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7.0 PHYSICAL ENVIRONMENT

7.1 Existing Conditions

This chapter of the environmental impact assessment for the proposed P4 All-Season Road Project (the 'Project') describes the physical components of the environment in the Regional Assessment Area in general and Local Assessment Area in more detail[1]. The Physical Environment chapter describes components including: climate and climate change; air quality; physiography; surface water and groundwater; and noise and vibration.

7.1.1 Climate and Climate Change

The Regional Assessment Area falls within the Mid-Boreal Ecoclimatic Region which extends from northwestern Ontario to the foothills of the Rocky Mountains (Smith *et al.* 1998). Four seasons with distinct temperature and precipitation regimes occur due to the continental climate. The Regional Assessment Area has a relatively short spring and fall, a wet warm summer characterized by longs days with minimal night-time darkness, and long cold winters with short days and long nights. The average day (i.e., light hours from sunrise to sunset) in June 2015 was 16 hours and 28 minutes long, with the longest day of the month lasting 16 hours and 42 minutes (Edwards 2015). The average day in December 2014 was 7 hours and 47 minutes long, with the shortest day of the month lasting 7 hours and 41 minutes (Edwards 2015). Outside of the communities of Berens River First Nation and Poplar River First Nation, there are no permanent light sources within the Regional Assessment Area that affect night-time light levels.

Local climate normals (1981-2010) recorded from the Berens River (airport) climate station show a mean annual temperature of 0.6°C. As shown in **Table 7.1**, July is the warmest month with a mean temperature of 17.7°C. January is the coldest month on average with a mean temperature of -18.9°C. The mean annual snowfall is 10.3 cm with the most snow falling in the month of November. The mean annual rainfall is 30.1 mm with the most rain falling in the month of August, reflecting the area's tendency for intense storms in the summer months.

Climate extremes recorded at the Berens River climate station between 1981 and 2010 were:

- Maximum temperature – 37.3°C June 29, 2002;
- Minimum temperature – -42.8°C February 1, 1996;
- Daily rainfall – 72.4 mm October 26, 1989; and
- Snow fall – 79 cm February 13, 1990 (Environment Canada 2015a).

Based on frequency analyses of the available precipitation data for the Project area, the 1 in 5 year probability and 1 in 100 year probability annual rainfall accumulations are 438 mm and 534 mm,

[1] Refer to **Chapter 6**, **Figures 6-1** and **6-2** for boundaries of the Local Assessment Area and Regional Assessment Area

respectively. The 1 in 5 probability and 1 in 100 year probability annual snowfall accumulations are 173 cm and 271 cm, respectively.

Table 7.1: Monthly Temperature, Rainfall and Snowfall Data from the Berens River Climate Station (1981-2010)

Parameter	Month												Year	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean Ann.	Total Ann.
Average daily temperature (°C)	-18.9	-16.2	-9.2	1.1	8.6	14.9	17.7	16.5	10.6	3.2	-6.5	-15.0	0.6	-
Rainfall accumulation (mm)	0.1	0.9	7.8	17.0	43.7	60.4	52.2	72.2	63.2	35.4	8.2	0.3	30.1	361.3
Snowfall accumulation (cm)	20.7	13.3	17.6	6.7	2.2	0.0	0.0	0.0	0.3	13.0	26.7	22.7	10.3	123.1

Source: Environment Canada (2015a)

Prevailing winds measured at the Berens River and Poplar River airports are representative of the Regional Assessment Area. Prevailing winds blow predominantly from the northwest, west and south, as illustrated in **Figure 7-1**.

It is widely believed that changes to worldwide climates are occurring due to the release of 'greenhouse gases'[2] (GHGs) to the atmosphere. The Climate and Air Quality Branch of Manitoba Conservation and Water Stewardship (MCWS) states that Manitoba is among the first to begin experiencing climate change effects due to its northern geography and location in the centre of the continent (Government of Manitoba 2012). GHG emissions for the current, undeveloped state of the P4 Project are estimated at 4,450 tonnes of CO_2e per year (Dillon Consulting Limited 2015[3]). This value includes the estimated GHG emissions associated with the existing winter road (construction, maintenance and vehicular use), area air travel, land clearing, forest processes (biomass decomposition and carbon sequestration) and wetland methane emissions.

As presented in the Asatiwisipe Aki Management Plan, the Anishinabek view climate and the history of climate change as fundamental to both the character of the land and their identity. Climate and seasonal conditions have historically dictated and currently influence access and movement throughout the territory (Poplar River First Nation 2011).

[2] A 'greenhouse gas' is a gas in the atmosphere that absorbs infrared radiation, traps heat in the atmosphere and contributes to the 'greenhouse gas effect', which is a phenomenon that contributes to the warming of the earth's surface and associated 'climate change' effect.
[3] The Dillon Consulting Limited (2015) greenhouse gas assessment report, including a map of the Cumulative Effects Spatial Area used for calculation purposes is provided as **Appendix 13-3** in **Chapter 13**.

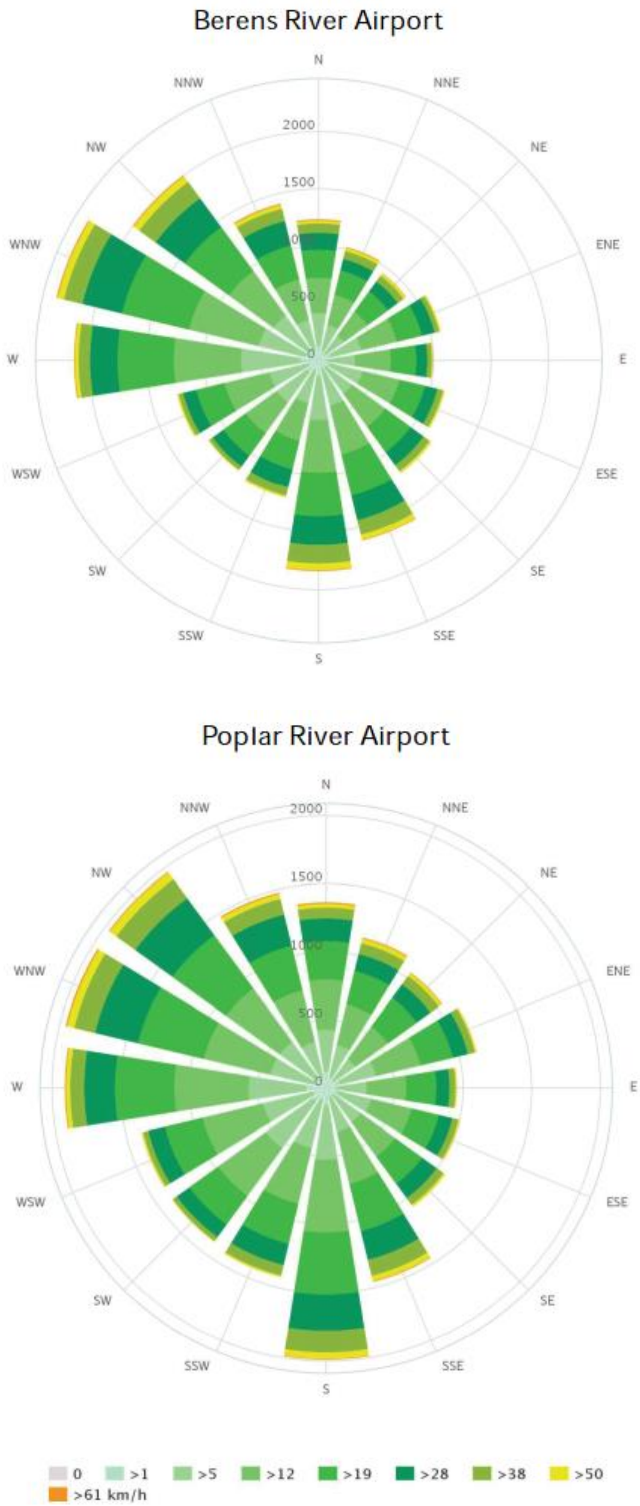

Figure 7-1: Wind Roses for the Berens River and Poplar River Airports (Meteoblue 2015a,b)

7.1.2 Air Quality

No air quality monitoring stations are located in the Regional Assessment Area or close to this area. Environment Canada operates two monitoring stations in the Province: one in Winnipeg and one in Brandon. Regional Assessment Area air quality is expected to be of very high as there are no emissions sources in the Regional Assessment Area or nearby. Major industrial facilities that may reduce air quality are well removed from the Regional Assessment Area with the closest industrial facilities located in Flin Flon, Thompson and Winnipeg. There are no major sources of air pollution which could be blown into the Regional or Local Assessment Areas by prevailing winds. Thus, it is unlikely that air quality is influenced by anything other than localized anthropogenic sources from Berens River and Poplar River First Nations related to on-reserve operations of vehicles and vehicle use of the winter road when open.

The most noteworthy influence on air quality of the Regional Assessment Area is forest fires that occur within and beyond the regional area. Forest fires contribute smoke, particulates, carbon monoxide and other compounds to airsheds. Other potential sources of emissions in the Regional Assessment Area are highly localized and may include airplanes, vehicular traffic within the remote communities, seasonal vehicular traffic on the winter road and snowmobile and ATV traffic on trails (Poplar River First Nation 2011). Little to no fire activity has been documented within the Local Assessment Area since 1970; however, it is possible for smoke and particulates to blow in from other parts of the Province and beyond provincial borders. Due to low population density and the absence of nearby industrial facilities, it is unlikely that the activities described contribute to the Regional Assessment Area air quality.

7.1.3 Physiography

7.1.3.1 Overview

The Regional Assessment Area of the proposed all-season road Project is located within the Precambrian Shield physiographic region and the Lac Seul Upland Ecoregion of the Boreal Shield Ecozone, the largest Ecozone in Canada, stretching from northern Saskatchewan to Newfoundland and covering much of Manitoba (Smith *et al.* 1998). The Lac Seul Upland Ecoregion is characterized by coniferous forest cover and level to gently-undulating landforms and extends from the Lake Winnipeg shoreline into western Ontario and from the Winnipeg River north to Norway House.

The Local Assessment Area of the proposed Project occurs within the Berens River and Wrong Lake Ecodistricts of the Lac Seul Upland Ecoregion (**Figure 7-2**). The Berens River Ecodistrict, situated adjacent to the Lake Winnipeg shoreline, is characterized by level peat-covered lowland, poor drainage conditions and extensive fen and bog communities. The Wrong Lake Ecodistrict, to the east of the Berens River Ecodistrict, is characterized by a transitional landscape between peat-covered lowland to the west and bedrock-dominated topography to the east, with effects of fire and the widespread occurrence of deep and shallow peatlands resulting in a fragmented forest cover (Smith *et al.* 1998). Across the Local Assessment Area topography is generally level or gently undulating peat-covered lowland, occasionally interspersed by rock outcrops. Elevation within the Local Assessment Area ranges between 222 and 245 metres above sea level (Smith *et al.* 1998).

Project 4 - All-Season Road Connecting Berens River to Poplar River First Nation

Figure 7-2
Ecological Land Classification in the Project Area

P4 All-Season Road Alignment
P1 All-Season Road (South of Berens to PTH 304) - Under Construction
2013/2014 Manitoba Winter Road
Local Assessment Area
Berens River Northern Affairs Community
Berens River First Nation Reserve
Poplar River First Nation Reserve
Ecozone Boundary

Ecodistricts:
Berens River Ecodistrict
Wrong Lake Ecodistrict

Map Drawing Information:
ESRI Base Layers, Province of Manitoba, CanVec, GeoGratis, Dillon Consulting Limited

Map Created By: ECH
Map Checked By: MG/PS/LD
Map Projection: NAD 1983 UTM Zone 14N

DATE: 4/8/2016

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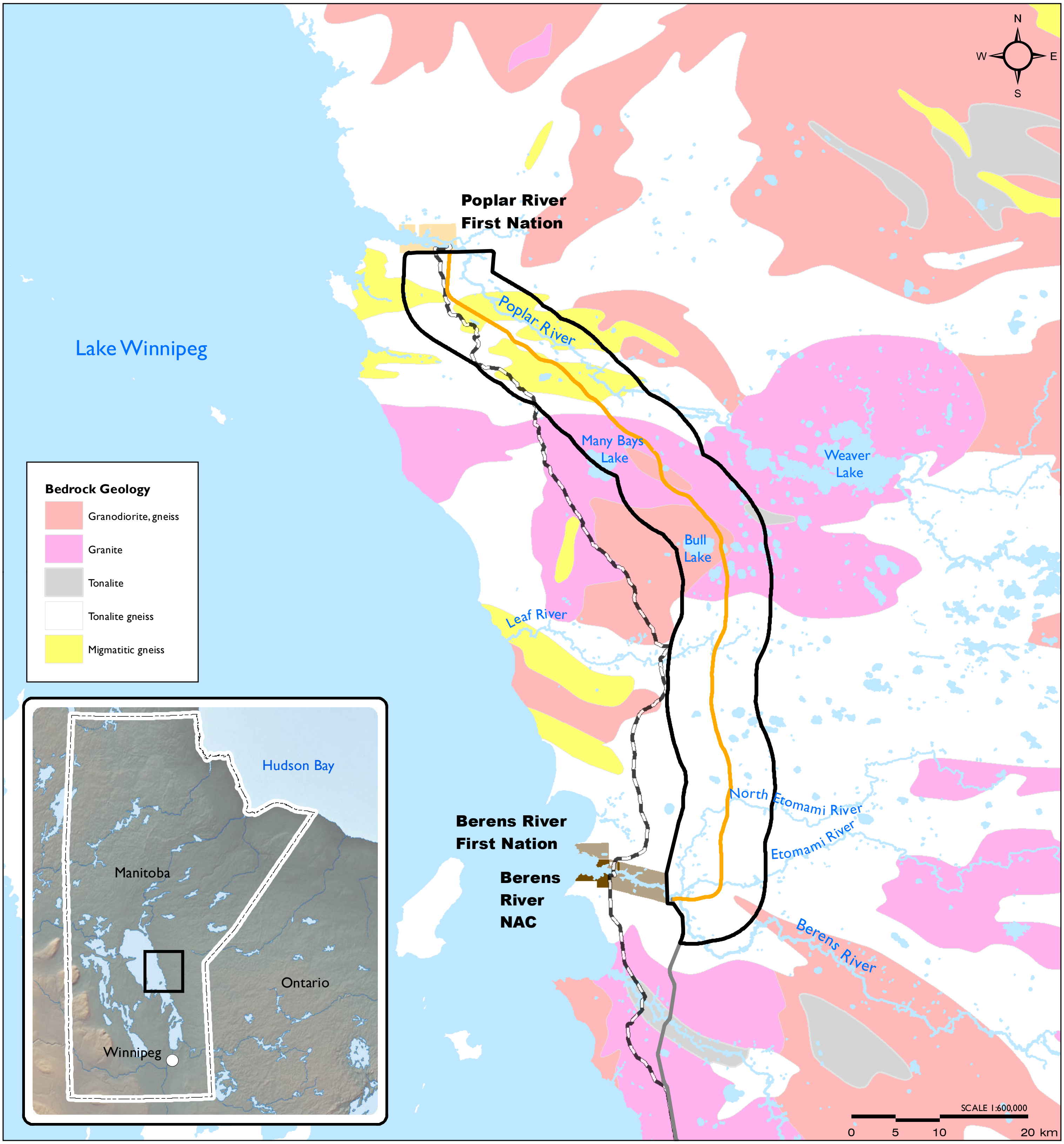
7.1.3.2 Bedrock and Surficial Geology

Bedrock geology in the Local Assessment Area comprises igneous and metamorphic crystalline rock (2.7 to 3 billion years old) of the Archean Era (Betcher, Grove, and Pupp 1995; Manitoba Mineral Resources 2015a). Bedrock geology is categorized into distinct lithological units of the Berens River Sub-province, part of the Superior Province. The Superior Province is dominated by granitic and gneissic rock types. The Berens River Sub-province is typified by high grade orthogneisses, granitoid rocks and minor supracrustal rocks. The Local Assessment Area is located over tonalitic gneiss, granodiorite and granite rock types (**Figure 7-3**).

There are known Greenstone belts and mineral exploration occurring in the Superior Province (Lesher, Goodwin, Campbell, and Gorton 1986; Bamburak 1990; Percival 2007) but not within in the Local Assessment Area of the Project. The most massive base-metal sulphide deposits of the Superior Province are associated with submarine felsic metavolcanic rocks (Lesher *et al.* 1986), none of which have been identified in, or proximal to, the Local Assessment Area. Historic and current mining activity is situated to the south at Bissett, to the northeast at Island Lake and to the northwest near Thompson.

There are no current mineral exploration licenses, or mining licenses near the Project Footprint with the exception of quarrying for construction materials (Manitoba Mineral Resources 2013; Manitoba Mineral Resources 2015b,c; **Figure 7-4**). The locations of historic, current and proposed quarry areas, as well as quarry land that has been withdrawn, are presented in **Figure 7-4**. ESRA has withdrawn quarry land within the Local Assessment Area to accommodate quarrying activities at proposed quarry sites with the exception of the Local Assessment Area, located with the Asatiwisipe Aki Traditional Land Use Planning Area. Activities related to future roads to Poplar River First Nation are permitted under the Asatiwisipe Aki Traditional Use Planning Area Regulation under *The East Side Traditional Lands Planning and Special Protected Areas Act*. Jointly held one-year casual quarry permit and individually held ten-year quarry lease areas are also indicated on **Figure 7-4**. One quarry held under a casual permit by Asatiwisipe Construction Inc. (owned by Poplar River First Nation) provides a local source of aggregate for the community. The total area of this quarry is 64.5 ha. It is located 1 km south of the Poplar River reserve (**Photograph 7-1**).

Sand and rocks in the Regional Assessment Area are, or have been, used by Berens River First Nation for traditional purposes such as medicine, jewelry and stone tools (CIER 2015). Elders note that they have identified mineral/metal deposits that are of interest to the community and have placed cabins on them to preserve the land and ecology from resource development (CIER 2015). The two areas of particular mineralogical importance to the Berens River First Nation are not within the Project Footprint.



Project 4 - All-Season Road Connecting Berens River to Poplar River First Nation

Figure 7-3
Bedrock Geology in the Project Area

P4 All-Season Road Alignment
P1 All-Season Road (South of Berens to PTH 304) - Under Construction
2013/2014 Manitoba Winter Road
Local Assessment Area
Berens River Northern Affairs Community
Berens River First Nation Reserve
Poplar River First Nation Reserve

Map Drawing Information:
ESRI Base Layers, Province of Manitoba, CanVec, GeoGratis, Dillon Consulting Limited
Manitoba Mineral Resources 2015a

Map Created By: ECH
Map Checked By: MG/PS/LD
Map Projection: NAD 1983 UTM Zone 14N

DATE: 4/8/2016

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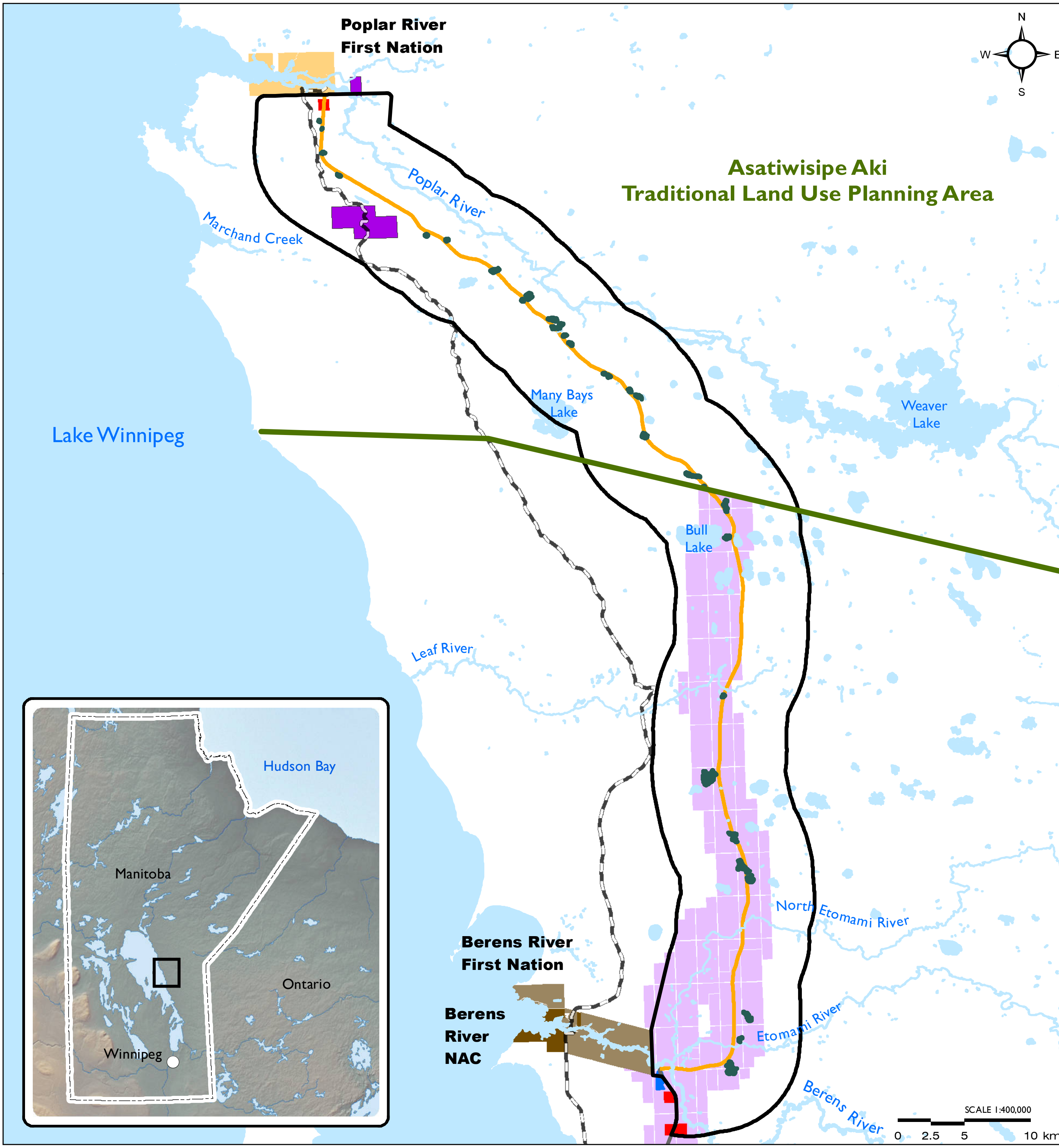

P4 All-Season Road Alignment	Berens River Northern Affairs Community	Casual Quarries Permits (Current)
P1 All-Season Road (South of Berens to PTH 304) - Under Construction	Berens River First Nation Reserve	Quarry Leases (Current)
2013/2014 Manitoba Winter Road	Poplar River First Nation Reserve	Quarry Withdrawals (Current)
Local Assessment Area	P4 Potential Quarry Areas	Quarry Withdrawals (Historical)

Project 4 - All-Season Road Connecting Berens River to Poplar River First Nation

Figure 7-4
Historical, Current, and Proposed Quarry Areas in the Local Assessment Area

Map Drawing Information:
ESRI Base Layers, Province of Manitoba, CanVec, GeoGratis, Dillon Consulting Limited

Map Created By: ECH
Map Checked By: MG/PS/LD
Map Projection: NAD 1983 UTM Zone 14N

DATE: 4/8/2016

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(**Source**: Provided by ESRA)

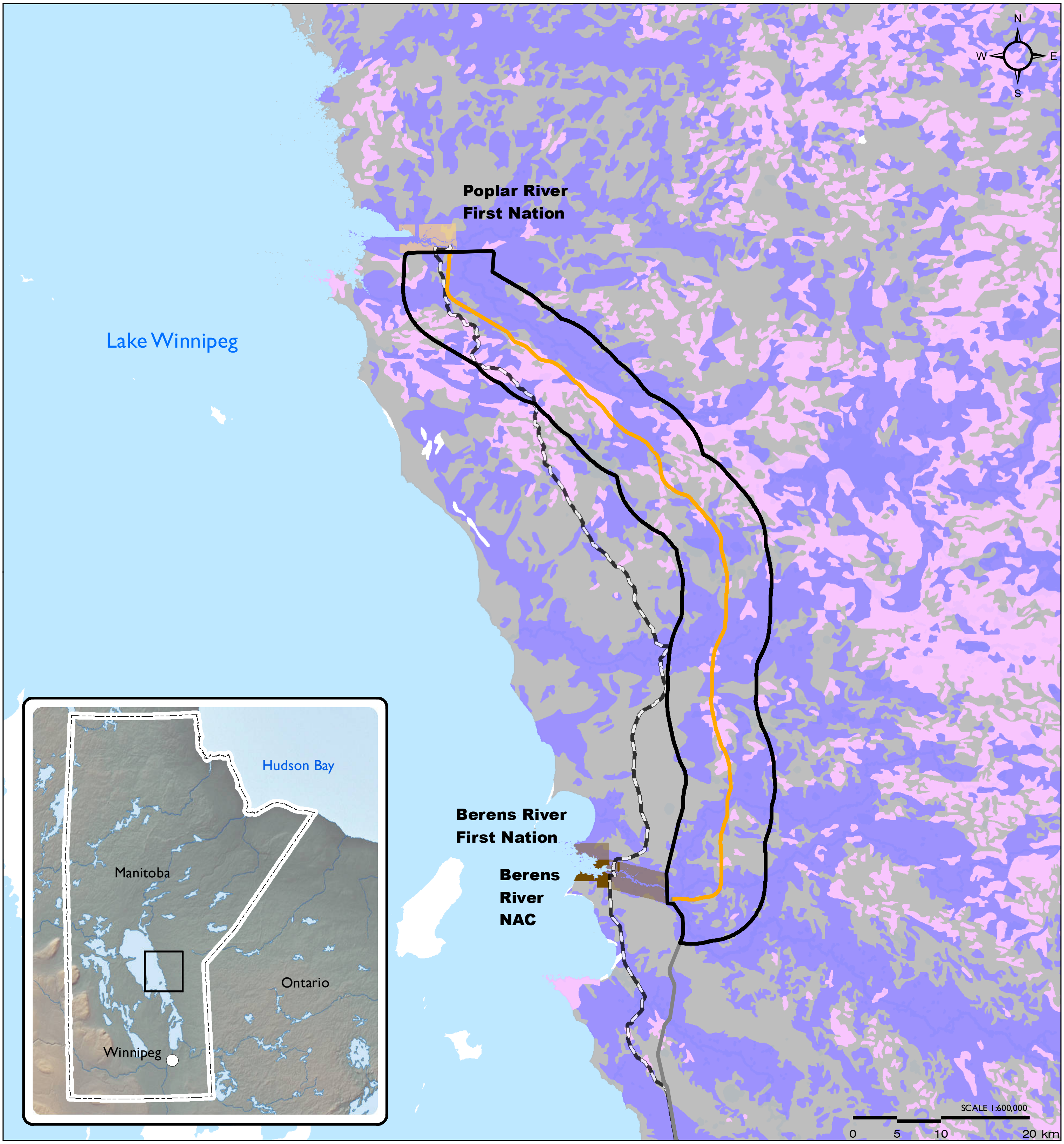
Photograph 7-1: Asatiwisipe Construction (Poplar River) Quarry

The surficial geology in the Local Assessment Area is characterized by a thin layer of organic and glaciolacustrine deposits interspersed with local Precambrian bedrock ridge and knoll outcrops (**Table 7.2**; **Figure 7-5**; Smith *et al.* 1998). Organic deposits are typically from 1 m to 5 m thick and accumulate in between bedrock lobes and in flat, lowland areas as fens and bogs. The glaciolacustrine sediments are very low relief, massive and laminated deposits of clay, silt and minor sand, deposited by glacial Lake Agassiz. No eskers or other substantial depositional areas have been observed or documented in the Local Assessment Area on mapping of geologic information produced by the provincial Mineral Resources Division or the National Topographic System mapping.

Table 7.2: Surficial Geology of the Local Assessment Area

Subunit	Percentage (%)
Glaciolustrine (silt and clay)	55
Organic	29
Precambrian rock	16

Source: Manitoba Mineral Resources (2015d)



Project 4 - All-Season Road Connecting Berens River to Poplar River First Nation

Figure 7-5
Surficial Geology in the Project Area

P4 All-Season Road Alignment

P1 All-Season Road (South of Berens to PTH 304) - Under Construction

2013/2014 Manitoba Winter Road

Local Assessment Area

Berens River Northern Affairs Community

Berens River First Nation Reserve

Poplar River First Nation Reserve

Surficial Geology Classification:

Organic

Glaciolacustrine - Silt and Clay

Rock - Precambrian

Map Drawing Information:
ESRI Base Layers, Province of Manitoba, CanVec, GeoGratis, Dillon Consulting Limited
Manitoba Mineral Resources 2015d

Map Created By: ECH
Map Checked By: MG/PS/LD
Map Projection: NAD 1983 UTM Zone 14N

DATE: 4/8/2016

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7.1.3.3 Soils

The general distribution of primary soil types found in the Local Assessment Area is illustrated on the maps in **Figure 7-6**. In the Berens River Ecodistrict, the dominant soils are poorly-drained, deep, or shallow organic Mesisols developed from moderately decomposed peat, which overlie finer glaciolacustrine sediments. Well- to imperfectly-drained Gray Luvisols occur in localized areas and are associated with calcareous glaciolacustrine, loamy and clay-textured soils. Poorly-drained peaty Gleysols occur north of the Local Assessment Area. To the east, within the Wrong Lake Ecodistrict, imperfectly-drained Gray Luvisols are the dominant soils, while organic Mesisols are slightly less widespread (Smith *et al.* 1998). Bedrock outcrops intersperse the extensively peat-covered lowland, increasingly more widespread to the east, with thin organic soils occurring in shallow depressions (Szwaluk Environmental Consulting Ltd., Newman and Calyx Consulting 2015a). Although permafrost is absent in the Local Assessment Area, thin seasonal frost layers can last into late summer (Szwaluk Environmental Consulting Ltd. *et al.* 2015a).

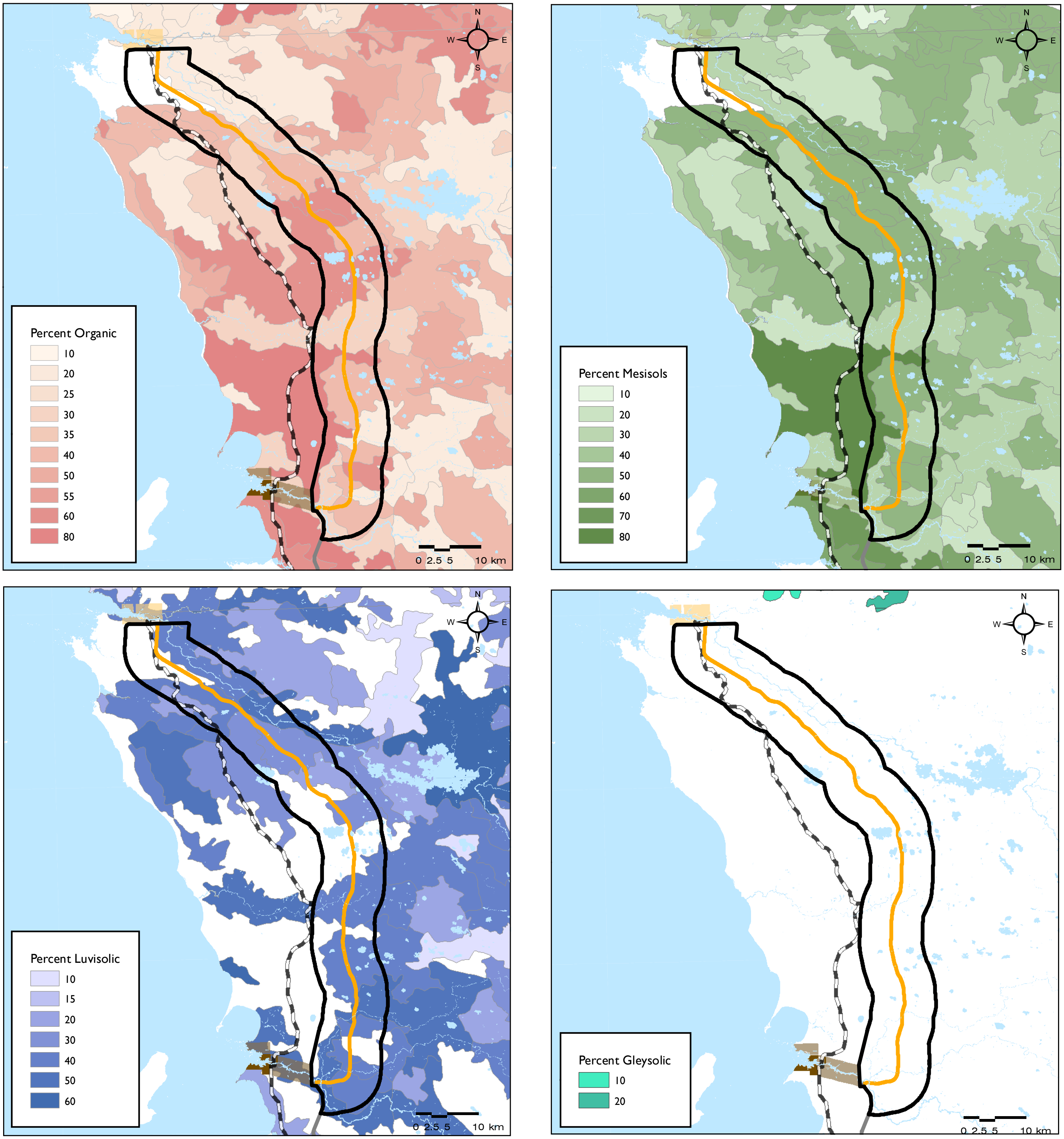
7.1.3.4 Seismic Activity

While earthquakes occur in all Canadian regions, the relative hazard risk varies greatly. The Regional Assessment Area, and the province of Manitoba as a whole, is rated as a region of lowest hazard for earthquakes in Canada (Natural Resources Canada 2013a). There is less than a 1% chance that a strong earthquake will occur in the Regional Assessment Area within 50 years (Natural Resources Canada 2013b).

7.1.4 Surface Water and Groundwater

7.1.4.1 Surface Water

Surface water in the Local and Regional Assessment Areas is abundant flowing west to Lake Winnipeg as part of the Lake Winnipeg East drainage division (Smith *et al.* 1998). The extensive bogs and fens of the Regional Assessment Area provide considerable surface water storage and drain to area creeks, rivers and lakes via small, often undefined drainage paths. Major watercourses in the Local Assessment Area crossed by the proposed all-season road are the Berens, Etomami, North Etomami and Leaf Rivers (**Figure 7-7**). Key attributes of the four rivers crossed by the proposed all-season road are presented in **Table 7.3**. The Berens River and Poplar River represent the potable water sources for the communities of Berens River and Poplar River, respectively. The potable water source for the Berens River NAC is Lake Winnipeg.



Project 4 - All-Season Road Connecting Berens River to Poplar River First Nation

Figure 7-6

Soils in the Project Area

Legend	
P4 All-Season Road Alignment	Berens River Northern Affairs Community
P1 All-Season Road (South of Berens to PTH 304) - Under Construction	Berens River First Nation Reserve
2013/2014 Manitoba Winter Road	Poplar River First Nation Reserve
Local Assessment Area	

Map Drawing Information:
ESRI Base Layers, Province of Manitoba, CanVec, GeoGratis, Dillon Consulting Limited

Map Created By: ECH
Map Checked By: MG/PS/LD
Map Projection: NAD 1983 UTM Zone 14N

DATE: 4/8/2016

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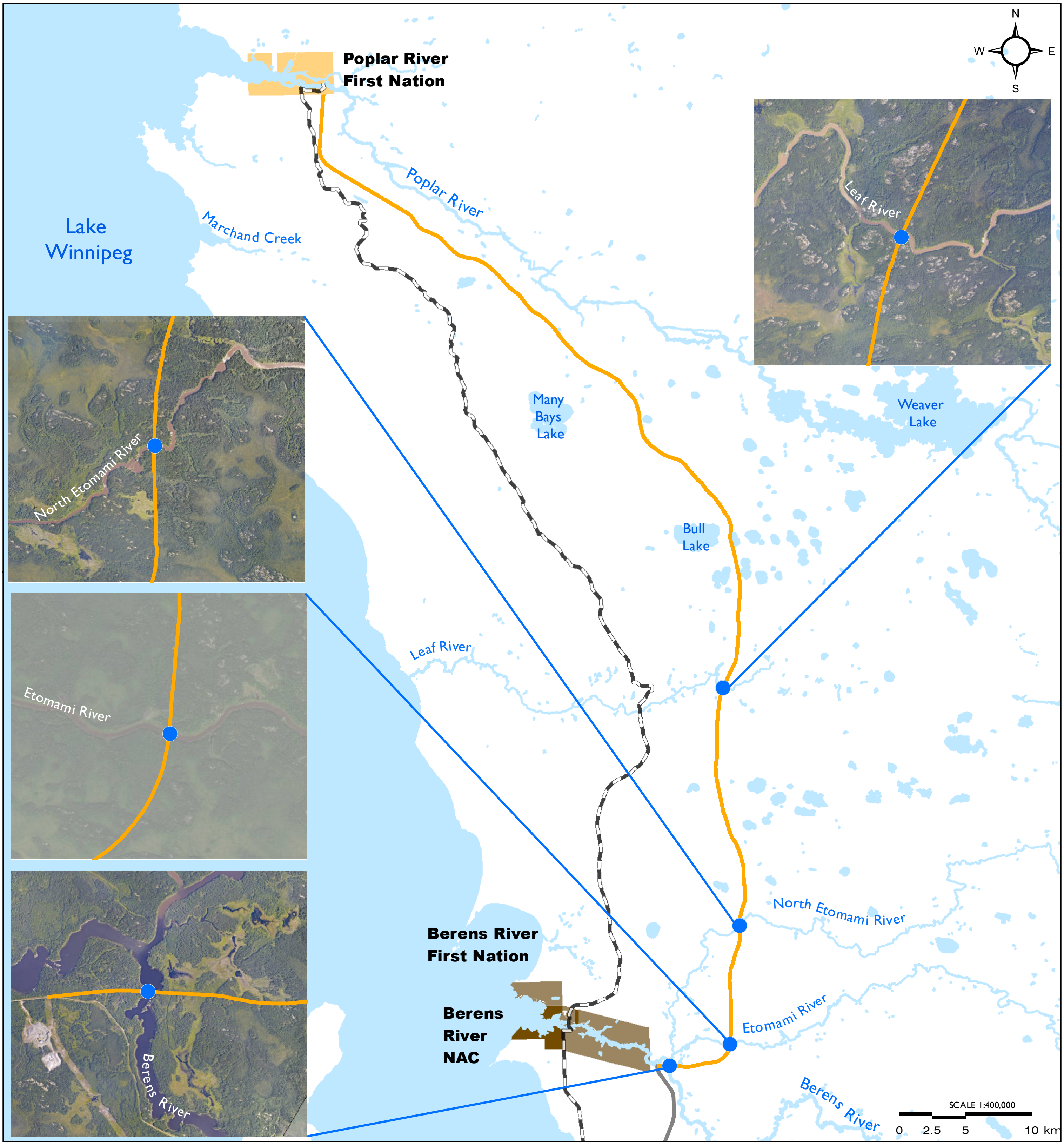

P4 All-Season Road Alignment (April 2015)

P1 All-Season Road (South of Berens to PTH 304) - Under Construction

2013/2014 Manitoba Winter Road

Major Crossing - Rivers

Berens River First Nation Reserve

Poplar River First Nation Reserve

Berens River Northern Affairs Community

Project 4 - All-Season Road Connecting Berens River to Poplar River First Nation

Figure 7-7

Locations of Major Water Crossings

Map Drawing Information:
ESRI Base Layers, Province of Manitoba, CanVec, GeoGratis, Dillon Consulting Limited

Map Created By: ECH
Map Checked By: MG/PS/LD
Map Projection: NAD 1983 UTM Zone 14N

DATE: 4/8/2016

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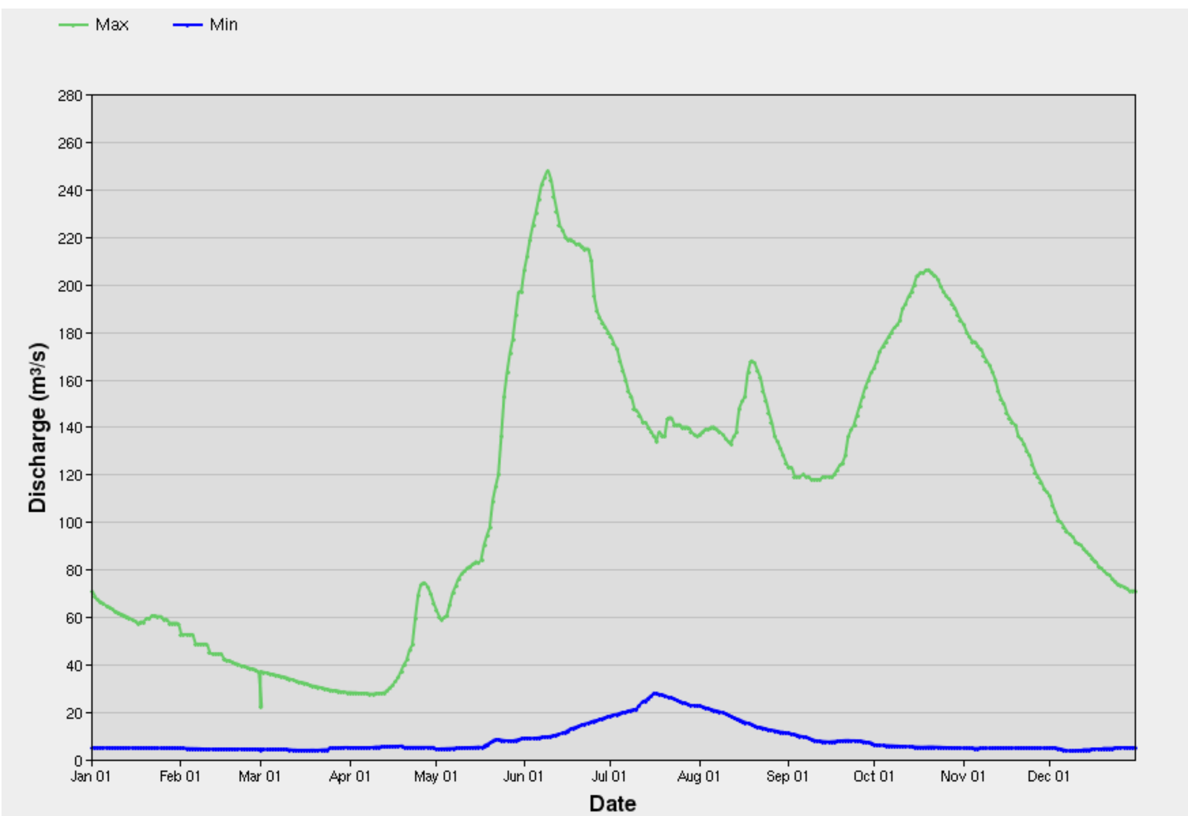
Table 7.3: Key Attributes of River Crossings in the Local Assessment Area

River	Upstream Drainage Area (km^2)	Channel Width at Crossing (m)	Maximum River Depth at Crossing (m)
Berens	1,195	63	8
Etomami	753	46	4
North Etomami	614	30	2
Leaf	594	34	2

Source: North/South Consultants Inc. (2015)

There are no active hydrometric data collection stations operated by the Water Survey of Canada on the four rivers intersecting the proposed all-season road. An historical hydrometric station was operated on the Berens River at the outlet of Long Lake approximately 75 river kilometres upstream of the proposed all-season road crossing location. The gauge operated between 1957 and 1992 and the average maximum and minimum daily discharge graph over this time period is presented in **Figure 7-8**.



Source: Environment Canada 2015b

Figure 7-8: Historical Daily Discharge Graph for the Berens River at Outlet of Long Lake (05RD007) Hydrometric Station (1957-1992)

Discharge levels in the four rivers, as well as other watercourses in the Local Assessment Area, are highest during spring freshet and exhibit periodic peaks during summer storms. During summer these watercourses become entirely dependent on precipitation (i.e., little groundwater influence) and discharge can drop to near zero during dry periods and through the winter. Water temperatures range from near 0°C at break-up in April or May and can rise rapidly to the mid-twenties by late May depending on warming trends (North/South Consultants Inc. 2015[4]).

The proposed P4 all-season road is also intersected by watercourses at 33 points along the alignment (North/South Consultants Inc. 2015). Water crossings account for less than 1% of the total footprint area of the all-season road alignment.

Consistent with water quality parameters expected in boreal forest areas, larger streams and rivers within the Local Assessment Area tend to be slightly acidic with oxygen levels near saturation, and do not undergo wide variation in these parameters as photosynthetic activity is limited by low light penetration through the water column. These "tea-stained" waters are low in suspended sediments and algae, but high in colour, due to the tannins released by decomposing peat in the headwaters. The local geology, natural acidity and lack of hardness in surface waters in the area result in significant concentrations of some metals which, at times, may exceed Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG) (Manitoba Water Stewardship 2011). Anthropogenic contamination of surface water in the area is minimal due to the remoteness of the P4 Project and the absence of human settlement and industrial or commercial development.

In 2014, *in situ* water quality parameters were measured at the major watercourse crossing (i.e., bridges and culverts) locations (North/South Consultants Inc. 2015). *In situ* water quality results for the four bridge crossings and one culvert crossing are presented in **Table 7.4**.

Water samples collected in the Project area in July 2014 were also subject to laboratory analysis to establish baseline conditions for nutrients and turbidity. Analyses indicated that the water quality of these watercourses have moderate to high nutrient concentrations and moderate clarity (**Appendix 7-1**). Nutrient concentrations were within MWQSOG ranges. Potable water in the communities of Berens River and Poplar River is sourced from surface water, and therefore surface water quality throughout the Regional Assessment Area can influence human health.

Potable water in the Poplar River First Nation and Berens River First Nation and NAC communities is sourced from surface water.

Reflective of the surficial geology in the area, streambed substrates are dominated by fine, highly organic sediments in the smaller and lower-gradient streams, with bedrock outcrops influencing the channel morphology in the larger rivers. In particular, high proportions of the Berens River channel are confined by bedrock. Gravel and sand deposits are generally rare to absent in the streams along the alignment.

[4] The North/South Consultants Inc. 2015 aquatic environment report is provided as **Appendix 8-1** in **Chapter 8**.

Table 7.4: *In situ* Water Quality Measured at Major Watercourse Crossings along the Proposed All-Season Road (July 2014)

	Temp. (°C)	Dissolved Oxygen (mg/L)	Oxygen Saturation (%)	Specific Conductance (µS/cm)	Conductivity (µS/cm)	Turbidity (NTU)	pH
MWQSOG	**-**	**6.0-6.5[1]**	**-**	**-**	**-**	**-**	**6.5-9.0[2]**
Site							
Berens River	20.8	8.32	93.0	49.0	45.1	4.7	5.97
Etomami River	20.9	7.04	79.4	36.9	34.0	12.5	5.18
North Etomami River	20.7	7.07	79.1	41.3	37.8	31.4	5.30
Leaf River	20.1	6.60	73.2	47.5	43.0	30.3	5.36
Okeyakkoteinewin Creek	16.8	6.77	70.1	62.1	52.2	28.4	5.72

Note: 1 Cool and cold water objectives, respectively
2 The lower and upper limits of the guideline for protection of aquatic life
Source: North/South Consultants Inc. (2015)

7.1.4.2 Groundwater

Little is known about groundwater in the Regional Assessment Area as a result of the sparse population, the abundance of surface water, the low demand for groundwater and the bedrock and surficial geology of the area. Precambrian rocks form the basal hydrostratigraphic unit of the Regional Assessment Area limiting groundwater flow to fractures. Permeability and hydraulic conductivity, therefore, is typically very low in the unfractured crystalline igneous and metamorphic rocks underlying the area. The thin surficial deposits above the bedrock are typically saturated with surface water. This condition persists throughout all seasons. Very few investigations of the groundwater potential of surficial deposits over the Precambrian Shield have been completed and therefore little is known regarding groundwater recharge/discharge. Groundwater discharge is known to have little influence on surface water flows of Regional Assessment Area watercourses.

A review of the 2013 GWRdrill database for groundwater wells in Manitoba identified no water well records in the vicinity of the Local Assessment Area. Potable water for the communities of Berens River First Nation/NAC and Poplar River First Nation is sourced from surface water. With abundant and high quality surface water available throughout the Regional Assessment Area there is no demand for groundwater as a source of potable water.

It is expected that groundwater of the area would contain low levels of dissolved solids with other dissolved constituents typically including sodium, calcium, magnesium and bicarbonate (Betcher *et al.* 1995). Anthropogenic contamination of groundwater in the Regional Assessment Area is expected to be negligible due to the remoteness of the P4 Project and the absence of human settlement and industrial or commercial development.

7.1.5 Noise and Vibration

Due to the absence of human settlement or development in the Regional Assessment Area, noise is extremely limited and restricted to local sources such as airplanes, vehicles on First Nation reserve roads, vehicular traffic along the winter road and snowmobile and ATV traffic on trails (Poplar River First Nation 2011). Sustained sources of noise originate only from the Poplar River First Nation and Berens River First Nation communities at the north and south termini of the all-season road, respectively. Vibration in the Regional Assessment Area occurs infrequently and is exclusively associated with blasting activities occurring at quarries. ESRA commissioned a study to assist in understanding, predicting, controlling and quantifying temporary ground and air-borne effects from aggregate blasting (RWDI Consulting Engineers & Scientists 2015).

Noise and vibration in the Regional Assessment Area is extremely limited and infrequent due to the absence of human settlement, development and industry.

Few human receptors to noise and vibration are present, with the majority located within the communities of Berens River First Nation/NAC and Poplar River First Nation. More information regarding the low population density in the Local and Regional Assessment Areas is provided in **Chapter 10** (Socio-Economic and Cultural Environment).

7.1.6 Valued Components

In consideration of the existing environment in the Project Local and Regional Assessment Areas as described in **Sections 7.1.1** to **7.1.5**, the assessment of potential environmental effects of the proposed Project (**Section 7.2**) has focused on the physical environment components that are particularly important to local communities and for environmental health as outlined in **Section 6.4.2** of **Chapter 6** (Environmental Impact Assessment Scope and Approach). The Valued Components (VCs) identified for the physical environment and rationale for selection are presented in **Table 7.5**.

Other components of the physical environment (i.e., soils, climate, etc.) are not identified as VCs as they were not identified through the VC screening process described in **Chapter 6**. However, many are discussed with respect to the pathways (i.e., 'cause-effect linkages') of potential Project effects on VCs of the Aquatic (**Chapter 8**), Terrestrial (**Chapter 9**) and Socio-Economic and Cultural environments (**Chapter 10**), as relevant.

Table 7.5: Physical Environment Valued Components and Selection Rationale

Valued Component	Selection Rationale
Surface Water	▪ Indicator of human and environmental health. ▪ Key measurement indicator for health of aquatic and terrestrial systems and resources. ▪ Linked to traditional Aboriginal activities (e.g., fishing and hunting) which are linked to water quality. ▪ MCWS precautionary note regarding type of rock material and blasting materials used (MCWS, personal communication, January 9, 2015). ▪ Regulated under Manitoba's *The Water Protection Act.*
Air Quality	▪ Indicator of changes to human health. ▪ Indicator of the quality and health of biological communities. ▪ Potential effects to climate. ▪ Indicator of changes to the atmospheric environment which CEA Agency Guidelines identify as a VC to be considered for assessment (CEA Agency 2015a). ▪ Manitoba's Ambient Air Quality Guidelines. ▪ MCWS precautionary note regarding need to adequately address air quality in the EIA (MCWS, personal communication, January 8, 2015).
Noise	▪ Changes in the acoustic environment can be indicative of changes in human and environmental health. ▪ Indicator of changes to the atmospheric environment which CEA Agency Guidelines identify as an environmental component to be assessed (CEA Agency 2015a).

7.2 Environmental Effects and Mitigation

The assessment of the potential effects of the Project activities on the Physical Environment VCs was conducted as described in **Section 6.4** of **Chapter 6**, and included the following approach:

- Identification of the interactions among the selected VCs and the Project construction and operations and maintenance activities;
- Identification of the potential environmental effects of the Project prior to the implementation of mitigation measures;
- Initial screening of the potential environmental effects via examination of the magnitude/ geographic extent, duration, frequency, reversibility and ecological context of the potential effects prior to the implementation of mitigation measures;
- Identification of appropriate mitigation measures and their application to reduce or avoid potential adverse effects; and
- Prediction of residual adverse environmental effects remaining after mitigation and determination of the significance of those residual adverse effects.

7.2.1 Valued Components and Project Interactions

Baseline physical environment data compiled and collected for the Regional Assessment Area has been supplemented with traditional knowledge provided by the Berens River and Poplar River First Nations to develop a thorough understanding of the physical conditions affecting, and potentially affected by, the Project. Traditional knowledge of the physical environment shared with ESRA has included the presence of, and interest in, mineral deposits (Berens River First Nation in CIER 2015) and forestry, mining and other industrial development opportunities in the Regional Assessment Area (Poplar River First Nation 2011).

Table 7.6 provides a summary of the interaction between Physical Environment VCs and key activities associated with the construction and operations and maintenance phases of the Project.

Table 7.6: Key Project Activity Interactions with Physical Environment Valued Components

Project Activities	Physical Environment VCs		
	Surface Water	Air Quality	Noise
Construction Phase			
Operation and staging of equipment, machinery and vehicles and transportation of equipment as necessary during construction phase*.	✔	✔	✔
Clearing road right-of-way including clearing vegetation, salvaging, burning, stockpiling, grubbing and mechanical brushing.	✔	✔	✔
Blasting.		✔	✔
Road construction including topsoil stripping, soil removal, rock placement/compaction, rock crushing, traffic control/signage and contouring.	✔	✔	✔
Grading and gravelling of road surface.		✔	
Bridge construction including construction of components, batching/pouring concrete and steel girder placement.	✔		✔
Culvert installation including coffer damming, stream excavation, geotextile material placement, filling, crossing streams, culvert placement, backfilling and compaction.	✔		
Erosion and sediment control including placing silt fencing and re-vegetation.	✔		
Establishment of staging areas and temporary components (i.e., quarry and borrow areas, temporary access and crossings, staging areas, camps).	✔		✔
Solid and liquid waste management.	✔	✔	
Storage and handling of hazardous materials.	✔	✔	
Site cleanup including waste removal, contaminated soil removal, stockpiling and recycling materials.	✔		
Closure and reclamation of temporary components (quarry and borrow areas, access, crossings, staging areas) including excavation, slope stabilization, re-vegetation and barrier installation.	✔		
Operations and Maintenance Phase			
Road maintenance including vegetation maintenance, grading, washout repair and traffic controls.	✔		✔
Ditch maintenance including excavation and debris removal.	✔		
Bridge and culvert maintenance including seasonal inspections and debris removal.	✔		
Erosion and sediment control including re-vegetation.	✔		
Clearing snow.	✔		
Operation and staging of equipment, machinery and vehicles and transportation of equipment as necessary during maintenance.		✔	✔

Note: * Other activities require the operation of equipment/vehicles/machinery. Therefore, influences on VCs for subsequent activities relate to how the completion of the activity potentially influences the VC.

7.2.2 Assessment of Potential Effects

As noted in **Chapter 6**, the potential environmental effects of the Project activities on the VCs were assessed using the steps outlined in **Section 6.4** and the assessment criteria described in **Table 6.3**. Various desktop and *in situ* studies were conducted to collect, record and analyse information on the physical environment of the proposed P4 all-season road Project Footprint, Local Assessment Area and Regional Assessment Area. This information was used to quantify the potential effects of Project activities on the selected VCs where quantification was possible, and to qualify the potential effects where quantitative data were unavailable.

7.2.3 Mitigation

As part of ESRA's commitment to environmental protection and sustainability, the design and routing of the Project has been developed with an acute awareness of the importance of the ecological and cultural resources of the area, including the value of the physical environment to the people and animals of the region. The final alignment for the proposed all-season road was selected following consideration of a number of alternative routes, as well as design options that were proposed, reviewed and rejected in terms of potential effects on the people, air, water, land, fish, vegetation, wildlife, Heritage Resources, Traditional land use and Traditional activities. Input received from Elders, elected officials and community members of Berens River and Poplar River was used to validate and refine the proposed all-season road alignment (**Chapter 2**) and contributed to the use of appropriate designs and the application of environmental protection measures for the pre-construction, construction and post-construction stages of the Project. The physical environmental components that contribute to the ecological and cultural resources of the area were examined individually and collectively to find the best possible alignment for the proposed all-season road that achieves the connection of communities to much needed services and amenities, while respecting and preserving the ecological and cultural resources of the region.

Many potential effects of road construction and operations and maintenance on the physical environment can be minimized or avoided through appropriate siting of the road alignment and road design. A variety of measures have been incorporated into the Project design to avoid or mitigate potential effects. They include:

- Selection of a road alignment that avoids important physical features such as waterbodies and watercourses and low-lying areas of organic soils, where possible;
- Designs of watercourse crossing structures (i.e., bridges, culverts) that span the wetted perimeter and maintain hydrometric conditions, where possible and meet 1:100 year design standards (i.e., Q1% flood/flow);
- Road designs that do not include permanent lighting thereby preserving existing night-time light levels;
- Culvert designs that preserve existing surface and shallow subsurface flow patterns;

- Selection of quarry, borrow and temporary work/staging locations that avoid sensitive physical features and minimize haul distances resulting in the reduced potential for noise, equipment emissions and dust; and
- Commitments to construction activities and practices (e.g., erosion and sediment control, schedule, blasting, equipment idling) in construction contract documents that avoid or minimize potential environmental effects on the physical environment.

Information on the route selection process is provided in **Chapter 2** (Project Justification and Alternatives Considered). Information on the design mitigation features and measures that were used to reduce or avoid a number of potential environmental effects are described in **Chapter 3** (Project Description) and **Chapter 5** (Environmental Protection and Sustainable Development).

Chapter 5 also outlines the environmental protection and management plans that will be implemented for the Project. ESRA has developed a series of Environmental Protection Specifications (e.g., General Requirements 130 [GR130]) that are distributed to contractors as part of the contract agreements for clearing and construction works. These plans and specifications will provide information on the appropriate physical environment mitigation methods and environment protection measures to be used before, during and after the works.

7.2.4 Effects on Surface Water, Air Quality and Noise

A description of the existing conditions for surface water, air quality and noise is provided in **Section 7.1**. There are potential temporary, short-term effects as well as longer term or permanent effects of Project clearing, construction and operations and maintenance activities that may affect the physical environment in the Project Footprint and Local Assessment Area. There are also linkages between the potential effects of environmental change on the health of community members. Potential effects may include:

- A minor, localized alteration of surface drainage patterns adjacent to the all-season road;
- A minor and temporary increase of in-stream sediment levels from construction and operations and maintenance activities;
- Minor alterations of ice dynamics at waterbody crossings;
- Minor, localized and temporary increase in fugitive dust and emissions (GHGs and VOCs) from construction vehicles/equipment and activities (e.g., clearing and woody debris burning, blasting, roadbed construction and maintenance works) and road users during the operations and maintenance phase;
- Minor permanent loss of carbon sink for atmospheric carbon storage through removal of vegetation required for the all-season road, quarries and on-going maintenance; and
- A minor and temporary sensory disturbance to local human receptors due to noise and/or vibration generated by construction and operations and maintenance Project phases is predicted as a residual effect of the Project.

Potential environmental effects related to the selected physical environment VCs are provided in **Section 7.2.4.1** (surface water), **Section 7.2.4.2** (air quality) and **Section 7.2.4.3** (noise). For each predicted adverse effect, mitigation measures are stated and assessments of the significance of residual environmental effects remaining after mitigation are provided.

The potential effects of Project construction on water quality include erosion and resulting sedimentation of streams and introduction of deleterious substances from vehicles into waterways.

7.2.4.1 Surface Water

A substantial base of literature exists regarding the effects of road development on hydrological systems (Burns 1972; Findlay and Houlahan 1997; Forman and Alexander 1998). These studies indicate that modifications to the hydrological environment due to road development may affect surface water flow and quality. Depending on local conditions, modification of natural surface water flow by road construction can concentrate flow at certain points potentially resulting in localized flooding, soil erosion, channel and bank modification and siltation of watercourses. Soil compaction occurring during construction can reduce infiltration potentially leading to an increase in runoff that can initiate and promote erosion and the transport of sediment to the aquatic environment. Sediment transport and deposition in the aquatic environment can reduce water quality and be detrimental to aquatic life. Other potential effects include changes to water levels with resulting changes to riparian vegetation and accidental spills of substances that are deleterious to aquatic life and downstream water users.

Potential effects to surface water and associated mitigation measures related to this Project are provided for the construction and operations and maintenance phases of the Project in **Sections 7.2.4.1.1** and **7.2.2.4.2**, respectively.

7.2.4.1.1 Construction Effects and Mitigation

The potential effects on surface water in the Local Assessment Area due to Project construction prior to the implementation of mitigation measures were identified as follows:

- Alteration of surface drainage patterns;
- Alteration of stream flow at watercourse crossing locations;
- Alteration of ice freeze-up/break-up dynamics at watercourse crossings;
- Temporary increase in suspended sediments and debris in watercourses; and
- Impaired surface water quality due to introduction of hazardous substances (e.g., concrete wash water).

Using the approach described above in **Section 7.2.2**, the overall level of effect of the potential construction effects on surface water prior to the implementation of mitigation measures was examined. **Appendix 7-2** provides a summary of the potential construction effects on surface water prior to the implementation of mitigation measures and the determined overall level of potential effect.

Based on the screening of potential effects in **Appendix 7-2**, the following potential adverse effects were identified as having an overall low level of effect:

- Temporary increase in total suspended solids (TSS) and turbidity levels in surface water; and
- Impaired surface water quality due to introduction of hazardous substances including the release of alkaline concrete or concrete water wash.

The following potential adverse effects were identified as having an overall moderate level of effect:

- Alteration of surface drainage patterns and stream flow; and
- Alteration of ice freeze-up/break-up dynamics at watercourse crossings.

No potential adverse effects were identified as having an overall high level of effect in **Appendix 7-2**.

The primary potential effects of Project construction on surface water quality include erosion and resulting sedimentation of streams and the accidental introduction of deleterious substances such as fuel and oil from construction equipment and vehicles into waterways (North/South Consultants 2015). Mitigation, such as the use of erosion and sediment control, is expected to minimize the frequency, magnitude and extent of sediment introduction into the water during the construction phase of the Project[5].

Monitoring of construction activities will occur at river and stream crossings to oversee the effective installation of mitigation measures to protect surface water quality, to assess the effectiveness of their application and to identify whether adaptive management of the mitigation is required (**Chapter 14**, Monitoring and Follow-up). Post-construction inspections will also be completed to confirm that crossing sites are stabilized and that additional restoration efforts are applied where necessary.

Surface water quality also has the potential to be altered due to geochemical leachate generated by the blasting and excavation of bedrock. The fracturing of granitoid and gneiss bedrock types at proposed quarry sites and along the proposed all-season road could, through natural chemical processes, generate acidic runoff that potentially leaches metals as both rock types may contain sulphide minerals and concentrations of metals. The increased acidity and/or elevated metal concentrations may negatively impact plants, animals and aquatic life that may be exposed to contaminated runoff and nearby soils through contact or ingestion pathways. The risk and degree of adverse environmental effects due to acid rock drainage and/or metal leaching is dependent on many factors such as the amount of sulphide mineralization compositions present in the exposed bedrock and the structure and mineral composition of the rock.

An evaluation of the potential for local bedrock formations to generate acid drainage has been undertaken by examining available geological and mineralogical data for the area such as records of known sulphide mineralization (including pyrite lithologies). There are no records of lithologies within

[5] Refer to **Chapter 8** (Aquatic Environment) for a detailed description of the mitigation that will be used to avoid or minimize erosion and sedimentation to protect waterways.

the Project Footprint or Local Assessment Area that are known to contain sulphide-bearing minerals and/or high metal content. There is some potential, however, that they may be present. On-site confirmation of the presence of sulphide mineralization or pyritic lithologies for potential quarry sites will occur prior to construction and following procedures such as:

- Visual inspection for the presence/absence of pyrite or other evidence of potentially acid generating rock (e.g., precipitates or accumulations of iron or sulphate minerals); and
- Laboratory testing (i.e., acid-generating potential, acid-neutralizing potential, sulphur analysis) of bedrock samples.

Sections of ESRA's Environmental Protection Procedures and ESRA's Environmental Protection Specifications (GR130s) that relate to surface water protection are listed in **Table 7.7**.

Table 7.7: ESRA's Protection Procedures and Specifications for Surface Water

Environmental Protection Procedures Section (Chapter 5, Appendix 5-3)	Environmental Protection Specifications (GR130s) (Chapter 5, Appendix 5-4)
Sec. 1 Clearing and Grubbing Sec. 2 Petroleum Handling and Storage Sec. 3 Spill Response Sec. 5 Materials Handling and Storage Sec. 6 Working within or near Fish Bearing Waters Sec. 7 Stream Crossings Sec. 8 Temporary Stream Diversions Sec. 11 Culvert Maintenance and Replacement Sec. 12 Blasting Near a Watercourse Sec. 16 Erosion and Sediment Control Sec. 17 Concrete Area Management Practices Sec. 18 Dust Suppression Practices	GR130.6 General GR130.8 Designated Areas and Access GR130.9 Materials Handling, Storage and Disposal GR130.10 Spills and Remediation and Emergency Response GR130.15 Working Within or Near Water GR130.16 Erosion and Sediment Control GR130.17 Clearing and Grubbing GR130.21 Cement Batch Plant and Concrete Wash-Out Area

In general, potential construction effects on surface water are expected to be localized within the Project Footprint. A summary of potential construction effects to surface water, mitigation measures that will be applied and the resulting residual effects following the application of mitigation is presented in **Table 7.8**.

Table 7.8: Summary of Potential Construction-Related Environmental Effects on Surface Water and Proposed Mitigation Measures

Construction Activities and Potential Environmental Effects	Proposed Mitigation Measures	Residual Effects	Significance Evaluation*
Drainage/Stream Flows			
Alteration of surface drainage patterns in the Local Assessment Area and of stream flow at watercourse crossing locations due to: ▪ Construction of the all-season road, establishment and use of quarries, borrow areas, temporary access trails and construction/ installation of bridges and culverts.	▪ Appropriately designed watercourse crossing structures and appropriately designed, number and placement of equalization culverts will be installed to preserve existing surface water drainage patterns to the extent feasible (Project Description **Chapter 3**). ▪ Where possible, roads will be located a minimum of 100 m from waterbodies except when crossing a watercourse. ▪ Surface water drainage will be directed along the road or around cleared areas and away from watercourses. ▪ Vegetation clearing will be limited to the extent feasible to minimize the potential for soil erosion. ▪ In-stream work will be conducted during winter months or low flow conditions and in isolation of flowing water. ▪ The existing alignment and gradient of the watercourse will be maintained.	Minor alteration of surface drainage and stream flow at watercourse crossings.	Not significant
Alteration of ice freeze-up/break-up dynamics at watercourse crossings due to: ▪ Construction/installation of bridges and culverts at watercourse crossings.	▪ Culverts/crossings will be designed to accommodate 1:100 year flows (Project Description **Chapter 3**). ▪ The existing alignment and gradient of the watercourse will be maintained.	Minor alteration of ice dynamics at watercourse crossings.	Not significant
Water Quality			
Temporary increase in suspended sediments and debris into watercourses in the Local Assessment area due to: ▪ Vegetation clearing and construction activities.	▪ Construction activities will not occur within 100 m of a watercourse with the exception of construction of watercourse crossings. ▪ Where a 100 m distance is not possible, a buffer zone of undisturbed vegetation between the construction activities and the watercourse will be established. The buffer zone width will be established according to the following formula: Width = 10 m + (1.5 X slope gradient) or 30 m whichever is greater. ▪ Riparian vegetation clearing within the right-of-way will be limited to the removal of trees and tall shrubs (to maintain line of sight safety requirements) with no removal of low growing vegetation.	None anticipated following the application of mitigation.	Not applicable

Construction Activities and Potential Environmental Effects	Proposed Mitigation Measures	Residual Effects	Significance Evaluation*
	▪ Clearing within 30 m of a watercourse will be completed by hand. ▪ Clearing near watercourses will be temporarily suspended during very wet or muddy conditions. ▪ Vegetation will be retained as long as possible to minimize the exposure time of disturbed/bare soils to potential erosion. ▪ Clearing limits will be clearly marked prior to riparian vegetation removal to avoid unnecessary damage to or removal of vegetation. ▪ Slash or debris piles will be stabilized and stored above the high water mark until disposal. ▪ Overburden will be adequately stabilized and stored above the high water mark. ▪ In-stream work will be conducted during winter months or low flow conditions and in isolation of flowing water (e.g., with the use of cofferdams, channel diversions, silt curtains) to mitigate downstream sediment transfer. ▪ Silt curtains will be installed downstream of in-water work, if appropriate. ▪ Appropriate erosion and sediment control (ESC) measures will be in place prior to the commencement of clearing and construction. ▪ ESC measures will be regularly inspected and maintained to confirm effectiveness throughout construction. ▪ Disturbed areas will be stabilized through revegetation with native plant species or other appropriate means (e.g., erosion control blankets) following completion of the works. ▪ ESC measures will remain in place until disturbed areas are stabilized and revegetated.		
Impaired surface water quality in the Local Assessment Area due to the introduction of hazardous substances due to: ▪ Equipment, vehicle and machinery use, including blasting activities.	▪ Fuels and other hazardous substances will be stored and dispensed at least 100 m from the high water mark of waterbodies and watercourses. ▪ Fuel will be stored in approved containers with secondary containment for potential leaks/spills. ▪ Drip-trays, blankets or pads will be used when transferring fuel at construction sites. ▪ Equipment, machinery and vehicles will be checked for cleanliness and leaks upon arrival to site and checked and maintained daily thereafter. ▪ Construction crews will be adequately trained on the handling, storage and disposal of hazardous substances. ▪ Spill clean-up kits will be available on site at all times.	None anticipated following the application of mitigation.	Not applicable

Construction Activities and Potential Environmental Effects	Proposed Mitigation Measures	Residual Effects	Significance Evaluation*
	▪ Spills will be contained, treated and disposed of and reported in accordance with applicable provincial regulations and ESRA protocol. ▪ Based on local geological conditions, acid rock drainage is unlikely. As part of the site selection criteria, potential quarries will be assessed in advance of development. Rock with acid rock drainage potential to affect surface water quality will not be used. ▪ Ammonium nitrate-fuel oil mixtures will not be used in or near watercourses. ▪ Blasting will not occur on shorelines of watercourses. ▪ Herbicides will be applied in accordance with manufacturers guidelines and not within 30 m of watercourses/waterbodies. ▪ Dust suppressants will not be applied to the road within 50 m of watercourses. ▪ Areas for cleaning of equipment used in concrete work will be a minimum 100 m from a watercourse or other sensitive feature and will not drain to watercourses. ▪ Uncured or partly cured concrete will be kept in isolation from watercourses. ▪ Water that has contacted uncured concrete will be isolated from watercourses until it has reached a neutral pH.		
Release of alkaline concrete or concrete wash water that can increase pH levels and negatively affect aquatic life due to: ▪ The use of cast in place concrete.	▪ Uncured or partly cured concrete will be kept in isolation from watercourses. ▪ Water that has contacted uncured concrete will be isolated from watercourses until it has reached a neutral pH. ▪ Equipment used in concrete work will be cleaned away from watercourses to prevent wash water from entering waterways.	None anticipated following the application of mitigation.	Not applicable

Note: * Refer to **Section 7.3.1** for additional details regarding the significance of residual effects conclusion and evaluation.

7.2.4.1.2 Operations and Maintenance Effects and Mitigation

The potential effects on surface water in the Local Assessment Area due to Project operations and maintenance prior to the implementation of mitigation measures are similar to those for construction, presented in **Section 7.2.4.1.1**.

Using the approach described above in **Section 7.2.2**, the overall level of effect of the potential operations and maintenance effects on surface water prior to the implementation of mitigation measures was examined. **Appendix 7-2** provides a summary of the potential operations and maintenance effects on surface water prior to the implementation of mitigation measures and the determined overall level of the potential effect. Potential pre-mitigation operations and maintenance effects with overall low and moderate levels of effect are similar to those for construction, and are listed in **Section 7.2.4.1.1**.

Surface water quality will be monitored for potential adverse effects of construction on fish, fish habitat and aquatic resources related to the introduction of sediment and other deleterious substances into watercourses. Water quality will be monitored during in-water works and/or other construction activities conducted near water, as appropriate.

During the Project operations and maintenance phase, potential effects to surface water are primarily associated with the maintenance and repair of culverts, watercourse crossings and the all-season road surface and shoulders. Routine operations and maintenance activities associated with culverts include the clearing of vegetation, branches, mud, ice, snow or other debris from the culvert inlets, barrels and outlets, as required, to maintain hydraulic capacity. Similar routine clearing activities are expected at bridge crossings to minimize the potential for the aggregation of organic materials or ice (i.e., jams) that may restrict flow. Regular inspections of culverts and watercourse crossings will be conducted during the operations and maintenance phase. Debris removal will be conducted by machinery operating from shore above the high water mark or by hand. Surface water quality may be potentially affected by these activities through the release and transport of deleterious substances caused by equipment used for clearing or disturbance of the watercourse bed or banks. Minor and temporary increases of suspended sediments may occur with the removal of debris from water crossing and culverts.

Vegetation along the all-season road right-of-way will be regularly managed (i.e., mowed, trimmed, cleared) during the operations and maintenance phase to maintain sightlines and a safe and secure travel corridor. Herbicides that may be required to control vegetation will not be applied within 100 m of watercourse crossings to minimize the potential for contact with surface water.

Road maintenance activities, such as grading and repair of the road surface and shoulders, will be on-going during the operations and maintenance phase. These activities will be completed by graders, dump trucks and backhoes and have the potential to generate sediment in runoff from the road surface.

Many of the mitigation measures proposed for application to Project construction activities also apply to the operations and maintenance phase of the Project. Erosion and sediment controls described in

Section 7.2.4.1.1 for the construction phase, for example, will also be used during the operations and maintenance phase. Similarly, mitigation measures applicable to the use of heavy machinery and vehicles for Project maintenance (e.g., road grading) were described in **Section 7.2.4.1.1**. Should culverts require replacement during all-season road operations, the same mitigation measures as implemented for culvert installation will be applied. Where protective coatings on bridge structures require removal and reapplication, these activities will be conducted in a manner that prevents deleterious substances (e.g., paint, paint flakes, blasting abrasives) from entering the watercourse (e.g., shrouding). Waste materials generated by these activities (e.g., paint flakes, abrasives) will be properly contained and disposed of at an approved disposal facility. Where possible, repair and maintenance activities associated with culverts and watercourse crossings will be scheduled with low water conditions to minimize potential adverse effects to surface water. No residual effects of Project operations and maintenance activities on surface water are anticipated.

7.2.4.2 Air Quality

Road development (i.e., road construction and operations and maintenance activities) has the potential to reduce air quality through the generation of fugitive dust and other particulates from blasting, clearing, burning of woody debris and other construction-related activities and through vehicle and equipment operations generating dust and emissions (Chang *et. al.* 2009). Spellerberg (1998) described potential effects of emissions on wildlife and plants that may extend beyond the right-of-way. Primary emissions from vehicles that can compromise air quality (GHGs) are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) (U.S. Environmental Protection Agency 2013). Other emissions include volatile organic compounds (VOCs) used during road construction (e.g., gasoline, diesel) and that may have potential adverse effects to human health and the environment if not stored and handled properly (Environment Canada 2013).

Potential environmental effects of airborne dust and emissions during Project construction and operations and maintenance phases are expected to be localized within the Project Footprint and adjacent Local Assessment Area. Greenhouse gases generated by Project construction and operations and maintenance contribute to the accumulation of greenhouse gases from other sources and potential associated effects on a global scale and are therefore assessed in **Chapter 13** (Cumulative Effects).

Project activities that result in the production of air quality pollutants and proposed mitigation measures for the avoidance or reduction air quality pollutants, are provided for the construction phase and operations and maintenance phase of the Project in **Section 7.2.4.2.1** and **Section 7.2.4.2.2**, respectively.

7.2.4.2.1 Construction Effects and Mitigation

The potential effects on air quality in the Local Assessment Area due to Project construction prior to the implementation of mitigation measures were identified as follows:

- Release and transport of dust and particulates;

- Increased greenhouse gases and VOCs;
- Increased particulate levels and greenhouse gas emissions;
- Reduction of carbon sink with removal of vegetation; and
- Blasting activities will potentially result in the release and transport of dust and particulates.

Using the approach described above in **Section 7.2.2**, the overall level of effect of the potential construction effects on air quality prior to the implementation of mitigation measures was examined. **Appendix 7-2** provides a summary of the potential construction effects on air quality prior to the implementation of mitigation measures and the determined level of the potential effect.

Based on the screening of potential effects in **Appendix 7-2**, the following potential adverse effects were identified as having an overall low level of effect:

- Release/transport of dust/particulate levels due to the use of vehicles/machinery and blasting;
- Increased greenhouse gases and VOCs due to the use of vehicles/machinery; and
- Increased particulate levels and greenhouse gas emissions due to vegetation removal.

Potential effects of airborne dust and emissions during Project construction are expected to be primarily localized within the Project Footprint and adjacent Local Assessment Area.

Reduction of carbon sink function for atmospheric carbon storage resulting from the removal of vegetation was identified as a potential adverse effect having an overall moderate level of effect. No potential adverse effects were identified as having an overall high level of effect in **Appendix 7-2**.

The proposed Project has the potential to result in small, temporary increases in fugitive dust and construction vehicle and equipment emissions within the Local Assessment Area during the construction phase. Construction activities having the potential to generate dust and emissions include right-of-way, quarry and access clearing, drilling and blasting and materials hauling. No exceedances of the Manitoba Ambient Air Quality Criteria (Government of Manitoba 2005) are anticipated to occur within the Local Assessment Area from construction activities. On occasion, smoke from the burning of cleared trees, shrubs and other organic material will occur during construction.

Proposed measures to mitigate potential adverse environmental effects of fugitive dust and emissions during the Project construction phase include implementing approved dust suppression measures (e.g., speed limits, watering, revegetation) on construction roads and areas of exposed soils, as required and limiting unnecessary use and idling of equipment and vehicles. Emissions from vehicles and equipment will also be limited by locating quarries, borrow areas and other temporary construction components (e.g., laydown areas) as close to the road corridor as feasible (Project Description, **Chapter 3**).

Sections of ESRA's Environmental Protection Procedures and Environmental Protection Specifications (GR130s) that relate to air quality protection are listed in **Table 7.9**.

Table 7.9: ESRA's Protection Procedures and Specifications for Air Quality

Environmental Protection Procedures Section (Chapter 5, Appendix 5-3)	Environmental Protection Specifications (GR130s) (Chapter 5, Appendix 5-4)
Sec. 1 Clearing and Grubbing	GR130.6 General
Sec. 2 Petroleum Storage	GR130.9 Materials Handling, Storage and Disposal
Sec. 3 Spill Response	GR130.10 Spills and Remediation and Emergency Response
Sec. 5 Materials Handling and Storage	GR130.11 Dust and Particulate Control
Sec. 12 Blasting Near a Watercourse	GR130.16 Erosion and Sediment Control
Sec. 15 Wildfires	GR130.17 Clearing and Grubbing
Sec. 16 Erosion and Sediment Control	GR130.20 Wildfires
Sec. 18 Dust Suppression Practices	

Although proposed mitigation measures can substantially reduce potential environmental effects on air quality during construction, not all potential effects are expected to be eliminated. Therefore, some minor residual effects in the Project Footprint and Local Assessment Area are predicted. For example, a temporary reduction in localized air quality due to equipment emissions and dust is anticipated in discrete work areas along the construction corridor which may result in a temporary disturbance to wildlife (see **Chapter 9**, Terrestrial Environment). In general, potential construction effects on air quality are expected to be temporary, minor and primarily localized within the Project Footprint and Local Assessment Area, and therefore not significant. No residual adverse effects to human health due to residual effects to air quality are expected due to the distance of the Project Footprint from community residences. Emissions from construction machinery and vehicles will result in minor contributions to greenhouse gases in the global atmosphere which is assessed in **Chapter 13** (Cumulative Effects). A summary of construction-related potential environmental effects on air quality and proposed mitigation measures is provided in **Table 7.10**.

Table 7.10: Summary of Potential Construction-Related Environmental Effects on Air Quality and Proposed Mitigation Measures

Construction Activities and Potential Environmental Effects	Proposed Mitigation Measures	Residual Effects	Significance Evaluation*
Release/transport of dust/particulate levels and Increased greenhouse gases and VOCs due to: ▪ Use of vehicles and machinery during construction activities.	▪ Appropriate erosion and sediment control (ESC) measures will be in place prior to the commencement of clearing and construction to control dust generation. ▪ Vegetation will be retained as long as possible to minimize exposure time of disturbed/bare soils to potential erosion and associated dust/particulate generation. ▪ All disturbed areas will be revegetated with native plant species following completion of the works to minimize potential erosion and associated dust/particulate generation. ▪ Water and other approved suppressants will be used to control dust as required. ▪ Quarries, borrow areas and other temporary construction components (e.g., laydown areas) will be located as close to the road corridor as feasible to limit distance travelled by construction vehicles. ▪ Idling time of equipment and vehicles will be restricted. ▪ Routine maintenance of construction equipment and vehicles will be undertaken. ▪ Proper storage and handling of fuels and other VOC-generating construction supplies.	Minor increase in particulate levels, greenhouse gases and VOC levels.	Not significant
Increased particulate levels and greenhouse gas emissions and reduction of carbon sink due to: ▪ Removal of vegetation for the Project Footprint; and ▪ Clearing and burning of vegetation.	▪ Clearing will be limited to the extent required to construct Project components. ▪ Communities will be contacted to identify opportunities for salvaging timber for alternate use to burning. ▪ Burning will normally occur between November 16 and March 31 in accordance with permit requirements. ▪ Work having the potential to create dust or smoke (e.g., debris burning) will not take place during high wind conditions. ▪ Disturbed areas will be revegetated with native plant species following completion of the works.	Minor increase in particulate levels and greenhouse gas emissions and minor loss of carbon sink.	Not significant
Release/transport of dust/particulates due to: ▪ Blasting activities.	▪ Explosive materials will be stored, handled and used according to applicable regulations and guidelines. ▪ Explosives will be detonated at sufficient setback distances to control for dust/debris expulsion. ▪ Blasting will not occur during high wind conditions.	Minor increase in particulate levels.	Not significant

Note: *Refer to **Section 7.3.2** for additional details regarding the significance of residual effects conclusion and evaluation.

7.2.4.2.2 Operations and Maintenance Effects and Mitigation

Using the approach described above in **Section 7.2.2**, the overall level of effect of the potential operations and maintenance effects on air quality prior to the implementation of mitigation measures was examined. **Appendix 7-2** provides a summary of the potential operations and maintenance effects on air quality prior to the implementation of mitigation measures and the determined overall level of the potential effect. Potential pre-mitigation operations and maintenance effects with overall low and moderate levels of effect are similar to those for construction and are listed in **Section 7.2.4.2.1**.

Potential environmental effects of Project operations and maintenance on air quality are almost exclusively associated with vehicle use of the all-season road. Primary effects include the generation of fugitive dust and emissions from vehicles as described in **Section 7.2.4.2.2**. The increases in dust and emissions within the Local Assessment Area due to Project operations are anticipated to be small and localized near the all-season road right-of-way due to the expected very low traffic volumes (estimated annual average of less than 500 vehicles) on the all-season road.

Anticipated environmental effects on air quality due to Project maintenance activities are expected to be similar to those described in **Section 7.2.4.2.1** for construction activities, except the frequency of those activities that affect air quality will be considerably less as effects are expected to be associated with only occasional scheduled and as needed maintenance activities (e.g., road and culvert maintenance, right-of-way vegetation maintenance). No residual adverse effects to human health due to residual effects to air quality are expected due to the distance of the Project Footprint from community residences.

The long-term operation and maintenance of the Project will result in periodic emissions of greenhouse gases from all-season road users including the travelling public and those responsible for road maintenance. Environmental effects of these emissions are discussed in **Section 7.2.4.2.2** and are anticipated to be very small due to the low traffic volumes projected and the high rate of dispersion expected.

Due to expected low traffic volumes on the all-season road, emissions related to the continuous road traffic on the all-season road during the operations and maintenance phase will result in minor contributions to the global accumulation of greenhouse gases in the atmosphere.

Emissions from road traffic on the all-season road, in combination with road traffic projected for other planned East Side Transportation Initiative roads, is predicted to result in a minor contribution to the global accumulation of greenhouse gases in the atmosphere (see **Chapter 13,** Cumulative Effects). The assessment considers the expected reduction of emissions from current forms of transportation (e.g., aircraft) required to access Berens River and Poplar River First Nations and other communities on the remote east side of Lake Winnipeg.

Environmental protection methods used for air quality control during construction, such as erosion control methods described in **Section 7.2.4.2.1,** will also be applied for similar activities that will be conducted during Project maintenance activities to reduce the potential for fugitive dust.

Potential effects of Project operations and maintenance activities, mitigation and residual effects on air quality are very similar to, and represented by, those described for the Project construction phase (see **Section 7.2.4.2.2**; **Table 7.10**). An assessment of the significance of those residual effects on air quality is provided in **Section 7.3.2**.

7.2.4.3 Noise and Vibration

As summarized in **Section 7.1.5**, with the exception of the settled communities of Berens River and Poplar River First Nations, the Regional Assessment Area is noise and vibration-free. There are no anthropogenic sources of noise or vibration and, with the exception of the local communities, there are no sensitive human receptors to noise or vibration. Environmental noise and vibration is unwanted or potentially adverse sound and vibration originating from anthropogenic sources such as construction activities, blasting and road traffic. Ground-borne vibration and air-borne noise may potentially affect local receptors (e.g., people and wildlife) depending on their magnitude and duration (e.g., Crocker 2007; Spellerberg 1998). The health effects of noise and vibration on people (i.e., effects on human hearing and speech production) are well documented (Crocker 2007). Spellerberg (1998) described ecological effects of noise related to roads including potential effects that may extend beyond the right-of-way and potentially affect wildlife. Potential effects of noise and vibration (i.e., 'sensory disturbance') on wildlife are discussed in **Chapter 9** (Terrestrial Environment). There are no federal or provincial noise guidelines or thresholds that apply to the location of the proposed P4 Project (Health Canada 2010).

7.2.4.3.1 Construction Effects and Mitigation

The potential effects on noise and vibration in the Local Assessment Area due to Project construction prior to the implementation of mitigation measures were identified as follows:

- Increased noise and vibration due to the use of vehicles, machinery and equipment; and
- Increased noise and vibration due to blasting activities.

Using the approach described above in **Section 7.2.2**, the overall level of effect of the potential construction effects on noise and vibration prior to the implementation of mitigation measures was examined. **Appendix 7-2** provides a summary of the potential construction effects on noise and vibration prior to the implementation of mitigation measures and the determined level of the potential effect.

Based on the screening of potential effects in **Appendix 7-2**, the following potential adverse effects were identified as having an overall low level of effect:

- Increased noise associated with the use of vehicles and machinery; and
- Increased noise and vibration as a result of blasting activities.

No potential adverse effects were identified as having overall moderate or high levels of effect in **Appendix 7-2**.

All-season road construction activities will generate a range of noise and vibration in the Local Assessment Area. In addition to the operation of heavy equipment/machinery and construction vehicles, rock blasting represents the single-most substantial source of noise and vibration during construction of the P4 Project. Many construction activities that generate noise will not generate vibration (e.g., chain saws used for clearing, construction vehicles). Construction blasting activities were described in **Chapter 3, Section 3.4.2** and will occur at the estimated 13 quarry sites within or adjacent to the proposed road corridor. A study of noise and vibration levels expected from blasting activities associated with the Project was commissioned by ESRA (RWDI Consulting Engineers & Scientists 2015). The study describes the factors that influence the magnitude of noise and vibration (e.g., soil type, terrain, vegetation cover, wind) and presents a site-specific example of potential noise and vibration levels that may result at the Project site.

No adverse effects of noise and vibration on local communities related to the construction phase are expected due to landscape buffering features and distance of Project components from local buildings.

The closest quarries along the proposed all-season road alignment are 6.6 km and 2.3 km from the nearest buildings on the Berens River and Poplar River First Nation Reserves, respectively. The closest proximity of the proposed road right-of-way to buildings on the Berens River and Poplar River First Nation Reserves is 1.4 km and 530 m, respectively.

Importantly, noise and vibration levels generated by construction activities, such as clearing and blasting, will be temporary and medium-term and due to the staging of construction with road components (i.e., road segments, bridges, quarries), potential effects will be centred around localized noise and vibration sources that will move along the proposed road alignment over the duration of construction.

Proposed measures to mitigate potential adverse environmental effects of noise are industry standard sound-reducing components (e.g., mufflers, acoustic linings and shields) that are installed on equipment, vehicles and machinery used by the contractor. Mitigation measures for noise and vibration generated by blasting include: the maintenance of undisturbed forest buffers, where possible, around the perimeter of quarries; the use of best management practices such as use of blasting plans, blasting mats, charging procedures and blasting ratios; the use of deterrents to exclude wildlife from the active blasting areas; and the scheduling of blasting when in the vicinity of sensitive wildlife sites. ESRA's environmental protection specification (GR130.12) regarding noise and noise limitations (**Chapter 5, Appendix 5-4**) and ESRA's environmental protection procedure regarding noise control and blasting near a watercourse (**Chapter 5, Appendix 5-3**) will be followed.

Regulations that will be followed regarding worker exposure to noise are provided in the Workplace Safety and Heath Regulation of Manitoba's *Workplace Health and Safety Act* 1993 and will include the use of appropriate personal protective equipment (including hearing protection) and coordinating the timing of blasting with the period of fewest on-site workers, when possible.

Potential adverse effects of noise and vibration on local communities (i.e., human health) during the construction phase of the proposed all-season road project are not expected following the application of mitigation measures due to the distance of the Project Footprint from community residences. A summary of construction-related potential environmental effects regarding noise and vibration and proposed mitigation measures, is provided in **Table 7.11**.

Table 7.11: Summary of Potential Construction-Related Environmental Effects of Noise and/or Vibration and Proposed Mitigation Measures

Construction Activities and Potential Environmental Effects	Proposed Mitigation Measures	Residual Effects	Significance Evaluation*
Increased noise due to: ▪ Use of vehicles, machinery and equipment .	▪ Vehicles, machinery and equipment will be fitted with factory-installed noise-reducing components (e.g., mufflers, acoustic linings, shields), where possible and will be maintained to minimize excessive noise.	Minor and temporary increase in potential disturbance of people and wildlife in the vicinity of construction activities.	Not significant
Increased noise and vibration due to: ▪ Blasting activities.	▪ Explosives will be detonated at sufficient distances from communities (i.e., First Nation reserves) to minimize noise/vibration effects. ▪ Industry best practices (e.g., blasting plans, blasting mats, appropriate charging procedures) will be when near sensitive receptors (e.g., powerlines, waterways, heritage resources) for blasting activities. ▪ Where possible, undisturbed forested buffers will be retained around quarries to reduce noise from quarry operations. ▪ Scheduling of blasting will occur when in the vicinity of sensitive wildlife sites.	Minor and temporary increase in potential disturbance of people and wildlife in the vicinity of blasting activities.	Not significant

Note: *Refer to **Section 7.3.3** for additional details regarding the significance of residual effects conclusion and evaluation.
Effects of sensory disturbance on wildlife (which includes noise and vibration) is provided in **Chapter 9.**

7.2.4.3.2 Operations and Maintenance Effects and Mitigation

Using the approach described above in **Section 7.2.2**, the overall level of effect of the potential operations and maintenance effects on noise and vibration prior to the implementation of mitigation measures was examined. **Appendix 7-2** provides a summary of the potential operations and maintenance effects on noise and vibration prior to the implementation of mitigation measures and the determined overall level of the potential effect. Potential pre-mitigation operations and maintenance effects with an overall low level of effect are similar to those for construction and are listed in **Section 7.2.4.3.1**.

No significant adverse effects on surface water are expected following the application of mitigation measures during the Project construction and operations and maintenance

During the operations and maintenance phase of the Project, typical traffic noise associated with the pass-by of vehicles using the all-season road will occur. Traffic noise is expected to be minimal given the very low volume of vehicles using the road. Vibration effects are not expected to occur with vehicle use of the road. Noise may also be expected as a result of road maintenance and repair activities that require the use of heavy machinery/equipment. Mitigation measures applicable to road repair and maintenance are the same as measures presented in **Section 7.2.4.3.2** for construction. It is expected that periodic, but infrequent, blasting at several quarries may be required to maintain stockpiles of rock for major road repairs; however, this would not be considered a routine activity associated with the operations and maintenance phase. Regardless, blasting mitigation presented for application during the construction phase would also apply to the blasting activities during the operation and maintenance phase. As indicated in **Section 7.2.4.3.2**, given the distance of the all-season road and quarries remaining open following road construction from the nearest residences on the Berens River and Poplar River Reserves, residual adverse effects of noise and vibration on local communities (i.e., human health) during the operations and maintenance phase of the proposed Project are not expected.

7.3 Summary of Project Residual Effects and Conclusion

7.3.1 Surface Water

Following application of the mitigation measures outlined in **Sections 7.2.4.1.1** and **7.2.4.1.2**, the residual Project-related effects remaining for surface water quality are:

- A minor, localized alteration of surface drainage patterns adjacent to the all-season road; and
- Minor alterations of ice dynamics at waterbody crossings.

The minor alterations of drainage patterns in the vicinity of the all-season road are not expected to result in significant adverse effects to surface water quantity or quality. The large number of equalization culverts and appropriately designed watercourse crossings that will be installed along the all-season road will minimize alteration of flow of local watercourses and attending bog and fen areas (**Section 3.3.2**, **Chapter 3**: Project Description).

Table 7.12 provides a summary of the Project-related residual effects assessment for surface water. With the use of appropriate mitigation, residual adverse effects of Project construction on surface water quality and quantity are not expected to be significant.

Table 7.12: Summary of Residual Project Effects and Significance Conclusions for Surface Water

Residual Effects	Residual Effects Characteristics/Level Rating						Ecological Context	Significance Conclusion
	Direction	Duration	Magnitude	Extent	Frequency	Reversibility		
Construction Phase								
▪ Minor alteration of surface drainage and stream flow at watercourse crossings.	N-	III	I	I	I	I	I	**N**
▪ Minor alteration of ice dynamics at watercourse crossings.	N-	III	I	I	II	I	I	**N**

KEY: (see also **Chapter 6, Section 6.4** for full definitions and Level of Effect criteria for determination of Significance)

Direction:
N- Negative
P+ Positive

Duration:
Short-term = Level I
Medium-term = Level II
Long-term = Level III

Magnitude:
Negligible or Low = Level I
Moderate = Level II
High = Level III

Extent:
Project Footprint = Level I
Local Assessment Area = Level II
Regional Assessment Area = Level III

Frequency:
Once = Level I
Intermittent = Level II
Continuous = Level III

Reversibility:
Reversible (short-term) = Level I
Reversible (long-term) = Level II
Irreversible = Level III

Ecological Context:
Low = Level I (Effect results in minimal disruption of ecological functions and relationships in the area).
Moderate = Level II (Effect results in some disruption of non-critical ecological functions and relationships in the area).
High = Level III (Effect results in disruption of critical ecological functions and relationships in the impacted area).

Significance Conclusion:
S = Significant residual effect
N = No significant residual effect

7.3.2 Air Quality

Following application of the mitigation measures outlined in **Sections 7.2.4.2.1** and **7.2.4.2.2**, the residual Project-related effects remaining for air quality are:

- Minor and localized increase in fugitive dust and particulate levels from vehicles using the road during the operations phase;
- Minor and temporary increase in vehicle/machinery emission levels (greenhouse gases and VOCs) due to Project construction and maintenance activities (e.g., clearing and woody debris burning, blasting, roadbed construction and maintenance works); and
- Minor loss of carbon sink (i.e., removal of vegetation) for permanent Project components (i.e., the all-season road and quarries required for on-going maintenance) and on-going vegetation maintenance along the all-season road right-of-way.

The residual effects on air quality from fugitive dust generation will be short-term for specific construction and maintenance activities (e.g., blasting, road grading) and long-term but intermittent during dry weather conditions of the operations phase (i.e., vehicle use). Dust is expected to dissipate quickly within the Local Assessment Area. Detectable (i.e., measurable) emissions from vehicles and machinery are expected to dissipate over the short-term within the Project Footprint. Emissions are expected to represent a minor contribution to global accumulations of greenhouse gas emissions[6]. Potential adverse effects to human health related to intermittent increases of fugitive dust and emissions in the Local Assessment Area related to Project construction and operations and maintenance phases are not predicted to be significant due to the very good ambient air quality and the distance of the Project from receptors (i.e., Berens River First Nation and Poplar River First Nation Reserves).

Potential adverse effects to human health related to the temporary, periodic increases fugitive dust and emissions in the Local Assessment Area are not anticipated to be significant due to the distance of the community residences from the Project.

Table 7.13 provides a summary of the residual effects assessment for air quality in the Project area. With the application of appropriate mitigation, no significant residual effects on air quality are expected.

[6] Refer to **Chapter 13** for a cumulative effects assessment of greenhouse gas emissions.

Table 7.13: Summary of Residual Project Effects and Significance Conclusions for Air Quality

Residual Effects	Residual Effects Characteristics/Level Rating						Ecological Context	Significance Conclusion
	Direction	Duration	Magnitude	Extent	Frequency	Reversibility		
Construction Phase								
▪ Minor and localized increase in fugitive dust and particulate levels	N-	III	II	II	III	I	II	N
▪ Minor and temporary increase in vehicle/machinery emission levels (greenhouse gases and VOCs)	N-	III	I	III	III	III	I	N
▪ Minor loss of carbon sink (i.e., vegetation removal)	N-	III	I	III	I	II	I	N
Operations and Maintenance Phase								
▪ Minor and localized increase in fugitive dust and particulate levels	N-	III	II	II	III	I	II	N
▪ Minor and temporary increase in vehicle/machinery emission levels (greenhouse gases and VOCs)	N-	III	I	III	III	III	I	N
▪ Minor loss of carbon sink (i.e., vegetation removal)	N-	III	I	III	I	II	I	N

KEY: (see also **Chapter 6, Section 6.4** for full definitions and Level of Effect criteria for determination of Significance)

Direction:
N- Negative
P+ Positive

Duration:
Short-term = Level I
Medium-term = Level II
Long-term = Level III

Magnitude:
Negligible or Low = Level I
Moderate = Level II
High = Level III

Extent:
Project Footprint = Level I
Local Assessment Area = Level II
Regional Assessment Area = Level III

Frequency:
Once = Level I
Intermittent = Level II
Continuous = Level III

Reversibility:
Reversible (short-term) = Level I
Reversible (long-term) = Level II
Irreversible = Level III

Ecological Context:
Low = Level I (Effect results in minimal disruption of ecological functions and relationships in the area).
Moderate = Level II (Effect results in some disruption of non-critical ecological functions and relationships in the area).
High = Level III (Effect results in disruption of critical ecological functions and relationships in the impacted area).

Significance Conclusion:
S = Significant residual effect
N = No significant residual effect

7.3.3 Noise and Vibration

A minor and temporary sensory disturbance to local human receptors due to noise and/or vibration generated by construction and operations and maintenance Project phases is predicted as a residual effect of the Project. This residual effect is not predicted to be significant due to the considerable distance between the noise/vibration source(s) and the Berens River and Poplar River First Nations Reserves, the short-term and intermittent occurrence of noise events related to Project construction and maintenance and the low traffic volumes expected during Project operations. Therefore, no residual adverse effects to human health are expected due to residual minor and temporary increases in noise and vibration.

Residual effects of noise and vibration (i.e., ‘sensory disturbance’) on wildlife are predicted and assessed in **Chapter 9** (Terrestrial Environment).

Table 7.14 provides a summary of the residual effects assessment for noise and vibration in the Project area. With the use of appropriate mitigation, no significant residual environmental effects of noise and vibration are expected.

Table 7.14: Summary of Residual Project Effects and Significance Conclusions for Noise and Vibration

Residual Effects	Residual Effects Characteristics/Level Rating						Ecological Context	Significance Conclusion
	Direction	Duration	Magnitude	Extent	Frequency	Reversibility		
Construction Phase								
▪ Minor and temporary sensory disturbance to local communities/people due to equipment/vehicle use and/or blasting.	N-	I	I	II	III	I	I	N
Operations and Maintenance Phase								
▪ Minor and temporary sensory disturbance to local communities/people due to equipment/vehicle use and/or blasting.	N-	I	I	II	III	I	I	N

KEY: (see also **Chapter 6, Section 6.4** for full definitions and Level of Effect criteria for determination of Significance)

Direction:
N- Negative
P+ Positive

Duration:
Short-term = Level I
Medium-term = Level II
Long-term = Level III

Magnitude:
Negligible or Low = Level I
Moderate = Level II
High = Level III

Extent:
Project Footprint = Level I
Local Assessment Area = Level II
Regional Assessment Area = Level III

Frequency:
Once = Level I
Intermittent = Level II
Continuous = Level III

Reversibility:
Reversible (short-term) = Level I
Reversible (long-term) = Level II
Irreversible = Level III

Ecological Context:
Low = Level I (Effect results in minimal disruption of ecological functions and relationships in the area).
Moderate = Level II (Effect results in some disruption of non-critical ecological functions and relationships in the area).
High = Level III (Effect results in disruption of critical ecological functions and relationships in the impacted area).

Significance Conclusion:
S = Significant residual effect
N = No significant residual effect