3.0 Affected Environment

3.1 Air Quality

Air quality in a given location is defined by pollutant concentrations in the atmosphere and generally is expressed in units of parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$). Visibility also is a measure of ambient air quality. Air quality within the Project area has the potential to be affected by such activities as emissions from the construction and operation of oil and gas facilities, access roads, and other elements of management activities. Regional air quality also is affected by natural events such as windstorms and wildfires, and larger emissions generating sources such as power plants, large manufacturing facilities, and transportation activities in urban corridors. Natural events generally are short lived, lasting from several hours to perhaps several weeks.

Both long-term climatic factors and short-term weather fluctuations are considered part of the air quality resource because they control dispersion and affect ambient air concentrations. The physical effects of air quality depend on the characteristics of the receptors (human or environmental) and the type, amount, and duration of exposure. This section describes the existing air quality resource of the region and the applicable air regulations that would apply to the Proposed Action and alternatives.

3.1.1 Air Quality Regulatory Framework

The CAA of 1970 (42 USC 7401 et seq.) as amended in 1977 and 1990 is the basic federal statue governing air pollution. Provisions of the CAA that are relevant to the Project include:

- National Ambient Air Quality Standards (NAAQS);
- Prevention of Significant Deterioration (PSD);
- New Source Performance Standards (NSPS);
- Maximum Achievable Control Technology (MACT) Standards;
- Conformity Requirements; and
- Climate Change.

In addition to federal regulations, the CAA provides states with the authority to regulate air quality within state boundaries. The State of North Dakota has enacted additional Ambient Air Quality Standards (AAQS) that are applicable to the Project area.

3.1.1.1 National and State Ambient Air Quality Standards

The federal CAA and the amendments of 1990 require all states to control air pollution emission sources so that NAAQS are met and maintained, enforced by the U.S. Environmental Protection Agency (USEPA) (USEPA 2004a). The CAA directs the USEPA to delegate primary responsibility for air pollution control to state governments. The State of North Dakota adopted the NAAQS as state air quality standards and has added more stringent AAQS applicable only to North Dakota. In addition to these requirements, the NPS Organic Act requires the NPS to protect the natural resources of the lands it manages from the adverse effects of air pollution.

The NAAQS establishes maximum acceptable concentrations for oxides of nitrogen (NO_X/nitrogen dioxide [NO_2]), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM) with an aerodynamic diameter less than or equal to 10 microns (PM_{10}), PM with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$), ozone (O_3), and lead. These pollutants are known as criteria pollutants. Primary standards set limits

to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against visibility impairment, and against damage to animals, crops, other vegetation, and buildings. These standards represent the maximum allowable atmospheric concentrations that may occur without jeopardizing public health and welfare, and include a reasonable margin of safety. The air quality impacts in the air quality Project area must meet the NAAQS, which apply nationwide. An area that does not meet the NAAQS is designated as a non-attainment area on a pollutant-by-pollutant basis. A list of the criteria pollutants regulated under the CAA for which specific concentration levels have been established, their currently applicable NAAQS, and State of North Dakota AAQS are listed in **Table 3.1-1**.

Table 3.1-1 National and North Dakota Ambient Air Quality Standards

Pollutant	Averaging Period	Ambient Air Quality Standards ($\mu g/m^3$)	
		National[1]	North Dakota[2]
NO_2	1-hour[3]	188	188
	Annual[4]	100	100
CO	1-hour[5]	40,000	40,000
	8-hour[5]	10,000	10,000
SO_2	1-hour[6]	196	196
	3-hour[5]	1,300	1,300
	24-hour[7]	Revoked	260[4]
	Annual[7]	Revoked	60
PM_{10}	24-hour[8]	150	150
	Annual[9]	Revoked	Revoked
$PM_{2.5}$	24-hour[10]	35	35
	Annual[4]	15	15
O_3	8-hour[11]	147	147
Lead	Rolling 3-month[12]	0.15	0.15
Hydrogen sulfide (H_2S)	Instantaneous[4]	--	14,000
	1-hour[13]	--	280
	24-hour[5]	--	140
	3-month[14]	--	28

1 Source: http://www.epa.gov/air/criteria.html#3.
2 Source: http://www.legis.nd.gov/information/acdata/pdf/33-15-02.pdf.
3 The 3-year average of the 98th percentile of the daily maximum 1-hour average is not to exceed this standard.
4 Not to be exceeded. Instantaneous H_2S would be assessed using 1-hour modeled impacts.
5 Not to be exceeded more than once per year.
6 The 3-year average of the 99th percentile of the daily maximum 1-hour average is not to exceed this standard.
7 The 24-hour and annual SO_2 NAAQS were revoked by USEPA on June 2, 2010; 75 Federal Register (FR) 35520.
8 Not to be exceeded more than once per year on average over 3 years.
9 The annual PM_{10} NAAQS of 50 $\mu g/m^3$ was revoked by USEPA on September 21, 2006; FR Volume 71, Number 200, 10/17/06.
10 24-hour average of the 98th percentile concentrations (effective December 17, 2006).
11 To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average O_3 concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm.
12 (a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is <= 1.
(b) The 1-hour NAAQS would no longer apply to an area 1 year after the effective date of the designation of that area for the 8-hour ozone NAAQS. The effective designation date for most areas is June 15, 2004 (40 CFR 50.9; see FR of April 30, 2004 [69 FR 23996]).
13 Not to be exceeded more than once per month.
14 Maximum arithmetic mean concentration averaged over 3 consecutive months.

3.1.1.2 New Source Review

New Source Review (NSR) requires stationary sources of air pollution to get permits before construction. NSR also is referred to as construction permitting or pre-construction permitting. The three types of NSR requirements that a source may need to meet are:

- PSD permits that are required for new major sources or existing major sources making a major modification in an attainment area;
- Non-attainment NSR permits that are required for new major sources or existing major sources making a major modification in a non-attainment area; and
- Minor source (non-PSD) permits.

3.1.1.3 Prevention of Significant Deterioration

PSD regulations apply to proposed new or modified sources in an attainment area that have the potential to emit criteria pollutants in excess of predetermined *de minimis* values (40 CFR Part 52). PSD regulations restrict the degree of ambient air quality deterioration that would be allowed. Allowable deterioration to air quality can be expressed as the incremental increase to ambient concentrations of criteria pollutants, or PSD increment. Increments for criteria pollutants are based on the PSD classification of the area. Class I designations allow the lowest amount of permissible deterioration by essentially precluding development near these areas. Class II areas are designed to allow for moderate, controlled growth, and Class III areas allow for heavy industrial use.

The NPS Organic Act requires the NPS to protect the natural resources of the lands it manages from the adverse effects of air pollution. Federal PSD Class I areas, which include certain national wilderness areas, national memorial parks, and national parks, are afforded the highest level of protection. Ambient air quality criteria that apply within Class I areas are the most stringent and include the regulation of air quality related values (AQRVs) within their borders. Federal Land Managers (FLMs) are responsible for the management of PSD Class I areas. The nearest Class I area is Theodore Roosevelt National Park, which runs alongside the proposed pipeline and is approximately 4 miles northwest of the Rail Loading Facility near Fryburg, North Dakota.

The North Dakota Department of Health (NDDH) – Air Quality Division (NDDH-AQD) generally does not require modeling for ozone impacts of minor sources. For PSD major sources, an evaluation of ozone levels and impacts is required if the total emission rate of volatile organic compounds (VOCs) is 100 tons per year (tpy) or more (40 CFR 52.21(i)(5)(i)) (USEPA 1990).

<u>PSD Increment</u>

A project's PSD increment consumption typically is determined through the use of an air quality dispersion model. Atmospheric concentrations of NO_2, SO_2, and PM_{10} predicted by the air quality model are compared with allowable PSD increments. The allowable PSD increments for Class I and Class II areas are given in **Table 3.1-2**.

PSD Class I and sensitive Class II areas are located within the air quality Project area. The closest PSD Class I area is Theodore Roosevelt National Park, which the proposed pipeline route borders and is approximately 4 miles northwest of the Fryburg Rail Loading Facility. The PSD Class I areas and sensitive Class II areas in proximity to the Project area are shown in **Figure 3.1-1** and include the following areas:

Table 3.1-2 Class I and Class II Area PSD Increments

PSD Class	Pollutant	Allowable Increment ($\mu g/m^3$)		
		Annual Arithmetic Mean	24-hour Maximum	3-hour Maximum
Class I	NO_2	2.5	-	-
	SO_2	2	5	25
	PM_{10}	4	8	-
Class II	NO_2	25	-	-
	SO_2	20	91	512
	PM_{10}	17	30	-

Source: 40 CFR §51.166(c).

NPS Class I Areas

- Theodore Roosevelt National Park

USFWS Class I Areas

- Lostwood Wilderness Area
- Medicine Lake Wilderness Area

Voluntary Class I Areas

- Fort Peck Indian Reservation

Sensitive Class II Areas

- Fort Berthold Indian Reservation

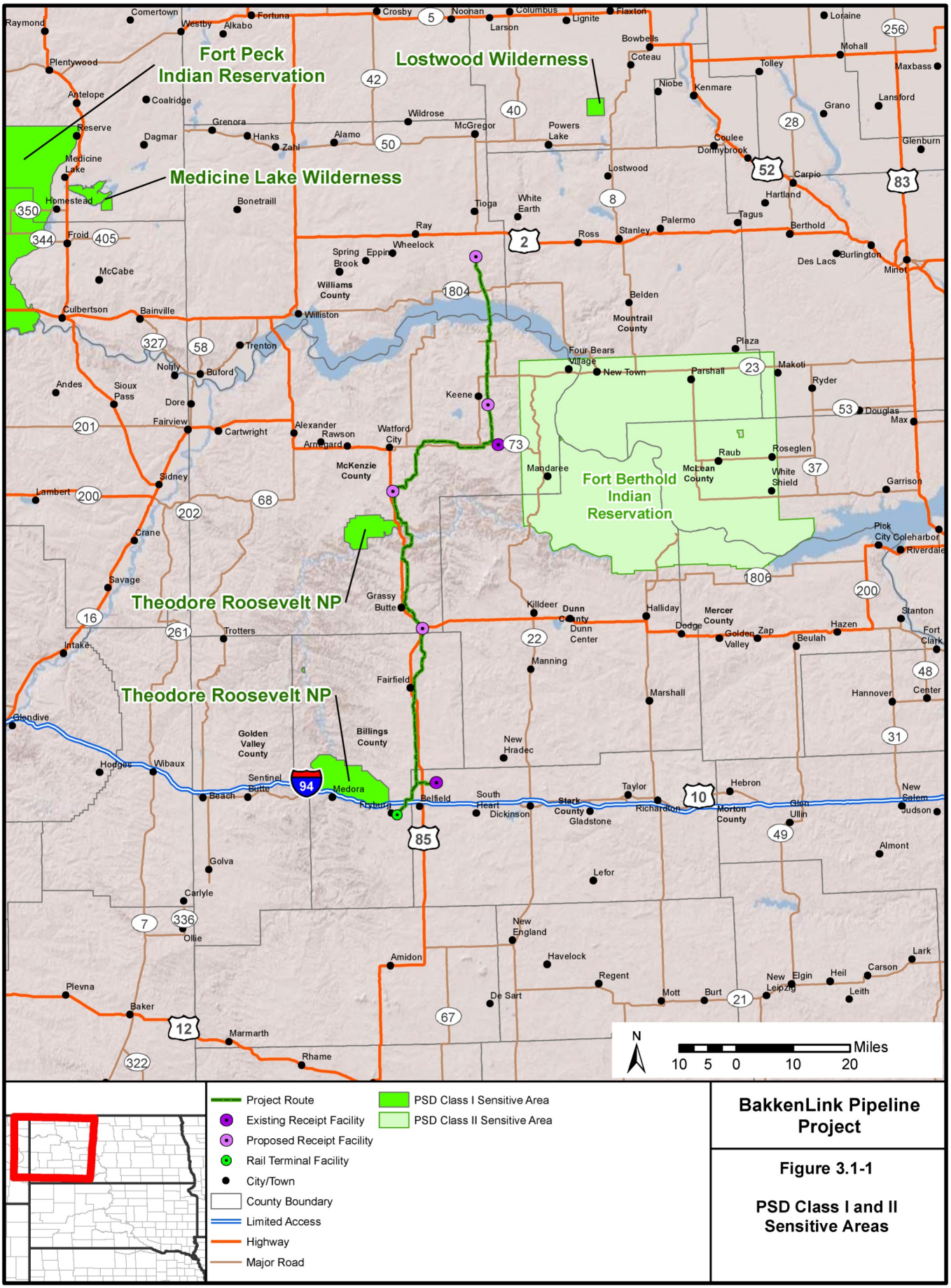
Air Quality Related Values

In addition to the more stringent PSD increments, Class I areas are protected by the FLMs who manage AQRVs. AQRVs include the potential air pollutant effects on visibility, atmospheric deposition, and the acidification of sensitive lakes and streams. They are applied to PSD Class I areas and sensitive Class II areas and set the level of acceptable change for each value. AQRVs reflect the land management agency's policy and are not legally enforceable standards.

Visibility

Visibility can be defined as the distance one can see (a standard visual range) or by the ability to perceive changes in color, contrast, and detail. The most commonly used reference for measuring visibility is the deciview, which is defined as a change in visibility that is just perceptible to the average person.

Regional haze is visibility impairment that is caused by the cumulative air pollutant emissions from numerous sources over a wide geographic area. Scattering and absorption of light by fine pollutant particles results in the development of regional haze and consequent visibility reduction. Some particles and gases



BakkenLink Pipeline Project

Figure 3.1-1

PSD Class I and II Sensitive Areas

scatter light while others absorb light. The primary cause of regional haze in many parts of the country is light scattering resulting from fine particles (i.e., $PM_{2.5}$) in the atmosphere. Coarse particles between 2.5 and 10 microns in diameter can contribute to light extinction. Each of these components of regional haze can be naturally occurring or the result of human activity. The natural levels of these components may result in some visibility impairment, even in the absence of human influences, and would vary with season, daily meteorology, and geography (USEPA 2003).

Atmospheric Deposition and Acid Neutralization Capacity

Atmospheric deposition, wet and dry, is the process whereby airborne particles and gases are removed from the atmosphere and deposited on the earth's surface.

Wet deposition is defined as the portion of atmospheric deposition contained in precipitation. Wet deposition is monitored by the National Atmospheric Deposition Program, a consortium of a large number of federal, regional, and state agencies, and academic institutions.

Dry deposition is the fraction deposited in dry weather through such processes as settling, impaction, and adsorption. The factors that influence dry deposition include whether the substance is in gaseous or particulate form, the solubility of the species in water, the amount of precipitation in the region, and the terrain and type of surface cover.

Mixing of specific compounds in the atmosphere can lead to acid deposition. Acidic wet deposition is called acid precipitation or, more commonly, acid rain. Acidity in precipitation is measured by collecting samples of rain and measuring its pH, which is lower when acidic compounds are present. "Clean" or unpolluted rain has a slightly acidic pH of 5.6, because carbon dioxide (CO_2) and water in the air react together to form carbonic acid, a weak acid. Throughout much of the eastern U.S., pH in rain is less than 4.5 (strongly acid). Acid deposition occurs when compounds in the atmosphere such as SO_2 and NO_X react to form sulfuric acid and nitric acid. These pollutants originate from natural sources (such as forest fires and volcanoes), as well as anthropogenic ones (such as the burning of fossil fuels in power plants and motor vehicles, and from agricultural practices). Acid deposition lowers pH in lakes and streams, which harms fish and other aquatic organisms, alters forest soils, degrades the growing conditions for some tree species, and affects other vegetation.

Existing Air Quality

Air quality in a given location is defined by pollutant concentrations in the atmosphere and generally is expressed in units of ppm or $\mu g/m^3$. The majority of the Project route traverses Billings and McKenzie counties and representative ambient background levels of pollutants measured in both counties (where possible) from the most recent year of data are shown in **Table 3.1-3**. Data for this table were obtained from the USEPA Air Monitoring Network data archives website. The sites were selected to provide a representative estimate for current background conditions in the Project area.

Air Quality Attainment Status

As the data shown in **Table 3.1-3** demonstrates, the area surrounding the Project area is in attainment for all criteria pollutants. Currently, North Dakota is in attainment for all criteria pollutants in all counties. However, if an area is designated as non-attainment, the State of North Dakota is required to develop a State Implementation Plan (SIP) under the CAA Section 176(c)(4)(E), which provides the requirements for SIPs.

Table 3.1-3 Ambient Air Quality Background Values

Pollutant	Averaging Period	Ranking[1]	Year	Concentration (ppb)	Monitor/ County	AQS Site ID
NO_2	1-hour	98th Percentile	2009-2011 Average	10.7	Dunn	38-025-0003
		98th Percentile	2009-2011 Average	9.0	McKenzie	38-053-0002
	Annual	H1H	2011	3.6	Dunn	38-025-0003
		H1H	2011	3.6	McKenzie	38-053-0002
CO	1-hour	H2H	2011	682	Cass [2]	38-017-1004
	8-hour	H2H	2011	400	Cass [2]	38-017-1004
SO_2	1-hour	99th Percentile	2009-2011 Average	12.7	Dunn	38-025-0003
		99th Percentile	2009-2011 Average	10.1	McKenzie	38-053-0002
	3-hour	H2H	2011	5.6	Dunn	38-025-0003
		H2H	2011	9.4	McKenzie	38-053-0002
	24-hour	H2H	2011	1.8	Dunn	38-025-0003
		H2H	2011	3.2	McKenzie	38-053-0002
	Annual	H1H	2011	1.1	Dunn	38-025-0003
		H1H	2011	1.7	McKenzie	38-053-0002
PM_{10}	24-hour	H2H	2011	74.0 [3]	Dunn	38-025-0003
		H2H	2011	30.0 [3]	McKenzie	38-053-0002
$PM_{2.5}$	24-hour	98th Percentile	2011	11.7 [3]	Dunn	38-025-0003
		98th Percentile	2009-2011 Average	14.5 [3]	McKenzie	38-053-0002
	Annual	H1H	2011	4.3 [3]	Dunn	38-025-0003
		H1H	2011	8.8 [3]	McKenzie	38-053-0002
O_3	8-hour	H2H	2011	57	Dunn	38-025-0003
		H2H	2011	62	McKenzie	38-053-0002

[1] H1H represents the highest overall value for the given year. H2H represents the high second high concentration (the second highest value form the highest impact receptor). The 98th and 99th percentile values were averaged over 3 years.

[2] CO measured at Cass County monitor, which is the only CO monitor in the State of North Dakota that is still active.

[3] All PM_{10} and $PM_{2.5}$ concentrations are expressed in units of $\mu g/m^3$.

Source: http://www.epa.gov/airdata/ad_rep_mon.html.

3.1.1.4 Non-attainment New Source Review and Conformity for General Federal Actions

While new emissions sources in attainment areas are required to follow PSD regulations, Non-attainment New Source Review is required for major stationary sources locating or expanding in non-attainment areas. According to Section 176 of the CAA (40 CFR 51.853), a federal agency must make a conformity determination in the approval of a project having air emissions that exceed specified thresholds in non-attainment and/or maintenance areas. This General Conformity Rule ensures that the actions taken by federal agencies in non-attainment and maintenance areas meet national standards for air quality and/or do not cause further degradation to air quality that would not be consistent with the attainment and maintenance of ambient air quality standards. The Project is not located within a non-attainment or maintenance area identified USEPA or the NDDH-AQD); therefore, a general conformity analysis would not be required for evaluating impacts to air quality before implementing the Project.

3.1.1.5 New Source Performance Standards

The regulation of new sources, through the development of standards applicable to a specific category of sources, was a significant step taken by the CAA. NSPS apply to all new, modified, or reconstructed sources within a given category, regardless of geographic location or the existing ambient air quality. The standards defined emission limitations that would be applicable to a particular source group. The NSPS potentially applicable to the Project include the following subparts of 40 CFR Part 60:

- Subpart A – General Provisions
- Subpart Kb – Standards of Performance for Volatile Organic Storage Vessels
- Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines
- Subpart JJJJ – Standards of Performance for Stationary Spark-Ignition Internal Combustion Engines

3.1.1.6 Maximum Achievable Control Technology

The CAA Amendments of 1990, under revisions to Section 112, required the USEPA to list and promulgate national emission standards for hazardous air pollutants from categories of major and area sources. Under the National Emissions Standards for Hazardous Air Pollutants (NESHAP), the USEPA regulates emissions of toxic air pollutants, listed as hazardous air pollutants (HAPs), from a published list of industrial sources referred to as “source categories.” USEPA has developed a list of source categories in 40 CFR Part 63 that must meet MACT requirements for these HAPs. The MACT categories that would potentially be applicable to the Project include:

- Subpart A – General Provisions; and
- Subpart EEEE – Organic Liquids Distribution (Non-gasoline).

3.1.1.7 Federal Operating Permits Program

All major stationary sources (primarily industrial facilities and large commercial operations) emitting certain air pollutants are required to obtain Title V operating permits under the Federal Operating Permits Program outlined in 40 CFR Part 70 of the CAA. Whether a source meets the definition of “major” depends on the type and amount of air pollutants it emits and, to some degree, on the overall air quality in its vicinity. Generally, major sources include those stationary facilities that emit 100 tons or more per year of a regulated air pollutant. Regulated pollutants include compounds such as NO_X, CO, SO_2, PM_{10}, $PM_{2.5}$, and volatile organics. Facilities that emit lesser amounts of a regulated air pollutant are considered major in areas that do not meet the national air quality standards for a particular pollutant. For example, certain

sources releasing 10 to 25 tons of pollutant emissions per year are considered major in areas with extreme ozone problems.

The Operating Permit program also covers a variety of other significant operations, including:

- Sources that are subject to requirements under NSPS and NESHAP.
- Sources of toxic air pollutants (i.e., any source that emits more than 10 tpy of an individual toxic air pollutant or more than 25 tpy or any combination of toxic air pollutants).
- Sources required to have pre-construction or new source permits (under NSR or PSD requirements); often very large facilities with a wide variety of process operations and hundreds of emission sources.

3.1.1.8 Hazardous Air Pollutants

HAPs are those pollutants known or suspected to cause cancer or other serious health effects, such as damage to reproduction, birth defects, or adverse environmental impacts. The USEPA has classified 187 air pollutants as HAPs, including formaldehyde; benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds; and normal hexane (n-hexane).

The area surrounding the Project has large sources of HAPs coming from oil and gas operations. These existing sources of HAPs include emission sources such as compressor engines (benzene, ethylbenzene, formaldehyde, toluene, xylenes, and n-hexane) and glycol dehydrators (benzene, toluene, ethylbenzene, H_2S, and xylenes). Neither the State of North Dakota nor the USEPA have established ambient air quality standards for HAPs; however, the 1990 CAA amendments established a program to regulate emissions of 190 HAPs by developing and promulgating technology-based standards based on the best-performing similar facilities in operation. The NESHAP established by the USEPA are part of the MACT standards. MACT standards are designed to reduce HAP emissions to a maximum achievable degree, taking into consideration the cost of reductions and other factors.

3.1.2 Climate Change

3.1.2.1 Regional Climate

Western North Dakota is considered part of the Great Plains and as such has a variable semi-arid climate characterized by extended periods of drought, high winds, low relative humidity, and a relatively large annual and diurnal temperature range. A climate summary for Fairfield, North Dakota, is presented in **Table 3.1-4**.

State-wide average annual precipitation ranges from about 14 inches over much of the western portion of the state to more than 22 inches in the east. A wide variation in annual totals is characteristic of arid and semi-arid climates and is illustrated by annual extremes of 7.64 and 22.52 inches at Fairfield during a period of more than 82 years. Precipitation during the warmest 6 months of the year, May through October, adds up to about 80 percent of the annual total in the Project area.

Winter precipitation is caused mainly by frontal activity associated with the general movement of Pacific Ocean storms across the country from west to east and pressure systems forming off the eastern slopes of the Canadian Rockies. As these storms move inland, much of the moisture is precipitated over the coastal and inland mountains ranges of California, Nevada, and Arizona. Much of the remaining moisture falls on the western slope of the Continental Divide and over northern high mountain ranges. Western North Dakota receives slightly more than 0.5 inch of precipitation each month during the period November through April.

Table 3.1-4 Monthly Climate Summary, Fairfield, North Dakota

Period of Record : 8/1/1928 to 12/31/2010													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Avg. Max. Temp. (°F)	22.1	27.8	38.4	53.5	65.6	74.2	82.2	81.9	69.5	56.3	38.2	26.1	53.0
Avg. Min. Temp. (°F)	2.8	7.9	17.6	29.3	40.7	49.9	55.5	53.9	43.4	32.5	18.6	7.0	29.9
Avg. Total Precip. (inches)	0.35	0.32	0.59	1.33	2.14	3.51	2.24	1.73	1.42	0.94	0.47	0.29	15.35
Avg. Total Snow Fall (inches)	5.5	4.9	5.6	4.5	1.0	0.0	0.0	0.0	0.2	2.3	4.9	4.7	33.6
Avg. Snow Depth (inches)	5	5	4	1	0	0	0	0	0	0	1	2	1

Source: High Plains Regional Climate Center 2011.

3.1.2.2 Climate Change

As discussed and summarized in the Climate Change Supplementary Information Report for Montana, North Dakota, and South Dakota (CCSIR 2010), earth has a natural greenhouse effect wherein naturally occurring greenhouse gases (GHGs) such as water vapor, CO_2, methane (CH_4), and nitrous oxide (N_2O) absorb and retain heat. Without this natural greenhouse effect, earth would be approximately 60°F cooler (CCSIR 2010). Current ongoing global climate change is believed by scientists to be linked to the atmospheric buildup of GHGs, which may persist for decades or even centuries. Each GHG has an individual global warming potential that accounts for the intensity of the GHG's heat-trapping effect and its longevity in the atmosphere (CCSIR 2010). The buildup of GHGs such as CO_2, CH_4, and N_2O since the start of the industrial revolution has substantially increased atmospheric concentrations of these compounds compared to background levels. At such elevated concentrations, these compounds absorb more energy from the earth's surface and re-emit a larger portion of the earth's heat back to the earth rather than allowing the heat to escape into space than would be the case under more natural conditions of background GHG concentrations.

Ongoing scientific research has identified the potential impacts of anthropogenic (man-made) GHG emissions and changes in biological carbon sequestration due to land management activities on a global climate. Through complex interactions on a regional and global scale, these GHG emissions and net losses of biological carbon sinks cause a net warming effect of the atmosphere, primarily by impeding the rate of heat energy radiated by the earth back into space. Although GHG levels have varied for millennia, recent industrialization and burning of fossil carbon sources have cause carbon dioxide equivalent (CO_2[e]) concentrations to increase dramatically, and are likely to contribute to overall global climatic changes. The Intergovernmental Panel on Climate Change (IPCC) recently concluded that warming of the climate system is unequivocal and most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations (IPCC 2007). Warming has occurred on-land surfaces, oceans and other water bodies, an in the troposphere (lowest layer of earth's atmosphere, up to 4 to 12 miles above the earth). Other indications of global climate change described by IPCC include:

- Rates of surface warming increased in the mid-1970s and the global land surface has been warming at about double the rate of ocean surface warming since then;

- Eleven of the last 12 years rank among the 12 warmest years on record since 1850; and
- Lower-tropospheric temperatures have slightly greater warming rates than the earth's surface from 1958-2005.

Global mean surface temperatures increased nearly 1.8°F from 1890 to 2006. Models indicate that average temperature changes are likely to be greater in the Northern Hemisphere. Northern latitudes (above 24°N) have exhibited temperature increases of nearly 2.1°F since 1900, with nearly a 1.8°F increase since 1970. Without additional meteorological monitoring systems, it is difficult to determine the spatial and temporal variability and change of climatic conditions, but increasing concentrations of GHGs are likely to accelerate the rate of climate change.

In 2001, the IPCC projected that by the year 2100, global average surface temperatures could increase anywhere from 2.5 to 10.4°F above 1990 levels. The National Academy of Sciences (2010) agrees with these findings, but also has indicated that there are uncertainties regarding how climate change may affect different regions. Computer model predictions indicate that increases in temperature would not be equally distributed, but are likely to be accentuated at higher latitudes. Warming during the winter months is expected to be greater than during the summer, and increases in daily minimum temperatures have been observed to increase in the region during the last few decades, while there are no strong indications of increases in daily maximum temperatures. Although large-scale spatial shifts in precipitation distribution may occur, these changes are more uncertain and difficult to predict.

As with any field of scientific study, there are uncertainties associated with the science of climate change; however, this does not imply that scientists do not have confidence in many aspects of climate change science. Some aspects of the science are known with virtual certainty because they are based on well known physical laws and documented trends (USEPA 2011).

Several activities contribute to the phenomena of climate change, including emissions of GHGs (especially CO_2 and CH_4) from fossil fuel development, large wildfires, activities using combustion engines, changes to the natural carbon cycle, and changes to radiative forces and reflectivity (albedo) of the earth-atmosphere system. It is important to note that GHGs would have a sustained climatic impact over different temporal scales. For example, recent emissions of CO_2 proper may influence climate for anywhere from 50 to 200 years.

It may be difficult to discern whether climate change already is affecting resources globally, let alone those in the vicinity of the Project. In most cases, there is little information about potential or projected effects of global climate change on resources. It is important to note that projected changes are likely to occur over several decades to a century. Therefore, many of the projected changes associated with climate change may not be measureable discernible within the reasonably foreseeable future. Existing climate prediction models are global in nature; therefore, they are not at the appropriate scale to estimate potential impacts of the climate change on the Project area and vicinity.

3.2 Geology and Minerals

3.2.1 Geology

The Project area is located in the Great Plains physiographic province (Fenneman 1928). In western North Dakota, the Great Plains is divided into two major sections, the Glaciated Missouri Plateau and the Unglaciated Missouri Plateau (**Figure 3.2-1**). The Missouri Plateau is a dissected plateau characterized by badlands, buttes and mesas, and exhumed mountain ranges such as the Black Hills. The glaciated area is generally of low relief as compared to the unglaciated area, which has more variety of landforms (Trimble 1980). The Glaciated Missouri Plateau is covered by glacial deposits, but the boundary between the glaciated and non-glaciated sections is not distinct because the glacial deposits thin gradually.

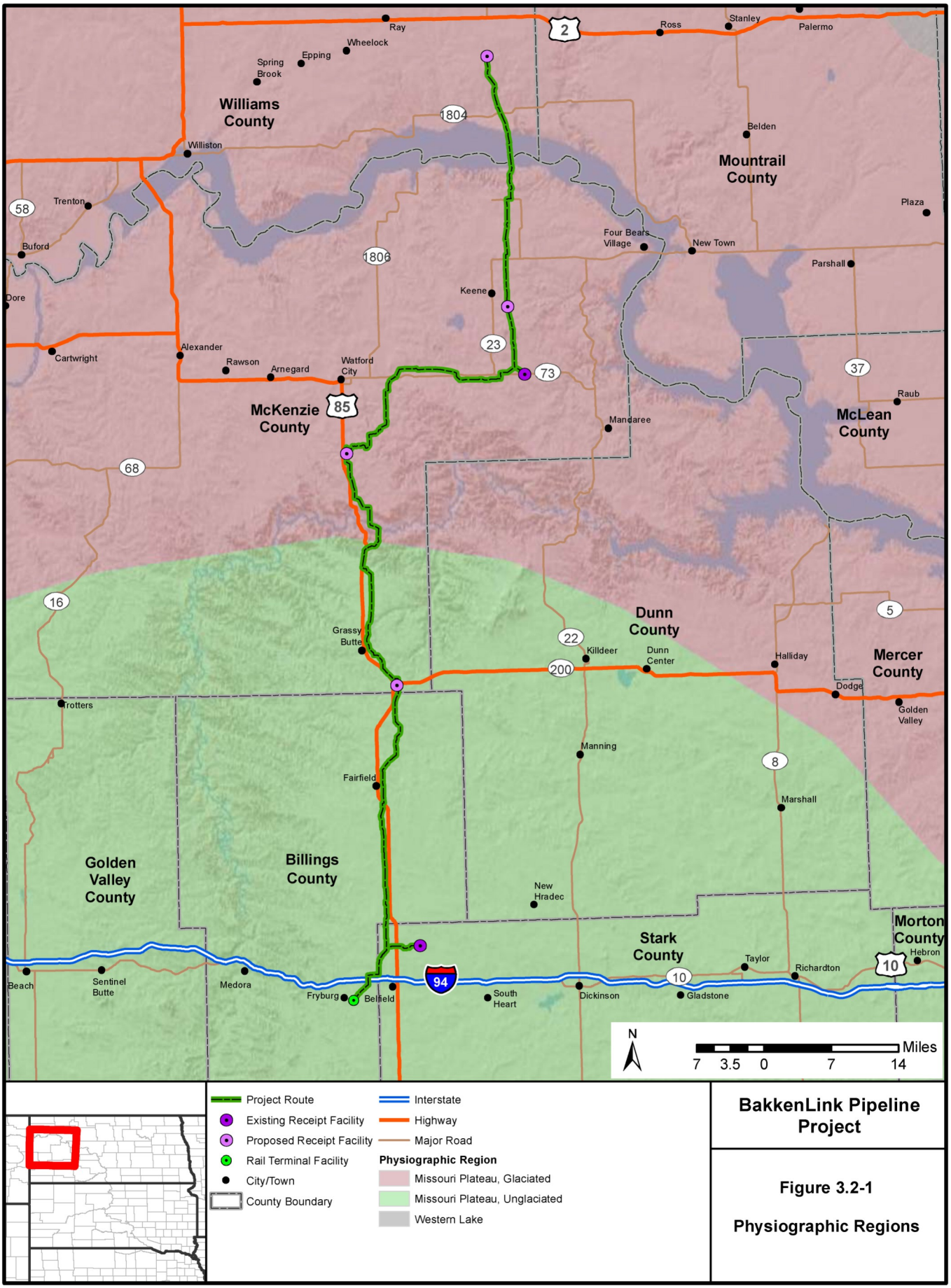
The northern part of the Project route is located in the Glaciated Missouri Plateau and elevations range from less than 2,000 feet above mean sea level (amsl) at the Missouri and Little Missouri River crossings to 2,400 feet amsl in the upland areas in eastern McKenzie County. A few miles north and south of the Little Missouri River crossing are the Little Missouri Badlands, a heavily dissected badland area caused by the post-glacial erosion of the Little Missouri River into upland areas (Carlson 1983). South of the Little Missouri River crossing, the Project route is in the Unglaciated Missouri Plateau where elevations range from 2,600 to 2,800 feet amsl.

The bedrock geology consists of the Bullion Creek, Sentinel Butte Formations of the Paleocene Fort Union Group, and the Eocene Golden Valley Formation. These formations are largely composed of claystone, siltstone, sandstone, and lignite. There are very few exposures of bedrock along the Project route north of Keene, North Dakota, in eastern McKenzie County. North of Watford City, North Dakota, the bedrock is mostly covered by glacially derived surficial deposits (Carlson 1985, 1983; Freers 1970). Glacial materials consist of till, lake deposits, and terraces and are composed of gravel, sand, and clay. The Project route and laterals cross the Sentinel Butte Formation south of Watford City, except for occasional isolated erosion remnants of the Golden Valley Formation and floodplain alluvial deposits.

The Project area is located in the Williston Basin, a major structural basin that covers northeastern Montana, most of North Dakota, and northwestern South Dakota (**Figure 3.2-2**) (Peterson and McCary 1987). The Williston Basin also extends north into Alberta, Saskatchewan, and Manitoba in southern Canada. The basin contains about 15,000 feet of Paleozoic through Tertiary sedimentary rock. The center of the basin is located in McKenzie County. The major structural feature in the Project area is the Nesson Anticline, a north-south trending structure in eastern Williams and McKenzie Counties (**Figure 3.2-3**) (Gerhard et al. 1987). Other important subsurface features are the Billings Nose, a north-south anticlinal feature located primarily in Billings County and the Little Knife Anticline, located in western Dunn County. North-south trending fault zones paralleling the Nesson Anticline have been mapped in the deeper bedrock in Williams County, but do not extend up to the surface.

3.2.2 Mineral Resources

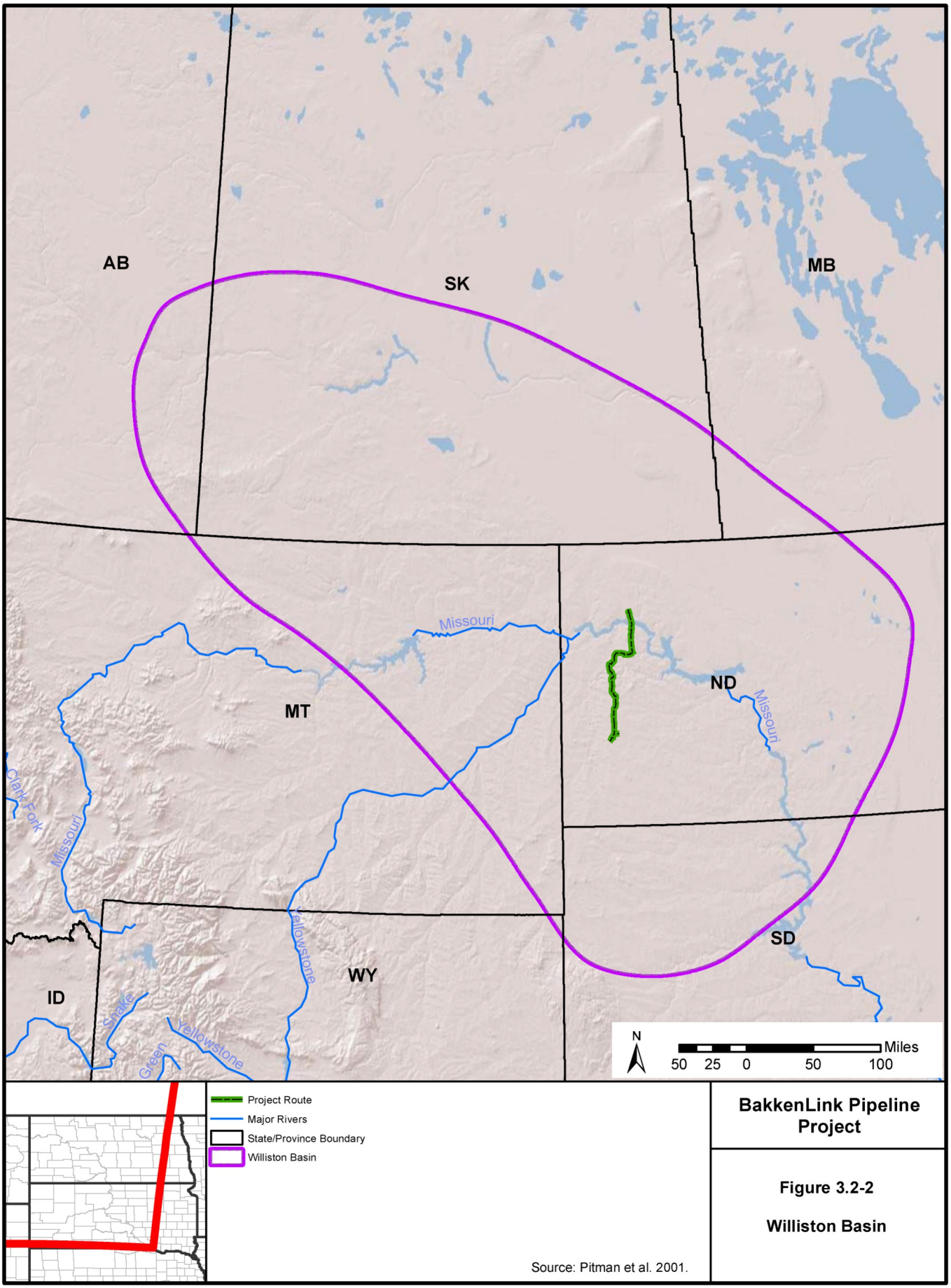
The major mineral resources in the Project area are oil, natural gas, and lignite (Freers 1970). The important non-fuel mineral resources are sand and gravel, clay, and scoria. Uranium deposits also occur in the area (**Figure 3.2-3**).



BakkenLink Pipeline Project

Figure 3.2-1

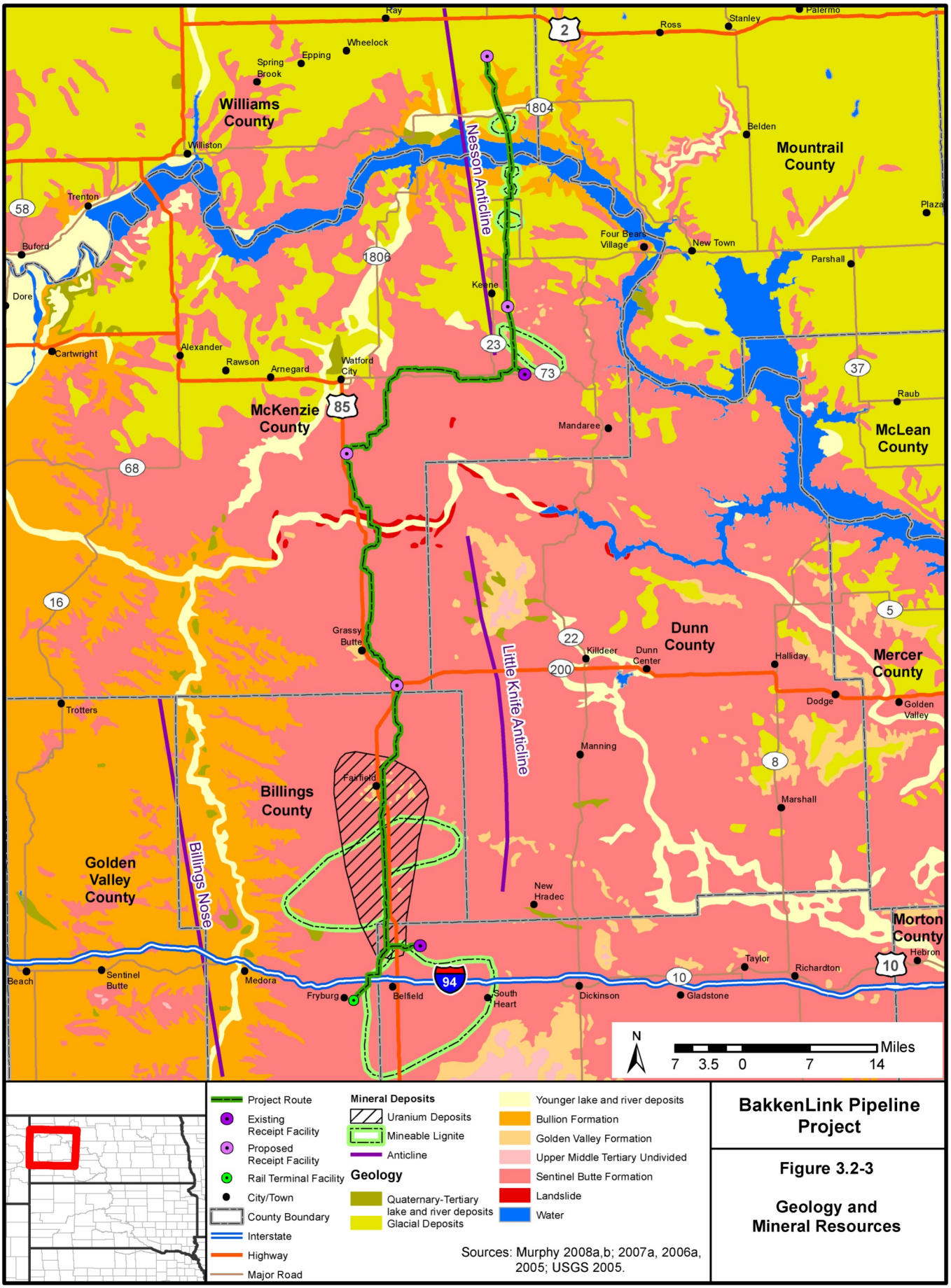
Physiographic Regions



BakkenLink Pipeline Project

Figure 3.2-2

Williston Basin



BakkenLink Pipeline Project

Figure 3.2-3

Geology and Mineral Resources

3.2.2.1 Oil and Natural Gas

The Williston Basin is a major oil and gas producing basin. In the U.S. portion of the basin, total production from 1951 to the end of 2010 was approximately 2.9 billion barrels of oil and over 470 billion cubic feet of gas (Burke 2006; Montana Board of Oil and Gas Conservation 2011; North Dakota Division of Oil and Gas 2011; South Dakota Oil and Gas Section 2011). The first commercial oil well in North Dakota was drilled in Williams County on the Nesson Anticline in 1951, about 7.0 miles south of Tioga (Freers 1970). The oil production decline in the 1990s has been offset in recent years by technological advances, which have allowed for increased production from the Bakken Formation that has an estimated mean technically recoverable resource of 3.7 billion barrels of oil and 1.9 trillion cubic feet of gas (U.S. Geological Survey [USGS] 2008). The northern segment of the Project route in McKenzie and Williams counties generally parallels the axis of the Nesson Anticline where numerous oil and gas fields have been developed and is the epicenter of the current Bakken play in North Dakota. West of the Project route in Billings County, the Billings Nose has been the location of much oil and gas development since the 1970s and was the site of an initial horizontal Bakken play in the 1980s (Heck et al. 2000; Stroud and Sonnenberg 2011). Bakken production has accounted for approximately 11 percent of total cumulative oil production in North Dakota. **Table 3.2-1** lists wells that are within 200 feet of the Project route.

3.2.2.2 Lignite

The Project area is located in the Fort Union Coal region (Averitt 1972). The lignite coal in the Project area is found in the Sentinel Butte Formation of the Fort Union Group. The Project route crosses areas that may contain economically minable coals (Murphy 2008a,b, 2007a, 2006a, 2005). **Table 3.2-2** summarizes the locations where the Project route and laterals cross potentially minable coal deposits.

3.2.2.3 Aggregate

Aggregate (sand and gravel) production is from localized deposits in floodplains or glacial deposits (Carlson 1985, 1983; Freers 1970). Some areas in McKenzie and Billings counties also have scoria deposits that are used for road topping. Scoria is formed from the in-situ burning of coal seams that result in baked rock. No gravel or scoria pits are located close to the Project route.

3.2.2.4 Uranium

Uranium occurs in uraniferous lignite beds in Lower Tertiary rocks in western North Dakota including the Sentinel Butte and Golden Valley formations. Uraniferous lignites were mined in the area during the 1950s and 1960s (Murphy 2007b). Often mining of lignite was accomplished by stripping the overburden and burning the lignite in place and shipping the ash off-site for further refinement, or shipping the lignite to a reduction facility southeast of Belfield, North Dakota. Generally there was no reclamation and only a few of the mined areas have been reclaimed under the North Dakota Abandoned Mine Lands program (North Dakota PSC 2011). In the modern resurgence of uranium exploration and mining, the uraniferous lignites would not be considered commercially viable, but a potential resource exists in sandstones that could be mined by using *in situ* methods. From Fairfield to just north of Belfield, North Dakota, the Project route crosses an area defined by Murphy (2007b, 2006b) as a “uranium deposit” based on exploration boring logs, and uranium bearing zones could be as shallow as 1 foot from the surface to 500 feet deep. In addition, there are five abandoned mines located within a mile to the west of the Project route and about 5 miles north of Belfield in Sections 6 and 7, Township 140 North (T140N), Range 100 West (R100W). No information was available concerning reclamation status of these mine sites.

3.2.3 Geological Hazards

3.2.3.1 Seismic Hazards

There are three major phenomena associated with seismic hazards: faults, seismicity, and ground motion. The following describes the potential for seismic hazard occurrence in the Project area.

Table 3.2-1 Oil and Gas Wells Within 200 Feet of Project Route

Pipeline/ Lateral[1]	MP	Direction and Distance from Centerline (feet)	API Number	Operator	Well Name	Well Type[2]	Status[3]
Main CL	0.102	West 62	33-105-00128	HESS CORPORATION	BEAVER LODGE-DU H-308D	SWD	IA
Main CL	0.301	East 113	33-105-02440	HESS CORPORATION	BL-S RAMBERG-155-95-0601H-2	C	C
Main CL	0.310	East 111	33-105-02441	HESS CORPORATION	BL-S RAMBERG-155-95-0601H-3	C	C
Main CL	3.353	East 102	33-105-00422	HESS CORPORATION	CMU O-214	OG	PA
Main CL	5.682	West 18	33-105-00524	HESS CORPORATION	CMU P-205	OG	TA
Main CL	8.866	East 85	33-105-00417	SM ENERGY COMPANY	HOFFLUND 16	OG	PA
Main CL	9.367	West 187	33-105-00305	RIM OPERATING, INC.	HOFFLUND 18HR	OG	A
Main CL	12.027	East 68	33-053-00065	TEXACO E&P INC.	CMNU A-134	OG	PA
Main CL	12.090	East 119	33-053-02369	AMERADA HESS CORP.	SANDY CREEK 27-14-H	OG	PA
Main CL	12.099	East 189	33-105-01265	DONALD C. SLAWSON	RIVERBED FEDERAL 1-27	OG	PNC
Main CL	12.204	West154	33-053-01061	PETRO-HUNT, L.L.C.	CMNU C134X	OG	AB
Main CL	12.375	East 177	33-053-00020	TEXACO E&P INC.	CMNU D-134	OG	PA
Main CL	12.982	East 165	33-053-00040	TEXACO E&P INC.	CMNU B-404	OG	PA
Main CL	13.241	West 16	33-053-01850	TEXACO INC.	CMNU C-404	OG	PNC
Main CL	13.500	West162	33-053-00165	TEXACO E&P INC.	CMNU D-404	OG	PA
Main CL	14.335	East 149	33-053-00259	THE TEXAS CO.	S. HOLMAN 1	OG	DH
Main CL	31.872	East 90	33-053-00502	AMERADA HESS CORP.	BLUE BUTTES-MU J-106	OG	DH
Main CL	32.278	East 178	33-053-02784	HESS CORPORATION	C. LOVAAS 6-5H	OG	PNC
Main CL	32.870	East 54	33-053-00304	THE TEXAS CO.	G. R. BROWN 1	OG	DH
Main CL	49.491	West 96	33-053-01092	GULF OIL CORP.	SHAFER STATE 1-23-3B	OG	DH
Main CL	53.734	East 106	33-053-00508	C. HUNT TRUST ESTATE	MARTIN NELSON 1-A	OG	DH
Main CL	67.115	East 88	33-053-01388	W. H. HUNT TRUST ESTATE	STUTRUD 1	OG	DH
Main CL	77.070	West 60	33-053-01212	PENNZOIL CO.	TWIN TANKS 36-32	OG	DH
Main CL	119.308	West 146	33-089-00677	WHITING O&G CORP.	FRANK 44-7PH	C	C
Main CL	124.079	West 175	33-007-01160	BASS ENT. PROD.CO.	KLEM 35-43	OG	DH

[1] CL – Centerline.

[2] SWD – Salt Water Disposal Well; C – Confidential; OG – Oil or Gas Well.

[3] IA – Inactive; C – Confidential, PA – Plugged and Abandoned; TA – Temporarily Abandoned; PNC – Permit Now Cancelled; AB – Abandoned; DH – Dry Hole.

Source: North Dakota Oil and Gas 2012.

Table 3.2-2 Mineable Coal Resources Crossed by the Project Route

Approximate MP[1]	General Location (Section-Township-Range)	County
13-16 Main CL	9, T154N, R95W	Williams
18-19 Main CL	4, 16, 21, 28, 33, T153N, R95W	McKenzie
22-24 Main CL	12, 13, 24, 25, T152N, R96N	McKenzie
31-33 Main CL	36, T151N, R96W; 1, T150N, R96W	McKenzie
107 to 113 Main CL	34, T142N, R 99W; 3, 10, 15, 22, 27, T141N, R99W	Billings
116 to 118 Main CL	7, 8, 18, T140N, R100W	Stark
1 to 3 Belfield Lateral	8, 9, 10, T140N, R100W	Stark

[1] CL – Centerline.

Sources: Murphy 2008a,b; 2007a, 2006a, 2005.

Faults are dislocations whereby blocks of earth material on opposite sides of the faults have moved in relation to one another. Rapid slippage of blocks of earth past each other can cause energy to be released, resulting in an earthquake. As described in Section 3.2.1, there is evidence of fault offset in older strata underlying the surficial cover, but no evidence that would lead to a conclusion of movement on the faults in the last 10,000 years. No active faults have been identified in the Project area (Crone and Wheeler 2000). An active fault is one in which movement can be demonstrated to have taken place within the last 10,000 years (USGS 2009).

Seismicity concerns the intensity, frequency, and location of earthquakes in a given area. From 1990 to 2006, almost no seismic events were recorded in North Dakota (USGS 2006a).

Ground motion hazards result when the energy from an earthquake is propagated through the ground. The USGS ground motion hazard mapping indicates that potential ground motion hazard in the Project area is low. The hazard map used estimates peak ground acceleration expressed as a percentage of the acceleration of gravity with a 2 percent probability of exceedance in 50 years (Peterson et al. 2008).

3.2.3.2 Landslides

Landslide is a term used for various processes involving the movement of earth material down slopes (USGS 2004a). Landslides can occur in a number of different ways in different geological settings. Large masses of earth become unstable and, by gravity, begin to move downhill. The instability can be caused by a combination of steep slopes, periods of high precipitation, undermining of support by natural processes (stream erosion), or unintentional undercutting or undermining the strength of unstable materials in the construction of roads and structures.

Along the Project route, there are landslide-prone areas on either side of the Lake Sakakawea and Little Missouri River crossing (POD, Appendix XXIV) (Murphy 2004a,b, 2003) (**Figure 3.2-4**). In the case of the Lake Sakakawea approaches, deeply incised glacial sediment has created badland topography and, combined with the steeper slopes, has created areas of instability. At the Little Missouri River crossing, Sentinel Butte Formation bedrock is exposed and has been eroded into badland topography creating an unstable situation. Additionally, bentonite layers that may be exposed also contribute to instability, especially during periods of high precipitation.

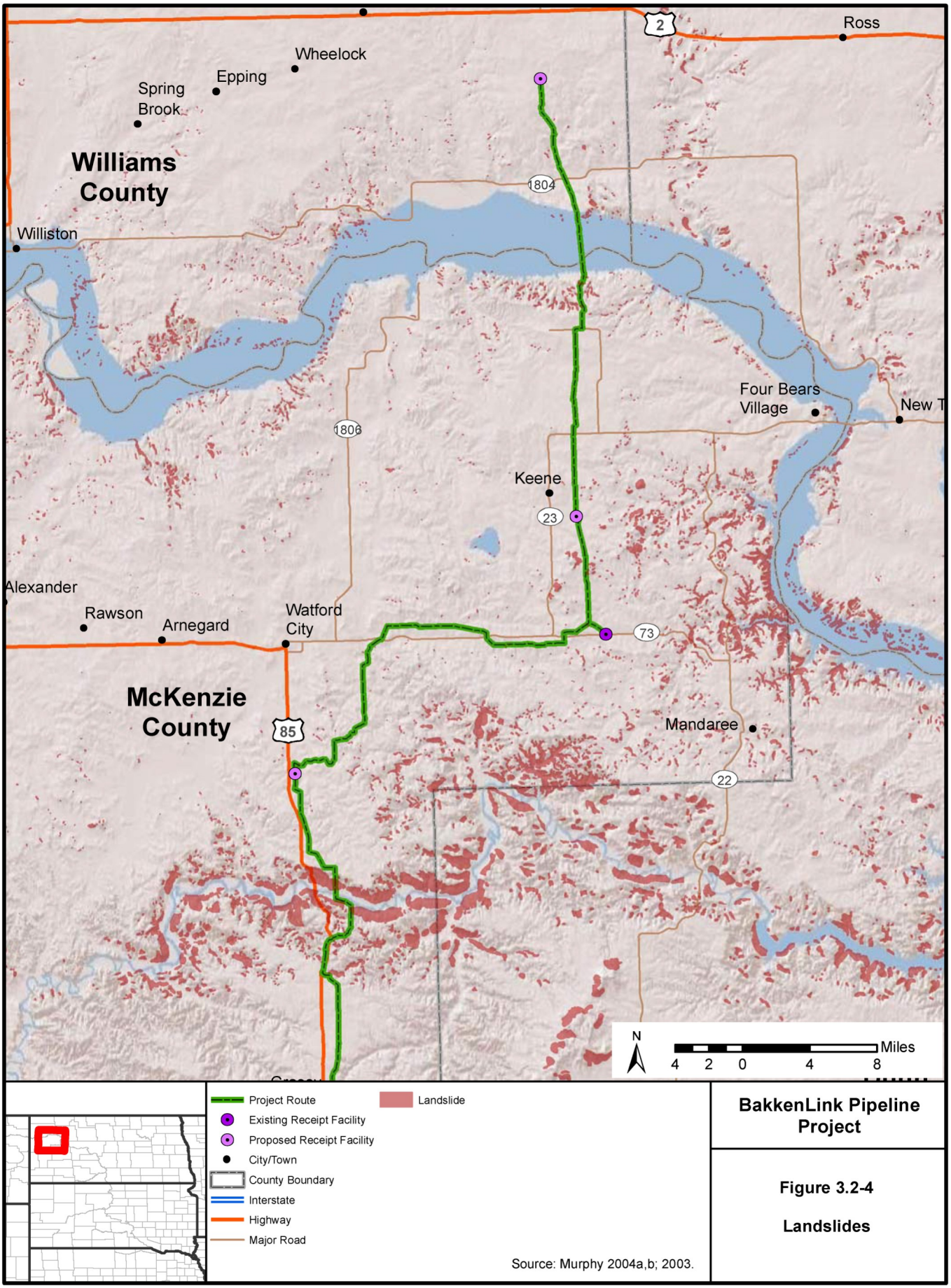
3.2.3.3 Subsidence

The major cause of concern regarding subsidence is historical mining of lignite. Lignite has been mined in the Project area for many years and before modern surface mining methods were employed that involve stripping off the overburden, backfilling, and reclamation, lignite was mined by room-and-pillar underground methods. Because the overburden was thin (often less than 50 feet), underground voids would collapse to the surface creating sinkhole-type subsidence, fissures, and unstable ground conditions. Two abandoned lignite mines are present in the Project area and are listed on **Table 3.2-3** (North Dakota Abandoned Mine Land Reclamation Division 2005).

Table 3.2-3 Abandoned Underground Lignite Mines in the Project Area

Mine	County	Location	Dates of Operation	Distance from Proposed ROW
Franson	Williams	SW Section 9, T155N, R95W	Active in 1923, duration of operation not known.	Not known
Edwardson	McKenzie	Section 23, T152N, R96W	1937-1944	Not Known

Source: North Dakota Abandoned Mine Land Reclamation Division 2005.



BakkenLink Pipeline Project

Figure 3.2-4

Landslides