MINNESOTA PUBLIC UTILITIES COMMISSION
PIPELINE ROUTING PERMIT
ENVIRONMENTAL ASSESSMENT SUPPLEMENT

SOUTHERN LIGHTS 20-INCH CRUDE LINE

Prepared by

NATURAL RESOURCE GROUP, INC.

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ENBRIDGE PIPELINES (SOUTHERN LIGHTS) L.L.C.
Environmental Assessment Supplement
Southern Lights 20-Inch Crude Line

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1.0 INTRODUCTION

This Environmental Assessment Supplement was prepared in support of Enbridge Pipelines (Southern Lights) L.L.C.'s (Enbridge) Application to the Minnesota Public Utilities Commission (PUC) for a Pipeline Routing Permit (Application) to construct and operate the Southern Lights 20-Inch Crude Line Project (referred to herein as the "LSr Project") in Minnesota. This document provides an assessment of the existing environment along the proposed pipeline route, an analysis of human and environmental impacts that could potentially result from pipeline right-of-way preparation, construction, operation and maintenance of the proposed pipeline facilities, and a summary of the protection and restoration measures to be implemented to avoid and/or minimize environmental impacts. It has been prepared in accordance with the PUC's Pipeline Routing rules (Chapter 4415) and expands on information in the following three sections of the Application:

- Location of Preferred Route and Description of Environment;
- Environmental Impact of Preferred Route; and
- Right-of-Way Protection and Restoration Measures.

1.1 PROJECT DESCRIPTION AND NEED

Enbridge is proposing a system expansion involving modifications to existing pipeline facilities and construction of a new pipeline in Minnesota to help address current and future demand by Midwestern refineries for supplies of economical and reliable petroleum from western Canada. To accommodate demand, Enbridge proposes to expand its system in the United States by constructing a new 136-mile-long pipeline (the "Project") of which approximately 107.7 miles will be located in Minnesota. This pipeline must be constructed and placed in service before other capacity expansion projects can be completed. The Project will have an annual capacity of approximately 186,000 barrels per day (bpd) of liquid petroleum delivery from Enbridge's existing facilities in Cromer, Manitoba to its tank farm in Clearbrook, Minnesota. From Clearbrook, the petroleum will be transferred to existing Enbridge pipelines for transportation in batches to Superior, Wisconsin or to provide increased capacity to meet anticipated demands by Minnesota refiners. The Project will require construction and operation of the following in Minnesota:

- approximately 107.7 miles of new 20-inch-diameter underground petroleum pipeline on or adjacent to the existing Enbridge right-of-way, or other existing rights-of-way, through six Minnesota counties near Mattson, Minnesota at the Minnesota/North Dakota border in Kittson County (milepost (MP) 801.8) to Enbridge's Clearbrook tankage terminal in Clearwater County (MP 909.4);

- modification to pumping units within the existing Enbridge pump station sites at Donaldson and Plummer, Minnesota; and

- mainline valves at major waterbody crossings and over the length of the pipeline route.

A general location map depicting the project route is included on figure 1.1-1.

Figure 1.1-1 LSr Project Route Map

The Project will cross portions of the following counties in Minnesota: Kittson, Marshall, Pennington, Red Lake, Polk, and Clearwater. Table 1.1-1 lists the locations and length of pipeline in each of the counties affected by the project.

TABLE 1.1-1

Length of LSr Pipeline in Each County Crossed by the Proposed Route

County	Mileposts	Pipeline Length (miles)
Kittson	801.8 - 817.1	15.3
Marshall	817.1 - 851.7	34.6
Pennington	851.7 - 871.3	19.7
Red Lake	871.3 - 886.9	15.5
Polk	886.9 - 900.5	13.6
Clearwater	900.5 - 909.4	9.0
Total		107.7

1.2 LAND REQUIREMENTS

Construction of the Project will generally require a 100-foot-wide construction right-of-way to allow temporary storage of topsoil and spoil and to accommodate safe operation of construction equipment. The spoil side (i.e., topsoil and ditch spoil stockpile area) will typically be 25 feet wide and generally located partially within the existing maintained right-of-way. The working side (i.e., equipment work area and travel lane) will typically be 75 feet wide and generally located outside the existing maintained right-of-way. A diagram illustrating the typical construction right-of-way is provided on figure 1.2-1. Following construction, a 40-foot-wide permanent right-of-way in addition to the existing permanent right-of-way will be maintained for operation of the pipeline.

1.2.1 Temporary Extra Workspaces

Additional temporary extra workspaces are anticipated to be needed at other locations where the project will cross features such as waterbodies, roads, railroads, foreign pipelines and utilities, horizontal directional drill (HDD) sites, and other special circumstances. These temporary extra workspaces are construction areas that are needed outside of the typical construction right-of-way to stage equipment and stockpile spoil material. Typical schematics showing the general locations and dimensions of the temporary extra workspaces are provided in Appendix A. Table 1.2.1-1 lists the typical dimensions of temporary extra workspaces that will be used for pipeline construction.

TABLE 1.2.1-1

Typical Dimensions of Temporary Extra Workspaces for the LSr Project

Feature	Dimensions on Each Side of Feature [a]
Open-cut Road Crossings	100 feet X 75 feet and 50 feet X 100 feet
Bored Road and Railroad Crossings	100 feet X 75 feet and 100 feet X 50 feet
Foreign Pipeline and Utility Crossings	100 feet X 75 feet and 100 feet X 50 feet
Pipeline Cross-under	100 feet X 100 feet and 100 feet X 100 feet
Waterbody Crossings >50' Wide	300 feet X 75 feet and 300 feet X 75 feet
Waterbody Crossings <50' Wide	200 feet X 75 feet and 200 feet X 75 feet

TABLE 1.2.1-1

Typical Dimensions of Temporary Extra Workspaces for the LSr Project

Feature	Dimensions on Each Side of Feature [a]
Horizontal Directionally Drilled Waterbody Crossings	200 feet X 75 feet and 200 feet X 75 feet
Wetland Crossings	200 feet X 75 feet and 200 feet X 75 feet

[a] Areas are in addition to the 100-foot-wide construction right-of-way.

Figure 1.2-1 LSr Project - Typical Construction Right-of-Way

1.2.2 Pipe/Material Storage Yards and Contractor Yards

During construction, Enbridge will temporarily use off-right-of-way areas for pipe and materials storage. In addition, construction contractors will require off-right-of-way areas to park equipment and stage construction activities. These yards have yet to be identified and this information will be filed when available, approximately July 2007.

1.2.3 Access Roads

Public roads will typically be used to gain access to the construction right-of-way. In areas where public roads are limited, existing privately owned roads may be used to provide access to the construction right-of-way. If neither public nor privately owned roads are available, Enbridge may need to construct new access roads. Use of private access roads, modifications to existing non-private roads, and construction of any new access roads will require obtaining landowner permission and environmental surveys prior to use. No private or new access roads have been identified at this time. This information will be filed when available, approximately April 2008.

1.2.4 Aboveground Facilities

Aboveground facilities associated with the Project will involve modifying existing pump station service at Enbridge's existing Donaldson and Plummer Station sites to accommodate the new pipeline and the installation of mainline valves. New aboveground facilities include one receiver, to be located at the Clearbrook Terminal. Because the Project will be collocated with the existing pipelines, new valves are anticipated to be sited at existing valve sites. Enbridge is currently assessing the need to install valves at additional locations. Aboveground facilities and locations are summarized in table 1.2.4-1.

TABLE 1.2.4-1

Aboveground Facilities Associated with the LSr Project

County	Facility	Milepost
Kittson	Red River South – New Mainline Valve	805.6
	Donaldson Pump Station Modifications & New Mainline Valve	814.1
Marshall	Tamarac River – New Mainline Valve	829.4
	Middle River – New Mainline Valve	834.5
	Snake River – New Mainline Valve	845.7
	Viking Pump Station - New Mainline Valve	848.2
Pennington	Red Lake River North – New Mainline Valve	864.1
	Red Lake River South – New Mainline Valve	865.1
Red Lake	Plummer Pump Station Modifications & New Mainline Valve	877.1
	Lost River – New Mainline Valve	885.7
Polk	Gully – New Mainline Valve	896.0
	Polk/Clearwater County Line – New Mainline Valve	899.4
Clearwater	Clearbrook Terminal – New Receiver and Mainline Valve	909.4

1.3 TYPICAL CONSTRUCTION SEQUENCE

A schematic depicting a typical pipeline construction sequence is provided on figure 1.3-1. Specialized construction techniques (e.g., waterbody crossings) are discussed in subsequent sections of this document. Construction associated with aboveground facilities (*i.e.*, mainline valves, station modifications) involves pipe reconfigurations and installation of equipment. The typical pipeline construction sequence is described below.

First, the right-of-way is surveyed, staked, and prepared for clearing. The right-of-way is then cleared and graded to the extent needed to provide construction access and safe movement of equipment and personnel during construction. Appropriate safety measures are implemented before excavation begins, including notification of the One-Call system to ensure foreign utilities are properly marked, and marking of the adjacent pipelines. Pipe, valves, and fittings are transported to the right-of-way by truck and placed along the right-of-way by side boom tractors or mobile cranes. After individual pipe sections are strung along the right-of-way, they are bent to conform to the contours of the trench and terrain. The pipe is then lined up, welded, field coated, and inspected. Trenching may occur before or after the pipe has been welded. Trenching is typically conducted using a backhoe or crawler-mounted, wheel-type trenching machine. Where appropriate, topsoil is segregated. Prepared pipe is lowered into the trench and, where applicable, tied into existing facilities. During backfilling, first the subsoil, then the topsoil is replaced. Precautions, such as padding, are taken during backfilling to protect the pipe from rock damage. Prior to the line being filled with petroleum and placed into service, the pipeline is hydrostatically tested to ensure its integrity. Following installation and testing, the right-of-way is cleaned up and restored as nearly as practicable to preconstruction conditions. Restoration includes implementing temporary and permanent stabilization measures such as slope breakers, mulching and seeding.

1.4 ENVIRONMENTAL RESTORATION AND MITIGATION

Enbridge has developed standardized erosion control and restoration measures to minimize potentially adverse environmental effects resulting from right-of-way preparation, construction, and maintenance of the proposed pipeline. These measures are described in Enbridge's Environmental Mitigation Plan (EMP), which is provided in Appendix B. Enbridge has also developed a construction Spill Prevention, Containment, and Control Plan (SPCCP) that describes planning, prevention and control measures to minimize impacts of construction-related spills. The SPCCP is provided in Appendix C of this document.

Enbridge will comply with applicable federal, state, and local rules and regulations and take all appropriate precautions to protect against pollution of the environment. In addition, Enbridge will retain Environmental Inspectors to verify that environmental protection measures, environmental permit conditions, and other environmental specifications are implemented appropriately by the contractor during construction of the proposed facilities.

Figure 1.3-1 Typical Pipeline Construction Sequence

2.0 ROUTE SELECTION AND ALTERNATIVES ANALYSIS

A rational and defensible route selection process for new pipeline facilities involves consideration of environmental, engineering, and economic factors in a multi-disciplinary and iterative fashion. Enbridge currently operates continuous pipeline facilities across North America. This system provides for a relatively direct route to transport petroleum between production areas and markets. The existing Enbridge pipeline system provides significant opportunities for collocating and using existing right-of-way for the planned capacity expansion projects.

For the Project, Enbridge is proposing to construct 107.7 miles of 20-inch-diameter new petroleum pipeline between the Minnesota/North Dakota border in Kittson County and the Clearbrook Tank Farm in Clearwater County. The new pipeline will parallel Enbridge's existing pipelines, except for minor deviations at the Snake and Middle Rivers and at the Donaldson Station (see section 2.3.4). These locations represent a total of 1.4 miles of deviations from the existing right-of-way.

In developing this route, referred to in this section as the "Project route," Enbridge studied a variety of alternatives for routing the Project. These alternatives consist of system alternatives, route alternatives, and route variations. Enbridge evaluated and compared several factors, including the ability to meet project objectives, technical and economic feasibility, and potential environmental impacts for each alternative. The following sections describe Enbridge's process for selecting the Project route and provide an analysis of alternatives.

2.1 PROJECT OBJECTIVES

The Project will increase energy reliability and security of U.S. crude petroleum supplies by increasing existing through-put capacity from expanding Canadian supplies to Enbridge's Clearbrook tank farm. It is critical for Enbridge to increase its delivery at the Clearbrook facility to preserve delivery capacity to current customers and to meet new customer demand for service at its Clearbrook tankage facility. The Project will have an annual through-put capacity of 186,000 barrels per day (bpd).

The capacity provided by this new pipeline provides independent utility to Enbridge and its customers, who would use the pipeline for the transportation of petroleum to Clearbrook, Minnesota, breakout tanks for subsequent delivery to interconnected existing pipeline systems to the south (via Minnesota Pipeline, which is owned by others) and east of Clearbrook, Minnesota (via Enbridge pipelines).

2.2 SYSTEM ALTERNATIVES

System alternatives are options to the proposed action that would make use of other existing or proposed pipeline or transportation systems to meet the stated objectives of the project. Although it is feasible to move some portion of the increased volumes from Canada through the Enbridge Pipelines (North Dakota) L.L.C. system ("Enbridge North Dakota System") to Clearbrook, Minnesota through what is known as the "Portal Link" crossing the international border, the Enbridge North Dakota System is currently at full capacity and will not accommodate this volume of crude oil. The more direct route on the proposed expanded Enbridge system is considered preferable for all North American shippers, including those that transport on the Enbridge North Dakota System. The TransCanada Keystone Pipeline, LLC (Keystone) is proposing the construction of a new, 1,833-mile pipeline from Alberta, through North Dakota, South Dakota and on to Patoka, Illinois. The Keystone Pipeline is not an alternative system as the proposed pipeline does not connect to the Minnesota, Wisconsin and greater Chicago area markets that the Enbridge Mainline System serves.

No other existing pipeline systems provide delivery between Cromer, Manitoba and Clearbrook, Minnesota. Any other pipeline system would require entirely new right-of-way as well as new pump station sites, power supplies, valve sites and potential access roads, whereas the existing Enbridge system enables collocation and use of existing infrastructure. Therefore, it is not advantageous to consider a greenfield pipeline to achieve the objectives of the Project. Using the existing infrastructure, Enbridge evaluated the following possible system alternatives:

- expanding Enbridge's pipeline system by constructing additional pump stations that provide additional horsepower, and constructing additional loops to the existing mainlines along the existing route; and

- truck delivery of petroleum supplies from Canada to Clearbrook, Minnesota.

2.2.1 Expanding Existing Enbridge Facilities

In the United States, the existing Enbridge system currently consists of five continuous, 136-mile-long, 18-, 20-, 26-, 34-, and 36/48-inch-diameter pipelines from the Canadian border near Neche, North Dakota, to Clearbrook, Minnesota. This existing Enbridge system does not contain any discrete pipe segments (loops). Adding new looping was found to be inadequate to meet the project objectives of delivering 186,000 bpd to meet demand requested by Midwestern refineries. The existing infrastructure, even with loop pipeline, is not able to accommodate this deliverable and, therefore, a new continuous line for petroleum is needed. However, if looping was feasible to ship petroleum, the operation and maintenance costs associated with additional pump stations and horsepower would not be cost effective. Due to these factors, expansion of existing facilities was not a factor in evaluating potential options.

2.2.2 Trucking

As an alternative to the Project, Enbridge could potentially transport petroleum supplies from its Cromer, Manitoba facility to the Clearbrook tankage facility by truck. This alternative is, however, characterized by higher public safety and environmental risk, unreasonable logistics, and higher incremental cost. Accident data consistently illustrate that pipelines are the safest form of transportation for bulk liquids, including petroleum. The safety risk is magnified significantly by the impact created by increased truck traffic on Minnesota highways. A typical truck transport would carry 150 barrels (bbls) of petroleum. Truck frequency for 186,000 bpd on a per annum basis would require 326 trucks (assuming 4 loads per day per truck) between Cromer, MB and Clearbrook. The trucks would primarily use U.S. Highway 59 in northern Minnesota which already carries a significant burden of commercial traffic. Collectively, the alternative would add 124,917,600 miles per year of additional truck traffic to Minnesota highways, and the trucks would consume approximately 27,759,467 gallons of fuel per year. Finally, the estimated trucking costs that incorporate operation and maintenance along with average fuels costs is greater than the existing alternative, which is the primary reason trucking currently is not used to move petroleum. The safety and environmental risks, logistical requirements, and high cost eliminate the trucking option as a viable alternative.

2.3 ROUTE ALTERNATIVES

Enbridge conducts extensive surveys and research to identify the optimal route for a new pipeline. Typically, the safest and least environmentally damaging route is within an existing right-of-way. However, in some cases, it is advantageous to deviate from an existing right-of-way in congested or environmentally sensitive areas. The existing Enbridge pipeline system provides significant opportunities for using existing right-of-way for the Project. Maximizing use of the existing Enbridge right-of-way for the Project will decrease environmental and land acquisition costs.

Enbridge identified and evaluated several options for routing its project. These studies were designed to define a proposed pipeline route that achieves project objectives, is technologically and economically feasible to construct, and minimizes impacts on landowners and the environment. The following sections provide a general discussion of the route selection process, an analysis of the various route alternatives evaluated for the Project, and a detailed comparison of minor route alternatives.

2.3.1 Initial Route Selection Process

During initial route studies, Enbridge determined that the Project should parallel its existing system from Neche, North Dakota to Clearbrook, Minnesota. However, the Enbridge right-of-way from Clearbrook to Neche already contains multiple pipelines and in some instances, crossings, workspace, or right-of-way is constrained by the presence and proximity of these multiple existing pipelines. Enbridge assessed the route from Neche to Clearbrook with the intent of maximizing the use of existing Enbridge right-of-way to the extent feasible while identifying specific areas where collocation may not be feasible.

The first step in the route selection process consisted of collecting publicly available environmental data to identify routing constraints. The sources of data consisted primarily of Geographic Information Systems (GIS) digital information layers including U.S. Geological Survey (USGS) topographic maps; USGS land use database; U.S. Department of Agriculture (USDA) Farm Services Agency 2003 and 2005 aerial photography; National Wetlands Inventory (NWI) maps; Minnesota Department of Natural Resources (MDNR) county biological survey maps; MDNR Natural Heritage information System database; Minnesota Department of Transportation (MDOT) highway maps; USDA state soil geographic (STATSCO and SSURGO) databases; and other natural feature databases obtained from the “data deli” on the MDNR website. Enbridge also consulted with the MDNR to identify other environmental routing constraints that may not be included in these publicly available data.

The next step involved mapping selected layers of the collected GIS data on 1:24,000-scale USGS topographic maps to identify the locations of environmental constraints within the study area. Existing major utility right-of-ways also were identified for potential use in collocation.

Collocating with the existing Enbridge right-of-way, generally on the southern/western edge of the right-of-way, between Neche and Clearbrook was determined to be the initial proposed pipeline route.

2.3.2 Refined Route Selection Process

Enbridge conducted a number of route reconnaissance efforts to further examine specific areas of concern identified during the desktop review. During the field review, the route was examined and adjustments were made to avoid or minimize potential impacts on sensitive environmental features, adjust for preferred construction alignment, or to accommodate landowner concerns. Further refinement of the route was completed as detailed engineering design efforts led to identifying specific facility modifications/additions. Enbridge's existing pipeline right-of-way provides for collocation and use of existing right-of-way, but in some locations it may not be feasible to use existing right-of-way because of congestion, poor crossing conditions, or other constraints on the existing right-of-way. Enbridge completed the route refinement process after engineering, environmental, and landowner issues were identified and addressed. The following sections describe the major and minor route alternatives identified as a result of these efforts.

2.3.3 Comparison of Major Route Alternatives

Enbridge conducted a detailed quantitative analysis of environmental impacts along each major route alternative. This analysis used the same sources of publicly available environmental data described in section 2.3.1, supplemented by field reviews. The analysis primarily focused on land use issues and wetland and waterbody crossings. In total, Enbridge identified and compared a variety of factors for each route, including: total length, proximity to an existing right-of-way, NWI-mapped wetlands and forested wetlands, highly wind erodible soils, depth to water table, hydric soils, agricultural land, forest and herbaceous lands, intermittent and perennial waterbodies, railroads, roads, and major highways. After review, Enbridge identified no major route alternatives in Minnesota for the Project.

2.3.4 Comparison of Minor Route Alternatives

Enbridge reviewed areas along the preferred route where construction of the Project will pose challenges due to impingements on the construction right-of-way from existing features. As with the analysis of major route alternatives, a detailed quantitative analysis of environmental impacts was conducted along each minor route alternative. Enbridge identified three minor route alternatives in Minnesota for the Project pipeline as discussed below. None of the alternatives were adopted as the preferred route.

Donaldson Station Alternative

The Donaldson Station Alternative would parallel the south side of the existing Enbridge pipeline right-of-way into the west side of Donaldson Station at MP 814.1 (see figure 2.3.3-1). The alternative route would turn east along the north side of Minnesota Highway 11 and cross a county road east of the station before turning south to cross Minnesota Highway 11. The route would then continue along the south side of the existing Enbridge pipeline right-of-way at MP 814.4. This alternative alignment is approximately 1,900 feet in length and would encounter utility congestion between Minnesota Highway 11 and the pump station's southern boundary.

The Project route would be 2,060 feet long. The Project route would turn south west of the Donaldson Station property boundary and be located adjacent to the existing Enbridge pipeline right-of-way between the station and existing high voltage electric transmission lines to the west. Once south of the station, the Project route would continue south under Minnesota Highway 11 and then be located between an existing electrical substation and an abandoned residence further to the south. The Project route would then turn southeast and then east to cross a county road before rejoining the south side of the existing Enbridge pipeline right-of-way. Table 2.3.3-1 provides a comparison of environmental features for the two routes.

Figure 2.3.3-1 Donaldson Station Alternative

TABLE 2.3.3-1

Environmental Features Comparison of the Proposed Pipeline Route and Donaldson Station Alternative (Between MPs 814.0 and 814.4)[a]

Environmental Features	Unit	Proposed Pipeline Route	Donaldson Station Alternative
Length	miles	0.4	0.4
Adjacent to Existing Right-of-Way	feet	0	1,900
Greenfield Route	feet	2,060	0
NWI-mapped Wetlands Crossed	feet	0	0
Highly Wind Erodible Soils [b]	feet	0	0
Depth to Water Table (≤ 6 feet)	feet	0	0
Shallow Bedrock	feet	0	0
Hydric Soils	miles	0.4	0.4
Prime Farmland Soils	miles	0.4	0.4
Forest Land Affected	miles	0.1	<0.1
Agricultural Land Affected	miles	0.2	0.3
Herbaceous Land Affected	miles	0	<0.1
Open Water Crossed	feet	0	0
Intermittent Waterbodies Crossed	no.	1	1
Perennial Waterbodies Crossed	no.	0	0
Railroad Crossings	no.	0	0
Interstate and Highway Crossings	no.	1	1

[a] Route characteristics that were not significantly different were not included in this comparison.
[b] Indicates length of pipeline that would cross soils with a wind erodible index of a potential for a loss of 134 to 310 tons per acre per year.
[c] Indicates length of route where project could encounter groundwater within 6 feet of the surface.

Neither route would cross NWI-mapped wetlands, shallow bedrock, or highly wind erodible soils. Both routes would traverse similar flat terrain comprising agricultural and commercial land before reconnecting with the existing route alignment. Also, both routes would cross road ditches along each road crossing; however, the alternative route would pose construction constraints due to the existing utilities and Minnesota Highway 11. Although longer, the Project would cross 1,056 feet of agricultural land compared to 1,742 feet for the Donaldson Station Alternative. The Project route would cross 158 feet additional hydric and prime farmland soils but would cross 581 feet less total agricultural land than the Donaldson Station Alternative. The Donaldson Station Alternative would be confined along Minnesota Highway 11 which would present difficulty during construction.

Middle River Alternative

The Middle River Alternative would parallel the south side of existing Enbridge pipeline right-of-way between MPs 835.4 and 835.9 (see figure 2.3.3-2). The alternative route would be directly offset and parallel to the river channel for about 500 feet presenting construction and restoration issues due to steep banks. The Middle River Alternative route could cause undercutting of the Project in the future during normal river flow. Also, the Middle River Alternative route would present potential constraints to waterbody construction given the river's close proximity and parallel alignment when compared to the proposed pipeline route across the Middle River south of the existing Enbridge pipeline right-of-way.

The Project route would deviate from the existing Enbridge pipeline right-of-way at MP 835.4 and proceed southeast to present a perpendicular waterbody crossing. The Project route would turn southeast for 1,800 feet, cross the river, turn south for 200 feet, and then cross under Marshall County Road 4 before turning east for 800 feet and rejoining the south side of the existing Enbridge pipeline right-of-way. Table 2.3.2-2 provides a comparison of environmental features for the two routes.

TABLE 2.3.3-2

Environmental Features Comparison of the Proposed Pipeline Route and Middle River Alternative (Between MPs 835.4 and 835.9) [a]

Environmental Features	Unit	Proposed Pipeline Route	Middle River Alternative
Length	miles	0.5	0.5
Adjacent to Existing Right-of-Way	feet	0	2,482
Greenfield Route	feet	2,800	0
NWI-mapped Wetlands Crossed	feet	0	0
Highly Wind Erodible Soils [b]	miles	0.3	0.2
Depth to Water Table (≤ 6 feet) [c]	feet	0	0
Shallow Bedrock	feet	0	0
Hydric Soils	miles	0.2	<0.1
Prime Farmland Soils	miles	0.1	0.2
Forest Land Affected	miles	<0.1	<0.1
Agricultural Land Affected	miles	0.4	0.5
Herbaceous Land Affected	miles	0	0
Open Water Crossed	feet	50	50
Intermittent Waterbodies Crossed	no.	0	0
Perennial Waterbodies Crossed	no.	1	1
Railroad Crossings	no.	0	0
Interstate and Highway Crossings	no.	1	1

[a] Route characteristics that were not significantly different were not included in this comparison.
[b] Indicates length of route that would cross soils with a wind erodible index of a potential for a loss of 134 to 310 tons per acre per year.
[c] Indicates length of route where project could encounter groundwater within 6 feet of the surface.

The Project route would deviate from the existing Enbridge pipeline right-of-way for a total of 2,800 feet compared to the 2,640-foot-long Middle River Alternative. No NWI-mapped wetlands would be crossed by either route. Both routes would traverse similar flat river basin terrain before reconnecting with the existing route alignment. The Middle River Alternative would cross more forested and agricultural land adjacent to the river compared to the proposed pipeline route. Neither of the routes would cross any shallow bedrock. The proposed pipeline route would cross 370 feet more highly wind erodible soils, 528 feet more of hydric soils, 422 feet less of prime farmland soils, less forest land, and less prime farmland when compared to the Middle River Alternative.

Figure 2.3.3-2 Middle River Alternative

In summary, the Project route would require a new right-of-way approximately 400 feet south of the existing Enbridge pipeline right-of-way; however, this would decrease disturbance to a highly erodible steep bank, forest land, and agricultural land when compared to the alternative route.

Snake River Alternative

The Snake River Alternative would parallel the south side of the existing Enbridge pipeline right-of-way between MPs 842.7 and 843.2, and would cross the river adjacent to the existing five pipelines (see figure 2.3.3-3). The Snake River Alternative would be 2,429 feet long and be parallel to the river in two locations within the right-of-way. The alternative alignment would present significant construction and restoration issues due to a meandering channel on both sides of the alignment. In addition, steep banks on the east side would further complicate this crossing and threaten maintaining a stable right-of-way due to potential undercutting during high water flow periods.

The Project route would be 2,481 feet long. It would depart the existing Enbridge pipeline right-of-way just east of Marshall County Road 14 and proceed southeast for about 1,400 feet beginning west of the high bank of the river, allowing for a perpendicular waterbody crossing. The Project route would then turn east-southeast to rejoin the existing Enbridge pipeline right-of-way. The Project would route alleviate potential construction and future operational issues and also preserve the river's natural channel configuration across the existing right-of-way. A new right-of-way would exist 350 feet south of the existing Enbridge pipeline right-of-way. Table 2.3.3-3 provides a comparison of environmental features for the two routes.

TABLE 2.3.3-3

Environmental Features Comparison of the Proposed Pipeline Route and Snake Alternative (Between MPs 842.7 and 843.2)[a]

Environmental Features	Unit	Proposed Pipeline Route	Snake River Alternative
Length	Miles	0.5	0.5
Adjacent to Existing Right-of-Way	Feet	0	2,429
Greenfield Route	Feet	2,534	0
NWI-mapped Wetlands Crossed	Feet	0	129
Highly Wind Erodible Soils [b]	feet	0.4	0.3
Depth to Water Table (≤ 6 feet)[c]	Feet	0	0
Shallow Bedrock	Feet	0	0
Hydric Soils	Miles	<0.1	0.1
Prime Farmland Soils	Miles	<0.1	0.0
Forest Land Affected	Miles	0.1	0.1
Agricultural Land Affected	Miles	0.4	0.3
Herbaceous Land Affected	Miles	0	0
Open Water Crossed	Feet	pending [d]	pending [d]
Intermittent Waterbodies Crossed	no.	0	0
Perennial Waterbodies Crossed	no.	1	1
Railroad Crossings	no.	0	0
Interstate and Highway Crossings	no.	0	0

a/ Route characteristics that were not significantly different were not included in this comparison.
b/ Indicates route length that would cross soils with a wind erodible index of a potential for a loss of 134 to 310 tons /acre/year.
c/ Indicates length of route where project could encounter groundwater within 6 feet of the surface.
d/ Data pending completion of field surveys.

Figure 2.3.3-3 Snake River Alternative

The Snake River Alternative would cross 129 feet of NWI-mapped wetland, compared to no wetlands crossed by the Project. Wetlands crossed by the Snake River Alternative include one wetland primarily associated with the river's riparian area. Both routes would cross similar flat river basin terrain before reconnecting with the existing route alignment. Neither the Project route nor the alternative would cross any shallow bedrock. The Project route would cross 211 feet more of highly wind erodible soils, 106 feet less of hydric soils, and 60 feet more of prime farmland soils than the Snake River Alternative.

In summary, the Project route would ensure a perpendicular approach and crossing of the Snake River to alleviate construction and restoration issues. The Project route would decrease disturbance to a highly erodible, steep eastern bank on the south side of the existing Enbridge pipeline right-of-way. Construction of the Project route would allow for a manageable waterbody crossing.

3.0 SOCIOECONOMICS

Construction and operation of the Project will result in both temporary and long-term socioeconomic impacts in the counties crossed by the Project. During construction, there will be temporary increases in local population, demand for short-term housing, use of transportation systems, and expenditures in local economies for goods and services. Construction will also result in temporary impacts on agricultural production. Long-term impacts associated with the Project include payment of local property and/or ad valorem taxes and the creation of both permanent and temporary jobs for pipeline operation and maintenance activities.

This section provides a description of the existing socioeconomic conditions in the counties along the Project and an analysis of temporary and long-term impacts on those conditions.

3.1 EXISTING SOCIOECONOMIC CONDITIONS

Enbridge reviewed 2005 U.S. Census Bureau, 2004 Northwest Area Foundation Indicator Website, and 2005 Minnesota Department of Employment and Economic Development Local Area Unemployment Statistics data to gather information on existing socioeconomic conditions in the six counties to be affected by the Project. The following paragraphs provide discussions on current population levels and density, per capita income, workforce, unemployment rates, and industry in these counties. Data on existing conditions also are summarized in table 3.1-1.

TABLE 3.1-1

Existing Socioeconomic Conditions in LSr Project Area

State/ County	Population Estimate [a]	Population Density (people per sq. mile) [a]	Per Capita Income [b]	Civilian Labor Force [c]	Unemployment Rate (percent) [c]	2000 Major Employment Industries [a]
MINNESOTA	5,132,799	62	$37,411	2,974,779	4.2	Educational, health, and social services; Manufacturing; Retail Trade
Kittson	4,792	5	$28,671	2,582	5.4	Educational, health, and social services; Manufacturing; Agriculture, forestry, fishing and hunting, and mining
Marshall	9,965	6	$26,901	5,453	7.3	Educational, health, and social services; Manufacturing; Agriculture, forestry, fishing and hunting, and mining
Pennington	13,608	22	$32,284	8,283	5.9	Educational, health, and social services; Manufacturing; Retail Trade
Red Lake	4,317	10	$22,715	2,301	6.8	Educational, health, and social services; Manufacturing; Retail Trade
Polk	31,133	16	$27,260	18,188	4.6	Educational, health, and social services; Retail Trade; Manufacturing
Clearwater	8,476	9	$22,734	4,002	11.3	Educational, health, and social services; Retail Trade; Construction

[a] U.S. Census Bureau, http://quickfacts.census.gov, 2005 (population) and 2000 (population density).
[b] Northwest Area Foundation Indicator Website, www.indicators.nwaf.org, 2004.
[c] Minnesota Department of Employment and Economic Development, LAUS Data, www.deed.state.mn.us, December 2006.

County population levels within the Project area range from a low of 4,317 persons in Red Lake County to a high of 31,133 persons in Polk County. In general, population levels are low in the northern counties. In addition to having smaller populations, the northern counties also experienced slower growth rates than other counties in Minnesota, or population losses, between 2000 and 2005. Kittson and Marshall Counties, for example, had growth rates of -9.3 and -1.9 percent, respectively, while slight population increases were seen in Pennington (0.2 percent), Red Lake (0.4 percent), and Clearwater (0.6 percent) Counties. Population density (an indicator of the extent of development) in the counties affected by the project averages 11 people per square mile. This is lower than the statewide average of 62 people per square mile and reflects the generally rural character of much of the proposed pipeline route.

Per capita income in 2004 ranged from a low of $22,715 in Red Lake County to a high of $32,284 in Pennington County. In general, per capita income is lowest in rural counties with low population densities and high unemployment rates, and highest in urban counties with high population densities and low unemployment rates.

The December, 2006 unemployment rate in the Project area varied from 4.6 percent in Polk County to 11.3 percent in Clearwater County. These are greater than the statewide average of 4.2 percent.

Employment in the Project area is concentrated in the manufacturing, accommodation, and food services, healthcare and social services, and retail trade industries. Educational, health, and social service, manufacturing, and retail trade are the top employment industries in the northern counties. Agriculture, forestry, fishing and hunting, and mining are also important industries in the counties along the pipeline route.

In general, the Project route avoids population centers and residential areas. Nine municipalities are located within approximately 1 mile of the pipeline route (see table 3.1-2). The majority of these communities have populations less than 500. The largest communities in the project area are Clearbrook, Gonvick, and Oklee.

TABLE 3.1-2

Municipalities within 1.0 Mile of the LSr Project Pipeline Route

County/Municipalities	Milepost	Population Estimate (2005) [a]
Kittson County		
Donaldson	815	38
Marshall County		
Viking	849	92
Pennington County		
Saint Hilaire	866	273
Red Lake County		
Plummer [b]	876	271
Oklee [b]	886	382
Polk County		
Trail [b]	895	63
Gully	898	106
Clearwater County		
Gonvick	903	297
Clearbrook	909	536

[a] U.S. Census Bureau, www.quickfacts.census.gov.
[b] City or Township will be crossed by the proposed pipeline route.

3.2 GENERAL CONSTRUCTION AND OPERATION IMPACTS AND MITIGATION

3.2.1 Construction Schedule and Workforce

Construction of the Project is scheduled to occur over a 6-month period, beginning in the second quarter of 2008, with an in-service date of late 2008. Enbridge anticipates that the total workforce over this period will be approximately 1,000 workers. Workers generally will be dispersed along the length of the construction route rather than concentrating at a single work site.

Enbridge, through its construction contractors and subcontractors, will attempt to hire local workers where the local workforce possesses the required skills. Construction personnel hired from outside the project area will augment the local workforce and consist of supervisors, environmental inspectors, and highly skilled mechanical, electrical, and instrumentation/control tradesmen. Non-local workers will relocate to the Project area for the duration of construction.

Local workers will commute from their residences to Project work sites on a daily basis. Non-local workers will reside in the vicinity of the Project for short periods and they will not typically be accompanied by family members. As a result, incremental demand from non-local workers for public services will be small.

Local communities will benefit from monies paid to construction workers, both local and non-local, throughout the construction period. Workers will spend a portion of their earnings locally, thereby providing significant revenues to local communities. Both local and non-local workers will use hospitality services such as restaurants, grocery stores, and gasoline stations. Non-local workers will require temporary housing in addition to hospitality services. Additionally, the construction contractors and subcontractors may purchase materials from local vendors, and lease land and equipment for temporary field offices and material storage areas. Operation of the Project will not require Enbridge to hire any new full-time employees.

Local communities also will benefit from periodic employment created by pipeline operation and maintenance activities. Workers for these activities may be local or non-local. Similar to the construction period, communities will benefit from the monies spent by temporary workers on local hospitality services and temporary housing. Additionally, construction contractors or Enbridge employees may purchase materials from local vendors.

3.2.2 Housing

Enbridge does not expect that construction crews will encounter difficulties finding temporary housing in the project area. Local workers will commute from their residences. Non-local workers will use hotels, motels, and apartments or bring their own mobile housing units (such as travel trailers or campers) and stay at local campgrounds. Because workers generally will be dispersed along the length of the Project route, demands for temporary housing within local communities will be minimal.

3.2.3 Transportation

Short-term impacts on local transportation systems may result from construction of the pipeline across roads and railroads; movement of construction equipment and material to work areas; and daily commuting of the construction workforce to work sites. These impacts are not expected to be significant.

Table 4.3.6-1 provides a summary of the types of roads that are crossed by the Project. Appendix D lists the roads that will be crossed by the pipeline route. Enbridge typically will construct the pipelines across paved roadways and railroads using road-boring equipment. This equipment installs the pipeline beneath the road without closing it, thereby avoiding disruptions to vehicular or railcar movement and physical impacts on road/railroad beds. Unpaved roadways will typically be crossed by boring or by using the open-cut method. The latter method will temporarily disrupt road traffic as the pipe trench is excavated across the roadway. To minimize traffic delays at open-cut crossings, Enbridge will establish traffic detours before excavating the roadbed. If no reasonable detours are feasible, at least one traffic lane of the road will be maintained, except for brief periods when road closure is essential to install the pipeline. Enbridge will minimize the duration of open-cut crossings and in most cases complete these road crossings in 1 day or less. Enbridge will notify local residents prior to road closures. Additionally, Enbridge will attempt to avoid closing roads during peak traffic hours.

To maintain safe conditions, Enbridge will direct its construction contractors to adhere to local weight restrictions and limitations for its construction vehicles, and to remove soil that is left on the road surface by the crossing of construction equipment. In addition, when it is necessary for construction equipment to move across paved roads, mats or other appropriate measures will be used to prevent damage to the road surface.

Enbridge anticipates that up to 11 truck loads of pipe joints will be needed per mile of pipeline over area roads to deliver the pipe along the construction route. Truck traffic associated with transporting this pipe as well as other construction-related travel associated with the project may increase the workload of local authorities to assist with traffic control. In addition, local authorities may need to assist with short-term detours at pipeline road crossings or delays in traffic flow from large, slow-moving vehicles. Enbridge does not anticipate that these project-related demands on local authorities will be significant.

The movement of construction personnel, equipment, and materials from contractor and pipe storage yards to the construction work area will result in additional short-term impacts on the local transportation system. Several construction-related trips will be made each day to and from the job site. Traffic will remain fairly consistent throughout the construction period, and will typically peak during early morning and evening hours. Enbridge anticipates that road congestion will increase during these peak hours but will not significantly disrupt the normal flow of traffic in the project area.

Incremental road congestion could be caused by construction workers commuting to and from work sites on a daily basis. However, due to the generally rural location of the project, notable increases in rush hour traffic are not anticipated. Furthermore, because pipeline construction generally is scheduled to take full advantage of daylight hours, most workers will commute during off-peak hours (i.e., early morning and evening). In addition, construction workers typically will leave their personal vehicles at contractor yards and participate in share rides to work sites with other workers; this will help reduce road congestion in the vicinity of work sites. Finally, as stated previously, workers generally will be dispersed along the entire length of the pipeline route, as opposed to concentrating at a single work site, thereby reducing impacts on traffic at any one location.

3.2.4 Loss of Agricultural and Timber Production

Construction of the Project will affect approximately 1,160 acres of agricultural land, including hayfields and pasture (see section 4.3.1). Landowners will be compensated for agriculture-related losses according to agreements negotiated between each landowner and Enbridge. Long-term effects on crop yields are not expected because Enbridge will use construction and restoration techniques designed to protect or restore soil productivity. These techniques are described in the Enbridge Agricultural Mitigation Plan (AMP) (see Appendix E).

Construction also will result in the removal of approximately 44 acres of timber resources within the construction right-of-way. Merchantable timber will be salvaged and sold if possible, unless otherwise agreed to by the landowner. If a commercial buyer cannot be found, the timber may be considered non-merchantable and disposed of by mowing, chipping, grinding, and/or hauling off site to an approved disposal facility. Burning of non-merchantable wood may be allowed only where the contractor has acquired all applicable permits and approvals (*e.g.*, agency and landowner) and in accordance with all federal, state and local regulations. No burning will be allowed in wetlands.

3.2.5 Tax Revenues

Long-term economic benefits associated with operation of the pipeline will include increased tax revenues at the state and county level in the form of property and/or ad valorem taxes. Enbridge estimates that the Project will generate approximately $9 million in annual local tax revenues for the counties, depending on the number of pipeline miles within the county and the placement of pipeline-related facilities such as pump stations.

4.0 LAND USE

4.1 EXISTING LAND USE

Land use along the pipeline route was characterized using the USGS Land Use and Land Cover Classification System. This system utilized satellite imagery taken in the early 1990s to classify land use into 21 categories. For the Project, these USGS land use categories were combined into five general categories: forest land, open land, agricultural land, developed land, and wetland/open water based on prevalent land use and vegetation cover types. Land use along the pipeline route was characterized, by milepost, into one of the five categories. Definitions of the five land use categories are presented below.

- Forest Land consists of areas classified as deciduous forest, evergreen forest, and mixed forest.
- Open Land consists of areas classified as bare rock, sand, or clay; quarries, strip mines, or gravel pits; transitional; shrubland; grasslands or herbaceous areas; and urban or recreational grasses.
- Agricultural Land consists of areas classified as orchards or vineyards, row crops, small grains, fallow, and pasture.
- Developed Land consists of areas classified as low intensity residential, high intensity residential, and commercial, industrial, and transportation.
- Wetland/Open Water consists of areas classified as woody wetlands, emergent herbaceous wetlands, and open water.

4.2 LAND USE AFFECTED BY PIPELINE CONSTRUCTION AND OPERATION

The Project will be constructed using a 100-foot-wide construction right-of-way and additional temporary extra workspaces at feature crossings (e.g., roads, waterbodies). For the 107.7-mile-long portion of the pipeline that will cross Minnesota, construction will affect approximately 1,305 acres of land. The predominant land use identified along the proposed Project route is agricultural land, which accounts for 1,299 acres (or 89.5 percent) of the total construction area. Of the agricultural land affected, approximately 87.4 percent (or 1135.3 acres) is cultivated and the remaining 12.6 percent (or 164.4 acres) is pasture land. Other land uses are forest land (81.1 acres or 5.6 percent), wetland/open water (56.1 acres or 3.9 percent), and developed land (9.8 acres or 0.7 percent). Table 4.2-1 provides a summary of the land uses affected by the project in Minnesota.

No additional land use impacts are expected to occur with regard to aboveground facilities because all work of this nature will occur within the boundaries of existing Enbridge aboveground facilities. No pipe storage yards or private or new access roads have been identified at this time. This information will be filed when available, approximately July 2007.

Following construction, Enbridge will maintain an additional 40-foot-wide permanent right-of-way beyond the existing permanent right-of-way for operation of the pipeline. Table 4.2-2 presents the land area permanently affected by operation of the pipeline.

TABLE 4.2-1

Land Uses Affected by the Construction of the LSr Project [a]

County	Forested		Agricultural		Developed		Open Land		Wetland/Water		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Kittson	1.8	0.1%	195.6	13.5%	2.6	0.2%	0.0	0.0%	0.8	0.1%	200.8	13.8
Marshall	11.0	0.1%	440.5	30.3%	1.4	0.1%	0.2	0.0%	3.0	0.2%	456.1	31.4
Pennington	29.9	2.1%	235.4	16.2%	1.6	0.1%	0.0	0.0%	7.3	0.5%	274.2	18.9
Red Lake	11.1	0.1%	193.8	13.3%	2.1	0.1%	0.3	0.0%	4.2	0.3%	211.5	14.6
Polk	18.2	1.3%	131.6	9.1%	0.6	0.0%	0.3	0.0%	31.0	2.1%	181.7	12.5
Clearwater	9.1	6.3%	102.8	7.1%	1.5	0.1%	4.5	0.3%	9.8	0.7%	127.7	8.8
Total Acres/Total Percent	**81.1**	**5.6%**	**1299.7**	**89.5%**	**9.8**	**0.7%**	**5.3**	**0.4%**	**56.1**	**3.9%**	1452.0	100

[a] Calculations were based on a 100-foot-wide construction right-of-way in all areas. Does not account for areas where the construction right-of-way may be reduced (e.g., wetlands). Does not include additional temporary workspaces, aboveground facilities, access roads, or pipe storage and contractor yards.

Note: Due to rounding, totals may be off by 0.1 place.

TABLE 4.2-2

Land Uses Affected by the Operation of the LSr Project [a]

County	Forested		Agricultural		Developed		Open Land		Wetland/Water		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Kittson	0.7	0.1%	72.6	13.9%	0.6	0.1%	0.0	0.0%	0.3	0.1%	74.2	14.2
Marshall	3.2	0.6%	163.3	31.3%	0.1	0.0%	0.1	0.0%	1.2	0.2%	167.9	32.2
Pennington	10.1	1.9%	81.7	15.7%	0.4	0.1%	0.0	0.0%	2.9	0.6%	95.1	18.2
Red Lake	2.3	0.4%	70.7	13.5%	0.8	0.2%	0.1	0.0%	1.7	0.3%	75.6	14.5
Polk	5.9	1.1%	47.3	9.1%	0.1	0.0%	0.1	0.0%	12.2	2.3%	65.6	12.6
Clearwater	2.1	0.4%	35.3	6.8%	0.4	0.1%	1.7	0.3%	3.9	0.7%	43.4	8.3
Total	**24.3**	**4.7%**	**470.9**	**90.2%**	**2.4**	**0.5%**	**2.0**	**0.4%**	**22.2**	**4.2%**	521.8	100

[a] Calculations were based on a 40-foot-wide permanent right-of-way in all areas. Does not include aboveground facilities.

Note: Due to rounding, totals may be off by 0.1 place.

4.2.1 Ownership Status of Lands Crossed by the Pipeline

As shown in table 4.2.1-1, the Project route predominantly crosses private lands located outside of municipal areas (103.6 miles or approximately 96 percent of the route). The route also crosses county lands (0.3 mile) and incorporated areas (3.7 miles). County lands consist of tax-forfeited parcels. Incorporated areas crossed by the pipeline include the Cities of Plummer, Oklee, and Trail. No federal or state lands are crossed by the proposed pipeline route.

TABLE 4.2.1-1

Ownership of Lands Crossed by the LSr Project Pipeline Route

Land Type/Location	Crossing Length (miles)	Percentage of Route
Federal lands	0.0	0
State Lands	0.0	0
County Lands	0.3	<1
Incorporated Areas:		
Plummer	2.0	2
Oklee	0.7	<1
Trail	0.8	<1
Private Land Outside Incorporated Areas	103.9	96
Total	107.7	100

4.2.2 Areas with Comprehensive Land Use Plans

The Project route will cross three watershed districts and three counties where comprehensive land use plans have been established: the Two Rivers Watershed District; Middle-Snake-Tamarac Rivers Watershed District; Red Lake Watershed District; Marshall County; Polk County; and Clearwater County. Both aboveground and buried utilities currently exist in these planning areas, and it is expected that the Project will be consistent with these land use plans. Enbridge will consult with affected watershed districts and counties to ensure that the Project is designed and constructed in a manner that minimizes impacts on the land use objectives for these areas.

4.3 GENERAL CONSTRUCTION AND OPERATION IMPACTS AND MITIGATION

4.3.1 Agricultural Land

Approximately 1,177 acres of agricultural land will be temporarily disturbed during construction of the Minnesota portion of the Project. Construction activities will temporarily utilize active cropland within construction work areas. Construction activities may also interfere with planting or harvesting, depending on the construction season. Following construction, agricultural activities will resume within the permanent pipeline right-of-way.

Enbridge will maintain access to fields, storage areas, structures, and other agricultural facilities during construction, and will maintain irrigation and drainage systems that cross the right-of-way to the extent practicable. All drainage systems will be identified and repaired in accordance with the AMP (Appendix E). Agricultural land in the construction right-of-way will generally be taken out of production for one growing season and will be restored to previous uses following construction. Landowners will be compensated for crop losses and other damages caused by construction activities.

Enbridge will implement measures to avoid, minimize, or mitigate potential impacts on soil productivity in accordance with the AMP (see Appendix E). These measures include topsoil segregation, stone removal (>4-inch diameter), and measures to avoid compaction or loosen compacted soils. To prevent soil compaction, drainage alteration, and damage to crops, operation of maintenance equipment on agricultural lands will be limited to access routes agreed to with landowners.

Based on a review of publicly-available information, including aerial photos along the Project route, Enbridge anticipates that no center-pivot irrigation systems will be crossed by the Project.

Enbridge will also take appropriate measures to protect livestock during construction. To minimize short-term disruption to livestock operations, Enbridge will minimize the length of time that the trench is open and will coordinate with landowners to minimize disruption of access. Where appropriate, Enbridge will maintain temporary access ways across the trench as necessary to allow the passage of livestock, and will erect temporary fences (including gates) as necessary to contain and protect livestock from construction-related hazards. After completing construction, fences and gates will be rebuilt to their former condition or better.

4.3.2 Forest Land

Approximately 60.9 acres of forest land will be temporarily disturbed during construction of the Minnesota portion of the Project. Following construction, approximately 24.3 acres of forest will be permanently converted to shrub and herbaceous cover types as the result of routine maintenance practices along the new pipeline. The 60.9 acres of trees temporarily cleared from the construction right-of-way will revegetate and develop forest communities.

Localized short- and long-term impacts will result from the construction of Project route through forested areas. Trees and brush will be removed from the construction right-of-way and temporary workspaces. Overlapping the construction right-of-way with Enbridge's existing maintained right-of-way to the greatest extent possible will minimize impacts on forest land. This existing permanent right-of-way is maintained in an herbaceous state to facilitate proper aerial inspection.

Following construction, forested areas located on the new permanent right-of-way will be seeded to promote herbaceous cover types. Consistent with previous practices, the new permanent right-of-way will be maintained in an herbaceous state. Forested areas on the temporary right-of-way and extra workspaces will be restored to allow the re-establishment of forest cover. The rate of forest reestablishment will depend upon the type and age of the vegetation cleared, as well as the natural fertility of the areas affected. It is anticipated that early successional species will begin to colonize the right-of-way within a few years after construction, followed by establishment of later successional species.

4.3.3 Wetland/Open Water

Approximately 55.5 acres of open water and wetlands will be affected by construction of the Minnesota portion of the Project. The open water will be affected at crossings of streams, rivers, and lakes. Wetlands will be allowed to revegetate naturally. Construction impacts associated with these crossings are discussed in sections 9.1.4, 9.2.4, and the EMP (see Appendix B).

4.3.4 Open Land

Approximately 5.1 acres of open land will be temporarily disturbed during construction of the Minnesota portion of the Project. Open land will be temporarily disturbed during grading, trenching, backfilling, and restoration. After final construction clean up, the open land in upland areas will be reseeded and mulched in accordance with the EMP (see Appendix B).

4.3.5 Developed Land

Approximately 6.2 acres of developed land will be affected during construction of the Minnesota portion of the Project. Based on examination of aerial photographs, there are approximately 61 residences and 137 commercial buildings within 500 feet of the construction right-of-way (see table 4.3.5-1). In addition, there are three residences within 50 feet of the construction work area. Many of the residences and most of the residential land are located in or near the incorporated areas identified in section 4.2.1.

TABLE 4.3.5-1

Summary of Structures Within 500 Feet of the Construction Work Area

County	Residential	Commercial	Total
Kittson	1	19	20
Marshall	4	28	32
Pennington	25	34	59
Red Lake	2	39	41
Polk	10	6	16
Clearwater	19	11	30
Total	61	137	198

During construction, residences in proximity to construction activities may be exposed to short-term increases in construction-related noise and dust. Construction-related dust emissions will generally be of short duration and dependent on soil type, weather conditions, and the extent of ground disturbance. Some minor dust emission is inevitable in any construction project; however, the construction right-of-way and access roads near residential areas will be sprayed with water as needed to control dust during active construction. During periods of high winds, work will be temporarily suspended if control measures are ineffective and if dust is excessive for the area. After construction is completed, measures to stabilize and revegetate the right-of-way will prevent ongoing dust emissions.

The heavy construction equipment needed to construct the Project will generate unavoidable short-term increases in ambient noise levels. Typical bulldozers, backhoes, and sideboom tractors used to install large-diameter pipelines generate 80 to 90 decibels within 50 feet of the equipment. Increases in ambient noise levels due to heavy equipment operation will be limited to the period of construction. Construction activities will generally be limited to daylight hours. No noise will be generated along the pipeline right-of-way during normal operation of the Project.

4.3.6 Transportation Corridors

The Project route will cross federal, state, county, city/township, and private/commercial roads, and railroads. In total, the Project route will cross 165 roads as summarized in table 4.3.6-1 and a complete list of road crossings is included in Appendix D.

TABLE 4.3.6-1

Number of Roads Crossed by the LSr Project Pipeline Route

County	State or Federal	Local
Kittson	2	22
Marshall	0	58
Pennington	2	39
Red Lake	1	16
Polk	1	15
Clearwater	1	8
Total	7	158

Construction methods will vary among roadway types crossed by the Project. Typical crossing methods are discussed in the Enbridge EMP (see Appendix B). Enbridge proposes to bore beneath most paved roads allowing them to remain open during construction. Open-cut construction is typically proposed for unpaved roads, which will require temporarily closing these roads and implementing detours. If no reasonable detour is feasible, at least one traffic lane will be maintained, except for brief periods essential to laying the new pipeline. Construction disturbance at each open-cut road crossing will typically be limited to 1 day, which is not expected to have a significant impact on local traffic patterns. Detour, warning, traffic control, and safety signs will be posted as prescribed by federal, state, and local (county) departments of transportation. Attempts will be made to avoid road closures during peak-traffic time periods.

The Project route will cross five railroads as identified in table 4.3.6-2. Enbridge plans to cross all railroads by boring beneath them, allowing them to remain operational during construction.

TABLE 4.3.6-2

Railroads Crossed by the LSr Project Pipeline Route

County	Milepost	Description	Township	Range	Section
Kittson	817.0	Burlington Northern & Santa Fe Railway	159	48	31
Marshall	846.6	Northern Plains Railroad	155	45	20
Pennington	863.8	Minnesota Northern Railroad, Inc.	153	43	29
Red Lake	875.8	Canadian Pacific Railway	151	42	9
Polk	896.0	Canadian Pacific Railway	150	39	28

No long-term effects are expected on roads and railroads crossed by the Project route because the function of these areas will be restored after construction.

Designated Roadways

No designated scenic roadways are crossed by the Project route in Minnesota.

Airports

There are no airports within 1 mile of the Project route in Minnesota.

5.0 TERRAIN / GEOLOGY

5.1 EXISTING TERRAIN AND GEOLOGY

The Project is located within the Western Lake section of the Central Lowlands Physiographic Province. Surface features in this area were formed mainly during the Wisconsin Glaciation. The area's topography is characterized by large, gently rolling till plains, hilly areas formed by glacial moraines, and outwash plains. In addition, the section contains glaciolacustrine deposits from Glacial Lake Agassiz, which covered the northwestern portion of Minnesota during the Wisconsin Glacial Age.

The Project route will cross extensively glaciated terrain. Surficial geology is characterized by ground and end moraines and glacial lake sediments deposited by the Des Moines Lobe of the Wisconsin Glaciation (Ojakangas and Matsch, 1982). Topography along the route includes nearly level to gently rolling glacial lake plains and rolling to steeply irregular moraine complexes (see figure 5.1-1). Numerous lakes and wetland areas have formed in depressions contained within the glaciated terrain. Elevations in the Project area range from approximately 766 feet to 1,369 feet above mean sea level (msl) and generally increase from north to south. Elevation along the Project route is summarized by county in table 5.1-1.

TABLE 5.1-1

Elevation Along the LSr Project Pipeline Route

	Milepost		Elevation Above Mean Sea Level (feet)		
County	Beginning	Ending	Lowest	Average	Highest
Kittson	801.8	817.1	766	804	826
Marshall	817.1	851.8	826	934	1,075
Pennington	851.8	871.4	1,075	1,108	1,140
Red Lake	871.4	887.0	1,105	1,136	1,156
Polk	887.0	900.5	1,151	1,217	1,337
Clearwater	900.5	909.5	1,269	1,305	1,369

The majority of the Project region is underlain by Late Archean sedimentary and igneous rocks, as well as Middle Ordivician to Cretaceous rocks (see figure 5.1-2). Bedrock along the pipeline route consists of mostly granite, sandstone, and basalt. Along the Project route, however, depth to bedrock can exceed more than 450 feet (Ojakangas and Matsch, 1982); none of the route will cross areas with bedrock at depths of less than 5 feet (see section 6.3.5) and, therefore, blasting and other methods required for construction in bedrock are not anticipated for the Project.

There is a low probability for earthquakes of significant intensity or other seismic events in the project area. In addition, the Project route will not cross any Quaternary-age faults (National Atlas of the United States, 2006).

Mineral resources in Minnesota include industrial (e.g., sand, gravel, and crushed stone) and metallic (e.g., iron ore, nickel, and titanium) minerals. Few sand and gravel quarry operations are present within the counties along the pipeline route (National Atlas of the United States, 2006). In addition, based on a review of USGS 7.5-minute-series topographic maps, no gravel pits or active mining operations were identified within 500 feet of the Project route.

Figure 5.1-1 Quaternary Geology in Project Area

Figure 5.1-2 Bedrock Geology in Project Area

5.2 GENERAL CONSTRUCTION AND OPERATION IMPACTS AND MITIGATION

Construction and operation of the Project will result in minor impacts on topography and geology. Primary impacts will be limited to construction activities and consist of temporary disturbance to slopes due to grading and trenching operations. These activities will be necessary to create a level and safe construction right-of-way.

Enbridge will minimize impacts by returning contours to pre-construction conditions to the extent practicable. In addition, Enbridge will implement the erosion control measures described in the EMP (Appendix B). These measures will consist of the installation of slope breakers, temporary sediment barriers, and permanent trench breakers, and revegetation and mulching of the construction right-of-way.

It is not anticipated that blasting will be required during construction of the Project because none of the Project route will cross areas with shallow bedrock. If blasting is required, however, Enbridge will conduct these activities in accordance with applicable regulations.

The Project will be installed adjacent to existing pipelines and primarily within existing maintained right-of-way. Therefore, any sand and gravel deposits in the Project area will be unavailable for mining.

Enbridge does not anticipate impacts associated with seismic activity within the Project area. Due to the limited potential for large, seismically induced ground movements, there is minimal risk of earthquake-related impacts on the Project, and no mitigation is needed.

6.0 SOILS

6.1 GENERAL SOIL COMPOSITION

The Project route will cross the Red River Valley of the North and the Northern Minnesota Gray Drift Major Land Resource Areas (MLRAs). The Red River Valley of the North MLRA consists of a nearly level glacial lake plain that is bordered on the east by outwash deposits, gravelly beaches, and dunes. The dominant soils in this area are Aquolls. These deep, somewhat poorly to poorly drained soils have a sandy to clayey texture and a frigid temperature regime. The Northern Minnesota Gray Drift MLRA consists of a rolling glacial moraine and associated outwash that has short, choppy, and complex slopes. The dominant soils in this area are Udalfs. These deep, well to moderately well drained soils have a medium texture, a frigid temperature regime, and mixed mineralogy (United States Department of Agriculture (USDA), 1978).

6.2 IDENTIFICATION OF SOIL CONDITIONS

6.2.1 Background and Methodology

Detailed soil characteristics along the Project route were identified and assessed using the Soil Survey Geographic (SSURGO) Database (USDA, NRCS, 2003). The SSURGO database is a digital version of the original county soil surveys developed by the NRCS for use with GIS. It provides the most detailed level of soils information for natural resource planning and management. Mapping scales in the project area generally range from 1:12,000 to 1:20,000, with a minimum delineation size of 1.4 to 4.0 acres. SSURGO is linked to an attribute database that gives the proportionate extent of the component soils and their properties for each map unit (USDA, NRCS, 1995). The SSURGO database was used to define soil characteristics along the pipeline route.

SSURGO attribute data consist of physical properties, chemical properties, and interpretive groupings. Attribute data apply to the whole soil (e.g., listed hydric, prime farmland soils or slope class) as well as to layer data for soil horizons (e.g., texture or permeability). The soil attribute data can be used in conjunction with spatial data to describe the soils in a particular area.

6.2.2 Soil Characteristics and Assessments

Enbridge digitized and overlaid the Project route onto the SSURGO database to identify soil mapping units in the project area (additional temporary extra workspaces at feature crossings were not included in the soil analysis). Based on an analysis of these data, Enbridge identified soil characteristics that could affect or be affected by pipeline construction. These characteristics include: highly erodible soils; prime farmland and hydric soils; compaction-prone soils; presence of stones and shallow bedrock; droughty soils; depth of topsoil; and percent slope.

Tables 6.2.2-1 and 6.2.2-2 provide a summary of significant soil characteristics identified along the Project route by county. Table 6.2.2-3 lists topsoil depths for prime farmland crossed by the Project route. Individual soil characteristics are discussed separately below.

TABLE 6.2.2-1

Soil Characteristics in the LSr Project Area [a]

County	Total Acres in County	Prime Farmland	Hydric Soils	Compact. Prone	Highly Erodible Water	Highly Erodible Wind	Reveg. Concerns	Stony/ Rocky	Shallow to Bedrock
		Acres (percent)							
Kittson	185.6	181.7	152.7	171.4	--	--	--	--	--
Marshall	420.3	296.9	180.2	156.3	1.4	105.4	156.5	--	--
Pennington	237.0	160.5	162.3	121.2	--	32.9	64.0	--	--
Red Lake	189.2	164.7	154.5	123.1	--	5.8	33.8	--	--
Polk	163.9	63.1	91.1	64.7	2.4	89.9	67.7	--	--
Clearwater	108.6	88.1	49.2	46.4	0.9	8.5	4.5	1.4	--
Pipeline Total	1304.6	955.0 (73)	790.0 (61)	683.1 (52)	4.7 (<1)	242.5 (19)	326.5 (25)	1.4 (<1)	0.0 (0)

[a] Acreage is based on a 100-foot-wide construction right-of-way and does not include access roads, temporary extra workspace, or areas of open water, and does not account for reduced right-of-way widths in wetlands and forested areas.

TABLE 6.2.2-2

Topsoil Depths and Slope Class in the LSr Project Area [a]

County	Total Acres in County	Topsoil Depth (inches) in Acres (percent)				Slope Class (percent) in Acres (percent)				
		0-6	>6-12	>12-18	>18	0-5	>5-8	>8-15	>15-30	>30
Kittson	185.6	--	162.9	13.0	9.7	185.6	--	--	--	--
Marshall	420.3	34.5	241.6	50.6	93.6	418.9	--	--	1.4	--
Pennington	237.0	82.0	103.7	37.7	13.6	235.8	--	--	1.2	--
Red Lake	189.2	20.1	169.1	--	--	189.2	--	--	--	--
Polk	163.9	50.3	90.4	23.2	--	135.3	--	9.9	18.7	--
Clearwater	108.6	69.3	37.9	--	1.4	106.4	--	2.2	--	--
Pipeline Total	1304.6	256.2 (20)	805.6 (62)	124.5 (10)	118.3 (9)	1271.2 (97)	0.0 (0)	12.1 (1)	21.3 (2)	0.0 (0)

[a] Acreage is based on a 100-foot-wide construction right-of-way and does not include access roads, temporary extra workspace, or areas of open water, and does not account for reduced right-of-way widths in wetlands and forested areas.

TABLE 6.2.2-3

Topsoil Depths on Prime Farmland in the LSr Project Area [a]

County	Total Acres in County	Topsoil Depth (inches) in Acres (percent)			
		0-6	>6-12	>12-18	>18
Kittson	181.7	0.0	160.2	13.0	8.5
Marshall	296.9	13.2	186.9	3.3	93.6
Pennington	160.5	45.1	78.8	23.0	13.6
Red Lake	164.7	16.8	147.9	0.0	0.0
Polk	63.1	17.4	24.6	21.1	0.0
Clearwater	88.1	63.5	24.6	0.0	0.0
Pipeline Total	955.0	156.0 (16)	623.0 (65)	60.3 (6)	115.7 (12)

[a] Acreage is based on a 100-foot-wide construction right-of-way and does not include access roads, temporary extra workspace, or areas of open water, and does not account for reduced right-of-way widths in wetlands and forested areas.

6.3 GENERAL CONSTRUCTION AND OPERATION IMPACTS AND MITIGATION

Pipeline construction activities such as clearing, grading, trench excavation, and backfilling, as well as the movement of construction equipment along the right-of-way may result in impacts on soil resources. Clearing removes protective cover and exposes soil to the effects of wind and precipitation, which may increase the potential for soil erosion and movement of sediments into sensitive environmental areas (such as wetlands). Grading and equipment traffic may compact soil, reducing porosity and percolation rates, which could result in increased runoff potential. Trench excavation and backfilling could lead to a mixing of topsoil and subsoil and may introduce rocks to the soil surface from deeper soil horizons. Contamination from spills or leaks of fuels, lubricants, and coolants from construction equipment also could impact soils. Enbridge will minimize or avoid these impacts on soils by implementing the mitigation measures described in the EMP, SPCCP, and AMP (see Appendices B, C, and E, respectively). Enbridge has developed a petroleum contaminated soils plan to address issues from prior contamination if encountered during construction (Petroleum-Contaminated Soil Management Plan, Appendix F).

6.3.1 Prime Farmland and Topsoil Segregation

Prime Farmland

The USDA defines prime farmland as “land that is best suited to food, feed, fiber, and oilseed crops” (Soil Survey Division Staff, 1993). This designation includes cultivated land, pasture, woodland, or other lands that are either used for food or fiber crops or are available for these uses. Urbanized land and open water are excluded from prime farmland. Prime farmland typically contains few or no rocks, is permeable to water and air, is not excessively erodible or saturated with water for long periods, and is not subject to frequent, prolonged flooding during the growing season. Soils that do not meet the above criteria may be considered prime farmland if the limiting factor is mitigated (e.g., by controlling soil moisture conditions through artificial drainage). Approximately 25 percent of the Project route will cross prime farmland soils with no limiting factor. An additional 48 percent of the soils crossed are considered prime farmland if limiting factors are mitigated.

Impacts on prime farmland from construction of the Project could include interference with agricultural drainage (if present), mixing of topsoil and subsoil, and compaction and rutting of soil. These impacts could result from right-of-way clearing, trench excavation and backfilling, and vehicular traffic within the construction right-of-way. With the mitigation measures specified in the AMP (see Appendix E), however, these impacts will be temporary and will not result in a permanent decrease in soil productivity.

Enbridge will implement the measures described in its AMP to minimize impacts on prime farmland and promote the long-term productivity of the soil. These measures will include topsoil segregation, compaction alleviation, removal of excess rock, and restoration of agricultural drainage systems and existing erosion control structures.

Topsoil Segregation

Topsoil thickness is the result of factors such as wetness, topography, climate, and the predominant vegetation present when the soil was being formed. Other factors being equal, prairie soils have more topsoil than forest soils; and wet soils have more topsoil than dry soils. According to data presented in tables 6.2.2-2 and 6.2.2-3, topsoil depths along the majority of the pipeline route are generally less than 12 inches but are thicker in some areas.

To minimize topsoil disturbance and topsoil and subsoil mixing associated with pipeline construction, Enbridge will remove and segregate topsoil in cropland, hay fields, pasture, residential areas and other areas as requested by the landowner (see EMP figures 1.2, 1.3, and 1.4 in Appendix B). Topsoil will be segregated using the "ditch plus spoil" method in active cropland unless another topsoil segregation method is requested by the landowner. The "trench-line-only" method will be used in unsaturated wetlands or where the width of the construction right-of-way is insufficient for other methods to be used. In upland areas with a thick sod layer such as hay fields, pasture, and residential areas, the "trench-line-only" method will be used unless otherwise requested by the landowner. Topsoil will be stripped to a maximum depth of 12 inches, unless otherwise requested by the landowner. If less than 12 inches of topsoil are present, every effort will be made to segregate to the depth that is present. The segregated topsoil and subsoil will be stockpiled separately and replaced in the proper order during backfilling and final grading of the construction right-of-way.

Additional procedures may be developed in consultation with the Minnesota Department of Agriculture (MDA) to minimize adverse impacts on crop yields that could occur when thick, dark colored topsoil layers with markedly different soil properties are mixed. Deeper topsoil may be relatively dark in color, but tends to be less productive, contains more rocks, and may have unfavorable soil chemistry (e.g., high carbonate content) that can affect plant nutrient uptake.

Implementation of proper topsoil segregation as detailed in the AMP prepared by Enbridge in consultation with the MDA (see Appendix E) will minimize the loss of crop productivity, ensure successful post-construction revegetation, and minimize the potential for long-term erosion problems. In the event of a conflict between the Routing Permit application and the AMP, the provisions of the AMP will prevail.

6.3.2 Soil Compaction and Rutting

Soil compaction modifies the structure and reduces the porosity and moisture-holding capacity of soils. Construction equipment traveling over wet soils could disrupt the soil structure, reduce pore space, increase runoff potential, and cause rutting. The degree of compaction depends on moisture content and soil texture. Fine-textured soils with poor internal drainage that are moist or saturated during construction are the most susceptible to compaction and rutting. Approximately 52 percent of the pipeline route is underlain by soils that are prone to compaction. In addition, approximately 5 percent of the pipeline route will cross soils with organic surface horizons. These horizons also may be susceptible to rutting during pipeline construction.

Enbridge will minimize compaction and rutting impacts by implementing the measures described in its EMP and AMP (see Appendices B and E), respectively. These measures may include temporarily suspending certain construction activities on susceptible soils during wet conditions, or constructing from timber mats or using low-ground-weight equipment in wetlands. On agricultural land, compaction impacts will be mitigated through the use of deep tillage operations during restoration activities. If subsequent construction and cleanup activities result in further compaction, additional measures will be undertaken to reduce soil compaction.

6.3.3 Erosion by Wind and Water

Erosion is a continuing natural process that can be accelerated by human activity. Factors that influence the degree of erosion include soil texture, soil structure, length and percent of slope, vegetative cover, and rainfall or wind intensity. Soils most susceptible to erosion by water are typified by bare or sparse vegetative cover, non-cohesive soil particles with low infiltration rates, and moderate to steep slopes. Wind erosion processes are less affected by slope length or steepness. Clearing, grading, and equipment movement could accelerate the erosion process and, without adequate protection, result in discharge of sediment to adjacent waterbodies and wetlands.

The majority of the pipeline route (greater than 99 percent) is underlain by soils that are not likely to be susceptible to water erosion (see table 6.2.2-1); these soils are generally found on terrain with slopes that are less than or equal to 5 percent. Approximately 19 percent of the soils along the pipeline route have a wind erodibility group (WEG) classification of two or lower and, therefore, are considered susceptible to wind erosion.

Enbridge will implement the erosion control measures described in the EMP (see Appendix B) to minimize erosion both during and after construction activities. These measures may include construction of silt fences, installation of slope breakers, temporary sediment barriers, and permanent trench breakers, and revegetation and mulching of the construction right-of-way. Erosion and sedimentation controls will be inspected and maintained as necessary until final stabilization is achieved. Enbridge also will implement dust mitigation measures, including the use of water trucks to moisten the right-of-way, as needed, to reduce impacts from wind erosion.

6.3.4 Droughty Soils

Droughty, or dry, soils were identified on the basis of surface texture and drainage class. Well drained to excessively drained soils with a coarse surface texture (i.e., fine sand or coarser) may be difficult to revegetate. Drier soils contain less water to aid in the germination and eventual establishment of new vegetation. Coarser textured soils also have a lower water holding capacity, which could result in moisture deficiencies in the root zone, creating unfavorable conditions for many plants. Twenty-five percent of the pipeline route will cross soils classified as droughty soils.

Enbridge will minimize the impacts of pipeline construction on droughty, non-cultivated soils by timely reseeding using species adapted to dry conditions and by applying mulch to conserve soil moisture. Enbridge will consult with appropriate soil conservation authorities to develop seed mixes and seeding dates adapted to the project area, including droughty soil areas.

6.3.5 Stony/Rocky Soils and Shallow Bedrock Soils

Trenching or grading can bring stones or rocks to the soil surface where they can damage farm equipment. Similarly backfilling shallow bedrock could redistribute rock to an overlying soil horizon, which may reduce soil moisture-holding capacity. Less than 1 percent of the route will cross stony or rocky soils, all of which are located in Clearwater County.

Based on the analysis of the SSURGO database, none of the soils crossed by the pipeline route contain shallow bedrock (i.e., bedrock within 5 feet of the surface). However, if bedrock is encountered within the trench, Enbridge only will backfill with this rock to the depth of the original bedrock layer. During clean up, Enbridge will use rock pickers or other rock removal equipment to remove rocks greater than 4 inches in diameter from the upper 12 inches of soil. Rock removal will be considered complete when the size and density of stones on the right-of-way are similar to undisturbed areas adjacent to the right-of-way.

7.0 VEGETATION, WILDLIFE, AND FISHERIES

7.1 VEGETATION

7.1.1 Existing Vegetation Resources

As described in section 4.0, approximately 89.5 percent of the area affected by the construction right-of-way will be agricultural land. This land consists of pastures and row crops such as corn, sunflowers, sugar beets, and soybeans. Potatoes also are a common crop in some of the counties in the project area (USDA, 2007). Approximately 5.6 percent of the area affected by the construction right-of-way will affect forest land consisting of upland forests and forested wetlands. The construction right-of-way will also affect wetlands (approximately 4 percent of the total) and commercial land (approximately 3 percent of the total). The wetlands comprise emergent marshes and scrub-shrub wetlands, and the open lands consist of maintained rights-of-way and fallow fields.

7.1.2 Ecological Classifications

Based on the Ecological Classification System, the LSr Project is located in the Prairie Parkland, Tallgrass Aspen Parklands and Eastern Broadleaf Forest Provinces (MDNR website http://www.dnr.state.mn.us/ecs/index.html).

Prairie Parkland Province

The pipeline route will cross the Red River Prairie subsection between approximate MPs 801.8 and 833.9. The majority of this subsection is a glacial lake plain with silty, sandy, and clayey lacustrine depositions. It is level, uniform, and relatively featureless, broken only by wetlands, meandering waterways, and old beach ridges. Much of this area has been converted to agriculture and is intensively ditched.

Tallgrass Aspen Parklands Province

The pipeline route will cross the Aspen Parklands subsection between approximate MPs 833.9 and 896.2. Well over 60 percent of this subsection is in agricultural production, mostly in the southern half. In the northern half, extensive areas have recently been cleared for farming. Some remnants of large contiguous patches of native plant communities, including wetlands, remain. Wild rice cultivation is common in the eastern edge of this area.

Eastern Broadleaf Forest Province

The pipeline route will cross the Hardwood Hills subsection within the Eastern Broadleaf Forest Province, between approximate MPs 896.2 and 909.5. Much of this area has been converted to agricultural production. Natural communities along the pipeline generally are limited to wetlands and small woodlots. Vegetation communities include aspen, mixed hardwood forests, emergent marshes, and scrub-shrub swamps.

7.1.3 Typical Vegetative Communities

As indicated by the descriptions of the ecological units crossed by the project, aspen-birch forest is the most common upland forest type in the project area. Northern mixed hardwood forests and pine forests also are present along the pipeline route in addition to some forested wetlands. The majority of the wetlands are emergent marshes and scrub-shrub swamps. The more common vegetative communities along the pipeline route are described below.

Aspen-Birch Forest

Aspen-birch forests dominate upland forested portions of the project. Quaking aspen and paper birch are primary components. A tall shrub layer may be present consisting of beaked hazel, mountain maple, and saplings of other tree species. Small shrubs such as bush honeysuckle, gooseberry, and raspberry may be present. The herbaceous layer is diverse and dominated by large-leaved aster, bunchberry, Canada mayflower, wild sarsaparilla, and lady fern.

Northern Hardwood Forest

Northern hardwood forests contain sugar maple, basswood, and birch as primary species. These forests often contain a conifer component and may also include red oak on drier sites. A shrub layer may be present depending on the amount of available sunlight. The species present in the shrub layer are typically fly-honeysuckle, beaked hazel, leatherwood, and mountain maple. Club mosses are frequent in the herbaceous layer.

Forested Wetlands

There are four types of forested wetlands in the vicinity of the project: black spruce swamps and bogs, tamarack swamps, cedar swamps, and hardwood swamps. Hardwood swamps are most frequent over the length of the project and are often intermixed with scrub-shrub swamps. Hardwood swamps in this region of Minnesota contain black ash as the primary component with green ash, paper birch, maple, balsam fir, and white cedar as secondary components. Sedges, grasses, and sphagnum moss are common in the understory of the conifer lowlands.

Scrub-shrub Swamps

Scrub-shrub swamps dominate lowland vegetation communities in the project area. In the northern region of Minnesota, scrub-shrub swamps contain speckled alder as the primary component. Shrubs such as willow and alder, and trees such as white cedars, tamaracks, black ash, and paper birch may also be present. Northern marsh fern, jewel-weed, and sedges are common in the herbaceous layer.

7.1.4 Sensitive Plant Communities

Information on sensitive plant species communities potentially found along the proposed right-of-way was obtained from the U.S. Fish and Wildlife Service (FWS) and the MDNR, Natural Heritage Program (NHP). Federal agencies provided information on special status species. Data on species of special concern were provided by the various state wildlife departments. The MDNR NHP provided information on the status of various wildlife populations. The majority of these species are found primarily in wetland or native prairie habitats.

Mesic Prairie Remnant

This grassland community occurs on rich, moist, well-drained sites. The dominant plant is the tall grass, big bluestem (*Andropogon gerardii*). The grasses little bluestem (*Andropogon scoparius*), indian grass (*Sorghastrum nutans*), porcupine grass (*Stipa spartea*), prairie dropseed (*Sporobolus heterolepis*), and tall switchgrass (*Panicum virgatum*) are also frequent. The forb layer is diverse in the number, size, and physiognomy of the species. Common taxa include the prairie docks (*Silphium spp.*), lead plant (*Amorpha canescens*), heath and smooth asters (*Aster ericoides* and *A. laevis*), sand coreopsis (*Coreopsis palmata*), prairie sunflower (*Helianthus laetiflorus*), rattlesnake-master (*Eryngium yuccifolium*), flowering spurge (*Euphorbia corollata*), beebalm (*Monarda fistulosa*), prairie coneflower (*Ratibida pinnata*), and spiderwort (*Tradescantia ohioensis*).

A review of the MDNR NHP database indicated a mesic prairie remnant within the right-of-way of the Burlington Northern & Santa Fe Railroad near MP 817.0. A mesic and wet prairie remnant was also identified within the Canadian Pacific Railway near MPs 875.8 through 896.0.

Mixed Cattail Marsh

The mixed cattail marsh community is typically dominated by cattails present on floating mats along shorelines in lakes, ponds, and river backwaters or rooted in mineral soil in shallow wetland basins. Vegetation is often composed of dense stands of cattails interspersed with pools of open water. Associated species are highly variable. Floating leaved and submergence aquatic plant cover is sparse, with species such as duckweed (*Lemna* spp.) and greater duckweed (*Spirodela polyrhiza*) frequent and common bladderwort (*Utricularia vulgaris*) and common coontail (*Ceratophyllum demersum*) occasionally present. Forb cover is strongly dominated by cattails (*Typha* spp.), usually with greater than 50 percent cover. Shrubs are absent or very sparse.

A review of the MDNR NHP database indicated a mixed cattail marsh between MPs 853 and 854.

7.1.5 General Construction and Operation Impacts and Mitigation

Clearing of herbaceous vegetation during construction is anticipated to be a short-term impact. Active revegetation measures and rapid colonization by annual and perennial herbaceous species in the disturbed areas will restore most vegetative cover within the first growing season. Clearing of woody shrubs and trees will be the primary long-term impact on vegetation associated with the project. Woody shrubs and trees will be allowed to recolonize the temporary construction right-of-way and extra workspaces as described in the EMP (see Appendix B). However, recolonization of disturbed areas by woody shrubs and trees will be slower than recolonization by herbaceous species. As natural succession is allowed to proceed in these areas, the early successional or forested communities present before construction will eventually re-establish.

The clearing of trees in the construction right-of-way could affect uncleared forest vegetation growing along the edges of the cleared areas. By exposing some edge trees to elevated levels of sunlight and wind, evaporation rates and the probability of tree knockdown could increase. Due to the increased light levels penetrating the previously shaded interior, shade intolerant species will be able to grow and the species composition of the newly created forest edge will likely change. The proposed clearing could also temporarily reduce local competition for available soil moisture and light, and may allow some early successional species to become established and persist on the edge of the uncleared areas adjacent to the site.

The project will result in the clearing of approximately 81.1 acres of forest land during construction. Approximately 24.3 acres of this forest land will be maintained clear of trees for operational purposes.

Impacts on vegetation adjacent to the project area will be minimized through adherence to soil erosion control specifications and by confining clearing activities to the approved right-of-way and extra workspaces. To prevent damage to adjacent trees, Enbridge will fell trees toward the cleared right-of-way. Upon completion of construction, Enbridge will revegetate disturbed areas in accordance with the EMP (see Appendix B) for the project, unless otherwise directed by landowners or land managing agencies. Timely restoration of the construction right-of-way and reseeding with an appropriate seed mix will minimize the duration of vegetative disturbance.

7.2 WILDLIFE

7.2.1 Existing Wildlife Resources

The LSr Project will be constructed through multiple biomes, including the deciduous and conifer-hardwood forest zones and the prairie zone. Wildlife habitats within these areas are diverse and include open areas, wetlands, and forested areas. Because the pipeline route will cross predominantly agricultural lands within these zones, wildlife habitat is more limited and confined primarily to the undeveloped areas. Existing wildlife resources in these areas are described below.

The project will cross land that has been altered for agricultural production, including row crops, small grains, hayfields, and pastures. These agricultural fields provide limited wildlife habitat. A few common wildlife species, including white-tailed deer, pheasant, and raccoon, use these areas for feeding and occasional cover. A few bird species such as starlings, crows, eastern meadowlark, and sparrows are occasionally found in the agricultural fields.

Forested areas affected by the project are found primarily along the eastern portion of the proposed pipeline route. Some of the common mammalian species in deciduous forests include white-tailed deer, bear, eastern cottontail rabbit, woodchuck, raccoon, skunk, gray and fox squirrel, gray and red fox, and several species of bat. The structural diversity of the forest provides a variety of habitats that can support a large number of avian species, including songbirds, hawks, and owls (Tester, 1995).

Wetlands affected by the project consist primarily of emergent, scrub-shrub, and forested wetlands. The emergent wetlands provide habitat for a variety of aquatic wildlife, including muskrat, beaver, mink, waterfowl, wading birds, and numerous species of reptiles and amphibians. The scrub-shrub wetlands and forested wetlands provide additional habitat for terrestrial wildlife, such as the white-tailed deer, moose, gray wolf, fox, bear, porcupine, and a variety of small mammals and songbirds.

Open land affected by the project consists primarily of open areas that serve as fallow fields or maintained rights-of-way. The open, grassy areas support several species of birds, numerous small rodents, and several species of snakes. Predatory species such as coyote, fox and variety of hawks hunt the grasslands for the abundant small rodents, birds and reptiles.

Other common wildlife species that occasionally may use the open areas include white-tailed deer, raccoon, squirrel, striped skunk, eastern cottontail rabbit, and white-tailed jackrabbit.

7.2.2 General Construction and Operation Impacts and Mitigation

Construction and operation of the project is not expected to have a significant impact on wildlife. Temporary impacts will occur during construction due to clearing of vegetation and disturbance of soils in the right-of-way. Long-term impacts will be limited to a loss of forest habitat because of clearing the temporary construction right-of-way and extra workspaces that are located in forested areas.

Long-term effects on wildlife species will be limited because the pipeline will be collocated with the existing pipeline right-of-way. Overall, construction and operation of the project will not significantly alter the character of the landscape along the pipeline route.

Clearing the construction right-of-way will remove vegetative cover and will cause temporary displacement of wildlife species along the pipeline route. The construction right-of-way and extra workspaces will remain relatively clear of vegetation until the project is completed. Some smaller, less mobile wildlife such as amphibians, reptiles, and small mammals may experience direct mortality during clearing and grading activities. The remaining wildlife, including the larger and more mobile animals, will disperse from the project area as construction activities approach. Displaced species may recolonize in adjacent, undisturbed areas, or re-establish in their previously occupied habitats after construction has been completed and suitable habitat is re-established. The intensity of construction-related disturbances will depend on the particular species and the time of year during construction.

Clearing of herbaceous and shrub communities in the open areas of the temporary right-of-way, both in upland and wetland areas, will be required for pipeline construction. This clearing will cause a short-term impact due to the relatively quick recolonization of plant species that comprise these communities. Herbaceous cover will be seeded on disturbed areas following the completion of pipeline construction and it is expected that pre-existing herbaceous and shrub habitats will quickly become re-established. Consequently, it is expected that the wildlife species that use these habitats will also return relatively soon after construction.

Temporary right-of-way and extra workspaces will be seeded with herbaceous species and allowed to revegetate naturally with tree and shrub species common to the area. The direct and long-term impacts on wildlife that use forests will be the temporary conversion of existing forested habitat to herbaceous-dominated habitat on the temporary construction right-of-way. It is expected that wildlife displaced from the cleared areas will relocate to nearby forests. Over time, natural growth and succession will restore the temporary portion of the construction right-of-way and extra workspaces to a forested community and wildlife typically inhabiting forest habitats will return.

A potential long-term impact on wildlife is associated with the clearing of forest vegetation. The project is parallel to an existing, maintained right-of-way thereby decreasing impacts on undisturbed forests. The project will involve the permanent removal of 17.3 acres of forested habitat for the maintained right-of-way. These areas will be permanently converted to non-forest habitat for the life of the pipeline. It is anticipated that the incremental loss of this forested habitat along the existing cleared right-of-way will not have a significant effect on wildlife species.

7.3 FISHERIES

7.3.1 Existing Fisheries Resources

The proposed pipeline route will cross 14 perennial streams, 33 intermittent streams, and 19 canals/ditches in Minnesota (see section 9.0). Most of these waterbodies contain warmwater fisheries. The LSr Project pipeline route does not cross any waterbodies designated as trout fisheries.

Table 7.3.1-1 provides the list of representative fish species identified by the MDNR for the warmwater waterbodies in the project area.

TABLE 7.3.1-1

Representative Fish Species in the LSr Project Area

Game Fish	Other Fish
Walleye	Carp
Sauger	Bullhead
Northern pike	Suckers
Muskellunge	Sculpin
Sunfish	Burbot
Crappie	Redhorse
Perch	Minnows and other forage fish
Channel catfish	
Bluegill	
Smallmouth bass	
Largemouth bass	

7.3.2 General Construction and Operation Impacts and Mitigation

Movement of fish upstream and downstream of the crossing site may be temporarily affected during installation of the pipeline across streams due to disturbances associated with construction. The physical disturbance of the streambed may temporarily displace adult fish and may dislodge other aquatic organisms, including invertebrates. Some limited mortality of less mobile organisms such as small fish and invertebrates may occur within the trenching area. Aquatic plants, woody debris, and boulders that provide in-stream fish habitat will also be removed during trenching. Noise disturbances upstream and downstream of the site will deter fish that may otherwise inhabit the area. These disturbances are temporary and are not expected to significantly affect fisheries resources. Studies have shown that natural re-colonization of the disturbed areas will begin soon after restoration of the streambed and will be completely re-colonized within one year after construction (Schubert et al., 1985; Anderson et al., 1997).

Sediment loads will be temporarily increased downstream during open-cut stream crossings. These increased loads may temporarily affect the more sensitive fish eggs, fish fry, and invertebrates inhabiting the downstream area. However, the suspended sediment levels will quickly attenuate both over time and distance and will not adversely affect resident fish populations or permanently alter existing habitat (McKinnon and Hnytka, 1988). The crossing will be completed as quickly as possible and the suspended sediment levels will return to preconstruction levels after instream work is completed.

Most streambank vegetation will be removed across the right-of-way during construction. After construction, an area over the pipeline will be maintained in a herbaceous state and trees that are located near the pipeline will be cut and removed from the right-of-way in accordance with the EMP (see Appendix B). Changes in the light and temperature characteristics of some streams may affect the behavioral patterns of fish, including spawning and feeding activities, at the pipeline crossing location. The maintained shorelines, however, are not wide enough to have a significant impact on general temperature and light conditions of the streams crossed by this project.

To minimize the potential for adverse impacts on the fisheries at river and stream crossings, Enbridge will implement erosion and sediment control measures specified in the EMP and limit the duration of construction in these waterbodies.

7.4 THREATENED AND ENDANGERED SPECIES

The MDNR and the FWS were consulted on the potential presence of threatened and endangered species in the vicinity of the project. The MDNR conducted a review of the Minnesota NHP database to determine if any federally or state-listed species are known to occur within approximately 1 mile of the project. The Minnesota NHP database indicated eight known occurrences of rare species or native plant communities in the area searched. The MDNR provided information on specific occurrences for elements that may be impacted by the proposed project. The FWS indicated that the home ranges of two federally listed species (gray wolf and Canada lynx) are located in the vicinity of the project but no know occurrences of these species have been recorded in the project area (MDNR, 2006b; FWS, 2006) The eight MDNR species and habitats are summarized in Table 7.4-1.

TABLE 7.4-1

Natural Heritage Information in the Vicinity of the LSr Project

County, State	Milepost(s)	Feature	Species/Issue
Kittson, Minnesota	816 to 817	Pipeline crossing of railroad.	Mesic Prairie Remnants within Burlington Northern & Santa Fe Railroad right-of-way.
Marshall, Minnesota	844	Pipeline runs adjacent to wet brush-native prairie community and prairie wetland complex.	Northern Singlespike Sedge (*Carex scirpoidea*).
Marshall, Minnesota	844	Pipeline runs through wet brush-native prairie community.	Northern Singlespike Sedge (*Carex scirpoidea*).
Pennington, Minnesota	853 to 854	Pipeline runs through “Site of Outstanding Biodiversity Significance.”	Mixed cattail marsh native plant community; Nelson’s sharp-tailed Sparrow (*Ammodramus nelsoni).*
Pennington, Minnesota	853 to 854	Pipeline is adjacent to Mesic brush prairie and Mesic oak woodland.	Nelson’s sharp-tailed Sparrow (*Ammodramus nelsoni).*
Pennington, Minnesota	864 to 865	Pipeline crossing of the Red Lake River.	Freshwater mussels: Creek Heelsplitter (*Lasmigona compressa*); Black Sandshell (*Ligumia recta*); Fluted Shell (*Lasmigona costata*).
Red Lake/Polk, Minnesota	886 to 890	Pipeline shares railroad right-of-way.	Mesic and wet prairie remnants within the right-of-way of the Canadian Pacific Railway.
Red Lake/Polk, Minnesota	885 to 886	Pipeline crossing of Lost River.	Creek Heelsplitter mussels.

7.4.1 General Construction and Operation Impacts and Mitigation

Enbridge will continue to consult with the MDNR and FWS on the status of mitigative strategies for these species. If any of the species are identified in the construction right-of-way during the surveys, Enbridge will work with these agencies to develop mitigation plans to avoid and minimize impacts on the potentially affected species.

Enbridge will also continue to consult with the MDNR and FWS to determine the exact location of the bald eagle nesting sites. If these sites are located in close proximity to the construction area, Enbridge will develop mitigation plans to avoid adverse effects on the bald eagle. Possible mitigation may include conducting surveys before construction to determine if any bald eagle nests within 0.25 mile of the pipeline route are active and/or avoiding construction within 0.25 mile of active nests during the bald eagle's nesting season between February 1 and August 15.

8.0 GROUNDWATER RESOURCES

Groundwater quality and quantity is primarily a function of a region's geologic and hydrogeologic setting. Thick glacial sediments including till, outwash, buried outwash, and lacustrine deposits cover much of the project area. Groundwater yields from these glacial deposits vary but typically range from less than one gallon per minute (gpm) in till and lacustrine deposits to greater than 500 gpm from outwash and buried outwash deposits (Kanivetsky, 1979). Well depths in the glacial deposits typically range from approximately 30 to 380 feet (USGS, 1985).

Groundwater is the primary source of water for private, public, and industrial uses in residences, communities, and commercial facilities located along the pipeline route. Groundwater occurs in surficial aquifers (water-bearing unconsolidated material deposited above the bedrock surface), buried drift aquifers, and bedrock aquifers.

8.1 SURFICIAL AQUIFERS

Surficial aquifers occur above the bedrock in unconsolidated sediments deposited by glaciers, streams, and lakes. The depth of the material is generally less than 100 feet, but may reach several hundred feet in some areas (Adolphson et al., 1981). Short-term groundwater yields from unconfined surficial aquifers vary, but can range from 10 gpm to approximately 3,000 gpm. Surficial aquifers are an important source of groundwater for much of the project area and can provide adequate water volumes to supply municipalities and irrigation systems. Table 8.1-1 lists major surficial aquifers crossed by the proposed pipeline route. Water quality of these surficial aquifers can be affected by surface activities including industrial and agricultural land use due to the relatively shallow depth of the water table and the relatively coarse texture of the material overlying the aquifer.

TABLE 8.1-1

Aquifers Crossed by the LSr Project Pipeline Route

Begin Milepost	End Milepost	Crossing Length (miles)	Aquifer Name
801.3	809.1	7.8	Red River-Winnipeg
809.1	820.2	11.1	Cretaceous
820.2	824.8	4.6	Red River-Winnipeg
824.8	831.4	6.6	Cretaceous
831.4	844.4	13.0	Red River-Winnipeg
844.4	870.0	25.6	Precambrian undifferentiated
870.0	884.8	14.8	Cretaceous
884.8	909.4	24.6	Precambrian undifferentiated

8.2 BURIED DRIFT AQUIFERS

Buried drift aquifers occur in well-sorted sand and gravel deposits in bedrock valleys, alluvial channels, and outwash plains formed by advancing and retreating glaciers. These deposits subsequently were covered by fine texture materials (generally clays), which form a confined layer above the aquifer. The confined and buried sand and gravel deposits typically are less than 30 feet thick but may extend to 150 feet thick in local areas. Buried drift aquifers have limited potential use for high capacity wells but constitute the most important source of groundwater for human uses (Minnesota Pollution Control Agency (MPCA), 1999). Well yields range from approximately 10 gpm to 1,000 gpm (Adolphson et al., 1981). The confining layer (e.g., clay material) above the aquifer generally protects it from contamination resulting from human activity at the surface. Water quality is typically very good in buried drift aquifers.

8.2.1 Red River-Winnipeg Aquifer

The Red River-Winnipeg Aquifer underlies several hundred feet of till and lake sediment of Glacial Lake Agassiz in northwestern Minnesota, and is composed primarily of sandstone, limestone, and shale formed during the Paleozoic age (225 to 600 million years ago). Water is under confined conditions throughout most of the aquifer. Artesian wells into this aquifer have recorded flows of 60 gpm and pumping wells commonly range from 100 to 250 gpm, with localized flows up to 500 gpm. The aquifer, which has a great potential for providing large supplies of water, is seldom used because the water is highly mineralized and has concentrations of dissolved solids ranging from 3,000 to 60,000 milligrams per liter (mg/l) and has large iron, sodium, and chloride concentrations.

8.2.2 Cretaceous Aquifer

The Cretaceous Aquifer in western and southwestern Minnesota was formed between 65 to 136 million years ago and consists of sandstone lenses near the base of predominantly gray, soft, argillaceous (solidified mud and clay) shale sections. The aquifer is generally confined and ranges from 280 to 620 feet below the surface. Wells utilizing this aquifer commonly yield 10 to 250 gpm, with local yields ranging up to 1,000 gpm. This aquifer is not widely used except where drift aquifers are absent or where well yields are poor. Most water use from this aquifer is for rural domestic and livestock supplies, and the potential for development of large municipal and industrial water supplies is low.

8.2.3 Precambrian Undifferentiated Aquifer

The Precambrian undifferentiated aquifer consists of granite, greenstone, and slate, which yield limited supplies of water for rural domestic and livestock wells in southwestern, central, and northeastern parts of Minnesota where fractures, faults, and weatherized zones provide porosity and permeability. These rock layers generally do not support an aquifer in the rest of the state. Wells using this aquifer are generally at a depth of 30 to 450 feet and provide flows of 5 to 25 gpm with localized wells exceeding 100 gpm. Yields generally increase where the bedrock is overlain by thick drift and some wells are drilled several hundred feet into the rocks so that the drilled hole acts as reservoir. Calcium magnesium bicarbonate laden water is more common in this aquifer and dissolved-solids concentrations are generally less than 300 mg/l.

8.3 EXISTING GROUNDWATER RESOURCES

8.3.1 Public Water Supply Wells

Enbridge reviewed the Minnesota Department of Health (MDH) water well database to identify public water supply wells near the pipeline route. No public water supply wells were identified within 100 feet of the proposed pipeline route.

8.3.2 Federal and State Designated Aquifers

The pipeline route will not cross any aquifers that are designated by the U.S. Environmental Protection Agency (EPA) as sole-source aquifers (EPA, 2006). The LSr Project pipeline route will cross about 0.4 mile of one Drinking Water Supply Management Area near MP 886.4 in the vicinity of Oklee, Minnesota. The MDH rates the vulnerability of the Oklee area as low. The proposed pipeline route will not cross any Wellhead Protection Areas (MDH, 2006b).

8.3.3 Domestic Water Supply Wells

Enbridge reviewed the Minnesota Geologic Survey and MDH water well information database (County Well Index or CWI) to identify domestic water supply wells along the pipeline route. The CWI is a database that contains basic information for over 340,000 water wells drilled in Minnesota. The data is derived from water well contractors' logs of geologic materials encountered during drilling.

Enbridge's review of the CWI database identified one domestic well within 200 feet of the pipeline route. The well is located approximately 23 feet northeast of MP 848.4 in Marshall County, Minnesota (CWI, 2006). This well is located at Enbridge's existing Viking Pump Station.

Enbridge will ask landowners along the pipeline route if they are aware of the presence of cased wells in close vicinity to the right-of-way. If such wells are identified, the locations of these wells will be noted.

8.3.4 Contaminated Groundwater

Enbridge accessed a Minnesota Pollution Control Agency (MPCA) database to identify sites with known or potential contamination within 0.5 mile of the proposed project (MPCA, 2005a). This database included federal regulatory listings such as the National Priority List (NPL, or federal Superfund); Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS, or potential NPL sites); No Further Response Action Planned (NFRAP); Resource Conservation and Recovery Act (RCRA) Treatment, Storage, and Disposal (TSDs); and RCRA hazardous waste generators (RCRAGEN). State listings included the Permanent List of Priorities (PLP, or state-equivalent Superfund); Delisted PLP (DPLP); Voluntary Investigation and Cleanup (VIC); Permitted Solid Waste Facilities (PSW); Unpermitted Dumps (UPD); Closed Landfill Program (CLP); and the State Assessment Program (SAP).

Table 8.3.4-1 summarizes the contaminated sites within 0.5 mile of the proposed project. Based on MPCA information and review of aerial photographs, three of the five sites were determined to be more than 500 feet from the proposed pipeline route and, therefore, are not anticipated to affect the project. Prior to construction of the project, Enbridge will assess the potential for encountering contaminated groundwater near the sites that are within 500 feet of the proposed pipeline route. If necessary, appropriate avoidance or mitigation measures will be developed and implemented in accordance with applicable state or federal regulations.

TABLE 8.3.4-1

Contaminated Sites within 0.5 Mile of the LSr Project Pipeline Route

County	Milepost	Distance (miles)	Entity Name	City	Listing Type
Pennington	854.7	<0.1	Unnamed Dump	Norden Township	Unpermitted Dump
Red Lake	885.7	<0.1	Red Lake County Demo LF	Oklee	Solid Waste Permit
Polk	897.1	0.3	Trail Dump	Trail	Unpermitted Dump
Polk	897.7	0.2	Gully Dump	Gully	Unpermitted Dump
Clearwater	903.0	0.2	Gonvick Dump	Gonvick	Unpermitted Dump

8.4 GENERAL CONSTRUCTION AND OPERATION IMPACTS AND MITIGATION

Construction of the LSr Project is not expected to have long-term impacts on groundwater resources. Ground disturbance associated with pipeline construction is primarily limited to the upper 10 feet, which is above the water table of most of the regional aquifers. Construction activities such as trenching, backfilling, and dewatering that encounter shallow surficial aquifers may result in minor short-term fluctuations in groundwater levels within the aquifer. Once the construction activity is complete, the groundwater levels typically recover quickly.

8.4.1 Blasting

Blasting to install the pipeline in a bedrock aquifer has the potential to adversely affect water quality and water yields in nearby water wells. However, as indicated in section 5.1, no areas of shallow bedrock have been identified within the project area and, therefore, blasting is not anticipated to be part of this project.

8.4.2 Spills and Leaks

The introduction of contaminants to groundwater due to accidental spills of construction related chemicals, fuels, or hydraulic fluid could have an adverse affect on groundwater quality, most notably near shallow water wells. Spill-related impacts from pipeline construction are primarily associated with fuel storage, equipment refueling, and equipment maintenance. Enbridge's SPCCP outlines measures that will be implemented to prevent accidental releases of fuels and other hazardous substances. The SPCCP also describes response, containment, and cleanup procedures. By implementing the protective measures set forth in the SPCCP, long term contamination due to construction activities is not anticipated. A copy of Enbridge's SPCCP is included as Appendix C.

Accidental leaks from the pipeline system during operations can also potential affect groundwater. As part of the pipeline operation, which is regulated by the Department of Transportation – Office of Pipeline Safety, Enbridge has an ongoing inspection program to monitor the integrity of the pipeline system. Monitoring activities include regular inspection of the cathodic protection system, which addresses the possible corrosion potential for a steel piped installed below the ground surface. In addition, Enbridge uses computerized inspection tools that travel through the inside of the pipeline to check pipe integrity. Enbridge also performs regular aerial flyovers to inspect the pipeline right-of-way. As required by federal law, Enbridge maintains an Emergency Response Plan, which has been reviewed an approved by the Department of Transportation – Office of Pipeline Safety to address pre-planning, equipment staging, notifications, and leak containment procedures to be implemented in the event of a pipeline leak.

9.0 SURFACE WATER RESOURCES

Minnesota is known for its abundant surface water resources, including lakes, rivers, streams, and wetlands. From a water resource management perspective, Minnesota is divided into 10 major drainage basins which are used by governing agencies to identify and assess water quality issues and develop water quality protection goals. The LSr Project pipeline route will cross portions of one major drainage basin, the Red River of the North Basin. The Red River of the North Basin encompasses a 35,530-square-mile surface drainage area to the main stem of the Red River of the North within the United States. The basin represents an important hydrologic region where good quality water is a valued resource vital to the region's economy.

Each drainage basin is divided into major and minor watersheds that correspond to the drainage of a tributary or lake system. As shown on Figure 9-1, the proposed pipeline route will cross the following five watersheds:

- Lower Red – HUC 09020311;
- Snake – HUC 09020309;
- Thief – HUC 09020304;
- Lake – HUC 09020303; and
- Clearwater – HUC 09020305.

The LSr Project pipeline route will cross three watershed management districts, the Two Rivers, Middle-Snake-Tamarac, and Red Lake districts. The primary purpose of these watershed districts and organizations is to conserve the natural resources of the state through land use planning, flood control, and other conservation practices.

9.1 WATERBODY CROSSINGS

9.1.1 Existing Waterbodies

Enbridge reviewed existing maps, USGS 7.5-minute-series topographic maps, NWI Maps, MDNR Protected Waters and Wetlands Maps, and Minnesota Public Recreation Information Maps, and aerial photography to identify waterbodies (lakes, streams, rivers, and drainage ditches) crossed by the proposed pipeline route. This review identified 66 waterbodies crossed by the proposed pipeline route, including 14 perennial streams and 33 intermittent streams, and 19 canals/ditches or artificial paths. Ten of these waterbodies are designated as Protected Waters by the MDNR. Waterbodies crossed by the LSr Project are summarized in table 9.1.1-1.

Figure 9-1 Watershed Basins in Project Area

TABLE 9.1.1-1

Summary of Waterbodies Crossed by LSr Project Pipeline Route [a]

County	Intermittent	Perennial	Protected	Wild and Scenic Rivers	State/County Canoe Routes	Trout Streams
Kittson	3	0	1	0	1	0
Marshall	11	3	2	0	0	0
Pennington	9	1	4	0	1	0
Red Lake	2	2	2	0	0	0
Polk	2	4	0	0	0	0
Clearwater	6	4	1	0	0	0
Total	33	14	10	0	2	0

[a] Based on review of USGS 7.5-minute-series topographic maps, Minnesota Department of Natural Resources (MDNR) Protected Waters maps, National Wetland Inventory maps, Minnesota Public Recreation Information Maps, and aerial photography.
Perennial as depicted on 1:24,000 USGS topographic maps.
Intermittent as depicted on 1:24,000 USGS topographic maps.
Protected as depicted on MDNR Protected Waters and National Wetland Inventory maps.
Trout as designated a Trout Stream, per Minnesota Rules 6264, Subp.4.

The pipeline route will cross four rivers that are approximately 100 feet or greater in width at the crossing locations, including the Red River of the North, Tamarac River, Middle River, and Red Lake River. Crossing widths will be determined based on pending field surveys. The milepost and waterbody names for each waterbody crossing are provided in table 9.1.1-2. Enbridge will determine the appropriate crossing method for each waterbody upon further consultation with appropriate regulatory agencies.

TABLE 9.1.1-2

Waterbodies Crossed by the LSr Project Pipeline Route

Milepost	Waterbody Name	Type	Hydrology	County
801.8	Red River of the North	River	Perennial	Pembina/Kittson
805.4	Trib. to the Red River	Stream	Intermittent	Kittson
810.1	unnamed county ditch	Stream	Intermittent	Kittson
810.1	unnamed county ditch	Stream	Intermittent	Kittson
811.6	County Ditch #19	Canal/Ditch	Canal/Ditch	Kittson
812.9	County Ditch #7	Canal/Ditch	Canal/Ditch	Kittson
814.4	County Ditch #16	Canal/Ditch	Canal/Ditch	Kittson
815.7	County Ditch #10	Canal/Ditch	Canal/Ditch	Kittson
817.1	Judicial Ditch	Canal/Ditch	Canal/Ditch	Marshall
818.9	County Ditch #11	Canal/Ditch	Canal/Ditch	Marshall
821.0	unnamed ditch	Connector	Connector	Marshall
821.1	unnamed ditch	Stream	Intermittent	Marshall
823.6	unnamed ditch, trib. to Tamarac	Stream	Intermittent	Marshall
825.8	Trib. to County Ditch #16	Stream	Intermittent	Marshall
826.1	County Ditch #16	Canal/Ditch	Canal/Ditch	Marshall
828.8	Tamarac River	River	Perennial	Marshall
828.9	Tamarac River	River	Perennial	Marshall
829.1	Tamarac River	River	Perennial	Marshall
831.1	Trib. to Tamarac River	Stream	Intermittent	Marshall

TABLE 9.1.1-2

Waterbodies Crossed by the LSr Project Pipeline Route

Milepost	Waterbody Name	Type	Hydrology	County
831.4	Trib. to Tamarac River	Stream	Intermittent	Marshall
831.4	Trib. to Tamarac River	Stream	Intermittent	Marshall
833.1	Trib. to Tamarac River	Stream	Intermittent	Marshall
834.1	Trib. to Middle River	Stream	Intermittent	Marshall
836.1	Middle River	River	Perennial	Marshall
839.8	Swift Coulee	Stream	Intermittent	Marshall
841.2	Trib. to Snake River	Stream	Intermittent	Marshall
843.2	Snake River	River	Perennial	Marshall
847.2	South Branch Snake River	River	Intermittent	Marshall
853.0	unnamed ditch	Stream	Intermittent	Pennington
855.1	unnamed ditch	Stream	Intermittent	Pennington
858.7	unnamed ditch	Stream	Intermittent	Pennington
860.1	unnamed ditch	Stream	Intermittent	Pennington
861.7	unnamed ditch	Stream	Intermittent	Pennington
863.5	Trib. to Red Lake River	Stream	Intermittent	Pennington
864.4	Red Lake River	Artificial Path	Perennial	Pennington
864.9	Ditch to Red Lake River	Canal/Ditch	Canal/Ditch	Pennington
866.2	Trib. to Red Lake River	Stream	Intermittent	Pennington
867.4	Ditch to trib. to Red Lake River	Canal/Ditch	Canal/Ditch	Pennington
868.2	Trib. to Red Lake River	Stream/River	Intermittent	Pennington
869.6	County Ditch #62	Stream	Intermittent	Pennington
869.8	County Ditch #62	Canal/Ditch	Canal/Ditch	Pennington
871.5	Judicial Ditch #15	Canal/Ditch	Canal/Ditch	Red Lake
872.1	Trib. to Judicial Ditch #15	Stream	Intermittent	Red Lake
872.5	Trib. to Judicial Ditch #15	Stream	Intermittent	Red Lake
873.8	Trib. to Judicial Ditch #15	Canal/Ditch	Canal/Ditch	Red Lake
875.4	Clearwater River	River	Perennial	Red Lake
880.3	County Ditch #18	Canal/Ditch	Canal/Ditch	Red Lake
884.7	County Ditch #61	Canal/Ditch	Canal/Ditch	Red Lake
885.9	Lost River	Stream/River	Perennial	Red Lake
886.7	County Ditch #71	Canal/Ditch	Canal/Ditch	Red Lake
888.0	Ditch to the Lost River	Stream	Intermittent	Polk
889.7	State Ditch #87/61	Canal/Ditch	Canal/Ditch	Polk
890.8	County Ditch #91	Stream/River	Perennial	Polk
894.0	unnamed ditch	Stream/River	Perennial	Polk
894.9	unnamed ditch	Stream/River	Perennial	Polk
900.3	unnamed trib.	Stream	Intermittent	Polk
900.9	unnamed	Stream	Intermittent	Clearwater
901.4	unnamed	Stream	Intermittent	Clearwater
902.1	Trib. to Lost River	Stream	Intermittent	Clearwater
902.9	Trib. to Lost River	Stream	Intermittent	Clearwater
904.1	Trib. to Lost River	Stream/River	Perennial	Clearwater
907.1	Silver Creek	Stream/River	Perennial	Clearwater
907.6	Silver Creek	Stream/River	Perennial	Clearwater
907.8	Silver Creek	Stream/River	Perennial	Clearwater
908.9	Trib. to Silver Creek	Stream	Intermittent	Clearwater
909.2	Trib. to Silver Creek	Stream	Intermittent	Clearwater

9.1.2 Special Designated Waterbodies

Outstanding Resource Value Water

The proposed pipeline route will cross approximately 675 feet of one wetland designated as an Outstanding Resource Value Water (ORVW) by the MDNR, the Viking Fen near MP 844.3 (based on review of MDNR Protected Waters and Wetlands Inventory Maps). ORVW are provided an additional level of protection to preserve their values for recreational, cultural, aesthetic, or scientific resources. Enbridge will consult with the MDNR to discuss appropriate mitigation techniques for construction in this area.

Wild and Scenic Rivers

The proposed pipeline route will cross two rivers listed on the Nationwide Rivers Inventory (NRI). Pursuant to Section 5(d) of the National Wild and Scenic Rivers Act, the National Park Service maintains a NRI of river segments that potentially qualify as national wild, scenic, or recreational river areas. NRI rivers are to be taken into consideration by each federal agency in its normal planning and environmental review process. Impacts need to either be avoided or mitigated to prevent adverse effects on the river. In addition, federal agencies need to consult the NPS prior to review of actions which may adversely affect a river listed on the NRI. The proposed pipeline will cross the Red River of the North at MP 801.8 (at the North Dakota/Minnesota border) and the Middle River at MP 836.1. Neither waterbody is a federally designated National Wild and Scenic River, but both are on the NRI as potentially qualifying for inclusion as a National Wild or Scenic River in the future. Enbridge will consult with the NPS prior to crossing these NRI rivers.

State and County Canoe/Boating Routes

The proposed pipeline route will cross two waterbodies listed as state-designated canoe and boating routes. These waterbodies are the Red River of the North at MP 801.8 and the Red Lake River at MP 864.4. The MDNR manages canoe/boating routes in the state, and Enbridge will consult with the MDNR regarding appropriate crossing plans.

9.1.3 Waterbody Construction Methods

Enbridge is planning to install the pipeline under most waterbodies using the open-cut method; however, a dry crossing method, such as the dam-and-pump or flume method, may be used where warranted by site conditions, stream type, and/or presence of sensitive species. Enbridge is evaluating the use of the HDD method to cross the Red River of the North and the Red Lake River. The following sections describe typical construction procedures that will be used to install the proposed pipeline across waterbodies.

Clearing and Grading

Enbridge will clear existing vegetation from the construction right-of-way as necessary to prepare for grading operations. A 10-foot buffer of undisturbed non-woody vegetation will be maintained on stream banks until the trenching begins at the stream crossing. Woody vegetation within this buffer may be cut manually and removed during initial clearing of the right-of-way. Additionally, some limited grading at stream banks may be necessary to install temporary bridges across streams. Grading will be directed away from the waterbody to reduce the potential for material to enter the waterbody.

Prior to trenching, Enbridge may need to grade approaches to waterbodies to create a safe working surface and to allow for limitations on pipe bending. Temporary erosion control measures (e.g., silt fences, straw bales) will be installed as necessary to minimize the potential for disturbed soils to enter the waterbody from the right-of-way as discussed in the EMP (see Appendix B). Extra workspaces at waterbody crossings typically will be set back 50 feet from the water's edge where topographic and other site conditions permit.

Spoil containment devices such as silt fence and/or straw bales will be installed and set back from the waterbody bank to minimize the potential for sediment to migrate off the construction right-of-way and back into the waterbody.

Temporary Equipment Bridges

To allow the passage of equipment along the construction right-of-way, temporary bridges will be installed across waterbodies with the possible exception of: waterbodies that are too wide to bridge; minor waterbodies such as agricultural and intermittent drainage ditches; and waterbodies that are not state-designated fishery streams. Equipment bridges generally will be installed during the clearing and grading phase of construction. Construction equipment, with the exception of clearing/bridge installation equipment, will be required to use the bridge to cross over the waterbody. The clearing equipment typically must cross the streams prior to bridge installation. Care will be taken to minimize bed and bank disturbance during bridge installation.

Equipment bridges will consist of one of the following: clean rock placed over flume pipes; prefabricated construction mats placed over the waterbody with or without a culvert; or flexi-float or other temporary bridging. Equipment bridges will be designed to pass the maximum foreseeable flow of the stream, and will be maintained to prevent flow restriction while the bridge is in place. Bridges will be cleaned as necessary to minimize loose soil from equipment entering the stream. Bridges will be removed during final cleanup of the right-of-way.

Trenching and Installation

After the initial clearing and grading is completed, the pipeline will be installed across the waterbodies using one of these four methods: open-cut, dam-and-pump, flume, or HDD as discussed in the EMP (see Appendix B). These methods are described below.

<u>Open-cut Method</u>

The open-cut method, also called the wet trench method, is a waterbody crossing technique that often minimizes total duration of in-stream disturbance. This method will involve excavating the trench through the waterbody or ditch using draglines or backhoes operating from the stream banks. Spoil excavated from the waterbody bed or banks will be temporarily placed on the right-of-way at least 10 feet from the water's edge or in extra workspaces typically set back 50 feet from the water's edge, except where the adjacent upland consists of actively cultivated or rotated cropland or other disturbed land. Spoil containment devices such as silt fences and/or straw bales will be installed to contain the spoil and to minimize the potential for sediment to migrate off of the construction right-of-way and back into the waterbody.

During excavation of the in-stream trench, earthen "trench plugs" will be left at each end of the excavation to isolate the in-stream trench segment from the adjacent pipeline trench and to prevent the stream flow from entering the adjacent excavated pipeline trench. When the trench through the waterbody is excavated to the appropriate depth, the trench plugs will be removed and a prefabricated section of pipe will be positioned and lowered into the trench. The trench then will be backfilled and the pipeline ends will be tied into the adjacent pipeline segments.

Enbridge will attempt to complete in-stream trenching and backfilling within 24 hours for minor waterbodies (<10 feet wide) and within 48 hours for waterbodies greater than 10-feet wide but less than 100 feet wide. Site-specific crossing conditions, permit requirements, or weather conditions may extend the completion of crossings beyond these time frames.

Dam-and-Pump Method

The dam-and-pump method is a dry crossing method used for sensitive streams with low gradients and flow or sensitive streams with meandering channels. This method involves constructing temporary dams, generally consisting of sandbags, plastic sheeting, and/or steel bulkheads, across the waterbody upstream and downstream of the crossing prior to excavation. Pumps will be used to transport the stream flow around the construction area. Pumping activities will commence simultaneously with dam construction to prevent interruption of downstream flow. The downstream discharge will be directed into an energy-dissipation device (e.g., splash pup, concrete weight, or equivalent) where required to prevent scouring of the waterbody bed or adjacent banks. The pump capacity will be greater than the anticipated flow of the waterbody being crossed. The pumping operation will be staffed continually and pumping will be monitored and adjusted as necessary to maintain the flow of water downstream and prevent excessive drawdown of the waterbody, upstream of the construction area. Additionally, a backup pump or pumps will be onsite in the event that the primary pump(s) fails.

Once the dams and pumps have routed the stream flow around the construction area, the water from the area between the dams will be pumped into a straw bale or similar dewatering structure. Dewatering structures will be located in well-vegetated upland areas, if present, and will be designed in a manner to prevent the migration of heavily silt-laden water into waterbodies or wetlands. Backhoes working from one or both waterbody banks, or within the isolated waterbody bed, will excavate the trench across the waterbody to the appropriate depth. Spoil will be temporarily stockpiled on the construction right-of-way at least 10 feet from the water's edge and/or in temporary extra workspaces at least 50 feet from the water's edge and contained by silt fence and/or staked straw bales.

After the trench is excavated to the proper depth, a prefabricated section of pipe will be positioned and lowered into the trench. The trench will then be backfilled with the material excavated from the stream, unless otherwise specified in federal or state stream crossing permits. The bottom contours of the streambed and the stream banks will be restored as near as practicable to preconstruction condition prior to removing the dams and restoring the stream flow. Water that accumulated in the construction area will be pumped into a straw bale or similar dewatering structure prior to backfilling and/or removal of the dams.

Flume Method

The flume method is a dry crossing method used for sensitive, relatively narrow waterbodies free of large rocks and bedrock at the trenchline and that have a relatively straight channel across the construction right-of-way. The flume method generally is not appropriate for wide, deep, or heavily flowing streams. This method will involve placing one or more pipes (i.e., flumes) in the waterbody bed to convey stream flow and isolate the construction area. The capacity of the flume(s) will be sufficient to transport the maximum flows that can be generated seasonally within the waterbody. Flume(s) typically will be 40 to 60 feet in length and will be installed before trenching. Flume pipes will be aligned to prevent impounding of water upstream of the construction area or to cause erosion downstream.

The upstream and downstream ends of the flume(s) will be incorporated into dams made of sandbags and plastic sheeting (or equivalent). The upstream dam will be constructed first and will funnel stream flow into the flume(s). The downstream dam will then be constructed to prevent water from flowing back into the area to be trenched. The dams will be monitored and adjusted as necessary to minimize leakage. The flume will remain in place until the portion of the pipeline under the stream is installed, the trench is backfilled, and the stream banks are restored.

Prior to trenching, the area between the dams typically will be dewatered. Backhoes are located on one or both of the waterbody banks or work within the isolated segment of the waterbody bed and will excavate a trench across the waterbody and under the flume(s). Excavated spoil material will be placed on the construction right-of-way and/or in temporary extra workspaces and will be contained by silt fences and/or staked straw bales. Water that accumulates in the construction area will be pumped into a dewatering structure prior to backfilling or removal of the dams.

After the trench is excavated to the proper depth, a prefabricated section of pipe will be positioned and lowered into the trench beneath the flume pipe(s). The trench is then backfilled with the material excavated from the stream unless otherwise specified in federal or state stream crossing permits. The bottom contours of the streambed and the stream banks will be restored as near as practicable to preconstruction conditions prior to removing the dams and flume pipes and returning the stream flow.

Horizontal Directional Drilling Method

Enbridge will evaluate use of the HDD method at selected waterbody crossings. This method can be used to minimize or avoid impacts on the streambed, banks, and associated riparian vegetation at the waterbody crossing. The feasibility of this method is dependent on subsurface geology and length of the drill path. The HDD method also requires additional temporary extra workspaces on both sides of the drilled area for materials and equipment associated with the drilling operation and to fabricate the pipeline segment that will be installed under the waterbody.

The HDD method will be accomplished in three general stages. The first stage will consist of drilling a small diameter pilot hole along a pre-determined path under the waterbody. The second stage will involve incrementally enlarging or “reaming” the pilot hole to a diameter that will accommodate the pipeline. The third stage will involve pulling a prefabricated segment of pipeline through the enlarged hole and then welding the pipe segment to the adjoining sections of pipeline.

Throughout the process of drilling and enlarging the pilot hole, a bentonite clay slurry (“drilling mud”) will be circulated through the drilling tools to lubricate the drill bit, remove drill cuttings, and stabilize the open hole. Drilling mud will be recycled to the extent practicable, and after the pipeline is installed, the mud will be disposed of according to applicable regulations. Enbridge has prepared a Drilling Mud Containment, Response, and Notification Plan that identifies procedures to address the potential for the inadvertent release of drilling mud during HDD operations (see Appendix G).

Enbridge will conduct geotechnical investigations to evaluate the feasibility of using the HDD method at the selected waterbodies. Geotechnical investigations are necessary because the pipeline route will cross regions with soils that may not be conducive to HDD technology, such as soils containing cobbles, boulders, layers of gravel, and/or non-cohesive sands. If these investigations determine that there potentially could be installation problems using the HDD method at the waterbody crossing, an alternate, environmentally acceptable method will be specifically designed for the crossing.

Restoration and Revegetation

The following discussion on restoration and revegetation applies to streams crossed using the open-cut, dam-and-pump, and flume crossing methods. Typically, stream bank and streambed restoration and stream bank revegetation will not be necessary when the stream is crossed using the HDD method.

After the trench is excavated to the proper depth, a prefabricated section of pipe will be lowered into position and the trench will be backfilled with the material excavated from the stream. Backfilling will commence after the pipe is positioned in the trench at the desired depth. Backfill material will consist of the spoil material excavated from the trench unless otherwise specified in federal or state stream crossing permits. The bottom contours of the streambed and the stream banks will be restored as near as practicable to preconstruction contours and condition. Steep stream banks will be re-contoured to a more stable configuration. If there is a potential for significant bank erosion, the disturbed banks will be stabilized with rock riprap or other bank protection measures. Jute thatching or erosion control blankets will be installed on the stream banks upslope of the riprap or on the entire bank if no riprap is used. The banks and adjacent disturbed areas will be seeded in accordance with seeding recommendations and/or permit stipulations, and mulch will be applied as needed on slopes. Stream banks will be stabilized and temporary sediment barriers will be re-installed within 24 hours of completing the crossing (weather and soil conditions permitting) to minimize the potential for sedimentation. Trench breakers will be installed at the stream banks, as needed, where slopes are adjacent to the waterbodies.

Flumes and temporary dams will be removed from the streambed after the crossing has been returned to original grade and the banks have been reconstructed and stabilized with erosion control materials. Temporary erosion control measures will be installed and maintained until permanent erosion control measures are installed and effective. Permanent slope breakers will be installed, where needed, across the full width of the right-of-way during final clean-up.

Where necessary for access, the travel lane portion of the construction right-of-way and the temporary bridge will remain in place until final clean-up activities. Temporary bridges will be removed after final clean-up, seeding, mulching, and other right-of-way restoration activities have been completed. The temporary erosion control measures will be removed after vegetation has been re-established.

The pipe section installed under the stream will be connected (tied-in) to the pipeline. If trench dewatering is necessary during the tie-in process, the water will be pumped into a filtration device located in well-vegetated areas and in a manner to prevent the migration of heavily silt laden water into waterbodies or wetlands.

9.1.4 General Construction and Operation Impacts and Mitigation

Pipeline construction across rivers and streams can result in temporary and long-term adverse environmental impacts if not mitigated. Temporary impacts from in-stream trenching could include an increase in the sediment load downstream of the crossing location. Sustained periods of exposure to high levels of suspended solids have been shown to cause fish egg and fry mortality and other deleterious impacts on fisheries and other aquatic resources. Surface runoff and erosion from the cleared right-of-way also can increase in-stream sedimentation during construction resulting in the shallowing of pools and a reduction of the quality of spawning beds and benthic substrate. Enbridge's proposed waterbody construction methods, specifically with respect to erosion control, bank stabilization, and bank revegetation, will minimize short- and long-term impact on the waterbodies along the pipeline route.

Long-term impacts on water quality can result from alteration of the streambanks and removal of riparian vegetation. Soil erosion associated with surface runoff and streambank sloughing can also result in the deposition of sediments in waterbodies. Sediments deposited on stream bed gravel could result in fish egg mortality and damaged spawning habitat. Removal of riparian vegetation also can lead to increased light penetration into the waterbody, causing increased water temperature, which potentially could be detrimental to coldwater fisheries.

Enbridge will avoid and minimize impacts on waterbodies by implementing the erosion and sediment control measures described in the EMP (see Appendix B). Enbridge also will limit the duration of construction within waterbodies and limit equipment operation within waterbodies to the area necessary to complete the crossing. Disturbed areas at crossings will be restored and stabilized as soon as practical after pipeline installation.

Alternative construction techniques (such as HDD or dry crossing methods) may be used at selected waterbodies to avoid and minimize impacts on these waterbodies. The HDD method is a well-established construction technique for installing pipeline under large waterbodies that avoids impacts associated with conventional open-cut methods. HDD installations have the potential to affect waterbodies, however, through inadvertent releases of drilling muds during construction. If HDD is used to cross waterbodies, Enbridge will follow the provisions of its Drilling Mud Containment, Response, and Notification Plan (see Appendix G) to prevent an inadvertent release of drilling mud or to minimize environmental effects in the event that a release occurs.

Spills from refueling operations, fuel storage, or equipment failure in or near a waterbody could affect aquatic resources and contaminate the waterbody downstream of the release point. Enbridge will minimize the potential impact of spills of hazardous materials by adhering to the relevant provisions in its SPCCP (see Appendix C).

9.1.5 Hydrostatic Testing

Enbridge will hydrostatically test the new pipe to verify its integrity prior to placing the pipeline in service. Hydrostatic testing will be conducted in accordance with the Office of Pipeline Safety regulations. The procedure consists of filling a section of pipe with water and maintaining a prescribed pressure for a prescribed period of time.

Enbridge is evaluating potential sources for appropriating hydrostatic test water, including major waterbodies crossed by or adjacent to the proposed pipeline and/or groundwater sources such as high-capacity irrigation wells or municipal wells. Enbridge is also evaluating transferring water from one test section to another to minimize the total quantity of water needed to complete the hydrostatic test. Enbridge will obtain the applicable water appropriation and discharge permits for hydrostatic testing activities.

Water used for hydrostatic testing will be discharged on land, returned to the waterbody where it was appropriated, or discharged to a different waterbody after hydrostatic testing is completed, depending on the National Pollutant Discharge Elimination System permit stipulations. If the water is discharged to an upland area, energy dissipation devices such as straw bale structures and controlled discharge rates will minimize the potential for erosion and subsequent release of sediment into nearby surface waters and wetlands. If hydrostatic test water is discharged directly into waterbodies, energy dissipation devices will be used to reduce the discharge energy to prevent stream bottom scour. Enbridge also will control the rate of discharge to prevent stream bottom scouring. No chemical additives will be introduced to the water used to hydrostatically test the new pipeline, and no chemicals will be used to dry the pipeline following the hydrostatic testing.

9.2 WETLAND CROSSINGS

9.2.1 Existing Wetland Resources

Enbridge identified wetlands along the pipeline route using NWI map data in digital format. This allowed digital analysis of wetland crossings using ArcView GIS® software. In addition, aerial photographs of the pipeline route were used in conjunction with the NWI maps to determine if wetlands adjacent to the proposed right-of-way could be affected by pipeline construction.

For routing and planning purposes, Enbridge used the NWI data to estimate the number, size, and locations of wetlands along the pipeline route. Enbridge conducted wetland delineation surveys along the pipeline route in the fall of 2006 to more accurately identify the wetlands that will be affected during project construction. Additional wetland surveys will be conducted during the "growing season" of 2007, as necessary. Wetlands were identified and mapped in general accordance with the Routing Determination method as specified in the *Corps of Engineers Wetland Delineation Manual* (U.S. Army Corps of Engineers (COE), 1987). A total of 68 wetlands were identified within a 150-foot-wide survey corridor along the pipeline route. A summary of the wetlands crossed by the pipeline route is provided in table 9.2.1-1.

TABLE 9.2.1-1

Summary of National Wetland Inventory Wetland Types Crossed by the LSr Project Pipeline Route

County	Distance (miles)	Number of Wetlands
Kittson	0.0	3
Marshall	0.2	5
Pennington	0.8	20
Red Lake	0.6	14
Polk	2.3	14
Clearwater	0.7	12
Total	4.6	68

A total of approximately 4.6 linear miles of wetlands will be crossed by the pipeline route. Predominant wetland types crossed by the project are palustrine emergent (PEM), palustrine shrub-scrub (PSS), and palustrine forested wetlands (PFO). Common plant species identified in these wetlands include: broad-leaved cattail (*Typha latiolia*), reed canary grass (*Phalaris arundinacea*), lake sedge (*Carex lacustris*), water sedge (*Carex aquatilis*), speckled alder (*Alnus rugosa)*, black willow (*Salix nigra*), black ash (*Fraxinus nigra*), tamarack (*Larix laricina*), and black spruce (*Picea mariana*). A summary of the wetlands types crossed, the total length of crossing, and area affected are presented in table 9.2.1-2.

TABLE 9.2.1-2

Summary of National Wetland Inventory Wetlands Affected by Construction of the LSr Project Pipeline

County	Wetland Type	Distance (miles)	Acres Affected [a]	Number of Wetlands
Kittson				
	PEM	0.0	0.0	3
Kittson Total		0.0	0.0	3
Marshall				
	PEM	0.0	0.0	2
	PFO	0.1	0.9	2
	PSS	0.0	0.0	1
Marshall Total		0.2	1.8	5
Pennington				
	PEM	0.5	4.5	12
	PFO	0.0	0.0	1
	PSS	0.2	1.8	4
	PUB	0.0	0.0	2
	R2U	0.0	0.0	1
Pennington Total		0.8	7.3	20
Red Lake				
	PEM	0.5	4.5	9
	PFO	0.1	0.9	2
	PUB	0.0	0.0	1
	R2U	0.0	0.0	2
Red Lake Total		0.6	5.5	14
Polk				
	PEM	1.5	13.6	8
	PSS	0.8	7.3	5
	PUB	0.0	0.0	1
Polk Total		2.3	20.9	14
Clearwater				
	PEM	0.2	1.8	7
	PFO	0.5	4.5	3
	PSS	0.1	0.9	2
Clearwater Total		0.7	6.3	12
Grand Total		4.6	41.8	68

TABLE 9.2.1-2

Summary of National Wetland Inventory Wetlands Affected by Construction of the LSr Project Pipeline

County	Wetland Type	Distance (miles)	Acres Affected [a]	Number of Wetlands

[a] Assumes a 75-foot-wide construction right-of-way in all wetland areas. Does not include additional temporary workspace, aboveground facilities, access roads, or pipe storage and contractor yards.

9.2.2 Protected Wetlands

The pipeline route will cross one wetland (public water wetland) listed on the MDNR Protected Waters Inventory. Public water wetlands are Type 3, 4, and 5 wetlands, as defined in the FWS Circular No. 39 (1971 edition), that are 10 acres or more in size in unincorporated areas or 2.5 acres or more in incorporated areas. Type 3, 4, and 5 wetlands are defined as inland shallow fresh marshes; inland deep fresh marshes; and inland open fresh water, shallow ponds, and reservoirs. These wetlands are regulated as public waters under MDNR's Public Waters Permit Program. The proposed pipeline route will cross about 675 feet of wetland 57-3-W between MPs 853.7 and 853.8 in Pennington County.

9.2.3 Wetland Construction Methods

Typical pipeline construction in most wetlands will be similar to construction in uplands and will consist of clearing, trenching, dewatering, installation, backfilling, cleanup, and revegetation. However, due to the unstable nature of some wetland soils, construction activities may differ somewhat from standard upland procedures. Construction activities will be minimized in wetlands and/or special construction techniques will be used to minimize the disturbance to vegetation and soils and to maintain wetland hydrology. Where a wetland cannot support construction equipment, construction activities will be accomplished from timber construction mats or by the use of low ground pressure equipment, thus limiting disturbance to the wetland. A typical construction schematic illustrating a wetland crossing is provided in the EMP in Appendix B.

Clearing and Grading

Vegetation within wetlands will be cut off at the ground level, leaving existing root systems intact to preserve natural sources of rootstock and to facilitate revegetation of the native wetland species after construction. Stumps will only be removed over the trench line and where necessary for safe operation of equipment. Trees, shrubs, and stumps that are removed will be properly disposed of outside wetlands. Timber construction mats, if needed and temporary erosion control measures will be installed at this time.

Trenching and Installation

The pipeline trench will typically be excavated in wetlands using a backhoe excavator. In unsaturated wetlands up to one foot of topsoil will be stripped from the trench line and stockpiled separately from trench spoil.

If the soils in the wetland area are stable and capable of supporting equipment with or without timber construction mats, the pipe will be strung, welded, and lowered into the trench as in upland areas. When water is present in the trench, the trench may be temporarily dewatered and/or the pipe flooded to sink it into the trench.

It may not be feasible to use the construction methods described above for crossing large wetlands with standing water and saturated soils. In these wetlands, the trench will be dug by a backhoe supported on timber mats but it is often not feasible to separate topsoil. The pipe will be assembled in an upland area and floated across the wetland in the excavated trench using the "push-pull" an/or "float" techniques. When the pipeline is in position, floats, if used, will be removed and the pipeline will be sunk into position and the pipe tied into the upland portion of the pipeline.

After the pipe has been installed, the trench will be backfilled and the original contours will be restored to the extent practical. In areas where the topsoil has been segregated, the topsoil will be replaced after backfilling to facilitate the natural revegetation process. Any excess backfill material will be removed to an upland area.

Cleanup and Revegetation

Cleanup and rough grading will begin as soon as practical after the trench is backfilled. Timber mats, if used, will be removed during the cleanup operations. Disturbed wetland areas will be revegetated with a cover crop in accordance with Natural Resources Conservation Service or other agency recommendations, unless standing water is prevalent or as otherwise directly by landowners or regulatory agencies. No fertilizer, lime, or mulch will be applied in wetlands.

9.2.4 General Construction and Operation Impacts and Mitigation

A total of 68 wetlands will be crossed by the proposed project in Minnesota, based on the review of NWI data. Pipeline construction across these wetlands will result in temporary impacts on approximately 41.8 acres. A summary of wetlands affected during construction is provided in table 9.2.1-2

Wetlands will not be permanently filled or drained as a result of constructing the project. Construction will result in temporary impacts and, in a few situations, minor changes in plant species composition. The temporary impacts include loss of wetland vegetation and wildlife habitat as a result of clearing and other construction activities; soil disturbance associated with clearing, trenching, and equipment traffic; and increases in turbidity and alterations of hydrology as the result of trenching, dewatering and soil stockpiling activities.

Approximately 24.4 acres of palustrine emergent wetland will be temporarily affected by pipeline construction. Enbridge anticipates that there will be no long-term impacts on emergent wetlands. The wetlands will be restored to preconstruction conditions and the herbaceous vegetation will be allowed to naturally revegetate in these areas.

Approximately 10.0 acres of palustrine scrub-shrub wetland and approximately 6.3 acres of palustrine forested wetland will be cleared and temporarily disturbed during pipeline construction. The impacts on scrub-shrub wetlands and forested wetlands will be of a longer duration than emergent wetlands because the woody vegetation will require a longer time to re-establish on the temporary right-of-way after restoration.

After the pipeline is constructed, an additional 40 feet of right-of-way will be maintained relatively free of larger-diameter trees along the existing right-of-way. This additional maintained right-of-way will result in the permanent conversion of approximately 3.4 acres of forested wetland to emergent or scrub-shrub wetland.

Enbridge will minimize impacts in wetlands by implementing the mitigative measures specified in the EMP, including:

- wetland vegetation will be cut off at ground level and removed from the wetland areas;
- construction mats will be used, as needed, to facilitate equipment access and pipeline installation;
- temporary erosion control devices will be installed prior to trenching activities;
- the top 1 foot of topsoil or the amount of topsoil present, whichever is less, will be stripped over the trench line, segregated, and replaced in unsaturated wetlands;
- wetlands will be restored to preconstruction contours;
- wetland hydrology will be maintained by using trench breakers when necessary, and sufficiently compacting the pipeline trench; and
- wetland vegetation will be allowed to naturally revegetate with wetland plants common to the area.

10.0 CULTURAL RESOURCES

10.1 EXISTING CULTURAL RESOURCES

Enbridge reviewed existing site file data maintained by the Minnesota Historical Society to determine if any portion of the proposed pipeline route was surveyed previously for cultural resources. A total of four previous archaeological studies have been completed that directly relate to the proposed pipeline route. The entire North Dakota/Minnesota border to Clearbrook portion of the corridor was first surveyed as part of Enbridge's 1994 Capacity Expansion Project (Minnesota State Historic Preservation Office (SHPO) No. 94-2227). In 1998, portions of the previous survey corridor were included in an Enbridge project named Terrace I or Terrace Expansion Project (Minnesota SHPO No. 98-2466). The Terrace I Project did not extend beyond the survey corridor for the 1994 Capacity Expansion and, therefore, no additional archaeological investigations were required for Terrace I. The reports of these previous surveys are as follows:

- Breakey, K. and C. Dobbs

  1993. *Files Search and Literature Review of Lakehead Pipeline Between Clearbrook, Minnesota and Neche, North Dakota*.

- Dobbs, C., K. Breakey, and H. Mooers

  1994. *A Model of Archaeological Sensitivity for Landforms Along the Lakehead Pipe Line Company Right-of-way from Neche, North Dakota to Clearbrook, Minnesota*.

- Breakey, K., C. Dobbs, and M. Murray

  1994a. *Phase I Archaeological Investigations of Selected Areas of the Lakehead Pipe Line Company Right-of-way between Neche, North Dakota and Clearbrook, Minnesota.*

  1994b. *Evaluation of the Archaeological Sites on the Lakehead Pipe Line Company Right-of-way between Neche, North Dakota and Clearbrook, Minnesota*.

Enbridge also reviewed the Minnesota SHPO's site files to identify previously recorded cultural resources within the proposed construction right-of-way. This review identified a single archaeological site located within the proposed LSr Project construction right-of-way. This site (21MA39) has been determined eligible for listing in the National Register for Historic Places (NRHP).

10.2 CONSULTATION WITH FEDERAL AND STATE AGENCIES

Enbridge initiated consultation with the St. Paul District of the COE for this project. Pursuant to Section 106 of the National Historic Preservation Act (16 USC 470), the COE will review the project for effects to cultural resources that are listed on or eligible for listing on the NRHP prior to issuing Section 404 and Section 10 permits for the project. The U.S. Department of State (DoS) and the COE will determine which federal agency will assume the lead role with overall responsibility for compliance with Section 106 requirements. It is expected that either the DoS or the COE will initiate consultation with the SHPO. The SHPO will assist the lead federal agency in reviewing the project for the potential to affect NRHP-listed or eligible properties.

In conjunction with the COE, Enbridge developed a survey implementation plan for the occurrence of undocumented cultural resources within the LSr Project survey corridor, where pervious survey has not occurred. The plan was reviewed and approved by the COE and field survey has begun. Enbridge anticipates that the field survey will be completed in the summer of 2007. The survey results will be summarized in an inventory report and submitted to the DoS/COE and SHPO for review.

10.3 TRIBAL CONSULTATIONS

The lead federal agency is responsible for consulting with federally recognized Indian tribes as part of the Section 106 process. For the LSr Project, Enbridge anticipates that the DoS/COE will contact the following tribes: Fond du Lac Band of Lake Superior Chippewa, Red Lake Band of Chippewa, White Earth Band of Chippewa, Leech Lake Band of Ojibwe, Mille Lacs Band of Ojibwe, and Bois Forte Band (Nett Lake) of Chippewa. Enbridge will assist the DoS/COE with tribal consultations as directed.

10.4 GENERAL CONSTRUCTION AND OPERATION IMPACTS AND MITIGATION

As noted above, Enbridge is currently conducting field surveys to identify cultural resources along the pipeline route. If the survey identifies any sites that are eligible for listing in the NRHP, Enbridge will consult with the DoS/COE and SHPO to identify measures to avoid, minimize, or mitigate adverse effects on these sites. These measures may include routing the pipeline around identified sites; installing the pipeline beneath the sites using conventional bore or HDD technology; fencing sites or portions of sites to ensure that they are not disturbed during construction; monitoring of construction activities by an archaeologist; or archaeological data recovery at the sites.

Enbridge will also develop and implement an unanticipated discoveries plan. This plan will describe measures to be followed in the event that a previously undocumented cultural resource site is discovered during construction activities. These measures will include documenting and evaluating the site; consulting with the DoS/COE and SHPO; and implementing measures to avoid, minimize, or mitigate adverse effects to the site if the site is eligible for listing on the NRHP.

11.0 FEDERAL, STATE, AND COUNTY RECREATIONAL AREAS

11.1 EXISTING DESIGNATED RECREATIONAL AREAS

The LSr Project pipeline route will not cross any national parks or forests, state parks or forests, wildlife management areas, county parks, state- or county-designated trails, or designated scenic byways. However, the proposed pipeline route will cross two state-designated canoe and boating routes as discussed below.

11.1.1 Federally Designated Recreation Areas and Trails

The proposed pipeline route will not cross any federal recreation areas or trails in Minnesota.

Nationwide River Inventory

As discussed in section 9.1.2, the pipeline route will cross two Minnesota rivers that are listed on the NRI. These rivers are the Middle River (MP 836.0) in Marshall County and the Red Lake River (864.4) in Pennington County. Neither waterbody is a federally designated National Wild and Scenic River, but both are on the NRI as potentially qualifying for inclusion as a National Wild or Scenic River in the future. Enbridge will consult with the NPS prior to crossing these NRI rivers.

Federal Forest Land

The proposed pipeline route will not cross any federal forest land in Minnesota.

11.1.2 State-Designated Recreation Areas

State Forest Land

The proposed pipeline route will not cross any state forest land in Minnesota.

State Wildlife Management Areas

Wildlife Management Areas (WMAs) are state lands that are actively managed for wildlife production and provide habitat for many wildlife species. WMAs are open to the public for recreational activities such as bird and wildlife watching, hunting, and trapping. WMAs generally are closed to motorized vehicles and horses. The proposed pipeline will be within approximately 0.5 mile of the Hangaard State WMA near MP 897.5.

State-Designated Trails and Canoe and Boating Routes

The proposed pipeline route will not cross any state trails in Minnesota. However, it will cross two state canoe and boating routes, the Red River of the North at MP 801.8 and the Red Lake River at MP 864.4.

11.1.3 County-Designated Recreation Areas

County Forest Land

The proposed pipeline route will cross approximately 0.3 mile of county-managed land. These lands are primarily forested, tax-forfeited parcels, but may be managed for various natural resource components in addition to providing recreational opportunities such as hunting and fishing. County-managed lands along the pipeline route are located in Clearwater County. Enbridge will consult with Clearwater County to minimize impacts on county lands.

11.1.4 Designated Scenic Byways

The pipeline route will not cross any designated scenic byways in Minnesota.

11.2 GENERAL CONSTRUCTION AND OPERATION IMPACTS AND MITIGATION

Construction and operation of the proposed pipeline are not expected to have significant impacts on recreational lands crossed by the pipeline. In Minnesota, more than 98 percent of the pipeline route will be constructed within or generally adjacent to Enbridge's existing pipeline right-of-way, which will minimize potential impacts on public lands and recreational areas. The proposed pipeline will have only minor and temporary impacts on public recreational areas. Impacts on recreational use of public land areas primarily will be limited to temporary inconveniences and localized disturbances, including noise, dust, and visual intrusions associated with construction activities. There will be no long-term impact on recreational activities within the public lands areas as the result of construction and operation of the pipeline. As discussed in section 7.1.5, vegetation maintenance of the permanent right-of-way will be required along the pipeline right-of-way, which could have limited visual impacts on public lands that are densely forested.

Project construction temporarily could restrict public use of the recreational areas crossed by the pipeline. Potential impacts on recreational activities will be dependent on the timing of construction, the season in which the recreational activity occurs, and the construction methods used. Public access to federal, state, and county lands will be maintained to the greatest extent possible during construction. Short-term closures of some areas may be necessary during construction. After construction is completed, the public lands will be restored to allow previous uses and recreational activities to continue. Enbridge will consult with the appropriate state and county land management agencies to avoid and minimize impacts on recreational areas.

Boating and recreational use of the waterbodies crossed by the project may be affected during construction of the pipeline, including state- and county-designated canoe routes. Depending on the crossing method used, impacts on waterbody users may include construction noise, downstream turbidity, or temporary obstructions such as sediment curtains or construction equipment at the crossing location. Enbridge will coordinate with the MDNR and local governments regarding the waterbody crossings.

12.0 REFERENCES

Adolphson, D.G., J.F. Ruhl, and R.J. Wolf. 1981. Designation of Principal Water-Supply Aquifers in Minnesota. U.S. Geological Survey. Water-Resources Investigation 81.51.

Anderson, P.G., C.G.F. Fraikin, and T.J. Chandler. 1997. Natural gas pipeline crossing of a coldwater stream: Impacts and Recovery. Proceedings of the 6th International Symposium Environmental Concerns in Rights-of-Way Management, February 22-26, 1997, New Orleans, LA.

Kanivetsky, R. 1979. Hydrogeologic Map of Minnesota: Quaternary Hydrogeology, Map S-6 Minnesota Geological Survey, University of Minnesota.

McKinnon, G.A. and F.N. Hnytka. 1988. The effect of winter pipeline construction on the fishes and fish habitat of Hodgson Creek, NWT. Can. Tech. Rep. Fish. Aquat. Sci. 1598.

Minnesota Department of Employment and Economic Development. LAUS Data. 2006. Available online at: http://www.deed.state.mn.us/. Accessed November 2006.

Minnesota Department of Health. 2006a County Well Index Online. Available online at: http://www.health.state.mn.us/divs/eh/cwi/#CWINotes. Accessed 2006.

Minnesota Department of Health, 2006b. Wellhead Protection Area. http://www.health.state.mn.us/divs/eh/water/swp/maps/index.htm. Accessed November 2006.

Minnesota Department of Natural Resources. 2006a. Minnesota Natural Heritage Database. Used with permission by Natural Resource Group, Inc.

Minnesota Department of Natural Resources. 2006b. Ecological Classification System. Available online at: www.dnr.state.mn.us/ecs/index. Accessed November 2006.

Minnesota Pollution Control Agency, 2006. Contamination database. Available online at: http://www.pca.state.mn.us/backyard/neighborhood.html. Accessed 2006.

Minnesota Pollution Control Agency. 1999. Baseline Water Quality of Minnesota's Principal Aquifers. Northwest Region. Minnesota Pollution Control Agency.

National Atlas of the United States. 2006. Quaternary Faults and mining operation data. Available online at: http://nationalatlas.gov/natlas/Natlasstart.asp. Accessed February 2007.

Northwest Area Foundation Indicator. 2004. Available online at http://www.indicators.nwaf.org. Accessed November 2006.

Ojakakangas, R. W. and Matsch, C. L. 1982 Minnesota's Geology. University of Minnesota Press, Minneapolis, 255 pp.

Schubert, J.P., W.S. Vinikour, and D.K. Gartman. 1985. Effects of Gas-Pipeline Construction on the Little Miami River Aquatic Ecosystem, Final Report (September 1983-April 1985). Gas Research Institute Report No. GRI-86/0024.

Soil Survey Division Staff. 1993. Soil Survey Manual. USDA Agricultural Handbook 18. U. S. Government Printing Office, Washington, DC.

Tester, J.R. 1995. Minnesota's Natural Heritage, An Ecological Perspective.

U.S. Army Corps of Engineers. 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. Waterways Experiment Station, Vicksburg Massachussetts.

U.S. Census Bureau. 2006. Available online at http://quickfacts.census.gov. Accessed November 2006.

U.S. Department of Agriculture. 1978. Agriculture Handbook No. 296, Land Resource Regions and Major Land Resource Areas of the United States. Also available on the Internet at: http://soils.usda.gov/survey/geography/mlra/index.html. Accessed November 2006.

U.S. Department of Agriculture, National Agricultural Statistics Service, Minnesota County Data – Crops. 2007. Available online at www.nass.usda.gov/QuickStats/Create_County_Indv.jsp. Accessed February 2007.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1995. Soil Survey Geographic (SSURGO) Data Base Data Use Information.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2003. Soil Survey Geographic (SSURGO) database for Pembina County, North Dakota; and Kittson, Marshall, Pennington, Red Lake, Clearwater, Beltrami, Hubbard, Cass, Itasca, Aitkin, St. Louis, and Carlton Counties, Minnesota. Available online at: http://www.ncgc.nrcs.usda.gov/products/datasets/ssurgo/. Accessed November 2006.

U.S. Environmental Protection Agency designated sole-source aquifers. 2006. Available online at: http://www.epa.gov/safewater/swp/ssa/reg5.html

U.S. Fish and Wildlife Service. 2006. E-mail dated March 6, 2007 from Laurie Fairchild (USFWS) to Daniel Flo (Natural Resource Group, Inc.).

U.S. Geological Survey. 1985. National Water Summary 1984, Water-Supply Paper 2275.