Lower Otter Tail River Ecosystem Restoration Project

Otter Tail and Wilkin Counties, Minnesota

Continuing Authorities Program: Section 1135 Ecosystem Restoration

Integrated Feasibility Report and Environmental Assessment

St. Paul District

Project Sponsor: Buffalo-Red River Watershed District

December 2021

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Lower Otter Tail River Ecosystem Restoration Project

Continuing Authorities Program: Section 1135 Ecosystem Restoration

Feasibility Report & Integrated Environmental Assessment

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, ST. PAUL DISTRICT
180 FIFTH STREET EAST, SUITE 700
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Regional Planning and Environment Division North

DRAFT FINDING OF NO SIGNIFICANT IMPACT

Continuing Authorities Program Section 1135

Lower Otter Tail River Ecosystem Restoration Project, Otter Tail and Wilkins Counties, Minnesota

The U.S. Army Corps of Engineers, St. Paul District (Corps) has conducted a feasibility report with an integrated environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The final Integrated Feasibility Report and Environmental Assessment (IFR/EA) dated **DATE OF IFR/EA**, for the Continuing Authorities Program Section 1135, Lower Otter Tail Ecosystem Restoration Project addresses the restoration of stream and riparian habitat opportunities and feasibility in the Lower Otter Tail River, Otter Tail and Wilkins Counties, Minnesota. The final recommendation is contained in the report of the Chief of Engineers, dated XX.

The Final IFR/EA, incorporated herein by reference, evaluated various alternatives that would achieve project goals and objectives to address existing and future habitat degradation in the study area. The Recommended Plan is the National Ecosystem Restoration (NER) Plan and includes the restoration and re-meandering of Feature Groups 2 and 3, and the head cut stabilization of Feature Group 8:

- 5 overflow structures
- 14 rock riffles
- 36 linear feet of toe wood sod mats
- 16 acres of channel excavation
- 7,490 acres of floodplain excavation, and,
- Monitoring and Adaptive Management Plan included in Appendix E. Monitoring is expected to last no more than 10 years.

In addition to a “no action” plan, two alternatives were evaluated for environmental benefits. These alternatives included Alternative C – restoration of Feature Groups 2, 3, and 8, and Alternative K – restoration of Feature Groups 1 through 8. Sections 3 through 5 and Appendix L of the report discusses alternative formulation and selection.

For all alternatives, the potential effects were evaluated, as appropriate. A summary assessment of the potential effects of the recommended plan are listed in Table 1:

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Summary table of Potential Effects of the Recommended Plan

	Insignificant effect	Insignificant effects as result of mitigation*	Resource unaffected by action
Aesthetics	☒	☐	☐
Air quality	☒	☐	☐
Aquatic resources/wetlands	☒	☐	☐
Invasive species	☒	☐	☒
Fish and wildlife habitat	☒	☐	☐
Threatened/Endangered species/critical habitat	☒	☐	☐
Historic properties	☐	☒	☐
Other cultural resources	☐	☒	☒
Floodplains	☒	☐	☐
Hazardous, toxic & radioactive waste	☐	☐	☒
Hydrology	☒	☐	☐
Land use	☒	☐	☐
Navigation	☐	☐	☒
Noise levels	☒	☐	☐
Public infrastructure	☐	☐	☒
Socio-economics	☐	☐	☒
Environmental justice	☐	☐	☒
Soils	☒	☐	☐
Tribal trust resources	☐	☒	☐
Water quality	☒	☐	☐
Climate change	☐	☐	☒

All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the Recommended Plan. Best management practices (BMPs) as detailed in the IFR/EA will be implemented, if appropriate, to minimize impacts.

No compensatory mitigation is required as part of the Recommended Plan.

Public review of the draft IFR/EA was completed on XX, 2022. All comments submitted during the public review period were responded to in the Final IFR/EA and FONSI.

Pursuant to Section 7 of the Endangered Species Act of 1973, as amended, the U.S. Army Corps of Engineers determined that the Recommended Plan will have no effect on federally listed species or their designated critical habitat.

Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, the U.S. Army Corps of Engineers has determined that historic properties would not be adversely affected by the Recommended Plan. Concurrence was received on XX, 2022.

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Pursuant to the Clean Water Act of 1972, as amended, the discharge of dredged or fill material associated with the Recommended Plan has been found to be compliant with section 404(b)(1) Guidelines (40 CFR 230). Section 404(b)(1) Guidelines were completed as part of Nationwide Permit 27, Aquatic Habitat Restoration, Enhancement, and Establishment Activities.

A water quality certification pursuant to Section 401 of the Clean Water Act was obtained by the Minnesota Pollution Control Agency on December 1, 2020 via Nationwide Permit 27. All conditions of the water quality certification shall be implemented in order to minimize adverse impacts to water quality.

All applicable environmental laws have been considered and coordination with appropriate agencies and officials has been completed.

Technical, environmental, economic, and cost effectiveness criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on this report, the reviews by other Federal, State, and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the recommended plan would not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.

_____ _____

Date

Karl Jansen
Colonel, Corps of Engineers
District Commander

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1 Introduction

This Integrated Feasibility Report and Environmental Assessment (IFR/EA) documents the planning process for evaluating potential alternatives to restore stream and riparian habitat to a more natural condition in the Lower Otter Tail River (LOTR) to demonstrate consistency with Corps planning policy and to meet the regulations that implement the National Environmental Policy Act (NEPA).

1.1 Study Authority

The Lower Otter Tail River channel improvement plan was part of the comprehensive plan for the Red River drainage basin authorized by the Flood Control Acts, approved June 30, 1948, and May 17, 1950. This report was prepared under the Continuing Authorities Program (CAP) Section 1135 authority of the Water Resources Development Act of 1986, as amended, in response to a December 2015 request for Federal assistance from the Buffalo-Red River Watershed District in Minnesota (BRRWD).

The CAP Section 1135 authority provides for the review and modification of structures and operations of water resource projects constructed by the Corps for the purpose of improving the quality of the environment when it is determined that such modifications are feasible, consistent with the authorized project purposes, and will improve that quality of the environment in the public interest. In addition, if it is determined that a Corps water resources projects has contributed to the degradation of the quality of the environment, restoration measures may be implemented at the project site or at other locations that have been affected by the construction or operation of the project, if such measures do not conflict with the authorized project purpose.

1.2 Purpose and Scope

The Buffalo-Red River Watershed District requested Corps of Engineers assistance to restore stream and riparian habitat after its initial project planning in order to assist with project development and implementation.

The purpose of this Corps of Engineers (Corps) Integrated feasibility Report and Environmental Assessment (IFR/EA) is to investigate and determine the feasibility of potential alternatives to restore stream and riparian habitat to a more natural condition within the study area. This report provides planning, engineering, and preliminary design details of the Tentatively Selected Plan (TSP) and an estimate of construction costs. The report documents existing conditions, project feature conditions, assesses the problem, provides and compares alternatives, and makes a recommendation to accomplish the project purpose of restoring and stabilizing stream function.

The LOTR Ecosystem Restoration Project Feasibility Study investigates alternatives to modify an existing flood control project constructed by USACE on the Lower Otter Tail River to restore and stabilize stream function. The original USACE project involved straightening, cleaning, and enlarging the river for drainage improvement to local agriculture. The project provided protection against a 10-year flood exceedance event by cleaning, enlarging, and straightening the existing river channel which led to a decreased channel length, increased channel grade, increased channel conveyance, increased bank erosion, and a reduced flood profile in the LOTR watershed. The length of the river within this reach was reduced from 18 miles to 11 miles as a

part of this project. The project has impaired the river so that now it is characterized by unstable banks, headcutting, excessive sediment loading, and degraded in-stream and riparian habitats. In 2006, the Minnesota Pollution Control Agency (MPCA) completed a Total Maximum Daily Load (TMDL) study on the LOTR. The TMDL study listed the LOTR reach as impaired for exceeding the turbidity standards for aquatic life and the study was approved in 2007 by the U.S. Environmental Protection Agency (EPA). The U.S. Geological Survey (USGS) confirmed the turbidity impairments and estimated that the annual sediment load was 40,400 tons at the sampling site in Breckenridge, Minnesota. Additionally, survey work has documented that the river banks have less than a 30 ft buffer between top of the bank and agricultural fields which is an inadequate buffer if flooding situations arise.

Under the CAP Section 1135 authority, improvements will reestablish the river back within natural conditions, stabilize and improve the channelization, and restore stream and riparian habitat. Upstream of Orwell Dam, the Otter Tail River is known to have the most diverse fish species populations in the Red River Basin. The Minnesota Department of Natural Resources (MNDNR) identified the LOTR as a key piece in their efforts to restore Lake Sturgeon (*Acipenser fulvescens*) populations to the Red River Basin. Lake sturgeon fingerlings have been getting stocked at multiple sites in the Otter Tail River watershed with a goal of getting introduced into the project area. Restoration of the LOTR would help to increase Lake Sturgeon population restoration efforts by restoring aquatic habitat, improving water quality, and restoring/enhancing adjacent wetland and riparian habitats. Additionally, restoration would benefit the broader fish community by increasing suitable fish habitat and improving water quality in the LOTR which would also lead to numerous ecological and recreational benefits. In accordance with the authorization provided by Section 1135 authorities, any modifications to the authorized Corps project must be accomplished without decreasing the original authorized project purpose of conveying a 10-year flood exceedance event with minimal impacts to adjacent agricultural fields. Any improvements in this area will be considered modification of an existing Corps project for the purpose of improving environmental quality.

1.3 Non-Federal Sponsor

In December 2015, the Buffalo-Red River Watershed District requested Corps of Engineers assistance to assist with project development and implementation to provide ecosystem restoration to the Lower Otter Tail River. The federal interest determination was approved in August 2016. The Buffalo-Red River Watershed District will serve as the project's non-Federal sponsor.

The Buffalo-Red River Watershed District has prepared a vision statement for the LOTR that describes a stable and healthy condition including the following:

- A meandering river with proper slopes, channel length, and speed of flow;
- Vegetated riparian buffers and floodplain that would greatly reduce bed and bank erosion and improve water quality;
- Quality, diverse aquatic habitat – deep swift pools, rocky riffles, overhanging and rooted bank vegetation;
- Quality riparian habitat to provide a buffer along the banks and a wildlife corridor;
- Improved water quality through cleaner, clearer water;

- A connected floodplain that helps to store and dissipate flood flows and provide wildlife habitat.

1.4 Agency Participants and Coordination

Agency coordination for this ecosystem restoration project has been ongoing with MNDNR since the kickoff meeting in 2017. Additional meetings with MNDNR have also taken place to discuss floodplain and river impacts, permitting, monitoring project success. Appendix I – Coordination and Correspondence contains additional information on the scoping meetings.

The following individuals played an active role in the planning of the project.

Table 1: Project Team

U.S. ARMY CORPS OF ENGINEERS		
Name	Discipline	Contribution
[redacted]	Project Manager	Project Manager
[redacted]	Lead Planner	Plan Formulation
[redacted]	Biologist	Environmental/HEP
[redacted]	Hydraulics	Hydrology/Hydraulics
[redacted]	Contracting	Contracting
[redacted]	Engineer	Geotechnical
[redacted]	Engineer	Geotechnical
[redacted]	Engineer	Costs & Specs
[redacted]	Engineer/Technical Lead	Civil/Layout
[redacted]	Archaeologist	Cultural Resources
[redacted]	Geographer	GIS
[redacted]	Real Estate	Real Estate
[redacted]	Real Estate	Real Estate
BUFFALO-RED RIVER WATERSHED DISTRICT		
[redacted]	Former District Administrator	Former District Administrator
[redacted]	District Administrator	District Administrator
[redacted]	Interim District Administrator	Interim District Administrator
WILKIN SOIL & CONSERVATION DISTRICT		
[redacted]	Resource Specialist	Resource Specialist
HOUSTON ENGINEERING		
[redacted]	Engineer / Project Manager	Engineering
[redacted]	Engineer	Engineering and H&H Modeling
MINNESOTA DEPARTMENT OF NATURAL RESOURCES		
[redacted]	River Ecologist	River Biologist
[redacted]	River Ecologist	River Biologist
[redacted]	Hydrologist	Area Hydrologist
[redacted]	Fisheries Biologist	Fisheries Biologist
MINNESOTA DEPARTMENT OF NATURAL RESOURCES		
[redacted]	Fisheries Biologist	Fisheries Biologist

1.5 Study Area

The project area is located east of the town of Breckenridge, Minnesota on a reach of the Lower Otter Tail River. The boundaries of the LOTR study area are Orwell Dam at the upstream extent and the Breckenridge Lake Dam (**Figure 1**). Breckenridge is approximately 45 miles south of Fargo, North Dakota and 180 miles northwest of Minneapolis, Minnesota. The Section 1135 proposed project area starts approximately 8.5 river miles upstream of the confluence with the Bois de Sioux River and continues upstream for approximately 11.5 river miles towards Orwell Dam (**Figure 2**).

The study area is about 2,600 acres in size (extent of LOTR and buffer zone of affected area) and is composed of six major cover types in the project area: agriculture (AG), forest, shrub grasslands, river, wetland, and disturbed (Appendix K). This is reflective of general land use in Otter Tail County which is composed of 70.6% cropland, 12.6% woodland, and 7.4% pasture. The Lower Otter Tail River channel improvement project was part of the comprehensive plan for the Red River of the North (Red River) drainage basin authorized by the Flood Control Acts approved June 30, 1948, and May 17, 1950. The project was constructed under one contract from 1952 to 1954, with a minor contract being completed in September 1955.

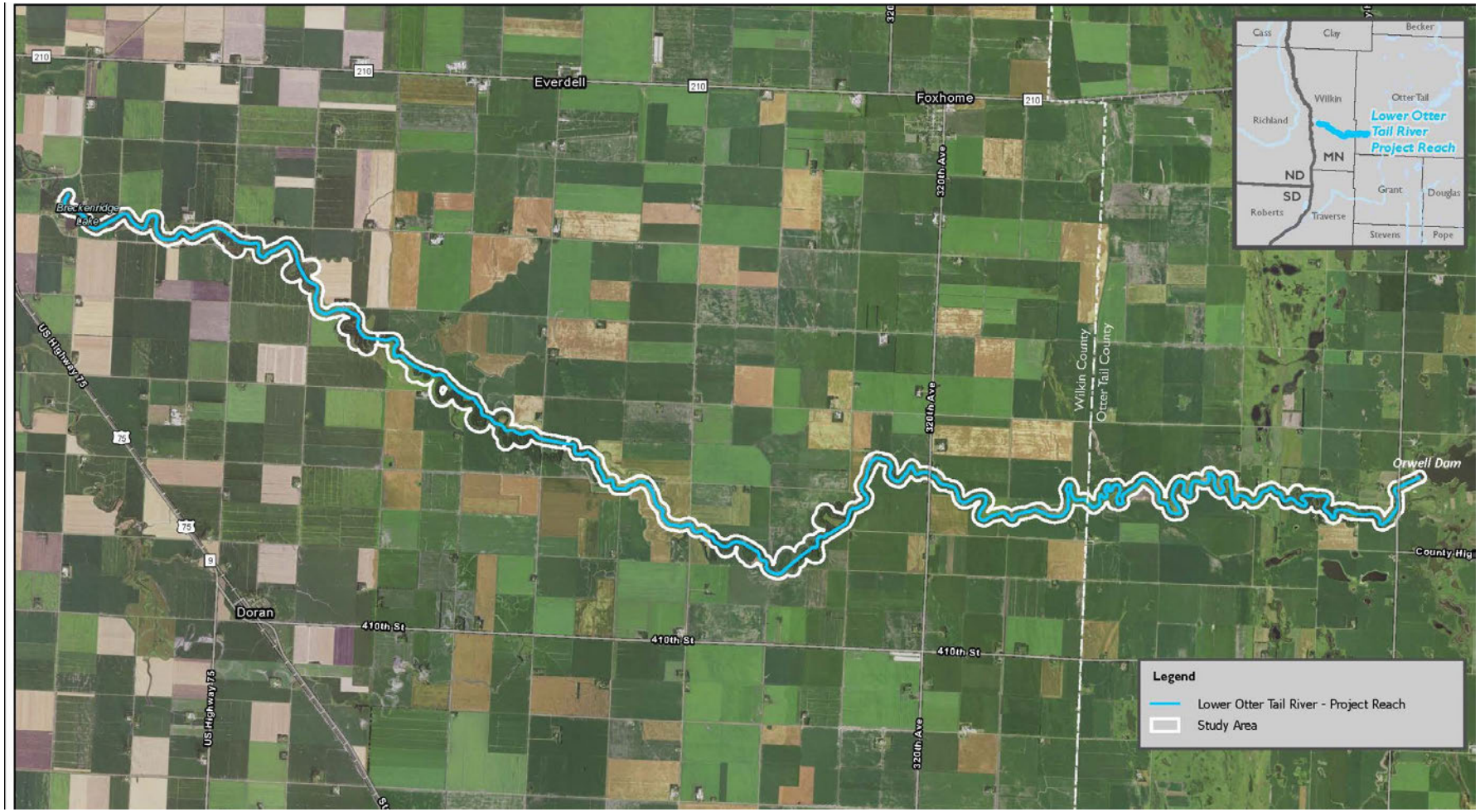

Figure 1: Lower Otter Tail Study Area

Figure 2. Lower Otter Tail River Proposed Project Area (Channelized Reach)

1.6 Prior Reports & Existing Projects

The United States Army Corps of Engineers and the Buffalo-Red River Watershed District have conducted a few studies relevant to this planning report. The following is a brief list of studies relevant to this study:

- USACE Otter Tail River Channel Improvement Plans, 1954; USACE.
- USACE Otter Tail River Channel Improvement Plans, 1955; USACE.
- USACE Fargo Moorhead Diversion Project (currently under construction)

This Feasibility Study Report builds upon information developed from the previously constructed Corps Project within the study area, but also utilizes knowledge gained from successful implementation of similar ecosystem restoration projects within the Red River Basin. Since the completion of the Corps' original channel improvement plan, the O&M of the LOTR had diminished and/or hasn't been documented. The Wilkin County Drainage and Conservancy District had received the project from the USACE in 1954; however, it was transferred to the Buffalo-Red River Watershed District (BRRWD) a few years ago. Upon transfer, the BRRWD began to plan a restoration effort that would restore a portion of the LOTR that was negatively affected by the original USACE channel improvement project.

The USACE Fargo Moorhead Diversion Project is a joint effort by USACE and the Diversion Board Authority that currently is being designed and constructed to reduce the risk to the Fargo-Moorhead-West Fargo metro area during extreme flooding. Project features include river control structures, floodwalls, levees, embankments, a diversion channel, and upstream mitigation. Aquatic ecosystem mitigation for the Fargo Moorhead Diversion Project includes restoration of the Lower Ottertail River to compensate for acres of public waters that may be removed by the diversion project. Mitigation is scheduled to begin ahead of the implementation of the proposed Lower Otter Tail CAP Section 1135 project and is anticipated to include features recommended in this study. While this did not change the plan formulation for the study, the study team acknowledged that this will influence the plan implementation and included an analysis to account for this. See Section 7.2 for additional details on the project implementation considerations for this study based on the USACE Fargo Moorhead Diversion Project mitigation.

1.7 Resource Significance

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) (P&G) and USACE 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 values are based on technical, institutional or public recognition of the ecological, cultural, and aesthetic attributes of resources in the project area (Corps 1997). The scientific community and natural resources management agencies recognize the technical significance of resources.

1.7.1 Institutional Significance

Institutional significance is that based on institutional recognition or the importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups.

The Otter Tail River is a DNR designated public waters from Section 25 of Foxhome Twp. to Section 8 of Breckenridge Twp. County Ditch Systems in the project area (Wilkin CD Nos. 2, 2A, 4, 4A, 8A and 27; and Co-Op Ditch No.1) flow into the Otter Tail River.

The Otter Tail River was designed by the 2006 Minnesota Legislature as a canoe and boating route, becoming the 31st "Water Trail" in Minnesota. A master plan was developed for water-based recreation specifically on the Otter Tail River, and it serves as a guide for local initiatives (Leitch et al. 2009). The river flows through wildlife sanctuaries, large lakes, urban areas and has 22 dams and 70 bridges across 186 river miles. The plan helps to identify obstructions to recreational navigation (e.g., dams, bridges, culverts, utility crossings) and potential solutions for canoe and kayak users.

1.7.2 Public Significance

Public significance is that based on public recognition or that some segment of the general public recognizes the importance of an environmental resource.

A number of Non-Government Organizations (NGOs) have an interest in the Otter Tail River and include the Red River Basin Commission, Audubon Society, Minnesota Center for Environmental Advocacy, Sierra Club, Minnesota Waters, Detroit Lakes Izaak Walton League, Clean Water Action Alliance of Minnesota, Minnesota Environmental Initiative, Minnesota Environmental Partnership, Minnesotans for Healthy Lakes, Minnesota Seasonal Recreational Property Owners, 1000 Friends of Minnesota, and Freshwater Society.

1.7.3 Technical Significance

Technical significance is that based on technical recognition or the importance of an environmental resource based on scientific or technical knowledge or judgment of critical resource characteristics.

The Lower Otter Tail River sediment TMDL report was completed in 2006 and identified sources of sediment both from the watershed and from the channel itself. Wilkin County, and more recently the Buffalo-Red Watershed District, has systematically installed buffers and side inlet sediment control BMPs on the tributary county ditch systems. Work completed by Wilkin County on the county ditch systems addressed much of the watershed sources of sediment.

1.8 Existing Conditions and Expected Future Without- Project Conditions

The Existing and Future Without Project (FWOP) condition is developed to describe the current and most likely future condition in the study area if no federal action is taken to address the identified problems. It forms the baseline for identifying the effects of the alternatives and is the No Action Alternative. The future is inherently uncertain, and conditions change over time.

The Corps is required to consider the option of "No Action" as one of the alternatives to comply

with the requirements of the National Environmental Policy Act (NEPA). The No Action alternative is synonymous with the FWOP Condition. The No Action alternative would not include any action by the Federal government under the CAP Section 1135 and no additional costs to the Corps would be generated. The No Action alternative would include restoration that is anticipated under the Fargo Moorhead Diversion Project Mitigation, however, details of this mitigation are currently unknown. Because it is currently unknown what features will be implemented by local entities ahead of the construction of the TSP, this report acknowledges the Fargo Moorhead Diversion Project Mitigation, but does not include the mitigation in the FWOP analysis. Additional information on the Fargo Moorhead Diversion Project mitigation can be found in Section 1.6.

1.8.1 Engineering

Straightening a river reach was, and continues to be, a common engineering practice to improve drainage capacity. The level of protection can be increased by increasing the conveyance capacity of a drainage pathway and shortening the travel time through the system. However, riverine straightening can also have negative consequences for stream geomorphology, water quality, and subsequently riverine ecology. In the case of the Lower Otter Tail River, approximately 18 river miles were reduced to 11 river miles as a result of the USACE project. However, the inlet and outlet elevations of the river reach remained approximately the same as the pre-USACE project. This results in an increase of average reach slope from 0.036% to 0.058%.

According to geomorphology principles developed by Lane (Lane 1955), natural river streams are constantly evolving to balance the systems sediment and water loads without either aggrading or degrading. This process occurs by way of a direct relationship between four system parameters, namely, the system flow, sediment load, average sediment size (D50), and stream slope. This relationship is known as Lane's balance. After the construction of Orwell Dam and the USACE straightening project, several of these parameters were drastically changed within the Lower Otter Tail River system. Reduced peak flows (due to the flood mitigation impoundment), reduced sediment load (due to the sediment settling occurring within the Orwell reservoir), and increased slope all contributed toward an unbalanced, unstable system. Over time, the river has degraded several feet resulting in many locations where unstable vertical banks exist along the channel. This has led to increased turbidity and a degradation of water quality within the system. An estimate of over 27,000 tons per year of sediment has been delivered to the river from its eroded banks.

Due to the straightening of the channel, the river experiences high stream velocities that contribute to degradation. A detail analysis of hydrologic modeling can be found in Appendix A. If no action is taken to remeander the LOTR, stabilize the banks, and stop the headcut, it is likely that the river would continue to degrade. The general trends of uncontrolled erosion along the banks and within the channel will worsen, eventually threatening existing public infrastructure (bridges), private land (farms and homesteads), and habitat (Conservation Reserve Program buffers). The headcut will continue to work its way upstream, eventually impacting Orwell Dam. Aggrading will continue, and unabated sediment loading will continue to impair the LOTR. This sediment will continue entering Breckenridge Lake, where it has and will continue to create conditions that degrade aquatic habitat and recreational value.

Figure 3. Bank degradation with tree collapse along Conservation Reserve Program buffers

1.8.2 Climate

The primary objective of the Lower Otter Tail River project is to improve ecological conditions on the reach of river below Orwell Dam and upstream of Wahpeton while maintaining flood protection. The information presented in the climate assessment (Appendix K), indicates that climate is a factor that should be considered when developing flood risk management and ecosystem restoration projects, strategies, and policies for the watershed. The results from this assessment indicate that there is evidence of climate change occurring in the basin and that the watershed naturally transitions between wet cycles and dry cycles which span multiple decades.

Evidence from the literature review and linear regression of observed data in the Red River Valley region shows that total annual snowfall, annual precipitation since 1970, and annual peak streamflow have experienced statistically significant increases throughout the watershed. Each of these factors contribute to increased flood risk in the basin. The Otter Tail River below Orwell Dam near Fergus Falls USGS gage (ID 05046000) contains flood records dating back to 1931. Five of the 12 largest recorded events within the Red River of the North basin have occurred since the year 2000. This is a qualitative indication that large-scale flooding occurs more frequently in the basin than in the past. Climate projections indicate that flood risk will increase in the future. Precipitation is projected to increase in the form of more frequent, intense, heavy rainfall events, and increases in mean annual maximum monthly flow are anticipated to increase. A shift in seasonality has also been observed in the basin with more flooding occurring during the summer and fall months which has implications for water management operations.

Results from the nonstationarity detection analyses show that there are strong nonstationarities within the period of record. Strong nonstationarities exist in 1941 and 1992. The period of record at the Lower Otter Tail River USGS gage shows that the statistical properties of the annual peak flow dataset are currently in flux which is further evidence to question the assumption of stationarity. Collectively, this shows that climate related changes have occurred in the watershed and should be considered when selecting the period of record for analysis and development of flood flow-frequency curves.

A key finding from this assessment is research which indicates the presence of long-term natural variability in the climate of the Red River Valley region which may be independent of anthropogenic influenced climate change. Peer-reviewed literature shows that the Red River

Valley region transitions between wet and dry cycles which can last multiple decades. The frequency of these cycles appears to be driven by natural factors. While this finding is significant and may help explain some of the nonstationarities detected in the period of record, it should also be noted that it is not possible to rule out the impacts from climate change to the frequency or magnitude of the cycles.

Perhaps the strongest evidence of non-natural climate change in the basin is the observed and projected increases in temperature. Climate is largely driven by the thermodynamic processes of the Earth's atmosphere. Temperature is anticipated to increase in the future which will impact climate in the Red River Valley. The weight of evidence from this assessment indicates warmer and wetter future conditions as a result of climate change coupled with the possibility of natural variability between wet and dry cycles over the long-term. This has implications for flood risk management projects and ecosystem restoration projects. Projected increases in temperature as a result of non-natural climate change coupled with the long-term natural variability between wet and dry cycles has the potential to exacerbate flooding in the basin during a wet cycle and drought during a dry cycle. An increase in the frequency or severity of droughts in the watershed would be especially detrimental to wetlands which require water to perform their many ecosystem functions.

1.8.3 Environmental Resources

The Otter Tail River watershed covers 1922 square miles and is a subwatershed of the Red River of the North Basin in former Lake Agassiz. Changes in land use associated with increased development in the region appear to be the primary reasons for watershed problems related to soil erosion, wetland management, surface water quality, stormwater runoff, and fish and wildlife habitat degradation. Currently, there are six general land cover types in the study area composed of agricultural, forested, river, shrubs/grasses, wetlands, and disturbed (**Figure 4**). As discussed in Section 7, the major resources of the river are strongly tied to these cover types.

Future without-project conditions are likely to show a continued degradation of the river's natural resources. As the headcut continues to migrate upstream, more of the river will become incised and disconnected to riparian. With less lateral connectivity, there will be a commensurate loss of nutrient and sediment influx to the floodplain. Riparian vegetation will decline, resulting in less habitat for wildlife populations. The loss of trees and shrubs along the banks will result in increased thermal loading. Bank erosion will continue and likely increase, resulting in higher turbidity in the water and sedimentation. River substrates will become covered in fine sediments, thus losing function as spawning areas for riverine fish. In summary, the river will continue to lose key fluvial geomorphic and riparian processes that are important in maintaining aquatic and terrestrial habitat that support fish and wildlife populations.

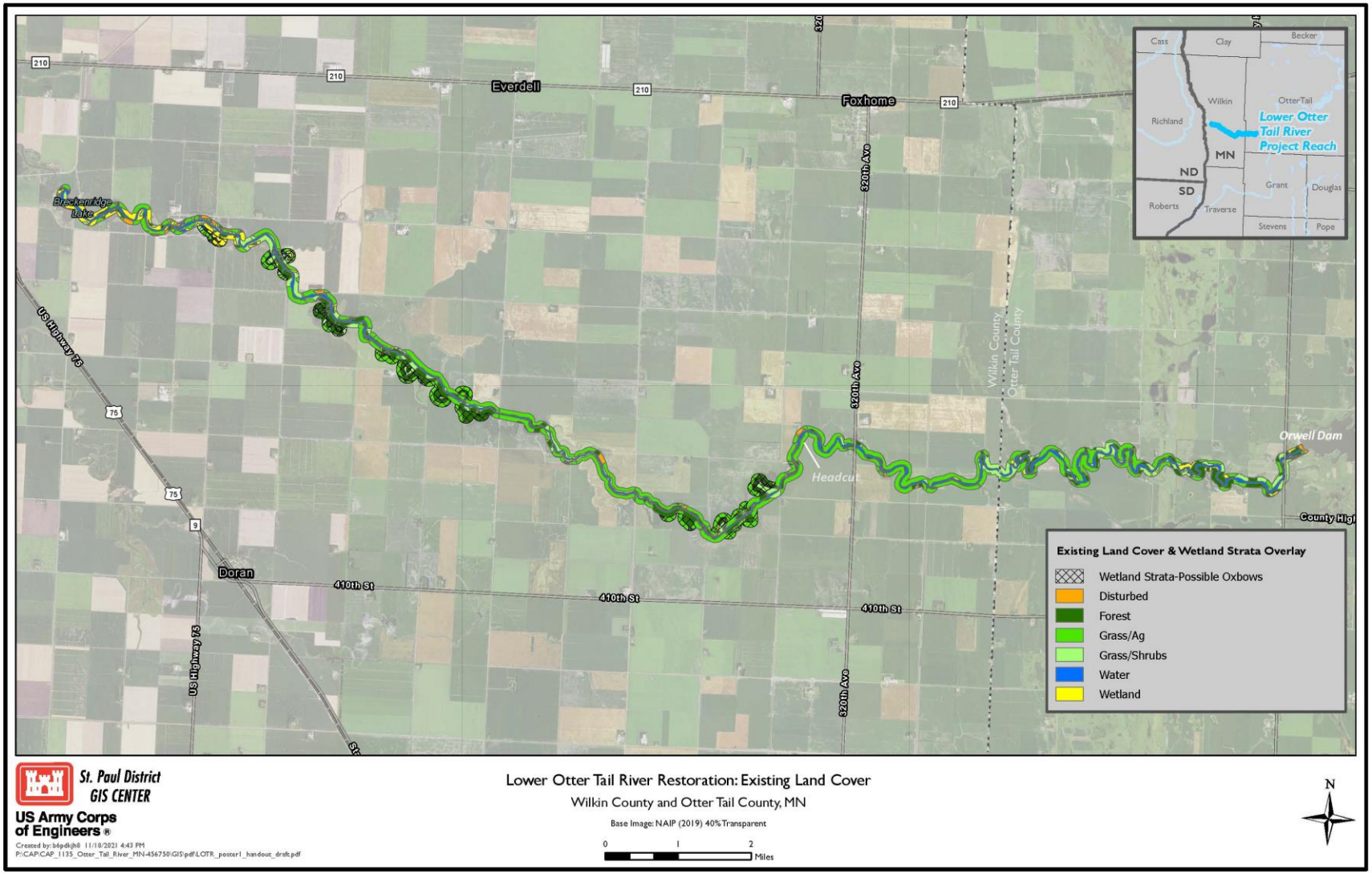

Figure 4: Existing Land Cover

1.8.4 Cultural Resources

Section 106 of the National Historic Preservation Act (NHPA) and its implementing regulation 36 CFR Part 800 Protection of Historic Properties requires that the impacts of federal projects on cultural resources be given consideration during project planning. Cultural resources include historic landscapes and properties, archaeological and architectural sites, sacred sites, and archaeological collections or other objects created by humans. These resources may be listed, or eligible for listing, in the National Register of Historic Places (NRHP).

Phase I archaeological surveys of all implementable project areas will be required, as the original project was constructed in the early to mid-1950s. Much of the project area is identified as sediment deposited in disconnected meander loops through erosion, and as dredged fill used to plug meanders, effectively segregating them from the stream channel excavated during construction of the original project. Immediately upstream of the project location, pedestrian archaeological survey, conducted by George R. Holley in October 2016, identified a light debris scatter of non-diagnostic bone and rock along the riverbank (21WL58). The Holley report also identified a poorly formed, near surface, buried A-Horizon that appeared to be continuous along a large section of the riverbank. This buried soil is plainly visible along the stream channel at multiple locations. Soils in the area are clayey and silty and contain lake modified till, with banks undergoing active erosion.

Figure 5. View of left bank descending between Oxbows 8 and 9, with yellow highlight indicating location of the dark buried soil

The paucity of archaeological sites identified along the Lower Otter Tail River, leads us to draw inferences of land use—during post-glacial periods—from the Red River Valley, where examples of small, and often ephemeral sites advocate for the past use of the river primarily as a means of travel. Holley suggests that the Otter Tail River may have connected the Red River with lakes to the east where resources varied from those of the plains (2016). The setting for the

Lower Otter Tail River is mostly flat, as it was formerly a part of Pleistocene Lake Agassiz. In 1859 when the area was platted as part of the General Land Office, Department of Interior, survey, areas in and along the waterway were overgrown with dense willow thickets. Subsequent establishment of trails used to transport goods between St. Paul and the Red River Valley, included the Historic Ox Cart trail and connection of the North Country Trail. Archaeological survey would address land use and transportation in the project area.

2 Plan Formulation

2.1 Overview of Plan Formulation

The Project Delivery Team (PDT) incorporated national planning goals and procedures which are defined in the "Planning Guidance Notebook" (Engineering Regulation 1105-2-100). Local standards and criteria were used by the PDT and integrated into the project design. The study team tried to take advantage of any secondary opportunities that the ecosystem restoration project might offer (for example, water quality and associated incidental benefits).

To be an implementable Federal project, the project must have the support of the non-Federal sponsor(s) and a demonstrated Federal interest in implementing the plan. To obtain Federal funding for a Section 1135 ecosystem restoration project, the plan formulation process must adhere to laws, policies, and regulations that define the planning and design process to be followed and establish specific design criteria and requirements. These criteria and requirements establish consistent standards for project designs and implementation/construction and assure that the project features will perform reliably.

To effectively formulate a feasible CAP Section 1135 ecosystem restoration project and assess its effects, a full array of potential ecosystem restoration strategies and associated specific plans must be considered. Plan comparison evaluations are done initially at a low level of detail through a Federal Interest Study (a Preliminary Restoration Plan, in this case). These initial efforts focus on determining the likelihood that a feasible plan exists in the Federal and local interest. If Federal and local interest is found, studies in a greater level of detail are completed during the feasibility study. Ecosystem restoration plans found to be environmentally feasible, economically feasible, and socially acceptable are evaluated further in a progressive screening process until a Tentatively Selected Plan is identified.

Public and interagency involvement, scoping, and product reviews are sought throughout the process to keep the public informed and to receive and incorporate pertinent ideas and concerns. Potentially-affected landowners and other stakeholders are also involved in the plan formulation process to try to find a project design that reasonably minimizes project related impact and can be supported from a general public perspective.

This section presents the rationale for the development of a TSP. It describes the USACE iterative six-step planning process used to develop, evaluate, and compare the array of management measures and preliminary alternative plans that have been considered

2.2 Problems

Water resources projects are planned and implemented to solve problems, meet challenges, and seize opportunities. In the alternative planning setting, a problem can be thought of as an undesirable condition. An opportunity offers a chance for progress or improvement of the situation. The identification of problems and opportunities gives focus to the alternative planning effort and aids in the development of planning objectives. Problems and opportunities can also be viewed as local and regional resource conditions that could be modified in response to

expressed public concerns. This section identifies the problems and opportunities in the study area based on the assessment of existing and expected FWOP conditions.

The overarching problem is that the Lower Ottertail River has unstable banks, headcutting, excessive sediment loading, degraded instream and riparian habitats, and turbidity levels exceeding the standard for aquatic life.

A sponsor and agency technical meeting was held on 11 April, 2017 to inventory conditions in the study area and define problems, opportunities, and study objectives. A conceptual ecological model (CEM) was developed to identify drivers, stressors, effects, and attributes (Figure 6). This CEM also identifies potential performance measures which will be discussed in the monitoring and adaptive management plan (Appendix E).

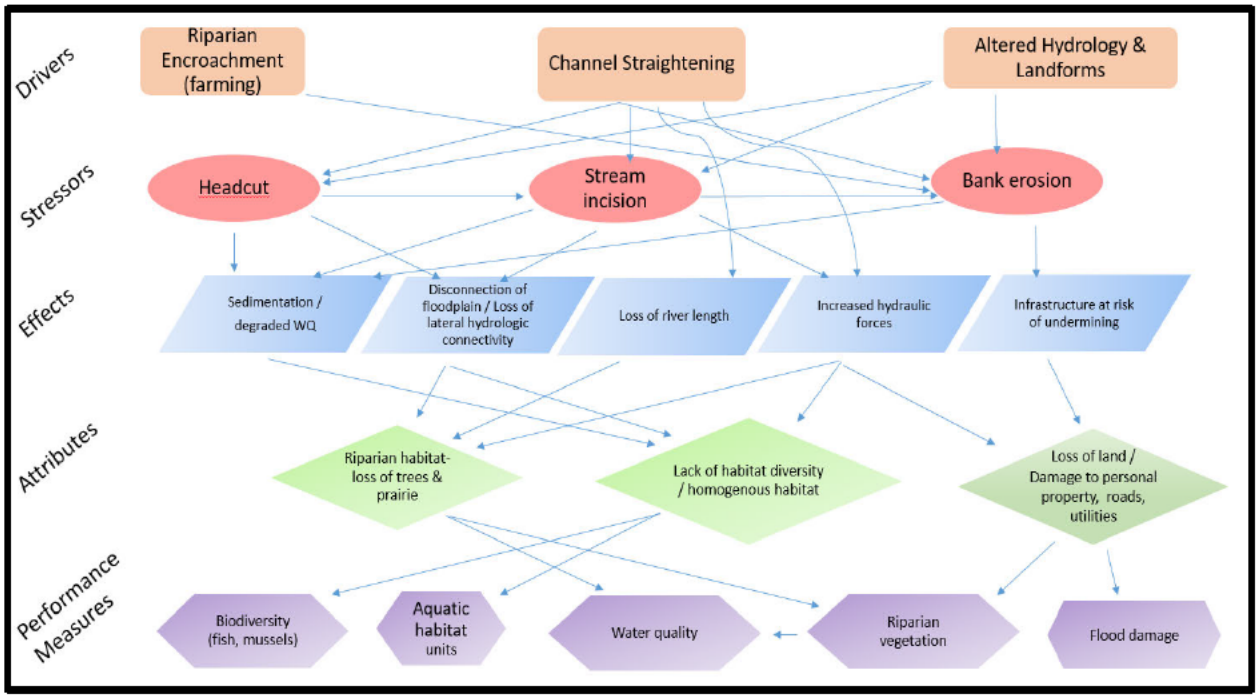

Figure 6. Lower Otter Tail Restoration Project Conceptual Ecological Model

Riparian Encroachment: Riparian encroachment primarily via farming activities have led to a loss of vegetation cover that contributes to bank erosion and a loss of terrestrial habitat.

Channel Straightening: The original channel straightening of the Lower Otter Tail River has led to a series of problems within the Corps designated reach of the river. The straightening of the river has caused multiple areas to experience bank failure/erosion and stream incision, which have contributed to the excessive sediment loading, degradation of in-stream and riparian habitats, aggradation on the lower 1/3 of the river, and reduced sinuosity throughout the entire reach of the LOTR. These identified problems, along with land use and climate changes, have also reduced the amount of riparian buffer and connection to the floodplain. The original channel straightening project removed 21 meanders from the main channel and there were approximately 6 oxbows that were cutoff prior to the Corps straightening project. With the

removal of the meanders, there was a significant loss of sinuosity and recreational and biologic connectivity. The loss of connectivity reduced habitat for wildlife and fish species that utilized the lower reaches. Excessive sediment loading has impaired the water quality evidenced by exceeding the standards for aquatic life in the Lower Otter Tail River (dissolved oxygen, turbidity, nutrient loading, and temperature). There are 150 potential drains coming off of local field into lower reach contributing to these impairments.

Altered Hydrology (Orwell Dam): Orwell Dam affects the Lower Otter Tail River habitat by influencing flows and blocking connectivity for fish passage. Water from Orwell Dam is sediment starved with clear water discharge causing bed degradation downstream. Dam operations (drawdown and maintenance times) may cause unnatural hydrology which impacts resident mussels that often get stranded after drawdown. In addition, flooding is a problem for events that exceed the LOTR channel capacity. Any alternative plan that may be selected may increase channel conveyance and flooding potential.

2.3 Opportunities

Environmental

1. Reduce bank erosion and enhance lateral connectivity to improve TMDL levels within the LOTR project area.
2. Improve stream resiliency from aquatic invasive species, climate, and land-use practices.
3. Restore Lake Sturgeon species back into the LOTR.
4. Reestablishment of channel dimension, pattern, and profile.
5. Increase riparian, prairie, and stream habitat within and alongside the LOTR project area.

Public

1. Improve fishing, wildlife viewing, paddling, nature viewing and other outdoor recreational opportunities to the LOTR.
2. Increase economic opportunities for counties surrounding the lower reach of the Otter Tail River.
3. Increase public, upland, and canoe/watercraft access throughout the LOTR from Breckenridge Lake to Orwell Dam.
4. Establish cultural resource presence such as the Historic Ox Cart trail, the connection of the North Country Trail and prehistoric sites on project lands.

2.4 Restoration Goals

The goal of the project is to create an environment along the Lower Otter Tail River where stable and desired stream conditions can be reached, and natural geomorphic process can maintain the constructed restored river. Stream stability is defined as “the ability of a stream to transport the water and sediment of its watershed in such a manner as to maintain its dimension, pattern, and profile, over time, without either aggrading or degrading” (Rosgen 1996). Stable stream conditions are expected to carry benefits for water quality and aquatic habitat while maintaining the flood damage reduction benefits of the 1953 USACE project (10-year level of protection).

2.5 Planning Objectives

The primary study objective is to restore stream and riparian habitat to a less degraded and more natural condition within the Lower Otter Tail River study area within the given constraints for the specified 50-year period of planning analysis. This objective will enhance river and riparian habitat in support of fish and wildlife populations. Secondary planning objectives supporting the primary study objective are discussed below.

2.5.1 Geomorphology and Water Quality

The geomorphology and water quality objective is to restore the slope, sinuosity, and meander belt within the Lower Otter Tail River project area through the 50-year period of analysis. Stabilizing the existing sloughing banks and headcuts will also be addressed by restoring the form and profile of the Lower Otter Tail River. Achievement of this objective would add additional length, habitat, and stabilize the river which will also improve the water quality thus improving the declining fisheries within the project area.

Stream stability includes channel geometry, pattern and profile, but may also include floodplain restoration. The original floodplain has been disconnected from the Lower Otter Tail River as the channel bottom has degraded over time. Without the floodplain, velocities continue to increase within the channel, making incising worse and causing higher flows during storm events. Since the 1953 USACE project, degradation of the channel in the upper reaches of the river has provided increased drainage for surrounding farmland. The current water table is likely lower than in the 1950's, allowing previously wet areas that were unsuitable for farming to be cultivated. A higher channel profile may also restore the water table to original levels and therefore enhance wetland conditions within the associated floodplain. The goal of the project is to create an environment along the river where stable stream conditions can be reached, and stable stream conditions require a healthy floodplain.

Enhancing fluvial geomorphology of the river will benefit aquatic habitat and associated aquatic biota. Multiple geomorphic features such as channel bedform, flow variability, and embeddedness have been implicated as important factors that affect fish assemblage diversity, composition, and distribution. Unionid mussel abundance, density, and species richness have also been tied to substrate size, shear stress, and channel gradient. The proposed measures will enhance geomorphic conditions that will benefit riverine fish, especially smallmouth bass and walleye. Coarser substrates will enhance spawning opportunities for fish as well as colonization of mussels and other benthic macroinvertebrates. Scour holes associated with sharp river bends will also improve conditions for lake sturgeon, which is a species that MNDNR has particular interest in repopulating along the Otter Tail River.

2.5.2 Self-Sustaining Riparian Habitats

The self-sustaining riparian habitat objective is to implement the restoration of natural processes (natural flow regime and floodplain connectivity) that will require the minimal amount of maintenance over time within the Lower Otter Tail River project area through the 50-year period of analysis. Healthy riparian conditions will benefit a wide variety of wildlife populations including aquatic mammals, waterfowl, shorebirds, songbirds, amphibian, and reptiles. The increased vegetative diversity and interspersion within the LOTR corridor would enhance the

area's suitability for many wildlife species and would provide a travel corridor between riparian and wetland habitats. Achievement of this objective would enhance lateral connectivity between the river and floodplain, which will mimic and restore natural process and require minimal maintenance following project completion.

2.6 Planning Constraints

Flood Control Project Authorized Purpose: The 1953 USACE project utilized the 10-year event (or an event that has a 10% chance occurring in any given year) for project design which equated to a flow of 1340 cfs at the upstream end of the project and 1625 cfs at the downstream end of the project.

The original USACE project was formulated and constructed with the intent of minimizing the damage to agricultural production as a result of flooding up to a 10-percent chance exceedance event. The CAP Section 1135 authority requires that any modification to an existing project must remain consistent with the original authorized purpose. The original 1952 project Analysis of Design states "The degree of protection to be provided by the project channel was established in the survey report as complete protection against a frequency of once in 10-years." The report also references the controlling bank elevation, stating "This profile indicates the points along the project reach at which significant flooding begins and is, therefore, the controlling factor in the design of the channel. Because of the importance of this profile, considerable investigation was made in its establishment." With these two statements, it was initially determined that both the original project's water surface profile and the 10-year event flows would be project hydraulic constraints.

Significant changes to the profile of the Lower Otter Tail River have occurred since the original LOTR project was constructed. In order to maintain flood damage reduction benefits, it was decided to adopt the new 10-year discharge of 2,450 cfs as the maximum design flow for flood protection. This means that if the existing channel can convey 2,450 cfs or more while staying below the 1950's design water surface profile, than the proposed conditions must do the same. However, if the existing channel cannot convey 2,450 cfs below the 1950's design profile (most likely due to aggradation), then a substitute flow that matches existing channel capacity should be used to define the hydraulic capacity of the existing channel at the 1950's design water surface profile. With these guidelines in place, the existing hydraulic capacity of the river was analyzed to determine the proposed design flows.

2.6.1 Planning Considerations

The following planning considerations were identified for the study:

Flooding mitigation: The sponsor has indicated that alternatives that would require levees to mitigate for flooding of private lands are not feasible based on cost and acceptability by landowners. However, this consideration was not considered as a part of initial screening.

Cultural Resources: The historic Ox Cart Trail is located near the intersection of Highway 19 and the Lower Otter Tail River. Any plan that is selected may be influenced by the presence of the historic trail near the project site.

Real Estate: All of the lands adjacent to the project site from Breckenridge, Minnesota to Orwell Dam are privately owned. The lack of USACE owned land near the project site may limit the alternative plans that can be implemented.

Orwell Dam Flood Control Operation: Orwell Dam operations may influence the hydrology of the reach which will impact the flow and connectivity of water upstream.

Section 408 Approval and Flood Insurance Study Acceptability: The ecosystem restoration project needs to be designed in the event that a Section 408 is needed to continue with future restoration projects within the LOTR. Additionally, the project needs to satisfy the Flood Insurance Studies (FIS) 10 and 100-year flood protection.

2.7 Management Measures

A management measure is a feature or activity that can be combined with other management measures to form alternative plans. Management measures were developed to address project area problems, meet project objectives, and to capitalize upon project area opportunities. Management measures were derived from a variety of sources including prior studies, the NEPA public scoping process, and the multidisciplinary, interagency project delivery team (PDT).

A total of ten measures were developed for the study. Six measures were developed that would address the identified problems and meet study objectives (Table 3). Stable stream conditions require a healthy floodplain and therefore mitigation measures were developed to allow for sufficient floodplain restoration while simultaneously lessening the negative impact of increased flooding. Four measures were developed as flood risk management for effects of the other six measures or as an alternative to re-meandering (shaded).

Table 2. List of Measures that will be used to address the identified LOTR problems

Label	Measure	Description / Purpose
RESTORATION MEASURES		
A	Oxbow grade control structure	Rock arch ramp placed in the channelized segment and downstream of the last restored meander to maintain water surface profile. Ensures that a headcut does not perpetuate from the river channel back into the proposed restored oxbows due to sharp changes in channel grade. Also enhances conditions for fish passage.
B	Overflow structure	1) Ensure flow is directed into restored oxbows under non-flood flow conditions. 2) Alleviates upstream stage increases during flood flow conditions by passing flow in the channelized segments.
C	Rock riffles	Rock riffle for grade control to ensure the design grade is maintained within feature group. Usually placed at the inflection points.
D	Oxbow channel excavation	Oxbow restoration and remeadering to include excavation in the oxbow to obtain original grade.
E	Toe-wood sod mat	Sod mats on top of anchored logs. Bank stabilization within restored meander, enhances nearshore vegetation for water quality, and enhances hydraulic diversity and fish habitat.
F	River grade control	Series of rock weirs for arresting the identified headcut.
FLOOD RISK MANAGEMENT MEASURES		
G	Setback levee & ditch	Set back levee to protect houses or other infrastructure.
H	Floodplain excavation	Excavation in the riparian for flow conveyance.
I	Flowage easements	Secure permissions to move water through an area.

Label	Measure	Description / Purpose
J	Instream Stabilization	An alternative to restoring oxbows in the event of a lack of landowner cooperation. Series of rock structure in a segment of the channelized river designed to: 1) pass flows in the channelized segment, 2) raise the river profile in the channelized segment to support lateral hydraulic connectivity, and; 3) enhance fish passage and habitat .

2.7.1 Oxbow Grade Control Structure (Measure A)

The preliminary design includes outlet grade control structures. The outlet structures will ensure that a headcut does not perpetuate from the river channel back into the proposed restored oxbow due to the sharp change in channel grade. At the same time, the structures will be designed to allow for fish migration upstream into the restored reaches. The structures are comprised of a rock arch ramp with a 3% slope (Class V and Class II riprap) with boulder arch weirs set with 0.7 (or less) feet of vertical drop between each weir.

2.7.2 Overflow Structure (Measure B)

Overflow structures are incorporated into the preliminary design downstream of each of the oxbow inlets at the main river channel. These overflow structures serve two purposes. The first is to ensure that the normal run of the river is redirected into the restored oxbow rather than through the straightened reach, even if the proposed restored oxbow is at a higher grade line than the existing channel. The second purpose the overflow structures serve is to alleviate upstream stage increases during larger flood events. Through bank erosion and channel degradation, the existing river channel has a much higher carrying capacity than it was designed for in the 1950s. The restoration of the river channel increases the hydraulic profile in each of the feature group regions. The overflow structure heights are designed to ensure that the stage increases do not exceed the original design profile from the 1953 project. Flood risk management measures were formulated for areas that exceed the design profile.

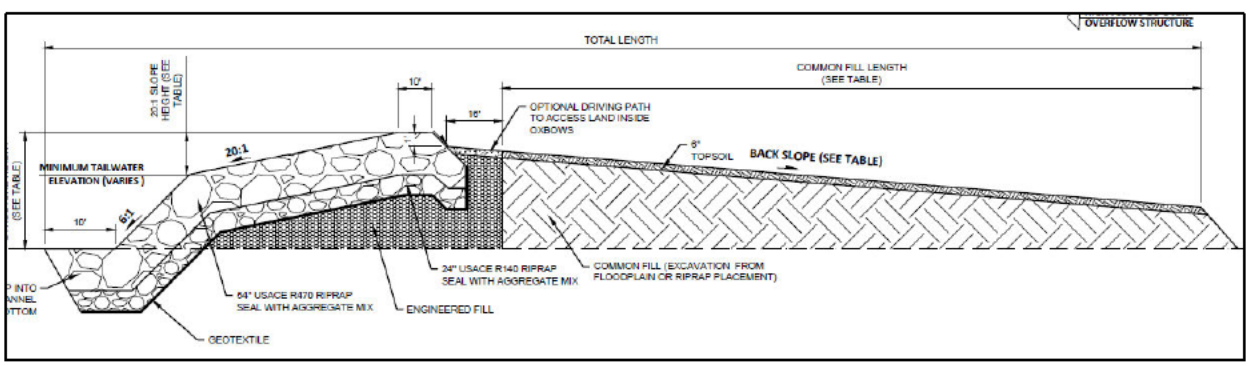

Figure 7. Overflow Structure Detail
Source: Overflow Structure Detail; Sheet 18 *IN* Houston 2019.

2.7.3 Rock Riffle (Measure C)

Rock riffles are grade control structures designed to ensure the design grade is maintained over time (**Figure 8**). Under the preliminary design rock riffles are placed at the inflection points of the restored oxbows and comprised of both MNDOT Class V and Class II riprap.

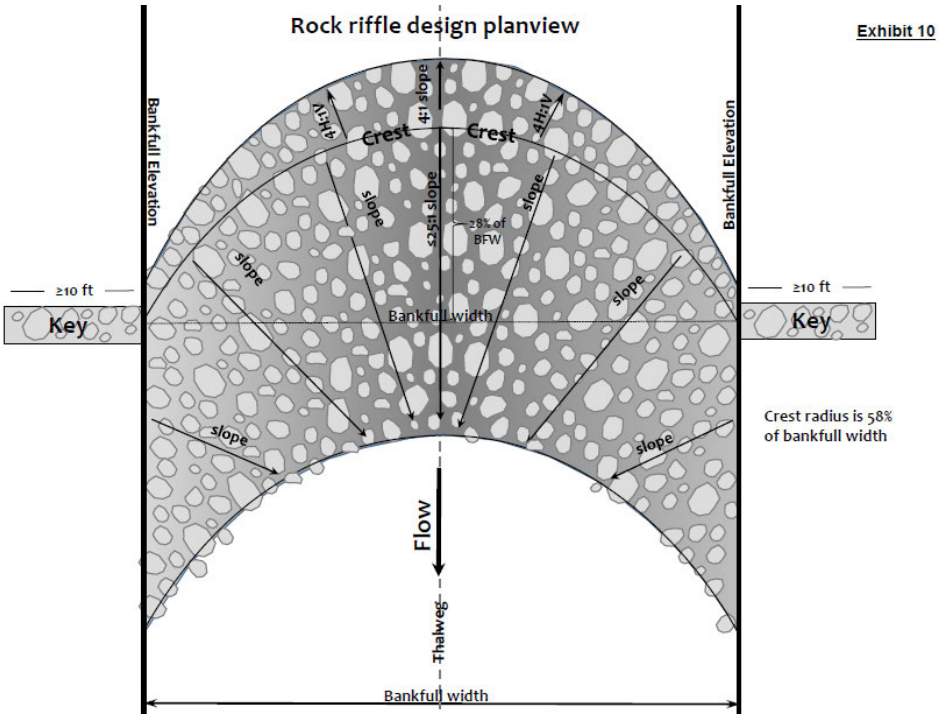

Figure 8. Rock Riffle Typical
Source: Exhibit 10 *IN* Houston Engineering 2019.

Figure 9. Example of a Riffle Structure

2.7.4 Oxbow Channel Excavation (Measure D)

The proposed oxbows will be excavated to their original grade, therefore reestablishing bankfull stage at the original floodplain elevation. When a river reaches bankfull stage, water will overflow into the floodplain, slowing velocities and storing floodwater during a large storm event. Stable stream conditions require a healthy floodplain and therefore mitigation measures for each alternative were considered to allow for sufficient floodplain restoration and simultaneously lessen the negative impact of increased flooding.

Excavation along the proposed restored river alignment is incorporated into the design and is distinguished between oxbow channel excavation and floodplain excavation.

Oxbow channel excavation is needed to create a new route for river flow and the appropriate channel planform and profile. The dimension of the restored river channel is designed to have capacity for the bankfull discharge. Bankfull width ranges from 80 to 150 feet, and the bankfull depth ranges from 4 to 5 feet. (Figure 10).

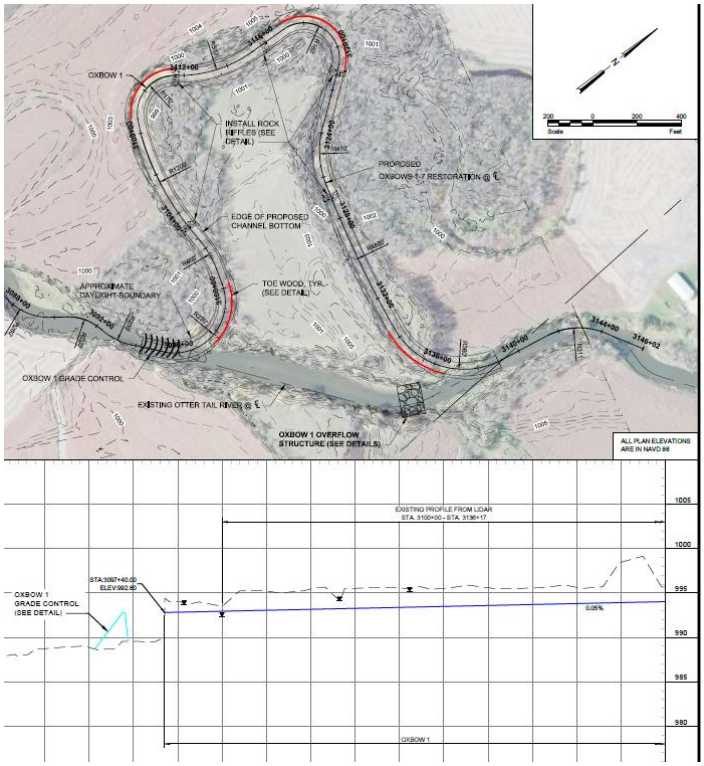

Figure 10. Example of Oxbow Excavation (Oxbow 1 of FG 7)
Source: Feature Group 7 Oxbows 1-7 Plan and Profile; Sheet 14 *IN* Houston 2019.

2.7.5 Toe-Wood Sod Mats (Measure E)

Toe-wood sod mats are incorporated into the design on outside bends of the restored channel to protect the disturbed bank from erosion. Toe-wood sod mats (MNDNR 2010) are meant to foster dense protective vegetative growth on a bank to provide lasting erosion control. Since many of the feature groups involve restoring a stream corridor through wooded areas, it is anticipated that a supply of root wads will be available locally on site for the installation of toe-wood sod mats.

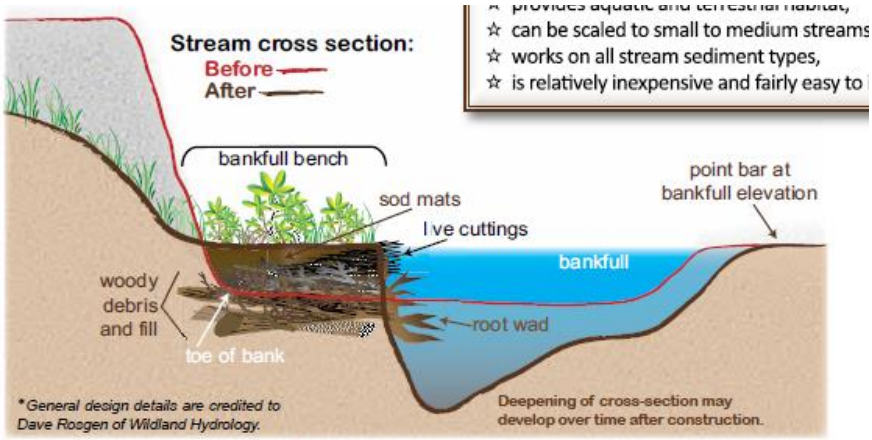

Figure 11. Toe Wood Sod Mat

2.7.6 River Grade Control Structure (Measure F)

This measure is intended to stabilize the identified active headcut. According to the bathymetric survey conducted, there is a stretch of river where the channel gradient shifts rapidly for a short distance, steepening to a 0.55% slope compared to the channel reaches upstream and downstream that have a 0.049% and 0.114% slope respectively. This relatively steep slope over a short distance increases channel velocities, increasing bed/bank shear stresses and subsequently moving larger material downstream. Through this mechanism, a headcut will perpetuate upstream as it continues to erode material. In order to stabilize a headcut, a rock ramp and boulder arch weirs are recommended to be installed. This solution would act as a grade control by armoring the bed and banks in a specific location with larger sized riprap that is able to withstand the higher shear stress caused by the steep slope. Boulder arches would be installed into the rock ramp to redirect flows away from the banks and toward the center of the channel, allow for pool spawning and migration habitat, and provide a more aesthetic structure that would emulate natural rock rapids found within river systems.

2.7.7 Setback Levee and Ditch (Measure G)

Reestablishing the original profile of the river will consequently cause increased flooding in comparison to existing conditions for some of the alternatives. The main goal of the setback levees is to prevent breakout water from ultimately flowing away from the river and flooding areas outside of the drainage area. Flowage easements were utilized in areas where additional flooding could not be alleviated by an overflow structure or a setback levee, or where floodplain restoration was required. The following assumptions were used when developing preliminary flood risk management options for each alternative:

- Protection was not considered for flooding that occurs on existing uncropped land such as wooded areas, wetlands, ditches, and well-defined swales.
- Setback levees will not be constructed within the FIS floodway boundary.
- Setback levees will be offset at least 100 feet from the bank of the river.
- Setback levees will be offset at least 50 feet from the edge of the existing forested areas.
- Setback levees will be offset at least 50 feet from lateral ditches.
- Existing forested areas that are disconnected from the river floodplain will be reconnected by excavating the USACE project spoil banks down to the bankfull stage.
- Setback levees will be constructed to 2 feet above the flood elevation.

If a levee was required but could not feasibly be constructed along the bank of the river, it was relocated to existing high ground, or the historic floodplain boundary. Levee protection was not considered practical for historic floodplain that would return to wetland conditions after restoration due to an increase in the water table.

Levees and floodplain excavation were measures that were included to reduce impacts the 10-year flood event. Levees would help to contain flows that spill outside the riverbanks while floodplain excavation would help improve conveyance to reduce impacts at higher flows. Hydraulic and hydrologic constraints were altered after cost estimates were developed for

alternatives that included levees and floodplain excavation. It was determined that the high cost of levees would be outside of the limit for the study and that levees were no longer needed due to the alteration in the hydraulic and hydrologic constraints. Floodplain excavation was carried forward as a viable measure to reduce impacts in the 10-year flood event.

2.7.8 Floodplain Excavation (Measure H)

Floodplain excavation is required along the project reach to help convey floodwaters and alleviate upstream stage increases. The proposed floodplain is located along the channelized reach and avoids impact to wooded riparian areas. The floodplain is set at the bankfull elevation to improve floodplain connection. After excavation, the area would be topsoiled and planted with water tolerant grasses and willows.

2.7.9 Floodplain Easements (Measure I)

In areas where floodplain excavation and overflow structures do not provide sufficient protection (under the hydrologic constraint) for the 10-year event, flowage easements are proposed. By purchasing flowage easements as opposed to increasing the capacity of the channel, the river will have access to its floodplain providing ecological benefits and reestablishing a healthy floodplain corridor along the project reach. A healthy floodplain provides several benefits including reduced channel velocity and erosion, greater riparian habitat, and sediment and floodwater storage.

2.7.10 Instream Stabilization (Measure J)

Instream riffles would serve as an alternative to oxbow restoration. The PDT recognizes that while the goal of the project would be to add stream length and diversity back to the Lower Otter Tail River, it will require much cooperation from the landowners. In-stream stabilization would put rock weirs throughout the existing channel to raise the water surface profile. The rock weirs structures will add pools and riffle habitat for fish species and the raising of the water surface profile will improve the riparian zone next to the channel. This group would need minimal involvement from landowners. This measure was not evaluated in alternative formulation, but was evaluated as an alternative option if landowners are unwilling to participate (additional details in Section 7.2).

2.8 Feature Groups

Feature Groups (FGs) were identified as a manageable combination of management measures in proximity to each other that are needed for restoring a target unit geographic unit. A target unit is a smaller section of the project area (usually an oxbow or series of oxbows) in which measures could be constructed with considerations towards practicality and efficiency.

Target units were identified and grouped into a total of eight FGs, numbered from downstream to upstream (Table 3; Figure 11).

Table 3. List of Feature Groups and Affected River Sections for the Lower Otter Tail River

FG[a]	Measures	Target Unit or River Section
1	B, C, D, E	Oxbows 26 – 27
2	B, C, D, E	Oxbows 22, 24, 25
3	A, B, C, D, E, H	Oxbows 20 – 21
4	A, B, C, D, E, G, H	Oxbow 18
5	B, C, D, E, G, H	Oxbows 12 – 17
6	A, B, C, D, E, G	Oxbows 8 – 9
7	A, B, C, D, E	Oxbows 1 – 7
8	F	River upstream of headcut

[a] Oxbow 23 appears to have cut itself off prior to the 1953 USACE project by natural processes, and is therefore not being considered for restoration. Oxbows 10 and 11 are each small, isolated oxbows that were excluded from analysis because, due to size, they would not provide appreciable benefits.

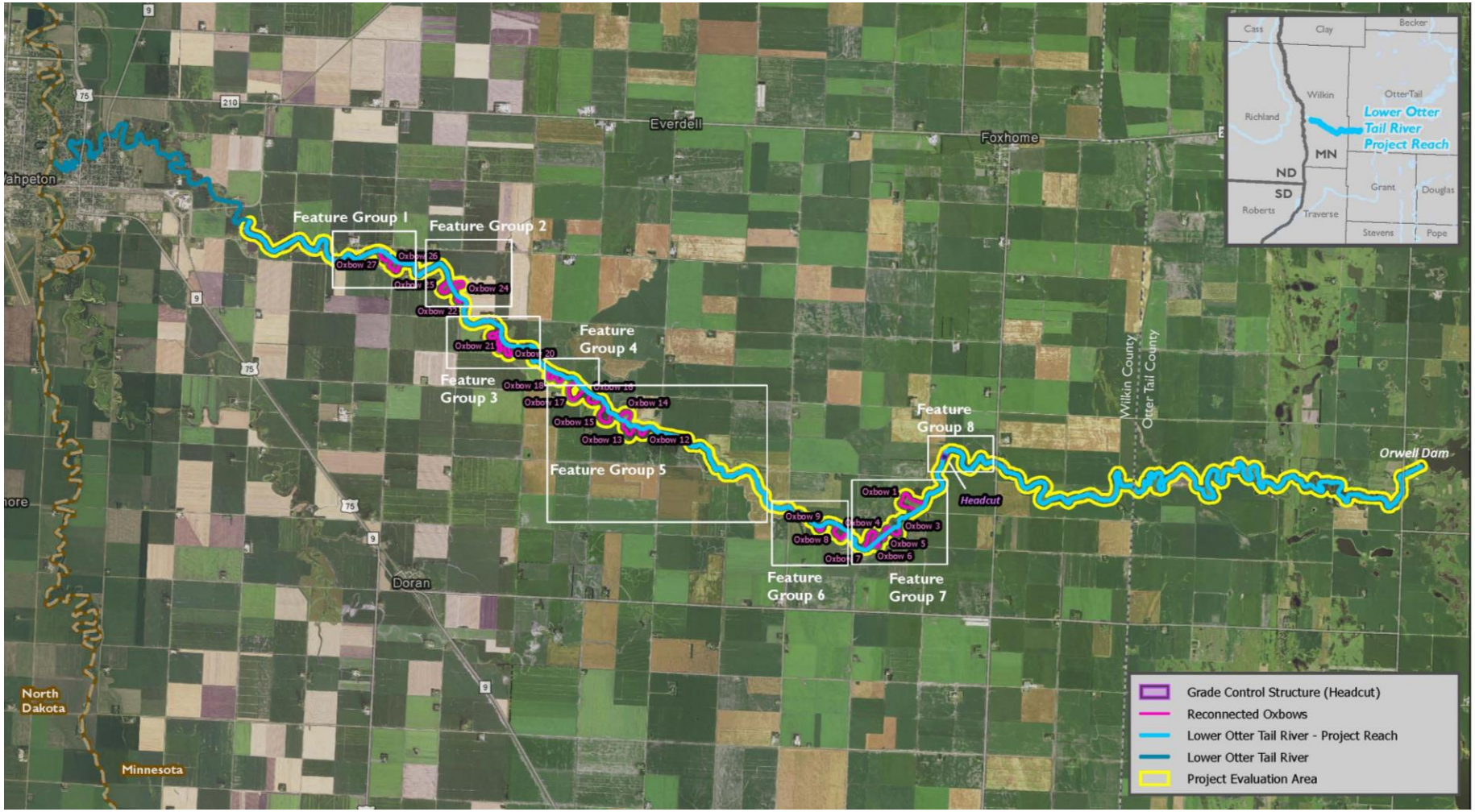

Figure 12: Lower Otter Tail River Restoration Project Overview

2.8.1 Feature Group 1: Oxbows 26-27 Restoration

Feature Group 1 involves the restoration and re-meandering of the LOTR channel through oxbows 26-27 using two overflow structures, six rock riffles, 2660 linear feet of toe wood sod mats, and 11.62 acres of channel excavation (**Figure 13: Management Measures for Feature Group 1**

). Oxbows 26 and 27 are the most downstream oxbows eliminated by the 1953 USACE project and are located just upstream of County Road 14 on the south side of the existing channel in Sunnyside Township. This FG would result in an increase in stream length by approximately 1502 linear feet.

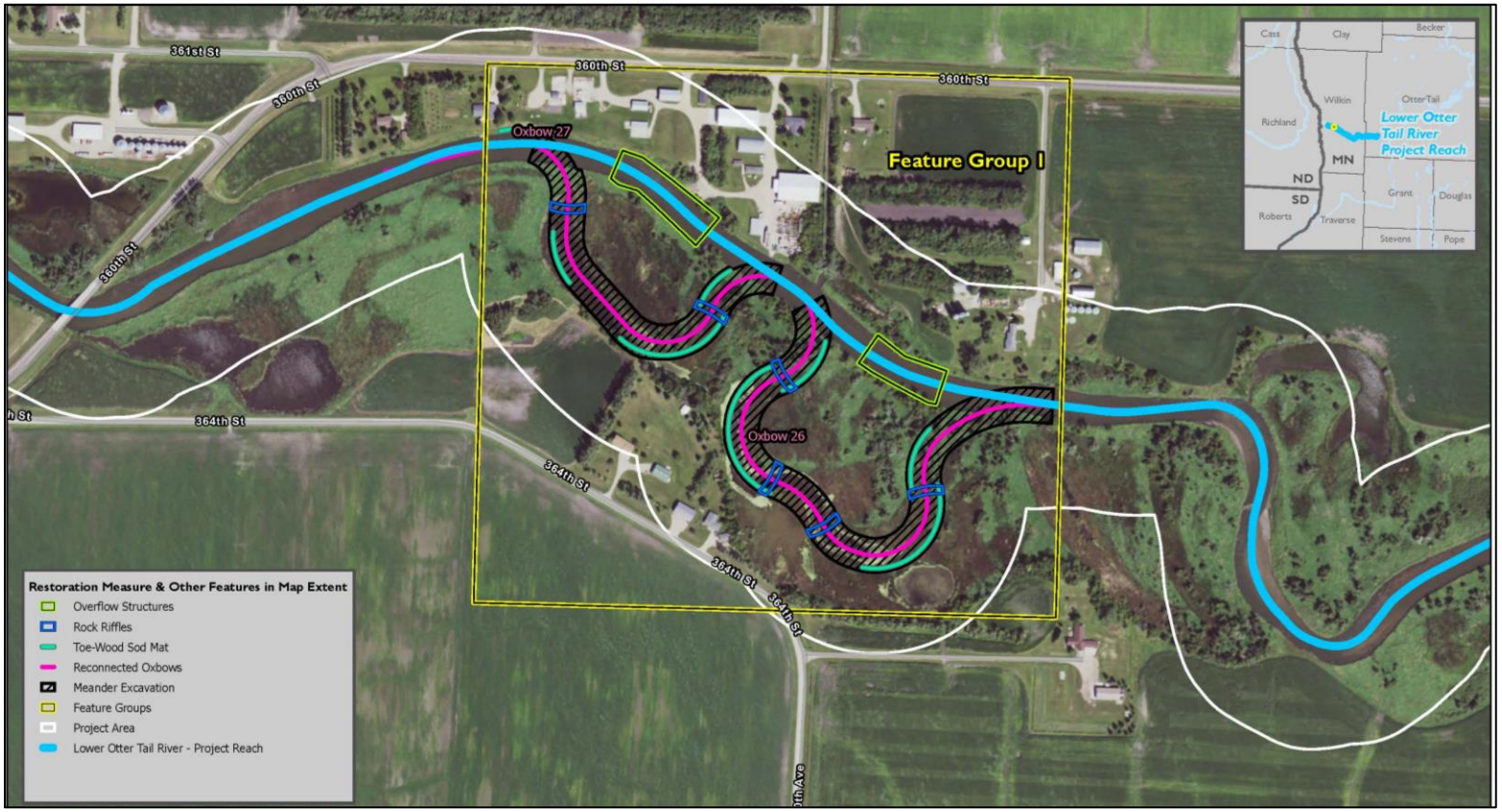

Figure 13: Management Measures for Feature Group 1

2.8.2 Feature Group 2: Oxbows 22, 24, 25 Restoration

Feature group 2 involves the restoration and re-meandering of the Otter Tail River through oxbows 22, 24, 25 using three overflow structures, five rock riffles, 3405 linear feet of toe wood sod mats, and 17 acres of channel excavation. These oxbows are located approximately 1 river mile upstream of Feature Group 1 in Sunnyside Township. Oxbows 22, 24, and 25 were disconnected by the 1953 project. Without the re-connection of oxbow 23, this FG would add about 2240 linear feet of channel (**Figure 14**).

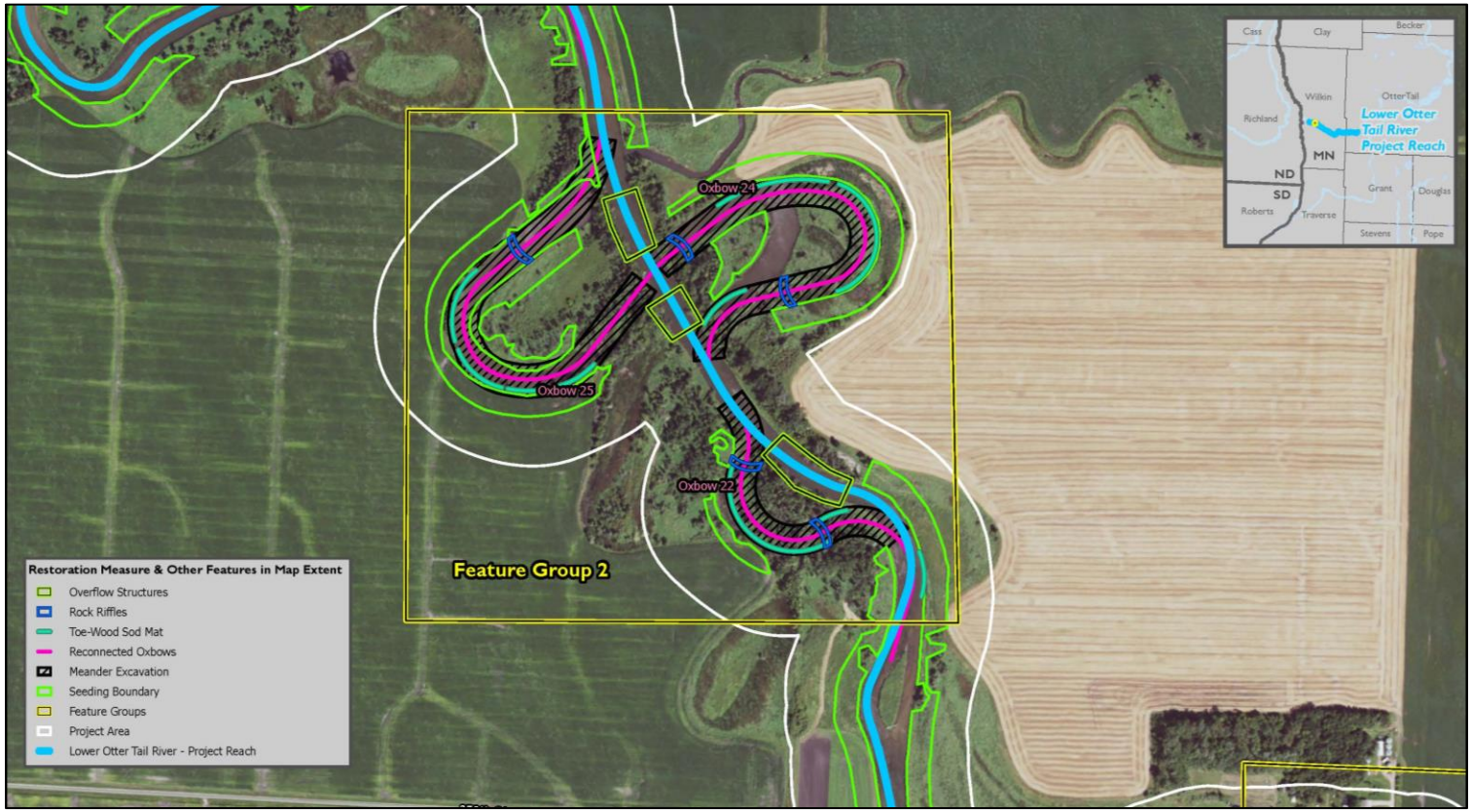

Figure 14: Management Measures for Feature Group 2

2.8.3 Feature Group 3: Oxbows 20-21 Restoration

Feature group 3 involves the restoration and re-meandering of the Otter Tail River through oxbows 20-21 using two overflow structures, nine rock riffles, 4084 linear feet of toe wood sod mats, 19 acres of channel excavation, and 16 acres of floodplain excavation. The feature group 3 oxbows are located approximately 1 river mile upstream of the FG 2 oxbows in Sunnyside Township. Reconnecting oxbows 20-21 would result in an increase in stream length of 2,870 linear feet. Oxbows 20 and 21 were disconnected by the 1953 USACE project (**Figure 15**).

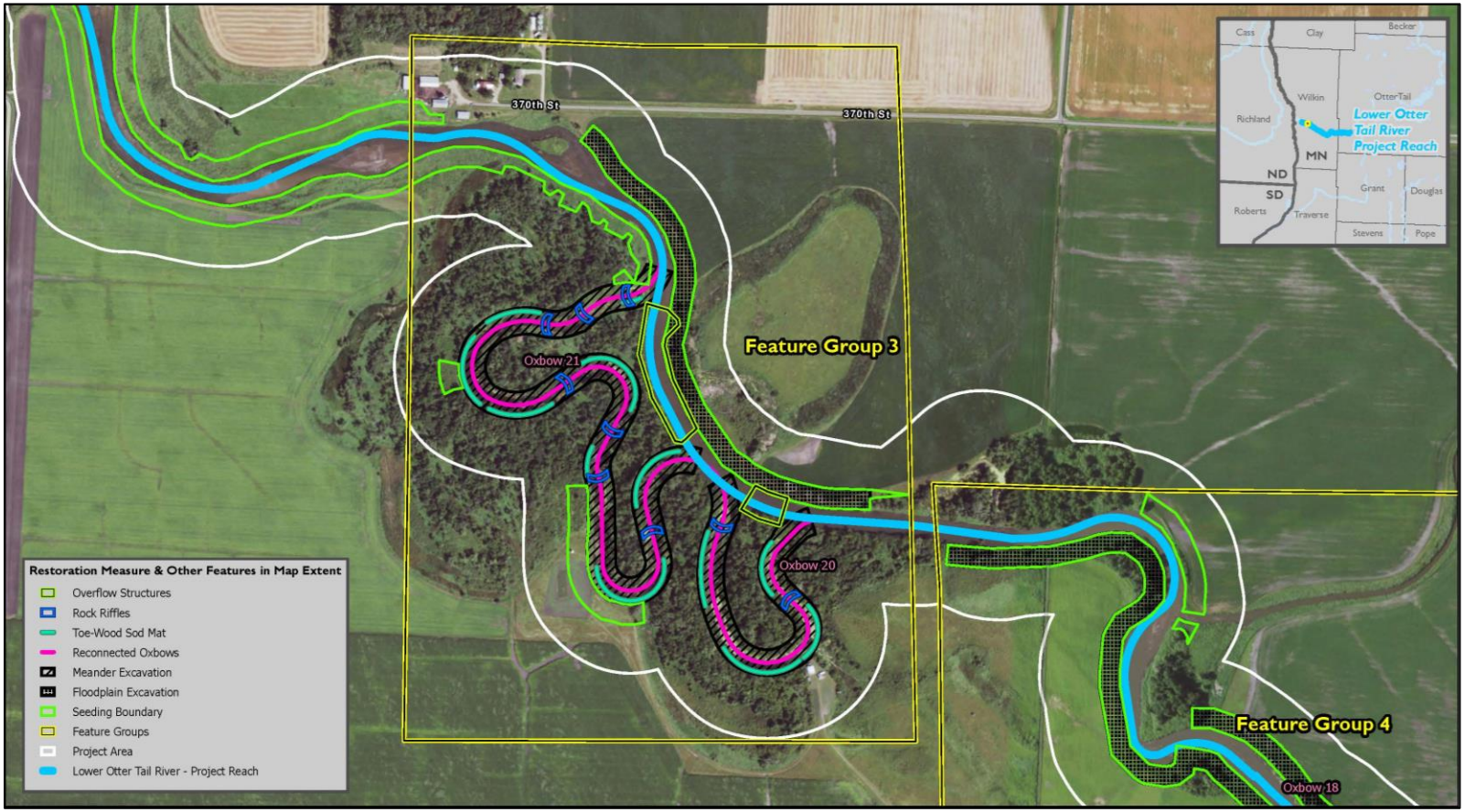

Figure 15:Management Measures for Feature Group 3

2.8.4 Feature Group 4: Oxbow 18 Restoration

Feature group 4 involves the restoration/reconnection of oxbow 18, located ½ river mile upstream from oxbows 19-21. Feature group 4 includes one overflow structure, four rock riffles, 2054 linear feet of toe wood sod mats, 8 acres of channel excavation, and 13 acres of floodplain excavation. The restoration of oxbow 18, which was eliminated by the USACE 1953 project, would result in an increase in stream length of 3421 linear feet (**Figure 16**).

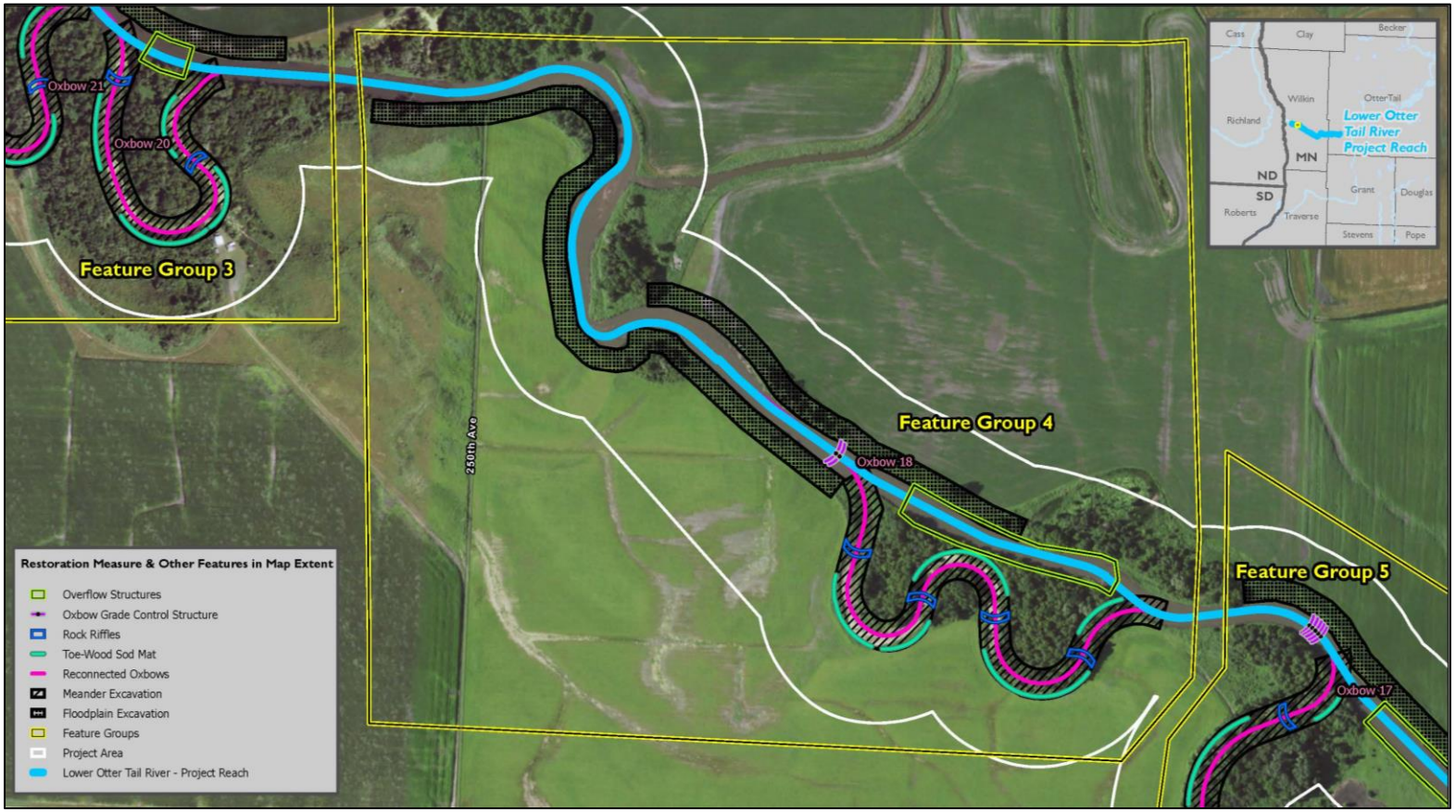

Figure 16: Management Measures for Feature Group 4

2.8.5 Feature Group 5: Oxbows 12-17 Restoration

Feature group 5 involves the restoration and re-meandering of the Otter Tail River through oxbows 12-17 using six overflow structures, fourteen rock riffles, 6548 linear feet of toe wood sod mats, 50 acres of channel excavation, and 18 acres of floodplain excavation. Oxbows 12-17 extend from about ¼ river mile upstream of oxbow 18 to County Road. Oxbow 12 was eliminated by the USACE 1953 project but from the design plans it appears oxbows 13-17 had been previously straightened prior to 1953. Instead of by natural meander movement it appears these oxbows were straightened by a channel straightening project. Given that it was not a part of the USACE project, FG 5 may not qualify for federal funding through the Section 1135 program. If restored, FG 5 would result an increase in stream length of 7074 linear feet (**Figure 17**).

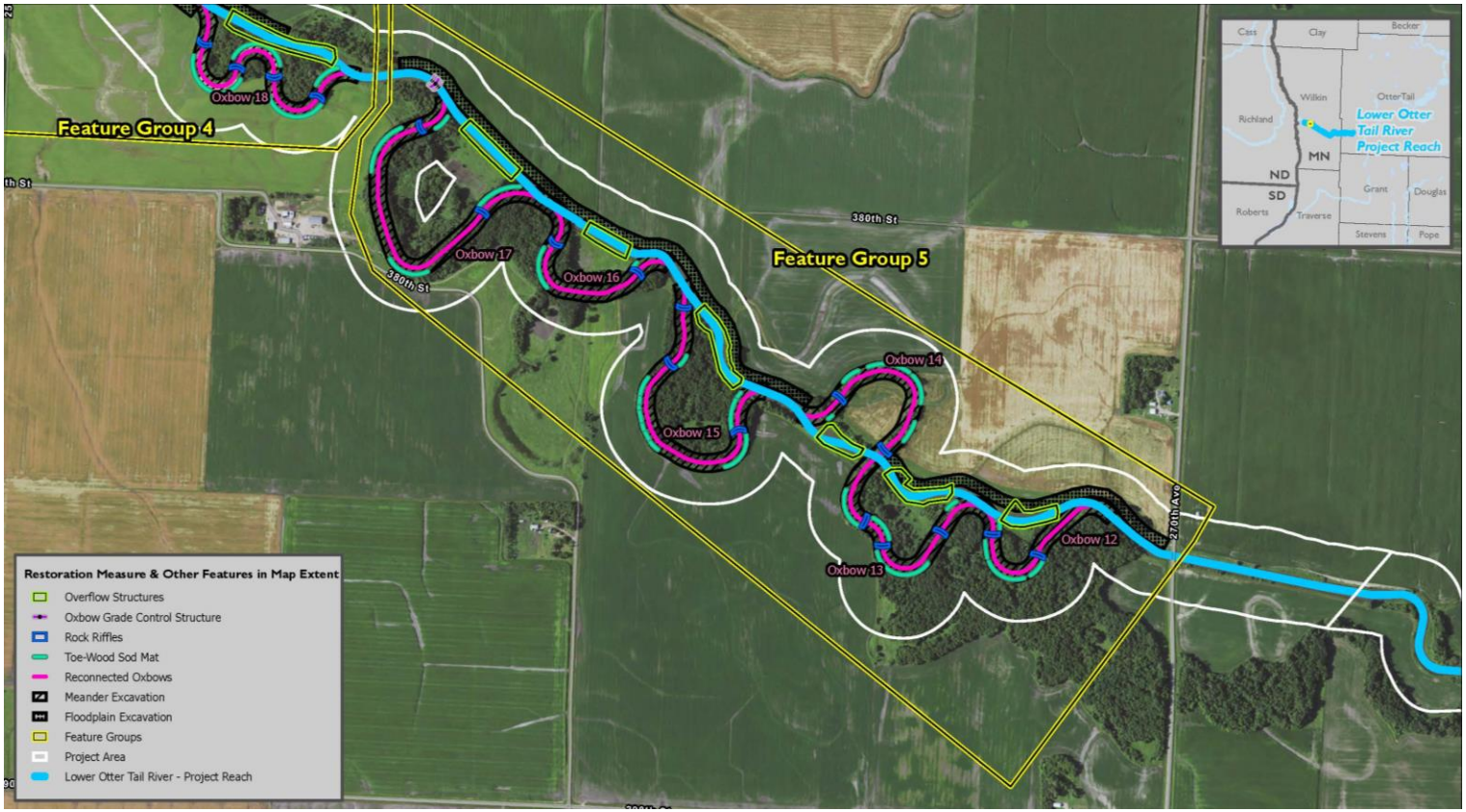

Figure 17: Management Measures for Feature Group 5

2.8.6 Feature Group 6: Oxbows 8-9 Restoration

Feature group 6 involves the restoration and re-meandering of the Otter Tail River through oxbows 8-9 using two overflow structures, seven rock riffles, 2260 linear feet of toe wood sod mats, and 7 acres of channel excavation. Oxbows 8-9 are located 3 1/3 river miles upstream of the FG 5 oxbows in Foxhome Township. FG 6 would result in an increase in stream length by 1235 linear feet. Both oxbows 8 and 9 were eliminated by the USACE 1953 project. Oxbows 10 and 11 are each small, isolated oxbows between groups 5 and 6. In the interest of analyzing feature groups that will have the most benefit to the river system, oxbows 10 and 11 were excluded from this FG development (**Figure 18**).

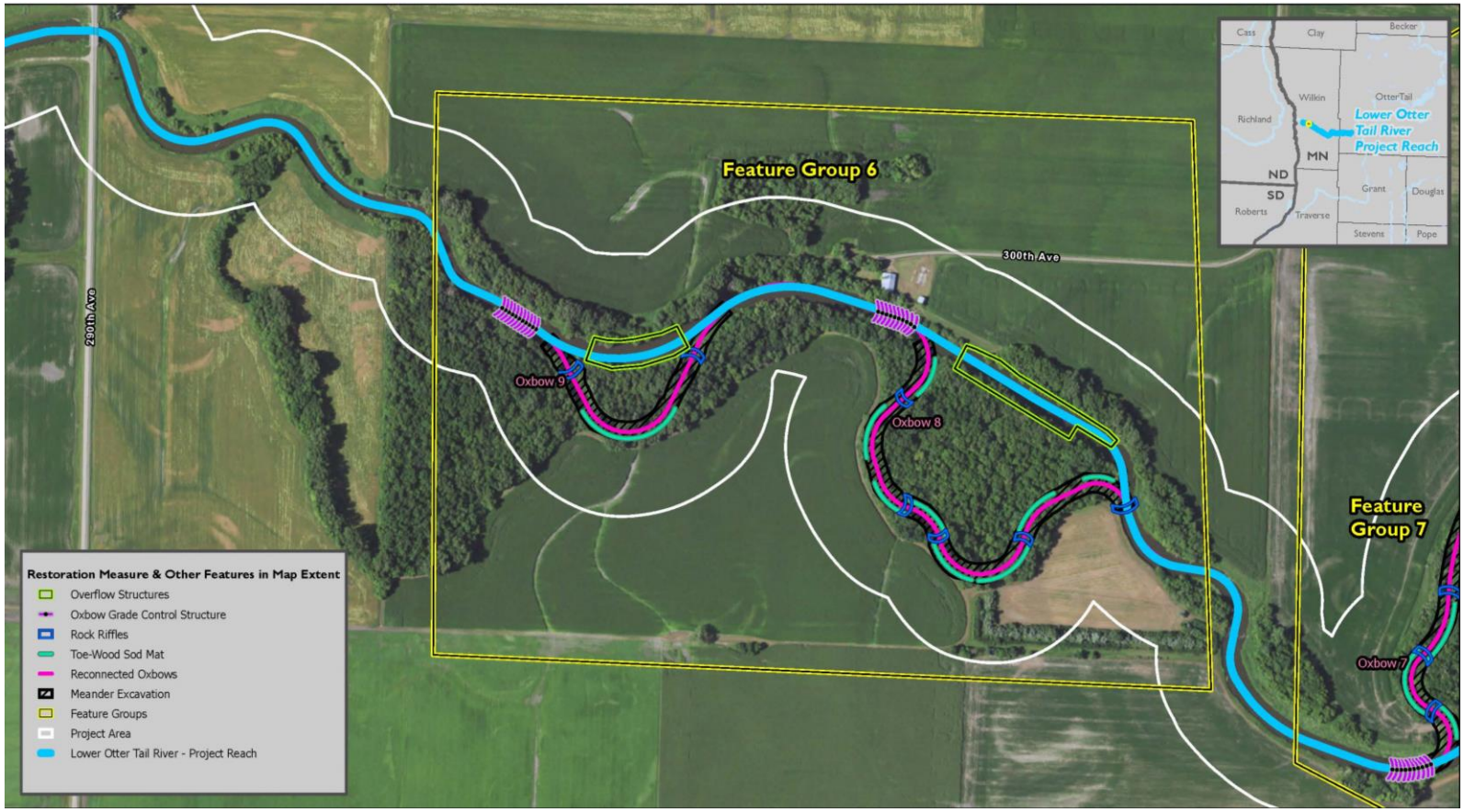

Figure 18: Management Measures for Feature Group 6

2.8.7 Feature Group 7: Oxbows 1-7 Restoration

Feature Group 7 involves the restoration and re-meandering of the Otter Tail River through oxbows 1-7 using six overflow structures, thirteen rock riffles, 6906 linear feet of toe wood sod mats, and 21 acres of channel excavation. Feature group 7 is composed of the most upstream 7 oxbows eliminated by the 1953 USACE project located in Foxhome Township and Bradford Township. Oxbow 1 is located approximately 2.0 river miles downstream of County Road 19 and the outlet of oxbow 7 is located about 0.5 mile upstream of the FG 6 restoration. Oxbow 2 appears to have too tight of a radius of curvature to feasibly restore to a stable state. This would result in an increase in stream length by 5662 linear feet (**Figure 19**).

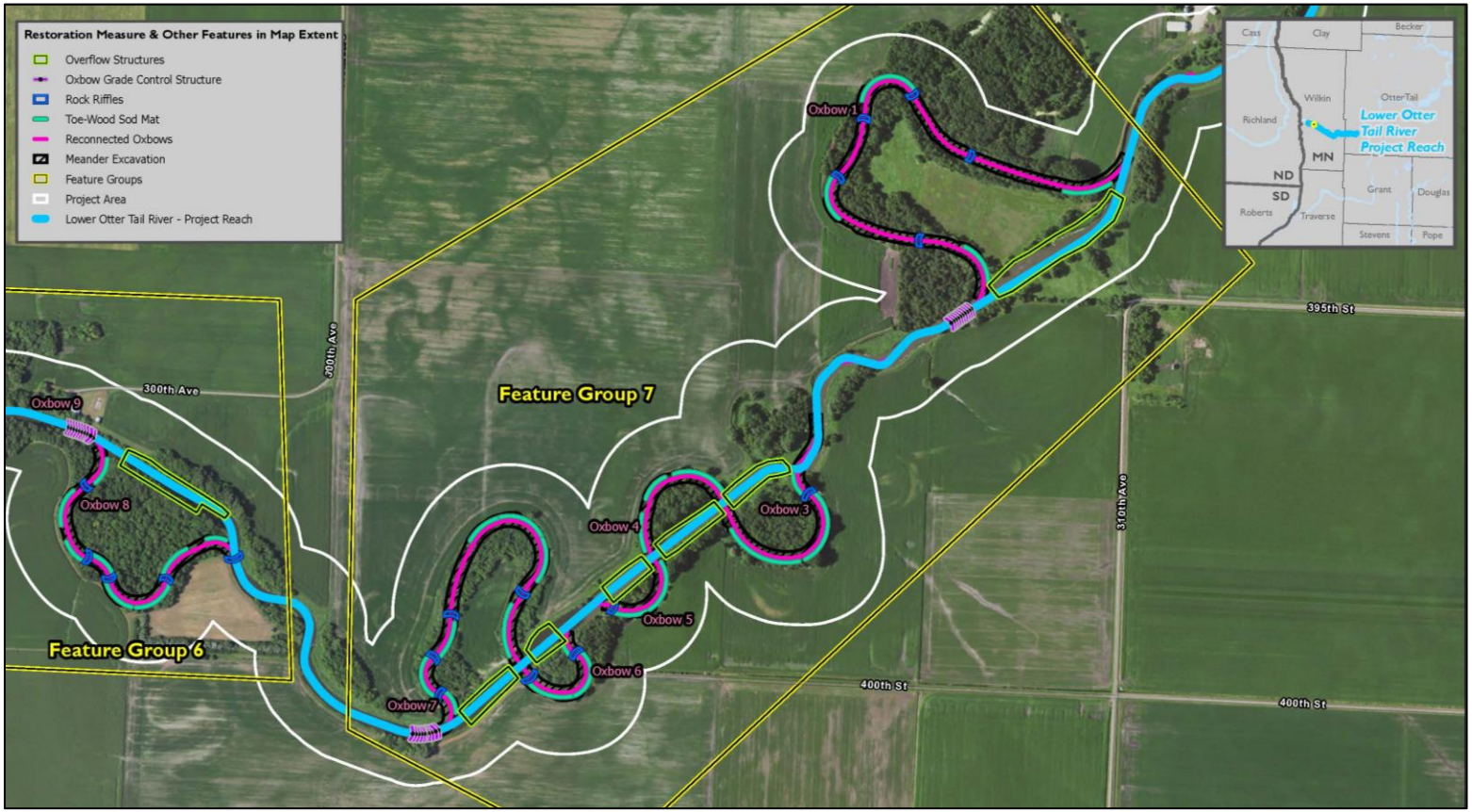

Figure 19: Management Measures for Feature Group 7

2.8.8 Feature Group 8: Headcut Stabilization

Feature group 8 proposes to stabilize the active headcut located between group 7 and County Road 19, and is comprised solely of Measure F. From bathymetric survey conducted, there is a stretch of river where the channel gradient shifts rapidly for a short distance, steepening to a 0.55% slope compared to the channel reaches upstream and downstream that have a 0.049% and 0.114% slope respectively. This relatively steep slope over a short distance increases velocities, increasing bed/bank shear stresses and subsequently moving larger material downstream. Through this mechanism, a headcut will perpetuate upstream as it continues to erode material. To stabilize a headcut, a rock ramp and boulder arch weirs are recommended to be installed. These would act as a grade control by armoring the bed and banks in a specific location with larger sized riprap that is able to withstand the higher shear stress caused by the steep slope. Boulder arches would be installed into the rock ramp to redirect flows away from the banks and toward the center of the channel, allow for pool spawning and migration habitat, and provide a more aesthetic structure that would emulate natural rock rapids found within river systems.

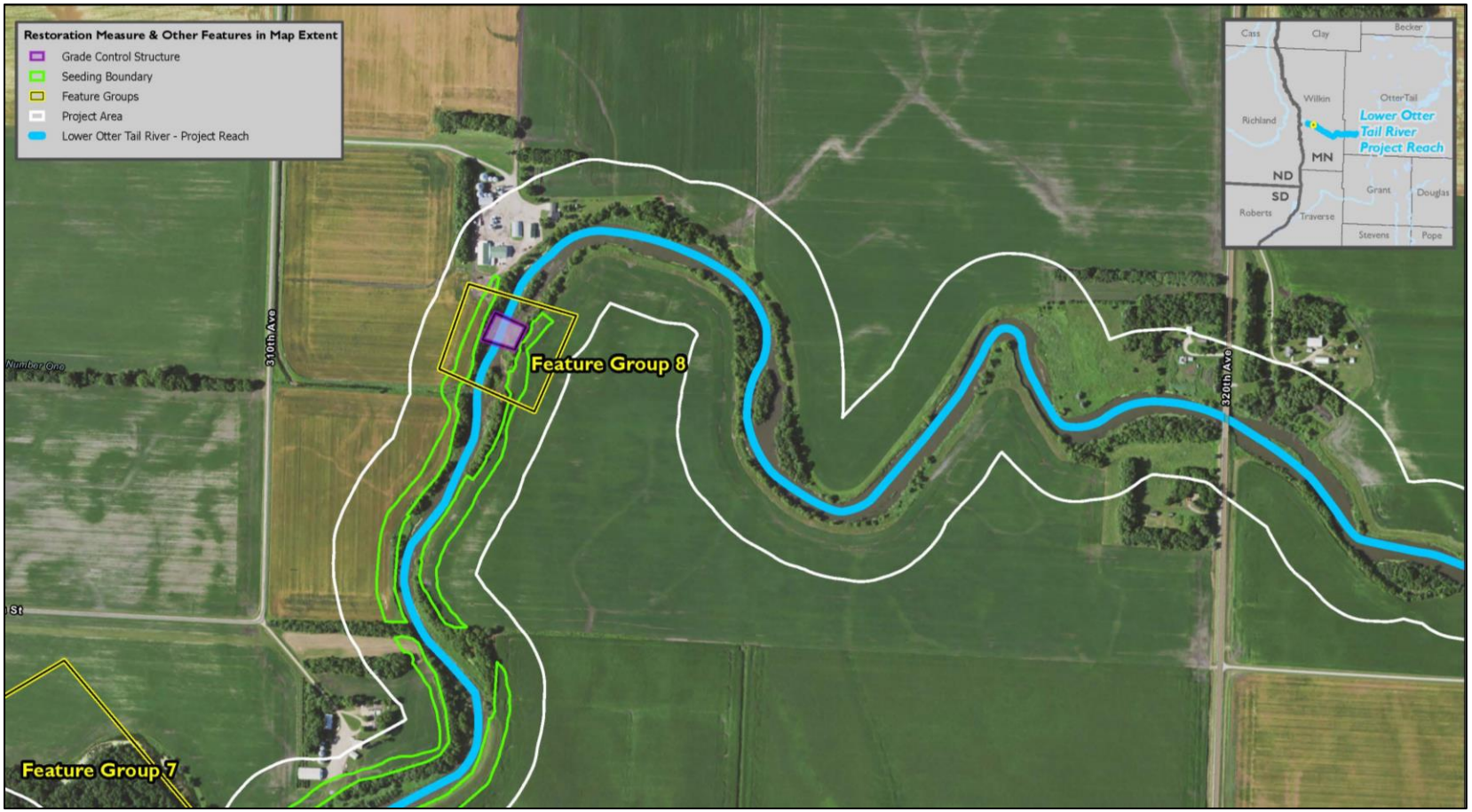

Figure 20: Management Measures for Feature Group 8

2.9 Formulation of Alternative Plans

Alternative plans are developed from the measures carried forward. Alternative plans are different combinations measures that would contribute to attaining the planning objectives.

FGs were used as the building blocks for identifying action alternatives. Alternatives were formed as FGs or combinations thereof under the following assumptions:

1. All identified measures identified for a FG are interdependent on each other. All measures are needed to restore a target section of the river.

2. There is only one scale for all measures.

3. FG 8 (river grade control structure) is independent of all other measures or FGs. This is the Base Plan and would be part of any action alternative.

Based on the dependencies of measures and feature groups for the project, there were a total of 129 possible combinations or alternative plans. This initial array of alternatives was screened using a Multi-Criteria Decision Assessment (MCDA) framework that emphasized cost effectiveness, and potential improvements as measured by geomorphology, and riparian criteria. Through a series of five MCDA iterations, a focused array of twelve alternatives (identified as the No Action or by the letters A through K) were recommended to be retained for further analysis in identifying the Tentatively Selected Plan (TSP) (**Table 4Error! Reference source not found.**). Additional details on the MCDA analysis are provided in Appendix M – Plan Formulation.

Table 4. Feature Group Combinations Retained Through MCDA Analysis

		MCDA ITERATION					
Alt	**FGs**	**A**	**B**	**C**	**D**	**E**	**Total**
No Action	0	X	X	X	X	X	5
A	8	X	X	X	X	X	5
B	8,3	X	X	X	X	X	5
C	8,2,3	X	X	X	X	X	5
D	8,3,5	X	X	X		X	4
E	8,3,7	X	X	X	X	X	5
F	8,2,3,5	X	X	X		X	4
G	8,3,4,7	X	X	X	X	X	5
H	8,3,5,7	X	X	X		X	4
I	8,2,3,4,7	X	X	X	X		4
J	8,2,3,5,7	X	X	X		X	4
K	8,1,2,3,4,5,6,7	X	X	X	X	X	5
	Total # of plans	**21**	**17**	**21**	**21**	**22**	

3 Evaluation and Comparison of Alternatives

The twelve alternatives recommended from the MCDA analysis were then further evaluated for their environmental benefits and cost effectiveness. This chapter outlines the evaluation of the alternatives and the Cost Effectiveness and Incremental Cost Analysis.

3.1 Environmental Benefits

The Environmental Restoration (ER) benefits and habitat modeling associated with the study are described in detail in Appendix J. Habitat models are used to evaluate impacts of water resource development activities such as flood control and navigation projects, and environmental benefits of restoration or mitigation projects. These models generally take the form of an index ranging from 0.0 (poor habitat) to 1.0 (optimum habitat), referred to as a "Habitat Suitability Index" (HSI). The HSIs are used to weight acres of affected habitat, a method that is integrated in the commonly used Habitat Evaluation Procedure (HEP) or other standard habitat assessment methodologies (U.S. Fish and Wildlife Service 1980). These methods multiply quality (i.e., HSI) and quantity (e.g., acres) to determine habitat conditions, expressed as Habitat Units (HUs). HUs can be compared among project alternatives and averaged over the life of the project (e.g., Average Annual Habitat Unit or AAHU).

After a review of Corps' approved or certified species models, two versions of the mink (*Mustela vison*) HSI model were selected. The wetland version (Allen 1986) was used for the disconnected oxbow area or strata, and the river version (Yager and Devendorf 2001) was applied to the river channel strata. Results of this analysis are provided in **Table 5**. Additional details on how habitat models were used to capture the environmental benefits of alternatives are provided in Appendix J.

Table 5: Ecological Benefits Comparison of Alternatives

Alternative	Description (Feature Groups)	River Strata, Total AAHUs	River Strata, Net AAHUs over no action	Wetland Strata, Total AAHUs	Wetland Strata, Net AAHUs over no action	Total Net AAHUs
No Action Alternative	Without Project	835	0	120	0	0
A	8	950	115	120	0	115
B	8,3	1,065	231	107	-13	217
C	8,2,3	1,168	334	94.2	-26	308

D	8,3,5	1,326	491	71.8	-48	443
E	8,3,7	1,254	419	78.9	-41	378
F	8,2,3,5	1,429	594	58.9	-61	533
G	8,3,4,7	1,292	457	73.6	-47	411
H	8,3,5,7	1,514	679	43.5	-77	603
I	8,2,3,4,7	1,395	560	60.6	-60	501
J	8,2,3,5,7	1,617	782	30.6	-90	693
K	8,1,2,3,4,5,6,7	1,872	1,037	11.7	-108	928

3.2 Alternative Cost Estimates

Table 6 documents the costs associated for each action alternative. The No Action Alternative has no Corps of Engineers involvement in design and implementation of a restoration project on the Lower Otter Tail River. More details on the project costs can be found in Appendix G – Cost Engineering Annualized costs were determined using the fiscal year 2022 discount rate; all costs have been rounded.

Table 6: Cost Breakdowns for Alternatives (2022 Price Level)

Alternative	Feature Groups	Estimated Cost	Average Annualized Cost (AAC) [a]
No Action	N/A	$0	$0
Alt A	8	$1,023,536	$36,090
Alt B	8,3	$8,194,666	$288,944
Alt C	8,2,3	$13,770,746	$485,557
Alt D	8,3,5	$25,315,899	$892,639
Alt E	8,3,7	$19,696,436	$694,496
Alt F	8,2,3,5	$30,891,979	$1,089,251
Alt G	8,3,4,7	$24,257,626	$855,324
Alt H	8,3,5,7	$36,817,668	$1,298,191
Alt I	8,2,3,4,7	$29,833,706	$1,051,936
Alt J	8,2,3,5,7	$42,393,748	$1,494,804
Alt K	8,1,2,3,4,5,6,7	$56,518,290	$1,992,835

[a] 2022 dollars.

3.3 Cost Effectiveness and Incremental Cost Analysis

ER benefits (increase in with-project AAHUs) and annual costs (expressed in thousands of dollars) for all alternatives were entered into IWR Planning Suite II and assessed for Cost Effectiveness (CE) (Table 7). Results show the AAC/AAHU ranged from $313 for Alternative A to $2,157 for Alternative J.

Table 7. Results of IWR Planning Suite II Cost Effective Analysis.

Alt	FGs	Total Cost[a]	AAC	Net AAHUs	AAC/AAHUs	Determination
NA	(NO ACTION)	0	$0	0	0	Best Buy
A	(8)	$1,023,536	$36,090	115	$313	Best Buy
B	(8, 3)	$8,194,666	$288,944	217	$1,332	Cost Effective
C	(8, 2, 3)	$13,770,746	$485,557	308	$1,576	Best Buy
D	(8, 3, 5)	$25,315,899	$892,639	443	$2,015	Cost Effective
E	(8, 3, 7)	$19,696,436	$694,496	378	$1,837	Cost Effective
F	(8, 2, 3, 5)	$30,891,979	$1,089,251	533	$2,044	Cost Effective
G	(8, 3, 4, 7)	$24,257,626	$855,324	411	$2,081	Cost Effective
H	(8, 3, 5, 7)	$36,817,668	$1,298,191	603	$2,153	Cost Effective
I	(8, 2, 3, 4, 7)	$29,833,706	$1,051,936	501	$2,100	Cost Effective
J	(8, 2, 3, 5, 7)	$42,393,748	$1,494,804	693	$2,157	Cost Effective

Alt	FGs	Total Cost[a]	AAC	Net AAHUs	AAC/AAHUs	Determination
K	(8, 1, 2, 3, 4, 5, 6, 7)	$56,518,290	$1,992,835	928	$2,147	Best Buy

[a] 2022 dollars.

3.4 Cost Effective Plans

Cost effective Alternative Plans are defined as the least expensive plan for a given set of benefits, or environmental output. In other words, no other plan would provide the same or more benefits for a lower cost. Of the twelve Alternative Plans, all were identified as cost effective plans (**Figure 21**). Cost effective plans (red triangles) include the identified "Best Buy" plans (green squares). It is speculated that the reason none of the alternatives were identified as non-effective plans is because of the screening process associated with the MCDA analysis, which was largely driven by anticipated response for geomorphology and riparian vegetation.

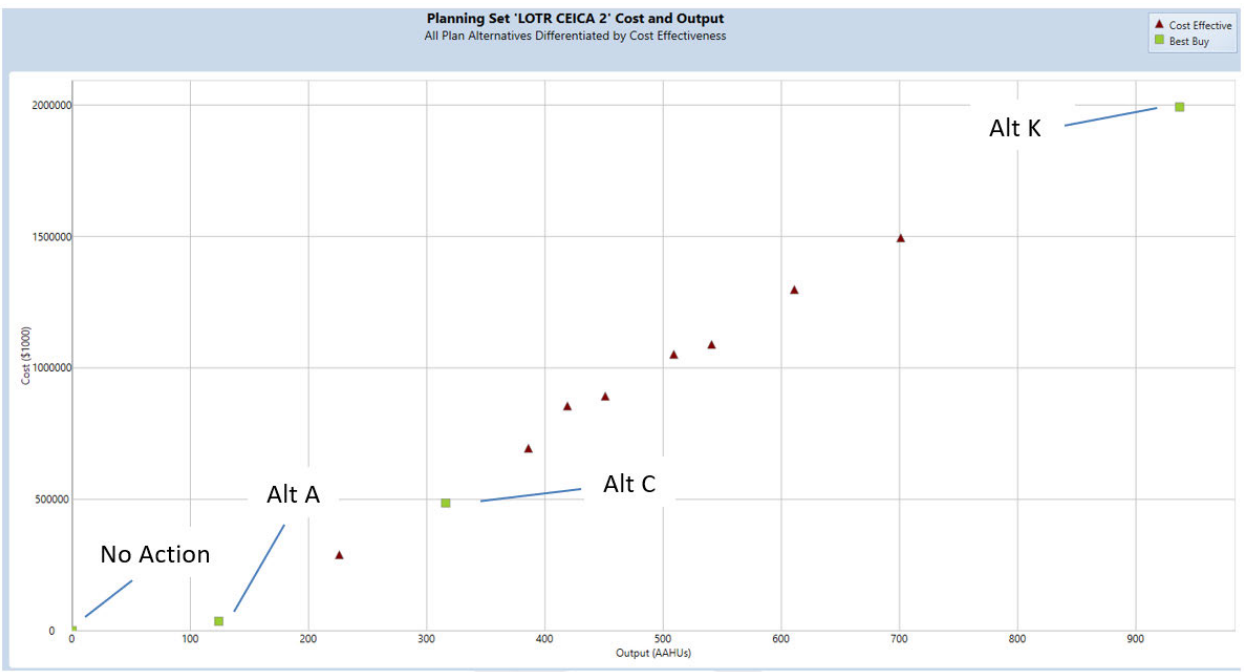

Figure 21. IWR Planning Suite II Cost Effectiveness Plot.

3.5 Best Buy Plans

The next step in the Cost Effectiveness and Incremental Cost Analysis (CE/ICA) is to perform an incremental cost analysis on the cost effective plans. ICA compares the incremental cost per incremental benefit (output or lift in environmental output) among the plans to identify plans that maximize the last dollar spent. Starting with the no action plan, the incremental cost per incremental benefit is calculated from the no action for each cost effective plan. The plan with

the least incremental cost per incremental output is identified as the first of the "with-project" best buy plans. Then, starting with that plan, the incremental cost per incremental benefit is calculated between that plan and each remaining cost effective plan, and the one with the least incremental cost per incremental benefit is identified as the next plan in the array of best buy plans. This process continues until there are no remaining plans. The last plan in the best buy array is typically the plan that contains all management measures being analyzed, or in this case, includes all feature groups.

Results show that of the twelve cost effective alternative plans, three plans were identified as "Best Buy" plans including the No Action plan (**Table 8**). The incremental AAC/AAHU ranged from $314 for Alternative A to $4,874 for Alternative G. The Best Buy Plans/final array of Alternative Plans are:

- No Action
- Alternative C
- Alternative K

Table 8. Results of IWR Planning Suite II Incremental Cost Analysis.

Incremental Cost of Cost Effective Plan Combinations (Ordered By Output) 11/17/2021 1:43:57PM

Planning Set: LOTR2 CEICA 14

Counter	Plan Alternative	Output (AAHUs)	Cost ($1000)	Average Cost ($1000/AAHUs)	Incremental Cost ($1000)	Inc. Output (AAHUs)	Inc. Cost Per Output
1	No Action Plan	0.000	0.000	0.000	0.000	0.000	0.000
2	A	115.000	36,090.000	313.826	36,090.000	115.000	313.826
3	B	217.000	288,944.000	1,331.539	252,854.000	102.000	2,478.961
4	C	308.000	485,557.000	1,576.484	196,613.000	91.000	2,160.582
5	E	378.000	694,496.000	1,837.291	208,939.000	70.000	2,984.843
6	G	411.000	855,324.000	2,081.080	160,828.000	33.000	4,873.576
7	D	443.000	892,639.000	2,014.986	37,315.000	32.000	1,166.094
8	I	501.000	1,051,936.000	2,099.673	159,297.000	58.000	2,746.500
9	F	533.000	1,089,251.000	2,043.623	37,315.000	32.000	1,166.094
10	H	603.000	1,298,191.000	2,152.887	208,940.000	70.000	2,984.857
11	J	693.000	1,494,804.000	2,157.004	196,613.000	90.000	2,184.589
12	K	928.000	1,992,835.000	2,147.452	498,031.000	235.000	2,119.281

Figure 22 displays the results of the incremental cost benefit analysis.

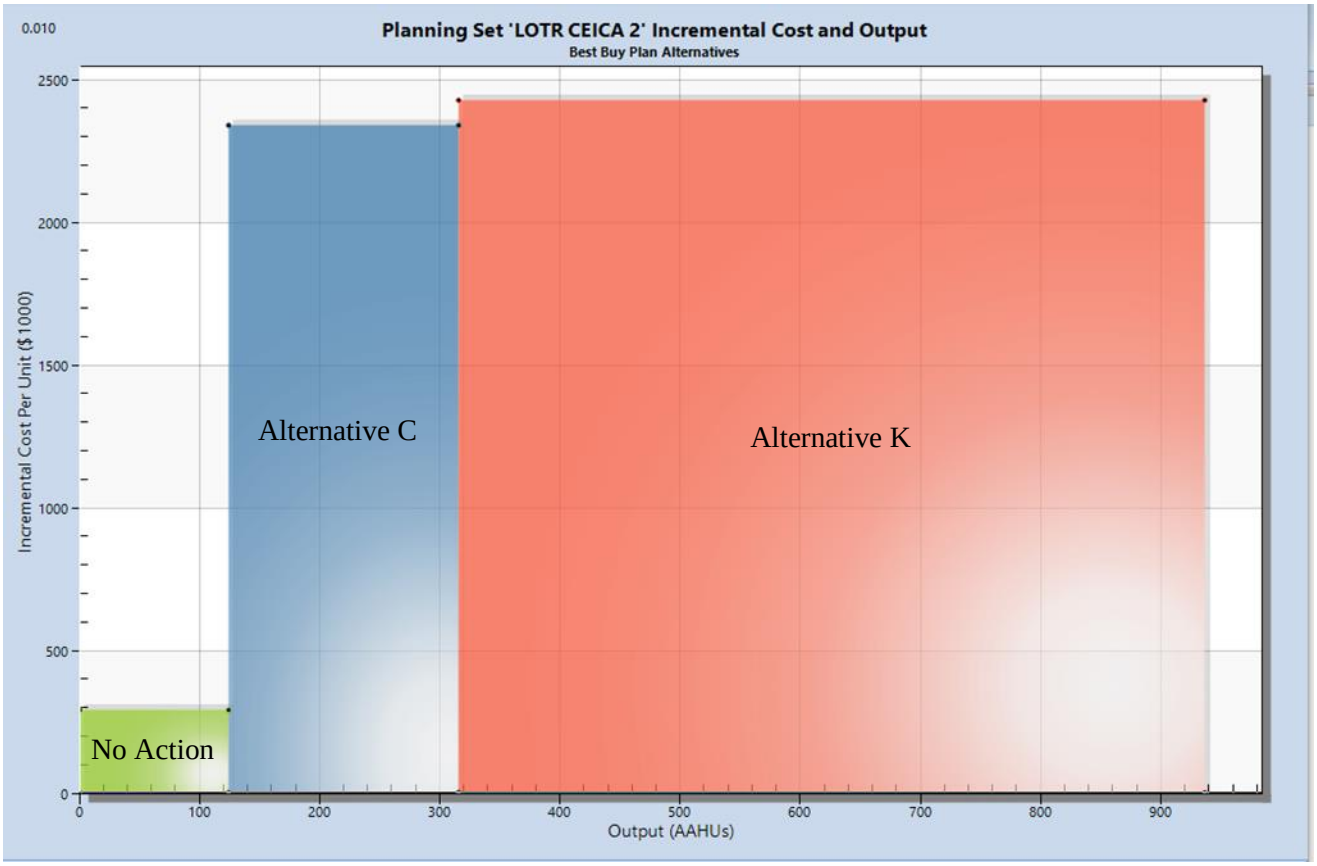

Figure 22: Incremental Cost Analysis Results

3.5.1 No Action Alternative

Under the no action alternative, the project area would continue to degrade and the headcut would continue to travel upstream. The riparian habitat would continue sloughing into the river and decline as the water quality wouldn't support both the riparian habitat and local fishery. The quality of habitat associated with the No Action Alternative would provide 955 AAHU across the River and Wetland HSI models.

Additionally, under the no action alternative, the Corps of Engineers would not have any involvement in design and implementation of a restoration project on the Lower Otter Tail River. The BRRWD would likely continue to seek other sources of state and federal funds to complete a design and move towards construction of a project to restore the straightened sections of the river. However, given the scope of the project, construction would most likely occur in phases if funding is obtained. This approach would delay the benefits expected from a restoration project and extend the period where water quality, aquatic habitat, and adjacent riparian areas are degraded by the straightened alignment of the river. Section 408 approval from the Corps of Engineers would be required for a restoration project in the river, in addition to any requirements of Section 404(b)(1) of the Clean Water Act.

3.5.2 Alternative C

Alternative C includes the restoration and re-meandering of feature groups 2 and 3, and the head cut stabilization of Feature Group 8. This alternative involves 5 overflow structures, 14 rock riffles, 7490 linear feet of toe wood sod mats, 36 acres of channel excavation, and 16 acres of floodplain excavation. The increased acreage and enhanced quality of habitat associated with this alternative would provide a net gain of 308 AAHUs over the No Action Alternative, with a total cost of approximately $14M.

3.5.3 Alternative K

Alternative K includes the restoration and re-meandering of all 7 feature groups and the head cut stabilization of Feature Group 8. This alternative involves 22 overflow structures, 58 rock riffles, 27,900 linear feet of toe wood sod mats, 133 acres of channel excavation, and 47 acres of floodplain excavation. The increased acreage and enhanced quality of habitat associated with this alternative would provide a net gain of 928 AAHUs over the No Action Alternative, with a total cost of approximately $56M.

4 Evaluation and Comparison of Final Array of Alternatives

As part of Federal guidelines for water resources projects, there are general feasibility criteria that must be met. The four formulation criteria suggested by the Principles and Guidelines (P&G) (completeness, effectiveness, efficiency, and acceptability) were used to aide in the selection of the Tentatively Selected Plan.

- **Completeness** is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives.
- **Effectiveness** is the extent to which an alternative plan addresses the specified problems and achieves the specified objectives.
- **Efficiency** is the extent to which an alternative plan is the most cost-effective means of addressing the specified problems and achieving the specified objectives.
- **Acceptability** refers to the workability and viability of the alternative with respect to acceptance by state and local entities and the public compatibility with existing laws.

Because all alternatives, excluding the No Action Alternative, include feature group 8 that addresses the headcut, and include all necessary parts and actions to produce the desired result and meet study objectives (albeit to a varying degree), they can all be considered complete. A comparison of the effectiveness of the alternatives can be found in Section 3 which outlines the environmental benefits of each alternative. Additionally, all alternatives avoid the study constraints. The CE/ICA was utilized to determine the efficiency of alternatives, with the best buy plans being identified as the most efficient plans based on habitat units and costs. All alternatives were determined to be acceptable, however, public acceptability will be evaluated during the public review of the study.

ER 1105-2-100 App.E-41 states that selection of the recommended ecosystem restoration plan requires careful consideration of the plan that best meets the planning objectives and constraints and reasonably maximizes environmental benefits while passing tests of cost effectiveness and incremental cost analyses, significance of outputs, acceptability, completeness, efficiency, and effectiveness.

Table 9 documents the costs associated for each best buy alternative. The No Action Alternative has no Corps of Engineers involvement in design and implementation of a restoration project on the Lower Otter Tail River. Alternative C includes primary work in feature groups 2, 3, and 8. Alternative K includes primary work in all 8 feature groups. Items included in the cost are and, easements, rights-of-way, relocation, and disposal areas (LERRDS), site access and restoration, channel excavation, common fill placement, aggregate, engineered fill, riprap, rock weir boulders, erosion control, toe-wood and sod mat, topsoil, seeding, and mulching. More details on the project costs can be found in Appendix G – Cost Engineering. Annualized costs were determined using the fiscal year 2022 discount rate; all costs have been rounded.

Table 9: Cost Breakdowns for Alternatives (2022 Price Level)

	Project First Costs ($1000s)		
Project Feature	**No Action Plan**	**Alternative C**	**Alternative K**
LERRDs	0	426	3,045
Channels	0	10,012	40,172
Cultural Resource Preservation	0	75	259
Project Features Total	**0**	**10,513**	**43,476**
PED Costs	0	2,022	8,102
S&A Costs	0	1,213	4,861
Total Project First Costs	**0**	**13,748**	**56,439**

Both Alternative C and Alternative K address the geomorphological and water quality objective, and the self-sustaining riparian habitats objective by restoring the slope and sinuosity through oxbow restoration and through the implementation of riffles and plantings to mimic natural processes. The construction of these measures will add additional length back to the Otter Tail River, decrease turbidity and improve water quality resulting in a less degraded and more natural condition within the study area. Both alternatives will be evaluated for compatibility with recreation features within the study reach. Because Alternative K will address the feature groups included in Alternative C, as well as feature groups 1, 4, 5, 6, and 7, Alternative K addresses project objectives to a higher degree than Alternative C. This includes the re-meandering of additional oxbows, additional benefits to the riparian area adjacent the river, and additional habitat benefits (Section 3).

4.1 National Economic Development / National Ecosystem Restoration

Based on the analysis outlined in Section 3, Alternative C would be recognized as the National Ecosystem Restoration Plan (NER). This plan maximizes ecosystem restoration benefits (analyzing using AAHU) by cost. It is recognized that Alternative K is also a best buy plan with greater associated net AAHUs and a total project first cost of approximately $56.5M, however the cost limit for the 1135 project is $12.5M with a Federal limit of $10M. Alternative C also exceeds the Section 1135 limit, and the PDT is currently pursuing a waiver for a total project cost limit of $16.66M.

4.2 Regional Economic Development

The Regional Economic Development (RED) account registers changes in the distribution of regional economic activity that result from each alternative plan. Regional Economic Development considers the changes in regional economic activity that result from each alternative plan. RED benefits impact a region, not the nation as a whole.

Regional impacts were not individually analyzed. Alternative K is anticipated to have similar types of effects as Alternative C, but at a larger scale. This includes potential regional employment associated with project construction, expenditures by contractors, and increased economic activity in the community by contractors during construction.

4.3 Environmental Quality

Displays non-monetary effects on significant natural and cultural resources. Environmental Quality criteria includes both beneficial and adverse changes in the ecological, aesthetic, and cultural attributes of natural and cultural resources. **Table 10** outlines that ecological benefits of the best buy alternatives. Alternative K provides the greatest total AAHUs, at 1,883 AAHUs. An in-depth discussion of ecosystem restoration benefits can be found in Section 4.1 and Appendix J. Cultural Impacts can be found in Section 8.3.

Table 10: Ecological Benefits of Best Buy Alternatives

Alternative	Description (Feature Groups)	River Strata, Total AAHUs	River Strata, Net AAHUs over no action	Wetland Strata, Total AAHUs	Wetland Strata, Net AAHUs over no action	Total AAHUs
No Action Alternative	Without Project	835	0	120.1	0	955
C	8,2,3	1,168	334	94.2	-26	1,262
K	8,1,2,3,4,5,6,7	1,872	1,037	11.7	-108	1,883

4.4 Other Social Effects

The Other Social Effects (OSE) account includes urban and community impacts; life, health, and other safety factors; displacement; long-term productivity; and energy requirements and energy conservation. Other criteria can be added to this category based on feedback from stakeholders.

The Otter Tail River is a DNR designated public water and was designated by the 2006 Minnesota Legislature as a canoe and boating route. Recreational activities in the project area include fishing, hunting, trapping, camping, canoeing, picnicking, bird watching, hiking and tubing. The No Action Alternative would allow for the continued degradation of the Otter Tail River. Although Alternatives C and K would have both temporary and permanent impacts, both alternatives would provide increased outdoor recreational opportunities. Benefits and impacts of Alternative K are expected to be similar to Alternative C, but at a larger scale.

5 Tentatively Selected Plan

Based on the discussion and criteria outlined in previous chapters, Alternative C was determined to be the NER and tentatively selected plan (TSP). Project features, benefits, real estate, construction, operation, maintenance, repair, replacement, rehabilitation, risk, and uncertainty are discussed in this section. The project schedule and initial cost estimates are provided. The project has been developed to a detailed feasibility level of design. Further details will continue to be refined in the plans and specifications (P&S) stage.

5.1 Plan Features

The Tentatively Selected Plan includes the restoration and re-meandering of feature groups 2 and 3, and the head cut stabilization of Feature Group 8. This alternative involves 5 overflow structures, 14 rock riffles, 7490 linear feet of toe wood sod mats, 36 acres of channel excavation, and 16 acres of floodplain excavation. (**Figure 14**,**Figure 15**, **Figure 20**).

Alternative C addresses the geomorphology and water quality objective by restoring the slope, sinuosity, and meander belt within feature groups 2 and 3, adding additional length and habitat back to the Otter Tail River, decreasing turbidity and improving water quality.

Alternative C addresses the self-sustaining riparian habitats objective through the implementation of riffles and riparian plantings throughout feature groups 2, 3, and 8 that will mimic and restore natural processes to a less degraded state.

Benefits for the tentatively selected plan include:

- The re-meandering of feature groups 2 and 3
- Increased sinuosity
- The headcut stabilization of feature group 8
- 91 acres of river habitat
- Long-term benefits on unaffected wetlands
- Increase river and habitat connectivity
- Increased vegetative diversity and habitat benefits in feature groups 2 and 3
- Improved water quality

Table 11: Ecological benefits of the TSP

Alt	FGs	Total Cost	AAC	Net AAHUs	AAC/AAHUs
NA	(NO ACTION)	0	$0	0	0
C	(8, 2, 3)	$13,770,746	$485,557	308	$1,576

5.1.1 Consistency with USACE Campaign Plan

The USACE has developed a campaign plan with a mission to “deliver vital engineering solutions, in collaboration with our partners, to secure our Nation, energize our economy, and reduce risk from disaster”. This Campaign Plan shapes the USACE command priorities, focuses

transformation initiatives, measures and guides progress, and helps the USACE adapt to the needs of the future by improving the current practices and decision-making processes of USACE. The USACE Campaign Plan is available at the following address: http://www.usace.army.mil/about/campaignplan.aspx. The goals and objectives outlined in the latest USACE Campaign Plan (FY21) include:

1. Support National Readiness
2. Modernize USACE
3. Improve Partnering and Strengthen Relationships
4. Revolutionize Program and Project Delivery

This project supports Goals 1 and 3 of the USACE Campaign Plan by addressing:

- Campaign Plan Goal 1: USACE is trusted by DA, DoD, our partners / stakeholders, and the Nation to deliver quality projects and programs, on time and within budget, that enable the National Command Authority to secure the homeland, project national power, and pursue our Nation's vital interests.
    - Carrying out and delivering the Program
- Campaign Plan Goal 3: USACE is the most trusted advisor and valued "partner of choice" for our International Allies and Partners, the Federal Government, industry, academia, State and local agencies, and the public through aggressive partnering that builds and maintains strong, meaningful, and lasting relationships.
    - Building and maintaining trust and understanding with customers, stakeholders, teammates, and the public through strategic engagement and communication.

5.1.2 Consistency with USACE Environmental Operating Principles

In 2002 and again in 2012, the USACE reaffirmed its commitment to the environment by formalizing a set of Environmental Operating Principles (EOP) applicable to all of its decision-making and programs. The formulation of alternatives considered for implementation met all of the EOPs. The seven EOPs are:

- Foster sustainability as a way of life throughout the organization
- Proactively consider environmental consequences of all the USACE activities and act accordingly
- Create mutually supporting economic and environmentally sustainable solutions
- Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE, which may affect human and natural environments
- Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs
- Leverage scientific, economic, and social knowledge to understand the environmental context and effects of the USACE actions in a collaborative manner
- Employ an open, transparent process that respects the views of individuals and groups who are interested in the USACE activities.

These principles are available at the following address:

http://www.usace.army.mil/Missions/Environmental/Environmental-Operating-Principles/.

The principles are consistent with the NEPA, the Army Strategy for the Environment, other environmental statutes, and the WRDA of 2007. The EOPs are considered at all stages of the study process at the same level as economic issues. Environmental consequences, sustainability, risk management, and stakeholder involvement were integral parts of the study process. The EOPs were considered during plan formulation and outreach. The selection of the Tentatively Selected Plan is consistent with the EOPs. The Tentatively Selected Plan promotes sustainability and economically sound measures by incorporating natural and least cost methods, where possible, for addressing study objectives erosion in the project area. Additional detail can be found in Section 7.

5.2 Real Estate – Project Lands, Easements, Right-of-way, Relocations, and Disposal/Borrow Areas (LERRD)

Nearly all project access and features will be on private property. All lands associated with the project's ecosystem restoration features will be acquired in Fee-Simple Absolute title. No facility or utility relocations are necessary for this project. The Sponsor possesses a Disposal Right-of-Way, easement and rights on land interest acquired for the original Federal project as follows:

"The full, complete and perpetual right, power, privilege, and easement to enter upon, occupy, use, clear, and remove therefrom and dispose of, all trees, brush, and material and natural or artificial structures or obstructions, together with the right to dig or cut away, and remove, all or any part of said lands, all as may be necessary in connection with the construction, operation and maintenance of the channel improvement on the Otter Tail River, Minnesota, or any enlargement thereof, together with the right, privilege and easement to maintain and operate the portion of the lands so excavated, cut away or removed, and the channel created thereby, together with the right , privilege and easement to maintain and operate the portion of the lands so excavated, cut away or removed, and the channel created thereby, as the part of the improved, realigned and reconstructed channel of the Otter Tail River, including the perpetual right and easement to flow and overflow said lands and to flow water through said reconstructed river channel," as identified in the recorded deed.

Additional information on Real Estate can be found in Appendix E.

5.2.1 Alternative C

Total LERRDs required for the Project is displayed in **Table 12**.

Table 12: Total LER required for Alternative C

Project Area	Ownership	Acres	Number of Parcels
Permanent Flowage Easement Protection Easement	Private	29.41	29
Temporary (Haul Road) Easement	Private	17.64	10
Permanent Project Features	Private	36.33	8
Total		**83.38**	**47 (~ 18 Owners)**

5.2.2 Alternative K

Total LER required for the Project is displayed in **Table 13**.

Table 13: Total LER required for Alternative K

Project Area	Ownership	Acres	Number of Parcels
Permanent Flowage Easement Protection Easement	Private	151.10	132
Temporary (Haul Road) Easement	Private	47.96	38
Permanent Project Features	Private	467.35	42
Total		**666.41**	**212 (~ 45 owners)**

5.3 Construction Implementation

Four target years (TYs) were identified throughout the 50-year planning period to capture significant thresholds in the anticipated response (Table 14). TYs were identified primarily driven by considerations for riparian vegetation and river geomorphology.

Table 14. Identified Target Years and Rationale.

Target Year (TY)	Rationale
0	Construction begins.
1	Construction ends. Disturbance due to construction of features a factor in determining vegetation response. However, immediate response to river plan form and profile associated with grade control structures.
3	Vegetation begins to respond. Plantings for grasses and shrubs take hold.
25	Planted trees grow into mature forest.
50	End of planning period.

5.4 Operation, Maintenance, Repair, Replacement, and Rehabilitation

The estimated operation and maintenance costs for the project would be approximately $2,000 annually. Maintenance for this project is considered minimal but would include yearly inspections of the rock structures and embankment for signs of erosion.

5.5 Risk and Uncertainty

Areas of risk and uncertainty have been analyzed and were defined so that decisions could be made with some knowledge of the degree of reliability of the estimated benefits and costs of

alternative plans. Risk is a measure of the probability and consequence of uncertain future events. Uncertainty refers to a lack of knowledge about critical elements or processes contributing to risk or natural variability in the same elements or processes.

The team worked to manage risk in developing measures. The team used experience from past projects to identify potential risks and reduce uncertainty during plan formulation.

Several general assumptions have been made in forecasting the FWOP conditions:

1. Excessive sediment transport would continue on the Lower Otter Tail River.
2. TMDLs on Lower Otter Tail River would continue to violate MPCA turbidity standards.
3. Based on past data, the headcut would continue upstream at a rate about 750 feet per year.
4. The quality of riparian habitat will continue to degrade. Forest and shrub cover will experience losses due to increased lateral disconnection with the river. This will be converted into other cover types such as shrubs or wetlands.

Specific assumptions on the future with- and future without-project conditions relevant to the HEP analysis are provided in Appendix J. Specific Risk and Uncertainty relevant to engineering can be found in Appendix A.

The PDT recognizes that mitigation from the Fargo Moorhead Diversion Project may result in the implementation of project features ahead of the construction of the Lower Otter Tail Section 1135 project. While this risk did not influence plan formulation, the PDT evaluated the benefits, costs, and impacts of Alternative K (including all 8 feature groups) to account for possible changes to the Recommended plan after project funding. See Section 7.2 for additional details.

Project features are exclusively located on private lands and implementation will require landowner negotiations. The PDT recognizes the implementation risk associated with landowner unwillingness and formulated the “instream stabilization” measures as an alternative to oxbow restoration in reaches that lack landowner participation for implementation. With the goal of the project being to add stream length and diversity to the river, the rock weirs would raise the water surface profile and benefit the riparian zone adjacent to the channel.

5.6 Project Cost Summary

Based on 2022 price levels, the project first cost is approximately $14.0M for the Tentatively Selected Plan. The fully funded estimated total project cost for the Tentatively Selected Plan is $14.6M including escalation to the midpoint of construction. In accordance with the cost share provisions of Section 1135 of the Water Resources Development Act (WRDA) of 1986, as amended (33 U.S.C. 2213), the Federal share of the project first cost is estimated to be $9.5M and the non-Federal share is estimated to be $5.1M, which equates to a 65% Federal and 35% non-Federal cost share. The non-Federal cost includes the value of lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas (LERRD) estimated to be $457K. **Table 15** provides the cost breakdown for project first cost, contingency is 30%.

Table 15. Tentatively Selected Plan Project First Cost Estimate (FY 2022 dollars)

Item	Project First Cost	Federal Cost	Non-Federal Cost
LERRD	$437,000	$284,050	$152,950
Construction	$10,264,000	$6,671,600	$3,592,400
Preconstruction Engineering and Design	$2,050,000	$1,332,500	$717,500
Construction Management	$1,230,000	$799,500	$430,500
Total	$13,982,000	$9,088,300	$4,893,700

* Numbers have been rounded.

Detailed information on project costs can be found in Appendix G – Cost Engineering.

5.7 Project Performance (Monitoring and Adaptive Management)

Section 2039 of WRDA 2007 directs the Secretary of the Army (Secretary) to ensure, when conducting a Feasibility Study for a project (or component of a project) for ecosystem restoration, the recommended project includes a plan for monitoring the success of the ecosystem restoration. The Corps implementation guidance for Section 2039, in the form of a CECW-PB Memo dated 31 August 2009, also requires an adaptive management plan be developed for all ecosystem restoration projects (Corps 2009). The monitoring plan shall include a description of the monitoring activities, the criteria for success, and the estimated cost and duration of the monitoring as well as specify that monitoring will continue until such time as the Secretary determines that the ecological success criteria have been met, up to a maximum of 10 years (Short-Term Monitoring). This is distinguished from Long-Term Monitoring that is additional monitoring beyond that required by the Secretary and which will be the sole responsibility of the project sponsor(s).

A Performance Monitoring and Adaptive Management Plan (AMP) for the Lower Otter Tail Restoration Project (Project) has been developed by the U.S. Army Corps of Engineers, St. Paul District in collaboration with the Buffalo-Red River Watershed District (BRRWD) and the Minnesota Department of Natural Resources (MNDNR). The purpose of the AMP is to provide details for assessing performance and identify adaptive management actions for the Project if necessary.

The AMP intends to ensure that monitoring and evaluation of the Project are conducted to evaluate the project for effectiveness in meeting objectives. The AMP is designed as a living document that will be continually edited and updated as new information is obtained. It considers changes to project features, available resources, and variations in environmental conditions (e.g., climate change). The estimated costs of AMP is anticipated to be less than 4% of the construction costs of the project. Additional details for the Monitoring and Adaptive Management Plan are provided in Appendix E.

Table 16: AMP Assignments

Objective	Task	Data Type / Format	Labor (hrs)	Responsible Party	Estimated Cost
1 - Restore River Slope and Sinuosity	1.1.1 –Longitudinal profiles (2X)	Elevation	180	MVP-CE	$25,200
	1.2.1 - Assess sinuosity via aerial imagery (2X)	Aerial imagery	60	MVP-GIS	$8,400
	Interim Reporting (TY 5)	Report / Word	24	MVP-GIS	$3,360
	Passive AM measures	PER	80	MVP-CE	$11,200
	Final reporting (TY10)	PER	8	MVP-CE	$1,120
	TOTAL for Objective		**352**		**$49,280**
2 - Stabilize Banks and Headcut	2.1.1 - Assess bank erosion (3X)	Erosion rate (cm/yr)	80	MVP-CE/GIS	$11,200
	2.2.2 – Assess headcut movement (2X)	Migration rate (m/yr)	32	MVP-CE/GIS	$4,480
	2.2.3 –Compile and Assess Turbidity (2X)	TSS (mg/l)	16	MVP-CE	$2,240
	Interim Reporting (TY 5)	Report / Word	24	MVP-CE/GIS	$3,360
	Passive AM measures	PER	80	MVP-CE	$11,200
	Final reporting (TY10)	PER	8	MVP-CE	$1,120
	TOTAL for Objective		**240**		**$33,600**
3 - Restore Meander Belt	3.1.1 –Assess meander belt dimensions (2X)	Maps/ArcGIS	80	MVP-CE/GIS	$11,200
	Interim Reporting (TY 5)	Report / Word	16	MVP-CE	$2,240
	Passive AM measures	PER	80	MVP-CE	$11,200
	Final report (TY10)	PER	8	MVP-CE	$1,120
	TOTAL for Objective		**184**		**$25,760**
4 - Increase In-Stream Habitat Diversity	4.1.1 - Assess Pool-Run-Riffle Ratio and Spacing (1X)	Map / Report	40	MVP-CE	$5,600
	Interim Reporting (TY 5)	Report / Word	16	MVP-CE	$2,240
	Passive AM measures	PER	80	MVP-CE	$11,200

Objective	Task	Data Type / Format	Labor (hrs)	Responsible Party	Estimated Cost
	Final Reporting (TY10)	PER	8	MVP-CE	$1,120
	TOTAL for Objective		**144**		**20,160**
5 - Restore Flow Regime & Increase Lateral Connectivity	5.1.1 - Assess flood-prone area and bankfull width (1X)	Maps	40	MVP-CE	$5,600
	Interim Reporting (TY 5)	Report / Word	16	MVP-CE	$2,240
	Passive AM measures	PER	80	MVP-CE	$11,200
	Final Reporting (TY10)	PER	8	MVP-CE	$1,120
	TOTAL for Objective		**144**		**$20,160**
6 - Restore Riparian Vegetation	6.1.1 - Assess nearshore riparian cover (2X)	Maps	160	MVP-CE/GIS	$22,400
	6.1.2 Assess riparian cover (2X)	Maps	240	MVP-CE/GIS	$33,600
	Interim Reporting (TY 5)	Report / Word	16	MVP-CE/GIS	$2,240
	Passive AM measures	PER	80	MVP-CE/GIS	$11,200
	Final Reporting (TY10)	PER	8	MVP-CE/GIS	$1,120
	TOTAL for Objective		**504**		**$70,560**
Drone Pilot Study	**Determine efficacy of drone usage for monitoring**	Report / Word	350	MVP-GIS/SUAS	$49,000
TOTAL COSTS		SUBTOTAL			**$268,520**
		10% Contingency			**$26,852**
		TOTAL			**$295,372**

6 Plan Implementation

6.1 Project Schedule

Table 17. Tentative Project Schedule

Requirement	Scheduled Date
Submit final Feasibility Report and Environmental Assessment to Mississippi Valley Division, U.S. Army Corps of Engineers.	Q3 2022
Obtain construction approval by Mississippi Valley Division U.S. Army Corps of Engineers.	Q4 2022
Enter into Project Partnership Agreement.	Q1 2023
Begin plans and specifications.	Q1 2023
Complete plans and specifications.	Q1 2024
Begin construction.	Q1 2024
Complete construction.	Q4 2025

6.2 Adaptive Implementation Plan

The PDT recognizes two significant implementation risks for the Section 1135 Project:

- Mitigation from the Fargo Moorhead Diversion Project (Section 1.7) will likely result in the implementation of project features ahead of construction of the Lower Otter Tail Section 1135 project based on CAP project funding availability.

- Project features are exclusively located on private lands and implementation will require landowner willingness to sell lands or accept flowage easements.

Both risks have the potential to change the implementable measure/feature groups included in the Tentatively Selected Plan. Due to the high probability of these risks influencing the implementable project features, the PDT devised solutions to address the risks. This section includes the evaluation of these solutions.

6.2.1 Fargo Moorhead Mitigation Risk

The Minnesota DNR permit condition for the Fargo Moorhead Mitigation Project will result in Fargo Moorhead Mitigation sponsors providing $8.3M to be used on the restoration of the Lower Otter Tail River, with a construction start date of March 2026. To address the risk associated with the implementation and construction of project features of the Tentatively Selected Plan, the PDT proposes utilizing the evaluation of Alternative K as a best buy plan, which contains all measures for all 8 feature groups, to justify the substitution of measures or feature groups into the Recommended plan if project features are constructed by the Fargo Moorhead Mitigation Project. The Real Estate Plan, the Environmental Assessment, and environmental compliance and coordination were all evaluated for Alternative K to include all measures and feature groups.

Table 18 displays the results of the Cost-Effective Analysis by feature group. The tentatively selected plan includes feature groups 2, 3, and 8. It is likely that feature group 8 would be the most likely to be constructed by the Fargo Moorhead mitigation, as the headcut is contributing to heavily to the identified problems in the Otter Tail River as it progresses upstream. Feature groups 1, 5, 6, and 7 show favorable AAC/AAHU when compared to feature groups included in the tentatively selected plan. Feature groups 1, 4, and 6 have similar total costs when compared to feature groups that were included in the tentatively selected plan. Based on the Cost Effective Analysis and total costs, feature groups 1 and 6 would be the top priority feature groups to construct if feature groups 2 or 3 are constructed with the mitigation project. As shown in **Table 8**, all 12 alternatives were considered cost effective plans.

Table 18: Results of Cost-Effective Analysis by Feature Group

FGs	Total Cost	AAC	Net AAHUs	AAC/AAHUs
1	$3,919,419	$138,199	849	$1,640
2	$5,576,080	$196,613	90	$2,186
3	$7,171,130	$252,854	102	$2,469
4	$4,561,191	$160,828	33	$4,881
5	$17,121,233	$603,695	225	$2,684
6	$5,643,932	$199,005	133	$1,492
7	$11,501,769	$405,552	175	$2,317
8	$1,023,536	$36,090	115	$292

Alternative K includes the restoration and re-meandering of all 7 feature groups and the head cut stabilization of Feature Group 8. This alternative involves 22 overflow structures, 58 rock riffles, 27,900 linear feet of toe wood sod mats, 133 acres of channel excavation, and 47 acres of floodplain excavation. The increased acreage and enhanced quality of habitat associated with this alternative would provide a net gain of 928 AAHUs over the No Action Alternative, with a total cost of approximately $56M.

Table 19: Cost Effective and Incremental Cost Analysis for Alternative K

Alternative	FGs	Total Cost	AAC	Net AAHUs	AAC/AAHUs
K	(8, 1, 2, 3, 4, 5, 6, 7)	$56,518,290	$1,992,835	928	$2,147

Real estate consideration are expected to be similar for Alternative C and K, but increased in scale for Alternative K. Total LER required for the Alternative K are displayed in **Table 20**. Additional real estate considerations for Alternative K can be found in the Real Estate Plan. OMRR&R is expected to be similar to the tentatively selected plan but increased in scale. OMRR&R costs are expected to be 20% of total project costs.

Table 20: Total LER required for Alternative K

Project Area	Ownership	Acres	Number of Parcels
Permanent Flowage Easement Protection Easement	Private	151.10	132
Temporary (Haul Road) Easement	Private	47.96	38
Permanent Project Features	Private	467.35	42
Total		**666.41**	**212 (~ 45 owners)**

Table 21 displays the total project first costs for Alternative K.

Table 21: Project Cost Summary for Alternative K (FY 2021 dollars)

Item	Project First Cost
LERRD	$3,045,000
Construction	$12,340,000
Preconstruction Engineering and Design	$8,102,000
Construction Management	$4,861,000
Total	$56,518,000

Environmental compliance and impacts for both Alternative C and Alternative K are outlined in Section 8.

6.2.2 Landowner Participation Risk

Project features for all alternatives and feature groups are located on private lands and implementation will require landowner willingness to sell lands or accept flowage easements. Although socialization of

the project has been initiated by the sponsor, a significant construction risk exists that may determine which features will be implementable. Instream stabilization was proposed as a measure to mitigate some of the impacts of landowner willingness to the project benefits. Rock weir structures can be implemented in reaches that do not have landowner cooperation to add pools and riffle habitat to the channel for fish species. Although the goal of the project is to add stream length back to the Otter Tail River by reconnecting oxbows to establish a more natural condition, instream stabilization will raise the water surface profile, improving the riparian habitat and would need minimal landowner participation.

Landowner participation will be further evaluated during the public review period for the study.

7 Assessment of Existing Resources and Environmental Consequences of Retained Alternatives

This chapter identifies the existing conditions of the resources for the study area and describes the environmental consequences of alternatives considered compared to the no-action FWOP condition. The depth of analysis of the alternatives corresponds to the scope and magnitude of the potential environmental impact. This chapter provides the scientific and analytic basis for the comparison of alternatives and describes the probable consequences ("impacts" or "effects") of each alternative on the selected environmental resources. The purpose of characterizing the environmental consequences is to determine whether the resources, ecosystems, and human communities of concern are approaching conditions where additional stresses will have an important effect.

In addition to the No Action, Alternative C and Alternative K are assessed for impacts. In general, resource impacts for action alternatives varied as a matter of scale, commensurate with the number of FGs and size of the affected river reach and associated riparian. The effects of Alternative K which had all eight FGs, were always greater than that of Alternative C, which had three of the eight FGs. However, the effects of alternatives were never different by an order of magnitude.

The resources described in this chapter are those recognized as significant by laws, executive orders (EO), regulations, and other standards of National, state, ore regional agencies and organizations; technical and scientific agencies, groups, or individuals; and the general public. Environmental consequences of the proposed action are discussed below and summarized in **Table 25**.

This analysis uses the terms "adverse" and "significant" to describe the potential impacts from the proposed action. These words are defined as:

- Adverse – is a negative impact on the human, natural, and/or physical environment.
- Significant – a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the proposed action, including, land, air, water, minerals, flora, fauna, ambient noise, and/or objects of historic or aesthetic value.
- For the purpose of this analysis, the magnitude of impacts are classified as negligible, minor, moderate, or major and defined as:
- Negligible: A resource was not affected, or the effects were at or below the level of detection; changes were not of any measurable or perceptible consequence.
- Minor: Effects on a resource were detectable, although the effects were localized, small, and of little consequence to the sustainability of the resource.
- Moderate: Effects on a resource were readily detectable, long-term, localized, and measurable.
- Major: Effects on a resource were obvious, long-term, and had substantial consequences on a regional scale.

The duration of the effects in this analysis is defined as follows:

- Short term[1] — when effects last less than three years.
- Long term — effects that last longer than three years.

7.1 Physical Setting

The Otter Tail River watershed covers 1,922 square miles and is a subwatershed of the Red River of the North Basin in former Lake Agassiz. The river originates in Big Rock Lake in Clearwater County and runs 186 miles through Becker, Otter Tail, and Wilkin counties and across three biomes: Coniferous Forest Biome, Eastern Deciduous Forest Biome, and Tall Grass Prairie Biome. The Otter Tail River joins the Bois de Sioux River at Breckenride, Minnesota where it becomes the Red River of the North. The reach of the river below Orwell Dam is described as "…a plains stream; slow, meandering, shifting sand bottom, and turbid with practically no valley, only a deep, steep-sided channel cut into flat glacial lake clay" (Kuitunen et al. 1997). The average gradient of the river is 4.5 feet per mile, dropping from an elevation of 1760 feet to 950 feet.

7.1.1 Land Cover / Land Use

Land Cover. Changes in land use associated with increased development in the region appear to be the primary reasons for watershed problems relate to soil erosion, wetland management, surface water quality, stormwater runoff, and wildlife habitat. A significant portion of the land within this watershed is considered highly erodible. Land use within the watershed is largely agricultural, accounting for about half of the overall watershed acres.

Currently, there are six general land cover types in the study area composed of 44% agriculture, 20% forested, 15% shrubs/grasslands, 14% water (river), 4% wetlands, and 2% disturbed (**Table 22**).

Table 22. Existing and Projected Land Cover with the LOTR Evaluation Area

Cover Type	Existing/FWOP		Alt C		Alt K	
	Acres	%	Acres	%	Acres	%
Agricultural	1168	44%	1166	44%	1162	44%
Disturbed	48	2%	48	2%	48	2%
Forest	526	20%	518	20%	468	18%
Shrub Grasslands	403	15%	400	15%	397.	15%
Water	379	14%	383	15%	428	16%
Wetlands	108	4%	115	4%	127	5%
Total:	2631	100%	2631	100%	2631	100%

The effects to land cover are described below, which overlaps with the discussions related to other specific natural resources identified in the following sections (e.g., Section 8.2.7 - Wetland

[1] This time frame is associated with the anticipated period for project construction and period for vegetation re-establishment.

Habitat).

Land Use. Land use within the watershed is largely agricultural, accounting for about half of the overall watershed acres. Much of the private lands within the project area are used for agriculture. Non-agriculture areas consist of heavy woods, grasses, or shrubs that can be used for outdoor recreation like hunting and wildlife viewing. A smaller portion of project area lands are considered "disturbed" which is typically mowed turf or roadways as a part of home dwellings. No buildings (commercial businesses or homes) fall within the proposed project footprint.

Impacts of the No-Action Alternative:

Land Cover. The No-Action would not appreciably affect land cover in the short-term, but would likely result in changed land cover over the long-term. As the river becomes more incised and experiences decreased lateral connectivity with the riparian zone, forest and shrub cover types would likely senesce into more drought tolerant grasses. Wetlands may be lost with a lowering of the water table. The effect would be most pronounced in areas immediately downstream of the headcut as it migrates upstream.

Land Use. There would be no effect on land use.

Impacts of Alternative C:

Land Cover. Alternative C would convert five oxbows within the FG 2 and FG 3 sub-reaches into river habitat, creating about 5 acres of this habitat. Portions of forest (9 acres) and shrub grasslands (3 acres) cover types would be displaced by the re-meandered river. Wetlands would also increase in acreages (8 acres). With enhanced lateral connectivity between the river and the floodplain, vegetation is likely to improve in the restored sub-reaches. The elevation of the water table will be raised in support of vegetation. The capture of sediment and nutrients will increase in the floodplain during high flow events.

Land Use. This alternative would affect about 2 acres of prime farmlands (**Error! Reference source not found.**). For example, a strip of private lands on the north side of the river (right descending bank) with FG 3 would be permanently converted from existing use to grass or shrub cover types as a part of floodplain excavation. This measure is needed for flow conveyance during flood events. Some within-channel features would need to be anchored on either side of the channel that could encroach on private lands. Some lands could experience flooding beyond the level of protection identified in the 1950's channel improvement project (the goals of the proposed project would not be achievable under the 1950's targeted level of protection). Additional discussion is in Section 8.4.6 and Appendix A. However, this would be addressed with flood easements or other measure. Over-land access to the lands contained within oxbows on the south side of the river (i.e., Oxbows 20 through 22, and 25) would be enhanced from the north side via overflow structures, but would not be possible from the south side. The opposite would be true of lands within oxbows on the north side of the river (i.e., Oxbow 24 would be accessible from the south, but not from the north). During construction, there would need to be temporary access across private lands for heavy machinery. No adverse effects to land use are anticipated as it would only involve willing landowners and flood risk management measures if needed.

Impacts of Alternative K:

Alternative K would have similar effects on land cover and land use as Alternative C, but over a larger geographic area, i.e., all FG sub-reaches.

Land Cover. This alternative would convert 23 oxbows into river habitat, creating about 49 acres of this habitat. Portions of forest (58 acres) and shrub grasslands (6 acres) cover types would be displaced by the re-meandered river. Wetlands would also increase in acreages (19 acres). Like Alternative C, the enhanced lateral connectivity between the river and floodplain will promote vegetation growth, but across all FG sub-reaches.

Land Use. Across all FGs, Alternative K would result in about 48 acres of land converted from agriculture to grass or shrub cover types as a part of floodplain excavation for flow conveyance during flood events. Of this, about 9 acres is considered prime farmland (**Error! Reference source not found.**). Additional flooding is anticipated, but would also be addressed. Over-land access to the lands contained within oxbows on the south side of the river (i.e., Oxbows 3, 5, 6, 8, 9, 12, 13, 15 through 18, 20 through 22, 26 and 27) would be enhanced from the north side of the river via overflow structures, but would not be possible from the south side. Access to land within oxbows on the north side (i.e., Oxbow 1, 4, 7, 14, 24) would be possible from the south, but not from the north. Construction access would also be needed over a larger area than Alternative C. Like Alternative C, no adverse effects to land use are anticipated as it would only involve willing landowners and flood risk management measures if needed.

Table 23. Acreages of Farmlands Affected by Proposed Alternatives

Alternative	Prime Farmland	Prime Farmland With Additional Measures[a]	Non-Farmland	Total
C	2.0	2.7	42.9	47.6
K	9.4	38.9	154.9	203.2

[a]Additional measures include draining, flood protection, or increased flooding.

7.1.2 Otter Tail River Geomorphology

Profile

The river profile within the evaluation area has changed in comparison to what was constructed for the Flood Risk Management (FRM) project in the 1950s. While the length of the river was shortened from 18 river miles to 11 river miles, the inlet and outlet elevations remained unchanged. This resulted in an increase in the average slope reach from 0.036% to 0.58%. As a result, part of the river became incised over time. At the upstream end of the project area (about 2 miles downstream of the Wilkin County State Aid Highway (CSAH) 19 bridge crossing), it has incised approximately 4 feet. However, as you move downstream, the river bottom profiles gradually converge and then it changes to an aggradation reach as you approach the downstream limits of the project (**Figure 23**). This aggradation is especially pronounced in Lake Breckenridge. From the survey, it appears that there is approximately 8 feet of accumulated sediment since the 1953 USACE project was completed. Lake Breckenridge is an artificial lake created by a dam placed on the LOTR for the purposes of impounding water for emergency water supply for the City of Breckenridge. The dam was modified in 2007 with the construction of boulder arch weirs

to allow for fish passage up the LOTR, though the dam crest elevation remained unchanged.

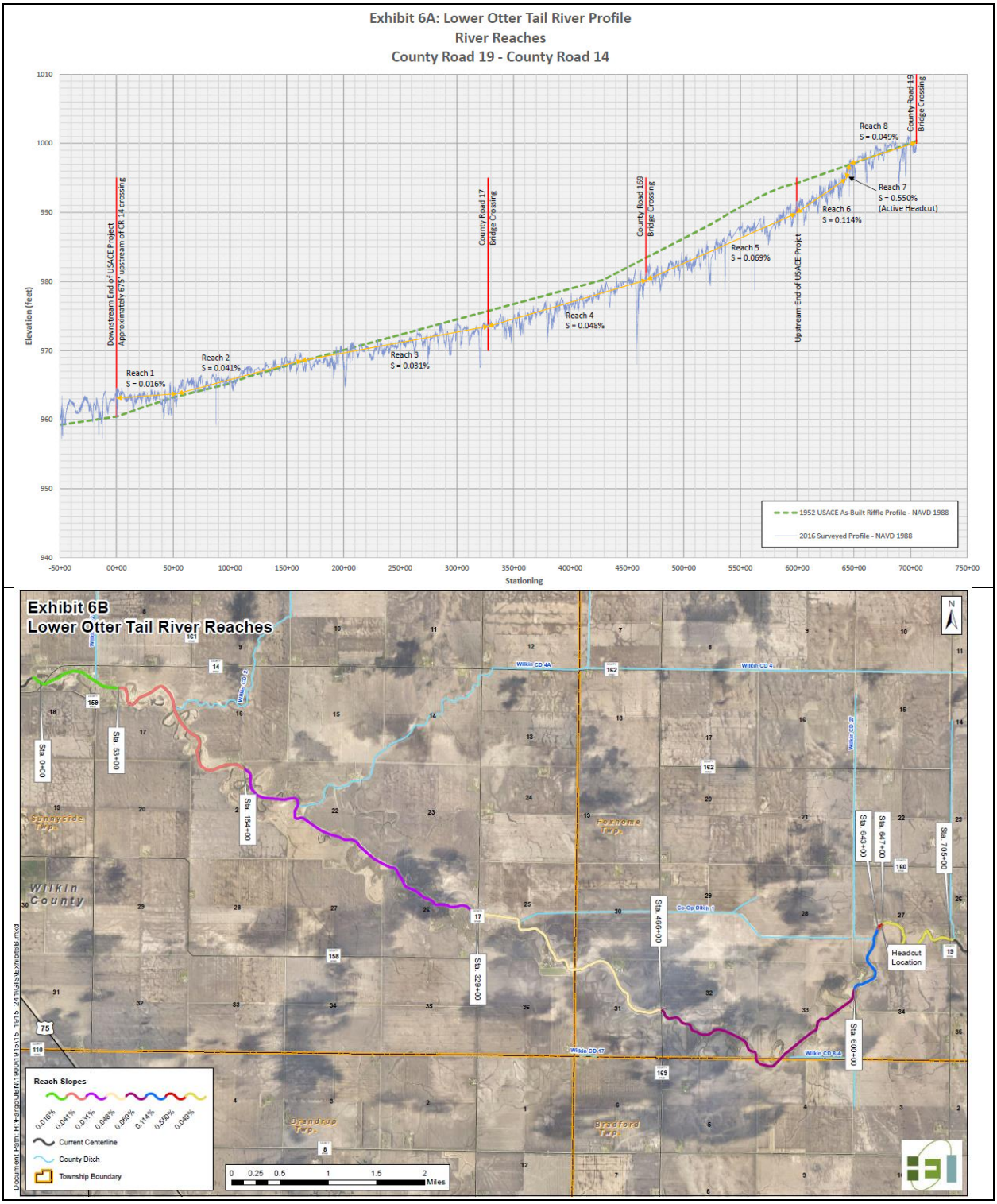

Figure 23. Comparisons of Lower Otter Tail River Profile in the Project Evaluation Area
Source: Exhibit 6 B *IN* Houston 2019.

Impacts of the No-Action Alternative:
The No-Action would not have immediate effects on the river profile. Over time, the headcut would continue to migrate upstream, lowering the channel profile. The upper section of the river immediately downstream of the headcut would continue to downcut, resulting in a more incised channel. The lower section of the river would continue to aggrade, resulting in more sedimentation.

Impacts of Alternative C:
Alternative C would restore the river profile to more closely resemble what it looked like before the FRM project was built within the FG 2 and FG 3 sub-reaches. The elevation of the river bottom would be raised several feet from the existing condition with grade control structures. The headcut structure will likely eliminate the headcutting from moving upstream to Orwell Dam and also reduce the volume of sedimentation in the river.

Impacts of Alternative K:
Alternative K would have similar effects as Alternative C, but throughout all FG sub-reaches.

Dimension

In addition to changes in the river profile, the channel has increased in width and steepened in side slopes, including near vertical banks in several areas of the river (**Figure 24**). The channel has become more trapezoidal shaped, leading to a loss of bathymetric diversity and habitat diversity.

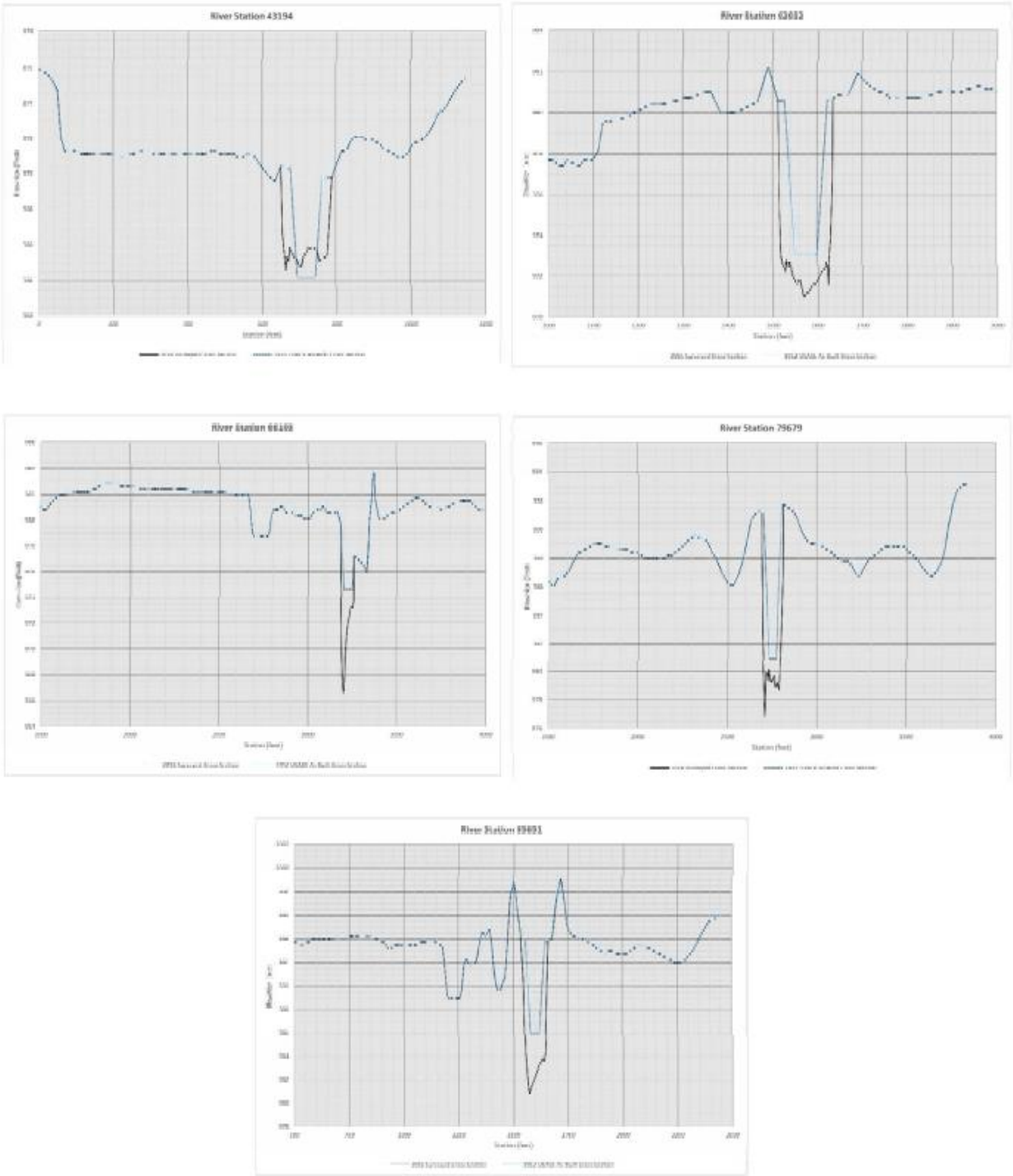

Figure 24. Cross Sectional Comparison Plots in Lower Otter Tail River
Blue dotted line = 1953 As-Built cross section; Black line = 2016 Surveyed cross section. Source: Exhibit 7 *IN* Houston 2019.

Impacts of the No-Action Alternative:
The No-Action would not have immediate effects on the river dimension. Over time, the river channel would likely continue to widen and lead to steeper banks. This would increase bank erosion and turbidity. These effects would be most profound in the area immediately downstream of the headcut.

Impacts of Alternative C:
Alternative C would restore the river dimension to more closely resemble what it looked like before the FRM project was built within the FG 2 and 3 sub-reaches. Restoring the river dimensions within these sub-reaches would create additional hydraulic diversity and contribute to the complexity of aquatic habitat.

Impacts of Alternative K:
Alternative K would have similar effects as Alternative C, but throughout all FGs sub-reaches.

Pattern

River pattern refers to the plan form and, in this case, was historically characterized as a sinuous dendritic pattern. However, as discussed previously, 18 river miles of the river within the project area was straightened and shortened to 11 river miles as a result of the FRM project constructed in the 1950s.

Impacts of the No-Action Alternative:
The No-Action would have negligible effects on the river pattern.

Impacts of Alternative C:
Alternative C would restore the river pattern to more closely resemble what it looked like before the FRM project was built within the affected sub-reaches. Sinuosity of the river would be restored.

Impacts of Alternative K:
Alternative K would have similar effects as the TSP, but throughout all FGs sub-reaches.

7.2 Natural Resources

7.2.1 Geology and Soil Substrate

The study area is located in the Red River Valley which is an area defined by historic glaciers. Most of the study area is located in the Glacial Lake Plain, in what was historically the bed of Glacial Lake Agassiz.

Lake Agassiz was the prominent geologic feature that covered the area nearly 12,000 years ago. This glacial lake was created by an accumulation of melt water as the glacier receded north. The glacial plain is a large flat area that was the former lake bed and includes lake sediments up to a depth of 80 feet, leaving behind an area with clay-rich sediment.

Glacial drift thickly mantles the majority of the glacial lake plain. The thickness of the drift can

exceed 600 feet in this area and consists primarily of unsorted and unstratified clay, silt, sand, gravel, and boulders referred to as till. Independent deposits of sorted and stratified sand and gravel can be found in till and range in size from an acre to multiple square miles; these deposits form the principal aquifers within glacial drift.

The glacial lake plain till on the west end of the study area includes as much as 95 feet of clay and silt-rich lake deposits from Glacial Lake Agassiz.

The predominant soil type present is a sandy clay till; however, there are varying amounts of fine and medium sand, silty sand, and sandy silt. Additionally, there were lesser amounts of silt and high liquid limit clays present intermittently along the channel. Soils in the project area are considered Type C (sandy clay loam with low infiltration) and Type D (clay loam, sandy clay, silty clay, or clay with high swelling potential). Fines rich with organic material are especially prevalent within the bottom of disconnected oxbows.

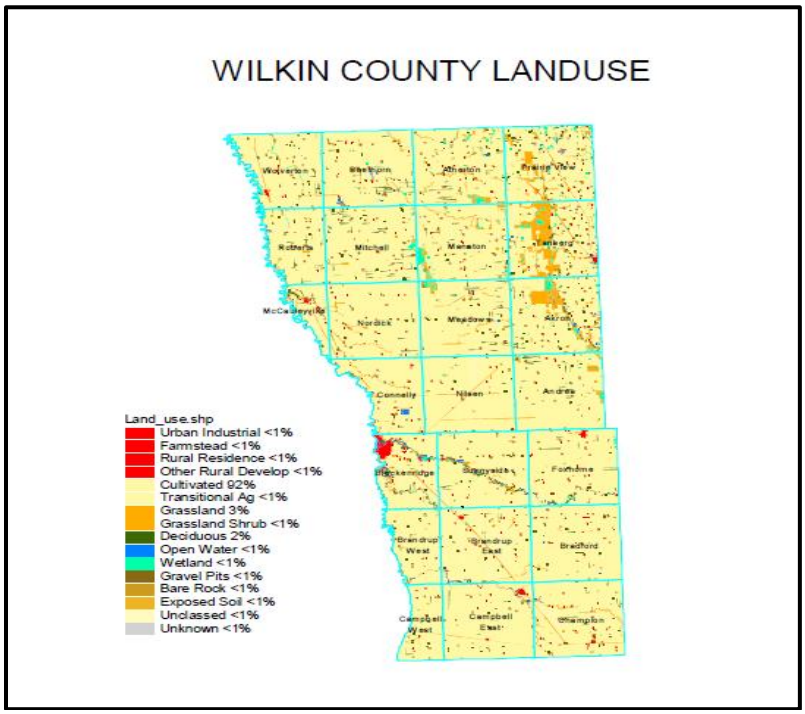

Figure 25. Land Use Map of Wilkin County, Minnesota

For the Otter Tail River, 151 potential bank gully erosion locations were identified between Breckenridge and Orwell Dam along the river. There are plans to address this problem with sediment BMP grade control structures, which is expected to eliminate more than 1,500 tons per year of gully erosion and sediment load (Houston 2019).

Impacts of the No-Action Alternative:
The No-Action is not anticipated to affect geology. Some soils may be affected with additional bank gully erosion between Breckenridge and Orwell Dam. This effect would be pronounced with the headcut migration and river incision. Some of these effects may be attenuated with implementation of the Otter Tail River TMDL.

Impacts of Alternative C:
Alternative C is not anticipated to have any general effects on geology, but would have effects on soil substrate within the affected sub-reaches. There would be temporary impacts to soils during construction, the most significant likely due to floodplain excavation. However, topsoil would be added to promote vegetation establishment. Some areas that receive excavated material from restored oxbows would be rich in organic matter. Over the long term, soil conditions would improve with increased lateral connectivity to the river which provides leaf litter, wood, sediment, and nutrients to the soil.

Impacts of Alternative K:
Alternative K would have similar effects as Alternative C, but throughout all FG sub-reaches for the reasons listed above.

7.2.2 Contaminants and River Substrate

No known potential environmental hazards are located in the project area. The substrate of the LOTR is dominated by sand and mud (Hanson et al. 1984).

Impacts of the No-Action Alternative:
The No-Action is not anticipated to have any effect on contaminants. River substrates would continue to be affected as the river incises in the upper reach and aggrades in the downstream reach.

Impacts of Alternative C:
Alternative C would not have any effect on contaminants as none are known with the affected sub-reaches. River substrates may be affected with measures that elevate the channel bottom.

Impacts of Alternative K:
Alternative H would not have any effect on contaminants as none are known with all FG sub-reaches. Like Alternative C, river substrates may be affected with measures elevating the channel bottom throughout all FG sub-reaches.

7.2.3 Hydrologic and Hydraulic

Results of hydrologic modeling of with- and without-project conditions for Alternative K is provided in Appendix A. Due to straightening of the channel, the Otter Tail River experiences high stream velocities which has led to the stream bed to degradation for most of the upstream section, and aggradation at the most downstream section of the project.

Impacts of the No-Action Alternative:
The No-Action is not anticipated to have any effect on hydrology. However, there will be adverse effects on hydraulic conditions. The upstream portion of the river will become further disconnected from the floodplain as the river continues to incise, and the headcut migrates further upstream. More flows will be contained within the channel, with infrequent overtopping, and thus increasing velocities. At the downstream portion of the river, the channel bed will collect more sediment and cause increased flooding.

Impacts of Alternative C:
Alternative C is not anticipated to have any effect on hydrology. However, there will be beneficial effects on hydraulic conditions from an environmental perspective. The river will have better connectivity to the floodplain in upstream areas where overtopping events will be more common in the subreaches that are restored. In general, the increased sinuosity will result in less slope, resulting in lower water velocities. However, there would be an increase in turbulent flow and higher velocity conditions across constructed riffles that create localized hydraulic diversity. The river headcut will also be restricted and not allowed to move further upstream due to the river grade control structure.

Impacts of Alternative K (All FGs):
Alternative K is not anticipated to have any effect on hydrology. However, hydraulic conditions will improve for ecosystem benefits as described for the TSP, throughout all subreaches that have been restored. The same can be said for subreaches of a particular FG.

7.2.4 Water Quality

In 1980, the river was classified by the MPCA as an 1C, 2B, 3B intrastate stream, indicating suitability for the propagation of cool and warmwater fish, aquatic recreation of all kinds, and use for public water supply with treatment (Hanson et al. circa 1980). However, fecal coliform counts and turbidity levels sometimes exceeded the standards of 200 organisms/100 ml and 25 FTUs, respectively. As a part of baseline fish and wildlife surveys (Hanson et al. circa 1980), water quality downstream of Fergus Falls was believed to be affected by agriculture, streambank erosion, municipal sewage, wastes from Canada geese, and power plants that used water for cooling. These factors affected turbidity and algal densities.

Section 303(d) of the Clean Water Act requires that states develop Total Maximum Daily Loads (TMDLs) for surface waters that do not meet and maintain applicable water quality standards. The MPCA publishes a list available online known as the 303(d) TMDL list, which is updated every two years. From its confluence with the Bois de Soix River to the outlet of Judicial Ditch No. 2, the LOTR is listed as an impaired water body for turbidity by the MPCA. Monitoring data show that the LOTR doesn't meet the state standard of 25 NTUs for turbidity. In 2006, the Minnesota Pollution Control Agency (MPCA), in conjunction with the Wilkin County Soil and Water Conservation District and Wilkin County, conducted a Total Maximum Daily Loads (TMDLs) study on the LOTR. The MPCA listed the LOTR reach as impaired for exceeding the turbidity standards for aquatic life (the only reach of the river listed as impaired for turbidity), which was approved by the U.S. Environmental Protection Agency (EPA) in 2007 (Wilkin Soil and Water Conservation District and MPCA 2007). The primary cause of turbidity in the LOTR is suspended sediment which impacts the growth and development of fisheries, increases stream channel width/depth ratios, and causes bank erosion and failure. The U.S. Geological Survey (USGS) confirmed these turbidity impairments and estimated that the annual sediment load was 40,400 tons at the sampling site in Breckenridge, Minnesota. It has been estimated that 60 to 70% of this is from the erosion of the banks of the river (Houston 2019). The TMDL report identifies a 17% load reduction goal in order to reach compliance with the state standard of sediment and lists best management practices for future implementation to achieve this goal.

Impacts of the No-Action Alternative:

The No-Action is anticipated to continue having adverse effects on water quality. As the headcut continues to migrate upstream and streambank erosion continues, sediment load and turbidity levels in the river will continue to increase.

Impacts of Alternative C:
Alternative C will have temporary adverse effects and long-term beneficial effects on water quality within the affected sub-reaches and areas downstream. During construction, disturbance to the river and riparian areas will result in increased turbidity. The proposed action would result in minor, short-term decreases in water quality because of localized increases in suspended sediments due to runoff from the construction area. A short-term risk for a fuel spill during construction activities would exist. The contractor would be required to have a spill prevention and clean-up plans and utilize Best Management Practices (BMPs) during construction. The effects would be minimized by the BMPs. Over the long term, turbidity levels will improve with bank stabilization, increased riparian vegetation, and increased lateral connectivity. Terrestrial vegetation would provide increased filtering of surface runoff which would reduce nitrogen, phosphorus, and sediment loading to the river. Increased shading of the stream channel with the re-meandering of the river and the establishment of riparian vegetation would be expected to result in reduced stream temperatures. Increases in turbulent flow across constructed riffles would increase mixing and provide for oxygenation of water in the river. Reduction in erosion will also be facilitated with the headcut structure in place, and also from reconnecting the oxbows due to lower channel velocities.

Impacts of Alternative K:
Alternative K will have the same effects to water quality as Alternative C, but at a larger magnitude and scale.

7.2.5 Air Quality

The U.S. Environmental Protection Agency is required by the Clean Air Act to establish air quality standards that primarily protect human health. These National Ambient Air Quality Standards (NAAQS) regulate six major air contaminants across the U.S. When an area meets criteria for each of the six contaminants, it is called an “attainment area” for the contaminant; those areas that do not meet the criteria are called “nonattainment areas”. Wilkin County is classified as an attainment area for each of the six contaminants and is therefore not a region of impaired ambient air quality. This designation means that the project area has relatively few air pollution sources of concern.

Carbon dioxide (CO2) is the primary greenhouse gas emitted from human activities, chiefly through combustion of fossil fuels. Greenhouse gases absorb reflected energy from the sun and warm Earth’s atmosphere. Increases in greenhouse gases have resulted in measurable warming of the Earth’s surfaces and ultimately changes to some ecosystems. Wetlands are able to reduce the amount of CO2 in the atmosphere by sequestering the gas during photosynthesis and returning oxygen to the atmosphere as a byproduct.

Impacts of the No-Action Alternative:

The No-Action alternative would have negligible effects to air quality or greenhouse gases. Continued habitat degradation will lessen the area’s carbon sequestration capacity.

Impacts of Alternative C:
Minor, temporary increases in airborne particulates are anticipated within the affected sub-reaches as a result of mobilization and use of construction equipment. Construction equipment would likely include but would not be limited to bulldozers, excavators, and dump trucks. The amount of particulates is anticipated to be of the magnitude of normal construction activities and is not expected to be excessive. Dust will be no more than the magnitude generated by adjacent agricultural production activities. Frequent inspections of construction equipment will be made during construction to ensure they are properly functioning and do not release unnecessary amounts of emissions. Project implementation is far enough away from the general public that this minor impact will be negligible. The improvement of the riparian vegetation growth in the FG 2, 3, and 8 sub-reaches could help to sequester carbon in new plant growth.

Impacts of Alternative K:
Alternative K is anticipated to have similar types of effects as Alternative C, but across all FG sub-reaches. Adverse effects would be slightly greater but still below levels that would be problematic. Potential for carbon sequestering would be slightly greater.

7.2.6 Aquatic Habitat

Aquatic habitat in the LOTR is riverine, with well-defined banks. Substrate in the upper end of this reach consists mostly of rubble and gravel, with some boulder areas. Further downstream, the substrate transitions to mostly sand and fines with some gravel (Hanson et al. 1984). The lower portion of the river within the project area is largely channelized, lacking microhabitats associated with sinuous patterns that promote scour and pool formation.

While aquatic vegetation has been surveyed in upstream Otter Tail River (Hanson et al. 1984), it is scarce in the study area due, in part, to high turbidities. River pondweed was the dominant species.

Impacts of the No-Action Alternative:

The No-Action is anticipated to result in the continued degradation of aquatic habitat as the river continues to incise and the headcut migrates upstream.

Impacts of Alternative C:
Alternative C would restore the river's plan form, profile and dimension, resulting in substantial improvements to the quality and quantity of aquatic habitat within the affected sub-reaches. Migration of the headcut would stop, thus protecting the river's upstream geomorphology. Establishment of a meandering channel with alternating riffle/pool/run habitat in the FG 2 and 3 sub-reaches would increase aquatic habitat complexity and diversity. Construction of meanders would increase stream length by approximately 8,000 linear feet and area by about 14 acres. Improved substrate conditions would be anticipated with the addition of large rock/cobble to establish riffles and initially stabilize channel meanders. The rock/cobble used would provide substrate suitable for colonization by aquatic invertebrates and cover for fish species. Increased bathymetric and hydraulic diversity would result in increased habitat diversity and interspersion. Also, the presence of a slightly higher velocity area across the riffles should enhance the overall

suitability of the river. Construction of project features would result in temporary adverse effects to aquatic habitat. Construction BMPs would minimize adverse effects.

Impacts of Alternative K:
Alternative K is anticipated to have similar types of beneficial effects as Alternative C, but across all FG sub-reaches. The benefits will extend throughout the entire restoration area, adding about 50 acres and about 42,000 linear feet of stream habitat.

7.2.7 Wetland Habitat

The USFWS National Wetlands Inventory (NWI) was used to identify wetlands for this study. Starting in the 1970s, the USFWS produced maps of wetlands (NWIs) based on aerial photographs and Natural Resources Conservation soil survey maps. Because land use has changed since the 1970s, wetlands shown on the NWI maps are sometimes inconsistent with current wetland conditions; however, NWIs are the most accurate and readily available database of wetland resources within the proposed project area.

Impacts of the No-Action Alternative:
The No-Action is anticipated to adversely affect wetland habitat over the long term. As the river becomes more incised, the disconnect between the river and wetlands increases. Wetlands would be subject to drier conditions more frequently. Wetland plants would likely degrade with infrequent flushing events and lack of organic inputs.

Impacts of Alternative C:
Alternative C would have mixed effects on wetlands within affected sub-reaches. Long-term adverse effects are anticipated as wetlands in the form of disconnect oxbows are converted to stream habitat. Approximately 8 acres of wetlands (i.e., disconnected oxbows) would be affected. Temporary adverse effects are also anticipated during construction activities such as excavation and poor water quality. However, this alternative would result in long-term beneficial effects on remaining wetlands. Elevating the river's profile would have a commensurate effect on the water table and increase lateral connectivity with the river during high flow events. The quality of wetland habitat would improve from this enhanced connectivity.

Impacts of Alternative K (All FGs):
Alternative K is anticipated to have similar types of effects as Alternative C, but at a larger scale. Approximately 19 acres of wetlands would be converted into river. However, there would be broader benefits from returning water levels to more natural levels, and improving lateral connectivity between river water and the floodplain.

7.2.8 Terrestrial Habitat

For vegetation cover, cropland predominates in the non-forested areas adjacent to the river. The main crops are spring wheat, soybeans, sugar beets, corn, barley and sunflowers. Areas of deciduous trees, shrubs, and grasslands are located along the riparian corridor of the study area. Fragments of the prairie grasses continue to grow on the river banks. Most of the agriculture along the river is in the fertile soils of the gently sloping prairie region.

Historically, hardwood forest species succeeded conifers in cut-over areas, including quaking

aspen (*Populus tremuloides*), white birch (*Betula papyrifera*), sugar maple (*Acer saccharum*), basswood (*Tilia* spp.), and red oak (*Quercus rubra*). White pine (Pinus strobus), jack pine (*Pinus banksiana*), and black spruce (*Picea mariana*) are the most common conifer species. Box elder (*Acer negundo*), willow (*Salix* spp.), and American elm (*Ulmus americana*) occasionally are found in small tracts next to the river. Other trees that occur are bur oak (*Quercus macrocarpa*), white birch (*Betula papyrifera*), and rock elm (*Ulmus thomasii*) (Hanson et al. 1984).

Common grasses associated with the tall grass prairie biome include big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), Indiangrass (*sorghastrum nutans*), and little bluestem (*Shizachyrium scoparium*). Other woody plants include annual sunflower (Helianthus annuus), leadplant (Amorpha caescens), scurfpea (Psoralea spp.), purple coneflower (*Echinacea atrorubens*), milk vetch (*Astragalus* spp.) fringed sagewort (*Artemisia frigida*), prickly pear (*Opuntia* spp.), and heath aster (*Aster ericoides*).

Wildlife that inhabit the LOTR are associated with the tall grass prairie biome such as white tailed deer, red fox, pheasants, and jack rabbit. Amphibians and reptiles include western painted turtle, red-bellied snake, eastern tiger salamander, and northern leopard frog.

Impacts of the No-Action Alternative:
The No-Action is anticipated to adversely affect terrestrial habitat and wildlife. As the river becomes more incised, the lateral disconnect with the floodplain forest will increase. The lowering of the water table may adversely terrestrial vegetation, especially shrubs and trees which are valuable to many mammal and bird species.

Impacts of Alternative C:
Alternative C will have localized long-term beneficial effects on terrestrial habitat and wildlife within the affected sub-reaches. Terrestrial vegetation in the footprint of terrestrial features would be destroyed during construction. However, vegetation would be re-established through topsoil, seeding and plantings, likely in the form of grasses, willows, and other flood tolerant species.

Terrestrial riparian vegetation in restored oxbows would benefit from the increased lateral connectivity to the river. With more frequent overtopping events, the water would also bring sediments and nutrients, thus benefiting the plant community. The restored water table elevation would also benefit vegetation, especially during periods of low precipitation.

Additional land adjacent to segments of the restored river would be given additional protections under Minnesota's land buffer rule which requires a perennial vegetative buffer of up to 50 feet along the shorelines.

Impacts of Alternative K:
Alternative K is anticipated to have similar types of beneficial effects as Alternative C, but at a larger scale that would also provide a migration corridor along the river.

7.2.9 Fish

The Otter Tail River and associated tributaries provide habitat to many fish species. Many of the smaller tributaries in the watershed provide spawning and rearing habitat for important Red

River of the North species.

Baseline fish surveys across the Otter Tail River were completed by the MNDNR in 1979 to 1980 (Hanson et al. 1984). Fish sampled across 24 miles of the river comprised 49 fish species representing 11 families (Appendix D). Species found in the LOTR included northern pike (*Esox lucius*), common carp (*Cyprinus carpio*), quillback sucker (*Capiodes cyprinus*), white sucker (*Catastomus commersoni*), bigmouth buffalo (*Ictiobus cyprinellus*), silver redhorse (Moxostoma anisurum), golden redhorse (Moxostoma erythrurum), shorthead redhorse (*Moxostoma macrolepidotum),* greater redhorse (*Moxostoma valenciennesi*), black bullhead (*Ictalurus melas*), rock bass (*Ambloplites rupestris*), yellow perch (*Perca flavescens*), and walleye (*Stizostedion vitreum vitreum*). Walleye were indicated as the most common game species in this reach. However, carp and catastomidae fishes (e.g., suckers) were found to be dominant.

Lake sturgeon (*Acipenser fulvescens*), a state-listed Species of Special Concern, is of particular interest to the MNDNR as a part of reintroduction efforts into the Red River of the North that began around 25 years ago. Once very common, overfishing, pollution, habitat loss, and fragmentation nearly extirpated the species from Minnesota. Lake sturgeon are highly migratory, and are hoped to expand their range in the Red River watershed over the long term. Such efforts include restoration of fish passage through many existing dams.

Impacts of the No-Action Alternative:
The No-Action may indirectly affect sensitive fish through the continued degradation of aquatic habitat over time. Species tolerant of degraded conditions would be favored over those that require habitat diversity.

Impacts of Alternative C:
The proposed TSP would increase the quantity and quality of riverine habitat in the LOTR within the affected sub-reaches over the long-term. Aquatic habitat would benefit from improved thermal and cover conditions resulting from restoration of riparian vegetation along the river and the construction of a meandered stream, which is captured in the HEP analysis. The resulting improvements would benefit the associated fish populations. Species like northern pike, walleye, smallmouth bass, and lake sturgeon would benefit from increased depth and substrate diversity. For example, lake sturgeon are benthic feeders preferring substrates of sand, gravel, and detritus. Spawning habitat consists of clear water and gravel or cobble substrates free of silt. Riverine adults seek out deeper refuge pools during the winter.

There would be localized short-term adverse effects on fish due to the effects of construction on water quality (e.g., increased turbidity), noise, and water levels (e.g., dewatering behind coffer dams). Dewatering activities, if needed, could result in fish become stranded. Fish would avoid construction areas but would return on completion.

Impacts of Alternative K (All FGs):
Alternative K is anticipated to have similar types of effects as Alternative C, but across all FG sub-reaches.

7.2.10 Wildlife

Baseline wildlife surveys in the Otter Tail River were completed by the MNDNR in 1978 – 1980 (Hanson et al. 1984; Kuitunen et al. 1997). Common wildlife found within the regional area includes large and small mammals, songbirds, waterfowl, raptors, fish, mussels, and insects. Wildlife throughout the study area consists of both resident and migratory species, which use the area habitat for forage, shelter, breeding, or as a stopover during migration. A total of 101 species of breeding birds have been reported from the area. Species include those found in agricultural landscapes, prairie remnants, pasture, grasslands, wetland, and riverine habitats. Common mammals for these habitats include raccoon (*Procyon lotor*), skunk (*Mephitis* spp.), white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), badger (*Taxidea taxus*), porcupine (*Erethizon dorsatum*), and rabbit (*Sylvilagus* spp.). Commonly found mammals include the arctic shrew (*Sorex arcticus*), masked shrew (*Sorex cinereus*), Hayden's shrew (*Sorex haydeni*), pygmy shrew (*Sorex hoyi*), northern short-tailed shrew (*Blarina brevicauda*), eastern chipmunk (*Tamias striatus*), thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), red squirrel (*Tamiasciurus hudsonicus*), white-footed mouse (*Peromyscus leucopus*), prairie deer mouse (*Peromyscus maniculatus bairdii*), southern red-backed vole (*Clethrionomys gapperi*), meadow vole (*Microtus pennsylvanicus*), and meadow jumping mouse (*Zapus hudsonius*). Common birds include songbirds, hawks such as red-tailed hawk (*Buteo jamaicensis*) and the broad-winged hawk (*Buteo platypterus*), waterfowl, and game birds such as ruffed grouse (*Bonasa umbellus*). Amphibians and reptiles include western painted turtle (*Chrysemys picta*), red-bellied snake (*Storeria occipitomaculata*), eastern tiger salamander (*Ambystoma tigrinum tigrinum*), and northern leopard frog (*Lithobates pipiens*).

Impacts of the No-Action Alternative:
The No-Action alternative would result in long-term degradation of terrestrial and semi-aquatic habitat that would negatively affect local wildlife populations.

Impacts of Alternative C:
Alternative C would benefit conditions for waterfowl, shorebirds, aquatic mammals, and a host of songbird, mammal, amphibian, and reptile species in the affected sub-reaches. The increased vegetative diversity and interspersion within the LOTR corridor would enhance the area's suitability for many wildlife species and would provide a travel corridor between riparian and wetland habitats. During construction, wildlife populations would experience disturbance associated with noise and ground clearing activities. These impacts would be temporary and minor.

Impacts of Alternative K (All FGs):
Alternative K is anticipated to have similar types of effects as the TSP, but across all FG sub-reaches.

7.2.11 Aquatic Macroinvertebrates

During river surveys completed below Orwell Reservoir in 1978, 11 mussel species found: Wabash pigtoe (*Fusconaia flava*), three ridge (*Amblema plicata*), spike (*Elliptio dilatatus*), mucket (*Actinonaias carinata*), black sand shell (*Ligumia recta*), fat mucket (*Lampsilis radiate siliquoidea*), pocketbook (*Lampsilis ventriocosa*), white heel splitter (*Lasmigona complanata*),

fluted shell (*Lasmigona costata*), floater (*Anodonta gradis*), and strange floater (*Strophitus undulatus*) (Hanson et al. 1984).

In 2004, surveys were completed by MNDNR in eight sites throughout the project area via snorkeling or wading (pollywogging). A total of 756 mussels were collected representing 12 species: threeridge (*Amblema plicata*), Wabash pigtoe (*Fusconaia flava*), plain pocketbook (*Lampsilis cardium*), fatmucket (*Lampsilis siliquoidea*), white heelsplitter (*Lasmigona complanata*), creek heelsplitter (*Lasmigona compressa*), flutedshell (*Lasmigona costata*), black sandshell (*Ligumia recta*), pink heelsplitter (*Potamilus alatus*), giant floater (*Pyganodon grandis*), mapleleaf (*Quadrula quadrula*), and strange floater (*Strophitus undulatus*).

From 2009 to 2018, mussel surveys were conducted in two sites of the Lower Otter Tail River (upstream of the proposed project area) as part of the Minnesota State Wildlife Action Plan (MNDNR 2018). Ten live species were encountered that included three ridge (*A. plicata*), Wabash pigtoe (*F. flava*), fluted shell (*L. costata*), fat mucket (*L. siliquiodea*), strange floater (*S. undulatus*), giant floater (*P. grandis*), white heel splitter (*L. complanata*), plain pocketbook (*L. cardium*), black sandshell (*L. recta*), paper pondshell (*Utterbackia imbecillis*).

In 2020, a mussel relocation effort associated with a bridge repair was completed just below Orwell Dam, within a 1,500m^2 area (Ostby and Beaty 2020). In total, 175 live mussels were relocated and a total of 11 species were detected, with eight represented by live species. Live species included threeridge, pink heelsplitter (*Potamilus alatus*), fat mucket, fluted shell, mapleleaf (*Quadrula quadrula*), plain pocketbook (*Lampsilis cardium*), black sandshell, and white heel splitter. Remnants of additional species (i.e., deadshell) were observed for Wabash pigtoe (*Fusconaia flava*), giant floater (*Pyganodon grandis*), and creeper (*Strophitus undulatus*). Investigators also observed very high densities of live zebra mussels (*Dreissena polymorpha*).

Other than mussels, benthic macroinvertebrates were sampled in the project area in 1978 and 1979 included 34 taxa that were dominated by Diptera, Trichoptera, Ephemeroptera, and Cleoptera groups (Hanson et al. 1984).

Additional details are provided in Appendix D.

Impacts of the No-Action Alternative:
The No-Action would have negligible effects on aquatic macroinvertebrates. Continued sedimentation will adversely affect interstitial spaces upon which macroinvertebrates colonize. Aquatic insects, mussels, and other macroinvertebrate populations would potentially decline as habitat deteriorates further.

Impacts of Alternative C:
Alternative C is anticipated to have short-term adverse effects on macroinvertebrates, but long-term beneficial effects across the affected area. Structures that require dewatering or fill in the river, such as overflow structures, will destroy any benthic macroinvertebrates within the footprint of such features, including mussels. Excavation within the restored oxbows will destroy macroinvertebrate populations that are found there. However, over the long-term, mussel communities and other riverine macroinvertebrates will benefit from the increase in river acreage and improved quality of aquatic habitat. These benefits far outweigh temporary, adverse effects that could occur during construction.

Impacts of Alternative K:
Alternative K is anticipated to have similar types of effects as Alternative C, but across all sub-reaches.

7.2.12 Sensitive Species

7.2.12.1 Federally-Listed Species

Section 7 of the Endangered Species Act generally requires Federal agencies to ensure that any action authorized, funded or carried out by the agencies are not likely to 'jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species (16 USC§ 1536(a)(2)(1988)).

A search on the USFWS' Information for Planning and Consultation (IPAC) website indicated that only one species was found in the project area: northern long-eared bat (NLEB; *Myotis septentrionalis*; Appendix D). This is a federally-threatened species found across much of the eastern and north central United States and all Canadian provinces from the Atlantic coast west to the southern Northwest Territories and eastern British Columbia. White-nose syndrome, a fungal disease known to affect bats, is currently the predominant threat to this bat. During the summer, northern long-eared bats roost singly or in colonies underneath bark, in cavities or in crevices of both live trees and snags (dead trees). The bat spends winter hibernating in caves and mines, called hibernacula. They use areas in various sized caves or mines with constant temperatures, high humidity, and no air currents. However, no known hibernacula or cave sites are found in the project area.

7.2.12.2 State-Listed Species

A search of the Minnesota Natural Heritage database indicated that seven state-listed species may occur in Otter Tail County with Threatened or Special Concern designations (**Table 24**).

Table 24. State-listed Species with Potential to Occupy the Project Area

Common Name	Scientific Name	Group	State Listed Status
Fluted-Shell	*Lasmigona costata*	Macroinvertebrate	Threatened
Black Sandshell	*Ligumia recta*	Macroinvertebrate	Special Concern
Creek Heelsplitter	*L. compressa*	Macroinvertebrate	Special Concern
Spike	*Elliptio dilatatus*	Macroinvertebrate	Threatened
Mucket	*Actinonaias carinata*	Macroinvertebrate	Threatened
Lake sturgeon	*Acipenser rubicundus*	Fish	Special Concern
Short-eared owl	*Asio flammeus*	Bird	Special Concern

Impacts of the No-Action Alternative:
The No Action alternative would have no effect on the NLEB.

State listed mussels would be affected for reasons listed in Section 8.2.11

Impacts of Alternative C:
The proposed action would have no adverse impacts on NLEB. At this point, tree removal is anticipated to take place during winter months, thus having no potential impacts to NLEB. Over the long-term, the improved riparian conditions would be expected to result in beneficial effects to NLEB habitat.

State listed mussels would be affected, both positively and adversely, for reasons listed in Section 8.2.11.

Impacts of Alternative K (All FGs):
Alternative K is anticipated to have similar types of effects as Alternative C, but at a larger scale. No effect would be expected to NLEB due to anticipated tree clearing.

7.2.13 Invasive Species

Orwell and Breckenridge Reservoirs, which bracket the project area, are identified as waters infested with zebra mussels (*Dreissena polymorpha*). Common carp is another common aquatic invasive species in the study area. The most prominent invasive plant species found in Otter Tail County include various thistle species (e.g., Canada thistle, *Cirsium arvense*), spotted knapweed (*Centaurea stoebe spp.*), musk purple loosestrife (Lythrum salicaria), common buckthorn (*Rhamnus cathartica*), reed canarygrass (*Phalaris arundinacea*), dandelion (*Taraxacum officinale*), Russian knapweed (*Rhaponticum repens*), and wild parsnip (*Pastinaca sativa*).

Impacts of the No-Action Alternative:
The No Action alternative would result in habitat degradation over time that would favor colonization and spread by invasive species.

Impacts of Alternative C:
Alternative C would have long-term benefits to native species in the restored sub-reaches over that of invasives which tend to spread and colonize in disturbed areas. Construction BMPs would be in place that minimize risk of spreading invasives.

Impacts of Alternative K:
Alternative K is anticipated to have similar types of effects as Alternative C, but at a larger scale.

7.3 Historic and Cultural Resources

Section 106 of the National Historic Preservation Act (NHPA) and its implementing regulation 36 CFR Part 800 Protection of Historic Properties requires that the impacts of federal projects on cultural resources be given consideration during project planning. Cultural resources include historic landscapes and properties, archaeological and architectural sites, sacred sites, and archaeological collections or other objects created by humans. These resources may be listed, or eligible for listing, in the National Register of Historic Places (NRHP). Traditional cultural

properties are resources that hold traditional, cultural, or religious significance to indigenous communities and may or may not be eligible for the NRHP. To be eligible for inclusion in the NRHP, a historic property is defined as typically being 50 years old and retaining its integrity of location, design, setting, materials, workmanship, feeling, and association, while meeting at least one of the following NRHP criteria (National Park Service [NPS]1995:3):

> Under Criterion A, a site would be considered eligible for NRHP nomination if it can be associated with an event that is significant to history.
>
> Under Criterion B, a site would be considered eligible if it can be associated with the lives of persons significant in our past.
>
> Under Criterion C, a site would be considered eligible if it:
>
> a. Embodies a distinctive characteristic of a type, period, or method of construction,
> b. Represents the work of a master,
> c. Possesses high artistic value,
> d. Represents a significant and distinguishable entity whose components may lack individual distinction.
>
> Under Criterion D, if a site has yielded, or is likely to yield, information important to our prehistory or history it could be eligible.

Consultation, (36 CFR Part 800.2) is the means through which agencies involve the State Historic Preservation Offices (SHPO), Tribal Historic Preservation Offices (THPO), representatives of local governments, applicants for Federal assistance, permits, licenses and other approvals, and additional interested parties including the public, affording them the opportunity to review and comment on federal undertakings. Formal consultation under the Section 106 process was initiated with Minnesota SHPO and with the THPOs of the Sisseton-Wahpeton Oyate of Lake Traverse, the Upper Sioux Community of Minnesota, the Lower Sioux Indian Community, and the Spirit Lake Tribe via correspondence dated February 10, 2020. The Advisory Council on Historic Preservation (ACHP) has also been invited to participate and declined. Consultation did not yet extend to include landholders or other community and municipality members.

Given both the complexity and potential constraints associated with the Corps' timeline for completion of the project, correspondence with SHPO and THPOs was focused on development of a Programmatic Agreement (PA) pursuant to 36 CFR 800.14(b)(1)(ii). Correspondence with MNSHPO provided insufficient resolution of a satisfactory area of potential effect (APE) to complete the development of an agreement document. Timing with respect to the development of the Tentatively Selected Plan (TSP) precluded an earlier opportunity to satisfactorily establish an APE, and a PA has yet to be executed for feature groups that may be selected for project implementation. A draft PA is in circulation for review and comment and will be executed prior to signing the FONSI. See Section 1.8.4 for additional discussion on existing historic and cultural resources.

Impacts of the No-Action Alternative:

Under the no-action alternative, lands would continue as private property where cultural resources surveys are not required. Continued erosion from flooding would adversely impact shoreline sites at cutbanks and may disturb near-surface features. The absence of cultural

resources survey data and site inventories precludes speculation as to the possible numbers of sites at risk.

Impacts of Alternative C (TSP):

Construction of access roads and construction staging areas along with other, as yet undetermined ground disturbance activities have the potential to adversely affect buried cultural deposits, areas of tree planting, floodplain excavation areas, and deepened excavation of previously filled meanders. The process used during the earlier project, of straightening the river, employed channel material to plug meanders, closing them off. The current project proposes to place water control and bankline stabilization structures in previously uninvestigated areas, as well as in previously disturbed locations. Grading and changes associated with the angle of repose, necessitated by the implementation of the project for placement of bank stabilization structures, would adversely affect any cultural resources that may be present.

Impacts of Alternative K (All FGs):

Construction of access roads and construction staging areas along with other, as yet undetermined ground disturbance activities have the potential to adversely affect buried cultural deposits, areas of tree planting, floodplain excavation areas, and deepened excavation of previously filled meanders. The process used during the earlier project, of straightening the river, employed channel material to plug meanders, closing them off. The current project proposes to place water control and bankline stabilization structures in previously uninvestigated areas, as well as in previously disturbed locations. Grading and changes associated with the angle of repose, necessitated by the implementation of the project for placement of bank stabilization structures, would adversely affect any cultural resources that may be present.

7.4 Socioeconomic

7.4.1 Noise

The project area is sparsely populated rural area. Any major noise levels are commonly generated by adjacent agricultural production activities.

Impacts of the No-Action Alternative:
The No-Action is not anticipated to have any effect on noise levels.

Impacts of Alternative C:
Alternative C is anticipated to temporarily affect noise levels within the affected reaches. Noise will be generated by the operation of large equipment. Noise will be no more than the magnitude generated by adjacent agricultural production activities. Construction equipment would likely include but would not be limited to bulldozers, excavators, and dump trucks. Of these, bulldozers are typically the loudest, ranging from 100 – 120 decibels. The closest high-density human use areas would be residents in the City of Breckenridge, MN, which is roughly 2 miles from the closest location to the Alternative C footprint. The Project area distance to receptor areas should be sufficient to displace much of the sound associated with construction activities. However, residents in close proximity to the construction activities will be subject to noise disturbance.

This will be from construction of project features and from trucks hauling material to/from the construction sites. Construction activities would be limited to daytime hours and construction would not be held during typical municipal quiet hours. Increased sound levels associated with construction of Alternative C could temporarily displace some wildlife and decrease recreational use. Noise levels throughout the Project area would return to the normal condition once construction activities cease.

Impacts of Alternative K:
Alternative K is anticipated to have similar types as Alternative C, but at a larger scale.

7.4.2 Aesthetics

Impacts of the No-Action Alternative:
The No-Action will have negligible effects on the aesthetic value of the project area. As the river continues to degrade, the aesthetic value of the area will decrease.

Impacts of Alternative C:
Alternative C will improve the aesthetic value within the affected sub-reaches over the long term as the ecosystem is restored. However, there will be short-term adverse effects associated with construction activities that disturb existing land cover.

Impacts of Alternative K:
Alternative K is anticipated to have similar types as Alternative C, but across all affected sub-reaches.

7.4.3 Recreation

Much of the recreation in the Otter Tail River watershed revolves around rivers and streams. Recreational activities include fishing, hunting, trapping, camping, canoeing, picnicking, bird watching, hiking and tubing. In proximity to the project area are the Tamarack National Wildlife Area, Hubbel Pond Wildlife Management Area, Orwell Wildlife Management Area, Phelps Mill County Park, and Broken Down Dam Park. There are also two state parks (Maplewood and Glendalough), a state Scientific and Natural Area (Otter Tail Prairie SNA), a recreation area at Orwell Reservoir, and numerous other state and federal lands that are open to public hunting and fishing. Within the project area, recreation opportunities are more limited, with emphasis on fishing, hunting, wildlife viewing and canoeing.

Impacts of the No-Action Alternative:
The No-Action is not anticipated to have any effect on recreation other than river-related recreation may diminish as habitat degrades. Activities such as fishing, bird watching, and hunting would be affected. This decline would lead to less human activity and interest throughout the Project area resulting in an overall minor adverse effect to recreation under the No-Action Alternative.

Impacts of Alternative C:
Alternative C is anticipated to have short-term adverse effects on river-related recreation as construction requires. However, long-term beneficial effects are anticipated as habitat improves with the affected sub-reaches. . This would, in turn, increase outdoor recreational opportunities including bird watching, hunting, fishing and other recreational water activities, resulting in a minor long-term benefit to recreation under the TSP when compared to the No-Action Alternative. Recreation activities could still be completed near construction activities where not a safety hazard. Opportunistic recreation features could be added as a part of the project, or may be a consideration during the plans and specifications phase. For example, enhanced access to the river or project features. In this case, recreation would be improved.

Impacts of Alternative K (All FGs):
Alternative K is anticipated to have similar types as Alternative C, but at a larger scale.

7.4.4 Hazardous, Toxic, Radioactive Waste

No known potential environmental hazards (Hazardous, Toxic, Radioactive Wastes or HTRW) are located in the project area. Additional details on HTRW conditions are provided in Appendix F.

Impacts of the No-Action Alternative:
The No-Action is not anticipated to have any effect on HTRW.

Impacts of Alternative C:
Alternative C is not anticipated to have any effect on HTRW. Safe handling, storage, and disposal of hazardous materials will be a requirement of any construction contract awarded for this project. The project is largely a channel restoration and is not expected to generate any hazardous materials.

Impacts of Alternative K:
Alternative K is not anticipated to have any effect on HTRW for the same reasons provided for Alternative C.

7.4.5 Flooding

The Climate Assessment for the project can be found in Appendix K, and Alternative K HEC-RAS model results in Appendix A. Flooding currently happens along the Lower Otter Tail River at varying elevations. Flooding at the downstream end occurs more routinely than it did when the original project was complete in 1950's due to the sedimentation build up in the channel and the increased intensity and recurrence intervals of the basin hydrology. The upstream section of the river floods less often than the 1950's due to the headcutting of the channel bed, even with the increase in flood intensity and recurrence intervals in the basin.

Impacts of the No-Action Alternative:
The No-Action is not anticipated to have negligible effects on the basin hydrology but will have

an effect on flow conveyance. On the upstream end of the project area, the river will continue to degrade, with headcutting allowing for more conveyance and less flooding. On the downstream end, sedimentation will continue causing flooding to occur more often.

Impacts of Alternative C:
Alternative C will not affect the basin hydrology. The hydraulics in the area of the FG 2 and FG 3 sub-reaches, based on assumptions from the Alternative K HEC-RAS modeling, will slightly increase due to the cutoff weir elevations, but will largely be flooding low-lying wooded areas and crop land. At the 100-year (1% AEP) event, the with-project stages are still slightly higher than the without-project conditions. Stabilization of the upstream channel bed with the river grade control structure will likely cause flooding to remain at the current rate with a more stable channel bed.

Impacts of Alternative K:
Alternative K is anticipated to have minor increased flooding in the downstream stretch of river (FG 1 – FG 5). At lower flows, the HEC-RAS model results show the flooding largely contained within the channel or in low laying wooded areas, ditches and crop land. At the 100-year (1% AEP) flows, it is expected that the lower part of the river for with- and without-project conditions to be very close in elevation.

In the upstream stretch of river (FG 6 and FG 7 sub-reaches), The upstream section will experience increased stages more than the downstream stretch of river due to the oxbow cutoff weirs needing very high elevations to push water out onto the floodplain. As the flows increase, the with- and without-project elevations do get closer. At the 100-year flows, the with- and without- projects elevations are about a foot apart near FG 7. Because the floodplain at FG 7 is confined, the additional flooding can be mitigated through flowage easements. FG 6 elevations differences are significantly less. While the near channel stages are higher for FG 6, the breakout into the southern watershed via Doran Slough has been minimized to about equivalent to without-project conditions.

7.4.6 Environmental Justice

The U.S. Environmental Protection Agency (USEPA) on-line EJScreen mapping tool (Version 2020) was used to characterize existing conditions for minority and low-income groups (Appendix H). This area was chosen by using the Project study area boundary, including a 1.5-mile buffer to the boundary, to determine the population most affected by the Project. The EJScreen tool estimated an approximate population of 400 in the analysis area. Neither the minority population nor the low income population is 50 percent or greater in the analysis area. The minority and linguistically isolated populations of the area are lower than the state and national averages. The minority population for this area is 5%, indicating that the analysis area does not have a EJ recognized minority population community based on minority population. Based on the EJ screen, 19% of the analysis area would be considered low income; however, this number is lower than the state average (25%) and the national average (33%). Other population dynamics show that 6% of the population over 25 years of age have less than a high school diploma and the population under 5 and over 64 years of age are 4% and 17%, respectively.

Impacts of the No-Action Alternative:
The No-Action would have no effect on environmental justice. All populations would experience the same impacts the same.

Impacts of Alternative C:
Alternative C would have no disproportional effects on minority or low-income groups.

Impacts of Alternative K
Alternative K would have no disproportional effects on minority or low-income groups.

7.4.7 Employment/Commerce

The study area is a rural part of Minnesota for which commerce is based largely on agriculture. The nearby City of Wahpeton has a population of about 8,000 and is home to the North Dakota State College of Science. It is home to several large manufacturing plants including Woodcraft Industries, WCCO Belting, Minn-Dak Farmers Cooperative, Cargill, ComDel Innovation, Heartland Precision, Doosan/Bobcat, Masonite, and Wil-Rich. The city also has numerous restaurants and retail stores, and a handful of lodging accommodations.

Impacts of the No-Action Alternative:
The No-Action would have no effect on employment or commerce.

Impacts of Alternative C:
Alternative C would provide temporary employment opportunities associated with construction of the project. Local businesses in the Wahpeton area would also benefit from servicing contractors (e.g., gas stations, retail, restaurants, grocery stores, lodging). The increases in commerce would contribute to sales tax revenue for the state.

Impacts of Alternative K
Alternative K is anticipated to have similar effects as Alternative C, but at a higher level and over a longer period of time.

Table 25. Environmental Matrix

Alternative	No Action							Alternative C							Alternative K						
Parameter	+++	++	+	o	-	--	---	+++	++	+	o	-	--	---	+++	++	+	o	-	--	---
A. Social Effects				X							X							X			
1. Noise Levels				X								ST							ST		
2. Aesthetic Values				X					X			ST				X			ST		
3. Recreational Opportunities				X						X		ST				X			ST		
4. Transportation				X							X							X			
5. Public Health and Safety				X							X							X			
6. Community Cohesion				X							X							X			
7. Community Growth & Development				X							X							X			
8. Business & Home Relocations				X							X							X			
9. Existing/Potential Land Use				X							X							X			
10. Controversy				X							X							X			
B. Economic Effects																					
1. Property Values				X							X							X			
2. Tax Revenue				X							X						ST				
3. Public Facilities & Services				X							X							X			
4. Regional Growth				X							X							X			
5. Employment				X						ST							ST				
6. Business Activity				X							X						ST				
7. Farmland/Food Supply				X							X							X			
8. Commercial Navigation				X							X							X			
9. Flooding Effects				X								X							X		
10. Energy Needs & Resources				X							X							X			

C. Natural Resource Effects																					
1. Air Quality				X								ST							ST		
2. Terrestrial Habitat					X					X		ST				X			ST		
3. Wetlands					X					X		X					X		X		
4. Aquatic Habitat					X				X			ST				X			ST		
5. Habitat Diversity & Interspersion				X						X						X					
6. Biological Productivity				X						X		ST				X			ST		
7. Surface Water Quality					X					X		ST				X			ST		
8. Water Supply				X							X							X			
9. Groundwater				X							X							X			
10. Soils					X					X							X				
11. Threatened or Endangered Species				X							X							X			
D. Cultural Resource Effects																					
1. Historic Architectural Values				X				TBD							TBD						
2. Pre- & Historic Arch. Values				X				TBD							TBD						

KEY

'+++' = significant beneficial effect
'++' = substantial beneficial effect
'+ = minor beneficial effect
'0' = no
effect
'---' = significant adverse effect
'--' = substantial adverse effect
'-' = minor adverse effect
'ST' = short-term effects
'TBD' = to be determined

8 Environmental Compliance and Public Involvement

The proposed action would comply with Federal environmental laws, Executive Orders and policies, and applicable State and local laws including but not limited to the Clean Air Act, as amended; the Clean Water Act, as amended; the Endangered Species Act of 1973, as amended; the Fish and Wildlife Coordination Act of 1958, as amended; the National Historic Preservation Act of 1966, as amended; the National Environmental Policy Act of 1969, as amended; Executive Order 11990 - Protection of Wetlands; Executive Order 12898 - Environmental Justice; the Farmland Protection Policy Act of 1981 (the proposed action would not result in the conversion of farmland, as defined by the Farmland Policy Act, to non-agricultural uses); and Executive Order 11988 - Floodplain Management (the work would not encourage additional development in the floodplain). The level of compliance may be re-evaluated during the Plans and Specifications phase.

8.1 Archaeological and Historic Preservation Act

The Archaeological and Historic Preservation Act (AHPA) of 1974 amended and expanded the Reservoir Salvage Act of 1960, requiring Federal agencies to provide for the preservation of historical and archaeological data, including material evidence, that might otherwise be destroyed or lost as a result of an undertaking. Subsequent legislation in 2014 requires Federal agencies to invest in historic preservation programs overseen by a historic preservation specialist to protect historic properties and objects belonging to the agency.

8.2 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act prohibits anyone from taking, possessing, or transporting an eagle, or the parts, nests, or eggs of such birds without prior authorization. Disturbing an eagle to a degree that causes, or is likely to cause injury to an eagle, decrease productivity, or cause nest abandonment are considered forms of take. Activities that directly or indirectly lead to take are prohibited without a permit.

Bald and Golden Eagle nest activities are dynamic. Existing nests may become inactive (e.g., the tree may fall or the nest is abandoned) or new nests may become established before or even during construction of the project. There are no known active bald eagle nests in the project area. However, an updated inventory of active nests will be completed during the plans and specifications phase. Take may be avoided if construction activities maintain a buffer (typically, 660 feet) around the tree and during nesting activity (typically February until June). If take is unavoidable, a permit from USFWS may be needed.

Alternatives C and K are fully compliant.

8.3 Clean Water Act

The Clean Water Act (CWA; 33 U.S.C. § 1251 et seq.) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. Section 404 of the CWA regulates the discharge of dredged or fill material into waters of the United States and is administered by the U.S. Environmental Protection Agency (EPA). To comply with Section 404 of the CWA for this Project, the Corps intends to comply with the provisions of Nationwide Permit (NWP) 27, Aquatic Habitat Restoration, Enhancement, and Establishment Activities, and therefore, an individual Clean

Water Act 404(b)(1) evaluation will not be prepared. Discharges in fill for a project are authorized under NWP 27 provided activities result in a net increase of aquatic resource functions and services. The aquatic benefits that this Project provides are discussed in Section 8.2.6. Another requirement for the use of NWP is that the aquatic habitat restoration must be planned, designed, and implemented so that aquatic habitat resembles an ecological reference or conceptual model. The benefits associated with the proposed project are based on models that target distinct aquatic habitat types and desired species. These models, their description and association with aquatic habitats and the direct benefits are discussed and evaluated in Figure 6 and Appendix J, Habitat Evaluation Procedures. Finally, the proposed project does not result in a change of aquatic habitat type when comparing the restored to historic conditions (e.g., stream to wetland or vice versa). The requirements for NWP 27 and General Conditions are available in Appendix N – Clean Water Act Compliance.

Section 401 of the Clean Water Act water quality certification is required for actions that may result in a discharge of a pollutant into waters of the United States to ensure that the discharge complies with applicable water quality standards. The Minnesota Pollution Control Agency (MPCA) is the administering agency for water quality certification on the Project. The State of Minnesota has issued a Section 401 water quality certification for use of NWP 27. The conditions associated with the 401 can be found in Appendix N – Clean Water Act Compliance. These conditions will be followed and required as part of plans and specifications.

Alternatives C and K are fully compliant at this time.

8.4 Endangered Species Act

As discussed in earlier in the report, there is one Federally-listed species that is believed or could occur within the Project area. The Corps has determined that the project alternatives would have no effect on the threatened NLEB and will complete the IPAC online consultation under ESA's 4(D) rule. If this determination changes, Section 7 consultation with the USFWS would be completed prior to construction.

Alternatives C and K are partially compliant at this time.

8.5 Fish and Wildlife Coordination Act

The planning for the proposed project has been an interagency effort involving the St. Paul District, the Minnesota DNR and Buffalo-Red River Watershed District. Additional coordination has also occurred with USFWS, MPCA and the Minnesota State Historic Preservation Office. Interagency meetings were held on a periodic basis throughout the study. In addition to the meetings, information and coordination took place on an as-needed basis to address specific problems, issues, and ideas. Members of the BRRWD have discussed the project with potentially affected landowners. The draft integrated Feasibility report and EA will undergo agency public review in 2022.

Alternatives C and K are partially compliant at this time.

8.6 Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918 (16 United States Code (USC) 703-712) governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests. The Fish and Wildlife Conservation Act of 1980 (16 USC 2901-2911) affords protection to Birds of Conservation Concern. Migratory birds and Birds of Conservation

Concern are an important component of biodiversity in North America. Many species are known to occur in the study area in a variety of upland and wetland habitats.

Potential effects to migratory birds will be further considered during the design and implementation of this project. Because of the low-quality and disturbed nature of the project area, there would be little potential for migratory bird take as defined by the Act.

Alternatives C and K are fully compliant at this time.

8.7 National Environmental Policy Act

This document has integrated the content required of a NEPA environmental compliance document. A range of alternatives has been presented and the significance of the proposed project's impacts have been evaluated. The document will be distributed to agencies, the public, and other interested parties to gather any comments or concerns. If no substantial effects to the environment are found during the comment period or moving forward with the Project design, the St. Paul District Commander will sign a Finding of No Significant Impact (FONSI).

Alternatives C and K are partially compliant at this time.

8.8 National Historic Preservation Act

The National Historic Preservation Act (NHPA) of 1966, as amended by Public Law 96-515 (94 Stat. 2987), established national policy for historic preservation, authorized the Secretary of the Interior to expand and maintain a National Register of Historic Places, and created the Advisory Council on Historic Preservation. Section 106 specifies that Federal agencies, before approval of any expenditure or before issuance of any license, must consider the effect of the action on any property included in or eligible for the National Register of Historic Places. Consultation was initiated on February 10, 2020 with the Minnesota State Historic Preservation Office (SHPO) and tribal historic preservation offices. Copies of the coordination letters will be in Appendix I – Correspondence and Coordination.

Alternatives C and K are partially compliant at this time.

8.9 Watershed Protection and Flood Prevention Act

The Watershed Protection and Flood Prevention Act of 1954 (WPFPA) is a law that protects watersheds from erosion, sedimentation, and flooding. Under WPFPA, federal agencies work with local organizations to develop and implement flood control and watershed runoff plans.

Alternatives C and K are fully compliant at this time.

8.10 Farmland Protection Policy Act

The FPPA is intended to minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. It assures that to the extent possible federal programs are administered to be compatible with state, local units of government, and private programs and policies to protect farmland.

Alternatives C and K would have minor effects on agriculture by converting farmland to non-agricultural uses. This would include up to 8 acres of prime or unique farmlands. However, this is necessary to meet project goals and constraints. These alternatives are ecosystem restoration, therefore, the study area which is primarily designated as rural land use, would remain rural land

use. Overall, no short-term or long-term substantial impacts to broad land use would occur. Both alternatives are fully compliant.

8.11 Consultation and Coordination with Indian Governments (E.O. 13175)

All Federal agencies are required under E.O. 13175 to consult with Indian Tribal Governments when considering policies that would impact Tribal communities. The Corps initiated consultation with tribal historic preservation officers of the Sisseton-Wahpeton Oyate of Lake Traverse, Upper Sioux Community of Minnesota, Lower Sioux Indian Community, and the Spirit Lake Tribe. This consultation is ongoing and would be satisfied prior to approval of the decision document.

Alternatives C and K are partially compliant at this time.

8.12 Floodplain Management (E.O. 11988)

Among other things, Executive Order 11988 directs Federal Agencies to assert leadership in reducing flood losses and losses to environmental values served by floodplains.

Alternatives C and K are fully compliant at this time.

8.13 Invasive Species (E.O. 13112)

Among other things, the Federal agencies shall identify actions that may affect the status of invasive species and prevent their spread. The Corps shall require BMPs to address this issue as part of developing plans and specifications and project construction

Alternatives C and K are fully compliant at this time.

8.14 Protection and Enhancement of Environmental Quality (E.O. 11514)

Among other things, the Federal Government shall provide leadership in protecting and enhancing the quality of the Nation's environment to sustain and enrich human life. Federal agencies shall initiate measures needed to direct their policies, plans and programs so as to meet national environmental goals.

Alternatives C and K are fully compliant at this time.

8.15 Protection and Enhancement of the Cultural Environmental (E.O. 11593)

This Executive Order directed federal agencies to identify, evaluate, and nominate all eligible historic properties to the National Register of Historic Places and to avoid impacts to eligible properties.

Alternatives C and K are fully compliant at this time.

8.16 Protection of Wetlands (E.O. 11990)

Executive Order 11990 requires minimization of the destruction, loss or degradation of wetlands and encourages preservation and enhancement of their natural and beneficial values.

As discussed in Section 3, Alternative C and K will result in converting disconnected oxbows to riverine habitat and improving wetland conditions for existing wetlands. Both alternatives are fully compliant.

8.17 Prime and Unique Farmland (CEQ Memorandum)

Federal agencies are directed to analyze the impacts of actions on prime or unique farmlands as a part of NEPA.

Alternatives C and K will affect up to 8 acres of prime or unique farmlands and are partially compliant at this time (Appendix D – Environmental). Additional coordination will be completed as part of the Plans and Specifications phase.

8.18 Environmental Justice (E.O 12898)

An evaluation of environmental justice impacts is mandated by Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (February 11, 1994). This Executive Order directs Federal agencies to identify and address, as appropriate, disproportionately high, and adverse health or environmental effects of its programs, policies, and activities on minority and low-income populations. Compliance with Executive Order 12898 Environmental Justice requires consideration of social equity issues, particularly any potential disproportionate impacts to minority or low income groups. Environmental justice issues have been considered during the planning of this project and no minority or low-income populations would be disproportionally affected.

Alternatives C and K would not have disproportional effects on minority and low-income groups and are fully compliant.

Table 26. Status of Environmental Compliance for Alternatives C and K

Environmental Requirement	Compliance[1]
Federal Statutes	
Archaeological and Historic Preservation Act	Partial
Bald and Golden Eagle Protection Act of 1940, as amended	Full
Clean Air Act, as amended	Full
Clean Water Act, as amended	Full
Endangered Species Act of 1973, as amended	Partial
Fish and Wildlife Coordination Act, as amended	Partial
Migratory Bird Treaty Act of 1918, as amended	Full
National Environmental Policy Act of 1969, as amended	Partial
National Historic Preservation Act of 1966, as amended	Partial
Watershed Protection and Flood Prevention Act	Full
Farmland Protection Policy Act of 1981	Partial
Executive Orders, Memoranda	
Consultation and Coordination with Indian Governments (E.O. 13175)	Partial
Floodplain Management (E.O. 11988)	Full
Safeguarding the Nation from the Impacts of Invasive Species (E.O. 13112)	Full
Protection and Enhancement of Environmental Quality (E.O. 11514)	Full
Protection and Enhancement of the Cultural Environment (E.O. 11593)	Full
Protection of Wetlands (E.O. 11990)	Full
Analysis of Impacts on Prime and Unique Farmland (CEQ Memorandum, 30 Aug 1976)	Partial
Environmental Justice (E.O. 12898)	Full

[1]The compliance categories used in this table were assigned according to the following definitions:
Full- All requirements of the statue, E.O., or policy and related regulations have been met for the current stage of planning.
Partial- Some requirements of the statue, E.O., or policy and related regulation remain to be met for the current stage of planning.
Noncompliance (NC) - Violation of requirement of the status, E.O., or policy and related regulation.
[2]Full compliance to be achieved with the District Engineer's signing of the Finding of No Significant Impact.

9 Recommendation

10 Literature Cited

Berg, M. S. 2018. Level 1 Qualitative Unionid Mussel Surveys, Otter Tail Power Company Recertification (FERC No. 10853), Otter Tail River – Red River of the North Drainage, Otter Tail County, MN. Report for The Otter Tail Power Company, Kleinschmidt Group, and the Minnesota Department of Natural Resources. 102 pp+appendices.

Hanson, Steven R., Paul A. Renard, Nancy A. Kirsch, and John W. Enblom. 1984. Biological Survey of the Otter Tail River. Special Publication No. 137, Division of Fish and Wildlife, Minnesota Department of Natural Resources, St. Paul.

Holley, George R. 2016. Otter Tail River Bank Restoration, Foxhome Township, Wilkin County, Minnesota. Technical report prepared by Minnesota State University Moorhead, Department of Anthropology and Earth Science.

Kuitunen, A., L. P. Aadland, J. Harvey, S. L. Johnson, and K. L. Terry. 1997. Otter Tail River Watershed: Recommendations for Streamflow and Habitat Protection. Minnesota Department of Natural Resources.

Leitch, J. A. R. Backman, and C. Laney. 2009. Otter Tail River Water Trail Master Plan. Report for the Minnesota Department of Natural Resources Division of Parks and Trails. https://riverkeepers.org/wp-content/uploads/2016/06/Master_Plan_04-30-09_web-1.pdf

Ostby B.J.K and B. B. Beaty. 2020. Relocation of Mussel Assemblage in the Otter Tail River at the CSAH 15 Bridge in Otter Tail County. Daguna Consulting.

Houston Engineering Inc. 2019. Engineer's Design Report, Lower Otter Tail River Channel Restoration.

Minnesota Department of Natural Resources. 2010. Toe Wood Sod Mat Factsheet. Retrieved from MN Department of Natural Resources: https://files.dnr.state.mn.us/publications/waters/toe_woodsod_mat_dec2010.pdf

Minnesota Department of Natural Resources. 2018. State Wildlife Action Plan Summary of Monitoring Results 2008 – 2018.

Minnesota Pollution Control Agency (MPCA). 2006. Lower Otter Tail River Turbidity Total Maximum Daily Load Report.

U.S. Army Corps of Engineers (Corps). 1997. Resource Significance Protocol for Environmental Project Planning. Report by Apogee Research, Inc. IWSR Report 97-R-4.

U.S. Fish and Wildlife Service. 1980. 102 ESM Habitat Evaluation Procedures (HEP. Division of Ecological Services. Washington D.C.

Wilkin Soil and Water Conservation District and MPCA. 2007. Lower Otter Tail River TMDL Implementation Plan. https://www.pca.state.mn.us/sites/default/files/wq-iw5-02c.pdf