Lake Winnipeg East System Improvement (LWESI) Transmission Project

Climate, Soils, Hydrogeology, and Geology Technical Report

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EXECUTIVE SUMMARY

This report provides information on the climate, soils, hydrogeology, and geology of the Project Study Area.

Historic climate data was collected and analyzed near the Project Study Area to characterize typical climate conditions that could be expected for the Project. Manitoba has a mid-continental climate characterized by four distinct seasons. The average annual precipitation is 586 mm, with most of that (461 mm) falling as rain. There is significant range of temperatures experienced throughout the year, with the highest monthly mean temperature of 19°C occurring in July, and the lowest monthly mean temperature of -18°C occurring in January. Extreme daily minimum and maximum temperatures for the period of record were -48°C in February and 38°C in June. The most frequent wind direction is from the south, followed by the south-southeast. There is also a large proportion of wind from the north, north-northwest, and northwest. The winds with the highest speeds, greater than 7 m/s (25 km/h), mostly come from the northwest, west-northwest, and north-northwest.

The terrain in the Project Study Area is characterized by level to gently undulating organic deposits overlying clayey glaciolacustrine sediments, broken by local bedrock ridges and knolls. Developed mineral soils are very limited, however there are extensive areas of organic terrain with a variety of marsh, fen, swamp, and bog deposits.

Groundwater resources are limited in the Project Study Area. The unconsolidated deposits overlying bedrock are typically fine grained and will not produce economical quantities of groundwater. Exceptions include localized areas of sands and gravels where the hydraulic conductivity is higher or areas of finer grained soils that are fractured and connected to a source of recharge water. There are no regional aquifers, and shallow aquifers will typically be of limited areal extent. Deeper wells may be more aerially extensive with recharge and discharge areas occurring at greater distances.

The bedrock underlying the Project Study Area is predominantly metasedimentary and metavolcanic crystalline gneiss of variable mineralogy but almost universally low in hydraulic conductivity. Occasional areas of bedrock outcrop may be encountered – typically associated with localized topographic highs.

The Line PQ95 corridor closely follows the alignment of the existing 66 kV transmission line, but takes advantage of the higher and drier lacustrine deposits and occasional areas of outcrop to minimize the challenges of tower foundations. However, crossing organic terrain is unavoidable given the abundance and distribution of this terrain type. There were no significant differences in soils, hydrogeology, or geology between the three Alternative Routes. Therefore, these features were not used in the selection of the Final Preferred Route.

No Valued Environmental Components were selected from climate, soils, geology, and hydrogeology.

Potential effects from construction of the new 115 kilovolt transmission line, from Powerview-Pine Falls, Manitoba to Manigotagan and Manigotagan Corner Station, include soil compaction and rutting, soil erosion and compaction, removal of aggregate materials through creation and/or expansion of borrow pits; and contamination of soil and groundwater due to spills and application of herbicides to control vegetation growth.

Based on adoption of Manitoba Hydro's mitigation measures outlined in their Environmental Protection Plan, effects to soils, hydrogeology and geology are expected to be minimal. Residual effects are predicted for loss of aggregate materials from existing or new borrow pits, and soil compaction at the Manigotagan Corner Station Site. These residual effects will be permanent, but are anticipated to be minor.

There are 83 quarry leases within the Project Study Area, and competition for existing borrow pits, and potential new borrow pit locations can be expected, particularly in the northern portion of the Project Study Area. Several of these quarry leases are held by the East Side Road Authority for supply of gravel for road construction.

Follow-up and monitoring activities will be implemented to assess the success of the proposed mitigation measures and to verify the magnitude and extent of residual effects.

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°C	degrees Celsius
ATK	Aboriginal Traditional Knowledge
EA	Environmental Assessment
km	kilometre
km^2	square kilometre
km/h	kilometres per hour
kV	kiloVolt
Line PQ95	Pine Falls–Manigotagan 115 kV Transmission Line
LWESI	Lake Winnipeg East System Improvement
m	metre
m/s	metres per second
mm	millimeter
ROW	right-of-way
the Project	Lake Winnipeg East System Improvement Transmission Project
VEC	Valued Environmental Component

1 INTRODUCTION

1.1 Project Overview

The Lake Winnipeg East System Improvement (LWESI) Transmission Project (the Project) is required to provide system upgrades in the region east of Lake Winnipeg. The Project will serve existing and new load growth, and provide firm transformation and adequate voltage support for the communities located in and around the region. It is expected that this new development will meet the electrical requirements for at least the next 20 years.

The Project includes the construction of a new 115 kilovolt (kV) transmission line, from Powerview-Pine Falls, Manitoba to Manigotagan [Pine Falls – Manigotagan 115 kV Transmission Line (Line PQ95)], approximately 75 kilometers (km) north of Powerview-Pine Falls. The project will require the development of a new 115-66 kV transmission station (Manigotagan Corner Station) west of the intersection of Provincial Road #304 and the Rice River Road, near the community of Manigotagan. This station will serve as the terminal for the new 115 kV transmission line as well as the existing 66 kV sub-transmission lines in the Manigotagan area.

This technical report supports the Environmental Assessment (EA) Report to meet the licensing requirements of the *Manitoba Environment Act* for a Class II License for this project. .

1.2 Report Outline

This report provides information on the climate, soils, hydrogeology, and geology of the Project Study Area. The report is organized as follows:

- **Section 1** gives an overview for the project;
- **Section 2** provides a description of the Project Study Area;
- **Section 3** summarizes the methods used in the report;
- **Section 4** provides a summary of the existing environment;
- **Section 5** provides an evaluation of alternative routes and infrastructure from a discipline perspective;
- **Section 6** summarizes potential effects, mitigation measures and residual effects, as well as a discussion on potential interactions with other projects, and monitoring and follow up activities;
- **Section 7** provides a conclusion; monitoring and follow up activities;
- **Section 8** provides a list of references and personal communications; and
- **Section 9** provides a glossary of terms.

2 STUDY AREA

2.1 General Regional Area Description

The Project Study Area includes an area of approximately 2,112 km^2 and extends from south of the Community of Powerview-Pine Falls, north to the Community of Manigotagan, and from the eastern boundary of Lake Winnipeg, to approximately 10 km east of Provincial Road #304. The Project Study Area contains three Alternate Routes and the Final Preferred Route for Line PQ95, a 60 m wide right-of-way (ROW) centered on the line route, the Manigotagan Corner Station and the Pine Falls Generating Station Switchyard. The Project Study Area was chosen to be of sufficient size to assess any potential project effects on biophysical and socio-economic components.

2.2 Study Area – Ecological Land Classification

The proposed LWESI Project is situated within the Boreal Shield Ecozone which is the largest ecozone in Canada. In the province of Manitoba, this ecozone extends northward from the south-east corner of the province between the east shore of Lake Winnipeg and the Manitoba-Ontario border and broadly proceeds across the top of Lake Winnipeg from the Manitoba-Ontario to the Manitoba-Saskatchewan borders. The ecozone is dominated by broadly rolling uplands and lowlands. The southern extent of the Project Study Area near Powerview-Pine Falls is situated within the northern portion of the Lake of the Woods Ecoregion. The middle and northern portion of the project study area is contained within the Wrong Lake Ecodistrict of the Lac Seul Upland Ecoregion (Smith et al. 1998). The terrestrial Ecoregions and Ecodistricts encompassing the Project Study Area are presented in Map 1.

3 METHODS

3.1 Data Collection and Analysis

3.1.1 Climate

Climate data was acquired from records at Environment Canada Meteorological stations (Environment Canada 2012). Two stations near Pinawa, Manitoba were selected because they were close to the Project Study Area (approximately 40 km south), and had long-term records for the climate variables required. The Pinawa WRNE (5032162) station was used for daily temperature and precipitation data. This station had daily data between 1963 and 2011. The Pinawa (503B1ER) station was used for hourly wind data. This station had wind data between 1988 and 2010.

3.1.2 Soil and Geology

Published soil, surficial geology, and bedrock geology maps were used to assess the mineral soils, surficial geology and bedrock geology of the region. Water well records were obtained from Manitoba Conservation and Water Stewardship to determine the amount of groundwater usage in the area and what formations are utilized for water supply. Information on mining claims and economic mineral potential were obtained from Manitoba Innovation, Energy and Mines.

3.2 Valued Environmental Component Selection

The environmental assessment was focused on Valued Environmental Components (VECs), which are aspects of the natural and socio-economic environment that are particularly notable or valued because of their ecological, scientific, resource, socio-economic, cultural, health, aesthetic, or spiritual importance. To be considered as a VEC, a component must have the potential to be adversely affected by project development or have the potential to have an effect on the Project.

A workshop was held with discipline experts to select VECs for the Project which met one or more of the following criteria:

- identified regulatory requirements;
- consultation with regulatory authorities;
- information derived from published and unpublished date sources;
- information and comment received during the engagement of local communities;
- feedback through the Public Engagement Program; and
- biophysical and heritage assessment field surveys.

A preliminary list of VECs was proposed, and revised throughout the EA process which balanced biophysical and socioeconomic components, and represented both potential positive and negative effects of the Project.

No VECs were selected from climate, soils, hydrogeology and geology.

4 EXISTING ENVIRONMENT

4.1 Overview

4.1.1 Climate

Manitoba has a mid-continental climate characterized by four distinct seasons. Generally, winters are long and cold, and summers are short and hot. Historic climate data was collected and analyzed near the Project Study Area in order to characterize typical climate conditions that could be expected for the Project.

A summary of the daily data at the Pinawa Station is shown in Table 1. The average annual precipitation is 586 mm, with most of that (461 millimetres [mm]) falling as rain. There is significant range of temperatures experienced throughout the year, with the highest monthly mean temperature of 19°C occurring in July, and the lowest monthly mean temperature of -‑8 degrees Celsius (°C) occurring in January. Extreme daily minimum and maximum temperatures for the period of record were -48°C in February and 38°C in June.

Climate normals from the Winnipeg Richardson International Airport A (5023222) station were also collected to compare with the averages calculated for the Pinawa station. The Winnipeg station is approximately 100 km from the Study Area, so is not likely be as representative as the Pinawa station. However, the climate normals are rated A (meeting the highest Environment Canada quality level) so any significant variation between the two stations could be an indicator of problems with the Pinawa data. The Winnipeg normal data are shown in Table 2 and do not indicate any issues with the summarized Pinawa data as there are no dramatic or unexpected differences between the two data sets.

Table 1: Summary of Climate Data from Pinawa (5032162), 1963 to 2009

Parameter	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Average Total Precipitation (mm)	24	17	26	33	65	96	80	73	66	46	29	27	586
Max.Total Precipitation (mm)	71	57	69	92	142	218	162	178	160	122	87	68	822
Min. Total Precipitation (mm)	3	0	3	2	0	24	16	11	2	9	4	9	400
Average Rainfall (mm)	0	2	8	23	63	96	80	73	66	38	8	1	461
Max.Rainfall (mm)	0	0	0	1	0	24	16	11	2	3	0	0	242
Min.Rainfall (mm)	5	23	46	73	142	218	162	178	160	99	76	21	696
Average Snowfall (cm)	23	16	18	10	2	0	0	0	0	8	22	26	125
Max.Snowfall (cm)	70	57	46	65	24	0	0	0	5	37	61	68	203
Min.Snowfall (cm)	3	0	0	0	0	0	0	0	0	0	0	9	58
Average Min. Temperature (°C)	-23	-20	-13	-3	4	10	13	12	7	1	-8	-18	-3
Extreme Min. Temperature (°C)	-44	-48	-41	-29	-14	-4	-1	-2	-7	-16	-35	-40	
Average Max. Temperature	-12	-8	-1	10	17	22	25	24	18	10	-1	-9	8
Extreme Max. Temperature (°C)	10	12	20	33	35	38	37	37	36	29	23	10	
Average Mean Temperature (°C)	-18	-14	-7	4	11	16	19	18	12	5	-4	-14	2

Source: Environment Canada (2012); Min. = minimum, Max. = maximum

Table 2: 1971 to 2000 Climate Normals for Winnipeg Richardson International Airport (5023222)

Parameter	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Average Total Precipitation (mm)	19.7	14.9	21.5	31.9	58.8	89.5	70.6	75.1	52.3	36	25	18.5	513.7
Average Total Rainfall (mm)	0.2	2.5	7.5	21.5	58	89.5	70.6	75.1	51.9	31	6.1	1.6	415.6
Average Total Snowfall (cm)	23.1	14.2	15.8	10.1	0.8	0	0	0	0.4	5	21.4	19.8	110.6
Average Daily Min.Temp.(°C)	-22.8	-18.7	-11	-2.4	4.8	10.7	13.3	11.9	6	-0.3	-9.6	-19.1	-3.1
Extreme Min.(°C)	-42.2	-45	-37.8	-26.3	-11.1	-3.3	1.1	0.6	-7.2	-17.2	-34	-37.8	
Average Daily Max. Temp. (°C)	-12.7	-8.5	-1.1	10.3	19.2	23.3	25.8	25	18.6	10.8	-0.9	-9.7	8.3
Extreme Max. (°C)	7.8	11.7	23.3	34.3	37	37.8	37.8	40.6	38.8	30.5	23.9	11.7	
Daily Average Temp. (°C)	-17.8	-13.6	-6.1	4	12	17	19.5	18.5	12.3	5.3	-5.3	-14.4	2.6
Average Wind Speed (km/h)	17.1	16.7	17.7	18.4	17.9	16.4	14.6	14.9	17.1	18	17.4	17.1	16.9
Most Freq. Wind Direction	S	S	S	S	S	S	S	S	S	S	S	S	S
Max. Hourly Wind Speed (km/h)	70	80	81	80	72	80	89	74	71	77	87	78	
Max. Gust Wind Speed (km/h)	106	129	113	106	109	127	127	122	98	119	124	98	
Direction of Max. Wind Gust	SE	NW	N	N	NW	W	S	NW	NW	W	W	W	NW

Source: Environment Canada (2012); Min. = minimum, Max. = maximum

A wind rose was generated using WRPlotView software (Lakes Environmental 2011) and is shown below (Figure 1).Wind speed and direction data used to generate the wind rose was from the Pinawa (503B1ER) station. The most frequent wind direction was from the south, followed by the south-southeast. There was also a large proportion of wind from the north, north-northwest, and northwest. The winds with the highest speeds, greater than 7 m/s (25 km/h), mostly came from the northwest, west-northwest, and north-northwest. The wind directions were generally similar to those indicated in the Winnipeg climate normals.

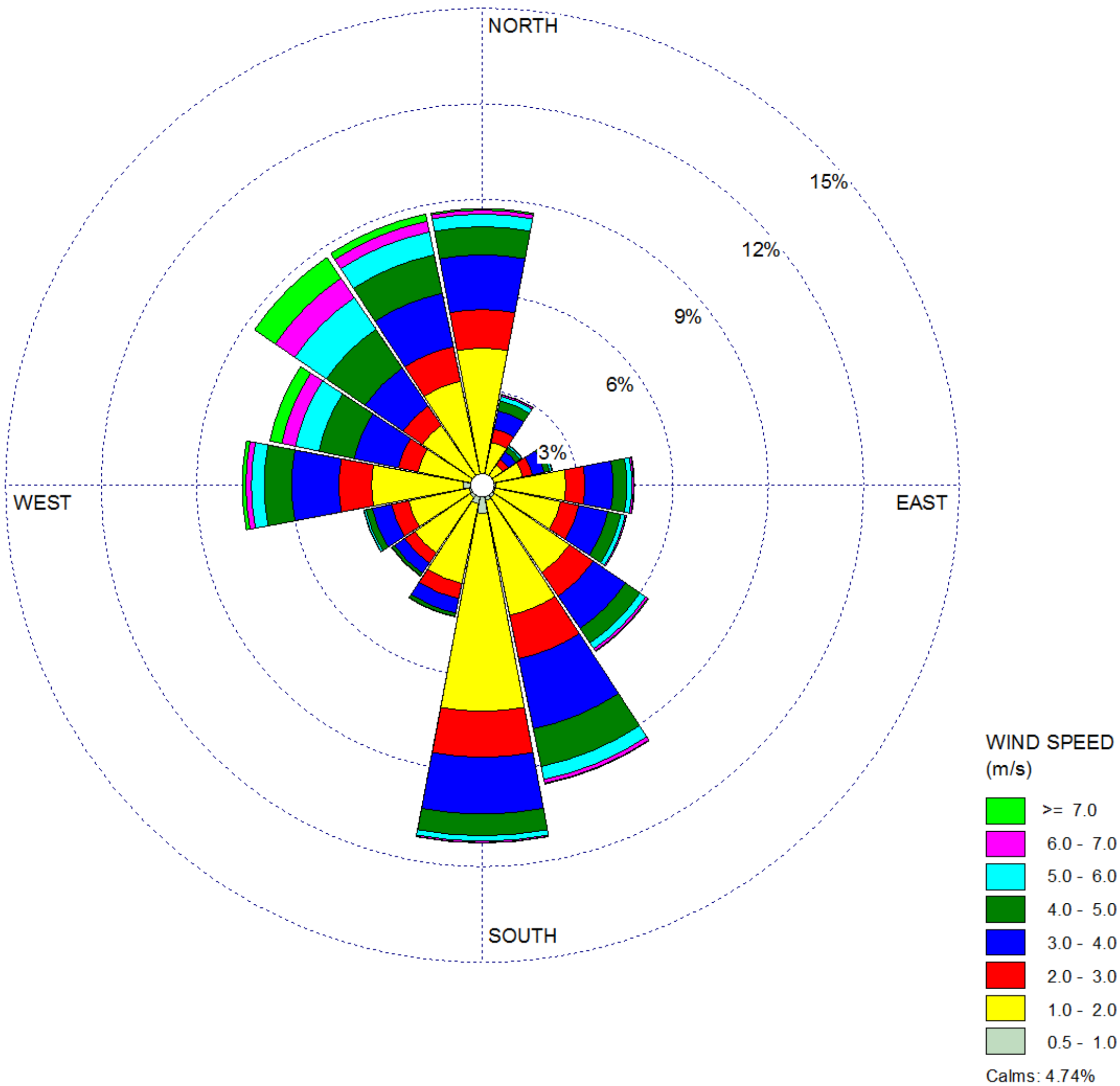

Figure 1: Wind Rose for Pinawa (503B1ER) from 1988 to 2010

4.1.2 Soils

Developed mineral soils are very limited in the region (Map 1). However, there are extensive areas of organic terrain that have a variety of marsh, fen, swamp, and bog features. Localized or discontinuous areas of lacustrine clays, silts, and sands have a limited mineral soil horizon. Shallow and deep mesisols and fibrisols are associated with the peatlands. Gleysolic soils have developed on the poorly drained areas of glaciolacustrine sediments. Grey luvisolic soils are associated with the moderately well to imperfectly drained glaciolacustrine blankets and veneers overlying bedrock (Smith et. al. 1998). Where higher elevation areas have a till cover over bedrock, there may be moss and lichen development with the possibility of a very limited zone of acidic mineral soil (Smith et al. 1998).

4.1.3 Hydrogeology

Groundwater resources are limited in the Project Study Area. The unconsolidated deposits overlying bedrock are typically fine grained and will not produce economical quantities of groundwater (typically fine grained soils will not release sufficient water to make well development economical). Exceptions include localized areas of sands and gravels where the hydraulic conductivity is higher or areas of finer grained soils that are fractured and connected to a source of recharge water, such as an adjacent river or lake. The bedrock underlying the Project Study Area is predominantly metasedimentary and metavolcanic crystalline gneiss of variable mineralogy but almost universally low in hydraulic conductivity. Secondary structure such as faults and fracture planes represent limited pathways for groundwater flow as long as a hydraulic connection to a source of recharge water exists.

Development in the area is limited so there is limited groundwater information available. Water well records that exist were obtained from Manitoba Conservation and Water Stewardship (2012). Records for 31 wells or test holes were provided within the Project Study Area. Thirteen were noted as dry, 14 were completed in bedrock and 3 were completed in sands and gravels above bedrock. For the test holes completed as wells, no detail was provided on the production capacity of the well or the quality of the groundwater. Most of the wells were probably installed for residential or recreational use. These applications require limited supply which may be satisfied with the low yield potential for the overburden and bedrock in the area. It appears that the majority of the groundwater usage is from limited aquifers within the bedrock.

It is expected that yields, where groundwater is encountered, will generally be low due to the limited hydraulic conductivity. There are no regional aquifers and because of the limited resources and demand for groundwater, no broad based aquifer studies have been completed. Shallow aquifers will typically be of limited areal extent and be bounded hydraulically by adjacent wetlands or water features. Deeper wells, in particular those in bedrock where more productive fractures have been encountered, may be more aerially extensive with recharge and discharge areas occurring at greater distances. Any deeper regional systems would tend to flow westward with Lake Winnipeg serving as a discharge boundary.

4.1.4 Terrain and Surficial Geology

Level to gently undulating organic deposits overlying clayey glaciolacustrine sediments, broken by local bedrock ridges and knolls, are characteristic of the terrain in the Project Study Area (Smith et al 1998). Relief is limited. The regional gradient is east to west with localized knolls reflective of shallow or exposed bedrock. Drainage is poor to imperfect with extensive areas of organic terrain.

The Alternative Routes pass through areas characterized by glaciolacustrine sediments, organic deposits, and Precambrian bedrock outcrop (Map 2). The glaciolacustrine sediments are comprised of clay, silt, and minor sand deposited in Glacial Lake Agassiz approximately 10,000 years ago. Roughly east-west trending lobes of glaciolacustrine deposits are crossed by the transmission line route at three locations, including near Powerview-Pine Falls at the south end, at the crossing of the Black River near the Black River First Nation, and in the low-lying areas around Manigotagan adjacent to the Sandy River, Duncan Creek, the Manigotagan River and the Wanipigow River. The glaciolacustrine deposits can be expected to range in thickness from 1 m to 20 m. They may appear as massive to laminated deposits.

Organic materials comprised of marsh, fen, swamp, and bog deposits are located in poorly drained areas crossed by segments of the Final Preferred Route. Two areas crossed by the Final Preferred Route that are characterized by this terrain include north to northeast of the Sagkeeng First Nation and to the south of the Sandy River. Such deposits typically range from one m to five m in thickness and are often underlain by glaciolacustrine materials described above.

Bedrock outcrop is a prominent feature below a 10 km segment of the preferred route located south of the O'Hanley River (i.e., the portion of the Final Preferred Route trending northwest). The bedrock in this area is composed of felsic (tonalitic) gneiss with minor amphibolite. Occasional areas of bedrock outcrop may be encountered – typically associated with localized topographic highs. The topography of the underlying bedrock surface will be generally mimicked in the surface topography except in the low and flat areas occupied by recent organic deposits.

For the most part, the Final Preferred Route takes advantage of the higher and drier lacustrine deposits and occasional areas of outcrop to minimize the challenges of tower foundations. However, crossing organic terrain is unavoidable given the abundance and distribution of this terrain type.

4.1.5 Bedrock Geology

The Project Study Area is underlain by 3 to 2.6 billion year old bedrock of the Superior Province of the Canadian Shield. This portion of the Canadian Shield is a stable crator created from a collage of ancient plates and arc terranes that were progressively amalgamated over a period of more than two billion years.

The majority of the bedrock that underlies the Final Preferred Route ROW is granodiorite gneiss, metasedimentary gneiss, and tonalite gneiss (Map 3). While most of the bedrock in the area has been subjected to some degree of metamorphism, the rock types are stable and durable from both a landform perspective and as a foundation unit for hydro towers where the rock is either exposed or within a reasonable distance of ground surface.

4.2 Aboriginal Traditional Knowledge

An Aboriginal Traditional Knowledge (ATK) study was undertaken to provide relevant information on local knowledge and land use that were absent from the Project Study Area data record. Data on ATK was gathered during five workshops that were held in the communities of Hollow Water, Manigotagan, Black River and Sagkeeng. Workshops were guided by a series of questions provided by discipline leads. Information was summarized in a series of map biographies on traditional and current land use practices, and interview summaries, and land use maps. Relevant information was integrated into the technical reports which support the EA Report.

No feedback on climate, soils, hydrogeology, and geology was received through the ATK process.

5 EVALUATION OF ALTERNATIVE ROUTES AND INFRASTRUCTURE

The overall route selection process for the Line PQ95 component is described in Chapter 3.0 of the EA Report. Evaluation of the Alternative Routes focused on a predetermined set of evaluation criteria. The evaluation criteria reflected the importance of known factors identified from various perspectives including socio-economic, biophysical, cost and technical aspects. These criteria, as well as valuable feedback obtained from the Public Engagement Program, became the basis from which the Final Preferred Route was identified.

The Manigotagan Corner Station Site was selected on the basis of engineering and technical criteria. The Preferred Station Site was integrated into the Public Engagement Program and received favorable feedback from local community representatives.

The section below describes the inputs for Line PQ95 Alternative Routes and the Manigotagan Corner Station Site from the soil, hydrogeology, and geology perspective.

5.1 Description and Evaluation of Alternative and Preferred Route

5.1.1 Overview

The ROW for the Final Preferred Route closely follows the alignment of the existing 66 kV line, but takes advantage of longer spans afforded by the larger towers to improve the alignment. The Final Preferred Route follows higher and better drained soils and occasional areas of outcrop to the extent possible to minimize the challenges of tower foundations. The majority of the non-organic terrain is clays and silts deposited in the latter stages of the last glacial era. Localized topographic highs may represent outcrops of till and even occasional small areas of exposed bedrock. However, crossing organic terrain is unavoidable given the abundance and distribution of this terrain type.

5.1.2 Alternative Routes

There were no significant differences in soil, hydrogeology, or geology between the three Alternative Routes. Therefore, these features were not used in the selection of the Final Preferred Route.

6 EFFECTS AND MITIGATION

6.1 PQ95 Transmission Line

Potential effects from construction of the PQ95 include

- soil compaction and rutting from construction of access roads, and vehicle access for clearing of ROW, transportation and erection of towers;
- loss of soil due to erosion;
- removal of aggregate materials through creation and/or expansion of borrow pits; and
- contamination of soil and groundwater due to spills and application of herbicides to control vegetation growth.

6.1.1 Soil Compaction and Rutting

Soil compaction and rutting can result from the movement of vehicles and equipment, storage of materials and placement of towers. Loams, clays and other fine textured soils are most prone to compaction and rutting.

Effects of soil compaction and rutting can be mitigated by managing equipment traffic routes and activities for clearing of the transmission ROW, and installation of transmission towers to minimize the impact. Former access routes from the 66 kV transmission line construction will be followed wherever possible to avoid disturbing new areas. These areas may require new clearing but are expected to recover naturally over time.

Construction of new access roads (if required), clearing of ROW, and erection of towers will be completed under frozen winter conditions to the extent possible to minimize surface disturbance. Surface disturbance is expected to recover naturally.

6.1.2 Soil Erosion

Erosion of soil can result when vegetation is removed and top soils are exposed to wind and water. This can occur from activities associated with construction of access roads, tower installation, water crossings and general access for construction. To mitigate impacts due to soil erosion, industry best practices will be adopted to avoid or mitigate disturbance to soil, and vegetation, particularly within riparian zones and on steeper slopes. When working on slopes adjacent to water courses, silt control from run-off will need to be managed using appropriate techniques (e.g., silt fences, check dams, diversion berms). Localized re-vegetation measures may be required where surface scars from equipment traffic are extensive and unlikely to regenerate or be delayed without some assistance.

Construction activities will be completed under frozen winter conditions to the extent possible to minimize surface disturbance. This is expected to minimize the potential for exposure of mineral soils to wind and water action that could result in erosion. Surface disturbance is expected to recover naturally.

6.1.3 Loss of Soil and Aggregate Materials

Aggregate materials will be required for upgrading of existing access roads and construction of new access roads (if required), as well as for tower platforms. This will require removing additional borrow materials from existing pits, and/or creation of new borrow pits for this purpose. Effects may include reconfiguration of terrain, removal of aggregate material, and creation of steep and potentially unstable slopes,

Effects of aggregate removal will be minimized by using existing access roads were possible to reduce the amount of aggregate material required. Clearing and construction under frozen conditions will also reduce the amount of material required for access roads. Effects will also be mitigated by using existing borrow pits where possible and implementing rehabilitation of borrow sites following use.

6.1.4 Contamination of Soils and Groundwater

Soil and groundwater contamination may occur with accidental spills of fuels and lubricants from during construction and operation, drilling for tower foundations, and the application of herbicide for vegetation management of ROW.

Construction and maintenance activities will follow best practices relative to storage and handling of fuels and lubricants for construction equipment.

Groundwater resources in the area of the new line are not significant or extensive, and are not considered susceptible to widespread contamination. Construction of the transmission line is not expected to have a negative impact on either the quality of the groundwater or the productivity of wells as long as standard mitigation measures are followed.

Manitoba Hydro's herbicide management program will be followed to ensure operational practices for vegetation control have minimal environmental impacts on soil or groundwater.

6.2 Manigotagan Corner Station

Potential effects from construction of the Manigotagan Corner Station include:

- soil compaction and rutting due to site preparation for station construction;

- loss of soil due to erosion due to removal/disturbance of vegetation and top soil;
- removal of aggregate materials through creation and/or expansion of borrow pits; and
- contamination of soil and groundwater due to spills.

6.2.1 Soil Compaction

The Manigotagan Corner Station Site footprint is approximately 5.5 hectares which will be cleared and levelled in preparation for construction of the Manigotagan Corner Station. This will likely result in compaction of soils at the site.

6.2.2 Soil Erosion

Soil erosion is expected to be minimal given that the site is relatively flat and will not likely be subject to significant erosion.

6.2.3 Loss of Soil and Aggregate Materials

Aggregate materials will be required for preparing the site for construction of the Manigotagan Corner Station. This will require removing additional borrow materials from existing pits, and/or creation of new borrow pits for this purpose. Site preparation will likely require transportation and spreading of aggregate materials to level the site.

Effects of aggregate removal will be minimized by using existing access roads were possible to reduce the amount of aggregate material required. Effects will also be mitigated by using existing borrow pits where possible and implementing rehabilitation of borrow sites following use.

6.2.4 Contamination of Soils and Groundwater

Construction and operation activities will follow best practices relative to storage and handling of fuels and lubricants for construction and operation phases of the Project.

Groundwater resources in the Project Study Area are not significant or extensive, and are not considered susceptible to widespread contamination. Construction and operation of the Manigotagan Corner Station is not expected to have a negative impact on either the quality of the groundwater or the productivity of wells as long as standard mitigation measures are followed.

6.3 Summary

Table 3 summarizes the expected effects, key mitigation measures, residual effects and significance criteria associated with construction of PQ95 and Manigotagan Corner Station Site. No residual effects on groundwater and bedrock are expected as a result of the Project. Minimal residual effects are expected due to loss of aggregate materials from existing and/or new borrow pits, and soil compaction at the Manigotagan Corner Station Site.

Table 3: Summary of Potential Effects, Mitigation Measures and Residual Effects on Soils, Geology and Groundwater

Potential Effect	Project Phase	Key Mitigation Measures	Residual Effect	Significance Criteria
PQ95 Transmission Line				
Construction/ Upgrading of Access Roads and Trails - vegetation and soil removal, compaction and rutting	Construction	• PC-1.7, Vehicle, machinery and pedestrian traffic will be restricted to established roads and trails, and cleared construction areas in accordance with the Access Management Plan. • PC-1.8, Access roads and trails will be provided with erosion protection and sediment control measures along shoulders, ditches and at stream crossings in accordance with the Erosion Protection and Sediment Control Plan. • PC-1.9, Construction vehicles will be wide-tracked or equipped with high flotation tires to minimize rutting and limit damage and compaction to surface soils. • PC-1.11, Approach grades to waterbodies will be minimized to limit disturbance to riparian areas. • PC-1.13, Equipment, machinery and vehicles will only travel on cleared access roads and trails, and will cross waterways at established temporary and permanent crossings. • PC-1.17, Access roads and trails no longer required will be decommissioned and rehabilitated in accordance with the site Rehabilitation Plan. • PC-1.21 Vegetation control along access roads and trails will be in accordance with contract specifications and Manitoba Hydro guidelines.	Minor compaction and rutting	**Direction:** Negative **Magnitude:** Small **Geographic Extent:** Project Footprint **Duration:** Short-term **Reversibility:** Reversible **Frequency**: Continuous
Clearing of ROW - vegetation and soil disturbance,	Pre-Construction/ Construction	• PA-3.17, Clearing will occur in accordance with established timing windows to minimize rutting and erosion. • PA-3.5, Existing low growth vegetation such as grasses, forbs and shrubs will be maintained to the extent possible. Disturbance to roots and adjacent soils will be minimized. • PA-3.6, Right-of-way boundaries, centrelines, buffers and sensitive areas (where applicable) will be clearly marked with stakes and flagging tape prior to clearing. • PA-3.7, Clearing and disturbance will be limited to infrastructure sites, borrow pits, marshalling yards, transmission line rights-of-way and associated access routes. • PA-3.9, Clearing and construction equipment will remain within designated infrastructure sites, rights-of-way and associated access routes. • PA-3.14, Selective clearing will be carried out in erosion prone areas. Low ground disturbance methods will be employed to minimize soil disturbance. • PA-3.15, Environmentally sensitive areas located adjacent to watercourses or located on rugged terrain will be cleared by approved methods according to the contract specifications. • PA-3.16, Trees within established buffer zones will be selectively cleared using low ground disturbance methods that cause the least impact. Low growth vegetation such as grasses and shrubs within buffer zones will not be cleared. • PA-3.18, Construction vehicles where possible will be wide-tracked or equipped with high floatation tires to minimize rutting and limit damage and compaction to surface soils.	Minor vegetation and soil disturbance	**Direction:** Negative **Magnitude:** Small **Geographic Extent:** Project Footprint **Duration:** short-term **Reversibility:** Reversible **Frequency**: Continuous

Table 3: Summary of Potential Effects, Mitigation Measures and Residual Effects on Soils, Geology and Groundwater (continued)

Potential Effect	Project Phase	Key Mitigation Measures	Residual Effect	Significance Criteria
Clearing of ROW - vegetation and soil disturbance (cont'd)	Pre-Construction/ Construction (cont'd)	• PA-3.19, The Construction Supervisor/Site Manager will issue a stop work order if extreme wet weather or insufficient frost conditions results in soil damage from rutting, and soil erosion is resulting in sedimentation of adjacent waterbodies. • PA-3.25, Vegetated buffers in riparian areas will be maintained in accordance with riparian buffer zones and setbacks • PA-3.27, Specified clearing methods will be carried out in a manner that minimizes disturbance to existing organic soil layer. • PA-3.28, Machine clearing will remove trees and brush with minimal disturbance to existing organic soil layer using only "V" or "K-G" type blades, feller-bunchers and other means approved by the Construction Supervisor/Site Manager. • PA-3.32, Danger trees will be identified and removed by hand or other methods that do not damage soils and adjacent vegetation. • PA-3.37, Chipped or mulched material may be collected for use in construction areas and sediment/erosion control.	Minor vegetation and soil disturbance (cont'd)	**Direction:** Negative **Magnitude:** Small **Geographic Extent:** Project Footprint **Duration:** short-term **Reversibility:** Reversible **Frequency**: Continuous (cont'd)
Erosion Protection and Sediment Control - risk of soil erosion and transport of eroded materials	Pre-Construction/ Construction	• EI-3.1, A project-specific Erosion Protection and Sediment Control Plan will be prepared prior to starting construction. The Plan will be prepared or approved by a Certified Professional in Erosion and Sediment Control (CPESC) • EI-3.13 Erosion protection and sediment control measures will be established for all decommissioned project areas and sites where necessary in accordance with the Decommissioning Plan. • EI-3.6, Erosion protection and sediment control measures will be put in place prior to commencement of construction activities and will remain intact for the duration of the project. • EI-3.7, Construction activities will be suspended during extreme wet weather events where erosion protection and sediment control measures are compromised. • EI-3.11, Erosion protection and sediment control installations will only be removed after disturbed areas are protected and sediments are disposed of in accordance with Erosion Protection and Sediment Control Plan. • EI-3.12, Erosion protection and sediment control measures will be left in place and maintained until either natural vegetation or permanent measures are established. • EI-3.14 The Environmental Inspector will make inspections of decommissioned project areas and sites in accordance with the Site Rehabilitation Prescription to ensure that environmental protection measures are effective and that any deficiencies are addressed.	Minor soil erosion	**Direction:** Negative **Magnitude:** Small **Geographic Extent:** Project Footprint **Duration:** Sort-term **Reversibility:** Reversible **Frequency**: Continuous

Table 3: Summary of Potential Effects, Mitigation Measures and Residual Effects on Soils, Geology and Groundwater (continued)

Potential Effect	Project Phase	Key Mitigation Measures	Residual Effect	Significance Criteria
Creation/Expansion of borrow pits for aggregate materials – loss of aggregate materials	Pre-Construction/ Construction	• PA-1.3 The Blasting Contractor will transport, store, handle and use explosives in accordance with provincial and federal legislation and guidelines, and Manitoba Hydro guidelines • PA-1.19 Blast rock will be collected and stockpiled as soon as possible for subsequent use or disposal off site. • PA-1.21 Site restoration will be completed as soon as possible after blasting in accordance with the Blasting Plan. • PC-2.2 Borrow pits and quarries will be designed, constructed and operated in compliance with provincial legislation and guidelines • PC-2.17 Erosion protection and sediment controls will be put in place before borrow pit excavation commences. • PC-2.21 Organic material, topsoil and subsoil will be stripped and stockpiled for use in future site rehabilitation.	Removal of Aggregate Material	**Direction:** Negative **Magnitude:** Small **Geographic Extent:** Project Footprint **Duration:** Long-term **Reversibility:** Permanent **Frequency**: Continuous
Release of contaminants to soil and groundwater	Construction	• EI-2.5 Contractors will take reasonable precautions to prevent fuel, lubricant, fluids or other products from being spilled during equipment operation, fuelling and servicing • EI-2.6 Emergency spill response and clean-up materials and equipment will be available at construction sites, marshalling yards, fuel storage facilities and standby locations. • E-2.8 Spill response and clean-up equipment will be capable of containing and recovering the largest release possible and be sitable for the site location. • PC-3.31, Chemical control of vegetation is not permitted during clearing.	Release of contaminants to the soil and groundwater	**Direction:** Negative **Magnitude:** Small **Geographic Extent:** Project Footprint **Duration:** Short-term **Reversibility:** reversible **Frequency**: Continuous
Vegetation Management – use of herbicides on ROW	Operation	• PC-8.10 Vegetation control along rights-of-way during construction and operation will be in accordance with the Vegetation Management Plan.	Migration of herbicides to soil and groundwater	**Direction:** Negative **Magnitude:** Small **Geographic Extent:** Project Footprint **Duration:** Long-term **Reversibility:** reversible **Frequency**: Continuous
Manigotagan Corner Station				
Soil Compaction	Construction	• PA-3.7, Clearing and disturbance will be limited to infrastructure sites, borrow pits, marshalling yards, transmission line rights-of-way and associated access routes. • PA-3.9, Clearing and construction equipment will remain within designated infrastructure sites, rights-of-way and associated access routes.	Soil compaction	**Direction:** Negative **Magnitude:** Small **Geographic Extent:** Project Footprint **Duration:** Long-term: **Reversibility:** Permanent **Frequency:** Continuous

Table 3: Summary of Potential Effects, Mitigation Measures and Residual Effects on Soils, Geology and Groundwater (continued)

Potential Effect	Project Phase	Key Mitigation Measures	Residual Effect	Significance Criteria
Erosion Protection and Sediment Control - risk of soil erosion and transport of eroded materials	Construction	• EI-3.1, A project-specific Erosion Protection and Sediment Control Plan will be prepared prior to starting construction. The Plan will be prepared or approved by a Certified Professional in Erosion and Sediment Control (CPESC) • EI-3.6, Erosion protection and sediment control measures will be put in place prior to commencement of construction activities and will remain intact for the duration of the project. • EI-3.7, Construction activities will be suspended during extreme wet weather events where erosion protection and sediment control measures are compromised. • EI-3.11, Erosion protection and sediment control installations will only be removed after disturbed areas are protected and sediments are disposed of in accordance with Erosion Protection and Sediment Control Plan. • EI-3.12, Erosion protection and sediment control measures will be left in place and maintained until either natural vegetation or permanent measures are established • EI-3.14 The Environmental Inspector will make inspections of decommissioned project areas and sites in accordance with the Site Rehabilitation Prescription to ensure that environmental protection measures are effective and that any deficiencies are addressed.	Minor soil erosion	**Direction:** Negative **Magnitude:** Small **Geographic Extent:** Project Footprint **Duration:** Long-term **Reversibility:** Permanent **Frequency**: Continuous
Creation/Expansion of borrow pits for aggregate materials – loss of aggregate materials	Pre-Construction/ Construction	• PC-2.2 Borrow pits and quarries will be designed, constructed and operated in compliance with provincial legislation and guidelines. • PC-2.17 Erosion protection and sediment controls will be put in place before borrow pit excavation commences. • PC-2.21 Organic material, topsoil and subsoil will be stripped and stockpiled for use in future site rehabilitation. • PC-2.18 Organic layer will be replaced on pit slopes and bottoms once the sites are ready to be decommissioned. • PC-2.4 Previously developed borrow sites and quarries will be used before new sites are developed if suitable materials are available. • PC-2.25 The Environmental Inspector will inspect active borrow pits and quarries regularly for adherence with environmental protection measures and unforeseen effects.	Removal of Aggregate Material	**Direction:** Negative **Magnitude:** Small **Geographic Extent:** Project Footprint **Duration:** Long-term **Reversibility:** Permanent **Frequency**: Continuous
Release of contaminants to soil and groundwater	Construction	• EI-2.5 Contractors will take reasonable precautions to prevent fuel, lubricant, fluids or other products from being spilled during equipment operation, fuelling and servicing • EI-2.6 Emergency spill response and clean-up materials and equipment will be available at construction sites, marshalling yards, fuel storage facilities and standby locations	Release of contaminants to the soil and groundwater	**Direction:** Negative **Magnitude:** Small **Geographic Extent:** Project Footprint **Duration:** Short-term **Reversibility:** reversible **Frequency**: Continuous

[a] Mitigation Measures identified in Manitoba Hydro (2012).

6.4 Interactions with Other Projects

The spatial boundary for the interactions with other projects is the Project Study Area. Potential interactions were determined for adverse residual effects to VECs that have the potential to interact with the effects of other past, current, or future projects and human activities. VECs with no residual effect or a positive residual effect were not included in the assessment. The assessment only included adverse residual effects on VECs that overlapped both spatially and temporally with the effects of other projects and human activities.

Project and human activities were selected for inclusion in the assessment based on the following criteria:

- **Past Projects:** Projects within the Project Study Area whose ongoing effects can be reasonably expected to change in the future and, as a result of those changes, interact with this Project's adverse residual effects.
- **Current Projects:** Projects in construction, development or operation within the Study Area.
- **Future Projects:** Projects approved for construction/development or in the permitting pipeline within the Study Area.
- **Prospective Projects:** Projects announced in the Study Area (e.g., wind farms, transmission expansion, government vision statements) but not yet moving along a development or permitting pathway, and any projected changes in land use patterns (e.g., changes in agricultural activity).

There are several past, on-going and proposed development projects in the region that currently has spatial overlap with, or will overlap spatially in the future with the LWESI Project (Table 4). Of the projects listed only two have the potential to interact with the soils, hydrogeology, and geology components of the project. Table 5 provides a list of ongoing and proposed projects within or near the Project Study Area that could potentially interact with the Project.

Table 4: Projects and Activities with the Potential to Interact with the LWESI Project

Sector	Project	Description	Location	Status	Timelines
Mining	San Gold Mine Expansion	• Planned expansion of San Gold's Gold Mine and tailings pond in Bissett, northeast of Project Study Area • Production is expected to double	Northeast of Project Study Area	Ongoing	
	Mineral Exploration	• The north end of the Project Study area overlaps with many mining claims and exploration activities (e.g. drill holes) • Mining claims are held by Golden Pocket Resources, DLW Gold Ventures Inc., Canada Bay Resources Ltd., and San Gold Corp.	North of Project Study Area	Ongoing/ Planned	
	Quarry Development	• There are 83 quarry leases within the Project Study Area, several in close proximity to the Project • Lease holders include private companies, as well as Manitoba Infrastructure and Transportation (MIT), and the East Side Road Authority • Development and expansion of existing and new quarries is likely, particularly for projects such as the East Side Road	Within the Project Study Area	Ongoing/ Planned	
Forestry	Timber Resource Harvesting	• Request for Proposal (RFP) to for timber resource harvesting in FML01 by Manitoba Conservation and Water Stewardship (Manitoba Conservation and Water Stewardship [MCWS]) • A potential respondent to the RFP would be a community and forest industry joint venture being spearheaded by the Manitoba Model Forest (Winnipeg River Integrated Wood and Biomass Project) • This would result in an estimated 400 to 450 direct jobs, up to 400,000 m^3 softwood/year and 200,000 m^3 hardwood/year	Within the Project Study Area	Planned	Within 1 – 3 years
Wildlife	Closure of Licensed and Rights Based Moose Hunting	• As of January 26, 2012, all licensed hunting in Game Hunting Area (GHA) 26 is closed • In addition, moose protection zones in areas of heavy moose concentration areas along roads and rivers are closed to hunting for rights-based peoples • Proposed decommissioning of roads by MCWS	GHA 26 within the Project Study Area	Ongoing/ Planned	2012

Table 4 Projects and Activities with the Potential to Interact with the LWESI Project (continued)

Sector	Project	Description	Location	Status	Timelines
Transportation & Communication Infrastructure	East Side Road Authority	• Construction of a 156 km all season gravel road along the east side of Lake Winnipeg from Provincial Road #304 east of Hollow Water to Berens River First Nation	North of Project Study Area	Ongoing	2010 - 2014
	Fibre Optic Cable	• The San Gold Mine in Bissett, and several community members have expressed an interest in fibre optic cable service in the area	Within and northeast of Project Study Area	Potential	Unknown
Cottage Development	Black River First Nation Cottage Development Initiative	• Expansion of cottage development within the Black River First Nations territory in conjunction with MCWS • Phase I of the project is underway with road development underway for servicing of 50 cottage lots • Future phases are planned for an additional 550 additional cottage lots	Black River First Nation Reserve at the west of the Project Study Area	Ongoing/ Planned	Phase I: underway (year 1 of 5) Phase II:– 5 – 10 years
	Hollow Water First Nation Cottage Development Plans	• Considering cottage development projects with MCWS	Hollow Water First Nation Reserve at the north end of the Project Study Area	Potential	Unknown
	Sagkeeng First Nation Cottage Development Plans	• Considering cottage development projects with MCWS	Sagkeeng First Nation Reserve at the southwest end of the Project Study Area	Potential	Unknown

Table 5: Ongoing and Proposed Projects and Activities that could Interact with the Project

Sector	Project	Description	Location	Status	Timelines
Mining/Quarry Development	Quarry Development	There are 83 quarry leases within the Project Study Area, several in close proximity to the Project; Lease holders include private companies, as well as Manitoba Infrastructure and Transportation (MIT), and the East Side Road Authority; Development and expansion of existing and new quarries is likely, particularly for projects such as the East Side Road;	Within the Project Study Area	Ongoing/ Planned	2014 to 2018
Transportation & Communication Infrastructure	East Side Road Authority	Construction of a 156 km all season gravel road along the east side of Lake Winnipeg from Provincial Road #304 east of Hollow Water to Berens River First Nation;	North of Project Study Area	Ongoing	2010 to 2014

There are 83 quarry leases within the Project Study Area, and competition for existing borrow pits, and potential new borrow pit locations can be expected. Construction of the new East Side Road is underway, and stretches from east of Hollow Water (just north of the Project Study Area), to Berens River First Nation. Several quarry leases within the northern portion of the Project Study Area are held by the East Side Road Authority for supply of gravel for road construction.

6.5 Monitoring and Follow-Up

Follow-up and monitoring activities will be implemented to:

- assess the success of the proposed mitigation measures; and
- to verify the magnitude and extent of residual effects.

This may involve monitoring potential accidental releases to the soil and groundwater environment, and extent and nature of borrow pit expansion.

7 CONCLUSIONS

Based on adoption of Manitoba Hydro's mitigation measures outlined in their Environmental Protection Plan (Manitoba Hydro 2012) effects to soils, hydrogeology, and geology are expected to be minimal. Residual effects are predicted for loss of aggregate materials from existing or new borrow pits, and soil compaction at the Manigotagan Corner Station Site. These residual effects will be permanent, but are anticipated to be minor.

8 REFERENCES

8.1 Literature Cited

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9 GLOSSARY

Arc Terrane: A landmass that originated as an island arc or a microcontinent that was later added onto a continent.

Alluvial: Pertaining to materials (e.g., clay, silt, sand, and gravel) deposited by running water including the sediments laid down in riverbeds, floodplains, lakes, and estuaries.

Amphibolite: A grouping of rocks composed mainly of amphibole and plagioclase feldspars, with little or no quartz.

Ecodistrict: A subdivision of an ecoregion **ch**aracterized by relatively homogeneous biophysical and climatic conditions.

Ecoregion: A geographical area characterized by a distinctive regional climate as expressed by vegetation.

Ecozone: An area of the earth's surface representing large and very generalized ecological units characterized by interacting abiotic and biotic factors; the most general level of the Canadian ecological land classification.

Felsic: Silicate minerals, and rocks which are enriched in the lighter elements such as silicon, oxygen, aluminium, sodium, and potassium.

Fibrisol: Soil composed largely of relatively undecomposed fibric organic material.

Glaciolacustrine: Pertaining to, derived from, or deposited in glacial lakes; especially said of the deposits and landforms composed of suspended material brought by meltwater streams flowing into lakes bordering the glacier, such as deltas, kame deltas, and varved sediments.

Gleysolic: An order of soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas, or prominent mottling, or both, in some horizons.

Gneiss: A type of rock formed by metamorphic processes from pre-existing igneous or sedimentary rock formations.

Granitic: Referring to a widely occurring type of igneous rock which is granular and crystalline in texture.

Hydraulic Conductivity: A property of soils or rock that describes the ease with which water can move through pore spaces or fractures

Luvisolic: An order of soils that have eluvial (Ae) horizons, and illuvial (Bt) horizons in which silicate clay is the main accumulation product. The soils developed under forest or forest-grassland transition in a moderate to hydraulic conductivity.

Mineral Soil: Shttp://www.biology-online.org/dictionary/Soiloil consisting primarily of mineral (sand, silt and clay) material, rather than organic matter.

Mesisol: A group of soils at a stage of decomposition intermediate between fibrisols and humisols.

Tonalite: An igneous, intrusive rock, of felsic composition.

Coordinate System: UTM Zone 14N NAD83
Data Source: MB Hydro, ProvMB, NRCAN
Date Created: November 22, 2012

0 6 12 Kilometres
0 4 8 Miles
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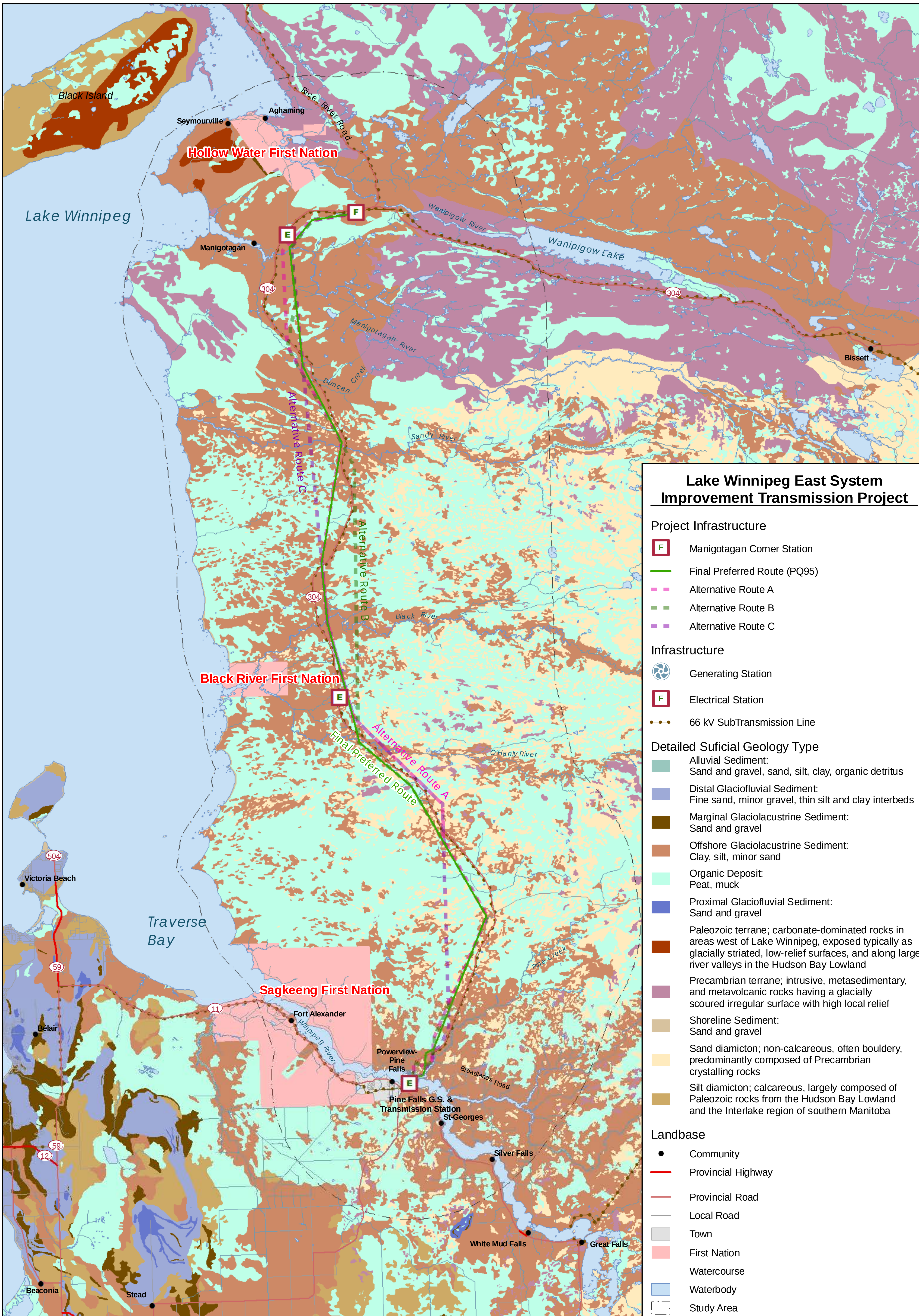
Golder Associates

General Location Map

Map 1



Golder Associates

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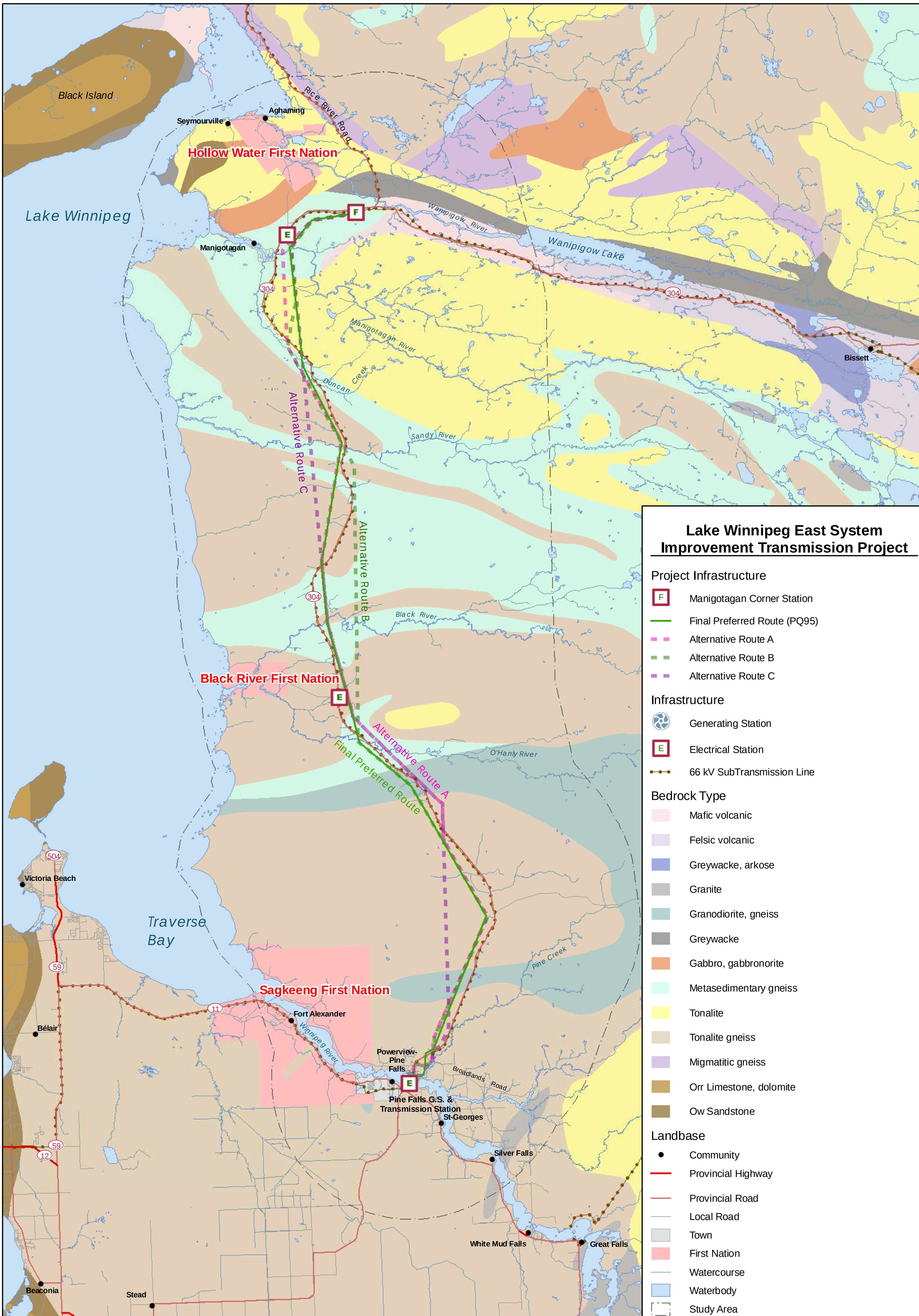
Surficial Geology

Map 2



Golder Associates

Coordinate System: UTM Zone 14N NAD83
Data Source: MB Hydro, ProvMB, NRCAN
Date Created: November 22, 2012

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Bedrock Geology

Map 3