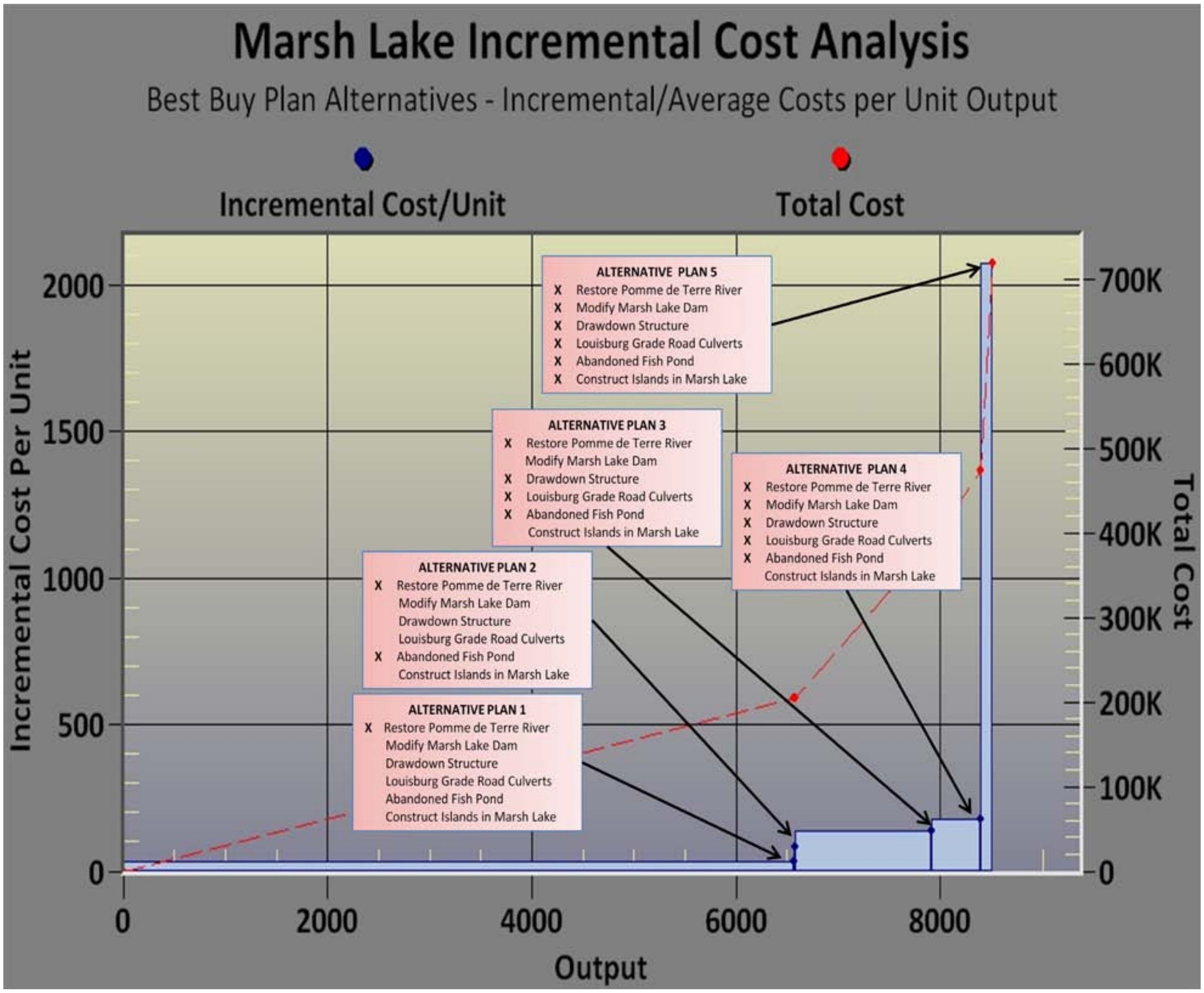
6.3 Alternative Plan Comparison: Incremental Cost Analysis

Incremental cost analysis compares the relative costs of alternative plans against each other. Incremental cost begins with the No Action Alternative and successively compares the cost per unit output of each plan to derive the additional benefit provided by each plan as well as the cost per unit incurred resulting from the selection of a given plan. The goal of this exercise is to identify which plans optimize efficiency of outputs in regards to cost. IWR Plan software is typically used for the purpose of this analysis. Results are included in Table 6-2 and Figure 6-1 below:

Table 6-2 Incremental costs of Best Buy/Alternative Plans

No.	Restore Pomme de Terre	Modify Marsh Lake Dam, Fishway	Drawdown Structure	Louisburg Grade Road Gated Culverts	Modify Abandoned Fish Pond	Construct Islands in Marsh Lake		Average Annual Habitat Units (AAHU)		Average Annual Costs		Average Costs per AAHU		Incremental Increase in Cost per AAHU	
0								0		$ -		$ -		$ -	
1	X							6567		$ 203,588		$ 31.00		$ 31.00	
2	X				X			6572		$ 204,009		$ 31.04		$ 84.20	
3	X		X	X	X			7907		$ 387,896		$ 49.06		$ 137.74	
4	X	X	X	X	X			8390		$ 473,278		$ 56.41		$ 176.77	
5	X	X	X	X	X	X		8508		$ 717,813		$ 84.37		$ 2,072.33	

Figure 6-1. Incremental analysis of the Best Buy/Alternative plans (October 2011, price level).



Increment 1, Restore Pomme de Terre River to its Historic Channel

Restoring the Pomme de Terre River to its former channel would re-connect aquatic habitat between Lac qui Parle and the Pomme de Terre River and reduce a major source of sediment loading to Marsh Lake. This measure provides the single highest level of benefit at the lowest cost per increment. The costs per average annual habitat unit (AAHU) for this increment is $31.00 with a projected total benefit of 6567 AAHU. In terms of cost efficiency, Increment 1 provides the greatest benefits at the lowest costs.

Increment 2, Breach Dike at Abandoned Fish Pond

Increment 2 is the additional measure of breaching the abandoned fish pond dike. The incremental increase in costs per average annual habitat unit (AAHU) for this increment is $84.20 and a total cumulative benefit of 6572 AAHU.

Increment 3, Drawdown Structure + Gated Culverts at Louisburg Grade Road

Increment 3 is the construction of a stoplog water control structure to lower lake levels periodically and construction of culverts at Louisburg Grade Road. The incremental increase in costs per average annual habitat unit (AAHU) for this increment is $137.74 and a total cumulative benefit of 7907 AAHU.

Increment 4, Modify Marsh Lake Dam to Attain Target Water Levels and Construct Fishway

Increment 4 is the modification of the Marsh Lake dam for passive water level management as well as construction of a fishway. The incremental increase in costs per average annual habitat unit (AAHU) for this increment is $176.77 and a total cumulative benefit of 8390 AAHU.

Increment 5, Construct Islands in Marsh Lake

Increment 5 is the addition of breakwater islands in Marsh Lake in combination with the full array of alternatives. The incremental increase in costs per average annual habitat unit (AAHU) for this increment is $2072.33 and a total cumulative benefit of 8508 AAHU.

6.4 Completeness, Effectiveness, Efficiency, Acceptability

USACE ER 1105-2-100 states that the selected plan should meet “planning objectives and constraints and reasonably maximize environmental benefits while passing tests of cost effectiveness and incremental cost analysis, significance of outputs, acceptability, completeness, efficiency and effectiveness.” These terms are defined as the following:

Completeness – the extent to which an alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of all planned effects.

Effectiveness – The extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities, as established in the planning objectives.

Efficiency – the extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specified opportunities as established in the planning objectives, consistent with protecting the nation's environment.

Acceptability – the workability and viability of the alternative plan with respect to acceptance by state and local entities and the public compatibility with existing laws, regulations and public policies.

An ordered ranking of the five plans is included in Table 6-3. (1=Highest Rank, 5=Lowest Rank)

Table 6-3. Rank order of the Marsh Lake project alterative plans by completeness, effectiveness, efficiency and acceptability.

Ordered Ranking of Plan Alternatives					
	Criteria				
	Completeness	Effectiveness	Efficiency	Acceptability	Average
Alternative Plan 1	1	5	1	5	3.0
Alternative Plan 2	1	4	2	4	2.8
Alternative Plan 3	1	3	3	3	2.5
Alternative Plan 4	1	2	4	2	2.3
Alternative Plan 5	1	1	5	1	2.0

While Alternative Plan 5 is the plan which maximizes the net environmental benefits, it is even more important to recognize that the Marsh Lake is a dynamic system that is influenced by a combination of factors that result in its current degraded state. Improving conditions within the lake is contingent upon fully addressing each of the ecosystem restoration objectives outlined in Section 3.4. Acknowledging that implementation of any of the identified measures alone or in combination would provide benefits to the lake ecosystem, Alternative Plan 5 is the only plan which would include the full array of measures to address all of the problems and ecosystem restoration objectives identified by this Feasibility Study. Implementation of these alternative measures in combination would provide the greatest potential for successfully changing the Marsh Lake ecosystem state. While Alternative Plan 4 is slightly more efficient than Alternative Plan 5, the latter plan ultimately ranks higher in each of the remaining selection criteria.

6.5 Comparison of Effects of the Alternative Plans

Table 6.2 is a summary of relative impacts of the alternative plans. Each resource category has a relative impact range from -6 to +6 for long term and short term effects. The relative impacts for each plan are combined (added) to identify the relative cumulative effects for each alternative plan.

Negative values indicate negative impacts, 0 depicts no effect, and positive values represent benefits. The values indicate relative level of impact. N/A indicates not applicable. The values do not distinguish temporal or spatial scales, but are provided as a relative indicator of the magnitude of impacts. The sum of all the values provides a general overall comparison of the alternative plans. Alternative Plan 5 would have the most overall benefits in addition to the largest summation of long-term benefits.

Table 6-1. Relative effects of the alternative plans for ecosystem restoration at Marsh Lake.

Resource	Allternative Plan 0 No Action		Alternative Plan 1 Restore Pomme de Terre River to its former channel		Alternative Plan 2 Restore Pomme de Terre River to its former channel + Breach Dike at Abandoned Fish Pond		Alternative Plan 3 Alternative Plan 2 + Drawdown Structure + Louisburg Grade Road Culverts		Alternative Plan 4 Alternative Plan 3 + Modify Marsh Lake Dam to Attain Target Water Levels and Construct Fishway		Alternative Plan 5 Alternative Plan 4 + Construct Islands	
Time Duration S = Short L = Long	S	L	S	L	S	L	S	L	S	L	S	L
Vegetation	-5	-5	-4	-4	-3	-3	3	5	4	5	4	6
Wildlife	-5	-5	1	2	2	3	3	5	4	5	4	6
Aquatic Resources	-5	-5	2	3	2	4	3	5	4	5	4	6
T&E Species	0	0	-1	4	-1	4	-1	4	-1	4	-1	4
Wetlands	-5	-5	1	2	1	3	1	5	1	6	1	6
Floodplains	-2	-6	1	1	1	1	1	1	1	1	1	1
Aesthetics	-4	-4	1	3	1	3	1	4	1	5	1	6
Land Use	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cultural Resources	0	0	0	0	0	0	0	0	0	0	0	0
Recreation	0	0	3	3	3	3	3	4	4	5	4	6
Socioeconomics	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Transportation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HTRW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Air Quality	0	0	0	0	0	0	0	0	0	0	0	0
Noise	0	0	0	0	0	0	0	0	0	0	0	0
River Geomorphology	-2	-2	2	4	2	4	2	4	2	4	2	4
Surface Water	-3	-3	-2	-2	-2	-2	3	5	4	5	4	6
Stormwater	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Utilities/Public Services	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sum	-31	-35	4	16	6	20	19	42	24	45	24	51
Overall	-1.55	-1.75	0.2	0.8	0.3	1	0.95	2.1	1.2	2.25	1.2	2.55

6.6. Summary of Environmental Effects of the Alternative Plans

Impacts of the alternative plans are described below and in Appendix D, the Section 404(b)(1) Clean Water Act Evaluation.

Alternative Plan 0: No Action

The no action alternative plan would result in the without-project future conditions described in Section 2.10 above. This alternative plan would not meet the project objectives for ecosystem restoration.

Alternative Plan 1: Restore Pomme de Terre River to its Historic Channel

Restoring the Pomme de Terre River to its former channel would re-connect aquatic habitat between Lac qui Parle and the Pomme de Terre River. A number of native fish species like walleye, white suckers, white bass, and northern pike would be able to gain access to the relatively high quality habitat in the Pomme de Terre River for spawning and feeding. This increased access to higher quality habitat would have positive effects on the size and fitness of the fish populations and resiliency of the fish community.

Although mussels in the lower reach of the Pomme de Terre River between the cut-off embankment and Marsh Lake would be killed by construction and lack of river flow, native mussels are expected to colonize the newly restored channel.

Fish in Marsh Lake would be subject to more severe low dissolved oxygen conditions during winter with the Pomme de Terre River diverted back into its former channel. This would reduce abundance of carp which contribute to turbidity and sediment resuspension. Northern pike are tolerant of low dissolved oxygen conditions during winter and the project would create conditions that generally favor native species. Sediment loads originating from the Pomme de Terre River would be eliminated within Marsh Lake as a result of the restoration of the Pomme de Terre to its historic channel. This reduction in sediment load will have a beneficial impact on the turbidity and overall water quality within the lake.

Restoring the Pomme de Terre River to its former channel would directly disturb the soil in the borrow area where material to construct the cut-off embankments would be removed. The area is currently an upland agricultural field. The borrow area would be covered with topsoil and planted with native vegetation. The borrow area would become more prone to flooding and would support native wet meadow vegetation.

Placing fill for the channel cut-off embankment to divert the Pomme de Terre River into its original channel would directly cover approximately 0.3 acres of the diverted portion of the river channel. All macroinvertebrates in the filled area would be killed. The area would be converted from aquatic habitat to terrestrial habitat.

No excavation of the historic channel will be required in order to reroute the Pomme de Terre River. Once rerouted into its former channel, the lower Pomme de Terre River would scour out approximately 1425 cubic yards of fine silty sediment that has accumulated in its former channel through natural processes. Some of that material would be deposited over-bank in the river floodplain; the rest of the material would be transported into Lac qui Parle.

Pomme de Terre River flow would be diverted into the historic river channel flowing into the Minnesota River downstream of the existing Marsh Lake Dam. The reach of the existing channel between the cut-off embankment and Marsh Lake would cease to flow. Most of the macroinvertebrates and mussels in that channel would die due to lack of flow and low dissolved oxygen. In addition, sediment loads previously entering Marsh Lake would flow into Lac qui Parle. Suspended sediment loading to Lac qui Parle would not change given the proximity of the existing Pomme de Terre outlet to the Marsh Lake Dam spillway. During higher levels of river discharge, sediment from the Pomme de Terre River would flow overbank and be deposited in the floodplain near the confluence with the Minnesota River.

Alternative Plan 2: Restore Pomme de Terre River to its Historic Channel + Breach Dike at Abandoned Fish Pond

This alternative plan would have the same impacts as Alternative Plan 1 described above. The additional measure of breaching the abandoned fish pond dike would not have adverse environmental effects and would provide fish in Lac qui Parle access to the fish pond area. The fish pond area would provide habitat for shorebirds and fish-eating birds.

Alternative Plan 3: Alternative Plan 2 + Drawdown Structure + Gated Culverts at Louisburg Grade Road

Alternative Plan 3 would have the effects described for Alternative Plan 2 above. Constructing the water control structure and replacing the culverts at Louisburg Grade Road would include temporary and localized increased suspended solids during construction. Growing season drawdowns of Marsh Lake would be done to restore emergent aquatic vegetation and winter drawdowns would be done to reduce carp abundance. Drawdowns would not be done every year, but as needed to restore vegetation and reduce carp abundance. Winter drawdowns should reduce carp abundance, grazing by carp on aquatic vegetation and macroinvertebrates, and sediment resuspension by carp. Drawdowns of Marsh Lake water level would kill benthic macroinvertebrates and some species of submersed aquatic plants in the dewatered areas. Sago pondweed, the target species of forage for migratory waterfowl, should persist through winter conditions noted above, thereby increasing in abundance within the lake.

The increased extent and abundance of emergent aquatic plants would provide food and habitat for many wetland species and would reduce wind-driven wave action and sediment resuspension.

Drawdowns of Marsh Lake water level would not go below elevation 936.0 to avoid dewatering the area between the colonial nesting bird islands and the shoreline to maintain protection of the islands from predators like foxes, coyotes, raccoons and skunks.

Installing water control structures in the Louisburg Grade Road culverts would allow northern pike to gain access to upper Marsh Lake and successfully spawn in years when Marsh Lake is drawn down.

Alternative Plan 4: Alternative Plan 3 + Modify Marsh Lake Dam to Attain Target Water Levels and Construct Fishway

This alternative plan would have the impacts as described for Alternative Plan 3. Construction of the fishway weir structure would result in localized and temporary increases in suspended solids. The fishway weir would provide passive water control for Marsh Lake water levels, restoring a more natural annual stage hydrograph. The fishway weir would provide target late summer and winter water levels that are lower than currently occur. This would improve growth of aquatic vegetation in Marsh Lake. The fishway would provide habitat connectivity for fish to move between Lac qui Parle and Marsh Lake, increasing the available habitat. Construction of a fishway weir would remove the dangerous ogee-crest spillway, improving safety at the dam for visitors.

Alternative Plan 5: Alternative Plan 4 + Construct Islands in Marsh Lake

This alternative plan would have impacts as described for Alternative Plan 4. In addition, construction of islands in Marsh Lake would result in localized and temporary increases in suspended solids. Benthic macroinvertebrates in the footprint of the islands would be killed. The islands would effectively reduce wind fetch, wave action and sediment resuspension in a large area in Marsh Lake, providing conditions more conducive to growth of submersed aquatic plants. Increased growth of submersed aquatic plants would provide food for waterfowl. The submersed plants would further reduce wind fetch and sediment resuspension resulting in clearer water for native fish. The rock islands would provide hard substrate for filter-feeding macroinvertebrates like caddisflies that are food for fish. The rock islands would provide sheltered resting areas for migrating waterfowl.

6.7 Effects on Environmental Resources

Table 6-2 is an environmental impact assessment matrix which provides a cursory overview contrasting the social, natural resource, economic, and cultural effects between the Action Alternative Plans (Alternative Plans 1-5) and the No-Action Alternative. All Action Alternative Plans are included categorically within the matrix and are assumed to bear effects increasing incrementally between plans.

Table 6-2. Environmental impact assessment matrix for the Marsh Lake project.

IMPACT ASSESSMENT MATRIX

NAME OF PARAMETER	NO ACTION							ALL ACTION ALTERNATIVE PLANS						
	MAGNITUDE OF PROBABLE IMPACT							MAGNITUDE OF PROBABLE IMPACT						
	<--- INCREASING BENEFICIAL				INCREASING ADVERSE --->			<--- INCREASING BENEFICIAL				INCREASING ADVERSE --->		
	SIGNIFICANT	SUBSTANTIAL	MINOR	NO APPRECIABLE EFFECT	MINOR	SUBSTANTIAL	SIGNIFICANT	SIGNIFICANT	SUBSTANTIAL	MINOR	NO APPRECIABLE EFFECT	MINOR	SUBSTANTIAL	SIGNIFICANT
A. SOCIAL EFFECTS														
1. Noise Levels				X							X			
2. Aesthetic Values					X					X				
3. Recreational Opportunities						X			X					
4. Transportation				X							X			
5. Public Health and Safety					X					X				
6. Community Cohesion (Sense of Unity)				X							X			
7. Community Growth & Development				X							X			
8. Business and Home Relocations				X							X			
9. Existing/Potential Land Use				X							X			
10. Controversy				X							X			
B. ECONOMIC EFFECTS														
1. Property Values				X							X			
2. Tax Revenues				X							X			
3. Public Facilities and Services				X						X				
4. Regional Growth				X							X			
5. Employment				X							X			
6. Business Activity				X							X			
7. Farmland/Food Supply				X							X			
8. Commercial Navigation				X							X			
9. Flooding Effects				X							X			
10. Energy Needs and Resources				X							X			
C. NATURAL RESOURCE EFFECTS														
1. Air Quality				X								X		
2. Terrestrial Habitat				X							X			
3. Wetlands						X			X					
4. Aquatic Habitat						X			X					
5. Habitat Diversity and Interspersion						X			X					
6. Biological Productivity						X			X					
7. Surface Water Quality						X			X					
8. Water Supply				X							X			
9. Groundwater				X							X			
10. Soils				X							X			
11. Threatened or Endangered Species				X								X		
D. CULTURAL EFFECTS														
1. Historic Architectural Values				X							X			
2. Pre-Hist & Historic Archeological Values				X							X			

6.7.1 Aesthetic Values

With the no action alternative, degradation of the existing natural resources at the site currently does and will continue to have a minor adverse impact on aesthetics for visitors to the site. Implementation of any of the Action Alternative Plans will increase the resource values and subsequent aesthetics of the site through improvements to area natural resources, namely Marsh Lake and the Pomme de Terre River. As the Action Alternative Plans increase in scale, the beneficial impact to resources increases. Winter fish kills will likely result in a temporary impact to aesthetics at the site, however, the rural nature of the management area will not present any lasting impact to area residents in the form of odor or other aesthetics.

6.7.2 Recreational Opportunities

With the no action alternative, recreational users of the site will experience a lower quality recreational experience in the future due to aging recreation infrastructure and degraded ecosystem values. Implementation of the stand-alone Recreation Plan will increase the resource value and recreational experience at the site through improvements to area natural resources and recreational infrastructure. As the Action Alternative Plans increase in scale, the beneficial impact to resources increases. The recreation plan proposed for the site will substantially improve opportunities for wildlife viewing, fishing and hunting at the site. Recreation will be temporarily impacted during construction, particularly around the dam. An existing canoe landing on the Pomme de Terre River will be relocated to the historic channel, but full recreational use of the site will be restored following project completion.

6.7.3 Transportation

None of the Alternative Plans impact any major roads or waterways. During construction, the hauling of materials and equipment may cause brief and temporary detours.

6.7.4 Public Health and Safety

As with all water control structures, there is an inherent risk of drowning, particularly in areas where recreation and water control structures coexist, as in the case of Marsh Lake Dam. As noted previously in Section 3, a drowning death did occur at the dam in 1991. While such incidents are infrequent, the dam does pose a minor threat to the safety of visitors to the site. Any of the Action Alternative Plans involving the modification of the Marsh Lake Dam (Alternative Plans 3-5) will improve the safety at the site through alteration to the hydraulic roller on the downstream portion of the dam, resulting from construction of the fishway. Reducing the hydraulic roller will have a minor increase to public safety at the site, but risk of accidental drowning will always remain.

6.7.5 Community Growth and Development

The recommended plan will likely benefit local income and employment due to construction activities.

6.7.6 Business and Home Relocations

None of the Alternative Plans are expected to have impact to housing, as the project area is not near any development and occurs entirely on public lands. During construction, temporary lodging may be needed in nearby communities for non-local workers.

6.7.7 Public Facilities and Services

As noted above in Section 6.7.2, with the no action alternative recreational users will experience a decline in the quality of public facilities over time due to aging infrastructure and degraded ecosystem values. Improving recreation with the Action Alternative Plans, as noted above, improves public facilities and the user experience offered by the Minnesota Department of Natural Resources as well as the U.S. Army Corps of Engineers.

6.7.8 Air Quality

Any construction activity at the site will result in a minor impact to local air quality. The effects will be temporary during the duration of construction.

6.7.9 Wetland Resources

Effects on aquatic and wetland resources are described in detail in Appendix D Section 404(b)(1) Clean Water Act Evaluation. Riparian wetlands along Marsh Lake, Lac qui Parle and the Pomme de Terre River will benefit from the ecosystem variability provided by natural resource improvements of the Action Alternative Plans recommended. Greater variation in water levels will allow for seasonal variability, consolidation of bottom sediments, reduced light attenuation from suspended sediment, increased abundance of submersed aquatic vegetation and increased abundance of emergent aquatic vegetation. Implementation of any of the Action Alternative plans would increase habitat quality for many wetland species by increasing the area of vegetated wetlands within the designated project area.

6.7.10 Aquatic Habitat

Aquatic habitat is substantially impact by the current conditions in Marsh Lake resulting from the multiple stressors of sediment loading, sediment resuspension, and lack of ecosystem connectivity and the dominance of invasive species. Implementation of any of the Action Alternative Plans will increase the aquatic habitat values of the site through addressing and alleviating stressors within Marsh Lake and the Pomme de Terre River. As the Action Alternative Plans increase in scale, the beneficial impact to resources increases (as summarized in Section 6.6).

6.7.11 Habitat Diversity and Interspersion

Similar to aquatic habitat noted above, habitat diversity and interspersion is substantially impact by the current conditions in Marsh Lake resulting from the multiple stressors of sediment loading, sediment resuspension, lack of ecosystem connectivity and the dominance of invasive species. Implementation of any of the Action Alternative Plans will increase both submersed and aquatic vegetation throughout Marsh Lake through addressing and alleviating stressors to the ecosystem. As the Action Alternative Plans increase in scale, the beneficial impact to resources increases (as summarized in Section 6.6).

6.7.12 Biological Productivity

Similar to aquatic habitat noted above, habitat diversity and interspersion is substantially impact by the current conditions in Marsh Lake resulting from the multiple stressors of sediment loading, sediment resuspension, lack of ecosystem connectivity and the dominance of invasive species. Implementation of any of the Action Alternative Plans will improve habitat quantity and quality and subsequently improve the biological productivity of waterfowl, fish and other organisms that depend on aquatic vegetation. As the Action Alternative Plans increase in scale, the beneficial impact to resources increases (as summarized in Section 6.6). Winter fish-kills occur periodically at the site in its existing condition and will continue to occur in the future with Action Alternative Plan implementation. Biological productivity of fish in Marsh Lake will be temporarily impacted during winters following drawdowns, however, improved ecosystem connectivity will allow for spring migration of fish from both the Minnesota River and Louisburg Grade Road area upstream as well as Lac qui Parle from the downstream end, ultimately improving the structure of the fishery from the current carp-dominated system. There is currently no plan to physically remove dead fish from the water following a winter fish-kill. Fish-kills under the ice are not assumed to impact biological oxygen demand as the majority of decomposition will occur simultaneously with spring flows and snow melt where dissolved oxygen levels within the lake will increase.

6.7.13 Surface Water Quality

Similar to aquatic habitat noted above, surface water quality is substantially impacted by the current conditions in Marsh Lake resulting from the multiple stressors of sediment loading, sediment resuspension, lack of ecosystem connectivity and the dominance of invasive species. Implementation of any of the Action Alternative Plans will improve long-term surface water quality throughout Marsh Lake by addressing and alleviating stressors to the ecosystem. As the Action Alternative Plans increase in scale, the beneficial impact to resources increases (as summarized in Section 6.6).

Rerouting the Pomme de Terre River into its historic channel will result in a temporary increase in sediment loading to Lac qui Parle. It is assumed that the historic channel will scour latent sediment over the course of the first season. Construction activities such as the diversion dikes of the Pomme de Terre River, the construction of a drawdown structure, the breaching of the abandoned fish pond dike, and the replacement of culverts at Louisburg Grade Road will result in exposed soil and bare slopes near surface waters. Erosion potential will be mitigated through the implementation and use of best management practices such as silt fence, erosion control blanket and temporary seeding during construction to minimize the negative impact on surface waters. Through use of best management practices, no adverse effects are anticipated from soil erosion near project features during construction.

6.7.14 Endangered Species

No Federally-listed threatened or endangered species occur in the Marsh Lake project area. Bald eagles nest and feed in the area. They are no longer listed as a Federal endangered species, but they are still protected by the Bald and Golden Eagle Protection Act. None of the alternative plans would affect any Federally-listed threatened or endangered species.

The bald eagle is a state-listed threatened species. The Dakota skipper is a rare prairie butterfly that occurs in the project area that is a candidate for state listing. The Pomme de Terre River has regionally significant populations of elktoe mussels (*Alasmidonta marginata* – state-listed as threatened) and black sandshell (*Ligumia recta* – state-listed as special concern). Mussels living near the existing outlet of the Pomme de Terre River would be adversely affected by the rerouting of the river. Re-routing the

Pomme de Terre River would include monitoring of mussels in the restored channel and the mussel population is expected to fully recover following project completion.

6.7.15 Cultural Resources

The area of potential effects for the Marsh Lake ecosystem restoration project consists of Marsh Lake dam and embankment, the pre-dam/restored Pomme de Terre River channel above and below the dam embankment, the cutoff dike locations above the dam embankment, the culverts along Louisburg Grade Road, the locations in Marsh Lake where three breakwater islands would be constructed, the abandoned fish rearing pond below the dam, and a proposed borrow area for material to construct the cutoff dikes for re-routing the Pomme de Terre River. The lakeshore and island shorelines at Marsh Lake is part of the area of potential effects for future growing season drawdowns, which can only occur after installation of the proposed water management structure at Marsh Lake Dam's existing emergency spillway and installation of stoplog structures at the culverts through Louisburg Grade Road.

Marsh Lake Dam (SW-APT-003) is currently the only historic property listed on or determined eligible to the National Register of Historic Places which will be directly affected by any modifications to the dam. When Marsh Lake Dam was built, the Pomme de Terre River was diverted to enter the reservoir above its dam embankment. Restoring the river to its pre-dam channel would involve cutting a notch through the Marsh Lake Dam embankment at the old river channel and constructing a bridge over the channel notch to allow continued access to the dam. The restored channel would not be dredged or otherwise modified so no disposal area would be needed. The flow of the Pomme de Terre River would be allowed to scour accumulated sediment and debris from the old channel. The diverted river channel would be abandoned. Earthen cutoff dikes or plugs would be constructed across two low areas and the diverted river channel above the dam embankment to prevent Marsh Lake from spilling into the restored river channel at times of high water. No archeological sites were located along the pre-dam/restored Pomme de Terre River channel or the cutoff dike locations during the 2008 Phase I cultural resources survey of these areas (Magner 2008). Any potential borrow area to be used for cutoff dike construction material will have a cultural resources survey conducted and coordination under Section 106 of the National Historic Preservation Act completed with the Minnesota SHPO prior to its use for project construction. Any proposed borrow area containing archeological site(s) will not be used.

The existing fixed-crest spillway of Marsh Lake Dam would be modified into a rock nature-like fishway which will allow for fish passage between Marsh Lake and Lac qui Parle Lake downstream. A new water management structure with 12 stoplog bays would be constructed at the existing emergency spillway to allow future manipulation of Marsh Lake's water levels. Future growing season drawdowns of Marsh Lake would be used as needed to restore aquatic vegetation beneficial to waterfowl. A pedestrian and bicycle bridge would be constructed over the fishway and the new water management structure to allow passage over the dam as part of the Minnesota State Trail. These proposed changes will alter the overall appearance and design of Marsh Lake Dam and embankment, but will not change the original purpose of the dam or the overall Lac qui Parle Flood Control Project. A Memorandum of Agreement to cover mitigation of adverse effects of the ecosystem restoration project to Marsh Lake Dam will be negotiated with the Minnesota State Historic Preservation Officer (SHPO) and Advisory Council on Historic Preservation, with mitigation to be completed prior to beginning construction on the proposed modifications to the dam and its embankment.

Archeological sites 21LP33 and 21BS67 in lower Marsh Lake (between Marsh Lake Dam and Louisburg Grade Road) and archeological sites 21LP36, 21BS47 and the Area J Granite Quarry site in upper Marsh Lake (between Louisburg Grade Road and Highway 75) may be eligible to the National Register of Historic Places. None of these five sites will be directly affected by construction of the proposed ecosystem restoration features at Marsh Lake. Construction of the breakwater islands in Marsh Lake are intended to reduce wave-caused sediment resuspension and should reduce erosion of the shoreline and islands in the lake and thus should protect island site 21BS67 from further erosion. In addition, natural armoring of the lakeshore and island shorelines against future erosion has been taking place as past erosion has exposed and deposited rocks and cobbles from the glacial soils in these areas. Future water level drawdowns of lower Marsh Lake would expose land presently inundated along the current lakeshore and island shorelines. Such a drawdown would not directly affect site 21LP33, which is located on a ridgetop back from the current shoreline. Site 21BS67 should not be adversely affected as a drawdown of lower Marsh Lake should not induce further erosion at that island site's location. Future water level drawdowns on upper Marsh Lake would not affect sites 21LP36, 21BS47, or the Area J Granite Quarry due to their locations on raised areas within or adjacent to the marshes covering most of the bottomlands between Louisburg Grade Road and Highway 75.

The archeological survey identified additional sites that were determined not eligible to the National Register (site 21BS35 in lower Marsh Lake and sites 21BS41, 21BS42, 21BS43, 21BS44, 21BS45, and 21BS46 in upper Marsh Lake) (Minnesota SHPO letter dated January 16, 2002). No further cultural resources investigations need be conducted at their locations.

Coordination between the Corps and SHPO resulted in the determination that mitigation is required for impacts resulting from modifications to the Marsh Lake Dam. As a part of this agreement, the historical conditions of the Marsh Lake Dam will be properly documented prior to any construction or alternation at the site.

6.7.16 Environmental Justice

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," provides that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, 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 Executive Order makes clear that its provisions apply fully to programs involving Native Americans.

The proposed project will not have a disproportionately high adverse effect on minority or low income populations and is in compliance with EO 12898. The project is located in a rural area with few residents nearby. Native American communities in the region do not use Marsh Lake or Lac qui Parle for subsistence hunting, gathering or fishing. The project would generally have beneficial social and economic effects and would generally affect all persons equally.

6.7.17 Cumulative Effects

Cumulative effects are the impacts on the environment that 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 the actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The cumulative effects of past actions on natural resources in the Marsh Lake project area have been large. Land cover has been altered from native prairie to intensive agriculture. Streams and rivers in the Upper Minnesota River Basin have been impounded, channelized, and regulated for flood damage reduction. The economy of the area has changed markedly in the last two centuries.

For this feasibility study and environmental assessment, the effects of the Marsh Lake ecosystem restoration project are addressed for cumulative impacts. The future without-project condition is described in Section 2 above. Some reasonably foreseeable actions and related ecosystem conditions that are either being planned or considered by other agencies or groups in the project area include the following:

- Continued operation and maintenance of the Lac qui Parle Flood Control Project
- Continued use and management of the Lac qui Parle Wildlife Management Area as a wildlife and hunting area
- Continued agricultural use of much of the Upper Minnesota River Basin.
- Improving water quality conditions in the Minnesota River through watershed and water quality management efforts in the basin to reduce nutrient and sediment loading
- Continued management of the popular walleye fishery in Lac qui Parle by the DNR
- Continued and increasing recreation activity

Impacts of the alternative plans are summarized in this report under Section 6.6 for adverse and beneficial effects. The intent of the Marsh Lake project is to maximize the extent and impact of beneficial effects on Marsh Lake, Lac qui Parle and the Pomme de Terre River to achieve the project objectives and the goal of returning the Marsh Lake area ecosystem to a less degraded and more natural and functional condition. Individually, each management measure would have a beneficial effect to counteract the stressors acting upon the Marsh Lake area ecosystem.

Anthropogenic influences within the watershed will not change as a result of project implementation. Sediment and nutrient loading will continue from both the Minnesota and the Pomme de Terre Rivers. Future efforts at watershed and water quality management are expected to reduce sediment and nutrient loading to the Minnesota River. Implementation of the project will minimize the adverse impacts of sediment and nutrient loading on the resources within the project area leading towards achievement of the project objectives.

The habitat and land cover changes that would occur are described above. The Pomme de Terre River channel would be restored to its former channel and should remain in that geometry for the foreseeable future. The Marsh Lake Dam would be modified with a fixed crest fishway and a controllable outlet structure. Approximately 41,045 cubic yards of rock would be removed from nearby field stockpiles and placed in Marsh Lake to construct islands. Nonrenewable petroleum fuel would be used to power trucks, excavators, towboats, and other equipment used in the construction.

7. RECOMMENDED PLAN

The alternative plan that reasonably maximizes the benefits in relation to cost and meets the overall planning objects is Alternative Plan 4. Alternative Plan 4 is recommended as the National Ecosystem Restoration Plan (NER Plan), described below in Section 7.1. On a relative scale, the incremental increase between Alternative Plans 3 to 4 is high; however, when viewed relative to the costs of similar ecosystem restoration projects, the average costs per habitat unit are relatively low. The $56.41 per AAHU created by the project is extremely efficient in achieving the stated ecosystem objectives (see Figure 5-15) and therefore deemed reasonable in cost. While Alternative 5 maximized ecosystem outputs, the last increment (per Section 6) of $2072.33 was not found to be cost efficient for inclusion in the NER Plan. Future monitoring detailed in Appendix R will provide information on the need for the last increment through future analysis. The NER Plan has strong support from the non-Federal sponsor and is consistent with regional and State planning for the area.

7.1 National Ecosystem Restoration Plan Description

Alternative Plan 4 is a combination of five of the stand alone restoration measures which include:

- Restore the Pomme de Terre River to its historic channel - The Pomme de Terre River will be rerouted into its former channel in a meander loop upstream of Marsh Lake Dam and into the longer former channel downstream of the Marsh Lake Dam by constructing three earthen cut-off dikes (Figure 4-1). The total length of river channel that would be restored is approximately 11,500 feet. With an average 80-ft wide channel, approximately 21 acres of river channel would be restored. This action will reduce sediment loading, restore floodplain processes to the Pomme de Terre River delta downstream of the Marsh Lake Dam, a 293-acre area as well as restore connectivity between Lac qui Parle and the Pomme de Terre River.
- Breach dike at abandoned fish pond - Breaching the dike in the abandoned fish pond will allow water levels within it to be the same as in the upper end of Lac qui Parle, and would allow fish access to the area. The shallow abandoned fish pond area will also provide shorebird habitat during times when Lac qui Parle water level is low.
- Construct drawdown water control structure - A water control structure will be built in the existing overflow spillway area to provide controlled discharge capacity to enable a drawdown. Growing season drawdowns are typically conducted following spring high water into September when plants go senescent. Growing season drawdowns can be done in two consecutive growing seasons to allow plants germinated in the first year to grow to full size before flooding to normal water levels. Once established, perennial aquatic plants can persist for years, providing valuable food and habitat for fish and wildlife. The drawdown structure would be 113.5-feet wide with 10 bays. The water control structure would have a 16-ft wide walkway across the top that could serve a secondary purpose as part of a trail across the dam in the future. Operation of the drawdown structure will be conducted consistent with the Monitoring and Adaptive Management Plan included in this report.
- Construct Louisburg Grade Road gated culverts - Water levels in the upper part of Marsh Lake will be managed separately from the main body of the lake,

particularly in drawdown conditions. For example, high water levels can be maintained for a time in early spring to provide flooded marsh habitat upstream of the Louisburg Grade Road for spawning northern pike and to improve survival of young-of-year fish. The stop logs would subsequently be removed to allow the fish to return to Marsh Lake. Implementation of this measure is designed to enhance both the fishery throughout Marsh Lake and promote native fish dominance.

- Modify the Marsh Lake Dam, construct fishway - Marsh Lake Dam will be modified with a fishway structure to provide a passive weir that would increase water level variability on Marsh Lake, attain the target water level regime and to allow year-round fish passage (Figure 4-4). The fishway will be constructed in the existing fixed crest spillway in Marsh Lake Dam. Nature-like fishways are effective in re-establishing fish migration routes past dams and other hydraulic obstacles. Nature-like fishways simulate natural river channels and the hydraulic conditions that fish have evolved to swim through. Nature-like fishways can be simple rock ramps that look like natural rapids or bypass channels with riffles and pools. Many nature-like fishways have been constructed in Minnesota and have been very effective in restoring migratory fishes to stream networks. The fishway design contains a series of arched rock riffles that concentrate flow toward the middle of the fishway. Shallow areas on the sides would have slower current velocities and would allow upstream passage by smaller and weaker-swimming fish. The riffles would be made of boulders imbedded into smaller rock, with pools of deeper water between the riffles. Water would flow between the boulders in the riffles at velocities that fish could still swim through.

With cost figures rounded to the nearest thousand, the estimated first project costs of the ecosystem restoration plan are $9,463,000 (average annual cost of $474,000 with OMRR&R) and would result in the creation of approximately 8400 AAHU over 50 years. A plan view of the recommended plan is included below in Figure 7-1:

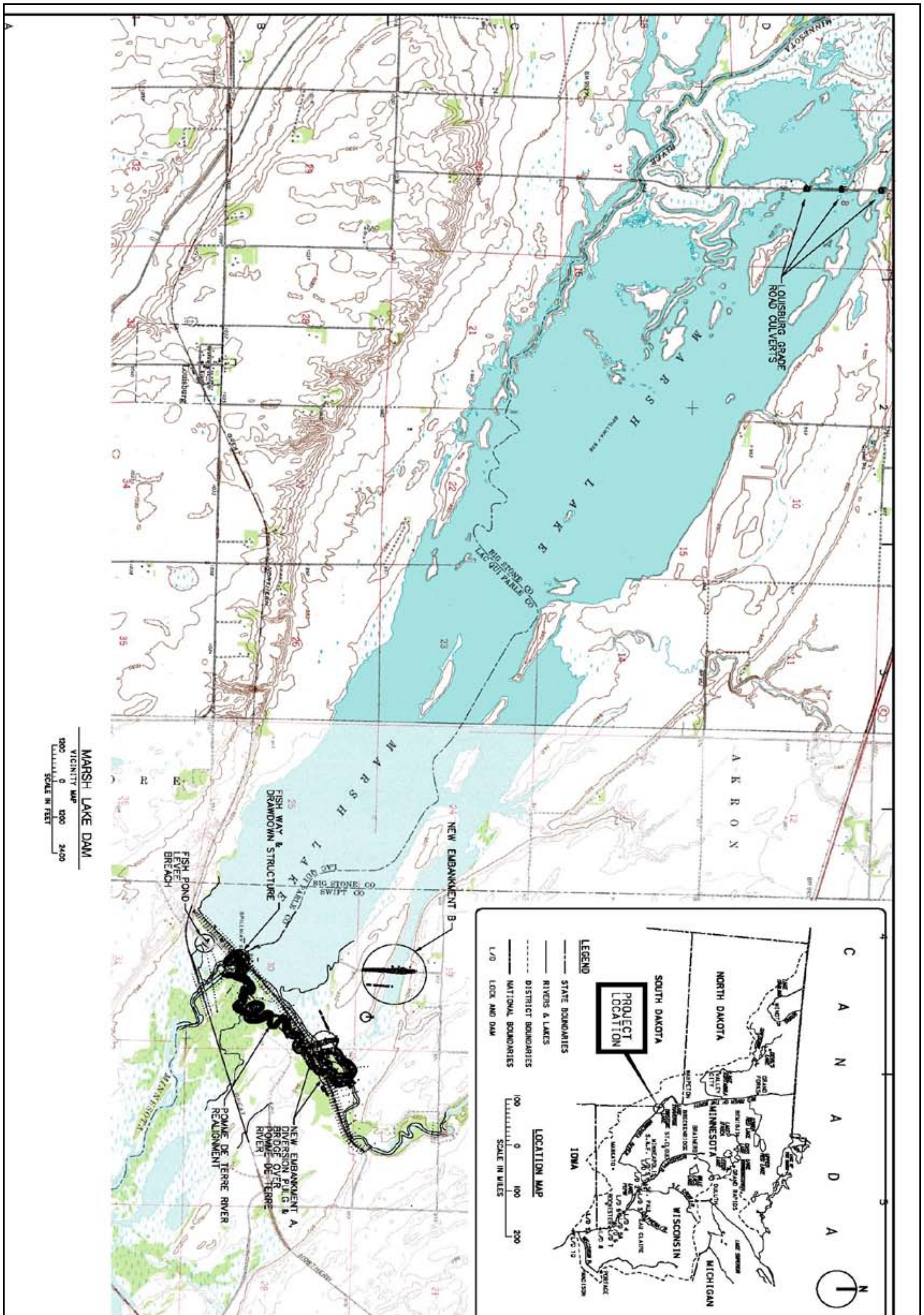


Figure 7-1, Plan view of the recommended plan project features

Problems and stressors addressed by the recommended plan include:

Marsh Lake Ecosystem State:

- Sediment Loading – **Restoring the Pomme de Terre** to the historic channel will serve to reduce sediment loading into Marsh Lake. Since turbidity is a limiting factor in the light attenuation and primary production in the aquatic community, sediment loading must be addressed in order to provide forage for migratory waterfowl that are limited by the availability of food within the lake. Rerouting the river to its historic channel will eliminate the Pomme de Terre as a sediment source to Marsh Lake and thereby decrease the turbidity within the lake, specifically near its current outlet.
- Sediment Resuspension – **Modification of the Marsh Lake Dam** to attain target water levels will induce seasonally lower levels in the lake and allow for consolidation of bottom sediments as well as light penetration to both exposed sediments for emergent plants and deeper depths for aquatic vegetation. **Construction of a water control drawdown structure** will allow lake managers to artificially mimic natural riverine drought conditions by periodically conducting drawdowns to lower water levels below the current outlet elevation which will assist in consolidating sediments for up to 90% of the lake area, germinate seeds within the lake sediments and allow for the penetration of light to the lake bottom sediments to enable plant growth. In combination, each of the identified measures for addressing sediment resuspension complements one another through synergistic relationships to ensure the establishment of healthy habitats and robust plant communities. The presence of aquatic vegetation and consolidated bottom sediments will ultimately reduce the frequency of high turbidity resulting from sediment resuspension and subsequently increase emergent and aquatic plant growth which is critical to support both fish and waterfowl communities.
- Lake Level Variability - **Modification of the Marsh Lake Dam** to attain target water levels will create greater variability in lake levels, allowing the lake to mimic more natural historical riverine conditions. As a result, lake levels will fluctuate with climatic conditions, creating greater ecosystem flux thereby increasing the functionality of floodplain and riparian areas.

Construction of a water control drawdown structure will allow lake managers to mimic natural riverine drought conditions by periodically conducting drawdowns to consolidate sediments for up to manage sediment resuspension (noted above) and enable plant growth. Introducing greater variability will benefit both floral aquatic and emergent communities within the lake and the fauna that depends on it, particularly waterfowl.

- Ecosystem Connectivity – **Restoring the Pomme de Terre River** to its former channel would provide walleye, white suckers, white bass and other migratory fish species in Lac qui Parle access to high quality spawning and nursery habitat in the Pomme de Terre River. Improved reproduction success and growth of juvenile fish in the Pomme de Terre River would increase the abundance of naturally-reproduced walleye in Lac qui Parle and would increase the diversity of the fish community. **Installation of gated culverts at Louisburg Grade Road** is a measure dependent upon **construction of a water control drawdown structure**. When growing season drawdowns are artificially conducted through the drawdown structure, the culverts at Louisburg Grade Road would be closed, impounding approximately 1100 acres of water upstream. This impounded area would serve as winter refuge for fish and preserve critical spring spawning habitat for northern pike. In the spring following drawdowns, the gates would be reopened. Native fish released from upstream of Louisburg Grade Road in addition to those migrating upstream from Lac qui Parle will benefit from reduced competition in the lake due to the lack of over-wintering populations of invasive common carp (see below). **Breaching the abandoned fish pond** adjacent to the Marsh Lake Dam will also provide additional connectivity to a currently isolated impoundment within the river previously managed by the DNR as a fish rearing pond. The fish pond area serves as valuable habitat for birds such as the great blue heron who fish this area frequently. Breaching the dike for the fish pond will allow fish access to the pond which will subsequently increase the food availability for herons and enhance the habitat value.

Low-Diversity Fish Community:

- Invasive Species - **Construction of a water control drawdown structure** to induce artificial drawdowns will serve to eliminate winter refuge for common carp within the lake. As an invasive species, carp are notoriously voracious foragers on aquatic plants. Elimination of carp in the wintertime will serve to both restore plant communities and augment the lake with native fish species through displacement in the spring following drawdowns. **Modification of the Marsh Lake Dam** to a lower elevation in conjunction with the construction of a fishway will enable passage of native fish between Lac qui Parle and Marsh Lake annually during spawning season, but particularly in the spring after artificial drawdowns. This effort is intended to displace invasive common carp with native fish throughout Marsh Lake. **Restoring the Pomme de Terre** to its historic channel will eliminate both a winter oxygen source within Marsh Lake as well as the physical connection between over-wintering carp communities in Marsh Lake with spawning habitat upstream on the Pomme de Terre. While common carp would still have availability and access to the Pomme de Terre from the restored outlet at Lac qui Parle, abundance and frequency of carp within Marsh Lake itself will decrease due to the cumulative effects of the combined measures noted above.
- Ecosystem Connectivity - **Restoring the Pomme de Terre** to the historic channel will provide access to walleye from Lac qui Parle to spawn. The walleye population within Lac qui Parle is stocked but healthy and available spawning habitat has been determined to be the limiting factor in the abundance of walleye within Lac qui Parle and Marsh Lake. **Modification of the Marsh Lake Dam** to a lower elevation in conjunction with the construction of a fishway will enable passage of native fish between Lac qui Parle and Marsh Lake. This will allow the northern pike community within Lac qui Parle to gain access to the spawning areas upstream of the Louisburg Grade Road. The subsequent effect will be healthier communities of pike within both Marsh Lake and Lac qui Parle. **Installation of gated culverts at Louisburg Grade Road** will ensure that lake elevations within the critical pike spawning area upstream of the Louisburg Grade Road are maintained as Marsh Lake water levels are

subjected to increased variability from the implementation of measures noted above.

Degraded Pomme de Terre Ecosystem State:

- Sediment Deposition - **Restoring the Pomme de Terre** to the historic channel will eliminate sediment deposition within Marsh Lake and restore a more natural, free flowing, meandering channel to the Pomme de Terre River. In its current state, the outlet of the Pomme de Terre into Marsh Lake occurs at a low gradient which is prone to deposition of sediment conveyed by the river at the outlet. This sediment becomes actively available for resuspension from physical force (wave, wind) and contributes to turbidity issues within Marsh Lake. Restoration of the historic channel will increase channel slope, channel length, the overall area of habitat availability, and will alter the composition of the river bottom through natural geomorphic processes from a system dominated by deposition of small grain size particles to a rocky, cobble substrate. The change in geomorphic form and habitat structure will provide critical spawning areas for walleye and other fish from Lac qui Parle.
- Ecosystem Connectivity - **Restoring the Pomme de Terre** to the historic channel will open new areas upstream of Lac qui Parle to the community of walleye who are limited by spawning habitat availability. As noted above, habitat suitability and access for walleye within Pomme de Terre are constrained by the presence of the Marsh Lake Dam and the current geomorphic condition. Rerouting the Pomme de Terre will have a substantial beneficial effect for walleye as well as other fish within Lac qui Parle.

7.2 Recreation-Related Project Features

The U.S. Army Corps of Engineers policy for ecosystem restoration projects recognizes that the lands used for project construction can also provide a low cost opportunity to provide recreation facilities. Recreation at ecosystem restoration projects should:

- Be compatible with ecosystem restoration and enhance the visitation experience.
- Build upon the ecosystem restoration objective rather than distract from it.
- Take advantage of the education and recreation potential of the ecosystem project.

Consistent with these purposes, a stand-alone Recreation Plan was developed and is detailed below. This Recreation Plan has been prepared through meetings among the US Army Corps of Engineers, the US Fish and Wildlife Service, and the Minnesota DNR. The team used Value Engineering techniques to brainstorm existing and potential recreational features then weigh the advantages, disadvantages and cost of each feature to develop an overall concept to include:

1. **Pedestrian Bridge across Marsh Lake Spillway** for improved safety, to provide angler access to both sides of the river, and as a future state bike trail connection.

2. **U.S. Army Corps of Engineers Day Use Facility at Marsh Lake Dam Improvements** to include a Pomme de Terre Canoe Access Point, a portage area, picnic tables, and shoreline fishing platforms.

3. **Shoreline Access Upgrades** to include shoreline fishing and interpretive signage**.**

All of the recreational features took into consideration the objectives of the Ecosystem Restoration project and also the Minnesota State Comprehensive Outdoor Recreation Plan's (SCORP) goal of increasing participation in outdoor recreation by Minnesotans and visitors.

Providing future recreational opportunities is an important goal of this region, as recreation would provide tourism dollars to the local economy and helps maintain a higher quality of life by providing opportunities for recreational experiences.

The major parts of the Recreation Plan are to:

(1) Increase connectivity to existing and future trail systems in the area.
(2) Upgrade existing facilities and create new facilities where needed.
(3) Provide interpretation and education at Marsh Lake.

Implementation of recreation features will help the State of Minnesota reach its goals of providing economic and recreational opportunities to its citizens.

Future conditions without recreational features will result in lost opportunities to:

- Provide connectivity of at least four different trail systems –National Scenic Byway, Minnesota State Bike Trail, Minnesota River Water Trail, and the Minnesota River Valley Prairie Waters Birding Trail.

- Increase the quality of life for local residents who use these recreational features throughout the year by updating day use facilities and boat ramps, and creating trail connections. In some cases, improving the recreation facilities will increase safety of users.

- Educate the public through interpretive panels on a variety of subjects which could include: shallow lake ecosystems, restoration efforts, agency cooperation, safety, wildlife, history, and recreational opportunities.

- Increase the economic vitality of the area through tourism dollars from both in state and out of state recreationalists. A positive economic state and improved quality of life should help maintain and possibly boost population in this area rather than seeing a decline.

7.2.1 Description of Proposed Recreational Features

<u>Feature 1 - Pedestrian Bridge across Marsh Lake Spillway</u>

An immediate benefit to building a bridge over the spillway is that it will provide a safe location for fisherman and other recreationalists to cross the Minnesota River. In the future this feature would facilitate the Minnesota River State Bike Trail development and connectivity.

Figure 7-1. Existing Marsh Lake spillway looking south.

It is envisioned that this area will have accessible shoreline fishing platforms both on the upstream and downstream side of the spillway and dike (see Feature 2, Figures 7-2 and 7-3). Currently, recreationalists are tempted to wade or swim across the river or, in low water, walk across the structure itself. One drowning has been reported at this site. A bridge will create a safe way to cross. Conversion of the spillway to a fishway weir structure (Figure 4-4 above) would eliminate the hydraulic backroller that forms below the existing ogee crest spillway and would improve recreational public safety.

Map 2.

Figure 7-2. Proximity of Marsh Lake to population centers. Blue pin = Marsh Lake. Green = 40 mile radius, Blue = 80 mile radius, Yellow = 160 Mile Radius

Fishing is a popular activity at Marsh Lake. In 2006, 1.1 million state residents 16 years old and older fished in Minnesota. (National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.) Within a 40 mile radius of Marsh Lake there are over 25,000 people who would have immediate access to the recreation features of this project (Figure 7-2).

The future Minnesota River State Bike Trail is broken down into segments. Segment 2 Ortonville to Appleton is located within the geographical scope of this project. Future trail alignment for this segment can be described in two parts: a loop around Big Stone National Wildlife Refuge and then, east of the refuge, an alignment on the south side of the river to the foot of Marsh Lake. It is at this point that a pedestrian bridge will provide connectivity to the State Trail which will continue south into Lac qui Parle Wildlife Management Area and connect to existing trails in Appleton. Generally the trail follows road corridors. However, it is envisioned that the Minnesota River Trail will be partially located on alignments that are separate from road rights-of-way, providing access to natural and cultural amenities along scenic routes that showcase Minnesota River valley landscape. (Minnesota River State Trail Master Plan, June 2007)

<u>Feature 2 - U.S. Army Corps of Engineers Day Use Facility at Marsh Lake Dam Improvements</u>

Figure 7-3. Existing day use recreation area at Marsh Lake Dam (A). Blue = Historic Pomme de Terre River channel to be restored.

The current day use facility built in 1938 needs improvements. The Ecosystem Restoration recommended plan includes rerouting the Pomme de Terre River, which will block the existing canoe landing on the Pomme de Terre River, approximately 0.5 miles east/northeast of the Marsh Lake spillway. A new canoe landing is recommended at the day use area to provide a canoe landing for both the Pomme de Terre and Minnesota Rivers. The canoe landing could be as simple as a mowed foot path leading to the water's edge with a primitive landing. When the Pomme de Terre is restored to its former channel, paddlers will then be able to paddle directly into the Minnesota River from the Pomme de Terre River without a portage. However, most paddlers will probably want to use the day use area as an exit/entry point or rest stop.

With the rerouting of the Pomme de Terre River to its historic location, the day use area will eventually be located between two flowing rivers. So in addition to the canoe access point mentioned above, it is recommended that the upgraded day use facility include:

- Picnic tables and park benches
- Vault toilets (handicapped-accessible) which have the capacity to withstand flooding.
- Shoreline fishing stations - Most should be handicapped-accessible. (See Figures A and B.)
- A safe portage across the Marsh Lake Dam from Marsh Lake to the Minnesota River in the day use area.
- Interpretive kiosk.
- Short foot path and ramp will be needed to access the pedestrian bridge across the spillway.

Note that not all public access areas on Marsh Lake are handicapped-accessible which is why more handicapped-accessibility features are recommended for the day use area.

The Marsh Lake Dam area will have a number of accessible shore fishing stations located above and below the dam on both sides of the spillway and near the mouth of the Pomme de Terre River. A safe area will be created for walk-in winter access along the dike. Flat rock/rustic fishing platforms will be installed as well as accessible concrete fishing platforms as shown in Figure 7-5.

Figure 7-4. Accessible fishing platform made from a box culvert section turned on end.

Figure 7-5. Example of an accessible shore fishing platform.

<u>Feature 3 - Boat Landing Improvements</u>

The Minnesota DNR maintains a number of boat landings around Marsh Lake (Figure 7-6). Improvements will consist mainly of shoreline fishing structures and interpretive signage using kiosks.

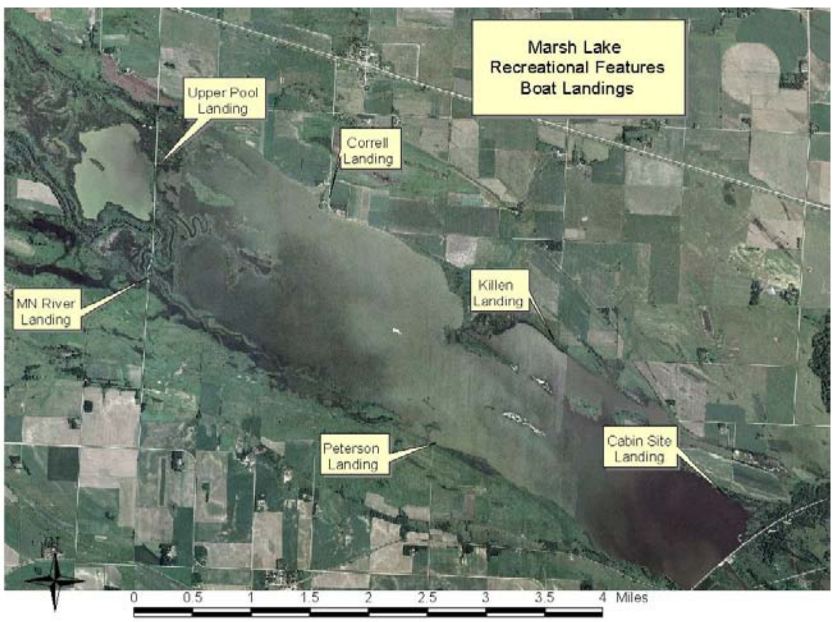


Figure 7-6. Boat landings at Marsh Lake used for hunting, fishing, and wildlife viewing.

Minnesota River Landing at the Upstream End of Marsh Lake

Proposed improvements include both shoreline fishing stations and an interpretive/educational kiosk. This site, which has the heaviest traffic, would have an interpretive kiosk highlighting the history of Marsh Lake, the current lake condition, shallow lake management, and ecosystem restoration efforts that are being taken to improve current conditions. This kiosk could also have a “you are here” type map along with any safety messages.

South Side of Minnesota River Landing

Proposed improvements would include boat access improvements including parking and accessible shore fishing stations below the bridge (Figure 7-7).

Figure 7-7. Example of an accessible trail to a shore fishing station.

North Side of Minnesota River Landing

Flat rock shore fishing stations would be installed (Figure 7-8).

Figure 7-8. Examples of flat rock type of shore fishing stations.

Upper Pool Landing

Proposed Improvements include accessible fishing platforms similar to the Minnesota River Landing above and an interpretive/educational kiosk.

Other Four Landings: Correll, Peterson, Killen, and Cabin Site

These sites would each have a simple educational/information kiosk which would not be as elaborate as the Minnesota River Landing kiosk. The kiosks could have the same “You are Here” maps showing other boat landings but then each landing could have different educational & interpretive material such as waterfowl migration, wildlife, waterfowl feeding and resting areas, islands, wave barriers, and types of emergent vegetation. These sites would also include shoreline fishing structures which could also be used by wildlife watchers.

It is important to note that the boat landings around Marsh Lake are also the main stopping points for wildlife viewers and visitors traveling along the National Scenic Byway and Audubon Minnesota River Valley Birding Trail. Birders flock to the area. This stretch is located in one of the major waterfowl flyways in North America with thousands of birds such as blue-winged teal, mallards, pintails, and wood ducks. Marsh Lake has the largest white pelican rookery in Minnesota and one of only two nesting colonies of the white pelican in the state. As many as 10,000 pelicans, tundra swans, snow geese, and sandhill cranes can be seen migrating through the area in a single day. The Lac qui Parle Wildlife Management Area is a major stop for hundreds of thousands of Canada geese. There are over 2 million resident and non-resident wildlife watching participants in Minnesota (2006 National Survey of Fishing, Hunting, and Wildlife Associated Recreation.) A 160 mile radius around the Marsh Lake project area, or less than a 2.5 hour drive away, includes over 3.5 million people from four states (Figure 7-2).

7.2.2 Benefit Computation

Recreation benefits attributable to the proposed trail system were based on projected demand for the recreational activities listed in Table 7-8. These demand estimates over the period of analysis were used in conjunction with Unit Day Values developed for each of the recreational activities. Demand for each project year was multiplied by the appropriate Unit Day Value for each recreation activity. The value of the recreation activity at each project year was converted to a present worth value using a 4 1/8 percent annual interest rate. The sum of these present worth values, by recreational activity, were converted to an average annual dollar value, given a 50 year project life and a 4 1/8 percent annual interest rate.

Table 7-8 – Project recreation average annual benefit.

Picnicking	$	14,500
Wildlife Viewing	$	84,400
Fishing	$	89,300
Canoe/kayak	$	36,800
TOTAL ANNUAL AVG BENEFITS	**$**	**225,000**

Rounded to nearest $1000

The present value of estimated construction costs, contingencies, engineering, design, construction management, and interest during construction were calculated to be

$516,000. This present value was amortized at 4 1/8 percent over the 50-year life of the project. The resulting annualized cost of $24,000 was added to the estimated annual operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) cost of $2,000 for a total annual cost of $26,000. The net annual benefits, or the annual benefits minus the annual costs, are $199,000. The benefit-cost ratio, or the annual benefits divided by the annual costs, was calculated to be 8.6. Therefore, the Marsh Lake proposed recreation plan is economically justified. The Federal costs of the Marsh Lake Ecosystem Restoration project with the recreation facilities would be approximately 0.4 percent greater than the Federal costs of the project without the recreation facilities, less than the 10 percent limit, in accordance with ER 1105-2-100.

7.3 Real Estate Requirements

The Minnesota Department of Natural Resources (DNR) is the non-Federal sponsor for the study. The DNR has fee title to the entire lake area northwest of the dam and southeast of Corps fee title land in and around the dam. Together, the Minnesota Department of Natural Resources and U.S. Army Corps of Engineers own all land required for the project in fee title.

7.4 Monitoring and Adaptive Management

A Monitoring and Adaptive Management Plan is included in Appendix R.

<u>System Hydrology</u>

The Corps will continue to maintain gages at Marsh Lake Dam and at Lac qui Parle Dam and a continuous record of water levels and discharge.

<u>Native Mussels in the Pomme de Terre River</u>

A plan for monitoring the effects of restoring the Pomme de Terre River to its former channel on native mussels is detailed in Section 4.1.4. The 2010 mussel survey was conducted by the DNR. The post-construction monitoring will be done by the DNR.

Aquatic Vegetation in Marsh Lake

Following project construction, the DNR will conduct annual surveys of aquatic vegetation in Marsh Lake by aerial photo interpretation and by sampling from a boat as shown in Section 2.8.5. Should submersed aquatic vegetation not increase in response to the measures implemented in the tentatively recommended plan after five years, rock islands will be constructed to meet project objectives 4 and 5: Reduced sediment resuspension in Marsh Lake and Increased extent, diversity and abundance of emergent and submersed aquatic plants in Marsh Lake. A determination of the need for the rock islands will be documented through monitoring and may be recommended for construction based on adaptive management criteria found in Appendix R.

7.5 Cost Estimates

Cost estimates for the recommended plan are summarized below:

Table 7-9. Economic summary of the recommended plan (October 2011 price levels).

Breakout of Total Project Costs and Benefits	
Marsh Lake Ecosystem Restoration - Recommended Plan	
	Ecosystem Restoration
Total Project First Costs	$ 9,967,000
Interest During Construction (4.125%)	$ 214,000
Present Worth of Investment	**$ 10,181,000**
Annualized Total Project Costs	$ 500,000
Annual Operations and Maintenance Costs	$ 35,000
Total Annual Benefits (Habitat Units)	8400
Total Annual Benefits (Recreation)	$ 225,000

Rounded to nearest $1000

8 Compliance with Environmental Laws and Regulations

8.1 Review of Federal Laws, Regulations, Policies and Executive Orders

The St. Paul District, U.S. Army Corps of Engineers has conducted this feasibility study and NEPA process in accordance with Corps of Engineers planning guidance (ER 1105-2-100) and requirements of applicable laws and regulations (Table 8-1). We have assessed the environmental effects of the alternative plans and the proposed action on the environment (Section 6.4 above and Table 8-2).

Compliance with applicable environmental quality statutes is summarized in the table below. Full compliance for this EA is defined as having met all requirements of the statute for the current stage of planning. In some cases, further authorization and certification will be required prior to and during construction. Partial compliance indicates that information is still being collected or disseminated to and from proper agencies. Further explanation for each statute is provided below.

Table 8.1 Laws, regulations and Executive Orders applicable to planning the Marsh Lake Project and current compliance status.

Federal Policy	Compliance Status
Bald and Golden Eagle Protection Act, 42 USC 4151-4157	Partial
Clean Air Act, 42 USC 7401-7542	Full
Clean Water Act, 33 USC 1251-1375	Full[1]
Comprehensive Environmental Response, Compensation, and Liability Act, 42 USC 9601-9675	Partial
Endangered Species Act, 16 USC 1531-1543	Partial
Farmland Protection Policy Act, 7 USC 4201-4208	Full
Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (EO 12898)	Full
Federal Water Project Recreation Act, 16 U.S.C. 460-1(12), et seq.	Full
Fish and Wildlife Coordination Act, 16 USC 661-666c	Partial
Floodplain Management (EO 11988 as amended by EO 12148)	Full[1]
Food Security Act of 1985, 7 USC varies	Full

Invasive Species (EO 13112)	Partial
Land and Water Conservation Fund Act, 16 USC 460d-461	Full
Migratory Bird Treaty Act of 1918, 16 USC 703-712	Full[1]
National Environmental Policy Act, 42 USC 4321-4347	Partial
National Economic Development (NED) Plan	Full
National Historic Preservation Act, 16 USC 470 et seq.	Partial
Noise Control Act, 42 USC 7591-7642	Full
Prevention, Control, and Abatement of Air and Water Pollution at Federal Facilities (EO 11282 as amended by EO's 11288 and 11507)	Full
Protection and Enhancement of the Cultural Environment (EO 11593)	Partial
Protection of Wetlands (EO 11990 as amended by EO 12608)	Full[1]
Protection and Enhancement of Environmental Quality (EO 11991)	Full
Protection of Migratory Birds (EO 13186)	Full[1]
Resource Conservation and Recovery Act, 42 USC 6901-6987	Full
Rivers and Harbors Act, 33 USC 401-413	Full[1]
Water Resources Development Acts of 1986, 1990, 2000 and 2007	Full
Wild and Scenic Rivers Act, 16 U.S.C. 1271, et seq.	Full

[1] Further certification or authorization required prior to construction.

8.2 Economic and Environmental Principles and Guidelines

The Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Achievement of the Federal objective is measured in terms of contribution to Federal accounts intended to track the overall benefits of a given project. The two accounts applicable to the Marsh Lake Ecosystem Restoration are the National Economic Development (NED) account and the Environmental Quality (EQ) account.

<u>National Economic Development (NED) Account</u>

Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation. For an ecosystem restoration project with accompanying recreation features, the NED is calculated by the sum of the average annual costs of the ecosystem restoration features, plus the average annual benefits of the recreation features, minus the average annual costs of the recreation features. The results for the Marsh Lake Ecosystem Restoration Project are as follows:

	Total Average Annual Recreation Benefits	$	225,000
-	Total Average Annual Recreation Costs	$	26,000
	Contribution to National Economic Development Account	$	199,000

Rounded to nearest $1000

<u>Environmental Quality (EQ) Account</u>

EQ attributes are the ecological, cultural, and aesthetic properties of natural and cultural resources that sustain and enrich human life. Evaluation of EQ in the planning process consists of the assessment and appraisal of effects. Four general actions—define, inventory, assess, appraise—are the phases of these procedures. For ecosystem restoration projects, contributions to the EQ account are detailed through NEPA compliance and calculation of net ecosystem benefits. The Marsh Lake Ecosystem Restoration Project includes an integrated Environmental Assessment where the necessary components of a NEPA evaluation are combined within each of the planning steps. This evaluation is summarized in a qualitative summary of environmental effects detailed in Table 6-1 as well as Section 6.6 of this report. In addition, Section 5 and Appendix E of this report contain quantitative information regarding net ecosystem benefits through use of Habitat Evaluation Procedures/Habitat Suitability Index. The credit to the EQ account is the quantified benefits resulting from the project, which, in the case of the recommended plan provides a net gain of 8400 average annual habitat units over the 50-year period of analysis.

8.3 USACE Environmental Operating Principles

Properly formulated ecosystem restoration projects should be consistent with USACE Environmental Operating Principles. The analysis included in the Marsh Lake Ecosystem Restoration Project Feasibility Study report shows that implementation of the recommended plan will have a substantial benefit to the ecosystem of Marsh Lake while balancing the existing use and function of the previously authorized project. Environmental Operating Principles are listed below for reference:

1. Strive to achieve environmental sustainability. An environment maintained in a healthy, diverse and sustainable condition is necessary to support life.
2. Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of Corps programs and act accordingly in all appropriate circumstances.
3. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.
4. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems.
5. Seeks ways and means to assess and mitigate cumulative impacts to the environment; bring systems approaches to the full life cycle of our processes and work.
6. Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of our work.

7. Respect the views of individuals and groups interested in Corps activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the nation's problems that also protect and enhance the environment.

8.4 Lessons Learned from Hurricanes Katrina and Rita

Following the devastation of Hurricanes Katrina and Rita, the U.S. Army Corps of Engineers drafted twelve actions for change to ensure that a systems based approach is incorporated into project planning, risk informed decision making is adopted throughout the organization, risks are adequately communicated to the public, and agency technical expertise is sufficiently leveraged. Below is a brief assessment of which of the twelve actions for change have been incorporated into the Marsh Lake Ecosystem Project Planning Process:

- **Theme 1: Comprehensive Systems Approach**
  - ✓ – Action 1: Employ integrated, comprehensive and systems-based approach
  - ✓ – Action 5: Employ adaptive planning and engineering systems
  - ✓ – Action 6: Focus on sustainability
- **Theme 2: Risk Informed Decision Making**
  - ✓ – Action 2: Employ risk-based concepts in planning, design, construction, operations, and major maintenance
  - ✓ – Action 7: Review and inspect completed works
- **Theme 3: Communication of Risk to the Public**
  - ✓ – Action 9: Effectively communicate risk
  - ✓ – Action 10: Establish public involvement risk reduction strategies
- **Theme 4: Professional and Technical Expertise**
  - – Action 3: Continuously reassess and update policy for program development, planning guidance, design and construction standards
  - ✓ – Action 4: Employ dynamic independent review
  - – Action 8: Assess and modify organizational behavior
  - – Action 11: Manage and enhance technical expertise and professionalism
  - ✓ – Action 12: Invest in research

9. Implementation Responsibilities

9.1 Federal (Corps)/Non-Federal Sponsor Implementation

When implementation funds are appropriated, a non-Federal sponsor will be identified. The State of Minnesota, Department of Natural Resources (DNR) served as the non-Federal sponsor for the Feasibility phase and will likely serve as the non-Federal sponsor for the Construction phase. Cost-sharing for plan implementation is subject to the rules for ecosystem restoration projects established in Section 210 of WRDA 1996. Accordingly, the non-Federal share will be 35 percent of the implementation costs. Recreation features would be cost shared 50%/50% with OMRR&R a local responsibility in accordance with the cost sharing established by WRDA 1986, as amended. Non-Federal sponsors are responsible for 100 percent of lands, easements, rights-of-way, utility or public facility relocations, and dredged or excavated material disposal areas (LERRD), and operation, maintenance, repair, rehabilitation, and replacement (OMRR&R). The value of LERRD is credited to the 35 percent share.

A breakdown of the project Federal and non-Federal sponsor costs is included below:

Table 9-1, Anticipated Project First Costs Allocated by Fiscal Year

Anticipated Project First Costs Allocated by Fiscal Year (Rounded to nearest $1000)							
	Estimated Amount Plus Contingency	Total Cost plus Interest During Construction	FY12	FY13	FY 14	FY 15	Total Project
Federal							
Preconstruction Engineering, Design	$ 645,000	$ 669,000	$ 669,000	$ -	$ -	$ -	$ 669,000
Construction Management	$ 405,000	$ 405,000	$ -	$ 163,000	$ 196,000	$ 47,000	$ 405,000
Construction	$ 5,346,000	$ 5,459,000	$ -	$ 2,289,000	$ 2,953,000	$ 217,000	$ 5,459,000
Federal LERRD	$ 7,000	$ 7,000	$ 7,000	$ -	$ -	$ -	$ 7,000
Total Federal	$ 6,403,000	$ 6,540,000	$ 676,000	$ 2,452,000	$ 3,149,000	$ 264,000	$ 6,540,000
Non-Federal							
Preconstruction Engineering, Design	$ 359,000	$ 373,000	$ 373,000	$ -	$ -	$ -	$ 373,000
Construction Management	$ 224,000	$ 224,000	$ -	$ 88,000	$ 105,000	$ 31,000	$ 224,000
Construction	$ 2,977,000	$ 3,040,000	$ -	$ 1,232,000	$ 1,590,000	$ 217,000	$ 3,040,000
Non-Federal LERRD	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Federal LERRD Cost Share	$ 4,000	$ 4,000	$ 4,000	$ -	$ -	$ -	$ 4,000
Total Non-Federal	$ 3,564,000	$ 3,641,000	$ 377,000	$ 1,320,000	$ 1,695,000	$ 248,000	$ 3,641,000
Total Project	$ 9,967,000	$ 10,181,000	$ 1,053,000	$ 3,772,000	$ 4,844,000	$ 512,000	$ 10,181,000

Table 9-2, Apportionment of Project First Costs

Apportionment of Project First Costs Between Federal and Non-Federal Sponsor			
	Federal	Non-Federal	Total
Ecosystem Restoration Features			
Preconstruction Engineering, Design	$ 619,000	$ 333,000	$ 952,000
Construction Management	$ 392,000	$ 211,000	$ 604,000
Construction	$ 5,133,000	$ 2,764,000	$ 7,897,000
LERRD	$ 7,000	$ 3,000	$ 10,000
Total Ecosystem Restoration	**$ 6,151,000**	**$ 3,311,000**	**$ 9,463,000**
Recreation Features			
Preconstruction Engineering, Design	$ 26,000	$ 26,000	$ 52,000
Construction Management	$ 13,000	$ 13,000	$ 26,000
Construction	$ 213,000	$ 213,000	$ 426,000
LERRD	$ -	$ -	$ -
Total Recreation Features	**$ 252,000**	**$ 252,000**	**$ 504,000**
Total Project	**$ 6,403,000**	**$ 3,563,000**	**$ 9,967,000**
Rounded to nearest $1000			

9.2 Real Estate Requirements

A real estate plan is included in this report as a stand-alone document in Appendix M. Because the entire project will be constructed on lands owned by the State and Federal government, no real estate acquisition is required for this project.

10 Coordination

10.1 Public Involvement

The State of Minnesota, Department of Natural Resources (DNR) has been actively involved in planning the Marsh Lake project over the course of the previous twelve years. Public involvement regarding conditions at Marsh Lake pre-dates the Marsh Lake Feasibility study. The Corps and the DNR worked together in 1999 and 2000 to consider potential modifications to the Marsh Lake Dam. As a part of that effort, approximately 50 citizens attended a public meeting on July 27, 2000 and provided 39 written comment sheets. No consensus was reached on desired actions at that time, but the public input was used to inform further discussions within the DNR. The DNR began a public planning process on November 9, 2000 to define problems and issues at Marsh Lake. This planning process ultimately served as the foundation for the current Corps Feasibility Study Report and State-Federal partnership.

A public review period was conducted from May 17, 2011 to June 25, 2011. A press release was issued, the project web site was updated with a copy of the project report and a video overview, and hard copies of the report were made available at two of the local libraries near the project location.

On May 26, 2011, project delivery team members conducted a series of meetings on site with stakeholders and the public to solicit input on the draft Feasibility Study Report during the public review period. Organizations in attendance included U.S. Fish and Wildlife Service staff, the Appleton Sportsman's Club, the Lac qui Parle Association, Coalition for a Clean Minnesota River (CCMR), Ducks Unlimited, the Upper Minnesota Valley Regional Development Commission, CURE (Clean Up the River Environment) as well as members of the general public. The project delivery team provided presentations about the project development process, the problems and opportunities, and the recommended plan. A question and answer period followed the presentation. The project was generally well-received with many of the participants showing support for the recommended plan. No negative comments were subsequently received during the review period and therefore no outstanding issues requiring resolution were identified during the review.

10.2 Federal Agencies

The U.S. Fish and Wildlife Service has participated in the planning of the Marsh Lake project and has been consulted on endangered species and has provided a letter in compliance with the Fish and Wildlife Coordination Act.

The U.S. Environmental Protection Agency, the U.S. Geological Survey, and the U.S. Department of Agriculture will be provided copies of this draft Feasibility Report and Environmental Assessment for review.

Per 36 CFR § 800.6, the Corps will notify the Advisory Council on Historic Preservation of the adverse effects of the ecosystem restoration measures on the National Register-eligible Marsh Lake Dam and request their participation in the Memorandum of Agreement to mitigate those adverse effects.

10.3 State Agencies

The DNR has been actively involved in planning the Marsh Lake project and has provided much of the information contained in this report. Public involvement regarding conditions at Marsh Lake pre-dates the Marsh Lake Feasibility study. The Corps and the DNR worked together in 1999 and 2000 to consider potential modifications to the Marsh Lake Dam. As a part of that effort, approximately 50 citizens attended a public meeting on July 27, 2000 and provided 39 written comment sheets. No consensus was reached on desired actions at that time, but the public input was used to inform further discussions within the DNR. The DNR began a public planning process on November 9, 2000 to define problems and issues at Marsh Lake. A public meeting was held on March 1, 2001 that generated 30 written comment sheets from over 50 attendees. Following the meeting, the DNR assembled a 10-member Marsh Lake Citizen Group to serve as a "sounding board," assist with generating ideas, develop public participation strategies, and communicate with other citizens and stakeholder groups. The Citizen Group met on April 3, 2001; July 13, 2001; February 6, 2002; and June 30, 2003. Press releases and informational mailings were sent periodically to a list of over 100 individuals, news organizations, environmental organizations, local governmental units and state agencies. On June 12, 2003, DNR officials signed an internal "Agreement in Principle" to document the strategies that were discussed by the Citizen Group and supported by the DNR's Divisions of Ecological Services, Fisheries and Wildlife to improve conditions on Marsh Lake. A final public meeting was held on August 26, 2003 to share the results of the DNR's planning process with the public.

The 2008 Phase I cultural resources survey of the Marsh Lake ecosystem restoration feature locations conducted by DNR archeologists was coordinated with the Minnesota State Historic Preservation Office. The SHPO responded that a Phase II evaluation of the National Register eligibility of site 21BS67 is needed prior to shoreline protection along that island's shoreline and the effects of the project on Marsh Lake Dam need to be assessed (SHPO letter dated February 20, 2009). The Corps has since consulted with the Minnesota SHPO and has prepared a Memorandum of Agreement covering mitigation of adverse effects to the National Register-eligible Marsh Lake Dam in order to comply with Section 106 of the National Historic Preservation Act and its implementing regulations, 36 CFR Part 800, Protection of Historic Properties.

A 401 Water Quality Certification is currently in the process of being obtained from the Minnesota Pollution Control Agency. A Minnesota Pollution Control Agency National Pollutant Discharge Elimination System (NPDES) Construction Stormwater (CSW) Permit for construction activities associated with the Recommended Plan may also be required.

10.4 Native American Tribes

Letters to initiate consultation of the Marsh Lake ecosystem restoration project with the Sisseton-Wahpeton Oyate of Lake Traverse Reservation in South Dakota, the Upper Sioux Community of Minnesota, and the Lower Sioux Indian Community of Minnesota under Section 106 of the National Historic Preservation Act, as amended, were sent to their tribal chairmen on December 12, 2008. Copies of these signed letters were sent to their respective Tribal Historic Preservation Officer or tribal cultural resources point-of-contact. The tribes were contacted again as part of the public review process. As of June 25, 2011, there has been no response from any of these tribes.

10.5 Local Units of Government and Non-Governmental Organizations

Local units of government in the counties adjoining the Marsh Lake project area and non-governmental organizations participated in early stages of project planning in a series of meetings with the DNR. Local governments and non-governmental organizations will be provided copies of this draft report for review and comment. They will also be invited to a public meeting to discuss the proposed project.

11 Recommendation

As District Engineer, I have considered the environmental, social, and economic effects, the engineering feasibility, and comments received from the other resource agencies, the non-federal sponsors, and the public, and have determined that the selected plan presented in this report is in the overall public interest and is technically sound, environmentally acceptable, and economically feasible. I recommend that the selected plan and associated features described in this report be authorized for implementation as a federal project.

The selected plan is the National Ecosystem Restoration Plan with a separately formulated recreation plan and appropriate mitigation measures as generally described in this report. The plan includes ecosystem restoration features including but not limited to rerouting the Pomme de Terre River to its historic channel, modifying the Marsh Lake Dam to achieve target water levels and fish passage, construction of a drawdown water control structure at the Marsh Lake Dam, installation of gated culverts at Louisburg Grade Road, and the breaching of a dike at an abandoned fish pond adjacent to the Marsh Lake Dam. The plan also contains recreation features including but not limited to shoreline fishing access structures, interpretive signage, a canoe landing, benches, picnic tables, trash receptacles, toilets, and parking lot improvements.

The estimated total project first costs of the selected plan is $9,967,000 and the estimated annual operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) cost is $35,000. The Federal portion of the estimated total project first costs is $6,403,000. The non-Federal sponsor's portion of the required cost share of total project first costs is $3,564,000. The estimated costs of the ecosystem restoration portion of the project are $6,151,000 Federal and $3,311,000 non-Federal. The estimated costs of the recreation features are $252,000 Federal and $252,000 non-

Federal. The ecosystem restoration features of the selected plan will provide an estimated 8400 net increase in average annual habitat units (AAHU's) and the recreation features have an overall benefit-cost ratio of 8.6.

The project will modify one existing Federal project at the Marsh Lake Dam, authorized as the Lac qui Parle Water Control Project under the Flood Control Act of 1936, Public Law 74-738. The modification of this project will not impact its authorized purpose.

These recommendations are made with the provision that, prior to implementation, the non-federal sponsors will agree to comply with the following requirements:

a. Provide 35 percent of total ecosystem restoration costs as further specified below:

    1. Provide 25 percent of design costs allocated by the Government to ecosystem restoration in accordance with the terms of a design agreement entered into prior to commencement of design work for the recreation features;

    2. Provide, during the first year of construction, any additional funds necessary to pay the full non-federal share of design costs allocated by the Government to ecosystem restoration;

    3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project;

    4. Provide, during the design and implementation phase, any funds necessary to make its total contribution equal to 35 percent of total project costs;

b. Provide 50 percent of total recreation costs as further specified below:

    1. Provide 25 percent of design costs allocated by the Government to recreation in accordance with the terms of a design agreement entered into prior to commencement of design work for the recreation features;

2. Provide, during the first year of construction, any additional funds necessary to pay the full non-federal share of design costs allocated by the Government to recreation;

3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the recreation features;

4. Provide, during construction, any additional funds necessary to make its total contribution for recreation equal to 50 percent of total recreation costs;

5. Provide, during construction, 100 percent of the total recreation costs that exceed an amount equal to 10 percent of the Federal share of total ecosystem restoration costs;

c. Provide, during the design and implementation phase, 100 percent of all costs of planning, design, and construction for the project that exceed the Federal share of the total project costs;

d. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized by Federal law;

e. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

f. Shall not use the project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project;

g. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 Code of Federal Regulations (CFR) Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

h. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

i. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

j. Hold and save the United States free from all damages arising from the design, construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

k. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 CFR Section 33.20;

l. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);

m. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

n. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

o. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA;

p. Provide, during the design and implementation phase, 35 percent of all costs that exceed $50,000 for data recovery activities associated with historic preservation for the project; and

q. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to Congress, the non-federal sponsor, the State of Minnesota, interested Federal agencies, and other parties will be advised of any modifications and will be afforded the opportunity to comment further.

Michael J. Price
Colonel, Corps of Engineers
District Engineer

15 July 2011
Date

12 Finding of No Significant Impact

DEPARTMENT OF THE ARMY

ST. PAUL DISTRICT, CORPS OF ENGINEERS
180 FIFTH STREET EAST, SUITE 700

ST. PAUL, MN 55101-1678

REPLY TO
ATTENTION OF

Environmental and Economic Analysis Branch
Planning, Programs and Project Management Division

FINDING OF NO SIGNIFICANT IMPACT

In accordance with the National Environmental Policy Act, the St. Paul District, Corps of Engineers, has assessed the environmental impacts of the following project:

ECOSYSTEM RESTORATION
MARSH LAKE, BIG STONE, LAC QUI PARLE AND SWIFT COUNTIES, MINNESOTA

The intent of this project is to provide ecosystem restoration to Marsh Lake, a part of the Lac qui Parle reservoir in Big Stone, Lac qui Parle and Swift Counties, Minnesota. The proposed project involves modification of a dam at the Marsh Lake outlet, rerouting of the Pomme de Terre River, and associated hydrologic modifications in and around Marsh Lake. This finding of no significant impact is based on the following factors: the project would have no adverse impacts on fish and wildlife resources, and the project would have only short-term minor negative impacts on the social environment, State-listed threatened or endangered species and on air quality. The project would substantially benefit wetland habitat, habitat diversity and interspersion, biological productivity and surface water quality and have minor benefits to recreation, public health and safety, and public facilities and services. Continued coordination, particularly regarding cultural resources, would be maintained with appropriate State and Federal agencies.

For the reasons stated above, the proposed action does not constitute a major Federal action significantly affecting the quality of the human environment. Therefore, an environmental impact statement will not be prepared.

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Date

Michael J. Price
Colonel, Corps of Engineers
District Engineer

13 List of Preparers

The following table includes the St. Paul District Corps of Engineers and Minnesota DNR Project Delivery Team members who contributed to this report and EA.

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Scott Goodfellow	
Daniel Wilcox	**Aquatic Ecology, Planning**
Lance Awsumb	**Economics, Sociology**
Ginny Gnabasik	**Cultural Resources**
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Josh Kavanagh	**Ducks Unlimited**
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Appendices

A. Project Management Plan
B. Federal Cost Sharing Agreement
C. Correspondence
D. Clean Water Act, Section 404(b)(1) Evaluation
E. Habitat Benefits Evaluation
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