Pointe du Bois to Whiteshell station 115kV Transmission Line (PW75)

Construction Environmental Protection Plan

Prepared by Manitoba Hydro

Project Management Division

Transmission & Distribution Environment

and Engagement Department

June 2023

Preface

Manitoba Hydro's environmental commitment

Manitoba Hydro is committed to protect and preserve natural environments and heritage resources affected by its projects and facilities. This commitment and a commitment to continually improve environmental performance is demonstrated through the company's Environmental Management System.

Environmental protection can only be achieved with the engagement of Manitoba Hydro employees, consultants, local communities, and contractors at all stages of projects from planning and design through construction and operational phases.

As stated in the corporate Environmental Management Policy:

"Manitoba Hydro is committed to protecting the environment by:

- ensuring that work performed by its employees and contractors meets environmental, regulatory, contractual, and voluntary commitments
- recognizing the needs and views of its interested parties and ensuring that relevant information is communicated
- continuously assessing its environmental risks to ensure they are managed effectively
- reviewing its environmental objectives regularly, seeking opportunities to improve its environmental performance
- considering the life cycle impacts of its products and services
- ensuring that its employees and contractors receive relevant environmental training, and
- fostering an environment of continual improvement

Manitoba Hydro's Environmental Management Policy has been used to guide the development of the Environmental Protection Program for the proposed project. Implementation of the program is practical application of the policy and will demonstrate Manitoba Hydro's dedication to environmental stewardship.

Adaptive management is being implemented within the Environmental Protection Program to be responsive and adaptive to changes to the project and on the landscape, stakeholder, and indigenous concerns, as well as inputs from our inspection and monitoring programs.

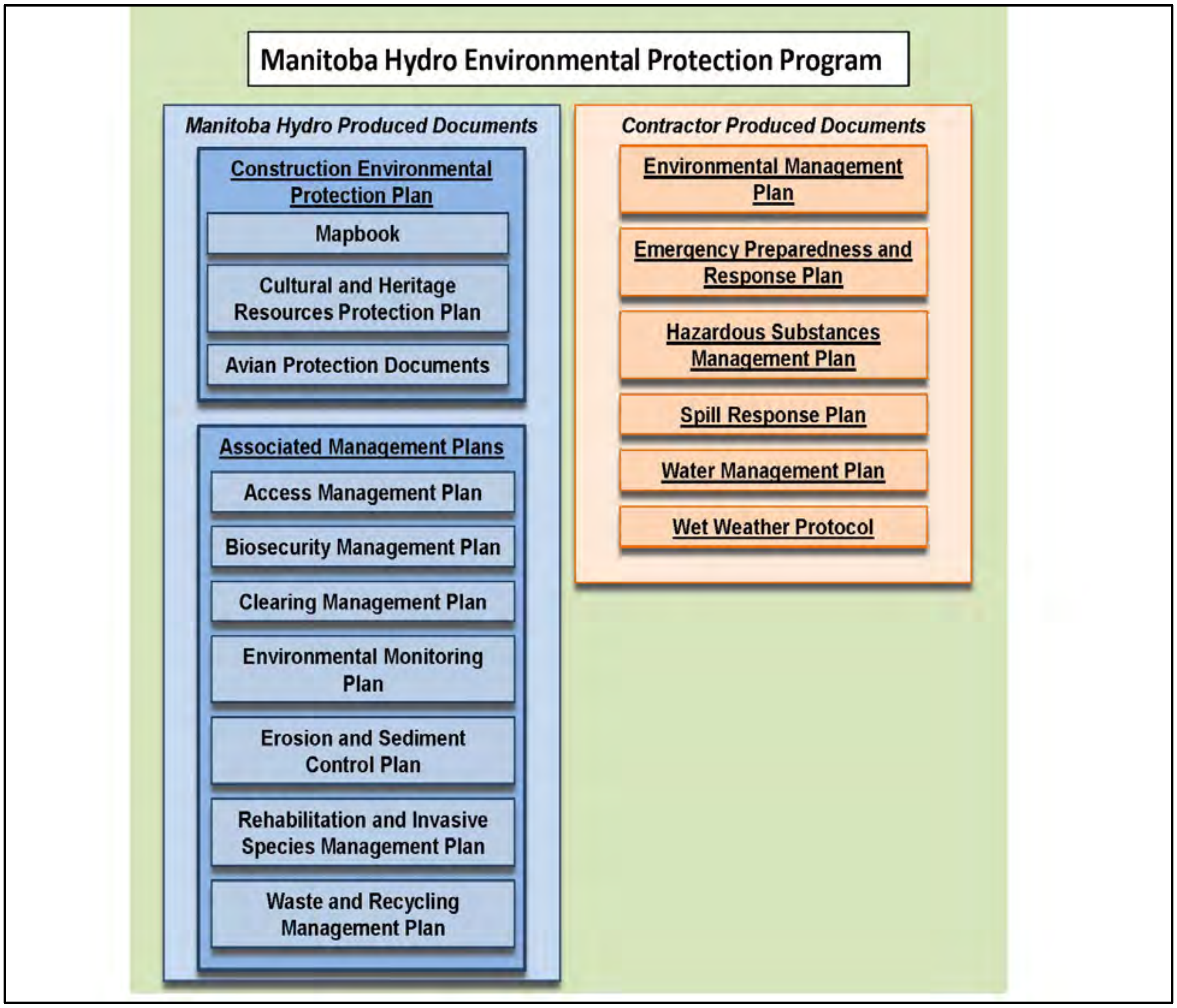

Figure 1: Diagram of environmental protection documents

Document Owner
Transmission & Distribution Environment and Engagement Department
Project Management Division
Manitoba Hydro

Version – Final 1.0

List of Revisions

NUMBER	NATURE OF REVISION	SECTION(S)	REVISED BY	DATE

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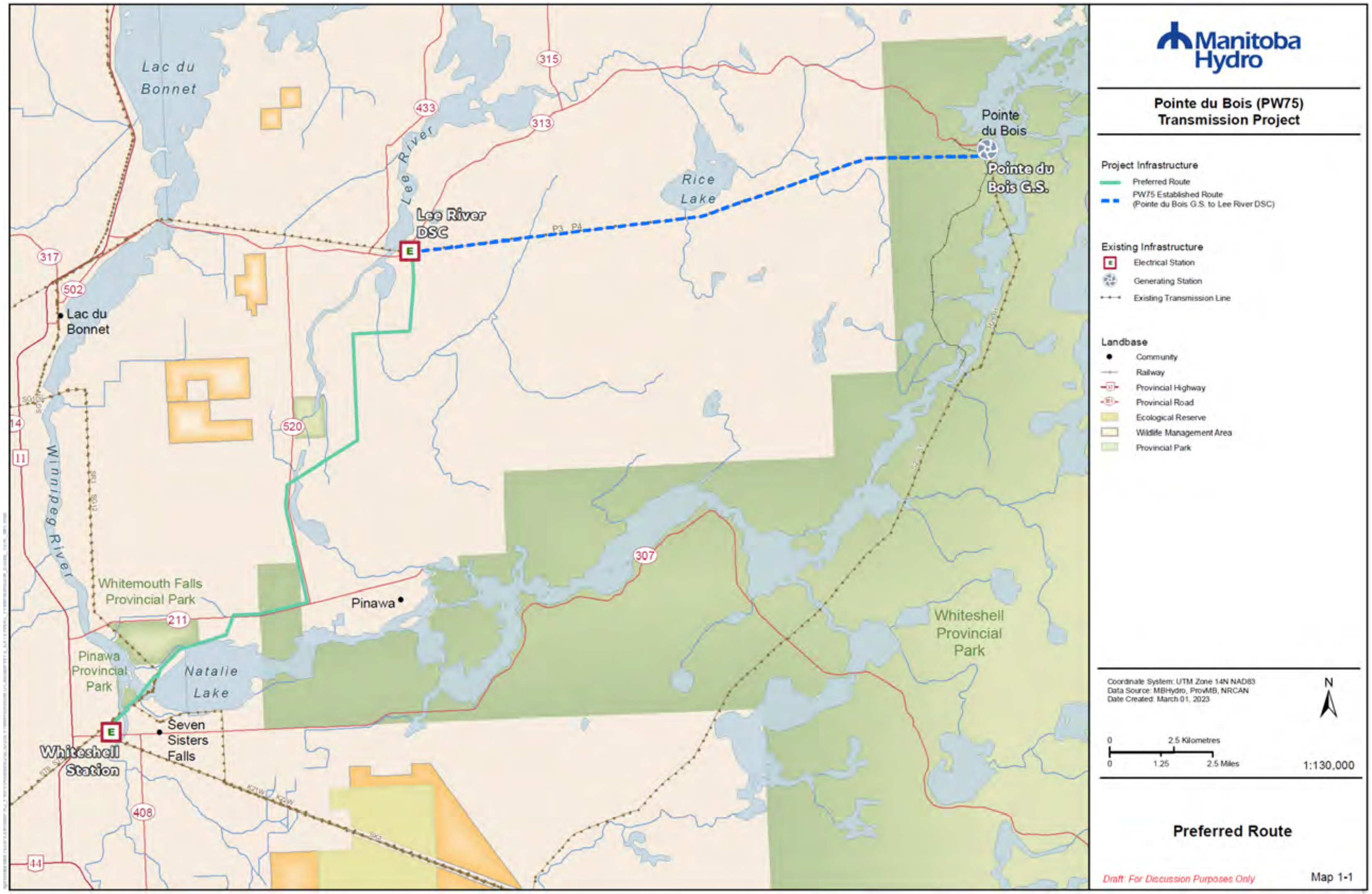
1.0 Introduction

The purpose of this construction environmental protection plan (CEnvPP) is to provide information that will guide contractors and field personnel while constructing the Pointe du Bois to Whiteshell station 115kV transmission line (the 'Project') in a manner that meets environmental legislation requirements and protects the environment. The activities and areas associated with the Project are as described in this CEnvPP, the associated management plans and the environmental assessment report. Generally, this includes rights of ways, transmission lines, stations, access routes, marshalling yards, and any other ancillary works and temporary workspaces developed for the sole purpose of constructing the project. The CEnvPP outlines the commitments and efforts that will be taken by Manitoba Hydro (MH) and contractors to protect the environment and mitigate potential environmental effects that may occur during construction of the Project. The use of environmental protection plans is a practical and direct implementation of Manitoba Hydro's commitment to responsible environmental stewardship.

This CEnvPP provides guidance for the implementation of environmental protection measures for the Project. The direction and guidance provided in this CEnvPP document applies to all lands related to the project both private land and crown land. The Project includes the construction of a 115kV transmission line (PW75) from Pointe du Bois Station to Whiteshell Station.

This document provides general and specific mitigation measures to reduce the potential for environmental effects that may occur during the Project's construction phase. It is designed to be a resourceful, user-friendly tool to guide onsite implementation of environmental protection measures. This document provides contractors and field personnel guidance on the implementation of environmental protection measures. Where contractors have experience using other federally or provincially accepted methods of environmental protection, they are encouraged to discuss with the MH environmental officer/inspector.

Map 1-1: Point du Bois to Whiteshell 115kV transmission line project



1.1 Document amendment process

To communicate the recent versions of environmental protection documents an amendment process has been established. This amendment process applies to both text (Part 1) and mapping (Part 2) documents. Throughout construction there will be changes and revisions to documents, these revisions are a result of errors and omissions or due to the ongoing adaptive management process to improve environmental protection measures.

In addition, Manitoba Hydro's Transmission & Distribution Environment and Engagement Department must approve all field decisions and/or changes to a procedure outlined in the CEnvPP. Figure 1-1 illustrates the document amendment process.

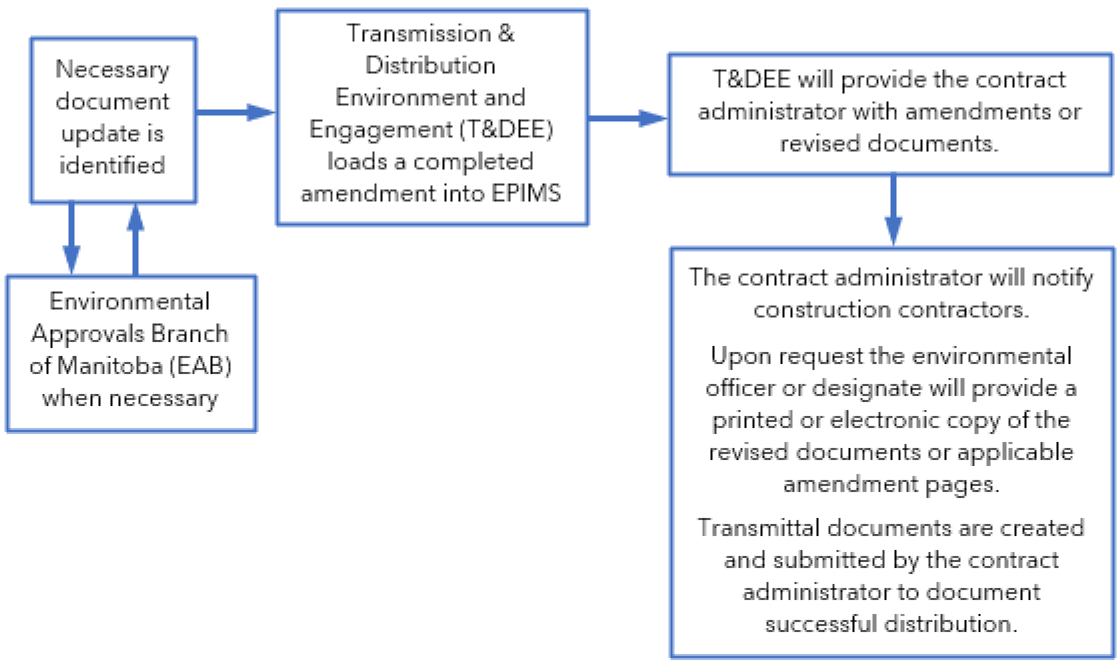


Figure 1-1 Document amendment process

1.2 Overview of the environmental protection plan

Part of Manitoba Hydro's commitment to environmental protection includes a comprehensive environmental protection program. This program includes the development of a CEnvPP specific to the project. The CEnvPP provides general and specific environmental protection information for project components and is intended for use by construction contractors and environmental staff.

Several environmentally sensitive sites (ESS) have been identified for the project. ESS are locations, features, areas, activities, or facilities that were identified in the Project environmental impact statement to be ecologically, socially, economically, culturally, or spiritually important or sensitive to disturbance and require protection during construction of the project. The determination of ESS has included the consideration of First Nations and Red River Métis traditional knowledge. Manitoba Hydro will continue to engage with First Nations, Red River Métis and interested parties in efforts to continually update this plan with sensitive sites and current knowledge as it is shared.

Map sheets have been developed for the project to present the location and spatial extent of ESS. Each map has corresponding tabular summary information including ESS feature information and relevant mitigation measures to address the potential environmental effects at each ESS.

1.3 Roles, responsibilities, and reporting

This section outlines the major roles and responsibilities of those involved in the implementation of the CEnvPP for the transmission components of the project. A summary of roles and key responsibilities is found in Table 1. Communication and reporting on environmental issues, monitoring and compliance will be as outlined in Figure 1-2. A contact list for key staff involved in supporting this CEnvPP is found in Appendix A.

Table 1-1: Environmental roles and responsibilities

Role	Key responsibilities
MH environmental officer (T&DEE) / business partner (T&DEE) / inspector	• The environmental officer reports to the line construction business partner / environmental specialist and provides advice and guidance to the contract administrator / field engineer • Provides support and guidance in developing solutions for environmental issues on-site with the contract administrator and the contractor and where applicable with the input from the line construction business partner / environmental specialist • Provides support and guidance to the contractor regarding CEnvPP • Participates in contractor environmental representative pre-job meeting and in contractor environmental pre-job orientation • Assists the contractor's environmental representative in ensuring that all necessary information is covered in the contractor's pre-job employee orientation and record is kept • Provides advice and guidance to the Contract administrator for non-compliance situations, environmental incidents, and emergencies • Conducts site inspections regularly and ensures that reports containing information on activities conducted as well as effectiveness of actions and outstanding issues • Prescribes follow-up mitigation measures and ensures proper implementation • Confirms that all ESS are correctly identified, delineated, and flagged/marked by the construction contractor in the field • Monitors the project for compliance of the CEnvPP, environmental license and other environmental regulatory requirements • Responsible for ongoing compliance monitoring of project activities to ensure consistent implementation of the CEnvPP and accurate reporting. • Manages MH and contractor spill response, clean-up, testing, follow-up and reporting

Role	Key responsibilities
MH Engineer (LC) / Contract Administrator (LC) / MH contract administrator(s) (LC)	• Monitor, track and prepare report on construction progress • Issue Work Instructions, Variations and Non-Conformance Reports as required • Assist in chairing progress meetings • Review and provide comments on Contractors reports, plans, schedules etc. • Ensure compliance of all contractual requirements • Responds to Environmental Non-Compliance Advisements with plan of action to correct non-compliances • Supervise construction inspectors • Arrange safety orientations with the Contractor for MH/Consultant staff/visitors. • Responsible for implementation of all construction related landowner commitments • Responsible for rectifying construction related Customer Complaints • Conduct regular site visits to identify any issues related to construction, safety, and environment • Facilitates construction contractor's implementation of remedial actions or responses to non-conformance situations or incidents are implemented as required • Works with the Line Construction Business Partner / Environmental Specialist and Environmental Officer/Inspector to ensure implementation of environmental protection measures.

Role	Key responsibilities
Construction Inspectors / Engineering Technicians (LC)	• Review all drawings and understand the technical specifications for the assigned work • Ensure the contractor is performing the work as per the drawings and technical specifications, and Environmental Protection Plans. • Monitor and report daily construction progress • Report any safety, environment, quality, material, design, and any other construction related concerns to the contract administrator and field engineer • Work collaboratively with Environmental Officer/Inspector to identify ESS, ensure all ESSs are correctly delineated and flagged/marked in the field locations and ensure that prescribed mitigation is being implemented and meeting regulatory requirements.
Construction contractor(s) (project manager / contract administrator)	• Accountable for all regulatory and environmental prescriptions (i.e., follow CEnvPP and mitigation measures prescribed) • Ensure all contractor project staff are adequately trained/informed of pertinent environmental requirements of the Project related to their position • Report any discoveries of non-compliance, accidents or incidents to the contract administrator and environmental officer / inspector • Ensure that all remedial actions are carried out as per Manitoba Hydro instruction • Ensure all discoveries of heritage resources, human remains, paleontological finds, environmentally sensitive sites, etc. are reported to the contract administrator and environmental officer / inspector • Responsible for providing a Final Environmental Report summarizing the environmental situations encountered, mitigation measures implemented, and rehabilitation completed by the contractor regarding its activities for the contract. • Providing a weekly progress report as part of the weekly progress report that shall include environmental information, descriptions and statistics for the contactor's site activities.

Role	Key responsibilities
Construction contractor staff	• Accountable for all regulatory and environmental prescriptions (i.e., follow CEnvPP and mitigation measures prescribed) • Ensure adequately trained with respect to, and informed of pertinent, environmental requirements of the project related to their position • Report any discoveries of non-compliance, accidents or incidents to the contract administrator and environmental officer / inspector • Ensures that all remedial actions are carried out as per Manitoba Hydro instruction • Ensures all discoveries of heritage resources, human remains, paleontological finds, environmentally sensitive sites, etc. are reported to the contract administrator and environmental officer / inspector
Construction contractor's environmental representative	• Must possess a post secondary education in an environmental or resource management discipline with minimum of 2 years relevant experience • Responsible for implementation, coordination, and verification of pre-project employee environmental orientation • Ensures that the contractor employees adhere to all aspects of the CEnvPP • Provides information and advice to the construction contractor employees on environmental protection matters • Responsible for implementation of the emergency response and hazardous materials plans, and other related topics • Liaises with MH environmental officer / inspector and MH field safety officers • Delineate and flag/sign all environmentally sensitive sites as identified in CEnvPP in the field as per flagging and signage standards • Identify, delineate, and flag or mark all access, right-of-way and other applicable boundaries in the field • Identify any previously unknown ESS to MH environmental officer / inspector

1.3.1 Environmental protection

Manitoba Hydro will provide copies of all available permits, licences, approvals, and authorizations obtained for the Project to the contractor. Prior to commencing associated work, the contractor will provide Manitoba Hydro with copies of all available permits, licences, approvals, and authorizations obtained for the project. Electronic copies of all permits are available for download from EPIMS.

The contractor will comply with the CEnvPP prepared for the project, including mitigation measures identified during the environmental assessment and contained herein. Environmental aspects of the work including applicable licence/permit conditions will be discussed during the environmental pre-job orientation, weekly progress meetings, and daily job planning meetings.

Without limiting or otherwise affecting the generality or application of any other term or condition of the contract, the contractor shall:

- Strictly comply with all environmental Legislation and have suitable corrective and/or preventive measures in place to address any previous environmental warnings, fines, or convictions; issued by regulatory agencies and/or Manitoba Hydro
- Do or cause to be done all things required or ordered, to mitigate environmental damage caused, directly or indirectly, by itself or by its servants, agents, employees, or subcontractors, accidentally or because of practices that are in contravention of the contract or any environmental legislation

1.3.2 Documentation and reporting

There is a requirement for the contractor to provide reports and documentation to Manitoba Hydro in an acceptable digital format. Manitoba Hydro during pre-job orientation will provide a list of all reporting and documentation submission requirements, timelines for submission, acceptable digital formats, and method of transmittal. (e.g., EPIMS, project Sharepoint site, email, FTP).

Examples of reports and documents that are required for the project are listed below (not an exhaustive list): Annual or post construction environmental reports

- Weekly environmental monitoring reports
- Spill reports
- Bird survey forms
- Amphibian survey forms

- Landowner permission forms
- Biosecurity forms (more information provided in management plan)
- Timber scaling records and copies of load slips (more information provided in management plan)
- Copies of all permits and approvals acquired by the contractor
- Copies of any contractor developed plans such as emergency response and hazardous materials plans
- Environmentally related incident reports

1.3.3 Environmental representative(s) / supervisor(s)

Before commencing the on-site work, the contractor shall identify its dedicated on-site representative(s) / supervisor(s), who shall attend the pre-job meeting (environmental component) to review environmental matters for the work. The dedicated on-site contractor environmental representative(s) / supervisor(s) shall be fully conversant with:

- Contractor's environmental practices and policies
- All applicable environmental legislation
- Mitigation measures outlined in the CEnvPP

The contractor will ensure enough environmental representatives are in place to fulfill the commitments of the project's environmental protection and management plans, and any associated licence conditions associated with the project. Manitoba Hydro and the contractor will jointly determine the resources required through criteria composed of a variety of factors including construction schedules, number of sub-contractors, division of construction segments, phase of construction, season, and the nature of the licence conditions.

1.3.4 Environmental improvement orders

Failure to comply with the environmental protection section above or unsatisfactory performance regarding any other environmental-related matter may result in Manitoba Hydro issuing environmental improvement orders to the contractor.

The environmental improvement order once communicated verbally or in writing is considered "effective immediately". Manitoba Hydro will establish a compliance date for each environmental improvement order issued. The contractor must provide written documentation of the actions taken regarding the environmental improvement order as follows:

The contractor shall:

- Prepare a written report on the measures taken to remedy the contravention and measures yet to be taken within the expiry date of the period specified in the order or any extension thereof
- Send a copy of the report to the Manitoba Hydro representative who made the order as well as all individuals cc'd on the transmittal document
- Provide a copy of the report to the employee(s) involved, if applicable,
- Review the contravention with all employees at a regular weekly meeting and post in a prominent place at or near the worksite

1.3.5 Environmental stop-work order

Manitoba Hydro may issue an environmental stop work order where any activities which are being, or are about to be, carried on at a worksite, involve or are likely to involve an imminent risk of serious impact to the environment, or where a contravention specified in an environmental improvement order was not remedied and warning was given. The environmental stop work order, once communicated, verbally or in writing is considered "effective immediately", for any one or more of the following matters:

- The cessation of those activities
- That all or part of the worksite be vacated
- That no resumption of those activities be permitted by the contractor
- That a Manitoba Hydro issued stop work order remains in effect until it is withdrawn in writing by Manitoba Hydro
- That Manitoba Hydro will not be held responsible for delays to the work or be required to compensate the contractor for any matters arising because of the Manitoba Hydro issued environmental stop work order

Note: A Manitoba Hydro-issued environmental stop work order does not prevent the contractor from completing any work or activity that may be necessary to remove the risk of injury referred to above.

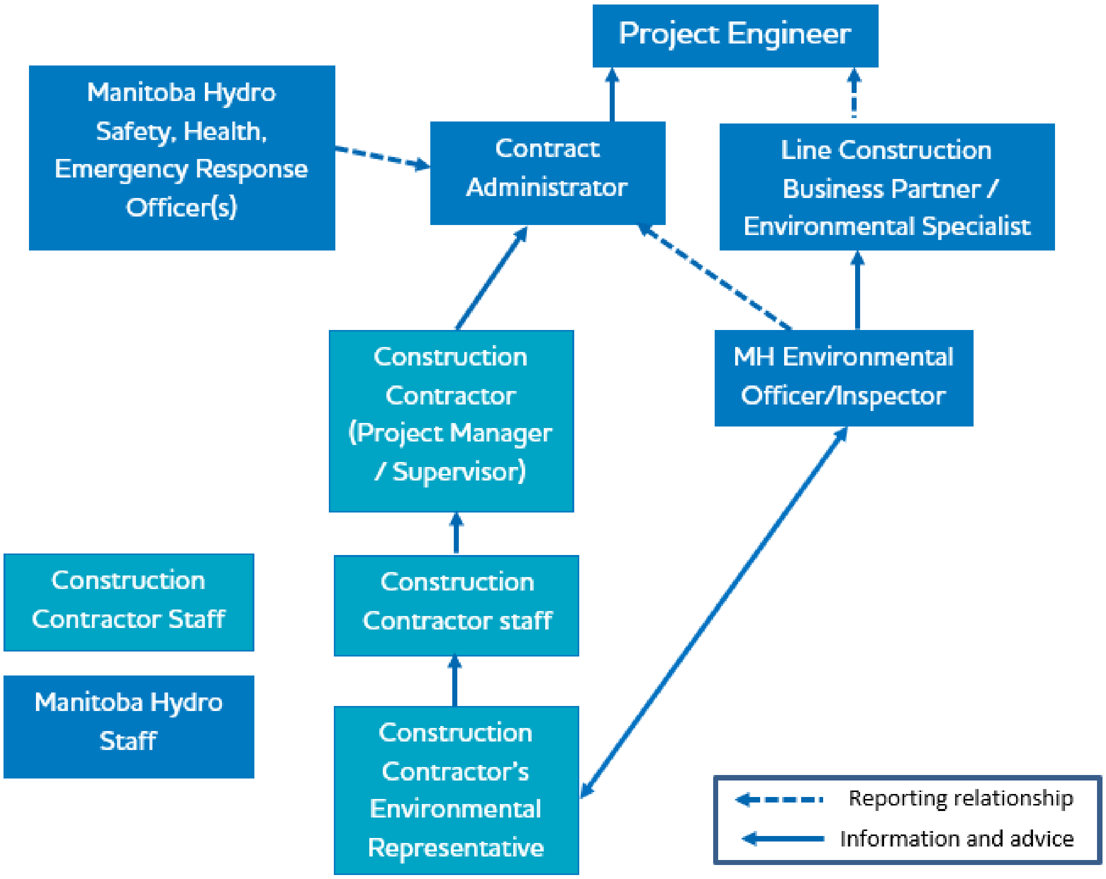


Figure 1-2: Environmental communication reporting structure

1.4 Environmental protection information management system

EPIMS will provide a single interface to store all environmental documentation. It will be utilized by project staff to submit permits, inspection reports, plans, logs, checklists, etc. for the management of all environmental protection implementation, regulatory compliance, and incident reporting.

1.5 Regulatory requirements

All relevant regulatory approvals for the project will be obtained by Manitoba Hydro prior to construction. All documentation will be kept on-site by both the contractor and Manitoba Hydro personnel. Manitoba Hydro requires that its employees and contractors comply with all federal and provincial regulatory requirements relating to the construction, operations and decommissioning of its projects and facilities. All Project licences, approvals and permits obtained can be found in Appendix B.

2.0 Environmental considerations

Important environmental considerations for pre-construction planning and construction activities are required at environmental sensitive sites (ESS), which include locations, features, areas, activities, or facilities that are identified in the CEnvPP mapbook(s). These ESS are identified to be ecologically, socially, economically, or culturally important or sensitive to disturbance which will require protection and mitigation during construction. ESS include riparian areas, valued and protected vegetation, wildlife, and habitats, cultural (heritage/archaeological and spiritual sites), unique terrain features, erosion and compaction prone soils and other important locations requiring specific protection (e.g., resource use, access).

2.1 Timing windows

2.1.1 Wildlife

The "Timing windows" table found in Appendix 'C' which outlines wildlife reduced risk work windows applicable to the Project. These windows are based on federal and provincial regulatory requirements as well as best management practices. Timing periods may refined based on further data collection, transmission line final design, and regulatory license and work permits to be issued for the project.
The recommended reduced risk timing windows table demonstrates periods of the year when wildlife species are sensitive to disruptive operations because of a sensitive lifecycle activity such as calving, nesting, and hibernation, etc. The "Timing windows table (in Appendix C) intends to assist in scheduling construction activities for the time of year when risks of adverse construction impacts are negligible. Where conflicting timing restraints with construction activities exist in a particular area, appropriate mitigation will be implemented to reduce effects.

2.1.2 Burning

Between November 16th to March 31st there is no requirement for a burning permit under the *Wildfires Act*. If burning is required outside of those dates (i.e., between April 1st and November 15th) a burning permit application is made to the local Manitoba Environment and Climate district office. A copy of the burning permit must be on hand while burning. All fires must be completely extinguished by March 15th.

2.1.3 Fish

Fish habitat can be adversely affected by in-stream work (none currently planned) that occurs during certain periods in their life history or at certain life stages. Life history periods or life stages susceptible to disturbances from in-stream construction work include the following:

- Spawning and egg incubation
- Movements to or from spawning or overwintering areas
- Egg and newly hatched fry

Timing works to avoid sensitive life history periods or life stages is an effective means of mitigating adverse effects. The "Timing windows" table (In Appendix C) contains general timing windows to avoid during construction.

2.2 Setbacks and buffers

Setbacks and buffer distances from sensitive environmental features are provided in a "Buffers and setbacks" table, found in Appendix D.

These setback and buffers may be expanded or refined based on further data collection, transmission line final design, regulatory license and work permits to be issued for the project.

Setbacks are areas to be maintained from a given environmental feature where no work shall occur unless authorized by the MH environmental officer/inspector.

Buffers are work areas where restricted activities such as low ground disturbance clearing are permitted.

Where applicable, site specific setback and buffers are prescribed in specific mitigation measures for each ESS.

2.2.1 Flagging and signage standards

Clear identification of ESS locations and applicable buffers in the field is an important part of successful environmental protection implementation. Establishing consistent use of signage and flagging tape across the project is important to reduce confusion and for the clear identification of environmentally sensitive sites (ESS) and travel routes.

2.2.1.1 Flagging

A system of standardized flagging colors has been established to reduce the potential for confusion during construction where there is multiple or overlapping areas being identified. Due to many ESS types, the flagging has grouped and categorized each category. The color pattern used to identify categories is found below and is also identified with the ESS in the associated CEnvPP Mapbook.

Yellow/Black-

Heritage (Archaeological, Cultural or Historic importance)

Orange/Black-

Access routes (Intersections with trails etc),

Land Use (Conservation, Crown Land Encumbrance, Recreation, Residential)

Resource Use (Agriculture, Food/Medicinal, Forestry, Hunting/Fishing, Trapping)

Pink/Black-

Ecosystem (Habitat, Research or Species of concern, Invasive Species, Traditional Use)

Soils and Terrain (Erosion, Terrain)

Wildlife (Birds and Habitat, Mammals and Habitat, Reptiles/Amphibians and Habitat)

Blue/White-

Water (Water Crossings, Wetlands, Ground Water)

A Cross hatched flagging has been chosen as it is distinct from other flagging present during construction. Figure 2-1 shows the currently approved patterns and colors.

Figure 2-1: Examples of approved flagging tape used in delineating ESS

Flagging Instructions

Consistency in flagging procedure is important to its effectiveness. The goal of flagging is to clearly indicate the boundary of an Environmentally Sensitive Site (ESS) that requires a modification to construction activities in relation to the surrounding area. When identifying an area, flagging tape (color determined by categories above) will be tied to wooden staking and/or sturdy trees or shrubs that won't be cleared during construction activities. Flagging spacing will be decided on a site by site basis and will take into account, density of flagging already present in the area, the size of the area being flagged (smaller area requires higher number of flags) and the density of vegetation or topography present. The primary objective would be to apply flagging at a frequency that would make the line of separation obvious to construction crews.

Flagging a buffer

Environmentally sensitive site mitigation often involves establishing a buffer of a certain size around a location so that activities are modified in that location:

Point- A Buffer is established by measuring out from the center of that point to form a perimeter buffer. (measured as a radius).

Line-When buffering a line feature, the buffer is measured from the edge of the feature that the line indicates (on both sides).

Polygon- The buffer of an area is established by measuring out from the features edge creating a perimeter buffer, similar to a point buffer.

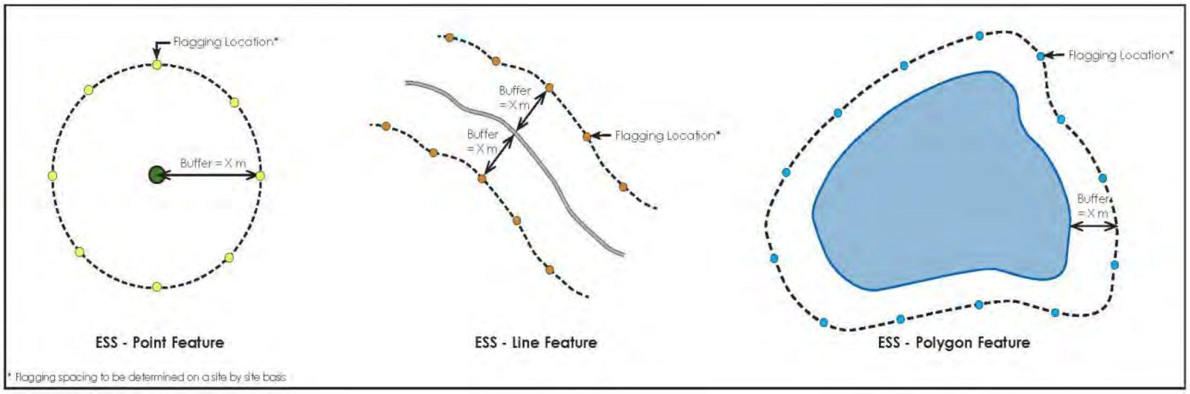


Figure 2-2: Buffer establishment for geometry types

2.2.1.2 Signage

Signage can be used in conjunction with flagging. Identification of vegetation clearing types, access, or bypass trails as well as identification of ESS can be accomplished using signage.

2.3 Riparian management

Based on characteristics and qualities of waterbodies in, or near the project footprint, contractors will need to modify land clearing, machinery passage and other construction activities. Locations identified in the CEnvPP mapbook as Aqua ESS (or other locations that may be identified in the field) will require riparian management.

2.3.1 Riparian buffers

Riparian buffers (as shown in Table 2-1) are applied to riparian habitats, which include, streams, rivers, lakes and wetlands within the project footprint in which all shrub and herbaceous vegetation will be retained and all trees that do not violate Manitoba Hydro vegetation clearance requirements will be retained. For slopes greater that 50% site investigation and prescription by the Manitoba Hydro environmental officer is required.

The riparian buffer is composed of two zones: a management zone (variable width based on Table 2-1) that allows equipment to conduct low ground disturbance clearing and a minimum 7m machine free zone which only allows reaching into zone with equipment but not entering the zone except at trail crossing Figure 2-3).

Table 2-1: Riparian buffer and machine free zone distances based on slope

Slope of Land Entering Waterway (%)	Width of Machine Free Zone (m)	Width of Riparian Buffer (m)
10	7	30
20	10	40
30	15	55
40	20	70
50	25	85

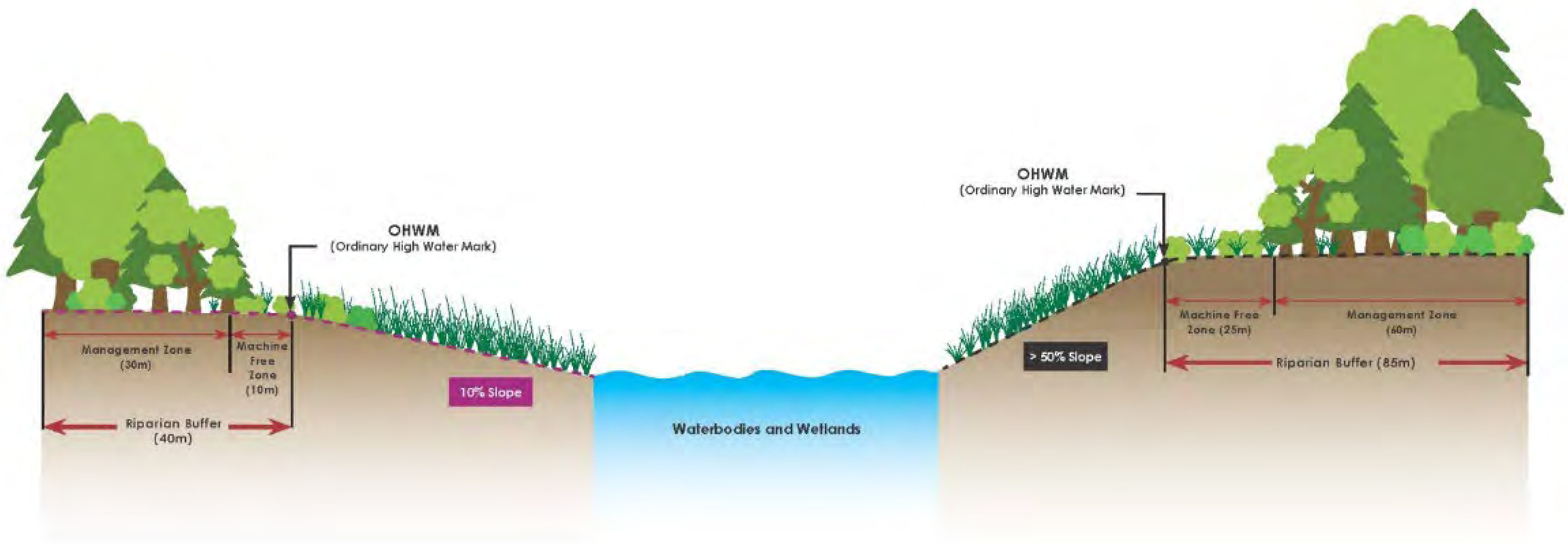


Figure 2-3: Example of zones in a riparian buffer

2.3.1.1 Machine free zones

Machine free zones are work areas where restricted activities such as low ground disturbance clearing (e.g., hand cutting or feller buncher) are permitted by reaching into zone with equipment but not entering the zone. Where applicable, site-specific buffers/setbacks are prescribed in specific mitigation measures for each feature.

Due to differences in topography and other site-specific factors the Manitoba Hydro environmental officer retains the ability to adjust the width of the Machine Free Zone- to not less than 7m, when required.

Setbacks, riparian buffers, and machine free zone distances from sensitive water features are provided in a "Buffers and setbacks" table found in Appendix D. Setbacks are to be maintained from a defined riparian habitat where no work shall occur.

Boundaries of riparian buffers and machine free zones are measured from the ordinary high-water mark (OHWM). If the OHWM is unable to be determined, measure from the tree line (Figure 2-3). Setbacks (if required) are measured from the tree line or from a defined riparian boundary as delineated by an aquatic specialist.

2.3.2 Riparian mitigation

Activities associated with project construction pose a low risk to fish habitat. Because of this low level of risk, general mitigation measures will be applied to modify construction of overhead lines, temporary water crossings, ice bridges and clean snow fills.

In addition to these general mitigation measures, contractors will implement setbacks and buffers as indicated on Site-specific information found in the map sheets of the construction section mapbook "Part 2".

2.3.3 Tower foundations within riparian buffers

In instances where tower placements are located within a riparian buffer, a tracked excavator will be allowed to excavate the foundation while minimizing ground disturbance as much as possible. The excavator must make one trail only and exit on that same trail. Each site where this occurs will be noted by MH environmental inspector/officers for monitoring by vegetation specialist the following season to determine if any further re-vegetation or rehabilitation is required.

2.4 Wildlife and habitat

2.4.1 Birds and habitat

Vegetation removal activities such as clearing and ground stripping can be destructive to birds and their habitat, such as tree and ground nests, as well as areas in which they find food (foraging areas).

Birds and their habitat are particularly vulnerable during the breeding season when they mate, lay eggs, and raise their young, as they are not able to relocate away from areas of disturbance. Migratory birds, such as geese, ducks and songbirds, and their habitat are protected by federal regulation, which prohibits killing, harassing, or destroying the nests of these birds.

Potential effects of the project on birds include mortality, habitat alteration and fragmentation, sensory disturbance, and disruption of movements. Increases in bird mortality can occur in a variety of forms including collisions with transmission wires and construction vehicles, electrocutions, increased predation, and hunting. Bird-wire strikes are one of the most common causes of mortality for birds, particularly birds with short wings and large body masses. Collisions with wires are more likely over or near open water, the risk of collision would likely be greatest near rivers. As mitigation, bird diverters or aerial markers may be installed in high bird traffic areas. The location of theses bird diverter installations will be provided through design specifications and engineering drawings.

Should construction activities be required during breeding bird timing windows (see "Timing windows" table in Appendix C) please refer to the general mitigation approach for reducing risk to nesting birds found in the "Avian protection documents" (Appendix E; E-1). This decision tree will help to apply the appropriate approach and direct mitigation measures found in Appendices E-1 to E-5. These appendices prescribe levels of disturbance, the breeding bird timing windows, nest sweep and reporting procedures as well as buffer guidelines for each species identified. Through this process, Manitoba Hydro and its contractors will reduce the effects to birds and continue to meet regulatory compliance requirements.

2.4.2 Reptiles / amphibians

Areas where reptiles and amphibians, such as garter snakes, frogs, and toads, mate, and lay eggs (i.e., breed) are sensitive to ground disturbance. Heavy equipment traffic and ground clearing activities that coincide with breeding activities can have a measurable effect on local populations. Further, Manitoba is home to unique and endangered reptiles and amphibians, such as northern leopard frog (found throughout the province) that are protected by legislation and policy.

Potential Project effects on northern leopard frog and common snapping turtle during construction include habitat loss and alteration, which are threats to these populations. As these species are mainly found in riparian areas near large rivers, bodies of water or productive marshes, minimal habitat effects are anticipated with mitigation such as riparian buffers.

Mortality could increase in the project study area during construction due to increased road traffic. Northern leopard frogs are particularly susceptible to road mortality during migration and dispersal.

2.4.2.1 Habitat identification

Amphibians should be assumed to be present in all wetland or shallow water areas supporting emergent vegetation (cattails, bulrushes, lily pads) during the amphibian emergence and breeding period (April 1st to August 15th). Where construction activities occur during this period, mitigations measures will be prescribed on a site-by-site basis, mitigations such as those found in the "Reptile and Amphibian protection document" found in Appendix F.

2.4.3 Mammals

Large-bodied mammals, such as white-tailed deer, are considered sensitive to disturbance. Sensory disturbance from construction activity could result in a temporary loss of effective habitat and disruption of movement, as individuals will likely avoid the construction zone. The risk of wildlife-vehicle collisions could increase due to a greater volume of traffic on roadways, increasing mortality of some mammal species, particularly larger ones such as white-tailed deer.

2.5 Species of concern

Species of concern can include rare vascular plants, rare non-vascular plants, rare wildlife species, and rare ecological communities. The environmental officer / inspector may develop additional mitigation measures in consultation with a qualified biologist and, when necessary, the appropriate regulatory authority.

2.5.1 Species of concern discovery during pre-project construction

Species of conservation concern discovered during pre-project studies along the route have been assessed by an environmental specialist and appropriate mitigation measures have been outlined in the Part 2 CEnvPP mapbook. If rare plants or wildlife species are discovered during future studies along the transmission line refer to the "Species of Concern contingency measures" document found in Appendix G. Further information regarding the discovery of bird nests can be found in Appendix E-3.

2.5.2 Species of concern discovery during project construction

If rare plants, wildlife species or rare ecological communities are identified or suspected along the construction right-of-way during construction (*e.g.*, during survey activities, prior to clearing and construction). Suspend work immediately in the vicinity of any newly discovered species of concern and follow the measures outlined in "Species of Concern contingency measures" document found in Appendix G. Further information regarding the discovery of bird nests can be found in Appendix E-3.

2.6 Agricultural biosecurity

Manitoba Hydro's Agricultural Biosecurity Policy was created to prevent the introduction and spread of disease, pests and invasive plant species in agricultural land and livestock operations. Manitoba Hydro employees and contractors will follow this corporate policy through the execution of the Biosecurity Management Plan found in Appendix H.

Manitoba Hydro staff and contractors have the potential to impact agricultural biosecurity through construction and/or maintenance activities requiring access to agricultural land. Acknowledging this risk, the purpose of the policy is to ensure that Manitoba Hydro staff and contractors take necessary precautions to protect the health and sustainability of the agricultural sector.

The Biosecurity Management Plan also includes procedures to provide guidance and direction to staff and contractors/consultants who may be required to enter agricultural land and the levels of cleaning necessary to reduce the likelihood of transport of invasive species, pests, or disease.

2.7 Soils and terrain

As the basis of natural, medicinal, spiritual, and commercial vegetation, soils and their quality are an important part of ecosystem health and human wellbeing. The types of soil considered to be sensitive are topsoil (the thin, nutrient rich surface soil layer), and soils susceptible to wind erosion. Soils are generally sensitive to loss by erosion or mixing with less suitable soils and quality degradation from compaction. For soil protection measures refer to the Erosion and Sediment Control Plan (Appendix). During construction, soil compaction and rutting can result from the movement of vehicles and equipment, storage of materials, and assembly and erection of towers. Effects of soil compaction and rutting can be mitigated by managing equipment traffic routes and activities for clearing of the transmission right-of-way, and installation of transmission towers to minimize the impact.

The risk to soils is highest with saturated soil conditions, should this situation arise during construction refer to Saturated/Thawed Soils Operating Guidelines (In Appendix J). Existing access routes are planned to be utilized wherever possible to avoid disturbing new areas.

2.7.1 Encountering unexpected contamination

If environmental contamination in the project work area is discovered that is not a result of project activities, report to Manitoba Hydro.

2.8 Cultural and heritage resources

Archaeological sites, or sites where historic and pre-historic artefacts of human activity are found, are sensitive to disturbance and loss from ground disturbance activities, such as clearing and excavation. Artefacts may include tools and objects, such as arrowheads, pottery shards or bottles, or burial sites and human remains. These sites and objects are protected under legislation as a part of our common heritage. Manitoba Hydro is committed to protecting and preserving the environment including, cultural landscapes, and heritage resources affected by the Project. Sites identified as having spiritual or cultural importance through an ongoing First Nations and Red River Métis engagement process (FNMEP) or other communications are considered sensitive to disturbance and should be respected for the values they have to communities.

The Cultural and Heritage Resources Protection Plan (CHRPP; Appendix L) is part of the environmental protection program.

The CHRPP sets out Manitoba Hydro's commitment to safeguard cultural and heritage resources and appropriately handle human remains or cultural and heritage resources discovered or disturbed during the construction of the project.

2.9 Access

Existing intersections, such as those for trails, provincial trunk highways (PTHs), provincial roads (PRs) and railways, are considered sensitive to change or conflicting land uses and as a fixed component of the larger transportation network, intersections are difficult to close or relocate. In conjunction with mitigation measures a standalone document, the access management plan (Appendix X), has been developed to safeguard and support the preservation of environmental, socio-economic, cultural and heritage values within the projects' area of direct impact in the creation of new access.

3.0 Orientation and awareness

3.1 Pre-job meeting (environmental component)

A pre-job meeting will be held between the contractor (senior project staff including contract administrators, environmental/safety officer) and Manitoba Hydro (senior staff including project engineer or designate, the senior environmental assessment officer/ Line Construction business partner, contract administrator and the MH environmental officer / inspector). Upon completion of the meeting, all individuals present at the orientation, both Manitoba Hydro and the contractor representatives, will sign the "Example Environmental pre-work orientation record" found in Appendix N.

The environmental portion of this meeting will include review of:

- Manitoba Hydro's environmental principles and key environmental specifications of the contract
- Further relevant information or precautions that Manitoba Hydro is aware of which pertain to the job
- Procedures/requirements for dealing with environmental stop work orders or improvement orders
- Reporting requirements for environmental incidents and emergencies
- Documentation needs including the review of all pertinent forms (e.g., job planning form; environmental checklist)
- Requirement to educate/train all project employees with respect to the requirements of the CEnvPP

The contractor shall communicate to all field supervisors, subcontractors, and work crews the work specifications, environmental requirements and information provided during the pre-job meeting and notify the senior environmental assessment officer in writing when it has been completed.

3.2 Contractor project orientation

A pre-work orientation meeting is held by the contractor with field crews prior to the initiation of work to ensure that they are aware of the environmental requirements of work at that location. Should project conditions dictate a change in work location, another start-up meeting may be convened.

The contractor is required to ensure minutes, attendance records, and all other pertinent information is recorded and distributed. Manitoba Hydro will attend and if asked, could provide an overview of the environmental concerns / ESS.

In situations where a new employee joins the project, it is the responsibility of the contractor's environment officer to ensure that that employee has been provided with the necessary information and/or training related to the environmental aspects of the project. The contractor will be required to document all instances of new employees to demonstrate that they have received the necessary training.

3.3 Weekly progress meetings

Key personnel will meet on a weekly basis to review and discuss progress to date and planned upcoming work. Environmental requirements for the Project and other environmental issues/concerns may also be discussed during this time. Manitoba Hydro will be responsible for the maintenance of minutes/documents related to these meetings.

3.4 Daily job planning meetings

Field crew job planning meetings will be held daily prior to the commencement of any work. The daily job-planning meeting will include a review of environmental requirements of the planned work and the applicable environmental precautions. All job planning meetings, including the environmental content, shall be documented by the contractor.

4.0 Contractor-developed environmental management plan

Construction contractors will be required to develop environmental management plans as part of the Environmental Protection Program for this project component.

The contractor shall be responsible to develop and implement specific plans for its work as described in Figure 1. The plans will require approval by the MH Line Construction Business Partner / Environmental Specialist.

5.0 Environmental mitigation requirements

Contractors must follow all mitigation measures identified to protect the environment, including environmental sensitive sites (ESS). Two types of mitigation measures must be followed:

- General mitigation measures apply to all project areas
- Specific mitigation measures apply to individual ESS

Contractors will need to modify construction activities in accordance with general mitigation measures (Section 5.2) and site-specific mitigation measures (see detailed maps and specific mitigation in the construction section CEnvPP Mapbook "Part 2").

5.1 General mitigation requirements

Construction considerations required for all Project areas are considered general mitigation and are applicable to all construction areas.

NOTE: Site specific mitigation measures found in mapbooks will override the general mitigation measures found below.

There is overlap and duplication of mitigation measures amongst the above categories, this allows the user to look up the actions they must perform by different categories. The general mitigation measures are provided under the following five categories: 1) Management (MM); 2) Project activity (PA); 3) Project component (PC); 4) Environment component (EC); and 5) Environmental issue (EI), as follows:

(MM) Management environmental protection measures include management, contractual, administrative, and other measures that are common to all environmental protection categories and topics.

(PA) Project activity environmental protection measures include construction activities that are likely to cause direct environmental effects. Project activities are action words or phrases that are carried out during construction of the Project such as drilling, clearing, etc.

(PC) Project component environmental protection measures relate to major components of the Project. The Project is very large and complex consisting of several major components including transmission lines, converter stations and ground electrode facilities, and involves access trails, stream crossings, construction camps, marshalling yards, etc.

(EC) Environmental component protection measures include important or vulnerable components of the environment that are subject to environmental effects of the Project. Some environmental components are particularly vulnerable to construction of transmission lines, converter stations, ground electrode facilities and other project components and activities, and warrant separate consideration. Example environmental components include agricultural areas, fish habitat, heritage sites and wetlands.

(EI) Environmental issue and topic protection measures include important issues and topics identified for the Project. Environmental issues and topics include emergency response, erosion/sediment control, hazardous substances, petroleum products and soil contamination.

5.2 General mitigation tables

Access roads and trails (PC-1)	
ID	**Mitigation**
PC-1.01	Access roads and trails no longer required will be decommissioned and rehabilitated in accordance with the Rehabilitation and Invasive Species Management Plan (Appendix X).
PC-1.02	Access roads and trails required for future monitoring, inspection or maintenance will be maintained in accordance with the Access Management Plan.
PC-1.03	Access roads and trails will be constructed to a minimum length and width to accommodate the safe movement of construction equipment.
PC-1.04	Access roads and trails will be constructed and operated in accordance with contract specifications.
PC-1.05	Access roads and trails will be provided with erosion and sediment control measures in accordance with the Erosion and Sediment Control Plan.
PC-1.06	All season access roads will not be permitted within established buffer zones and setback distances from waterbodies, wetlands, riparian areas and water bird habitats.
PC-1.07	Approach grades to waterbodies will be minimized to limit disturbance to riparian areas.
PC-1.08	Bypass trails, sensitive sites and buffer areas will be clearly marked prior to clearing, to identify that prescribed selective clearing is to occur as per map sheets.
PC-1.09	Contractor will be restricted to established roads, trails and cleared construction areas in accordance with the Access Management Plan.
PC-1.10	During winter construction, where necessary (i.e., unfrozen wetlands, creeks), equipment will be wide-tracked or equipped with low-ground pressure tires to minimize rutting and limit damage and compaction to surface soils. If wet conditions exist the use of construction matting/temporary bridge is also permitted.

Access roads and trails (PC-1)	
ID	**Mitigation**
PC-1.11	Equipment, machinery and vehicles will only travel on cleared access roads and trails, and will cross waterways at established temporary and permanent crossings.
PC-1.12	Existing access roads, trails or cut lines will be used to the extent possible. Permission to use existing resource roads (i.e. forestry roads) will be obtained.
PC-1.13	MSD work permits will be obtained prior to the commencement of the project.
PC-1.14	No chemical melting agents are to be utilized.
PC-1.15	Only water and approved dust suppression products will be used to control dust on access roads where required. Oil or petroleum products will not be used.
PC-1.18	Routing for access roads and trails should follow natural terrain contours to the extent possible and should be minimized adjacent to and approaching waterbodies.
PC-1.19	Surface water runoff will be directed away from disturbed and erosion prone areas but not directly into waterbodies.
PC-1.20	Vegetation control along access roads and trails will be in accordance with Rehabilitation and Invasive Species Management Plan.
PC-1.23	The contractor shall check that rock utilized for access road construction does not have acid or alkali generating properties.
PC-1.24	All constructed access points onto Manitoba Infrastructure (MI) roadways (Provincial Roads or Provincial Trunk Highways) will require a permit from MI.
PC-1.25	Heavy equipment will not be allowed access to MI roadways without the appropriate protection and permits.
PC-1.26	Access roads and trails that use or cross MI roadways care will be taken to ensure excessive amounts of material are not tracked onto the roadway, with contractor being responsible for cleanup.

Access roads and trails (PC-1)	
ID	**Mitigation**
PC-1.27	Any temporary constructed access and associated debris within an MIT right of way will need to be removed seasonally and once the project is completed.
PC-1.28	All works undertaken within the MI right-of-way (ROW) will adhere to the MI traffic control policies.
PC-1.30	Required travel off existing roads will be minimized and restricted to previously designated and approved routes.
PC-1.31	The contractor is required to install and maintain access road signage indicating road or trail number as per signage standards.
PC-1.32	If a prospective access road or trail is located off easement and on private land, a private land agreement must be submitted to MH for approval prior to any access use occurring

Agricultural areas (EC-1) [If applicable]	
ID	Mitigation
EC-1.01	All fences and gates will be left in "as-found" condition.
EC-1.02	Any necessary access on agricultural lands will be discussed in advance with the landowner.
EC-1.03	Construction areas and sites will be assessed for compaction and if required will be rehabilitated as per the Rehabilitation and Invasive Species Management Plan, prior to returning them to agricultural use.
EC-1.04	Erosion and sediment control measures will be established in accordance with the Erosion and Sediment Control Plan before construction work commences in agricultural areas where necessary.

Agricultural areas (EC-1) [If applicable]	
EC-1.05	Excess construction materials (i.e. waste, granular fill, clay) will be removed from construction sites and areas located on agricultural lands. Area will be restored to pre-existing conditions.
EC-1.06	Existing access to agricultural lands will be utilized to the extent possible.
EC-1.07	Required travel off existing roads will be minimized and restricted to previously designated and approved routes.
EC-1.08	Vehicle and equipment travel on agricultural lands will follow existing roads, trails and paths to the extent possible.
EC-1.09	Where access to agricultural land is necessary the biosecurity management plan must be followed.
EC-1.10	When construction activities take place through agricultural lands drainage patterns are not to be altered, any anticipated diversions of surface water will require authorization under The *Water Rights Act*. This applies to creating new drainage, blocking natural drainage or diverting flows around a site.

Aircraft use (EI-1) [If applicable]	
ID	Mitigation
EI-1.01	Contractors using aircraft (including drones) will submit flight plans in advance of flying to the Manitoba Hydro project engineer or delegate during active construction periods.
EI-1.02	Fuel storage, handling and dispensing at aircraft landing areas will conform to provincial legislation and guidelines.

Blasting and exploding (PA-1)	
ID	Mitigation
PA-1.01	A communication protocol will be developed to notify affected parties of blasting operations and conductor splicing. Affected parties may include Manitoba Environment and Climate, RCMP, municipalities, landowners, and resource users.
PA-1.02	Blasting will be conducted and monitored in accordance with Fisheries and Oceans Canada Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters.
PA-1.04	Blasting will not be permitted during timing windows established for sensitive bird breeding, nesting and brood rearing months.
PA-1.05	Explosives will be stored, transported and handled in accordance with federal requirements through the *Explosives Act* and *Transportation of Dangerous Goods Act* and provincial regulations stated in *The Workplace Safety and Health Act*.
PA-1.06	Implode compression conductor splicing will be minimized to extent possible on weekends and after normal working hours in residential areas.
PA-1.07	Quarry blasting operations and conductor splicing will be scheduled to minimize disturbance to wildlife and area residents, and to ensure the safety of workers.
PA-1.08	The blasting contractor will be in possession of valid licenses, permits and certificates required for blasting in Manitoba.
PA-1.09	The blasting contractor will submit a blasting plan to the contract administrator for review and approval prior to commencement of blasting operations.

Blasting and exploding (PA-1)	
ID	Mitigation
PA-1.10	Use of ammonium nitrate and fuel oil will not be permitted in or near waterways. Only DFO approved explosives shall be permitted in or near waterways.
PA-1.11	Warning signals will be used to warn all project personnel and the public of safety hazards associated with blasting.
PA-1.12	Written and/or oral notification will be outlined in the communication plan prior to each blasting period.
PA-1.15	The blasting contractor shall check that blast rock does not have acid or alkali generating properties.

Borrow pits and quarries (PC-2)	
ID	Mitigation
PC-2.01	Decommissioning of access to abandoned borrow pits and quarries will be managed in accordance with the Access Management Plan.
PC-2.02	All equipment and structures will be removed from borrow pits prior to abandonment.
PC-2.03	Borrow pits and quarries will be designed, constructed and operated in compliance with provincial legislation and guidelines.
PC-2.04	Borrow pits and quarries will not be located within 150 m of a provincial trunk highway or provincial road unless an effective vegetated berm is provided to shield the area from view.

Borrow pits and quarries (PC-2)	
ID	Mitigation
PC-2.05	Borrow pits and quarries will not be located within established buffer zones and setback distances from identified environmentally sensitive sites without approval from MH environmental officer.
PC-2.06	Drainage water from borrow pits and quarries will be diverted through vegetated areas, existing drainage ditch(es) or employ a means of sediment control prior to entering a waterbody.
PC-2.07	Erosion and sediment controls will be put in place in accordance with the Erosion and Sediment Control Plan before borrow pit excavation commences, when required as determined by the MH environmental officer / inspector.
PC-2.08	Fuel storage will not be permitted near stockpiles outlined in PC 5.21.
PC-2.09	Garbage, debris or refuse will not be discarded into borrow pits and quarries.
PC-2.10	Only water and approved dust suppression products will be used to control dust on access roads where required. Oil or petroleum products will not be used.
PC-2.11	Organic material, topsoil and subsoil with-in borrow pits and quarries will be stripped and stockpiled for use in future site rehabilitation.
PC-2.12	Previously developed borrow sites and quarries will be used to the extent possible before any new sites are developed.
PC-2.15	Vegetated buffer areas will be left in place when borrow pits are cleared in accordance with provincial guidelines.
PC-2.16	Vegetation control at borrow pits and quarries will be in accordance with the Rehabilitation and Invasive Species Management Plan.

Borrow pits and quarries (PC-2)	
ID	Mitigation
PC-2.17	Vegetation in active Manitoba Hydro permitted borrow pits and quarries will be maintained as per the Rehabilitation and Invasive Species Management Plan.
PC-2.18	Worked out borrow pits and granular quarries will be left with a slope no steeper than 4:1 (horizontal to vertical) side slopes.
PC-2.24	The blasting contractor shall check that blast rock does not have acid or alkali generating properties.
PC-2.26	Vehicles hauling materials to or from the work site that have the potential for dust emissions should be hauled with the load enclosed by an anchored tarp, plastic or other material.
PC-2.27	As marshalling yards, borrow sources, temporary work spaces, work camps are identified or route changes required, additional heritage monitoring activities may be required to be conducted prior to approval.
PC-2.28	If weeds (invasive species) are present on the surface of a borrow or quarry where material is being sourced, the surface must be stripped (to a minimum depth of 10 centimetres) and stockpiled separately from materials that will be transported away from the site.

Built-up and populated areas (EC-2) [If applicable]	
ID	Mitigation
EC-2.01	Construction activities and equipment shall be managed to avoid damage and disturbance to properties, structures and operations within or adjacent to the project work area. If damages occur, repairs must be completed to a pre-existing or improved condition in a timely manner.

Built-up and populated areas (EC-2) [If applicable]	
EC-2.02	Mud, dust and vehicle emissions shall be managed in a manner that ensures safe and continuous public activities near construction sites where applicable.
EC-2.03	Water or dust suppression products approved by Manitoba Hydro will be used to control dust on access roads as required.
EC-2.04	Vehicles hauling materials to or from the work site that have the potential for debris or dust emissions should be hauled with the load enclosed by an anchored tarp, heavy plastic sheeting or other suitable material.
EC-2.05	Noisy construction activities where noise and vibration may cause disturbance and stress in built-up areas shall observe all applicable noise bylaws.
EC-2.06	All necessary traffic signage, barricading and other appropriate protective measures shall be provided and maintained so as to cause the least risk and inconvenience to vehicle and pedestrian/recreational traffic and other public use in accordance with Municipal and Provincial requirements.
EC-2.07	Retain existing vegetation to extent where possible and revegetate disturbed areas to the pre-existing or improved condition in a timely manner.

Burning (PA-2)	
ID	Mitigation
PA-2.01	All occurrences of uncontrolled burning or fire spreading beyond the debris pile will be reported immediately to Manitoba Hydro.
PA-2.02	Any residue or unburned materials remaining post-burn is not to encumber operations or re-vegetating activities.
PA-2.04	Burning of solid wastes including kitchen wastes and treated wood will not be permitted.
PA-2.05	Burning will be monitored to ensure that fires are contained and subsequent fire hazards are not present. Post season all burn piles will be scanned for hot spots using infrared scanning technology.
PA-2.06	Burning will not be carried out within riparian buffer zones or setbacks for stream crossings or waterbodies.
PA-2.07	A burning permit is required between April 1st and November 15.
PA-2.08	Debris and wood chip piles located near habitation or highways will only be burned when weather conditions are favorable to ensure the safe dispersal of smoke and in accordance with burning permits where applicable.
PA-2.10	Firefighting equipment required by legislation, guidelines, contract specifications and work permits will be kept on site and maintained in serviceable condition during burning.
PA-2.11	Slash will be piled in a manner that allows for clean, efficient burning of all material and on mineral soils where applicable.
PA-2.12	Burning of any material is not permitted on Manitoba Infrastructure (MI) roadway right-of-way's.

Burning (PA-2) - continued	
ID	Mitigation
PA-2.13	The contractor will take steps (such as choosing location and weather conditions) to minimize the impact that smoke from slash burning may have on landowners, and specifically landowner residences.

Clearing (PA-3)	
ID	Mitigation
PA-3.01	Riparian buffers shall be a minimum of 30 m and increase in size based on slope of land entering waterway (see riparian buffer table in CEnvPP). Within these buffers shrub and herbaceous understory vegetation will be maintained along with trees that do not violate Manitoba Hydro vegetation clearance requirements.
PA-3.02	Access to clearing areas will utilize existing roads and trails to the extent possible.
PA-3.03	All clearing and construction equipment is to remain within the bounds of access routes and the Project footprint identified.
PA-3.04	Areas identified for selective clearing (e.g., buffer zones, sensitive sites) will be flagged prior to clearing.
PA-3.05	Chipped or mulched material may be collected for use in construction areas and sediment / erosion control on site.
PA-3.07	Cleared trees and woody debris will not be pushed into (or adjacent) to standing timber, or within the high-water mark of wetlands or waterbodies
PA-3.10	Clearing is allowed only within the reduced risk time period for wildlife illustrated (in Appendix C). If clearing within the sensitive time period for wildlife, further mitigation and approvals would be required.
PA-3.11	Clearing within environmentally sensitive sites, not designated for organic removal will be carried out in a manner that minimizes disturbance to existing organic soil layer.
PA-3.12	Construction vehicles where possible will be wide-tracked or equipped with low-ground pressure tires to minimize rutting and limit damage and compaction to surface soils.

Clearing (PA-3)	
ID	Mitigation
PA-3.13	Construction vehicles, machinery and heavy equipment will not be permitted in designated machine-free zones except at designated crossings.
PA-3.14	Danger trees will be flagged/marked for removal using methods that do not damage soils and adjacent vegetation.
PA-3.15	During clearing environmentally sensitive sites, along the right of way will be clearly identified by signage and/or flagging
PA-3.16	In locations where grubbing and vegetation stripping is not required, disturbance to roots and adjacent soils will be minimized.
PA-3.17	Machine clearing will remove trees and brush with minimal disturbance to existing organic soil layer using a shear "V" or "K-G" type blades, feller-bunchers, mulcher, chipper and other means approved by the MH environmental officer.
PA-3.18	Property limits, right-of-way boundaries, buffers and sensitive areas (where applicable) will be clearly marked with stakes and/or flagging tape prior to clearing.
PA-3.20	Slash piles will be placed at least 15 m from forest stands.
PA-3.21	Slash piles will not be placed on the surface of frozen waterbodies and will not be located within established setbacks from waterbodies or within the ordinary high water mark.
PA-3.22	If extreme wet weather or insufficient frost conditions results in soil damage from rutting refer to the sediment and erosion control plan as well as the saturated/thawed soils operating guidelines
PA-3.23	Trees containing active nests and areas where active animal dens or burrows are encountered will be left undisturbed until unoccupied.

Clearing (PA-3)	
ID	Mitigation
PA-3.24	Trees will be felled toward the middle of rights-of-way or cleared area to avoid damage to standing trees. Trees will not be felled into waterbodies.
PA-3.26	As per Clearing Management Plan (Appendix X), timber that is not salvaged will be chipped and/or mulched in accordance with timing windows, or permit conditions.
PA-3.28	If clearing is needed on a Manitoba Infrastructure (MI) roadway right-of-way, clearance must be obtained from MI in advance.
PA-3.29	When elm trees are removed the stump must be debarked to the soil line or stump must be ground or removed to flush or just below the soil line.
PA-3.30	All elm wood must be immediately disposed of onsite by burning/chipping (<5cm) or transported to a designated elm disposal site.
PA-3.31	Storing elm wood firewood is prohibited under the *Dutch Elm Disease Act*.
PA-3.32	During mulching or chipping activities, debris must be directed away and not enter watercourses.

Concrete wash water and waste (EI-13)	
ID	Mitigation
EI-13.01	Wash water and solid waste will not be discharged onto the ground at the project site.

Concrete wash water and waste (EI-13)	
ID	Mitigation
EI-13.02	All concrete solid waste and wash water will be collected and removed from the project site by the concrete supplier or treated on site in an approved settling pond.
EI-13.03	High density polyethylene geomembrane liners and either earth or physical berms may be used for a temporary concrete washout for uncured or partially cured concrete.
EI-13.04	All water from chute washing activities will be contained in leak proof containers or in an approved settling pond.
EI-13.05	All water that has been used for wash out purposes and associated activities will be disposed in an appropriately sized settling pond(s) treated to meet turbidity (total suspended solids [TSS]) and pH requirements prior to discharge. Turbidity will be treated by settlement or filtration; pH will be treated by use of acid, dry ice, carbon dioxide gas or other methods.
EI-13.06	All water that has been used for wash out purposes and associated activities will be treated to meet the Manitoba Water Quality Standards, Objectives, and Guidelines (Tier 1) for municipal wastewater effluents of 25 mg/L TSS prior to discharge.
EI-13.07	All water that has been used for wash out purposes and associated activities will be treated to meet the Manitoba Water Quality Standards, Objectives, and Guidelines (Tier 3; MWS 2011) for the protection of aquatic life for pH 6.5-9.0, prior to discharge into a watercourse.
EI-13.08	Cured concrete can be transported in non-hazardous waste containers and disposed of at a licensed facility.
EI-13.09	Any uncured and partly cured concrete will be kept isolated from watercourses/ditches.

Construction camps (PC-3) [If applicable]	
ID	Mitigation
PC-3.01	A food handling permit will be obtained from the local public health inspector prior to the operation of kitchens.
PC-3.02	Animal-proof garbage containers with regular removal of food waste to approved waste management facilities will be used to manage food waste.
PC-3.03	Construction camp sites will be kept tidy at all times. Waste materials including litter will be collected for disposal..
PC-3.04	Construction camps will be located based on criteria that consider soil type, topography, land form type, wildlife habitat and other environmental factors.
PC-3.05	Crown land permits will be obtained for construction camps as required.
PC-3.06	Erosion sediment control in accordance with the Erosion and Sediment Control Plan and drainage management measures will be put in place prior to construction where applicable.
PC-3.07	Feeding or harassment of any wildlife is prohibited.
PC-3.08	Firebreaks will be constructed around camp locations where there is a risk of fire.
PC-3.09	Hunting and harvesting of wildlife by project staff will not be permitted while working on the project sites.
PC-3.10	Liquid and solid sewage wastes held in tanks will be removed in accordance with the Waste and Recycling Management Plan (Appendix X) by a licensed contractor and taken to licensed or approved disposal areas.

Construction camps (PC-3) [If applicable]	
ID	Mitigation
PC-3.11	Problem wildlife will be reported immediately to the nearest Manitoba Environment and Climate office.
PC-3.12	Propane tanks for camp use will be stored in dedicated, vehicle protected and secure areas at a safe distance from kitchen and sleeping quarters in accordance with provincial legislation and national codes.
PC-3.13	Sewage and grey water holding tanks will be sited in accordance with provincial legislation, and federal and provincial guidelines, and a minimum of 100 m from the ordinary high water mark of any waterbody.
PC-3.14	Sewage and grey water will be collected in holding tanks and chemical toilets.
PC-3.15	Spill control and clean-up equipment and materials will be provided for construction camps in accordance with the Emergency Preparedness and Response Plan.
PC-3.16	The MH Environmental Officer /Inspector will inspect rehabilitated construction camps in accordance with the Rehabilitation and Invasive Species Management Plan to assess the success of re-vegetation and to determine if additional rehabilitation is required.
PC-3.17	Vegetation control at construction camps will be in accordance with the Rehabilitation and Invasive Species Management Plan.
PC-3.18	Waste and recyclables will be sorted, segregated and removed in accordance with the Waste and Recycling Management Plan to a licensed or approved waste management facilities site and/or recycling facility.
PC-3.19	Food, greases and wastes will be stored in sealed, air-tight containers and managed as per PA-3.2.

Construction camps (PC-3) [If applicable]	
ID	Mitigation
PC-3.20	If a prospective camp is to be located on private land, a private land agreement must be submitted to MH for approval prior to any setup occurring
PC-3.21	As marshalling yards, borrow sources, temporary work spaces, work camps are identified or route changes required, additional heritage monitoring activities may be required to be conducted prior to approval.
PC-3.22	Burning of solid wastes including kitchen wastes will not be permitted.

Construction matting (PA-11)	
ID	Mitigation
PA-11.01	Verify that mats are clean and free of soil, debris and plant material when they arrive for use on site.
PA-11.02	Mats cannot be constructed of chemically treated wood products.
PA-11.03	In wetlands three mats is the maximum number that can be stacked and used in one location.
PA-11.04	Follow the biosecurity management plan for cleaning washing and disinfecting matting prior to moving it to a new project location.
PA-11.06	Matting should not impede or redirect natural drainage patterns or water courses.
PA-11.07	Mat removal will take place from the existing mat road, working in a backwards fashion (from work site to initial access point).
PA-11.08	When mat removal is complete all remaining matting debris will be cleaned, up and transported to an approved waste disposal facility
PA-11.09	When matting is removed any compaction of soils will have to be rehabilitated

Demobilizing and cleaning up (PA-4)	
ID	Mitigation
PA-4.01	Temporary buildings, structures, trailers, equipment, utilities, waste materials, etc. will be removed from construction areas and sites when work is completed.
PA-4.02	Construction access roads/trails will be decommissioned and rehabilitated as per the Access Management Plan.
PA-4.03	After demobilizing and clean-up, construction areas and sites will be assessed by the contractor for rehabilitation. Contractor prescriptions will be developed as per Rehabilitation and Invasive Species Management Plan and submitted for approval to MH environmental officer.
PA-4.05	Petroleum product and other temporary hazardous material storage areas will be cleaned up, assessed and, if necessary, remediated in accordance with provincial guidelines and Manitoba Hydro guidelines.
PA-4.06	Water crossings, ditches and drains will be left free of obstructions so as not to impede water flow.

Directional drilling (PA-12)	
ID	Mitigation
PA-12.01	A frac-out contingency plan will be prepared that includes measures to stop work, contain the drilling mud and prevent its further migration into the watercourse.
PA-12.02	When drilling takes place under a watercourse, the drill entry and exit points will be outside of the riparian buffer of that watercourse.
PA-12.03	A dugout/settling basin at the drilling exit site will be constructed to contain drilling mud to prevent sediment and other deleterious substances from entering the watercourse. If this cannot be achieved, silt fences or other effective sediment and erosion control measures will be installed to prevent drilling mud from entering the watercourse.
PA-12.04	Excess drilling mud, cuttings will be disposed of at an adequately sized disposal site located away from the water to prevent it from entering the watercourse.
PA-12.05	Keep all material and equipment needed to contain and clean up drilling mud releases on site and readily accessible in the event of a frac-out.
PA-12.06	In the event of a frac-out, implement the frac-out contingency plan and notify all applicable authorities. Prioritize clean-up activities relative to the risk of potential harm and dispose of the drilling mud in a manner that prevents re-entry into the watercourse.
PA-12.07	Stabilize any spoil materials to prevent them from entering the watercourse.
PA-12.08	Re-vegetate any disturbed native vegetation by seeding with native grass species and cover such areas with mulch to prevent erosion and to assist in seeds germination. If there is insufficient time remaining in the growing season, the site should be stabilized (e.g., cover exposed

Directional drilling (PA-12)	
ID	Mitigation
	areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring.
PA-12.09	Maintain effective sediment and erosion control measures in accordance with the Erosion and Sediment Control Plan until re-vegetation of disturbed areas is achieved.
PA-12.10	When obtaining water from fish bearing waterways all pump intakes will be screened according to the *Freshwater Intake End-of-Pipe Fish Screen Guideline* (DFO 1995).
PA-12.11	Water, to mix the drilling mud, shall be brought in from off site and stored in tanks at the entry locations or be withdrawn from local a watercourse.

Draining (PA-5)	
ID	Mitigation
PA-5.01	Construction activities shall not block natural drainage patterns.
PA-5.02	Culverts will be installed and maintained in accordance with *Manitoba Stream Crossing Guidelines* (DFO and MNR 1996) and relevant provincial and municipal acts, regulations and bylaws.
PA-5.03	Dewatering discharges from construction activities will be directed into vegetated areas, existing drainage ditch(s) or a means of sediment control at such a rate that will have adequate flow dissipation at the outlet to ensure it does not cause erosion at the discharge point or at any point downstream.
PA-5.04	Drainage water from construction areas will be diverted through vegetated areas, existing drainage ditch(s) or a means of sediment control prior to entering a waterbody.
PA-5.05	Erosion and sediment control will be provided by the contractor in accordance with the Erosion and Sediment Control Plan.
PA-5.06	Existing, natural drainage patterns and flows will be identified and maintained to the extent possible.
PA-5.14	Flows to Manitoba Infrastructure (MI) roadway drains and ditches will not be altered by construction (increased flow, de-watering and other flow effects) without department approval in advance.
PA-5.15	All drainage, natural or manmade that may deposit construction generated sediments on the MI roadway right-of-way will be managed through the Erosion and Sediment Control Plan.

Drilling (PA-6)	
ID	Mitigation
PA-6.01	Abandoned drill holes will be sealed with bentonite or other effective sealers to prevent interconnection and cross-contamination of ground and surface waters.
PA-6.03	Drilling equipment and machinery will not be serviced within 100 m of waterbodies or riparian areas.
PA-6.04	Drilling fluids and waste materials will be contained and not allowed to drain into waterbodies, riparian areas or wetlands.
PA-6.05	Drilling in environmentally sensitive sites, features and areas will not be permitted unless approved in advance by MH Environmental Officer /Inspector and mitigation measures are implemented.
PA-6.07	Drilling will not be permitted within established buffer zones and setback distances from waterbodies unless approved in advance by MH environmental officer.
PA-6.08	Spill control and clean-up equipment will be provided at all drilling locations.
PA-6.09	The drilling contractor will ensure that equipment and materials are available on site for sealing drill holes.
PA-6.10	The drilling contractor will inspect drilling equipment and machinery for fuel and oil leaks prior to arrival at the project site, and will inspect for fuel and oil leaks and spills regularly.
PA-6.11	Where there is potential for mixing of surface and groundwater, precautions will be taken to prevent the interconnection of these waters.
PA-6.12	The contractor must submit a plan to the MH environmental officer describing how surface water, drill flush, and excess waste grout will be controlled and disposed of, including emergency response plans for

Drilling (PA-6)	
	working in groundwater environmentally sensitive sites for sealing/grouting artesian wells and pumping (if required) excess groundwater.

Emergency response (EI-2)	
ID	Mitigation
EI-2.01	All fires will be reported to Manitoba Hydro
EI-2.02	All spills at construction sites will be reported to Manitoba Hydro
EI-2.03	All vehicles hauling petroleum products will carry spill containment and clean-up equipment.
EI-2.04	Clean-up and the disposal of contaminated materials will be managed in accordance with provincial guidelines and Manitoba Hydro guidelines.
EI-2.05	Emergency Preparedness and Response Plans and procedures will be communicated to all project staff and a copy will be made available at the project site.
EI-2.06	Emergency spill response and clean-up materials and equipment will be available at construction sites, marshaling yards, fuel storage facilities and standby locations.
EI-2.07	Fire extinguishers will be mounted on buildings at locations where they will be most readily accessible. Safety officers will conduct annual inspections of fire extinguishers.
EI-2.08	Orientation for contractor and Manitoba Hydro employees working in construction areas will include emergency response awareness.

Emergency response (EI-2)	
ID	Mitigation
EI-2.09	Contractor to conduct investigation for all provincially reportable spills and fires reported to ensure that procedures are followed and plans remain effective.
EI-2.10	Project emergency response and evacuation procedures in the Emergency Preparedness and Response Plan will be adhered to in the event of forest fires.
EI-2.11	Reasonable precautions will be taken to prevent fuel, lubricant, fluids or other products from being spilled during equipment operation, fuelling and servicing.
EI-2.12	Spill response and clean up equipment will be available for responding to releases for a site location.
EI-2.13	Temporary construction camps will have a designated fire marshal in accordance with the Emergency Preparedness and Response Plan.
EI-2.14	The Emergency Preparedness and Response Plan will be prepared by the contractor, approved by the MH environmental officer prior to construction and updated annually.
EI-2.15	The hazardous materials incident report form will be completed when reporting a spill.
EI-2.16	Should a forest fire be caused by project activities, it must be reported to Manitoba Hydro immediately.
EI-2.17	Firefighting equipment required by legislation, guidelines, contract specifications and work permits will be kept on site and maintained in serviceable condition.

Erosion and sediment control (EI-3)	
ID	Mitigation
EI-3.01	Accumulated sediment will be removed from silt fences and other barriers in accordance with the Erosion and Sediment Control Plan to ensure proper functioning.
EI-3.02	Construction activities may be suspended during extreme wet weather events as per the Saturated/Thawed Soils Operating Guidelines.
EI-3.04	Erosion and sediment control installations will only be removed after disturbed areas are protected and sediments are disposed of in accordance with Erosion and Sediment Control Plan.
EI-3.05	Erosion and sediment control measures will be left in place and maintained until either natural vegetation or permanent measures are established.
EI-3.06	Erosion and sediment control measures will be put in place in accordance with the Erosion and Sediment Control Plan prior to commencement of construction activities and will remain intact for the duration of the project.
EI-3.08	The contractor will be responsible for implementing the Erosion and Sediment Control Plan with procedures put in place prior to commencement of applicable construction activities.
EI-3.09	The contractor will be responsible for monitoring and if required modifying erosion and sediment control installations to ensure continued effectiveness.
EI-3.10	The contractor will communicate the requirement to follow the Erosion and Sediment Control Plan to all project staff and a copy will be made available at the project site.

Erosion and sediment control (EI-3)	
EI-3.11	The MH Environmental Officer /Inspector will make inspections of erosion and sediment control measures to confirm implementation and continued effectiveness.

Fish protection (EC-3)	
ID	Mitigation
EC-3.01	When a work, undertaking or activity results in the deposit of a deleterious substance or creates the potential for such a deposit, Manitoba Hydro will advise DFO of the situation.
EC-3.02	Disturbances to waterbodies, shorelines, riparian areas, etc. will be stabilized to prevent erosion immediately.
EC-3.03	Erosion and sediment control measures will be put in place in accordance with the Erosion and Sediment Control Plan at all project locations where surface drainage is likely to flow into fish bearing waters.
EC-3.04	Fish and fish habitat will be protected in accordance with federal legislation and federal and provincial guidelines.
EC-3.05	Prior to seeking authorization from Manitoba Environment and Climate (MEC) for removal of a Muskrat house, Beaver Dam or Lodge documentation of reasonable attempts to trap resident beavers/muskrat must be provided. Attempts to trap resident Beavers/muskrats must be undertaken by a licensed trapper or person with a valid Wild Animal Kill Permit.
EC-3.06	Project personnel will be prohibited from fishing at project locations or along rights-of-way.

EC-3.07	When obtaining water from fish bearing waterways all pump intakes will be screened according to the *Freshwater Intake End-of-Pipe Fish Screen Guideline* (DFO 1995).
EC-3.08	The withdrawal of any water will not result in reduction in the wetted width of a stream, in order to maintain existing fish habitat
EC-3.09	In watercourses where mussel species of conservation concern are known to occur, watercourse crossings may occur by boat or barge, or during winter (i.e., under frozen conditions) to prevent mortality of the mussels.
Fish protection (EC-3) – continued	
ID	Mitigation
EC-3.10	Muskrat house, Beaver Dam or Lodge removal requires consultation with and the Department of Fisheries and Oceans who may require additional authorizations. House, Dam or Lodge removal may require heavy equipment or explosives which would require an additional Work Permit from Sustainable Development when located on Crown Land.

Grading (PA-7)	
ID	Mitigation
PA-7.02	Grading for gravel pads for construction areas and access roads will be limited to areas where it is needed for the safe and efficient operation of vehicles, machinery and construction equipment.
PA-7.03	Grading for site rehabilitation and restoration will be in accordance with the Rehabilitation and Invasive Species Management Plan.
PA-7.04	Grading will not be permitted within established buffer zones and setback distances from waterbodies.
PA-7.05	Grading will only be permitted within rights-of-ways and construction areas.
PA-7.06	Gravel pads will be graded so the surface runoff is directed away from waterbodies, riparian areas and wetlands.
PA-7.07	Required erosion and sediment control measures will be put in place prior to grading in accordance with the Erosion and Sediment Control Plan.

Groundwater (EC-4)	
ID	Mitigation
EC-4.01	Potable water samples will be collected every two weeks and submitted for analysis according to provincial sampling and analysis protocol.
EC-4.02	Well locations will be marked with flagging tape prior to construction.
EC-4.03	Where there is potential for mixing of surface and groundwater, precautions will be taken to prevent the interconnection of these waters.
EC-4.04	The contractor must submit a plan to the MH environmental officer describing how surface water, drill flush, and excess waste grout will be controlled and disposed of, including emergency response plans for working in groundwater environmentally sensitive sites for sealing/grouting artesian wells and pumping (if required) excess groundwater

Grubbing (PA-8)	
ID	Mitigation
PA-8.01	Construction areas containing soil with high silt content, artesian springs or areas of previous erosion will assessed by MH environmental officer / inspector for additional erosion and sediment control measures.
PA-8.02	Construction areas requiring extensive grubbing will be stabilized as soon as possible to minimize erosion.
PA-8.03	Grubbing will be halted during heavy precipitation events when working in areas of finely textured soils.
PA-8.04	Grubbing will not be permitted within 2 m of standing timber to prevent damage to root systems and to limit the occurrence of blow down.
PA-8.05	Grubbing will not be permitted within established buffer zones and setback distances from waterbodies unless approved by the MH environmental officer.
PA-8.06	Stockpiled materials from grubbing will not block natural drainage patterns.
PA-8.07	Unless required for the work, grubbing will be minimized to the extent possible.
PA-8.08	When not under frozen conditions, erosion and sediment control measures will be put in place in accordance with the Erosion and Sediment Control Plan prior to grubbing in accordance with the Erosion and Sediment Control Plan.
PA-8.09	Windrows of grubbed materials will be piled at least 15 m from standing timber.
PA-8.10	If grubbing is needed on a Manitoba Infrastructure (MI) right-of-way, clearance must be obtained from MI in advance.

Hazardous materials (EI-4)	
ID	Mitigation
EI-4.01	A contractor specific Hazardous Substances Management Plan will be prepared by the contractor; approved by the MH environmental officer prior to construction and updated annually.
EI-4.02	Access to hazardous materials storage areas will be restricted to authorized and trained contractor and Manitoba Hydro personnel.
EI-4.03	An inventory of WHMIS controlled substances will be prepared by the contractor and maintained at each project site and updated as required by provincial legislation.
EI-4.04	Bulk waste oil will be stored in approved aboveground tanks provided with secondary containment in accordance with provincial legislation.
EI-4.06	Contractor personnel will be trained and certified in the handling of hazardous materials including emergency response procedures in accordance with provincial legislation.
EI-4.07	Contractor personnel will receive WHMIS training in accordance with provincial legislation.
EI-4.08	Controlled substances will be labeled in accordance with WHMIS requirements. Required documentation will be displayed and current Materials Safety Data Sheets will be available at each project site in accordance with the Hazardous Substances Management Plan.
EI-4.09	Empty hazardous waste containers will be removed to a licensed or approved disposal site by the contractor.
EI-4.10	Hazardous materials storage sites will be secured, and signs will be posted that include hazard warnings, contacts in case of a release, access restrictions and under whose authority the access is restricted.

Hazardous materials (EI-4)	
EI-4.13	Hazardous substances management procedures will be communicated to all project staff and a copy will be made available at the project site.
EI-4.14	Hazardous substances storage areas including coke materials for ground electrode facilities will be located a minimum of 100 m from the ordinary high water mark of a waterway and above the 100-year flood level.
EI-4.16	Hazardous waste materials will be segregated and stored by type in approved containers within a secondary containment system.
EI-4.17	Indoor storage of flammable and combustible substances will be in fire resistant and ventilated enclosed storage area or building in accordance with national codes and standards.
EI-4.19	Non-hazardous products will be used in place of hazardous substances to the extent possible.
EI-4.20	Orientation for contractor and Manitoba Hydro employees working in construction areas will include hazardous substance awareness.
EI-4.21	Pesticide storage will be in accordance with provincial legislation.
EI-4.22	The contractor will be responsible for the safe use, handling, storage and disposal of hazardous materials including waste as well as procedures for emergency conditions in accordance with provincial and federal legislation and standards.
EI-4.23	The contractor will monitor containers of hazardous substance containers regularly for leaks and to ensure that labels are legible and prominently displayed.
EI-4.24	The MH Environmental Officer /Inspector will make routine inspections of hazardous substance storage sites to confirm that environmental protection measures are implemented and effective.

Hazardous materials (EI-4)	
EI-4.25	Waste oil will be transported by licensed carriers to licensed or approved waste oil recycling facilities.
EI-4.26	Wet batteries will be stored and transported to licensed or approved waste recycling facilities.
EI-4.27	Hazardous waste can be stored temporarily for no longer than 30 days before removal to a licensed or approved disposal site.
EI-4.28	Temporary hazardous material storage containers will be located on level ground and within a structure that is covered by roofing preventing precipitation from entering the storage area or the secondary containment system

Heritage resources (EC-5)	
ID	Mitigation
EC-5.01	All archaeological finds discovered during site preparation and construction will be left in their original position until the project archaeologist is contacted and provides instruction.
EC-5.02	Construction activities will not be carried out within established buffer zones for heritage resources except as approved by the project archaeologist.
EC-5.03	Environmental protection measures for heritage resources will be reviewed with the contractor and employees prior to commencement of any construction activities.
EC-5.04	Orientation for project staff working in construction areas will include heritage resource awareness and training including the nature of heritage resources and the management of any resources encountered.
EC-5.05	Orientation information will include typical heritage resource materials and reporting procedures.
EC-5.06	The contractor will report heritage resource materials immediately to the contract administrator. Construction activities will cease in the immediate vicinity until the project archaeologist is contacted and provides further instruction.
EC-5.07	The Culture and Heritage Resource Protection Plan will be adhered to during preconstruction and construction activities.
EC-5.08	The MH environmental officer / inspector will inspect borrow pits and other excavations for the presence of heritage resource materials.
EC-5.09	As marshalling yards, borrow sources, temporary work spaces, work camps are identified or route changes required, additional heritage monitoring activities may be required to be conducted prior to approval.

Management measures (MM)	
ID	Mitigation
MM-01	All licenses, permits, contracts, project specifications, guidelines and other applicable documents will be obtained and in the possession of both the contractor and Manitoba Hydro prior to commencement of applicable work.
MM-02	All project participants will ensure that project activities are carried out in compliance with applicable legislation, guidelines and, contractual obligations and environmental protection plan provisions.
MM-03	Environmental concerns will be identified and discussed at planning meetings on an as required basis.
MM-04	Manitoba Hydro will notify First Nation and Red River Métis leadership of active construction schedules, prior to project start-up as per project Communication Plan.
MM-05	Manitoba Hydro will contact local municipal authorities prior to project start-up as per project Communication Plan.
MM-06	Manitoba Hydro will contact local resource users, lodge operators, outfitters and recreational resource users and associations to the extent feasible and practical prior to project start-up as per project Communication Plan.
MM-07	Manitoba Hydro will contact Manitoba Environment and Climate and forest management licence holders prior to clearing regarding timber use opportunities.
MM-08	Manitoba Hydro will meet the contractor at the beginning of each new contract to review environmental protection requirements including mitigation measures, inspections and reporting.
MM-11	Project construction update meetings will be held weekly and include discussion of environmental and safety issues.

Management measures (MM)	
MM-12	Relevant documents including licenses, permits, approvals, legislation, guidelines, environmental protection plans, orthophotos maps, etc. will be made available to project participants.
MM-14	The contractor will obtain all licenses, permits, contracts and approvals other than those that are Manitoba Hydro's responsibility prior to project start-up.
MM-15	The contractor will review terms and conditions of all authorizations, contract specifications, agreements, etc. prior to project start-up or as authorization are acquired and will discuss any questions or concerns with Manitoba Hydro.
MM-16	In areas of active construction the contractor must provide Manitoba Hydro representatives with full and unrestricted access to the right-of-way and all project related work areas so that inspections can occur.
MM-17	The CEnvPP text and map book will available at active construction project sites.
MM-18	The contractor’s environment officer is responsible for the delineation and flagging of all identified project environmentally sensitive sites as per CEnvPP.
MM-19	The contractor must submit all contractor developed environmental plans to Manitoba Hydro before work on the project can commence, the plan may be updated as required.
MM-20	Aside from service animals, pets are not permitted on active construction project sites.
MM-21	Affected private landowners and Crown land encumbrance holders will be notified in advance of the schedule for construction, operation and maintenance.

Management measures (MM)	
MM-22	Temporary work spaces are prohibited from being placed within ESS without written approval from Manitoba Hydro , exceptions may be subject to Sustainable Development approval

Marshaling yards (PC-5) [If applicable]	
(These measures may also apply to Fly yards, Temporary work spaces, Staging areas, Material placement areas etc.)	
ID	Mitigation
PC-5.01	Contractor employees responsible for receipt and distribution of hazardous substances will be trained in handling and transportation of dangerous goods, and WHMIS.
PC-5.02	Emergency Preparedness and Response Plan and procedures for marshaling yards will be developed.
PC-5.03	Erosion, sediment control and drainage management measures will be put in place in accordance with Erosion and Sediment Control Plan.
PC-5.04	Fire breaks will be established a minimum of 6 m around marshaling yards in areas where there is a risk of fire.
PC-5.05	Garbage and debris will be stored in approved containers, sorted for recycling and disposed of at a licensed or approved waste management facilities site.
PC-5.06	Hazardous materials entering and leaving the marshaling yards will be inventoried and accounted for.
PC-5.07	Hazardous materials will be stored in accordance with provincial legislation, and provincial and national codes and standards.
PC-5.08	Marshaling yards will be located based on criteria that consider soil type, topography, land form type, wildlife habitat and other environmental factors.

Marshaling yards (PC-5) [If applicable]	
PC-5.09	Marshaling yards will be located in existing clearings or natural openings.
PC-5.10	Marshaling yards will be located, constructed, operated and decommissioned in accordance with contract specifications and in accordance with the Rehabilitation and Invasive Species Management Plan.
PC-5.11	Once marshaling yards are no longer required, structures, equipment, materials, fences, etc. will be dismantled and moved to storage or a new location.
PC-5.12	Organic material, topsoil and sub-soil stripped during site preparation will be stockpiled separately for later use in site rehabilitation.
PC-5.13	Petroleum products will only be stored, handled and dispensed in designated areas within marshaling yards in accordance with provincial legislation and guidelines.
PC-5.14	Spill control and clean-up equipment to be located at designated areas within marshaling yards.
PC-5.16	Vegetation control at marshaling yards will be in accordance with Rehabilitation and Invasive Species Management Plan.
PC-5.17	Vehicle, machinery and equipment maintenance and repairs will be carried out in designated areas within marshaling yards.
PC-5.18	Hazardous waste materials, fuel containers and other materials will be stored in approved containers and transported to licensed or approved waste management facilities by a licensed carrier.
PC-5.19	Welding mats will be used to minimize the risk of fire.
PC-5.20	The MH environmental specialist will inspect rehabilitated marshaling and work storage areas in accordance with the Rehabilitation and

Marshaling yards (PC-5) [If applicable]	
	Invasive Species Management Plan to assess the success of re-vegetation and to determine if additional rehabilitation is required.
PC-5.21	The contractor will assess lands required for marshaling yards, camps or petroleum storage, dispensing areas and hazardous materials storage areas for potential contamination following Canadian Standards Association Environmental Site Assessment (CSA Z768- 01) procedures.
PC-5.22	As marshalling yards, borrow sources, temporary work spaces, work camps are identified or route changes required, additional heritage monitoring activities may be required to be conducted prior to approval.
PC-5.23	If a prospective camp is to be located on private land, a private land agreement must be submitted to MH for approval prior to any setup occurring.

Petroleum products (EI-5)	
ID	Mitigation
EI-5.01	Aboveground tanks will be equipped with overfill protection, spill containment and collision protection as per legislation.
EI-5.02	All aboveground petroleum product tanks with a capacity greater than 5,000 L will be registered with Manitoba Environment and Climate and have a valid operating permit posted onsite.
EI-5.03	Construction, installation or removal of petroleum product storage tank systems will only occur under the supervision of a registered licensed petroleum technician.
EI-5.04	Use of stationary petroleum product storage tanks with a capacity over 230 liters requires containment for the tank and fueling area (i.e., HDPE spill containment berm).
EI-5.05	Contractors will inspect all mobile and stationary equipment using petroleum products on a regular basis to ensure that measures are taken immediately to stop any leakage discovered.
EI-5.06	Fueling of equipment or portable storage tanks will be a minimum of 100 m from the ordinary high-water mark of any waterbody, unless approved by Manitoba Hydro Environmental Officer, additional mitigations measures will apply, including: • Equipment will fuel up prior to moving into these areas so the need to refuel will be minimized. • Two people will be utilized during refueling - one operator at the switch and another operator at the pump. • The person fueling will attend the nozzle at all times during the fueling operation and not lock out the nozzle. • Personnel involved in fueling will be versed in the requirements of the Spill Response Plan. • Once fueling is complete the fuel truck will leave the area immediately.

Petroleum products (EI-5)	
	• All equipment will be inspected for leaks, frayed hoses and loose fittings before operating. • Large sized spill kit will be present onsite during activities and crews made aware of location of kit and spill procedures.
EI-5.07	Fuelling operations require the operator to visually observe the process 100% of the time.
EI-5.08	Containment areas (berms/dykes/trays, etc.) will be dewatered after precipitation events and the containment water disposed of as specified in contract specifications.
EI-5.10	Only approved aboveground petroleum storage tanks will be used during the construction phase of the project. No underground tanks will be permitted.
EI-5.11	Orientation for contractor and Manitoba Hydro employees working in construction areas will include petroleum product storage and handling awareness.
EI-5.13	Petroleum product inventories will be taken weekly by the owner/operator on all aboveground tanks greater than 5,000 L and retained for inspection by Manitoba Hydro or Manitoba Environment and Climate upon request.
EI-5.14	Petroleum product storage containers in excess of 230 L will be located on level ground and will incorporate secondary containment with a capacity of 110% of the largest container volume. Water collected in the containment shall be removed regularly so as not to diminish the capacity of the containment.
EI-5.15	Petroleum product storage sites and mobile transportation units will be equipped with fire suppressant equipment and products.
EI-5.16	Petroleum product storage tanks will have adequate collision protection.

Petroleum products (EI-5)	
EI-5.17	Petroleum product storage will be located a minimum of 100 m from waterbodies, riparian areas or wetlands.
EI-5.18	Petroleum products stored outside will be in waterproof and labeled containers, placed on spill containment pallets.
EI-5.20	Petroleum products will display required signage, placards and labeling, and will be transported, handled and stored in accordance with provincial legislation.
EI-5.21	Petroleum products will only be stored and handled within designated areas at construction camps and marshaling yards.
EI-5.22	Portable petroleum product storage containers will be placed on spill trays with a capacity of 110% of the largest container when not in use. Accumulated precipitation collected in the containment shall be removed regularly so as not to diminish the capacity of the containment.
EI-5.23	Slip tanks and barrels will be securely fastened to the vehicle during transport and fuelling operations.
EI-5.24	Spill control and clean-up equipment and materials will be available at all petroleum product storage and dispensing locations.
EI-5.26	The contractor will be responsible for the safe use, handling, storage and disposal of petroleum products including waste as well as procedures for emergency conditions in accordance with provincial and federal legislation and standards.
EI-5.27	The contractor will inspect all petroleum product storage tanks and containers regularly for leaks, and product inventories will be recorded and retained for inspection by Manitoba Hydro and Manitoba Environment, Climate, and Parks.

Petroleum products (EI-5)	
EI-5.28	Ignition sources (i.e. smoking) must be at least 7.5m from petroleum product storage areas.
EI-5.29	Transfer of petroleum products between storage areas and work sites will not exceed daily requirements and will be in accordance with provincial legislation and guidelines.
EI-5.30	Used petroleum products (including empty containers) will be collected and transported to a licensed oil recycling facility in approved storage containers.
EI-5.31	Vehicles hauling petroleum products will carry equipment and materials for emergency spill containment and clean-up.
EI-5.32	Warning signs will be posted in visible locations around petroleum product storage areas. Signs will indicate hazard warning, contact in case of a spill, access restrictions and authority.
EI-5.33	All slip tanks are to meet ASTM or ISO or CSA or FMCSA (Federal Motor Carrier Safety Administration) certification.
EI-5.34	Drip containers will be placed beneath all Slip tank nozzles when not in use and regularly monitored, any accumulation removed and appropriately disposed.
EI-5.35	Nozzles used for dispensing petroleum products will have their lever catches removed so that the operator will be present while product is being dispensed.
EI-5.36	When a spill or release is identified, it shall be flagged off to prevent disruption of that area until clean up takes place.
EI-5.37	The contractor is responsible for reporting a spill to Manitoba Hydro of any quantity within 2 hours, with a written report due in 24 hours.

Petroleum products (EI-5)	
EI-5.38	In the case of an externally reportable spill, the contractor is required to contact an MH Environmental Officer /Inspector immediately

Potable water (EI-11)	
ID	Mitigation
EI-11.01	Drinking water holding tanks will be designed for potable water containment.
EI-11.02	Drinking water holding tanks will be cleaned and disinfected before use.
EI-11.03	Potable water used to fill the drinking water holding tanks will be in compliance with federal legislation.
EI-11.05	Leaking fixtures will be repaired in a timely manner.

Rehabilitating and re-vegetation (PA-9)	
ID	Mitigation
PA-9.01	Construction areas no longer required will be re-contoured, stabilized, re-vegetated and restored to near natural conditions in accordance with Rehabilitation and Invasive Species Management Plan.
PA-9.02	Natural re-vegetation will be allowed to occur although active rehabilitation programs may be required at specific sites where erosion warrants seeding or planting.
PA-9.03	Organic material, topsoil and subsoil stripped from construction areas will be stockpiled and protected to be used for future site rehabilitation.
PA-9.04	Rehabilitation of construction areas will incorporate erosion and sediment control measures in accordance with the Erosion and Sediment Control Plan as required.
PA-9.05	Rehabilitation plans will include objectives for restoration of natural conditions, erosion and sediment control, non-native and invasive plant species management, wildlife habitat restoration and restoration of aesthetic values as required.
PA-9.06	Where appropriate, regional native grass mixtures will be used to assist re-vegetation of disturbed areas to control erosion or prevent invasion of non-native species. The mixtures will not contain non-native or invasive species.

Rights-of-way (PC-8)	
ID	Mitigation
PC-8.01	Access to transmission line rights-of-way for clearing and construction will utilize existing roads and trails to the extent possible.
PC-8.02	Access to transmission line rights-of-way will be closed, signed and/or controlled in accordance with an Access Management Plan (Appendix X).
PC-8.03	Additional clearing outside established rights-of-way is subject to Manitoba Environment and Climate approval.
PC-8.04	Clearing and disturbance will be limited to defined rights-of-way and associated access routes to the extent possible.
PC-8.05	Clearing of rights-of-way will occur under frozen or dry ground conditions to minimize rutting and erosion.
PC-8.06	Construction equipment will be wide-tracked or equipped with low-ground pressure tires if there is a potential for rutting and/or compaction to surface soils.
PC-8.07	Disturbed areas along transmission line rights-of-way will be rehabilitated in accordance with site Rehabilitation and Invasive Species Management Plan.
PC-8.08	Environmentally sensitive sites, features and areas will be identified and mapped prior to clearing.
PC-8.09	In situations where the right-of-way doesn't have completely frozen or dry ground conditions alternate products such as construction mats may be used as per the contract specifications.
PC-8.10	Contractors are to develop wet weather protocols that provide for mitigation measures to be implemented when wet soil conditions exist (see wet soil section)

Rights-of-way (PC-8)	
PC-8.11	Temporary work spaces are prohibited from being placed within ESS without written approval from Manitoba Hydro , exceptions may be subject to Sustainable Development approval

Soil contamination (EI-7)	
ID	Mitigation
EI-7.01	A closure report will be prepared for completed soil remediation projects in accordance with provincial guidelines.
EI-7.02	A remediation plan will be prepared by the contractor and submitted to MH environmental officer for sites contaminated by project activities and will remediate soils according to provincial standards.
EI-7.03	All spills and releases reported will be responded to in accordance with provincial legislation and Manitoba Hydro external reporting requirements. (Refer to Appendix K).
EI-7.04	Any contaminated soil treatment areas must be designed and constructed to contain surface runoff and prevent leaching to soil and groundwater.
EI-7.05	Contractor personnel will take all reasonable steps to prevent soil, groundwater and surface water contamination.
EI-7.07	If laboratory results show that the soil is contaminated the soil must be transported to an approved landfill or land farm for remediation, in accordance with a Manitoba Hydro approved remediation plan.
EI-7.10	The contractor will assess lands required for marshaling yards, camps or petroleum storage, dispensing areas and hazardous materials storage areas for potential contamination following Canadian Standards Association Environmental Site Assessment (CSA Z768- 01) procedures.
EI-7.11	The contractor will carry out a CSA Phase I Environmental Site Assessment (CSA Z768-01) at abandoned construction camps, marshaling yards, petroleum product storage, dispensing areas and hazardous materials storage areas if contamination is suspected by MH environmental officer. If required Phase II Environmental Site Assessment (CSA Z769-00) will be conducted by contractor.

Soil contamination (EI-7)	
EI-7.12	The MH environmental officer / inspector will inspect contaminated site assessment and remediation work regularly to confirm that environmental protection measures are implemented and effective.
EI-7.13	When a spill or release is identified, it shall be flagged off to prevent disruption of that area until clean up takes place.

Stripping (PA-10)	
ID	Mitigation
PA-10.01	Construction areas containing soil with high silt content, artesian springs or areas of previous erosion will receive special erosion and sediment control techniques in accordance with the Erosion and Sediment Control Plan.
PA-10.02	Erosion and sediment control measures will be put in place prior to stripping in accordance with the Erosion and Sediment Control Plan as required.
PA-10.03	In areas of known salinity, excavated or stripped soil will be stored on liners or in designated areas were possible.
PA-10.04	Mineral topsoils and surficial organic materials should be stripped separately from subsoils, segregated, and stockpiled for later use in backfilling, contouring and rehabilitation. When soils are backfilled, they are to be replaced in the same order from which they were removed.
PA-10.05	Stockpiled materials from stripping will not block natural drainage patterns.
PA-10.07	Stripping will not be permitted within established buffer zones and setback distances from waterbodies except where approved in work permits, authorizations or contract specifications.
PA-10.08	The contractor will stabilize construction areas requiring extensive stripping as soon as possible to minimize erosion.

Transmission towers and conductors (PC-10)	
ID	Mitigation
PC-10.01	Areas where soil was disturbed will be stabilized and re-vegetated with low growth vegetation as soon as practical.
PC-10.02	During tower foundation excavation organic material/topsoil that was stripped and stockpiled will be spread back evenly over the surface of the disturbed area to encourage site re-vegetation.
PC-10.03	Excavations required for tower installations will be restricted to the minimum required footprint.
PC-10.04	The contract administrator will issue a stop work order if extreme wet weather conditions result in soil damage from rutting and erosion is resulting in sedimentation of adjacent waterbodies.

Vehicle and equipment maintenance (EI-9)	
ID	Mitigation
EI-9.01	An Emergency Preparedness and Response Plan and spill control and clean-up equipment will be provided at all designated vehicle, equipment and machinery maintenance areas.
EI-9.02	Vehicle, equipment and machinery maintenance repair procedures will include containing waste fluids and will use preventative measures such as spill trays and tarps where required.
EI-9.03	Unnecessary idling of vehicles, equipment and machinery will be avoided to the extent practical.
EI-9.04	Vehicle, equipment and machinery maintenance, washing and repairs will be carried out in designated areas located at least 100 m from the ordinary high water mark of a waterbody, riparian area or wetland.
EI-9.05	Vehicle, equipment and machinery operators will perform a daily inspection for fuel, oil and fluid leaks and will immediately shutdown and repair any leaks found. All machinery working near watercourses will be kept clean and free of leaks.
EI-9.06	Vehicles transporting dangerous goods or hazardous products will display required placards and labeling in accordance with provincial legislation.
EI-9.07	Vehicles, equipment and machinery must arrive on site in clean condition of fluid leaks and weed seeds.
EI-9.08	Vehicles, equipment and machinery that carry fuel, hydraulic oil and other petroleum products will also carry spill control and clean-up equipment and materials.

Waste management (EI-10)	
ID	Mitigation
EI-10.01	A Waste and Recycling Management Plan will be developed, prior to construction and updated annually.
EI-10.02	Animal-proof garbage containers with regular removal of food waste to approved waste management facility grounds will be used to manage food waste.
EI-10.03	Construction sites will be kept tidy at all times and bins will be provided wherever solid wastes are generated.
EI-10.04	Indiscriminate burning, dumping, littering or abandonment will not be permitted.
EI-10.06	Waste materials will be collected and transported to a licensed or approved waste management facility in accordance with the Waste and Recycling Management Plan.
EI-10.07	Waste materials remaining at snow disposal sites after melting will be disposed of at a licensed or approved landfill.

Wastewater (EI-12)	
ID	Mitigation
EI-12.01	All sewage haulers will be registered with the Manitoba Environment, Climate, and Parks. A copy of the hauler registration will be provided to MH environmental officer / inspector upon request.
EI-12.02	Wastewater holding tanks will be installed as per provincial legislation and regulation and a minimum of 100 m from the ordinary high water mark of any waterbody.
EI-12.03	Wastewater will be removed from holding tanks when they are no more than 90% full by a registered sewage hauler and disposed of at a licensed wastewater treatment facility.
EI-12.04	Sewage and grey water will be collected in holding tanks and chemical toilets.

Water crossings (PC-9)	
ID	Mitigation
PC-9.01	Access road crossings will be at right angles to waterbodies to the extent possible.
PC-9.02	Riparian buffers shall be a minimum of 30 m and increase in size based on slope of land entering waterway (see riparian buffer table in CEnvPP). Within these buffers shrub and herbaceous understory vegetation will be maintained along with trees that do not violate Manitoba Hydro vegetation clearance requirements.
PC-9.03	Construction vehicles and equipment will not be permitted in designated machine-free zones except at designated crossings.
PC-9.04	Construction of stream crossings will follow the *Manitoba Stream Crossing Guidelines For The Protection of Fish and Fish Habitat* (DFO and MNR 1996).
PC-9.05	Ice bridges are constructed of clean water, ice and snow and snow fills are constructed of clean snow. Materials such as gravel, rock and loose woody material are cannot be used. Crossings cannot impede water flow at any time of the year.
PC-9.06	The withdrawal of any water will not result in reduction in the wetted width of a stream, in order to maintain existing fish habitat. Water flow is maintained under the ice, where this naturally occurs, and If water is being pumped from a lake or river to build up the ice bridge, the intakes are sized and adequately screened to prevent debris blockage and fish mortality.
PC-9.07	Where logs are required for use in stabilizing shoreline approaches, they are clean and securely bound together, and they are removed either before or immediately following work or before the spring freshet.
PC-9.08	When the crossing season is over and where it is safe to do so, create a v-notch in the centre of the ice bridge to facilitate water flow and also to

Water crossings (PC-9)	
	prevent blocking fish passage, channel erosion and flooding. Compacted snow and all crossing materials will be removed prior to the spring freshet.
PC-9.09	No logs or woody debris are to be left within the water body or on the banks or shoreline where they can wash back into the water body.
PC-9.10	Grading of the stream banks for the approaches should not occur. Establish a single entry and exit. If minor rutting is likely to occur, stream bank and bed protection methods (e.g., swamp mats, pads) should be used provided they do not constrict flows or block fish passage.
PC-9.11	Fording should occur only after authorization from an MH environmental Officer/Inspector. Machinery fording a flowing watercourse to bring equipment required for construction to the opposite side is limited to a one-time event (over and back) and is to occur only if an existing crossing at another location is not available or practical to use. One-time fording will be timed to prevent disruption to sensitive fish life stages by adhering to appropriate fisheries timing windows and will not be permitted to occur in areas that are known fish spawning sites.
PC-9.12	Fording should occur under low flow conditions and not when flows are elevated due to local rain events or seasonal flooding, the channel width at the crossing site is no greater than 5 metres from ordinary high water mark to ordinary high water mark.
PC-9.13	In watercourses where mussel species of conservation concern are known to occur, watercourse crossings may occur by boat or barge, or during winter (i.e., under frozen conditions) to prevent mortality of the mussels.
PC-9.14	The contractor is responsible for having signage at each end of any ice bridges indicating the ice thickness (Appendix X) and the date it was last measured.

Water crossings (PC-9)	
PC-9.15	Cleared trees and woody debris will not be pushed into (or adjacent) to standing timber, or within the high-water mark of wetlands or waterbodies
PC-9.16	The contractor requires approval from a Manitoba Hydro Environmental Officer prior to withdrawing water from any waterbody. The withdrawal of water from a waterbody will not reduce water levels to the point of exceeding that waterbody's ability to sustain an active beaver lodge
Wetlands (EC-8)	
ID	Mitigation
EC-8.01	Clearing wastes and other construction debris or waste will not be placed in wetland areas. Existing logs, snags and wood debris will be left in place.
EC-8.02	Wetland areas will be prescribed riparian buffers in site specific mitigation tables in which understory low-growth vegetation will be maintained where possible. Environmental protection measures for working in and around wetlands will be reviewed with the contractor and employees prior to commencement of any construction activities.
EC-8.03	Natural vegetated buffer areas of 30 m will be established around wetlands and riparian zones will be maintained to the extent possible.
EC-8.04	Disturbance of wetlands will only be carried out under frozen ground conditions. If frozen ground conditions don't exist alternate mitigation measures such as construction matting may be used to minimize surface damage, rutting and erosion if approved by MH environmental officer / inspector.
EC-8.05	Cleared trees and woody debris will not be pushed into (or adjacent) to standing timber, or within the high-water mark of wetlands or waterbodies

Wildlife protection (EC-9)	
ID	Mitigation
EC-9.01	Any injured or killed wildlife encountered on the transmission line rights-of-way and associated access roads/trails will be reported to Manitoba Environment, Climate, and Parks.
EC-9.02	Bird Diverters or aerial markers may be installed in high bird traffic areas.
EC-9.03	Boundaries of important wildlife habitats (i.e. mineral licks and stick nests) will be identified in mapsheets and flagged prior to clearing.
EC-9.04	Clearing and construction activities are allowed only within the reduced risk time period for wildlife illustrated (in Appendix C). If clearing within the sensitive time period for wildlife, further mitigation and approvals would be required.
EC-9.06	Animal-proof garbage containers with regular removal of food waste to approved waste management facility will be used to manage food waste.
EC-9.07	Hunting and harvesting of wildlife by project staff will not be permitted while working on the project sites.
EC-9.09	If animal traps or bait sites are encountered within the project footprint they are to be removed for the safety of workers and construction equipment. If found on private land, the landowner will be contacted and have the materials returned to them. If found on Crown land the materials will be released to Manitoba Environment, Climate, and Parks.
EC-9.10	Prior to seeking authorization from Manitoba Environment and Climate (MEC) for removal of a Muskrat house, Beaver Dam or Lodge documentation of reasonable attempts to trap resident beavers/muskrat must be provided. Attempts to trap resident Beavers/muskrats must be undertaken by a licensed trapper or person with a valid Wild Animal Kill Permit.

Wildlife protection (EC-9)	
EC-9.11	No firearms will be permitted at construction sites.
ID	Mitigation
EC-9.12	Orientation for contractor and Manitoba Hydro employees will include awareness of environmental protection measures for wildlife and wildlife habitat.
EC-9.13	Problem wildlife will be reported immediately to Manitoba Environment, Climate, and Parks.
EC-9.15	Trees containing large nests of sticks and areas where active animal dens or burrows are encountered will be left undisturbed until unoccupied. Artificial structures for nesting may be provided if unoccupied nests must be removed.
EC-9.16	Vehicles will not exceed posted speed limits and wildlife warning signs may be installed in high density areas and at known crossings locations as a result of wildlife monitoring.
EC-9.18	Wildlife and wildlife habitat will be protected in accordance with provincial and federal legislation and provincial and federal guidelines.
EC-9.19	Wildlife will not be fed, befriended or harassed.
EC-9.22	New by-pass trails and access routes will be sited where possible to utilize existing natural terrain features and existing vegetation to minimize line of site.
EC-9.23	New occurrences of any listed rare, threatened or endangered species will be documented and provided to Manitoba Environment, Climate, and Parks.
EC-9.24	In watercourses where mussel species of conservation concern are known to occur, watercourse crossings may occur by boat or barge, or

Wildlife protection (EC-9)	
	during winter (i.e., under frozen conditions) to prevent mortality of the mussels.
EC-9.25	Muskrat house, Beaver Dam or Lodge removal requires consultation with and the Department of Fisheries and Oceans who may require additional authorizations. House, Dam or Lodge removal may require heavy equipment or explosives which would require an additional Work Permit from Sustainable Development when located on Crown Land.
EC-9.26	The contractor requires approval from a Manitoba Hydro Environmental Officer prior to withdrawing water from any waterbody. The withdrawal of water from a waterbody will not reduce water levels to the point of exceeding that waterbody's ability to sustain an active beaver lodge

Map sheets and mitigation tables

The map sheets and specific mitigation tables are presented in "Part 2" of the CEnvPP "map book" format. The map sheets provide an overview of environmentally sensitive sites (ESS), while the associated mitigation tables provide specific mitigation requirements related to these ESS.

6.0 References

DFO. 1995. Freshwater intake end-of-pipe fish screen guidelines. Department of Fisheries and Oceans. Published by: Communications Directorate, Department of Fisheries and Oceans, Ottawa, Ontario.

DFO and MNR. 1996. Manitoba stream crossing guidelines for the protection of fish and fish habitat. Fisheries and Oceans Canada and Manitoba Natural Resources.

MWS. 2011. Manitoba water quality standards, objectives and guidelines. Manitoba Water Stewardship Report 2011-01. Water Science and Management Branch, Manitoba Water Stewardship.

PART 2

Construction environmental protection plan Mapbook

PW75 Transmission Project

Construction Environmental Protection Plan Mapbook

July 2023

Draft

Prepared by:

Licensing and Environmental Assessment Department

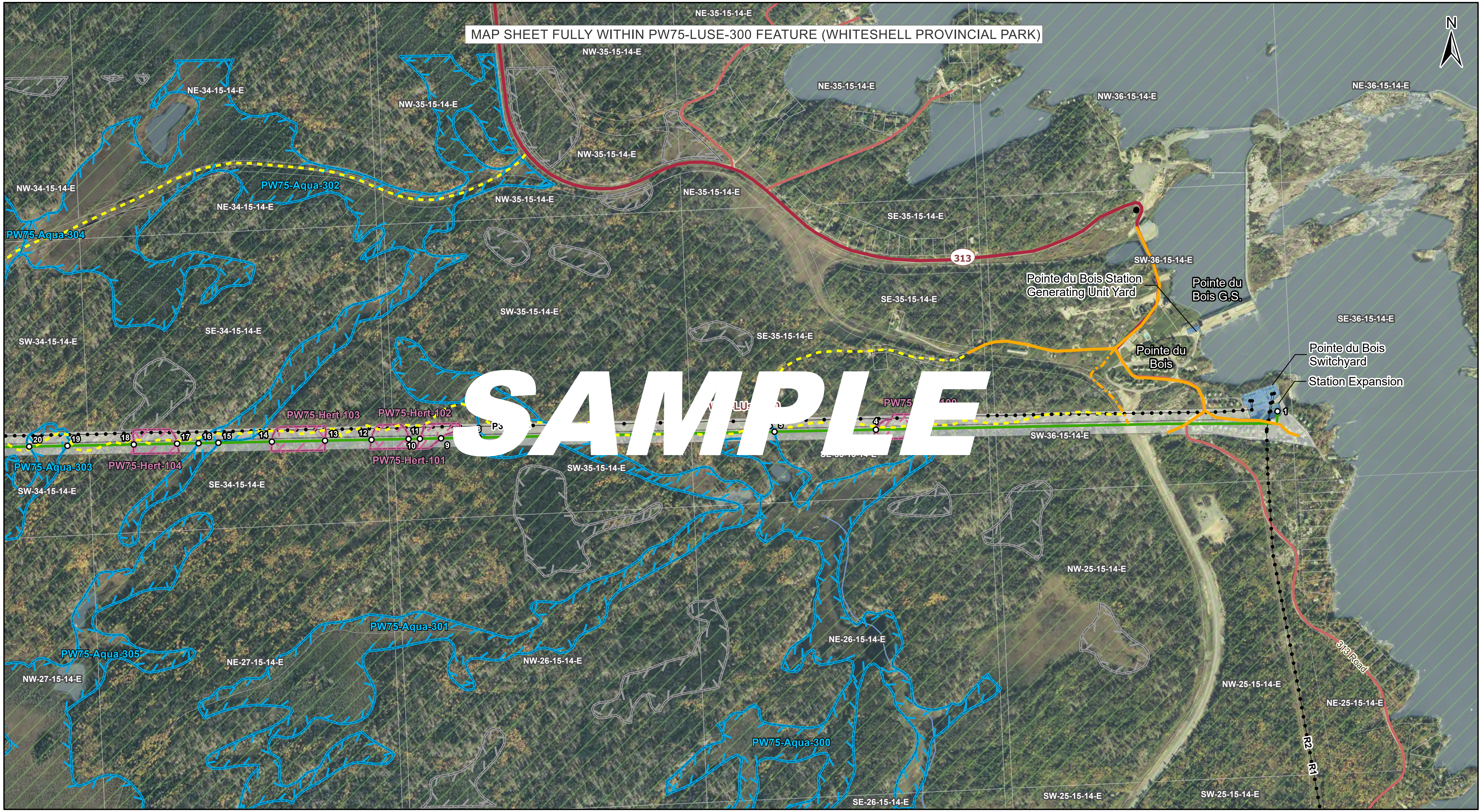
Manitoba Hydro

Document Owner:
Licensing and Environmental Assessment Department
Transmission Planning and Design Division
Transmission Business Unit
Manitoba Hydro

Draft

List of Revisions – PW75 Construction Environmental Protection Plan Mapbook

Number	Nature of Revision	Page/Map #	Revised By	Date
Draft	Added ESS points, lines and polygons	Maps 1-14	Manitoba Hydro	20230707



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Manitoba Hydro

Coordinate System: UTM Zone 14N NAD83
Data Source: MB Hydro, ProvMB, NRCAN
Date Created: July 07, 2023
Version: Draft

0 125 250 500
Metres
1:10,000

Land Base
- Transmission Line
- Highway
- Major Road
- Local Road
- Railway (Operational)
- Railway (Discontinued)
- Provincial Park
- Parcel Fabric
- Rural Municipality

*Tower locations subject to final design

Project Infrastructure
- Final Preferred Route
- Right of Way
- Station / Expansion Area

Sensitive Sites
- Point Features
- Linear Features
- Area Features

Points of Access
- No Crossing
- Existing Gravel Road
- Existing Gravel/Dirt Road
- Field Access
- New Trail
- Restricted Access
- Load Restriction
- Bypass Trail

*Some road names have not been verified

ESS Features
Heritage
- Archaeological

Land Use
- Recreation

Water
- Wetland

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

Draft: For Discussion Purposes Only

Map 1

SAMPLE MITIGATION TABLE (See KEY below for additional Information)

ESS Group: Wetlands 1

**Features represented as polygons* 2

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
Aqua-301	Wetland	21 to 22	E-671537 N-5525458	E-671580 N-5525456	43

3

Potential Effects: 4
Increased erosion and sedimentation; rutting of floodplains; loss of riparian vegetation; potential impact to reptile and amphibian habitat

Specific Mitigation (ID #205): 5

- Carry out construction activities on frozen or dry ground to minimize surface damage, rutting and erosion. Construction matting will be used to protect the area from rutting and exposure to mineral soil during
- Identify and flag a 30 m vegetated (shrub and herbaceous) buffer around site
- Remove trees by low-disturbance methods
- The application of herbicides is prohibited
- Maintain shrub and herbaceous vegetation to the extent possible

KEY to Sample Mitigation Table

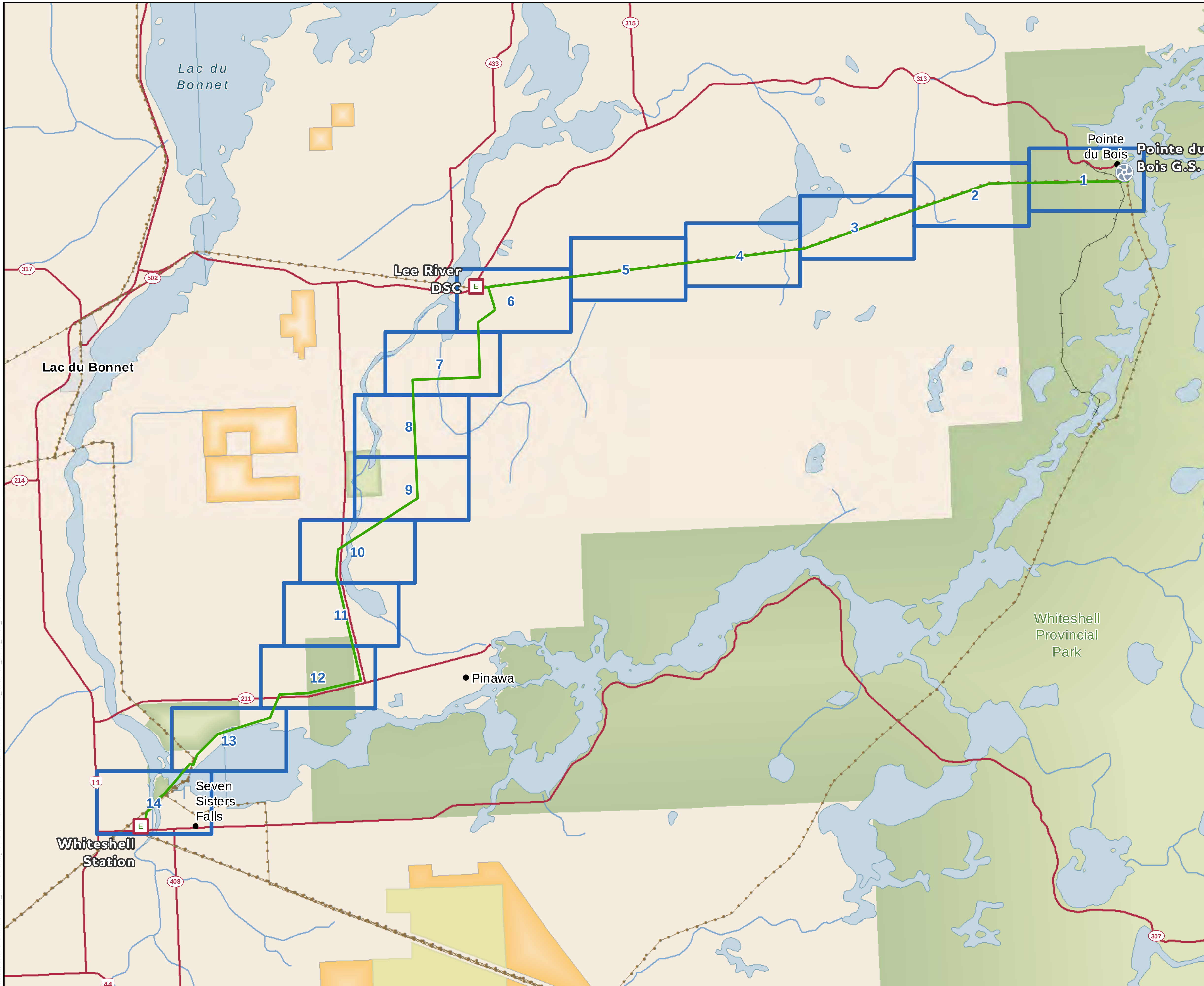
1 ESS Group classification of Environmentally Sensitive Sites (ESS) which are shown on the map
2 Notation indicates the geometry type of the ESS feature
3 ESS location summary; includes the following fields:
- ESS ID - Site specific ID assigned to each ESS according to naming convention **(See ESS naming convention table)**
- ESS Name - Brief name/description of ESS
- Site - identification numbers for the start and stop site points of ESS intersection with the ROW (lines and polygons only)
- Easting/Northing - UTM Zone 14 coordinates of ESS location (for points only)
- Start/Stop - UTM Zone 14 coordinates of the start/stop identification numbers listed in the "Location" field (lines and polygons only)
- Distance – length of ESS feature in meters

4 Potential effects identified for ESS listed in the ESS Location Summary table
5 Mitigation measures identified for a specific site. The ID number indicates a specific combination of mitigation measures
6 Map on which ESS listed in the ESS Location Summary tables are illustrated

ESS NAMING CONVENTION

CATEGORY	GROUP (Number Series Representing Group)	ESS ID (Category-Group Number)
Access	Recreation Trail (100)	RecUse-100
Ecosystem	Habitat (100)	Eco-100
	Research (200)	Eco-200
	Species of Concern (300)	Eco-300
	Invasive Species (400)	Eco-400
	Traditional Use (500)	Eco-500
Heritage	Archaeological (100)	Hert-100
	Cultural (200)	Hert-200
	Historic (300)	Hert-300
Land Use	Conservation (100)	LUse-100
	Crown Land Encumbrance (200)	LUse-200
	Recreation (300)	LUse-300
	Residential (400)	LUse-400
	Community (500)	LUse-500
	Infrastructure (600)	LUse-600
Resource Use	Agriculture (100)	RUse-100
	Food/Medicinal (200)	RUse-200
	Forestry (300)	RUse-300
	Hunting/Fishing (400)	RUse-400
	Trapping (500)	RUse-500
Soils and Terrain	Permafrost (100-200)	Soils-100
	Erosion (300)	Soils-300
	Terrain (400)	Soils-400
Water	Water Crossing (100)	Aqua-100
	Groundwater (200)	Aqua-200
	Wetlands (300)	Aqua-300
	Aquatic Invasive Species (400)	Aqua-400
Wildlife	Birds and Habitat (100)	Wild-100
	Mammal and Habitat (200)	Wild-200
	Reptiles/Amphibians and Habitat (300)	Wild-300
	Line of Sight Buffer (400)	Wild-400

6 Map Number: 7



Manitoba Hydro

Pointe du Bois (PW75) Transmission Project

Project Infrastructure
- Final Preferred Route

Map Tile Index - 1:10,000
- Map Series Tile

Existing Infrastructure
- Electrical Station
- Generating Station
- Existing Transmission Line

Landbase
- Community
- Railway
- Provincial Highway
- Provincial Road
- First Nation Lands
- Ecological Reserve
- Wildlife Management Area
- Provincial Park

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date Created: June 27, 2023

N

0 5 Kilometres
0 1.5 3 Miles

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Index of Map Series Environmental Protection Plan

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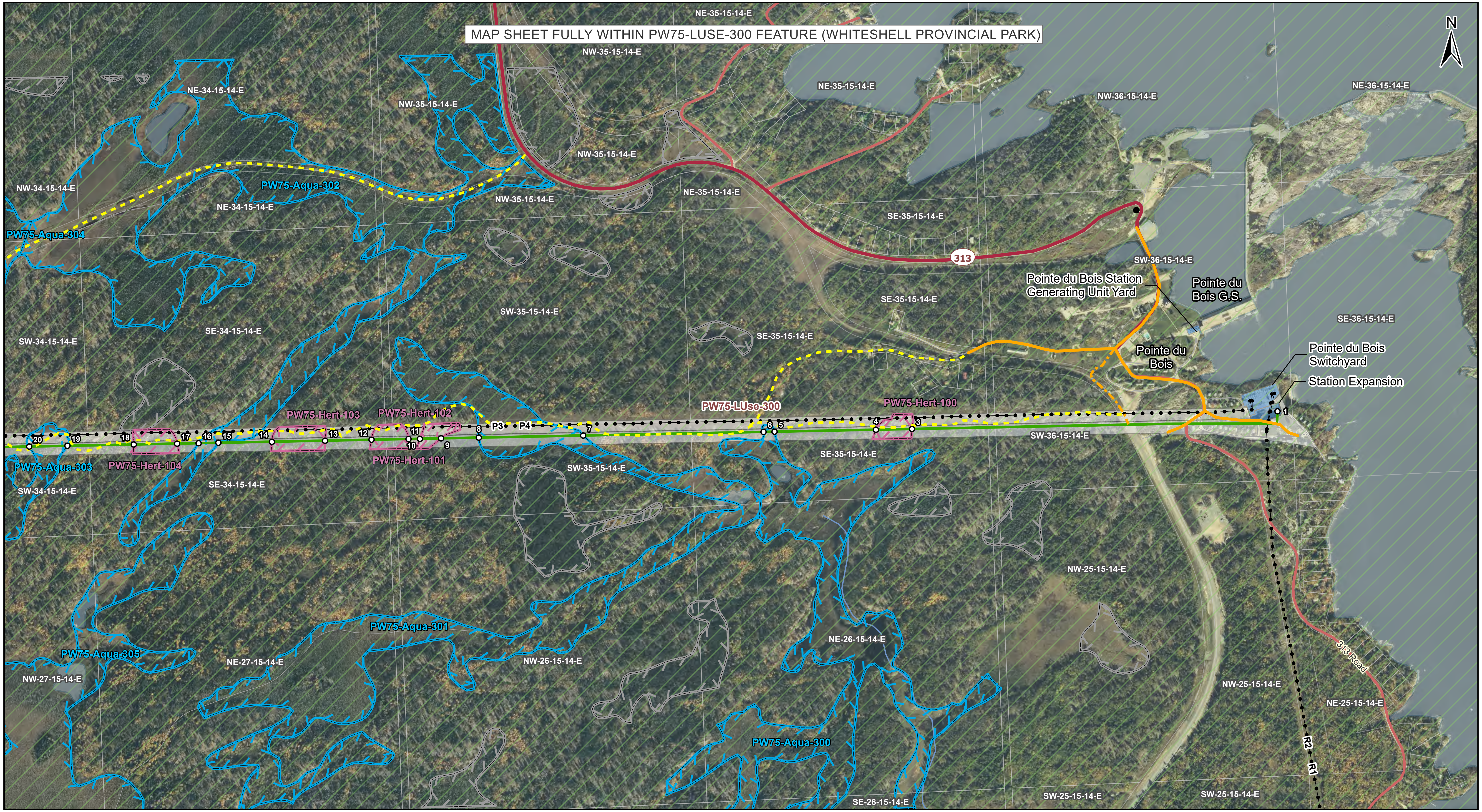

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Manitoba Hydro

Coordinate System: UTM Zone 14N NAD83
Data Source: MB Hydro, ProvMB, NRCAN
Date Created: July 07, 2023
Version: Draft

0 125 250 500
Metres
1:10,000

Land Base
- Transmission Line
- Highway
- Major Road
- Local Road
- Railway (Operational)
- Railway (Discontinued)
- Provincial Park
- Parcel Fabric
- Rural Municipality

*Tower locations subject to final design

Project Infrastructure
- Final Preferred Route
- Right of Way
- Station / Expansion Area

Sensitive Sites
- Point Features
- Linear Features
- Area Features

Points of Access
- No Crossing
- Existing Gravel Road
- Existing Gravel/Dirt Road
- Field Access
- New Trail
- Restricted Access
- Load Restriction
- Bypass Trail

*Some road names have not been verified

ESS Features
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PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

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Map 1

ESS Group: Archaeological

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Hert-100	Potential Archaeological Site	3 to 4	E-744970 N-5577175	E-744872 N-5577173	97
PW75-Hert-101	Potential Archaeological Site	9 to 10	E-743692 N-5577149	E-743634 N-5577148	57
PW75-Hert-102	Potential Archaeological Site	11 to 12	E-743603 N-5577148	E-743503 N-5577146	100
PW75-Hert-103	Potential Archaeological Site	13 to 14	E-743377 N-5577143	E-743233 N-5577140	144
PW75-Hert-104	Potential Archaeological Site	17 to 18	E-742975 N-5577135	E-742858 N-5577133	117

Potential Effects:
Higher potential for discovery of cultural and heritage resources in this area

Specific Mitigation (ID# 303):

- Carry out construction activities using methods that minimize surface damage, rutting and erosion. Construction matting may be required to protect the area from rutting and exposure to soil
- In the event of a discovery, stop work in the area and contact the Project Archaeologist immediately. Refer to Cultural and Heritage Resources Protection Plan for further guidance
- Should heritage resources be discovered during the pre-construction survey the project Archaeologist may prescribe additional mitigation measures

ESS Group: Recreation

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-LUse-300	Whiteshell Provincial Park	1 to 2	E-745962 N-5577223	E-741863 N-5577113	4130

Potential Effects:
Potential disruption to Provincial Park use

Specific Mitigation (ID# 409):

- Follow all provincial park work permit conditions
- Observe local by-laws and protocols (ie. noise by-laws, etc)
- Minimize noise, dust and other emissions from work activities and maintain clean work site
- Appropriate signage, barricades, etc with adequate illumination and reflectorization are required at work site boundaries as well as at bypass or other previous intersection(s) to minimize safety risk and inconvenience to other local users, particularly cyclists.

ESS Group: Wetland

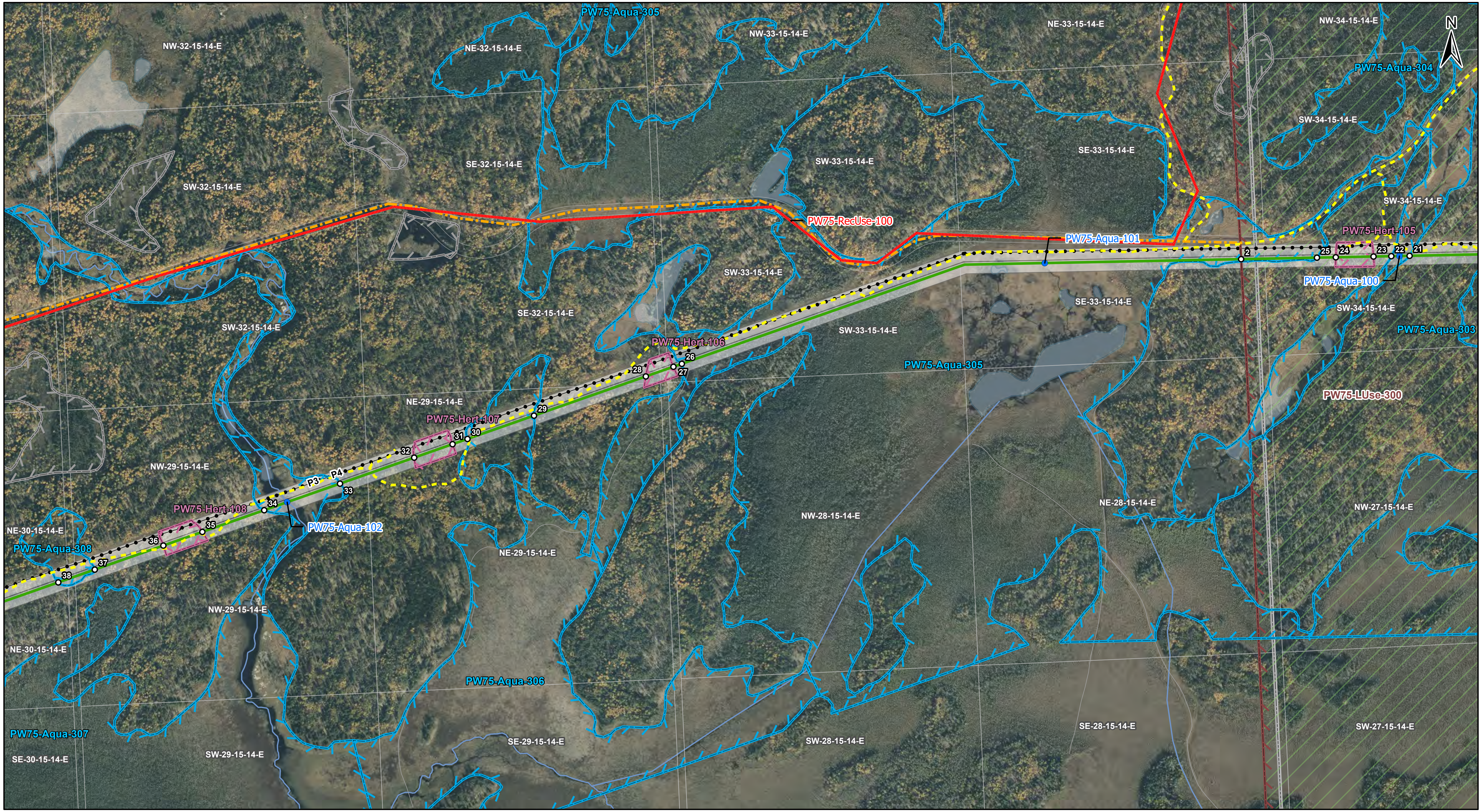
**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-300	Wetland	5 to 6	E-744597 N-5577167	E-744567 N-5577167	29
PW75-Aqua-301	Wetland	7 to 8	E-744077 N-5577157	E-743794 N-5577151	283
PW75-Aqua-302	Wetland	15 to 16	E-743087 N-5577137	E-743034 N-5577136	53
PW75-Aqua-303	Wetland	19 to 20	E-742678 N-5577129	E-742574 N-5577127	103

Potential Effects:
Increased erosion and sedimentation; rutting of floodplains; loss of riparian vegetation; potential impact to reptile and amphibian habitat

Specific Mitigation (ID# 205):

- Carry out construction activities on frozen or dry ground to minimize surface damage, rutting and erosion. Construction activities occurring during non-frozen ground conditions may require that additional mitigation be implemented (ie. use of construction matting, etc)
- Identify and flag a 30 m vegetated (shrub and herbaceous) buffer around site
- Retain understory and ground vegetation less than 2 meters in height to the extent possible.
- Application of herbicides will adhere to appropriate general mitigation measures and all chemical applications will be conducted by a certified licensed applicator in accordance with a Pesticide Use Permit.



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Date Created: July 07, 2023
Version: Draft

0 125 250 500
Metres
1:10,000

Land Base
- Transmission Line
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- Major Road
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- Rural Municipality

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- Right of Way
- Station / Expansion Area

Sensitive Sites
- Point Features
- Linear Features
- Area Features

Points of Access
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- Existing Gravel/Dirt Road
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- Restricted Access
- Load Restriction
- Bypass Trail

*Some road names have not been verified

ESS Features
Access
- Recreation Trail

Water
- Water Crossing

Heritage
- Archaeological

Land Use
- Recreation

Water
- Wetland

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

Draft: For Discussion Purposes Only

Map 2

ESS Group: Archaeological

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Hert-105	Potential Archaeological Site	23 to 24	E-742222 N-5577120	E-742120 N-5577118	102
PW75-Hert-106	Potential Archaeological Site	27 to 28	E-740322 N-5576821	E-740247 N-5576795	79
PW75-Hert-107	Potential Archaeological Site	31 to 32	E-739723 N-5576611	E-739619 N-5576574	110
PW75-Hert-108	Potential Archaeological Site	35 to 36	E-739044 N-5576373	E-738938 N-5576335	112

Potential Effects:
Higher potential for discovery of cultural and heritage resources in this area

Specific Mitigation (ID# 303):

- Carry out construction activities using methods that minimize surface damage, rutting and erosion. Construction matting may be required to protect the area from rutting and exposure to soil
- In the event of a discovery, stop work in the area and contact the Project Archaeologist immediately. Refer to Cultural and Heritage Resources Protection Plan for further guidance
- Should heritage resources be discovered during the pre-construction survey the project Archaeologist may prescribe additional mitigation measures

ESS Group: Recreation

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-LUse-300	Whiteshell Provincial Park	1 to 2	E-745962 N-5577223	E-741863 N-5577113	4130

Potential Effects:
Potential disruption to Provincial Park use

Specific Mitigation (ID# 409):

- Follow all provincial park work permit conditions
- Observe local by-laws and protocols (ie. noise by-laws, etc)
- Minimize noise, dust and other emissions from work activities and maintain clean work site
- Appropriate signage, barricades, etc with adequate illumination and reflectorization are required at work site boundaries as well as at bypass or other previous intersection(s) to minimize safety risk and inconvenience to other local users, particularly cyclists.

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-102	Unnamed Tributary to Bear Creek	E-739274 - N-5576453

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 715):

- Use existing trails, roads or cut lines whenever possible as access routes
- Carry out construction activities within riparian area on dry or frozen ground to minimize surface damage, rutting and erosion
- A minimum 7m no machine zone will restrict equipment in close proximity to the waterbody (except if travelling on an approved access route/crossing)
- Riparian Buffers shall be a minimum of 30m and increase in size based on slope of land entering waterway. Within these buffers shrub and herbaceous understory veg will be maintained along with trees that do not violate MH Veg Clearance Requirements
- Identify and flag the riparian buffer area prior to construction activities in proximity to this ESS
- Ground disturbance in riparian areas must be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Avoid refueling or vehicle/equipment maintenance within 100m of a water crossing. If refueling or vehicle/equipment maintenance is required within 100m of a water crossing, contractor must obtain approval from MH Environmental Officer and adhere to additional mitigation measures.

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-100	Unnamed Tributary to Bear Creek	E-742292 - N-5577121
PW75-Aqua-101	Unnamed Tributary to Bear Creek	E-741330 - N-5577102

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 717):

- Use existing trails, roads or cut lines whenever possible as access routes
- Ground disturbance to be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Refueling or vehicle/equipment maintenance should be avoided when in proximity to this location

ESS Group: Wetland

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-304	Wetland	21 to 22	E-742320 N-5577122	E-742270 N-5577121	49
PW75-Aqua-305	Wetland	25 to 26	E-742069 N-5577117	E-740345 N-5576829	1769
PW75-Aqua-306	Wetland	29 to 30	E-739944 N-5576688	E-739763 N-5576625	191
PW75-Aqua-307	Wetland	33 to 34	E-739417 N-5576504	E-739212 N-5576431	217
PW75-Aqua-308	Wetland	37 to 38	E-738752 N-5576270	E-738653 N-5576235	104

Potential Effects:
Increased erosion and sedimentation; rutting of floodplains; loss of riparian vegetation; potential impact to reptile and amphibian habitat

Specific Mitigation (ID# 205):

- Carry out construction activities on frozen or dry ground to minimize surface damage, rutting and erosion. Construction activities occurring during non-frozen ground conditions may require that additional mitigation be implemented (ie. use of construction matting, etc)
- Identify and flag a 30 m vegetated (shrub and herbaceous) buffer around site
- Retain understory and ground vegetation less than 2 meters in height to the extent possible.
- Application of herbicides will adhere to appropriate general mitigation measures and all chemical applications will be conducted by a certified licensed applicator in accordance with a Pesticide Use Permit.

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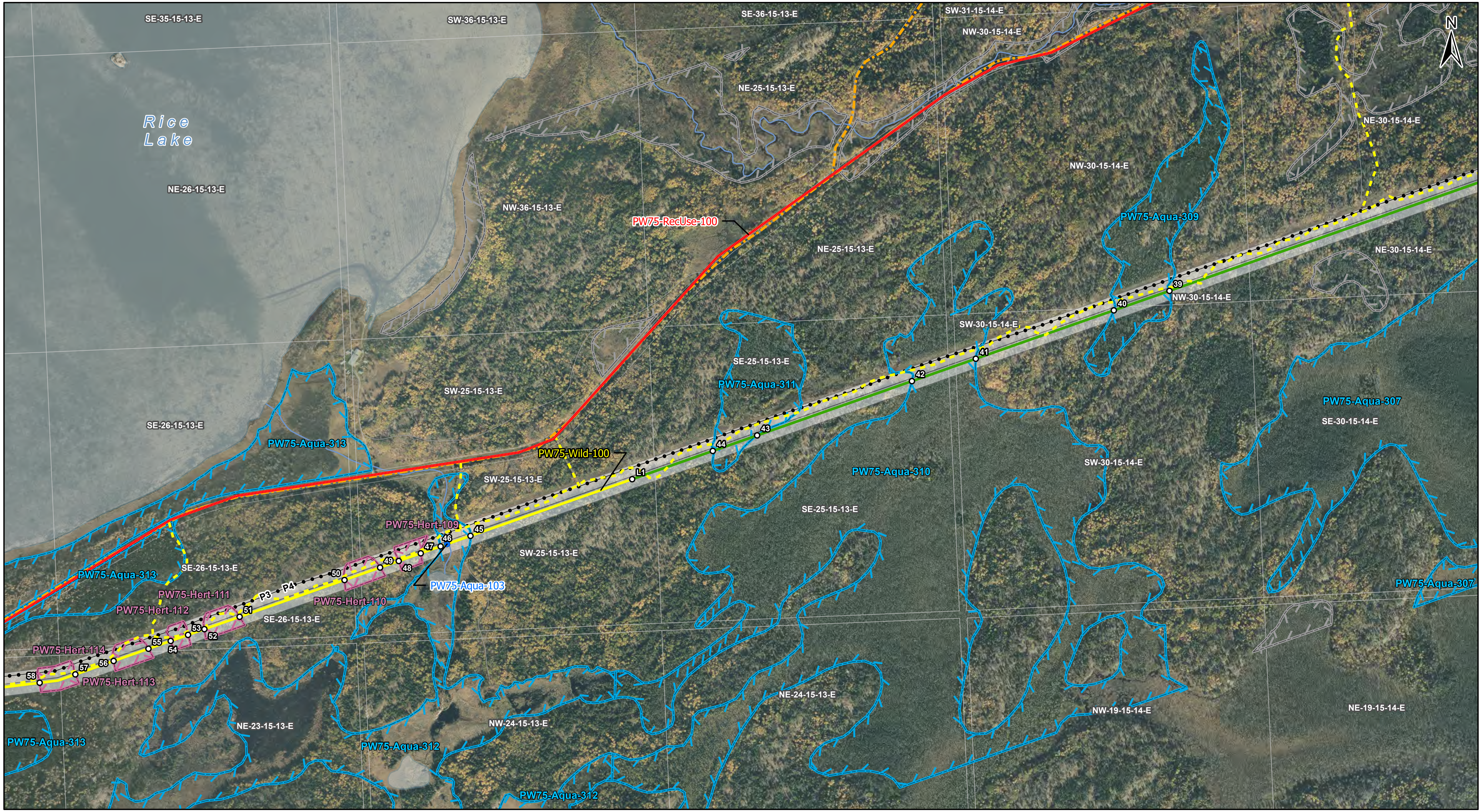

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Manitoba Hydro

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Land Base
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- Provincial Park
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- Rural Municipality

*Tower locations subject to final design

Project Infrastructure
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- Right of Way
- Station / Expansion Area

Sensitive Sites
- Point Features
- Linear Features
- Area Features

Points of Access
- No Crossing
- Existing Gravel Road
- Existing Gravel/Dirt Road
- Field Access
- New Trail
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- Load Restriction
- Bypass Trail

*Some road names have not been verified

ESS Features

Access
- Recreation Trail

Wildlife
- Birds and Habitat

Water
- Water Crossing

Heritage
- Archaeological

Water
- Wetland

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

Draft: For Discussion Purposes Only

Map 3

ESS Group: Archaeological

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Hert-109	Potential Archaeological Site	47 to 48	E-735637 N-5575178	E-735577 N-5575157	63
PW75-Hert-110	Potential Archaeological Site	49 to 50	E-735526 N-5575139	E-735430 N-5575105	102
PW75-Hert-111	Potential Archaeological Site	51 to 52	E-735145 N-5575005	E-735049 N-5574972	101
PW75-Hert-112	Potential Archaeological Site	53 to 54	E-735005 N-5574956	E-734958 N-5574940	49
PW75-Hert-113	Potential Archaeological Site	55 to 56	E-734898 N-5574919	E-734803 N-5574886	100
PW75-Hert-114	Potential Archaeological Site	57 to 58	E-734699 N-5574849	E-734602 N-5574826	100

Potential Effects:
Higher potential for discovery of cultural and heritage resources in this area

Specific Mitigation (ID# 303):

- Carry out construction activities using methods that minimize surface damage, rutting and erosion. Construction matting may be required to protect the area from rutting and exposure to soil
- In the event of a discovery, stop work in the area and contact the Project Archaeologist immediately. Refer to Cultural and Heritage Resources Protection Plan for further guidance
- Should heritage resources be discovered during the pre-construction survey the project Archaeologist may prescribe additional mitigation measures

ESS Group: Birds and Habitat

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Wild-100	Bird migration area	L1 to L2	E-736210 N-5575379	E-733280 N-5574663	3033

Potential Effects:
Higher risk of wire collision, Risk of wire collision is localized to the right-of-way

Specific Mitigation (ID# 827):

- Bird diverters will be installed in a manner to maximize visibility
- Install bird diverter with spacing as per Transmission Line Design specifications for these spans
- Install bird diverters in a timely manner after conductor stringing.

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-103	Unnamed Tributary to Bear Creek	E-735708 - N-5575203

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 717):

- Use existing trails, roads or cut lines whenever possible as access routes
- Ground disturbance to be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Refueling or vehicle/equipment maintenance should be avoided when in proximity to this location

ESS Group: Wetland

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-309	Wetland	39 to 40	E-737668 N-5575890	E-737517 N-5575837	159
PW75-Aqua-310	Wetland	41 to 42	E-737143 N-5575706	E-736970 N-5575645	183
PW75-Aqua-311	Wetland	43 to 44	E-736549 N-5575498	E-736429 N-5575456	127
PW75-Aqua-312	Wetland	45 to 46	E-735772 N-5575225	E-735691 N-5575197	85

Potential Effects:
Increased erosion and sedimentation; rutting of floodplains; loss of riparian vegetation; potential impact to reptile and amphibian habitat

Specific Mitigation (ID# 205):

- Carry out construction activities on frozen or dry ground to minimize surface damage, rutting and erosion. Construction activities occurring during non-frozen ground conditions may require that additional mitigation be implemented (ie. use of construction matting, etc)
- Identify and flag a 30 m vegetated (shrub and herbaceous) buffer around site
- Retain understory and ground vegetation less than 2 meters in height to the extent possible.
- Application of herbicides will adhere to appropriate general mitigation measures and all chemical applications will be conducted by a certified licensed applicator in accordance with a Pesticide Use Permit.

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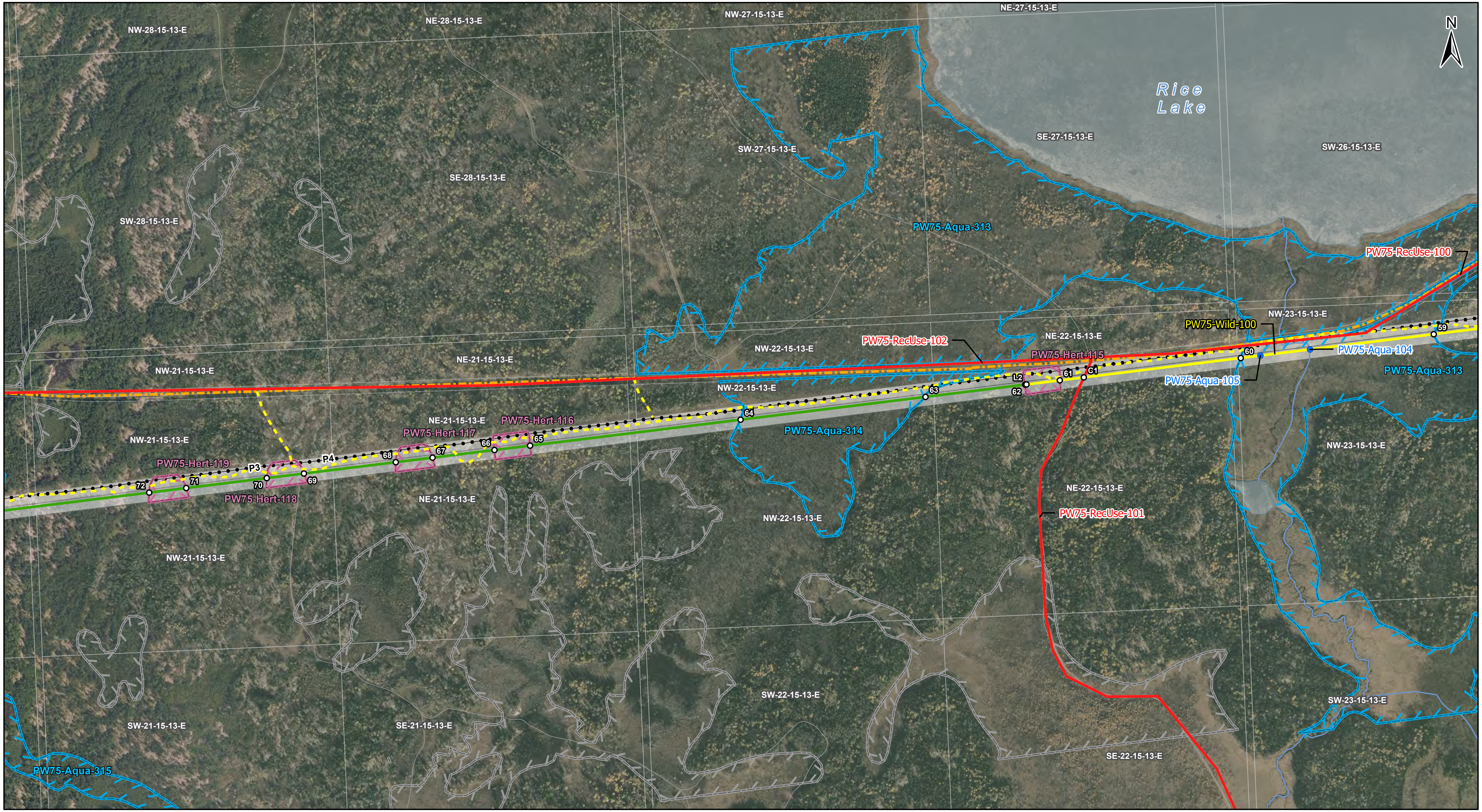

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ESS Features

Access
- Recreation Trail

Wildlife
- Birds and Habitat

Water
- Water Crossing

Heritage
- Archaeological

Water
- Wetland

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

Map 4

Draft: For Discussion Purposes Only

ESS Group: Archaeological

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Hert-115	Potential Archaeological Site	61 to 62	E-733371 N-5574675	E-733277 N-5574663	94
PW75-Hert-116	Potential Archaeological Site	65 to 66	E-731933 N-5574497	E-731837 N-5574485	97
PW75-Hert-117	Potential Archaeological Site	67 to 68	E-731669 N-5574465	E-731569 N-5574452	100
PW75-Hert-118	Potential Archaeological Site	69 to 70	E-731320 N-5574422	E-731219 N-5574409	101
PW75-Hert-119	Potential Archaeological Site	71 to 72	E-731000 N-5574382	E-730900 N-5574370	101

Potential Effects:
Higher potential for discovery of cultural and heritage resources in this area

Specific Mitigation (ID# 303):

- Carry out construction activities using methods that minimize surface damage, rutting and erosion. Construction matting may be required to protect the area from rutting and exposure to soil
- In the event of a discovery, stop work in the area and contact the Project Archaeologist immediately. Refer to Cultural and Heritage Resources Protection Plan for further guidance
- Should heritage resources be discovered during the pre-construction survey the project Archaeologist may prescribe additional mitigation measures

ESS Group: Birds and Habitat

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Wild-100	Bird migration area	L1 to L2	E-736210 N-5575379	E-733280 N-5574663	3033

Potential Effects:
Higher risk of wire collision, Risk of wire collision is localized to the right-of-way

Specific Mitigation (ID# 827):

- Bird diverters will be installed in a manner to maximize visibility
- Install bird diverter with spacing as per Transmission Line Design specifications for these spans
- Install bird diverters in a timely manner after conductor stringing.

ESS Group: Intersection

**Features represented as lines*

ESS ID	ESS Name	Site	Location
PW75-RecUse-101	Snoman Trail	C1	E-733436 N-5574683

Potential Effects:
Potential interference with trail users; safety issues

Specific Mitigation (ID# 103):

- Trail closures are anticipated during construction phase but will be planned and avoided to the extent possible
- Communication about trail closures and planned impacts and mitigations will occur prior and during construction with local trail users (ie. Snoman, etc)
- Existing vegetation will be retained to the extent possible and disturbed areas will be rehabilitated &/or revegetated in a timely manner to the pre-existing or improved condition
- If damages occur, repairs must be completed to a pre-existing or improved condition in a timely manner
- Appropriate signage, barricades, etc with adequate illumination and reflectorization are required at work site boundaries as well as at bypass or other previous intersection(s) to minimize safety risk and inconvenience to other local users, particularly cyclists.
- Contractor is required to provide appropriate traffic control including advance warning and guidance on any Multi-Use Recreational Trail as needed (ie. onsite traffic control persons will be required if warranted)

ESS Group: Intersection

**Features represented as points*

ESS ID	ESS Name	Location
PW75-RecUse-100	Snoman Trail	*See Map

Potential Effects:
Potential interference with trail users; safety issues

Specific Mitigation (ID# 103):

- Trail closures are anticipated during construction phase but will be planned and avoided to the extent possible
- Communication about trail closures and planned impacts and mitigations will occur prior and during construction with local trail users (ie. Snoman, etc)
- Existing vegetation will be retained to the extent possible and disturbed areas will be rehabilitated &/or revegetated in a timely manner to the pre-existing or improved condition
- If damages occur, repairs must be completed to a pre-existing or improved condition in a timely manner
- Appropriate signage, barricades, etc with adequate illumination and reflectorization are required at work site boundaries as well as at bypass or other previous intersection(s) to minimize safety risk and inconvenience to other local users, particularly cyclists.
- Contractor is required to provide appropriate traffic control including advance warning and guidance on any Multi-Use Recreational Trail as needed (ie. onsite traffic control persons will be required if warranted)

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-104	Unnamed Tributary to Rice Lake	E-734050 - N-5574758
PW75-Aqua-105	Unnamed Tributary to Rice Lake	E-733915 - N-5574742

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 715):

- Use existing trails, roads or cut lines whenever possible as access routes
- Carry out construction activities within riparian area on dry or frozen ground to minimize surface damage, rutting and erosion
- A minimum 7m no machine zone will restrict equipment in close proximity to the waterbody (except if travelling on an approved access route/crossing)
- Riparian Buffers shall be a minimum of 30m and increase in size based on slope of land entering waterway. Within these buffers shrub and herbaceous understory veg will be maintained along with trees that do not violate MH Veg Clearance Requirements
- Identify and flag the riparian buffer area prior to construction activities in proximity to this ESS
- Ground disturbance in riparian areas must be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Avoid refueling or vehicle/equipment maintenance within 100m of a water crossing. If refueling or vehicle/equipment maintenance is required within 100m of a water crossing, contractor must obtain approval from MH Environmental Officer and adhere to additional mitigation measures.

ESS Group: Wetland

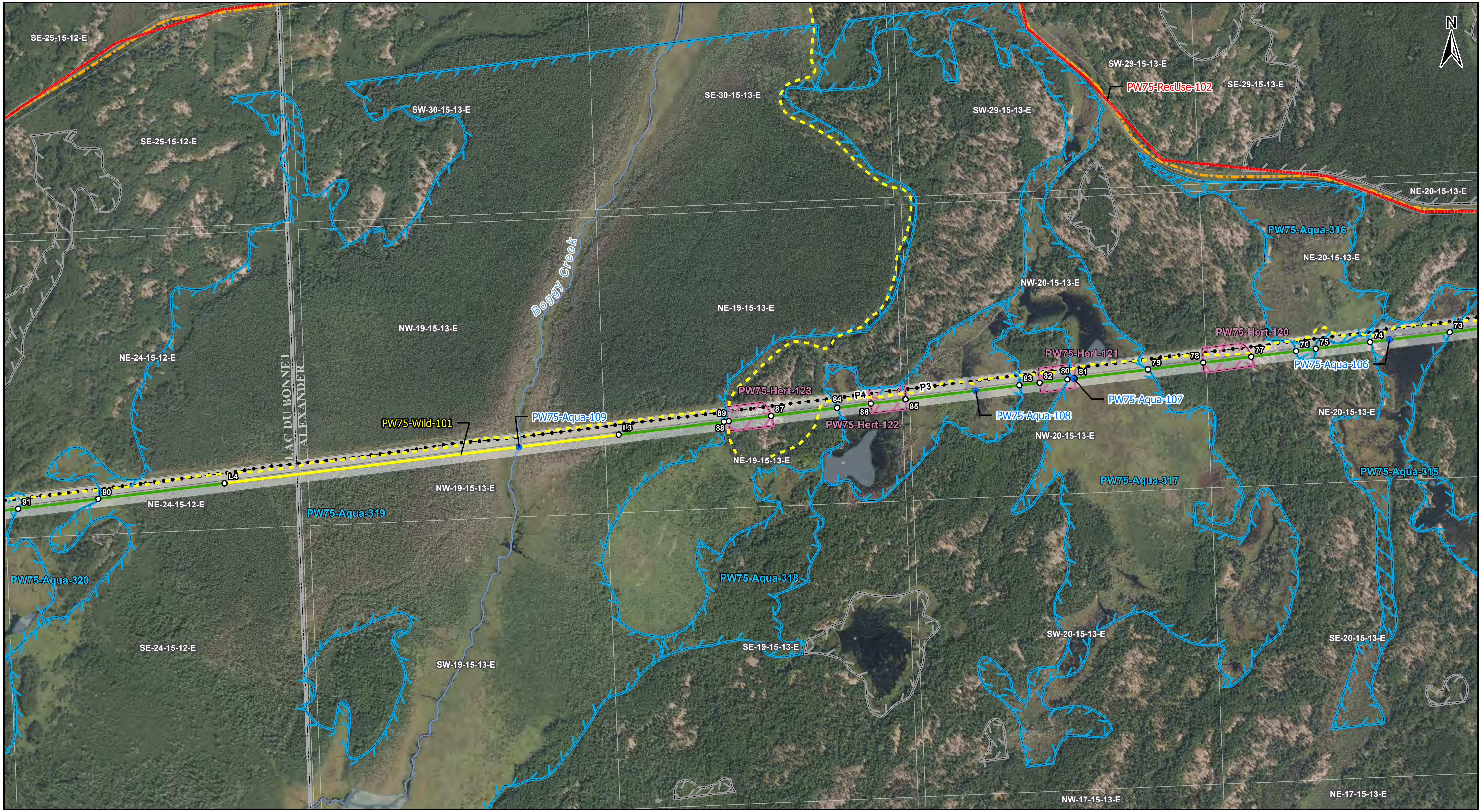
**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-313	Wetland	59 to 60	E-734386 N-5574800	E-733862 N-5574735	527
PW75-Aqua-314	Wetland	63 to 64	E-733006 N-5574630	E-732505 N-5574568	505

Potential Effects:
Increased erosion and sedimentation; rutting of floodplains; loss of riparian vegetation; potential impact to reptile and amphibian habitat

Specific Mitigation (ID# 205):

- Carry out construction activities on frozen or dry ground to minimize surface damage, rutting and erosion. Construction activities occurring during non-frozen ground conditions may require that additional mitigation be implemented (ie. use of construction matting, etc)
- Identify and flag a 30 m vegetated (shrub and herbaceous) buffer around site
- Retain understory and ground vegetation less than 2 meters in height to the extent possible.
- Application of herbicides will adhere to appropriate general mitigation measures and all chemical applications will be conducted by a certified licensed applicator in accordance with a Pesticide Use Permit.



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Manitoba Hydro

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*Some road names have not been verified

ESS Features

Access
- Recreation Trail

Wildlife
- Birds and Habitat

Water
- Water Crossing

Heritage
- Archaeological

Water
- Wetland

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

Draft: For Discussion Purposes Only

Map 5

ESS Group: Archaeological

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Hert-120	Potential Archaeological Site	77 to 78	E-729890 N-5574245	E-729760 N-5574229	131
PW75-Hert-121	Potential Archaeological Site	81 to 82	E-729411 N-5574186	E-729316 N-5574175	95
PW75-Hert-122	Potential Archaeological Site	85 to 86	E-728952 N-5574130	E-728858 N-5574118	94
PW75-Hert-123	Potential Archaeological Site	87 to 88	E-728587 N-5574085	E-728472 N-5574071	115

Potential Effects:
Higher potential for discovery of cultural and heritage resources in this area

Specific Mitigation (ID# 303):

- Carry out construction activities using methods that minimize surface damage, rutting and erosion. Construction matting may be required to protect the area from rutting and exposure to soil
- In the event of a discovery, stop work in the area and contact the Project Archaeologist immediately. Refer to Cultural and Heritage Resources Protection Plan for further guidance
- Should heritage resources be discovered during the pre-construction survey the project Archaeologist may prescribe additional mitigation measures

ESS Group: Birds and Habitat

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Wild-101	Bird migration area	L3 to L4	E-728174 N-5574034	E-727104 N-5573902	1078

Potential Effects:
Higher risk of wire collision, Risk of wire collision is localized to the right-of-way

Specific Mitigation (ID# 827):

- Bird diverters will be installed in a manner to maximize visibility
- Install bird diverter with spacing as per Transmission Line Design specifications for these spans
- Install bird diverters in a timely manner after conductor stringing.

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-109	Boggy Creek	E-727904 - N-5574001

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 715):

- Use existing trails, roads or cut lines whenever possible as access routes
- Carry out construction activities within riparian area on dry or frozen ground to minimize surface damage, rutting and erosion
- A minimum 7m no machine zone will restrict equipment in close proximity to the waterbody (except if travelling on an approved access route/crossing)
- Riparian Buffers shall be a minimum of 30m and increase in size based on slope of land entering waterway. Within these buffers shrub and herbaceous understory veg will be maintained along with trees that do not violate MH Veg Clearance Requirements
- Identify and flag the riparian buffer area prior to construction activities in proximity to this ESS
- Ground disturbance in riparian areas must be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Avoid refueling or vehicle/equipment maintenance within 100m of a water crossing. If refueling or vehicle/equipment maintenance is required within 100m of a water crossing, contractor must obtain approval from MH Environmental Officer and adhere to additional mitigation measures.

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-106	Unnamed Tributary to Boggy Creek	E-730265 - N-5574292
PW75-Aqua-107	Unnamed Tributary to Boggy Creek	E-729408 - N-5574186
PW75-Aqua-108	Unnamed Tributary to Boggy Creek	E-729143 - N-5574153

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 717):

- Use existing trails, roads or cut lines whenever possible as access routes
- Ground disturbance to be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Refueling or vehicle/equipment maintenance should be avoided when in proximity to this location

ESS Group: Wetland

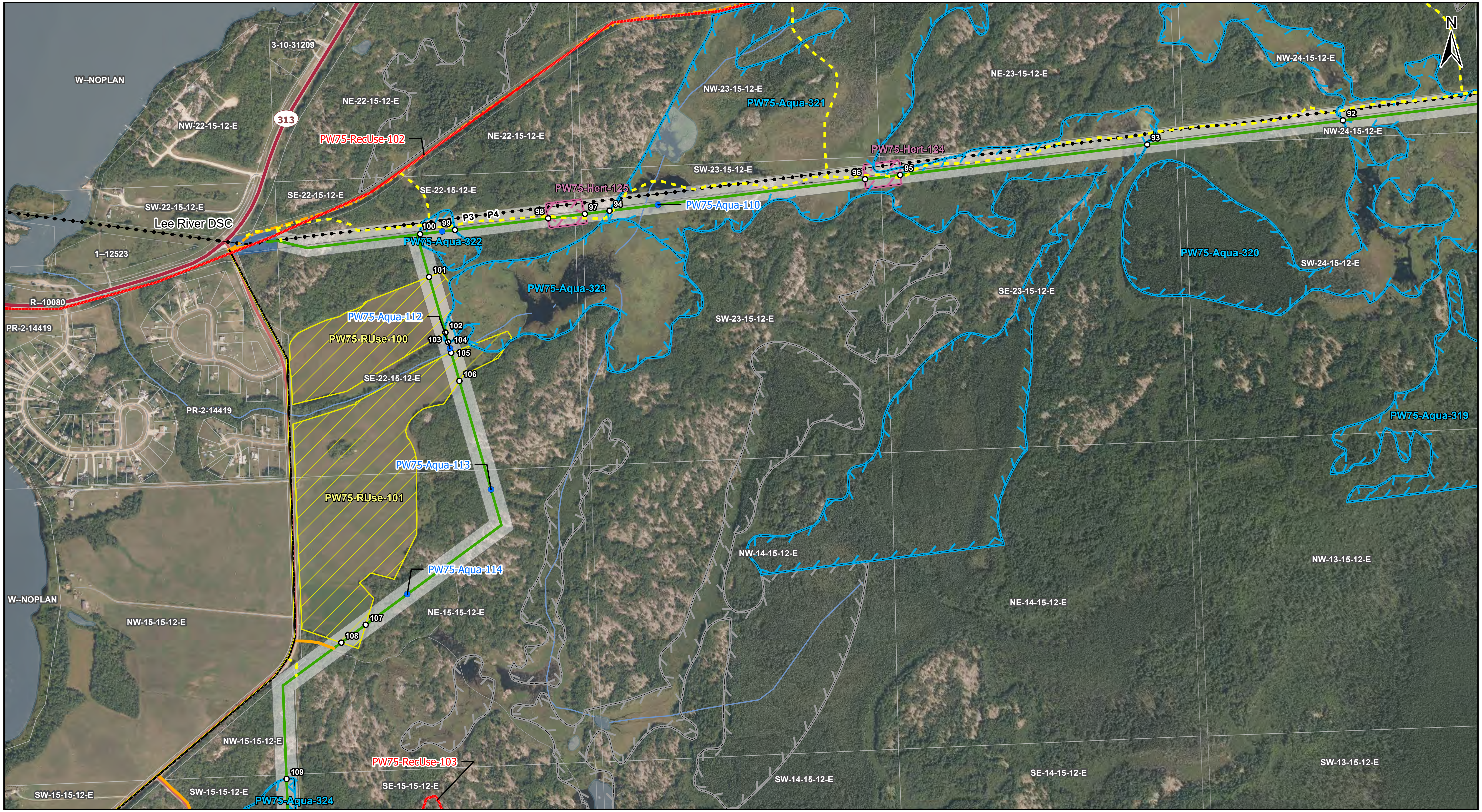
**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-315	Wetland	73 to 74	E-730429 N-5574312	E-730213 N-5574285	217
PW75-Aqua-316	Wetland	75 to 76	E-730066 N-5574267	E-730012 N-5574261	53
PW75-Aqua-317	Wetland	79 to 80	E-729610 N-5574211	E-729392 N-5574184	220
PW75-Aqua-318	Wetland	83 to 84	E-729261 N-5574168	E-728767 N-5574107	498
PW75-Aqua-319	Wetland	89 to 90	E-728459 N-5574069	E-726762 N-5573860	1710
PW75-Aqua-320	Wetland	91 to 92	E-726544 N-5573833	E-726139 N-5573783	407

Potential Effects:
Increased erosion and sedimentation; rutting of floodplains; loss of riparian vegetation; potential impact to reptile and amphibian habitat

Specific Mitigation (ID# 205):

- Carry out construction activities on frozen or dry ground to minimize surface damage, rutting and erosion. Construction activities occurring during non-frozen ground conditions may require that additional mitigation be implemented (ie. use of construction matting, etc)
- Identify and flag a 30 m vegetated (shrub and herbaceous) buffer around site
- Retain understory and ground vegetation less than 2 meters in height to the extent possible.
- Application of herbicides will adhere to appropriate general mitigation measures and all chemical applications will be conducted by a certified licensed applicator in accordance with a Pesticide Use Permit.



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ESS Features

Access
- Recreation Trail

Water
- Water Crossing

Heritage
- Archaeological

Resource Use
- Agriculture

Water
- Wetland

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

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Map 6

ESS Group: Agriculture

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-RUse-100	Agriculture	101 to 102	E-723660 N-5573358	E-723704 N-5573207	157
PW75-RUse-101	Agriculture	105 to 106	E-723720 N-5573152	E-723742 N-5573076	79
PW75-RUse-101	Agriculture	107 to 108	E-723487 N-5572414	E-723421 N-5572365	82

Potential Effects:
Potential biosecurity risk to agricultural activities

Specific Mitigation (ID# 391):

- Access/activities in agricultural areas must adhere to biosecurity cleaning and documentation requirements.

ESS Group: Archaeological

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Hert-124	Potential Archaeological Site	95 to 96	E-724938 N-5573635	E-724843 N-5573623	96
PW75-Hert-125	Potential Archaeological Site	97 to 98	E-724082 N-5573529	E-723983 N-5573517	100

Potential Effects:
Higher potential for discovery of cultural and heritage resources in this area

Specific Mitigation (ID# 303):

- Carry out construction activities using methods that minimize surface damage, rutting and erosion. Construction matting may be required to protect the area from rutting and exposure to soil
- In the event of a discovery, stop work in the area and contact the Project Archaeologist immediately. Refer to Cultural and Heritage Resources Protection Plan for further guidance
- Should heritage resources be discovered during the pre-construction survey the project Archaeologist may prescribe additional mitigation measures

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-112	Unnamed Tributary to Lee River	E-723716 - N-5573164

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 715):

- Use existing trails, roads or cut lines whenever possible as access routes
- Carry out construction activities within riparian area on dry or frozen ground to minimize surface damage, rutting and erosion
- A minimum 7m no machine zone will restrict equipment in close proximity to the waterbody (except if travelling on an approved access route/crossing)
- Riparian Buffers shall be a minimum of 30m and increase in size based on slope of land entering waterway. Within these buffers shrub and herbaceous understory veg will be maintained along with trees that do not violate MH Veg Clearance Requirements
- Identify and flag the riparian buffer area prior to construction activities in proximity to this ESS
- Ground disturbance in riparian areas must be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Avoid refueling or vehicle/equipment maintenance within 100m of a water crossing. If refueling or vehicle/equipment maintenance is required within 100m of a water crossing, contractor must obtain approval from MH Environmental Officer and adhere to additional mitigation measures.

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-110	Unnamed tributary to Lee River	E-724281 - N-5573554
PW75-Aqua-111	Unnamed Tributary to Lee River	E-723695 - N-5573482
PW75-Aqua-113	Unnamed Drain [manmade]	E-723828 - N-5572781
PW75-Aqua-114	Unnamed Drain [manmade]	E-723600 - N-5572497

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 717):

- Use existing trails, roads or cut lines whenever possible as access routes
- Ground disturbance to be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Refueling or vehicle/equipment maintenance should be avoided when in proximity to this location

ESS Group: Wetland

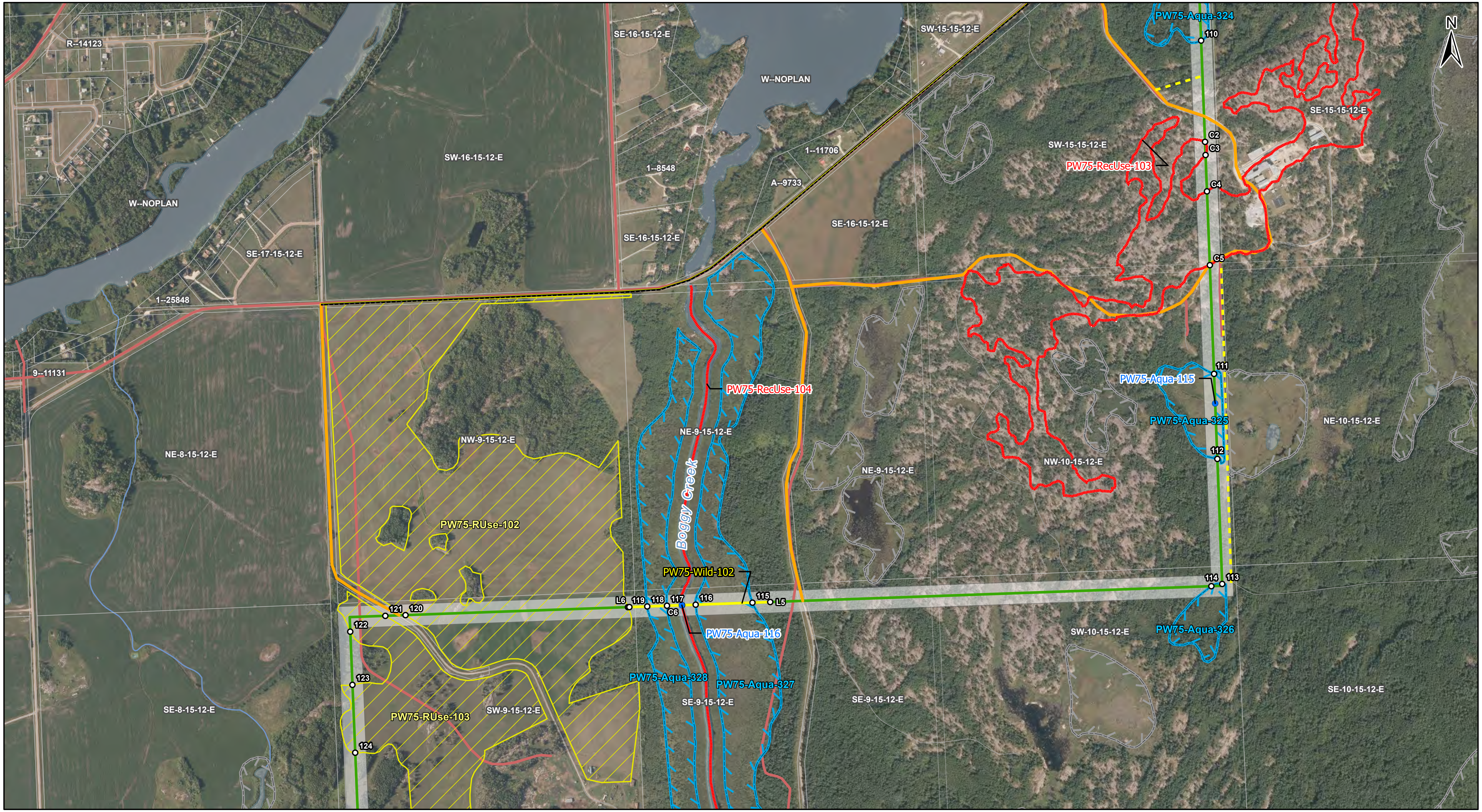
**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-320	Wetland	91 to 92	E-726544 N-5573833	E-726139 N-5573783	407
PW75-Aqua-321	Wetland	93 to 94	E-725608 N-5573718	E-724149 N-5573538	1470
PW75-Aqua-322	Wetland	99 to 100	E-723730 N-5573486	E-723635 N-5573474	95
PW75-Aqua-323	Wetland	103 to 104	E-723704 N-5573207	E-723711 N-5573182	26
PW75-Aqua-324	Wetland	109 to 110	E-723273 N-5571995	E-723280 N-5571810	185

Potential Effects:
Increased erosion and sedimentation; rutting of floodplains; loss of riparian vegetation; potential impact to reptile and amphibian habitat

Specific Mitigation (ID# 205):

- Carry out construction activities on frozen or dry ground to minimize surface damage, rutting and erosion. Construction activities occurring during non-frozen ground conditions may require that additional mitigation be implemented (ie. use of construction matting, etc)
- Identify and flag a 30 m vegetated (shrub and herbaceous) buffer around site
- Retain understory and ground vegetation less than 2 meters in height to the extent possible.
- Application of herbicides will adhere to appropriate general mitigation measures and all chemical applications will be conducted by a certified licensed applicator in accordance with a Pesticide Use Permit.



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Manitoba Hydro

Coordinate System: UTM Zone 14N NAD83
Data Source: MB Hydro, ProvMB, NRCAN
Date Created: July 07, 2023
Version: Draft

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Land Base
- Transmission Line
- Highway
- Major Road
- Local Road
- Railway (Operational)
- Railway (Discontinued)
- Provincial Park
- Parcel Fabric
- Rural Municipality

*Tower locations subject to final design

Project Infrastructure
- Final Preferred Route
- Right of Way
- Station / Expansion Area

Sensitive Sites
- Point Features
- Linear Features
- Area Features

Points of Access
- No Crossing
- Existing Gravel Road
- Existing Gravel/Dirt Road
- Field Access
- New Trail
- Restricted Access
- Load Restriction
- Bypass Trail

*Some road names have not been verified

ESS Features

Access
- Recreation Trail

Wildlife
- Birds and Habitat

Water
- Water Crossing

Resource Use
- Agriculture

Water
- Wetland

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

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Map 7

ESS Group: Agriculture

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-RUse-102	Agriculture	119 to 120	E-721724 N-5570272	E-721121 N-5570250	603
PW75-RUse-103	Agriculture	121 to 122	E-721066 N-5570248	E-720971 N-5570205	136
PW75-RUse-103	Agriculture	123 to 124	E-720977 N-5570061	E-720984 N-5569877	184

Potential Effects:
Potential biosecurity risk to agricultural activities

Specific Mitigation (ID# 391):

- Access/activities in agricultural areas must adhere to biosecurity cleaning and documentation requirements.

ESS Group: Birds and Habitat

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Wild-102	Bird migration area	L5 to L6	E-722111 N-5570286	E-721728 N-5570272	382

Potential Effects:
Higher risk of wire collision, Risk of wire collision is localized to the right-of-way

Specific Mitigation (ID# 827):

- Bird diverters will be installed in a manner to maximize visibility
- Install bird diverter with spacing as per Transmission Line Design specifications for these spans
- Install bird diverters in a timely manner after conductor stringing.

ESS Group: Intersection

**Features represented as lines*

ESS ID	ESS Name	Site	Location
PW75-RecUse-103	Hiking and Biking Trail	C2	E-723291 N-5571535
PW75-RecUse-103	Hiking and Biking Trail	C3	E-723292 N-5571499
PW75-RecUse-103	Hiking and Biking Trail	C4	E-723296 N-5571400
PW75-RecUse-103	Hiking and Biking Trail	C5	E-723304 N-5571200

Potential Effects:
Potential interference with trail users; safety issues

Specific Mitigation (ID# 103):

- Trail closures are anticipated during construction phase but will be planned and avoided to the extent possible
- Communication about trail closures and planned impacts and mitigations will occur prior and during construction with local trail users (ie. Snoman, etc)
- Existing vegetation will be retained to the extent possible and disturbed areas will be rehabilitated &/or revegetated in a timely manner to the pre-existing or improved condition
- If damages occur, repairs must be completed to a pre-existing or improved condition in a timely manner
- Appropriate signage, barricades, etc with adequate illumination and reflectorization are required at work site boundaries as well as at bypass or other previous intersection(s) to minimize safety risk and inconvenience to other local users, particularly cyclists.
- Contractor is required to provide appropriate traffic control including advance warning and guidance on any Multi-Use Recreational Trail as needed (ie. onsite traffic control persons will be required if warranted)

ESS Group: Intersection

**Features represented as lines*

ESS ID	ESS Name	Site	Location
PW75-RecUse-104	Recreational Use Waterway Boggy Creek	C6	E-721871 N-5570277

Potential Effects:
Potential inconvenience to users of this waterway

Specific Mitigation (ID# 115):

- During stringing activities appropriate signage, barricades, etc is required to minimize risk and inconvenience to other users of this waterway
- If applicable refer to approval under the Canadian Navigable Waters Act (CNWA)

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-116	Boggy Creek	E-721871 - N-5570277

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 715):

- Use existing trails, roads or cut lines whenever possible as access routes
- Carry out construction activities within riparian area on dry or frozen ground to minimize surface damage, rutting and erosion
- A minimum 7m no machine zone will restrict equipment in close proximity to the waterbody (except if travelling on an approved access route/crossing)
- Riparian Buffers shall be a minimum of 30m and increase in size based on slope of land entering waterway. Within these buffers shrub and herbaceous understory veg will be maintained along with trees that do not violate MH Veg Clearance Requirements
- Identify and flag the riparian buffer area prior to construction activities in proximity to this ESS
- Ground disturbance in riparian areas must be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Avoid refueling or vehicle/equipment maintenance within 100m of a water crossing. If refueling or vehicle/equipment maintenance is required within 100m of a water crossing, contractor must obtain approval from MH Environmental Officer and adhere to additional mitigation measures.

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-115	Unnamed Tributary to Boggy Creek	E-723318 - N-5570825

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 717):

- Use existing trails, roads or cut lines whenever possible as access routes
- Ground disturbance to be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Refueling or vehicle/equipment maintenance should be avoided when in proximity to this location

ESS Group: Wetland

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-324	Wetland	109 to 110	E-723273 N-5571995	E-723280 N-5571810	185
PW75-Aqua-325	Wetland	111 to 112	E-723315 N-5570905	E-723324 N-5570674	231
PW75-Aqua-326	Wetland	113 to 114	E-723337 N-5570335	E-723308 N-5570329	34
PW75-Aqua-327	Wetland	115 to 116	E-722062 N-5570284	E-721908 N-5570278	154
PW75-Aqua-328	Wetland	117 to 118	E-721830 N-5570276	E-721777 N-5570274	53

Potential Effects:
Increased erosion and sedimentation; rutting of floodplains; loss of riparian vegetation; potential impact to reptile and amphibian habitat

Specific Mitigation (ID# 205):

- Carry out construction activities on frozen or dry ground to minimize surface damage, rutting and erosion. Construction activities occurring during non-frozen ground conditions may require that additional mitigation be implemented (ie. use of construction matting, etc)
- Identify and flag a 30 m vegetated (shrub and herbaceous) buffer around site
- Retain understory and ground vegetation less than 2 meters in height to the extent possible.
- Application of herbicides will adhere to appropriate general mitigation measures and all chemical applications will be conducted by a certified licensed applicator in accordance with a Pesticide Use Permit.

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Manitoba Hydro

Coordinate System: UTM Zone 14N NAD83
Data Source: MB Hydro, ProvMB, NRCAN
Date Created: July 07, 2023
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Land Base
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Sensitive Sites
- Point Features
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ESS Features
Access
- Recreation Trail

Water
- Water Crossing

Resource Use
- Agriculture

Water
- Wetland

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

Draft: For Discussion Purposes Only

Map 8

ESS Group: Agriculture

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-RUse-104	Agriculture	125 to 126	E-721033 N-5568676	E-721065 N-5567899	777

Potential Effects:
Potential biosecurity risk to agricultural activities

Specific Mitigation (ID# 391):

- Access/activities in agricultural areas must adhere to biosecurity cleaning and documentation requirements.

ESS Group: Water Crossing

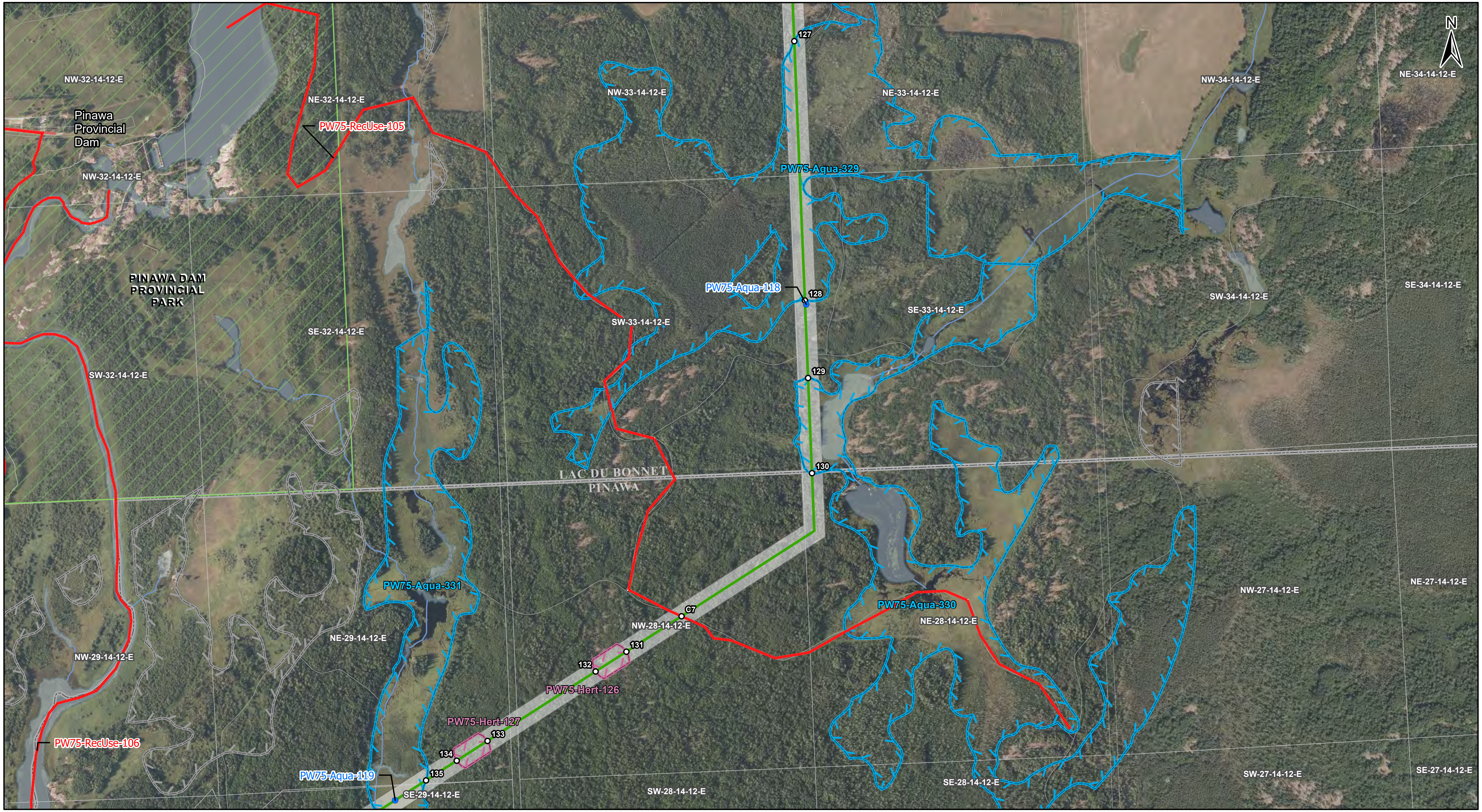
**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-117	Unnamed Drain [manmade]	E-721031 - N-5568672

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 717):

- Use existing trails, roads or cut lines whenever possible as access routes
- Ground disturbance to be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Refueling or vehicle/equipment maintenance should be avoided when in proximity to this location



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Access
- Recreation Trail

Water
- Water Crossing

Heritage
- Archaeological

Water
- Wetland

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

Draft: For Discussion Purposes Only

Map 9

ESS Group: Archaeological

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Hert-126	Potential Archaeological Site	131 to 132	E-720629 N-5565771	E-720545 N-5565717	99
PW75-Hert-127	Potential Archaeological Site	133 to 134	E-720252 N-5565529	E-720169 N-5565475	99

Potential Effects:
Higher potential for discovery of cultural and heritage resources in this area

Specific Mitigation (ID# 303):

- Carry out construction activities using methods that minimize surface damage, rutting and erosion. Construction matting may be required to protect the area from rutting and exposure to soil
- In the event of a discovery, stop work in the area and contact the Project Archaeologist immediately. Refer to Cultural and Heritage Resources Protection Plan for further guidance
- Should heritage resources be discovered during the pre-construction survey the project Archaeologist may prescribe additional mitigation measures

ESS Group: Intersection

**Features represented as lines*

ESS ID	ESS Name	Site	Location
PW75-RecUse-105	Snoman Trail	C7	E-720779 N-5565867

Potential Effects:
Potential interference with trail users; safety issues

Specific Mitigation (ID# 103):

- Trail closures are anticipated during construction phase but will be planned and avoided to the extent possible
- Communication about trail closures and planned impacts and mitigations will occur prior and during construction with local trail users (ie. Snoman, etc)
- Existing vegetation will be retained to the extent possible and disturbed areas will be rehabilitated &/or revegetated in a timely manner to the pre-existing or improved condition
- If damages occur, repairs must be completed to a pre-existing or improved condition in a timely manner
- Appropriate signage, barricades, etc with adequate illumination and reflectorization are required at work site boundaries as well as at bypass or other previous intersection(s) to minimize safety risk and inconvenience to other local users, particularly cyclists.
- Contractor is required to provide appropriate traffic control including advance warning and guidance on any Multi-Use Recreational Trail as needed (ie. onsite traffic control persons will be required if warranted)

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-119	Unnamed Tributary to the Pinawa Channel (Lee River)	E-720001 - N-5565368

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 715):

- Use existing trails, roads or cut lines whenever possible as access routes
- Carry out construction activities within riparian area on dry or frozen ground to minimize surface damage, rutting and erosion
- A minimum 7m no machine zone will restrict equipment in close proximity to the waterbody (except if travelling on an approved access route/crossing)
- Riparian Buffers shall be a minimum of 30m and increase in size based on slope of land entering waterway. Within these buffers shrub and herbaceous understory veg will be maintained along with trees that do not violate MH Veg Clearance Requirements
- Identify and flag the riparian buffer area prior to construction activities in proximity to this ESS
- Ground disturbance in riparian areas must be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Avoid refueling or vehicle/equipment maintenance within 100m of a water crossing. If refueling or vehicle/equipment maintenance is required within 100m of a water crossing, contractor must obtain approval from MH Environmental Officer and adhere to additional mitigation measures.

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-118	Unnamed Tributary to Boggy Creek	E-721117 - N-5566714

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 717):

- Use existing trails, roads or cut lines whenever possible as access routes
- Ground disturbance to be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Refueling or vehicle/equipment maintenance should be avoided when in proximity to this location

ESS Group: Wetland

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-329	Wetland	127 to 128	E-721085 N-5567428	E-721113 N-5566724	704
PW75-Aqua-330	Wetland	129 to 130	E-721122 N-5566514	E-721133 N-5566255	258
PW75-Aqua-331	Wetland	135 to 136	E-720085 N-5565421	E-719952 N-5565336	158

Potential Effects:
Increased erosion and sedimentation; rutting of floodplains; loss of riparian vegetation; potential impact to reptile and amphibian habitat

Specific Mitigation (ID# 205):

- Carry out construction activities on frozen or dry ground to minimize surface damage, rutting and erosion. Construction activities occurring during non-frozen ground conditions may require that additional mitigation be implemented (ie. use of construction matting, etc)
- Identify and flag a 30 m vegetated (shrub and herbaceous) buffer around site
- Retain understory and ground vegetation less than 2 meters in height to the extent possible.
- Application of herbicides will adhere to appropriate general mitigation measures and all chemical applications will be conducted by a certified licensed applicator in accordance with a Pesticide Use Permit.

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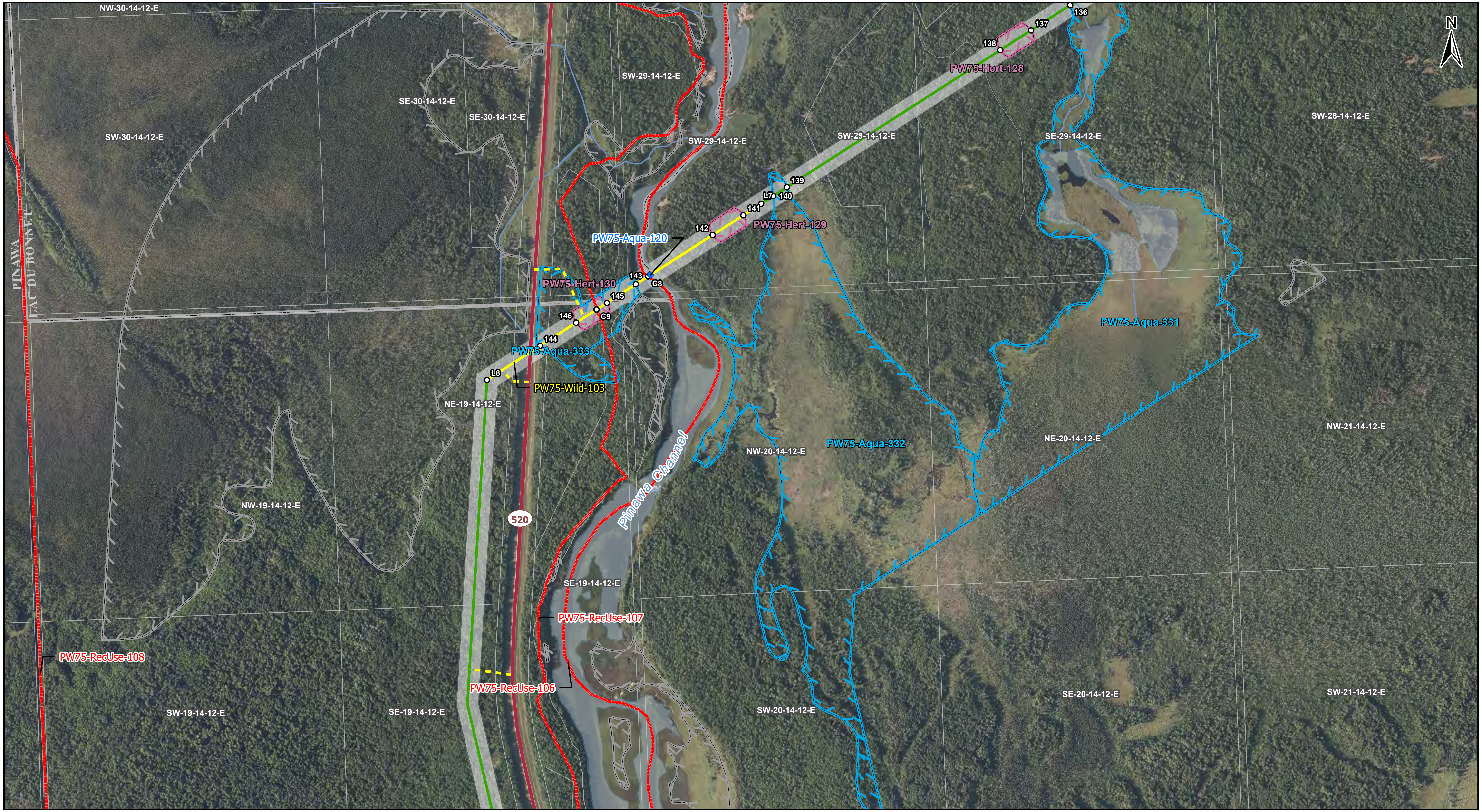

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ESS Features

Access
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Wildlife
- Birds and Habitat

Water
- Water Crossing

Heritage
- Archaeological

Water
- Wetland

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

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Map 10

ESS Group: Archaeological

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Hert-128	Potential Archaeological Site	137 to 138	E-719846 N-5565267	E-719762 N-5565214	99
PW75-Hert-129	Potential Archaeological Site	141 to 142	E-719065 N-5564766	E-718982 N-5564712	99
PW75-Hert-130	Potential Archaeological Site	145 to 146	E-718695 N-5564528	E-718611 N-5564474	99

Potential Effects:
Higher potential for discovery of cultural and heritage resources in this area

Specific Mitigation (ID# 303):

- Carry out construction activities using methods that minimize surface damage, rutting and erosion. Construction matting may be required to protect the area from rutting and exposure to soil
- In the event of a discovery, stop work in the area and contact the Project Archaeologist immediately. Refer to Cultural and Heritage Resources Protection Plan for further guidance
- Should heritage resources be discovered during the pre-construction survey the project Archaeologist may prescribe additional mitigation measures

ESS Group: Birds and Habitat

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Wild-103	Bird migration area	L7 to L8	E-719113 N-5564797	E-718369 N-5564319	884

Potential Effects:
Higher risk of wire collision, Risk of wire collision is localized to the right-of-way

Specific Mitigation (ID# 827):

- Bird diverters will be installed in a manner to maximize visibility
- Install bird diverter with spacing as per Transmission Line Design specifications for these spans
- Install bird diverters in a timely manner after conductor stringing.

ESS Group: Intersection

**Features represented as lines*

ESS ID	ESS Name	Site	Location
PW75-RecUse-107	TransCanada Trail	C9	E-718667 N-5564510

Potential Effects:
Potential interference with trail users; safety issues

Specific Mitigation (ID# 103):

- Trail closures are anticipated during construction phase but will be planned and avoided to the extent possible
- Communication about trail closures and planned impacts and mitigations will occur prior and during construction with local trail users (ie. Snoman, etc)
- Existing vegetation will be retained to the extent possible and disturbed areas will be rehabilitated &/or revegetated in a timely manner to the pre-existing or improved condition
- If damages occur, repairs must be completed to a pre-existing or improved condition in a timely manner
- Appropriate signage, barricades, etc with adequate illumination and reflectorization are required at work site boundaries as well as at bypass or other previous intersection(s) to minimize safety risk and inconvenience to other local users, particularly cyclists.
- Contractor is required to provide appropriate traffic control including advance warning and guidance on any Multi-Use Recreational Trail as needed (ie. onsite traffic control persons will be required if warranted)

ESS Group: Intersection

**Features represented as lines*

ESS ID	ESS Name	Site	Location
PW75-RecUse-106	Recreational Use Waterway Pinawa Channel	C8	E-718806 N-5564600

Potential Effects:
Potential inconvenience to users of this waterway

Specific Mitigation (ID# 115):

- During stringing activities appropriate signage, barricades, etc is required to minimize risk and inconvenience to other users of this waterway
- If applicable refer to approval under the Canadian Navigable Waters Act (CNWA)

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-120	Pinawa Channel	E-718813 - N-5564604

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 715):

- Use existing trails, roads or cut lines whenever possible as access routes
- Carry out construction activities within riparian area on dry or frozen ground to minimize surface damage, rutting and erosion
- A minimum 7m no machine zone will restrict equipment in close proximity to the waterbody (except if travelling on an approved access route/crossing)
- Riparian Buffers shall be a minimum of 30m and increase in size based on slope of land entering waterway. Within these buffers shrub and herbaceous understory veg will be maintained along with trees that do not violate MH Veg Clearance Requirements
- Identify and flag the riparian buffer area prior to construction activities in proximity to this ESS
- Ground disturbance in riparian areas must be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Avoid refueling or vehicle/equipment maintenance within 100m of a water crossing. If refueling or vehicle/equipment maintenance is required within 100m of a water crossing, contractor must obtain approval from MH Environmental Officer and adhere to additional mitigation measures.

ESS Group: Wetland

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-331	Wetland	135 to 136	E-720085 N-5565421	E-719952 N-5565336	158
PW75-Aqua-332	Wetland	139 to 140	E-719183 N-5564842	E-719146 N-5564818	44
PW75-Aqua-333	Wetland	143 to 144	E-718773 N-5564578	E-718514 N-5564411	308

Potential Effects:
Increased erosion and sedimentation; rutting of floodplains; loss of riparian vegetation; potential impact to reptile and amphibian habitat

Specific Mitigation (ID# 205):

- Carry out construction activities on frozen or dry ground to minimize surface damage, rutting and erosion. Construction activities occurring during non-frozen ground conditions may require that additional mitigation be implemented (ie. use of construction matting, etc)
- Identify and flag a 30 m vegetated (shrub and herbaceous) buffer around site
- Retain understory and ground vegetation less than 2 meters in height to the extent possible.
- Application of herbicides will adhere to appropriate general mitigation measures and all chemical applications will be conducted by a certified licensed applicator in accordance with a Pesticide Use Permit.

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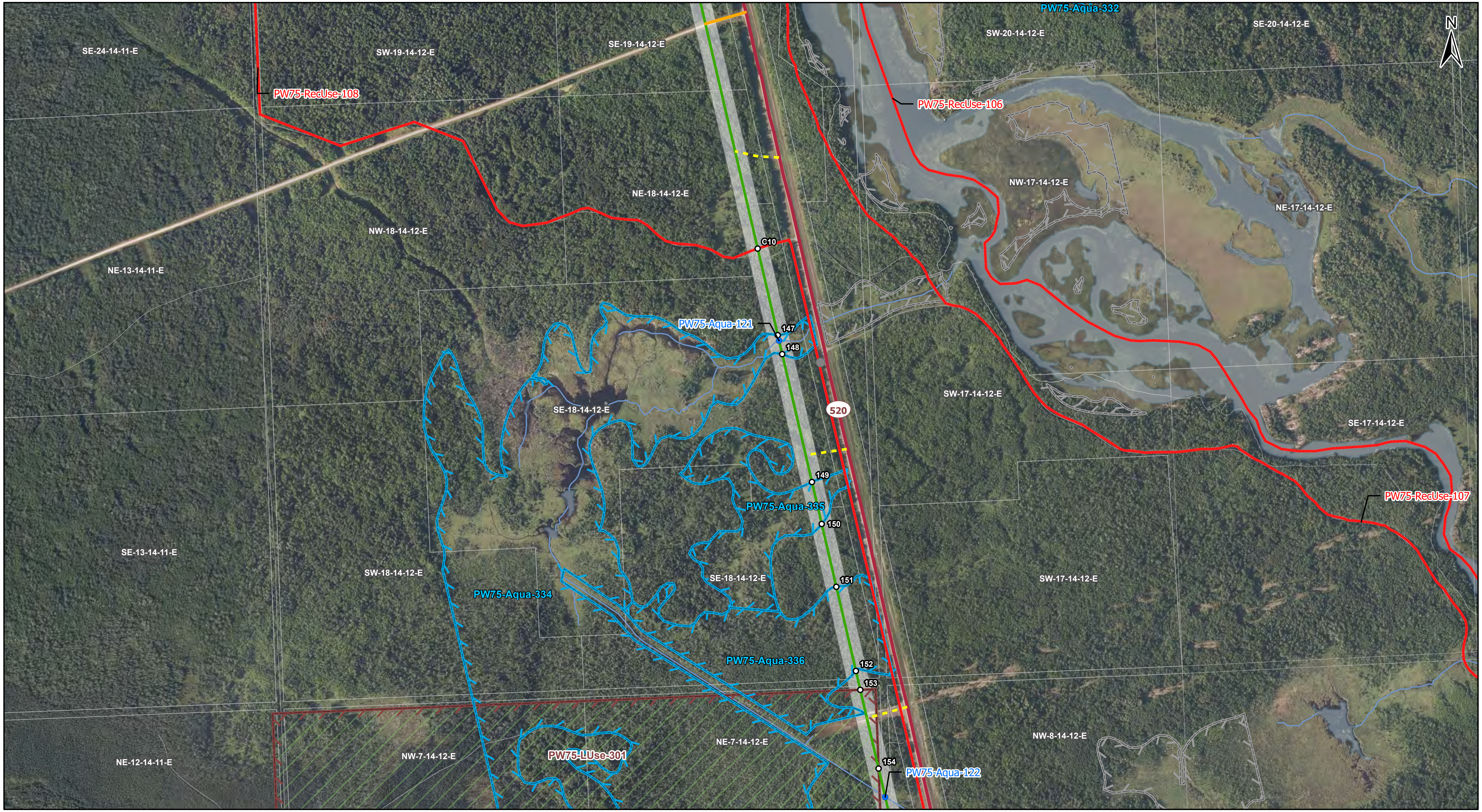

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Manitoba Hydro

Coordinate System: UTM Zone 14N NAD83
Data Source: MB Hydro, ProvMB, NRCAN
Date Created: July 07, 2023
Version: Draft

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Metres

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Land Base
- Transmission Line
- Highway
- Major Road
- Local Road
- Railway (Operational)
- Railway (Discontinued)
- Provincial Park
- Parcel Fabric
- Rural Municipality

*Tower locations subject to final design

Project Infrastructure
- Final Preferred Route
- Right of Way
- Station / Expansion Area

Sensitive Sites
- Point Features
- Linear Features
- Area Features

Points of Access
- No Crossing
- Existing Gravel Road
- Existing Gravel/Dirt Road
- Field Access
- New Trail
- Restricted Access
- Load Restriction
- Bypass Trail

*Some road names have not been verified

ESS Features

Access
- Recreation Trail

Water
- Water Crossing

Land Use
- Recreation

Water
- Wetland

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

Draft: For Discussion Purposes Only

Map 11

ESS Group: Intersection

**Features represented as lines*

ESS ID	ESS Name	Site	Location
PW75-RecUse-108	Snoman Trail	C10	E-718538 N-5562485

Potential Effects:
Potential interference with trail users; safety issues

Specific Mitigation (ID# 103):

- Trail closures are anticipated during construction phase but will be planned and avoided to the extent possible
- Communication about trail closures and planned impacts and mitigations will occur prior and during construction with local trail users (ie. Snoman, etc)
- Existing vegetation will be retained to the extent possible and disturbed areas will be rehabilitated &/or revegetated in a timely manner to the pre-existing or improved condition
- If damages occur, repairs must be completed to a pre-existing or improved condition in a timely manner
- Appropriate signage, barricades, etc with adequate illumination and reflectorization are required at work site boundaries as well as at bypass or other previous intersection(s) to minimize safety risk and inconvenience to other local users, particularly cyclists.
- Contractor is required to provide appropriate traffic control including advance warning and guidance on any Multi-Use Recreational Trail as needed (ie. onsite traffic control persons will be required if warranted)

ESS Group: Recreation

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-LUse-301	Whiteshell Provincial Park	153 to 154	E-718816 N-5561287	E-718866 N-5561074	219

Potential Effects:
Potential disruption to Provincial Park use

Specific Mitigation (ID# 409):

- Follow all provincial park work permit conditions
- Observe local by-laws and protocols (ie. noise by-laws, etc)
- Minimize noise, dust and other emissions from work activities and maintain clean work site
- Appropriate signage, barricades, etc with adequate illumination and reflectorization are required at work site boundaries as well as at bypass or other previous intersection(s) to minimize safety risk and inconvenience to other local users, particularly cyclists.

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-121	Unnamed Tributary to the Pinawa Channel (Lee River)	E-718596 - N-5562235

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 715):

- Use existing trails, roads or cut lines whenever possible as access routes
- Carry out construction activities within riparian area on dry or frozen ground to minimize surface damage, rutting and erosion
- A minimum 7m no machine zone will restrict equipment in close proximity to the waterbody (except if travelling on an approved access route/crossing)
- Riparian Buffers shall be a minimum of 30m and increase in size based on slope of land entering waterway. Within these buffers shrub and herbaceous understory veg will be maintained along with trees that do not violate MH Veg Clearance Requirements
- Identify and flag the riparian buffer area prior to construction activities in proximity to this ESS
- Ground disturbance in riparian areas must be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Avoid refueling or vehicle/equipment maintenance within 100m of a water crossing. If refueling or vehicle/equipment maintenance is required within 100m of a water crossing, contractor must obtain approval from MH Environmental Officer and adhere to additional mitigation measures.

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-122	Unnamed Drain [manmade]	E-718884 - N-5560996

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 717):

- Use existing trails, roads or cut lines whenever possible as access routes
- Ground disturbance to be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Refueling or vehicle/equipment maintenance should be avoided when in proximity to this location

ESS Group: Wetland

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-334	Wetland	147 to 148	E-718593 N-5562250	E-718605 N-5562199	52
PW75-Aqua-335	Wetland	149 to 150	E-718685 N-5561851	E-718712 N-5561738	116
PW75-Aqua-336	Wetland	151 to 152	E-718751 N-5561567	E-718804 N-5561339	234

Potential Effects:
Increased erosion and sedimentation; rutting of floodplains; loss of riparian vegetation; potential impact to reptile and amphibian habitat

Specific Mitigation (ID# 205):

- Carry out construction activities on frozen or dry ground to minimize surface damage, rutting and erosion. Construction activities occurring during non-frozen ground conditions may require that additional mitigation be implemented (ie. use of construction matting, etc)
- Identify and flag a 30 m vegetated (shrub and herbaceous) buffer around site
- Retain understory and ground vegetation less than 2 meters in height to the extent possible.
- Application of herbicides will adhere to appropriate general mitigation measures and all chemical applications will be conducted by a certified licensed applicator in accordance with a Pesticide Use Permit.

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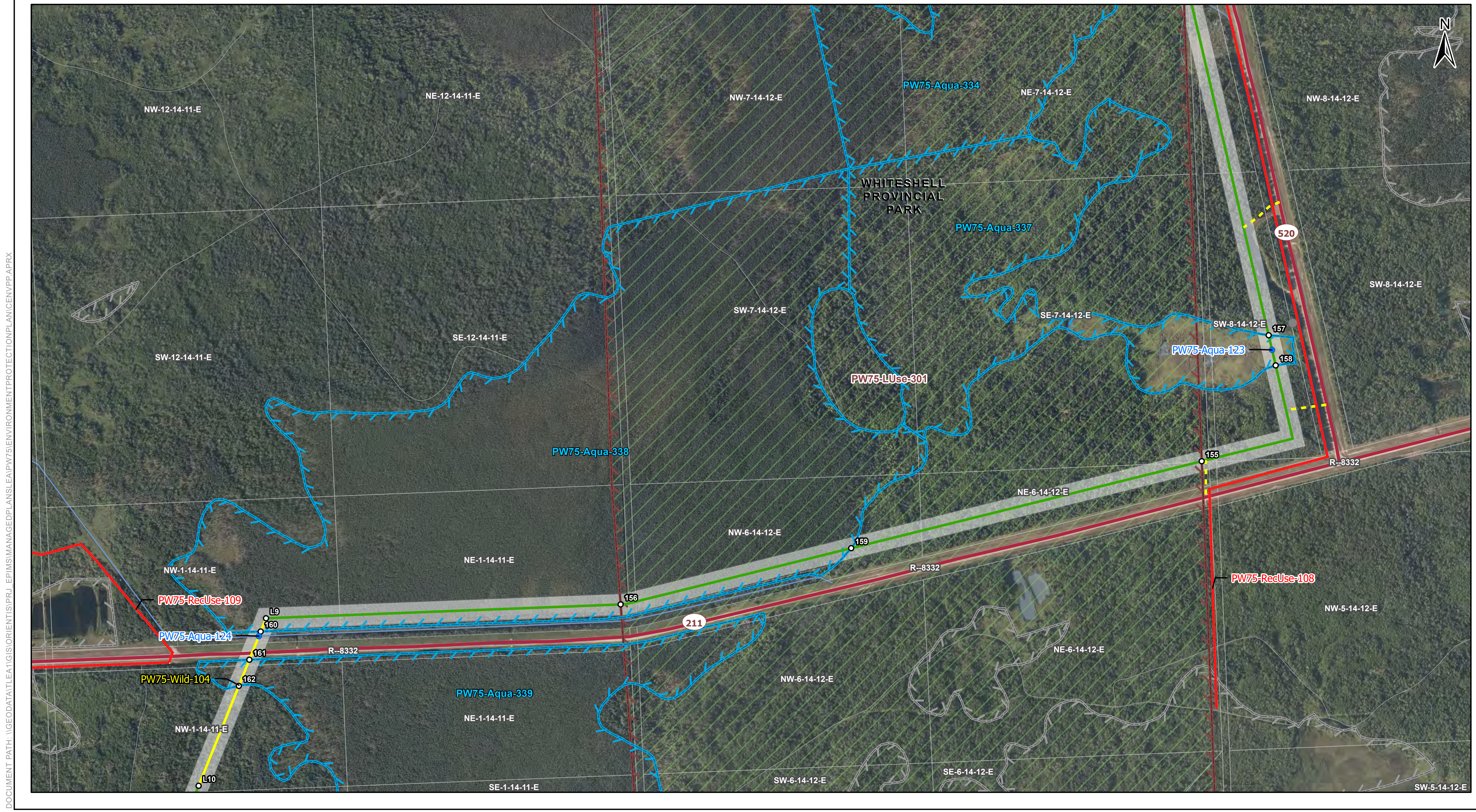

Manitoba Hydro

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Land Base
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- Area Features

Points of Access
- No Crossing
- Existing Gravel Road
- Existing Gravel/Dirt Road
- Field Access
- New Trail
- Restricted Access
- Load Restriction
- Bypass Trail

*Some road names have not been verified

ESS Features
Access
- Recreation Trail

Wildlife
- Birds and Habitat

Water
- Water Crossing

Land Use
- Recreation

Water
- Wetland

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

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Map 12

ESS Group: Birds and Habitat

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Wild-104	Bird migration area	L9 to L10	E-716320 N-5559257	E-716133 N-5558791	501

Potential Effects:
Higher risk of wire collision, Risk of wire collision is localized to the right-of-way

Specific Mitigation (ID# 827):

- Bird diverters will be installed in a manner to maximize visibility
- Install bird diverter with spacing as per Transmission Line Design specifications for these spans
- Install bird diverters in a timely manner after conductor stringing.

ESS Group: Recreation

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-LUse-301	Whiteshell Provincial Park	155 to 156	E-718920 N-5559693	E-717305 N-5559295	1663

Potential Effects:
Potential disruption to Provincial Park use

Specific Mitigation (ID# 409):

- Follow all provincial park work permit conditions
- Observe local by-laws and protocols (ie. noise by-laws, etc)
- Minimize noise, dust and other emissions from work activities and maintain clean work site
- Appropriate signage, barricades, etc with adequate illumination and reflectorization are required at work site boundaries as well as at bypass or other previous intersection(s) to minimize safety risk and inconvenience to other local users, particularly cyclists.

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-123	Unnamed Tributary to Pinawa Channel (Lee River)	E-719115 - N-5560003
PW75-Aqua-124	Unnamed Drain [manmade]	E-716300 - N-5559207

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 717):

- Use existing trails, roads or cut lines whenever possible as access routes
- Ground disturbance to be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Refueling or vehicle/equipment maintenance should be avoided when in proximity to this location

ESS Group: Wetland

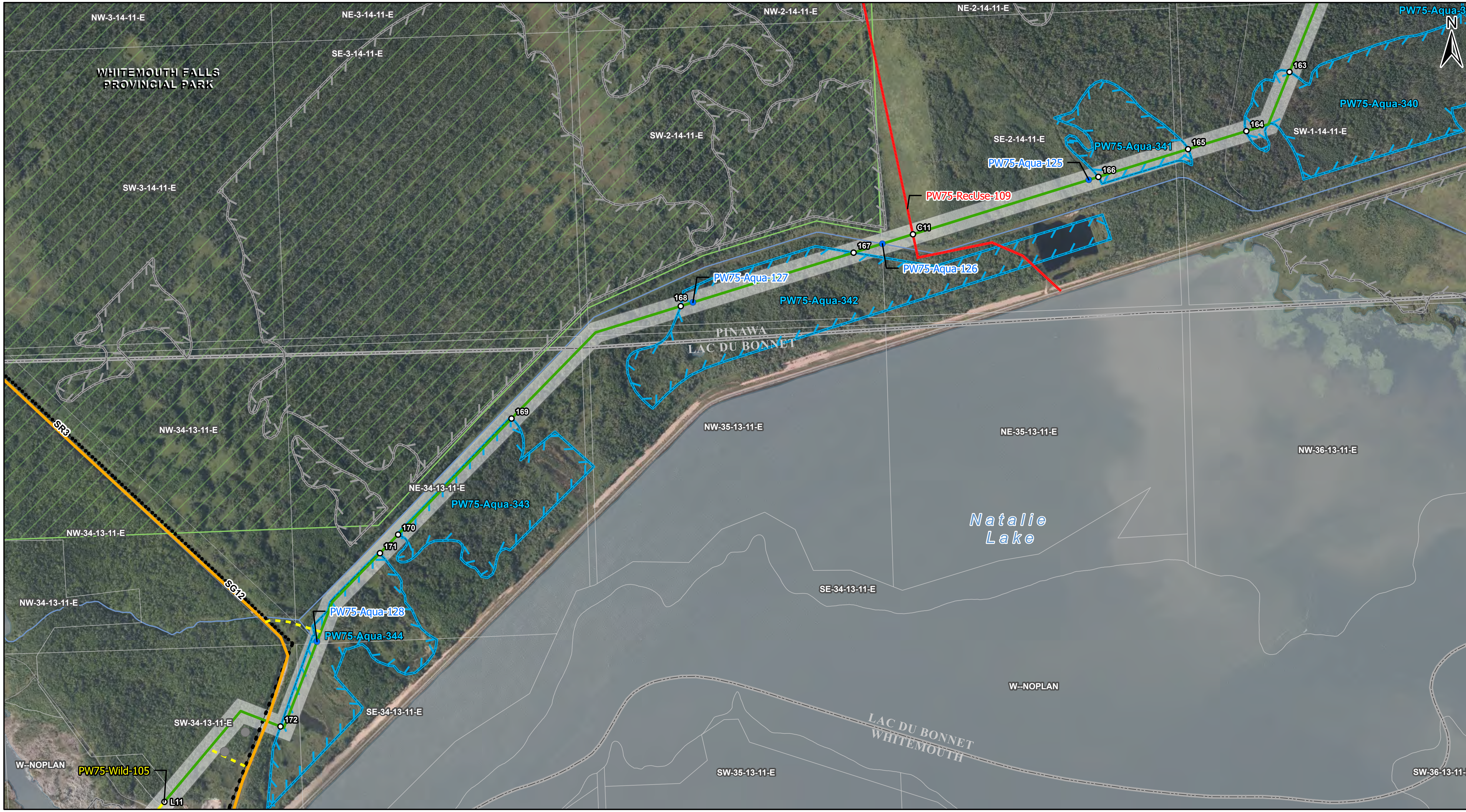
**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-337	Wetland	157 to 158	E-719106 N-5560043	E-719125 N-5559959	86
PW75-Aqua-338	Wetland	159 to 160	E-717946 N-5559452	E-716305 N-5559220	1685
PW75-Aqua-339	Wetland	161 to 162	E-716273 N-5559141	E-716244 N-5559069	78

Potential Effects:
Increased erosion and sedimentation; rutting of floodplains; loss of riparian vegetation; potential impact to reptile and amphibian habitat

Specific Mitigation (ID# 205):

- Carry out construction activities on frozen or dry ground to minimize surface damage, rutting and erosion. Construction activities occurring during non-frozen ground conditions may require that additional mitigation be implemented (ie. use of construction matting, etc)
- Identify and flag a 30 m vegetated (shrub and herbaceous) buffer around site
- Retain understory and ground vegetation less than 2 meters in height to the extent possible.
- Application of herbicides will adhere to appropriate general mitigation measures and all chemical applications will be conducted by a certified licensed applicator in accordance with a Pesticide Use Permit.



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- Linear Features
- Area Features

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- Existing Gravel/Dirt Road
- Field Access
- New Trail
- Restricted Access
- Load Restriction
- Bypass Trail

*Some road names have not been verified

ESS Features

Access
- Recreation Trail

Wildlife
- Birds and Habitat

Water
- Water Crossing

Water
- Wetland

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

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Map 13

ESS Group: Birds and Habitat

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Wild-105	Bird migration area	L11 to L12	E-712997 N-5556603	E-711692 N-5555142	2060

Potential Effects:
Higher risk of wire collision, Risk of wire collision is localized to the right-of-way

Specific Mitigation (ID# 827):

- Bird diverters will be installed in a manner to maximize visibility
- Install bird diverter with spacing as per Transmission Line Design specifications for these spans
- Install bird diverters in a timely manner after conductor stringing.

ESS Group: Intersection

**Features represented as lines*

ESS ID	ESS Name	Site	Location
PW75-RecUse-109	Snoman Trail	C11	E-715028 N-5558144

Potential Effects:
Potential interference with trail users; safety issues

Specific Mitigation (ID# 103):

- Trail closures are anticipated during construction phase but will be planned and avoided to the extent possible
- Communication about trail closures and planned impacts and mitigations will occur prior and during construction with local trail users (ie. Snoman, etc)
- Existing vegetation will be retained to the extent possible and disturbed areas will be rehabilitated &/or revegetated in a timely manner to the pre-existing or improved condition
- If damages occur, repairs must be completed to a pre-existing or improved condition in a timely manner
- Appropriate signage, barricades, etc with adequate illumination and reflectorization are required at work site boundaries as well as at bypass or other previous intersection(s) to minimize safety risk and inconvenience to other local users, particularly cyclists.
- Contractor is required to provide appropriate traffic control including advance warning and guidance on any Multi-Use Recreational Trail as needed (ie. onsite traffic control persons will be required if warranted)

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-126	Unnamed Drain [manmade]	E-714945 - N-5558118
PW75-Aqua-128	Unnamed Tributary to Winnipeg River (Lac du Bonnet)	E-713411 - N-5557038

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 715):

- Use existing trails, roads or cut lines whenever possible as access routes
- Carry out construction activities within riparian area on dry or frozen ground to minimize surface damage, rutting and erosion
- A minimum 7m no machine zone will restrict equipment in close proximity to the waterbody (except if travelling on an approved access route/crossing)
- Riparian Buffers shall be a minimum of 30m and increase in size based on slope of land entering waterway. Within these buffers shrub and herbaceous understory veg will be maintained along with trees that do not violate MH Veg Clearance Requirements
- Identify and flag the riparian buffer area prior to construction activities in proximity to this ESS
- Ground disturbance in riparian areas must be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Avoid refueling or vehicle/equipment maintenance within 100m of a water crossing. If refueling or vehicle/equipment maintenance is required within 100m of a water crossing, contractor must obtain approval from MH Environmental Officer and adhere to additional mitigation measures.

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-125	Unnamed Tributary to Winnipeg River (Lac du Bonnet)	E-715505 - N-5558292
PW75-Aqua-127	Unnamed Tributary to Winnipeg River (Lac du Bonnet)	E-714431 - N-5557959

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 717):

- Use existing trails, roads or cut lines whenever possible as access routes
- Ground disturbance to be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Refueling or vehicle/equipment maintenance should be avoided when in proximity to this location

ESS Group: Wetland

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-340	Wetland	163 to 164	E-716049 N-5558584	E-715932 N-5558424	215
PW75-Aqua-341	Wetland	165 to 166	E-715774 N-5558375	E-715531 N-5558300	254
PW75-Aqua-342	Wetland	167 to 168	E-714867 N-5558094	E-714398 N-5557949	490
PW75-Aqua-343	Wetland	169 to 170	E-713939 N-5557644	E-713631 N-5557329	440
PW75-Aqua-344	Wetland	171 to 172	E-713582 N-5557278	E-713312 N-5556808	560

Potential Effects:
Increased erosion and sedimentation; rutting of floodplains; loss of riparian vegetation; potential impact to reptile and amphibian habitat

Specific Mitigation (ID# 205):

- Carry out construction activities on frozen or dry ground to minimize surface damage, rutting and erosion. Construction activities occurring during non-frozen ground conditions may require that additional mitigation be implemented (ie. use of construction matting, etc)
- Identify and flag a 30 m vegetated (shrub and herbaceous) buffer around site
- Retain understory and ground vegetation less than 2 meters in height to the extent possible.
- Application of herbicides will adhere to appropriate general mitigation measures and all chemical applications will be conducted by a certified licensed applicator in accordance with a Pesticide Use Permit.

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Sensitive Sites
- Point Features
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- Area Features

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- Existing Gravel Road
- Existing Gravel/Dirt Road
- Field Access
- New Trail
- Restricted Access
- Load Restriction
- Bypass Trail

*Some road names have not been verified

ESS Features

Access
- Recreation Trail

Wildlife
- Birds and Habitat

Water
- Water Crossing

Heritage
- Archaeological

Land Use
- Recreation

Resource Use
- Agriculture

Water
- Water Crossing
- Wetland

Manitoba Hydro

PW75 Transmission Project
Construction Environmental Protection Plan
Environmentally Sensitive Site Locations

Draft: For Discussion Purposes Only

Map 14

ESS Group: Agriculture

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-RUse-105	Agriculture	187 to 188	E-711932 N-5555343	E-711722 N-5555167	273
PW75-RUse-106	Agriculture	189 to 190	E-711693 N-5555142	E-711612 N-5554655	494

Potential Effects:
Potential biosecurity risk to agricultural activities

Specific Mitigation (ID# 391):

- Access/activities in agricultural areas must adhere to biosecurity cleaning and documentation requirements.

ESS Group: Archaeological

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Hert-131	Potential Archaeological Site	177 to 178	E-712495 N-5556006	E-712418 N-5555914	120
PW75-Hert-132	Potential Archaeological Site	179 to 180	E-712324 N-5555810	E-712247 N-5555746	99
PW75-Hert-133	Potential Archaeological Site	181 to 182	E-712129 N-5555648	E-712119 N-5555501	207
PW75-Hert-134	Potential Archaeological Site	185 to 186	E-711942 N-5555352	E-711866 N-5555288	99

Potential Effects:
Higher potential for discovery of cultural and heritage resources in this area

Specific Mitigation (ID# 303):

- Carry out construction activities using methods that minimize surface damage, rutting and erosion. Construction matting may be required to protect the area from rutting and exposure to soil
- In the event of a discovery, stop work in the area and contact the Project Archaeologist immediately. Refer to Cultural and Heritage Resources Protection Plan for further guidance
- Should heritage resources be discovered during the pre-construction survey the project Archaeologist may prescribe additional mitigation measures

ESS Group: Birds and Habitat

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Wild-105	Bird migration area	L11 to L12	E-712997 N-5556603	E-711692 N-5555142	2060

Potential Effects:
Higher risk of wire collision, Risk of wire collision is localized to the right-of-way

Specific Mitigation (ID# 827):

- Bird diverters will be installed in a manner to maximize visibility
- Install bird diverter with spacing as per Transmission Line Design specifications for these spans
- Install bird diverters in a timely manner after conductor stringing.

ESS Group: Intersection

**Features represented as lines*

ESS ID	ESS Name	Site	Location
PW75-RecUse-111	Hiking Trail	C13	E-712477 N-5555985
PW75-RecUse-112	Snoman Trail	C14	E-712118 N-5555580
PW75-RecUse-111	Hiking Trail	C15	E-712124 N-5555572

Potential Effects:
Potential interference with trail users; safety issues

Specific Mitigation (ID# 103):

- Trail closures are anticipated during construction phase but will be planned and avoided to the extent possible
- Communication about trail closures and planned impacts and mitigations will occur prior and during construction with local trail users (ie. Snoman, etc)
- Existing vegetation will be retained to the extent possible and disturbed areas will be rehabilitated &/or revegetated in a timely manner to the pre-existing or improved condition
- If damages occur, repairs must be completed to a pre-existing or improved condition in a timely manner
- Appropriate signage, barricades, etc with adequate illumination and reflectorization are required at work site boundaries as well as at bypass or other previous intersection(s) to minimize safety risk and inconvenience to other local users, particularly cyclists.
- Contractor is required to provide appropriate traffic control including advance warning and guidance on any Multi-Use Recreational Trail as needed (ie. onsite traffic control persons will be required if warranted)

ESS Group: Intersection

**Features represented as lines*

ESS ID	ESS Name	Site	Location
PW75-RecUse-110	Recreational Use Waterway Winnipeg River	C12	E-712693 N-5556242
PW75-RecUse-113	Recreational Use Waterway Whitemouth River	C16	E-712041 N-5555435

Potential Effects:
Potential inconvenience to users of this waterway

Specific Mitigation (ID# 115):

- During stringing activities appropriate signage, barricades, etc is required to minimize risk and inconvenience to other users of this waterway
- If applicable refer to approval under the Canadian Navigable Waters Act (CNWA)

ESS Group: Recreation

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-LUse-302	Whitemouth Falls Provincial Park	175 to 176	E-712544 N-5556064	E-712097 N-5555605	653

Potential Effects:
Potential disruption to Provincial Park use

Specific Mitigation (ID# 409):

- Follow all provincial park work permit conditions
- Observe local by-laws and protocols (ie. noise by-laws, etc)
- Minimize noise, dust and other emissions from work activities and maintain clean work site
- Appropriate signage, barricades, etc with adequate illumination and reflectorization are required at work site boundaries as well as at bypass or other previous intersection(s) to minimize safety risk and inconvenience to other local users, particularly cyclists.

ESS Group: Water Crossing

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-129	Winnipeg River	173 to 174	E-712872 N-5556455	E-712524 N-5556040	541

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 715):

- Use existing trails, roads or cut lines whenever possible as access routes
- Carry out construction activities within riparian area on dry or frozen ground to minimize surface damage, rutting and erosion
- A minimum 7m no machine zone will restrict equipment in close proximity to the waterbody (except if travelling on an approved access route/crossing)
- Riparian Buffers shall be a minimum of 30m and increase in size based on slope of land entering waterway. Within these buffers shrub and herbaceous understory veg will be maintained along with trees that do not violate MH Veg Clearance Requirements
- Identify and flag the riparian buffer area prior to construction activities in proximity to this ESS
- Ground disturbance in riparian areas must be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Avoid refueling or vehicle/equipment maintenance within 100m of a water crossing. If refueling or vehicle/equipment maintenance is required within 100m of a water crossing, contractor must obtain approval from MH Environmental Officer and adhere to additional mitigation measures.

ESS Group: Water Crossing

**Features represented as points*

ESS ID	ESS Name	Location
PW75-Aqua-131	Unnamed Drain [manmade]	E-711614 - N-5554663

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 717):

- Use existing trails, roads or cut lines whenever possible as access routes
- Ground disturbance to be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Refueling or vehicle/equipment maintenance should be avoided when in proximity to this location

ESS Group: Water Crossing

**Features represented as polygons*

ESS ID	ESS Name	Site	Start	Stop	Distance (m)
PW75-Aqua-130	Whitemouth River	183 to 184	E-712113 N-5555496	E-711972 N-5555377	184

Potential Effects:
Habitat loss and contamination from structure foundations & installations; increased erosion & sedimentation of streams; Damage to stream banks; Loss of riparian vegetation; Fish habitat disturbances and impeded fish movement; Rutting of floodplain

Specific Mitigation (ID# 719):

- Use existing trails, roads or cut lines whenever possible as access routes
- Carry out construction activities within riparian area on dry or frozen ground to minimize surface damage, rutting and erosion
- A minimum 7m no machine zone will restrict equipment in close proximity to the waterbody (except if travelling on an approved access route/crossing)
- Riparian Buffers shall be a minimum of 30m and increase in size based on slope of land entering waterway. Within these buffers shrub and herbaceous understory veg will be maintained along with trees that do not violate MH Veg Clearance Requirements
- Identify and flag the riparian buffer area prior to construction activities in proximity to this ESS
- Ground disturbance in riparian areas must be stabilized as soon as practical to prevent erosion and/or sedimentation (active revegetation may be required)
- Avoid refueling or vehicle/equipment maintenance within 100m of a water crossing. If refueling or vehicle/equipment maintenance is required within 100m of a water crossing, contractor must obtain approval from MH Environmental Officer and adhere to additional mitigation measures.
- The Whitemouth River provides critical habitat for the endangered Carmine Shiner and the riparian buffer area must be a minimum 50m from the ordinary high water mark

Appendix A: Contact list
Appendix B: Environmental licences, approvals and permits
Appendix C: Timing windows
Appendix D: Buffers and setbacks
Appendix E: Avian protection documents
Appendix F: Reptile and amphibian protection document
Appendix G: Species of concern contingency measures
Appendix H: Biosecurity management plan
Appendix I: Erosion and sediment control plan
Appendix J: Saturated/thawed soils operating guidelines
Appendix K: Cultural and heritage resources protection plan
Appendix L: Access management plan
Appendix M: Example environmental pre-work orientation record
Appendix N: Rules for externally reportable releases
Appendix O: Rehabilitation and invasive species management plan
Appendix P: Clearing management plan
Appendix Q: Waste and recycling management plan
Appendix R: Ice thickness chart

APPENDICES

Appendix A

Contact list

Contact list

Contact	Name	Phone Number(s)
Construction contractor		
Contractor project manager		
Contractor field lead		
Contractor safety		
Environmental representative		
Manitoba Hydro		
Project engineer		
Contract administrator		
Line contracts business partner		
environmental officer / inspector		
FSO: field safety officer		
Hazardous materials officer		
Area spill response coordinator		
Emergency response services		
Project archaeologist (Primary contact)		
Manitoba Environment and Climate contacts		
24 hr environmental emergency response reporting line		1-204-944-4888 or Toll free at 1-855-944-4888

Appendix B

Environmental licences, approvals and permits

List of Potential Approvals required for Construction

Approval required (Applicable Legislation / Regulation)	Type of Approval needed	Responsibility
Environment Act Licence (Class 2)	Licence	T&DEE
Crown Lands Act (General Permit)	Permit	Property Dept.
Storage and Handling of Gasoline and Associated Products Regulation, Generator Registration and Carrier Licencing Regulation (Dangerous Goods Handling and Transportation Act)	Permit	Contractor
Highways Protection Act	Permit	LC
The Heritage Resources Act (when required)	Permit	T&DEE
A permit from Manitoba Infrastructure is required for any construction above or below ground level that falls within 250 ft. of a Provincial Trunk Highway right-of-way edge or within 150 ft. of a Provincial Road right-of-way edge.	Permit	Property Dept.

Note: Permits, Licences and Approvals are the sole responsibility of those groups indicated in this table

T&DEE – Manitoba Hydro Transmission & Distribution Environment and Engagement Department

LC – Line Contracts Department

Appendix C

Timing Windows

Timing Windows

Project Wildlife Reduced Risk Timing Windows

Species	Sensitivity	January		February		March		April		May		June		July		August		Septembe		October		Novembe		Decembe	
Mammals	Denning Sites																								
Amphibians/Reptiles	Amphibian Bearing Wetland																								
Snakes	Hibernaculum																								
Bats	Hibernaculum																								
Birds	Breeding and Nesting																								
Fish	Spawning Areas																								

Reduced Risk to Wildlife

Sensitive Time Period for Wildlife (Where construction activities occur during this period, mitigations measures will be prescribed on a site-by-site basis)

Examples of Mitigations that may be approved by T&DEE Department during Sensitive Time Period for Birds or Amphibians/Reptiles are found in Appendix E and F respectively.

Appendix D

Buffers and Setbacks

Buffers and setbacks

Feature	Activity	Non Frozen Ground Setback Distance[1]	Frozen Ground Setback Distance[1]	Vegetated Buffer Distance[2]
Vegetation				
Plant Species at Risk	Tower Foundation Siting	100m	100m	
	Clearing And Construction	30m		30m
	Maintenance	30m		30m
	Access Trail	30m	30m	
Anthropogenic				
Heritage and Cultural	All	Varies	Varies	Varies
Amphibians				
Northern Leopard Frog (Known breeding pond, watering site)	Tower Foundation Siting	30m	30m	
	Clearing And Construction	30m		30m
	Maintenance	30m		
	Access Trail	30m	30m	
Reptiles				
Garter Snake Hibernaculum	Tower Foundation Siting	200m	200m	
Landforms				
Wetlands	Clearing And Construction			30m
	Maintenance			30m
	Access Trail			30m
	Hazardous Material Handling/Storage	100m	100m	
	Soil Stockpiles	30m		30m
Mammals				
Mineral Licks	All	120m		120m

Feature	Activity	Non Frozen Ground Setback Distance[1]	Frozen Ground Setback Distance[1]	Vegetated Buffer Distance[2]
Occupied Mammal Dens[3](Red fox, Gray fox, Coyote, Wolf, Bobcat, American badger, American marten, Fisher, Least weasel and Raccoon)	All	50m	50m	
Occupied Bear Den	All	150m	150m	150m

NOTE: ALL MEASUREMENTS ARE FROM EDGE OF FEATURE

[1]NO WORK ALLOWED WITHOUT MANITOBA HYDRO LICENSING AND ENVIRONMENTAL ASSESSMENT DEPARTMENT REVIEW AND APPROVAL, WHICH MAY BE SUBJECT TO REGULATORY APPROVAL.

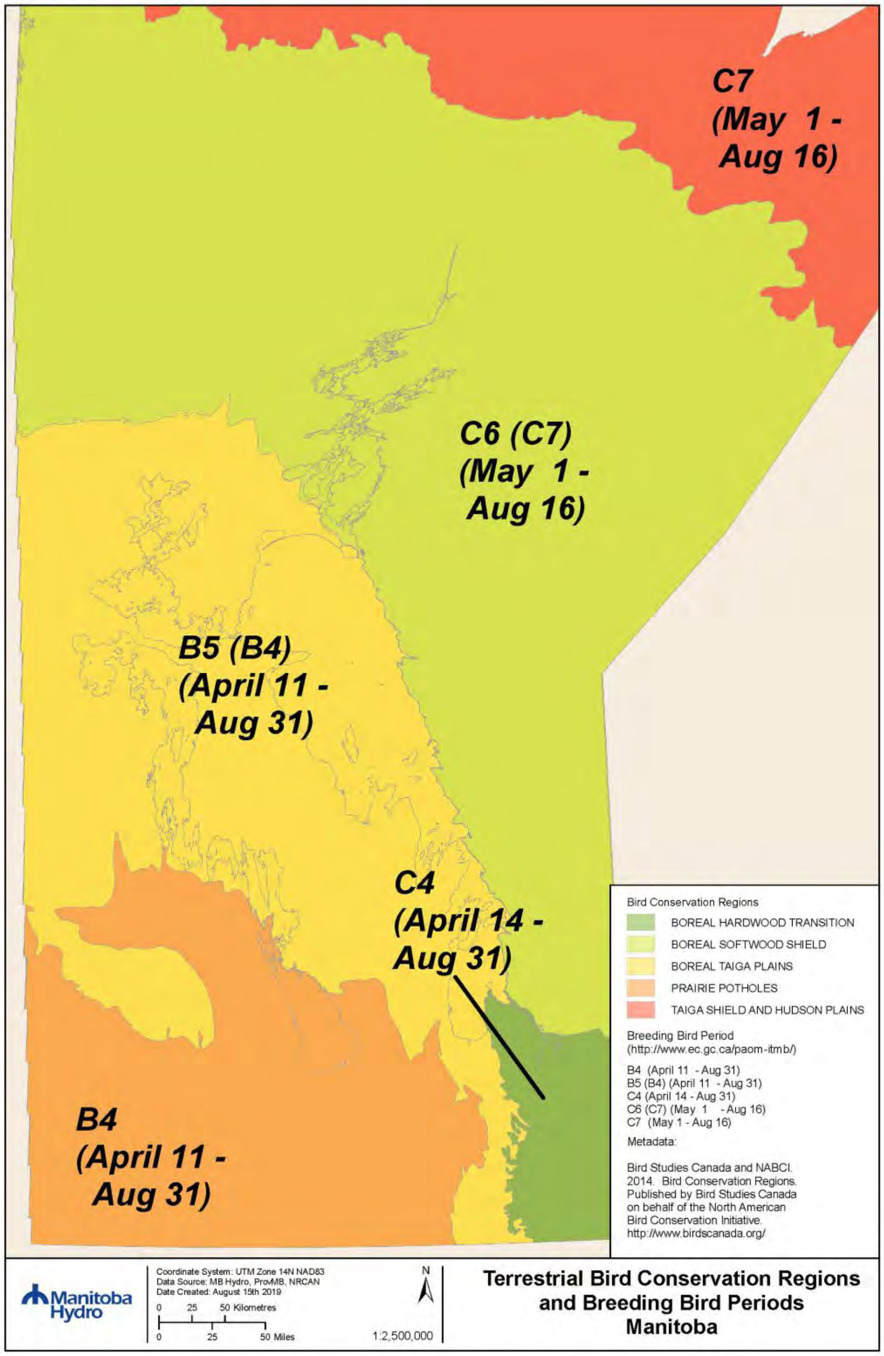
[2]SHRUB AND HERBACEOUS VEGETATION RETAINED)

[3]BEAR/MAMMAL DEN SITES ARE HIGHLY VARIABLE AND MAY BE FOUND IN CAVES, CREVASSES, OVERTURNED TREES, OPEN GROUND NESTS, AND LOW-SWEEPING BRANCHES OF A CONIFEROUS TREE.

Appendix E

Avian Protection Documents

Appendix E-1: Terrestrial Bird Conservation Regions and Breeding Bird Seasons for Manitoba*



* Adapted from Environment and Climate Change. Dates should be considered as guidelines.

Appendix E-2: Determining Disturbance Level for Nesting Birds during Breeding Bird Season

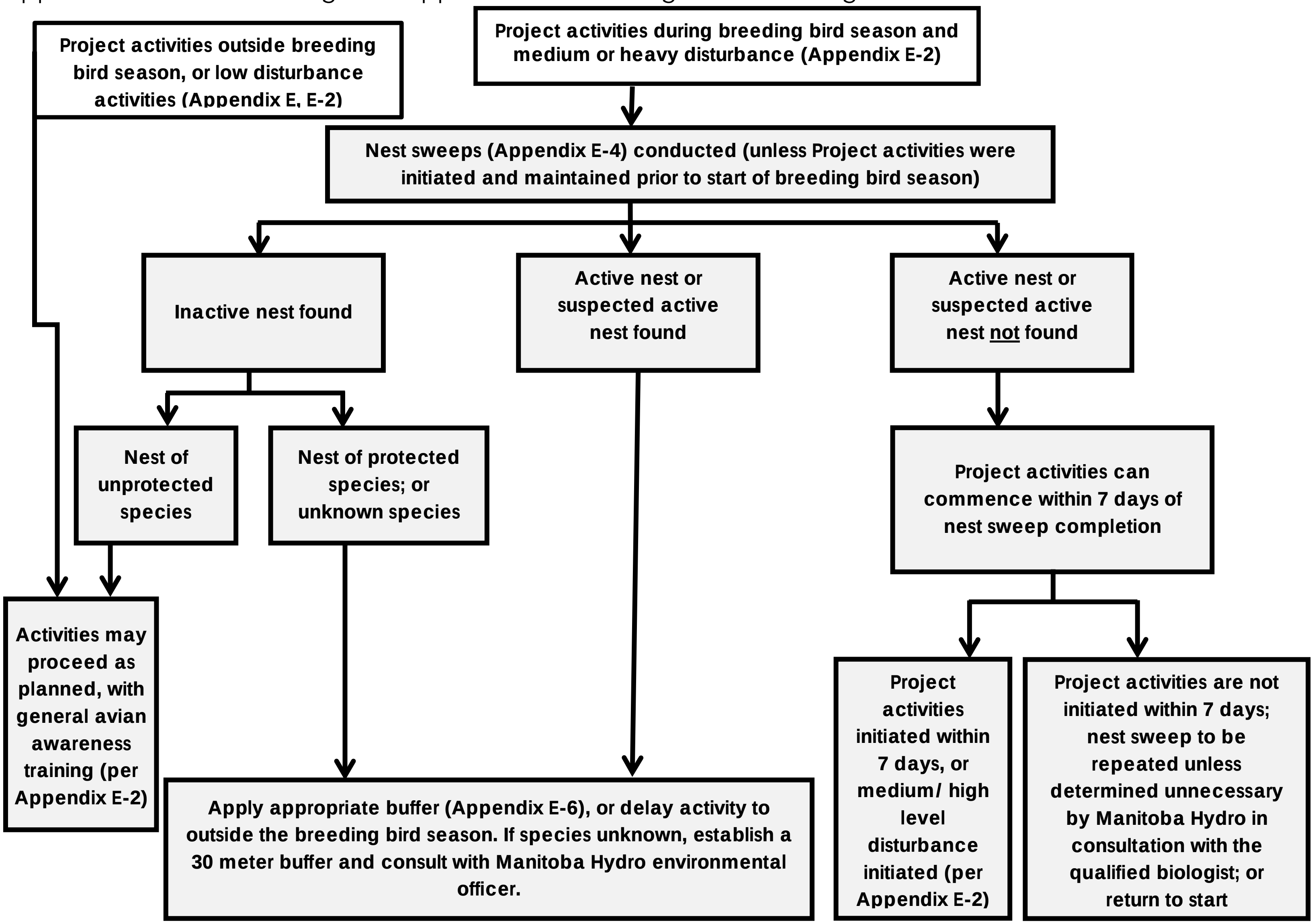
<table>
<tr><th>Activity (examples provided for guidance)</th><th>Disturbance Level</th><th>Training Required</th><th>General Mitigation</th></tr>
<tr><td>1 vehicle/equipment round trip (two passes) per 0.5 hour;
Foot traffic, surveying;
Spacer damper installation;
Medium helicopter work at top of tower;
Stringing (helicopter, pulling conductor);
Inspection activities</td><td>Low</td><td>General Avian Awareness Training*</td><td>Operators and workers remain vigilant for any possible bird nesting activity, provide 5 m berth</td></tr>
<tr><td>2-5 vehicle/equipment round trip (two passes) per 0.5 hour;
Any sustained activity for >1-4 hours over a 12 hour period within 100m of work site;
Plumbing and tensioning guys;
Tower hooking;
Anchor pull testing;
Clipping in conductor</td><td>Moderate</td><td rowspan="2">General Avian Awareness Training*
and
Consult a Manitoba Hydro Environmental Officer</td><td rowspan="2">General Mitigation Approach for Reducing Risk to Nesting Birds as per Appendix E-3

Nest sweep protocol as per Appendix E-4</td></tr>
<tr><td>>5 vehicle/equipment round trip (two passes) per 0.5 hour;
Any sustained activity for >4 hours within 100m of work site;
Vegetation clearing;
Foundation installation;
Stringing (implode sites, tensioner/puller sites);
Tower assembly or installation;
Road/trail construction</td><td>High</td></tr>
</table>

*General Avian Awareness Training

General avian awareness training is to be provided by the Contractor to all crews and contractors conducting field work during the sensitive time period for birds identified in Timing Windows appendix. General avian awareness training involves basic introduction to bird biology, nesting characteristics, government regulations, and instruction on how to contact Manitoba Hydro Environmental officers, when specific questions arise.

Appendix E-3: General Mitigation Approach for Reducing Risk to Nesting Birds



Appendix E-4: Nest Sweep Protocol

Birds may nest on the ground, others nest in shrubs and/or trees, while other nest along the edges of water bodies. Nest sweeps are too be conducted on lands having potential to support bird nesting. Qualified[1] biologists employed / retained by the contractor are to complete nest sweeps no more than 7 days before disturbance activities. To complete a nest, sweep the qualified biologist must:

1. Nest sweeps are to be done on foot and can be completed from sunrise until 1800 hours, however birds are most active from sunrise until 1000 hours. Nest sweeps will be discontinued during high winds or precipitation as birds are less active.
2. In advance of any medium or heavy disturbance activity (Appendix E-2) walk the entire area, ensuring full coverage. Recommended spacing between parallel transects is approximately 10 m, but surveyors may reduce this spacing as necessary.
3. Walk slowly, observing from ground-level, to the tops of the trees.
4. If a nest is suspected to be nearby based on bird behavior (e.g., acting strange/aggressive or agitated vocalizations), try to locate the nest location.
5. If the nest is found, mark the location with flagging tape (tie the flagging tape to a tree or other landmark several meters away). Record the following information on the flagging tape: location of the nest including UTM coordinates, type of bird (songbird, waterfowl) and the date.
6. If the bird species and the corresponding necessary buffer size cannot be readily determined, establish a temporary minimum 30 meter "no disturbance" buffer around the nest site.
7. Once the bird species has been determined, an appropriately sized "no disturbance" buffer must be setup around the nest location. Consult Appendix E-6 and select the most appropriate buffer or contact a Manitoba Hydro Environmental Officer.
8. Use flagging tape or appropriate signage to mark the required buffer around the nest location.

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[1] Qualified Biolgist is someone who has at least one field season of demonstrated experience in nest sweeps or avian surveys with references, and a post-secondary degree/diploma in wildlife biology, resume to be supplied to Manitoba Hydro for review and approval 15 days prior to construction activities occurring within Sensitive time period for birds.

9. Enter each nest observation into the nesting bird collection form (Appendix E-5- MH will provide digital version in Excel format for submission) and include what actions were taken or what actions are recommended*.
10. Continue nest sweep until the entire area scheduled for construction activity has been adequately searched.
11. Submit to MH an Excel spreadsheet that is continuously updated throughout the sensitive timing window with structures and/or areas that have had nest sweeps conducted and the expiration date for those sweeps.
12. If a nest was found, there are two options:
    a. Defer disturbance within the required buffer as outlined in Appendix E-6. Activity can recommence after breeding bird nesting season, as described in Appendix E-1; or
    b. Check the nest again seven (7) days from the day it was found to see if eggs have hatched and birds have left. If there is no sign of activity, complete another nest sweep of the buffer area. If no nests are found, proceed with activity. If after (7) days, the nest is still occupied, continue checking at seven (7) day intervals.

Nest Sweep Extension

As per Appendix E-3 nest sweeps may be extended from the original expiry date for an additional day if a medium or high level disturbance is initiated on the expiry date or extended continuously if medium or high level disturbances are sustained un-interrupted.

Scenarios for nest sweep extension or expiration

Day 01	Day 02	Day 03	Day 04	Day 05	Day 06	Day 07	Day 08	Day 09 – August 31
Original Sweep – clear of nesting activity						Medium or high level disturbance initiated at site	Sweep expiry date extended based on initiation of Medium or high level disturbance at site the previous day	Expiry Date continuously extended based on sustained Medium or high level disturbance at site the previous day

Day 01	Day 02	Day 03	Day 04	Day 05	Day 06	Day 07	Day 08
Original Sweep – Clear of nesting activity		Medium or high level disturbance initiated at site	Medium or high level disturbance sustained at site	Medium or high level disturbance sustained at site	No Medium or high level disturbance at site	Original Sweep Expiry No Medium or high level disturbance at site	Second sweep required due to un-sustained medium or high level activities

Appendix E-5: Bird nesting collection form

Bird Nesting Collection Form (start sheet(s) for each new Location)

Name(s):

Date:

Location and general description of ROW area to be surveyed (i.e. S1 between towers 1234-1280 near Holland, MB):

Habitat (photo # and description):	Temperature:	Wind	Noise	Precipitation	Cloud Cover	Weather (description):
		Calm Light Air Light Breeze Gentle Breeze	None Low Moderate High	None Haze/Fog Drizzle Rain	0 - 25% 25 - 50% 50 - 75% 75 - 100%	

GPS Tracks should be recorded by each member on the survey and submitted with the daily reports.

Observation	Time	UTM Zone	Easting	Northing	Species	Status of Nest/Parents	Mitigation Applied	GPS Photo	Comments
(Nest/Territory)	(HH:MM:SS)	(14/15)	635401	5568325	(if not able to identify provide written description of nest site and surroundings)	Status (under const/# eggs /# hatchlings) Parents (/incubating/feeding)	(flagging an appropriate buffer, alerting appropriate Environmental Supervisor)	(Photo #)	Any Comments regarding the site

Appendix E-6 Manitoba Hydro Breeding Bird Buffer Guidelines

Key	
(red)	Manitoba Conservation Data Centre specified
(green)	100-200 m Buffer
(orange)	50 m Buffer
(white)	25 m Buffer

Species	Scientific Name	SARA (schedule & status)	COSEWIC (status & date assessed)	Habitat	Minimum Suggested Buffer (Meters)	Incubation Time (days)	Estimated Time to Leaving Nest or Fledging after hatching (Days)	Jurisdiction for Birds (F=Federal migratory, P=Provincial year-round resident), Nests = Provincial legislation for Herons, Eagles and others
Alder Flycatcher	*Empidonax alnorum*				25	12-14	12-15	F
American Bittern	*Botaurus lentiginosus*			Emergent-dominated wetlands	25	24-28	1-4	F
American Coot	*Fulica americana*			Emergent-dominated wetlands	25	21-25	1-4	F
American Crow	*Corvus brachyrhynchos*				25	15-18	28-35	None
American Dipper	*Cinclus mexicanus*				25	13-18	12-14	F
American Goldfinch	*Spinus tristis*				25	10-12	12-14	F
Green-winged Teal	*Anas c. carolinensis*				25	20-24	1-4	F
American Kestrel	*Falco sparverius*			Forest clearings, grassland, or pasture	25	29-30	30	F
American Pipit	*Anthus rubescens*				25	13-15	12-14	F
American Redstart	*Setophaga ruticilla*				25	12-14	12-14	F
American Robin	*Turdus migratorius*				25	12-14	12-14	F
American Three-toed Woodpecker	*Picoides dorsalis*				25	12-14	18-23	P
American Tree Sparrow	Spizella arborea				25	12-14	12-14	F
American white pelican	Pelecanus erythrorhynchos			isolated islands	1000	30		F
Arctic Warbler	Phylloscopus borealis				25	12-14	12-14	F
Bald Eagle	*Haliaeetus leucocephalus*			forests near water	1000	28-35	35-49	P
Baltimore Oriole	*Icterus galbula*			Forest, deciduous	25	12-14	12-14	F
Band-tailed pigeon	*Patagioenas fasciata*	Special Concern -1	Special Concern	Riparian Forest;Pasture/Old Field;Cultivated Field;Deciduous/Broadleaf Forest;Conifer	25			
Bank Swallow	*Riparia riparia*		Threatened (Apr 2013)	Rivers	300	14-16	17-18	F
Baird's Sparrow	*Ammodramus bairdii*	Special Concern -1	Special Concern	Native grass prairie	500	11-12	8-11	F
Barn Swallow	*Hirundo rustica*		Threatened (May 2011)	Forest clearings, grassland, or pasture	150	13-17	17-18	F
Barred Owl	*Strix varia*			mature forest	1000	28-33	28-35	P
Barrow's Goldeneye	*Bucephala islandica*			Open water wetlands or riparian	25	28-44	1-4	F

Appendix E-6 Manitoba Hydro Breeding Bird Buffer Guidelines

Key	
(red)	Manitoba Conservation Data Centre specified
(green)	100-200 m Buffer
(orange)	50 m Buffer
(white)	25 m Buffer

Species	Scientific Name	SARA (schedule & status)	COSEWIC (status & date assessed)	Habitat	Minimum Suggested Buffer (Meters)	Incubation Time (days)	Estimated Time to Leaving Nest or Fledging after hatching (Days)	Jurisdiction for Birds (F=Federal migratory, P=Provincial year-round resident), Nests = Provincial legislation for Herons, Eagles and others
Bay-breasted Warbler	*Setophaga castanea*			Forest, coniferous	50	12-14	12-14	F
Belted Kingfisher	*Megaceryle alcyon*			Open water wetlands or riparian	25	22-24	27-29	F
Black Swift	*Cypseloides niger*			Riparian areas and forest; streams	25	24-27	12-14	F
Black Tern	*Chlidonias niger*			Open water wetlands or riparian	25	17-22	12-14	F
Black-and-white Warbler	*Mniotilta varia*				50	10-12	12-14	F
Black-backed Woodpecker	*Picoides arcticus*				25	12-14	21	P
Black-billed Magpie	*Pica hudsonia*				25	16-21	12-14	P
Black-capped Chickadee	*Poecile atricapillus*				25	11-13	12-14	P
Blackpoll Warbler	*Setophaga striata*					11-13	12-14	F
Black-throated Green Warbler	*Setophaga virens*			Forest, mixed wood; riparian	50	11-13	12-14	F
Blue Jay	*Cyanocitta cristata*				25	16-18	17-21	P
Blue-headed Vireo	*Vireo solitarius*				25	12-14	12-14	F
Blue-winged Teal	*Anas discors*			Open water wetlands or riparian	25	22-27	1-4	F
Bobolink	*Dolichonyx oryzivorus*		Threatened	forage crops	400	12	11-12	F
Bohemian Waxwing	*Bombycilla garrulus*				25	13-15	17-21	P
Boreal Chickadee	*Poecile hudsonicus*				25	14-18	12-14	P
Boreal Owl	*Aegolius funereus*			Forest, coniferous	1000	28-30	28-35	P
Brewers Blackbird	*Euphagus cyanocephalus*				5	11-17	12-16	None
Brewer's Sparrow	Spizella breweri				25	12-14	12-16	F
Broad-winged Hawk	*Buteo platypterus*			Forest, deciduous	200	28-31	28-35	F
Brown Creeper	*Certhia americana*			Forest, coniferous	25	14-18	12-16	P
Brown-headed Cowbird	*Molothrus ater*				25	10-13	12-16	F
Buff-brested Sandpiper	*Calidris subruficollis*	Special Concern-1	Special Concern (2012)	Stop-over sites, short grass	200	23-25	18-20	F
Bufflehead	*Bucephala albeola*				25	28-33	12-14	F
Burrowing owl	*Athene cunicularia*	Endangered-1	Endangered	pasture	500	28	21	F
Calliope Hummingbird	*Stellula calliope*				25	15-16	12-14	F
Canada Goose	*Branta canadensis*				25	25-30	1-2	F
Canada Warbler	*Cardellina canadensis*	1-Threatened (Feb 2010)	Threatened (Mar 2008)	Forest, mixed wood	450	11-13	12-14	F

Appendix E-6 Manitoba Hydro Breeding Bird Buffer Guidelines

Key	
(red)	Manitoba Conservation Data Centre specified
(green)	100-200 m Buffer
(orange)	50 m Buffer
(white)	25 m Buffer

Species	Scientific Name	SARA (schedule & status)	COSEWIC (status & date assessed)	Habitat	Minimum Suggested Buffer (Meters)	Incubation Time (days)	Estimated Time to Leaving Nest or Fledging after hatching (Days)	Jurisdiction for Birds (F=Federal migratory, P=Provincial year-round resident), Nests = Provincial legislation for Herons, Eagles and others
Canvasback	*Aythya valisineria*			Open water wetlands or riparian	25	23-29	1-4	F
Cape May Warbler	*Setophaga tigrina*			Forest, coniferous	50	11-13	12-14	F
Cassin's Finch	*Carpodacus cassinii*				25	12-14	12-14	F
Cedar Waxwing	*Bombycilla cedrorum*				25	12-16	12-14	F
Chestnut-collared longspur	*Calcarius ornatus*	1-Threatened	Threatened	mixed grass prairie	650	11		F
Chestnut-sided Warbler	*Setophaga pensylvanica*				25	11-14	12-14	F
Chimney swift	*Chaetura pelagica*	1-Threatened	Threatened	anthropogenic	300			F
Chipping Sparrow	*Spizella passerina*				25	11-14	12-14	F
Clay-colored Sparrow	*Spizella pallida*				25	10-12	12-14	F
Cliff Swallow	*Petrochelidon pyrrhonota*			Open water wetlands or riparian	25	14-16	12-14	F
Common Goldeneye	*Bucephala clangula*			Open water wetlands or riparian	25	28-33	1-2	F
Common Grackle	*Quiscalus quiscula*				5	12-14	12-14	None
Common Loon	*Gavia immer*				50	26-31	1-2	F
Common Merganser	*Mergus merganser*				25	28-35	1-2	F
Common Nighthawk	*Chordeiles minor*	1-Threatened (Feb 2010)	Threatened (Apr 2007)	Forest clearings, grassland, or pasture	300	19-20	17-18	F
Common Raven	*Corvus corax*				25	18-21	12-14	P
Common Redpoll	*Acanthis flammea*				25	10-11	9-14	P
Common Yellowthroat	*Geothlypis trichas*				25	11-14	12-14	F
Connecticut Warbler	*Oporornis agilis*			Forest, deciduous	50	11-14	12-14	F
Dark-eyed Junco	*Junco hyemalis*				25	11-14	12-14	P
Double-crested cormorant	*Phalacrocorax auritus*			aquatic	750			F
Downey Woodpecker	*Picoides pubescens*				25	11-14	12-14	P
Dusky Flycatcher	*Empidonax oberholseri*			Forest, coniferous	25	12-16	12-14	F
Dusky Grouse	*Dendragapus obscurus*			Shrubland or young forest	25	25-26	1-4	P
Eastern Kingbird	*Tyrannus tyrannus*			Open water wetlands or riparian	25	16-18	12-14	F
Eastern screech owl	*Megascops asio*			tree cover	500	26-30		P
Eastern whip-poor-will	*Antrostomus vociferus*	1-Threatened	Threatened	open woodland	300	19-21		F
Eastern wood-pewee	*Contopus virens*		Special Concern	clearings, forest edges	300	12-13		F
European Starling	*Sturnus vulgaris*				0	N/A	N/A	P
Evening Grosbeak	*Coccothraustes vespertinus*			Forest, mixed wood	25	12-16	12-14	P
Ferruginous hawk	*Buteo regalis*	1-Threatened	Threatened	open country	1000	32-33		P
Flammulated owl	*Psiloscops flammeolus*	1- Special Concern	Special Concern		50			
Fox Sparrow	*Passerella iliaca*				25	12-14	12-14	P

Appendix E-6 Manitoba Hydro Breeding Bird Buffer Guidelines

Key	
(red)	Manitoba Conservation Data Centre specified
(green)	100-200 m Buffer
(orange)	50 m Buffer
(white)	25 m Buffer

Species	Scientific Name	SARA (schedule & status)	COSEWIC (status & date assessed)	Habitat	Minimum Suggested Buffer (Meters)	Incubation Time (days)	Estimated Time to Leaving Nest or Fledging after hatching (Days)	Jurisdiction for Birds (F=Federal migratory, P=Provincial year-round resident), Nests = Provincial legislation for Herons, Eagles and others
Golden Eagle	*Aquila chrysaetos*			Cliffs	1000	41-45	45-81	F
Golden-crowned Kinglet	*Regulus satrapa*				25	14-15	12-14	P
Golden-crowned Sparrow	*Zonotrichia atricapilla*				25	11-14	12-14	F
Golden-winged warbler	*Vermivora chrysoptera*	1-Threatened	Threatened	open woodland	450	10-11		F
Grasshopper sparrow	*Ammodramus savannarum*			open grassland, prairie	400	11-13		F
Gray Jay	*Perisoreus canadensis*				25	16-18	22-24	P
Great Blue Heron	*Ardea herodias*			Forest, mixed wood	750	25-30	49-81	P
Great Gray Owl	*Strix nebulosa*			Forest, mixed wood	1000	28-30	28-35	P
Great Horned Owl	*Bubo virginianus*			Forest, mixed wood	100	28-35	28-35	P
Greater Scaup	*Aythya marila*			Open water wetlands or riparian	25	24-28	1-4	F
Greater Yellowlegs	*Tringa melanoleuca*			Open water wetlands or riparian	25	20-24	1-4	F
Grebes				Colonial nesting sites	200			F
Green-winged Teal	*Anas crecca*				25	20-24	1-4	F
Gulls/Terns				Colonial nesting sites	500			F
Hairy Woodpecker	*Picoides villosus*				25	11-15	28-30	P
Hammond's Flycatcher	*Empidonax hammondii*				25	12-16	12-14	F
Harlequin Duck	*Histrionicus histrionicus*			Open water wetlands or riparian	100	27-30	1-2	F
Hermit Thrush	*Catharus guttatus*				25	12-14	12-14	F
Herons spp.				Nesting Colony	500			F
Hoary Redpoll	*Acanthis hornemanni*				25	9-12	12-14	P
Hooded Merganser	*Lophodytes cucullatus*				25	32-33	1-4	F
Horned Grebe	*Podiceps auritus*		Special Concern	Open water wetlands or riparian	400	22-25	1-4	F
Horned Lark	*Eremophila alpestris*			Alpine, subalpine	25	11-12	12-14	F
House Finch	*Carpodacus mexicanus*				25	12-14	12-14	F
House Sparrow	*Passer domesticus*				0	N/A	N/A	P
House Wren	*Troglodytes aedon*				25	12-16	12-14	F
Killdeer	*Charadrius vociferus*			Forest clearings, grassland, or pasture	25	22-28	1-2	F
Le Conte's Sparrow	*Ammodramus leconteii*			Emergent-dominated wetlands	25	12-14	12-14	F
Least Flycatcher	*Empidonax minimus*				25	12-17	12-14	F
Least Bittern	*Ixobrychus exilis*	Threatened-1	Threatened		200			F
Lesser Scaup	*Aythya affinis*			Open water wetlands or riparian	25	21-28	1-2	F
Lesser Yellowlegs	*Tringa flavipes*				25	22-23	1-2	F
Lincoln's Sparrow	*Melospiza lincolnii*				25	12-14	12-14	F
Loggerhead shrike prairie subspecies	*Lanius ludovicianus excubitorides*	1-Threatened	Threatened	open woodland	500	16		F
Long-eared Owl	*Asio otus*				200	26-28	28-35	P
MacGillivray's Warbler	*Geothlypis tolmiei*				25	11-12	12-14	F
Magnolia Warbler	*Setophaga magnolia*				25	11-14	12-14	F

Species	Scientific Name	SARA (schedule & status)	COSEWIC (status & date assessed)	Habitat	Minimum Suggested Buffer (Meters)	Incubation Time (days)	Estimated Time to Leaving Nest or Fledging after hatching (Days)	**Jurisdiction for Birds** (F=Federal migratory, P=Provincial year-round resident), Nests = Provincial legislation for Herons, Eagles and others
Mallard	*Anas platyrhynchos*				25	26-30	1-2	F
Marsh Wren	*Cistothorus palustris*				25	12-16	12-14	F

Appendix E-6 Manitoba Hydro Breeding Bird Buffer Guidelines

Key	
Red	Manitoba Conservation Data Centre specified
Green	100-200 m Buffer
Orange	50 m Buffer
White	25 m Buffer

Species	Scientific Name	SARA (schedule & status)	COSEWIC (status & date assessed)	Habitat	Minimum Suggested Buffer (Meters)	Incubation Time (days)	Estimated Time to Leaving Nest or Fledging after hatching (Days)	Jurisdiction for Birds (F=Federal migratory, P=Provincial year-round resident), Nests = Provincial legislation for Herons, Eagles and others
Merlin	*Falco columbarius*				25	28-32	29	F
Mountain Bluebird	*Sialia currucoides*				25	12-14	12-14	F
Mountain Chickadee	*Poecile gambeli*				25	11-12	12-14	P
Mountain White-crowned Sparrow	*Zonotrichia l. oriantha*				25	11-14	12-14	F
Mourning Warbler	*Geothlypis philadelphia*			Forest, mixed wood	25	12-14	12-14	F
Nashville Warbler	*Oreothlypis ruficapilla*				25	11-12	12-14	F
Nelson's Sparrow	*Ammodramus nelsoni*			Open water wetlands or riparian	50	11-12	12-14	F
Northern Flicker	*Colaptes auratus*				25	11-16	24-27	F
Northern Goshawk	*Accipiter gentilis*				200	36-41	12-14	P
Northern Harrier	*Circus cyaneus*			Forest clearings, grassland, or pasture	100	28-36	12-14	F
Northern Hawk Owl	*Surnia ulula*			coniferous or mix forest near open areas	1000	25-30	25-30	P
Northern Pintail	*Anas acuta*			Open water wetlands or riparian	25	22-25	1-2	F
Northern Pygmy-owl	*Glaucidium gnoma*			Forest, coniferous; forest, mixedwood	200	29-30	28-35	P
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*			Open water wetlands or riparian	25	11-14	18-21	F
Northern Saw-whet Owl	*Aegolius acadicus*				100	26-28	28-35	P
Northern Shoveler	*Anas clypeata*				25	21-27	1-2	F
Northern Shrike	*Lanius excubitor*				25	15-16	20-21	F
Northern Waterthrush	*Parkesia noveboracensis*				25	11-14	12-14	F
Olive-sided Flycatcher	*Contopus cooperi*	1-Threatened (Feb 2010)	Threatened (Nov 2007)	Forest, coniferous	300	14-17	12-14	F
Osprey	*Pandion haliaetus*				200	35-40	36-42	P
Ovenbird	*Seiurus aurocapilla*				25	11-14	12-14	F
Pacific Wren	*Troglodytes pacificus*					12-16	12-14	F
Pacific-slope Flycatcher	*Empidonax difficilis*			Forest, coniferous	25	14-16	12-14	F
Peregrine Falcon	*Falco peregrinus*	1-Threatened (May 2003)	Special Concern (Apr 2007)		1000	28-32	35-42	P
Philadelphia Vireo	*Vireo philadelphicus*			Shrubland or young forest	25	11-14	12-14	F
Pied-billed Grebe	*Podilymbus podiceps*			Open water wetlands or riparian	25	23-27	1-2	F
Pileated Woodpecker	*Dryocopus pileatus*			Forest, deciduous	25	15-18	24-28	P
Pine Grosbeak	*Pinicola enucleator*			Forest, deciduous	25	10-12	12-14	P
Pine Siskin	*Spinus pinus*			Forest, coniferous	25	11-14	12-14	P
Piping plover	*Charadrius melodus melodus*	E-1	Endangered		400	25-27	Jan-00	F
Purple Finch	*Carpodacus purpureus*			Forest, coniferous	25	11-14	12-14	F

Appendix E-6 Manitoba Hydro Breeding Bird Buffer Guidelines

Key	
(red)	Manitoba Conservation Data Centre specified
(green)	100-200 m Buffer
(orange)	50 m Buffer
(white)	25 m Buffer

Species	Scientific Name	SARA (schedule & status)	COSEWIC (status & date assessed)	Habitat	Minimum Suggested Buffer (Meters)	Incubation Time (days)	Estimated Time to Leaving Nest or Fledging after hatching (Days)	Jurisdiction for Birds (F=Federal migratory, P=Provincial year-round resident), Nests = Provincial legislation for Herons, Eagles and others
Red Crossbill	*Loxia curvirostra*			Forest, coniferous	25	12-18	12-14	P
Red-breasted Merganser	*Mergus serrator*			Open water wetlands or riparian	25	29-35	1-2	F
Red-breasted Nuthatch	*Sitta canadensis*			Forest, coniferous	25	11-14	12-14	P
Red-breasted Sapsucker	*Sphyrapicus ruber*			Forest, deciduous	25	12-14	24-27	F
Red-eyed Vireo	*Vireo olivaceus*			Forest, deciduous	25	11-14	12-14	F
Redhead	*Aythya americana*			Open water wetlands or riparian	25	23-29	1-2	F
Red-headed woodpecker	*Melanerpes erythrocephalus*	1-Threatened	Threatened	open woodland	200	12-14		F
Red Knot	*Calidris canutus rufa*	E-1	Endangered	Stop-over sites	200	20-22	1-Feb	F
Red-naped Sapsucker	*Sphyrapicus nuchalis*			Forest, deciduous	25	12-14	24-27	F
Red-necked Grebe	*Podiceps grisegena*			Open water wetlands or riparian	25	20-23	1-2	F
Red-necked Phalarope	*Phalaropus lobatus*		Special Concern	Open water wetlands or riparian	25	17-21	1-2	F
Red-tailed Hawk	*Buteo jamaicensis*				100	30-35	42-46	F
Red-winged Blackbird	*Agelaius phoeniceus*			Open water wetlands or riparian	5	11-14	12-14	P
Ring-necked Duck	*Aythya collaris*			Open water wetlands or riparian	25	23-29	1-2	F
Rose-breasted Grosbeak	*Pheucticus ludovicianus*			Forest, deciduous	25	12-14	12-14	F
Ross's Gull	*Rhodostethia rosea*	Threatened-1	Threatened		1000	19-22	19-22	F
Rough-legged Hawk	*Buteo lagopus*			Alpine, subalpine, grassland, pasture	200	30-35	42-46	F
Ruby-crowned Kinglet	*Regulus calendula*				25	12-14	12-14	F
Ruby-throated Hummingbird	*Archilochus colubris*				25	11-16	12-14	F
Ruffed Grouse	*Bonasa umbellus*			Forest, mixed wood	25	21-28	1-4	P
Rufous Hummingbird	*Selasphorus rufus*			Forest, coniferous; Riparian areas and forest	25	12-14	12-14	F
Rusty Blackbird	*Euphagus carolinus*	1-Special Concern (Mar 2009)	Special Concern (Apr 2006)	Open water wetlands or riparian	300	12-18	12-14	F
Sandhill Crane	*Grus canadensis*				100	28-32	1-4	F
Savannah Sparrow	*Passerculus sandwichensis*				25	11-14	12-14	F
Say's Phoebe	*Sayornis saya*				25	12-14	12-14	F
Sharp-shinned Hawk					100	34-35	21-28	F
Sharp-tailed Grouse	*Tympanuchus phasianellus*			Forest clearings, grassland, or pasture (25m for a nest and 1000m for a lek)	25	21-28	1-4	P
Short-eared Owl	*Asio flammeus*	1-Special Concern (Jul 2012)	Special Concern (Mar 2008)	Alpine, subalpine, grassland, pasture	500	25-29	28-35	F
Snow Bunting	*Plectrophenax nivalis*				25	10-16	12-14	P
Snowy Owl	*Bubo scandiacus*			Forest clearings, grassland, or pasture	N/A	N/A	N/A	F

Appendix E-6 Manitoba Hydro Breeding Bird Buffer Guidelines

Key	
	Manitoba Conservation Data Centre specified
	100-200 m Buffer
	50 m Buffer
	25 m Buffer

Species	Scientific Name	SARA (schedule & status)	COSEWIC (status & date assessed)	Habitat	Minimum Suggested Buffer (Meters)	Incubation Time (days)	Estimated Time to Leaving Nest or Fledging after hatching (Days)	**Jurisdiction for Birds** (F=Federal migratory, P=Provincial year-round resident), Nests = Provincial legislation for Herons, Eagles and others
Solitary Sandpiper	*Tringa solitaria*				25	23-24	17-20	F
Song Sparrow	*Melospiza melodia*				25	12-14	12-14	F
Sora	*Porzana carolina*				25	18-20	1-4	F
Spotted Sandpiper	*Actitis macularius*				25	20-24	1-4	F
Sprague's Pipit	*Anthus spragueii*	1-Threatened	Threatened	open grassland	650	12-14	12-14	F
Spruce Grouse	*Falcipennis canadensis*				25	21-24	1-4	P
Steller's Jay	*Cyanocitta stelleri*				25	16-18	16	P
Surf Scoter	*Melanitta perspicillata*			Open water wetlands or riparian	25	25-30	1-4	F
Swainson's Hawk	*Buteo swainsoni*				200	28-32	21-28	F
Swainson's Thrush	*Catharus ustulatus*			Forest, mixed wood	25	12-14	12-14	F
Swamp Sparrow	*Melospiza georgiana*				25	12-15	12-14	F
Tennessee Warbler	*Oreothlypis peregrina*				25	11-14	12-14	F
Townsend's Solitaire	*Myadestes townsendi*			Alpine, subalpine	25	12-14	12-14	F
Townsend's Warbler	*Setophaga townsendi*				25	12-14	12-14	F
Tree Swallow	*Tachycineta bicolor*			Open water wetlands or riparian	25	12-16	12-14	F
Trumpeter Swan	*Cygnus buccinator*				1000	32-37	1-4	F
Tundra Swan	*Cygnus columbianus*			Open water wetlands or riparian	100	31-40	1-4	F
Turkey Vulture	*Cathartes aura*				100	38-41	60-84	F
Upland Sandpiper	*Bartramia longicauda*			Forest clearings, grassland, or pasture	50	21-27	30-31	F
Varied Thrush	*Ixoreus naevius*				25	12-14	12-14	F
Vaux's Swift	*Chaetura vauxi*			Forest, coniferous; Forest, deciduous	25	18-20	12-14	F
Vesper Sparrow	*Pooecetes gramineus*			Forest clearings, grassland, or pasture	25	11-14	12-14	F
Violet-green Swallow	*Tachycineta thalassina*			Meadows; open woodlands; wooded canyons	25	12-14	12-14	F
Warbling Vireo	*Vireo gilvus*				25	12-14	12-14	F
Western Bluebird	*Sialia mexicana*				25	12-14	12-14	F
Western Grebe	*Aechmophorus occidentalis*			Open water wetlands or riparian	50	23-24	1-4	F
Western Kingbird	*Tyrannus verticalis*				25	18-20	12-14	F
Western Meadowlark	*Sturnella neglecta*				25	12-16	12-14	F
Western Palm Warbler	*Setophaga palmarum*				25	12-14	12-14	F
Western Tanager	*Piranga ludoviciana*				25	12-14	12-14	F
Western Wood-Pewee	*Contopus sordidulus*			Forest, coniferous;	25	12-14	12-14	F
White-breasted Nuthatch	*Sitta carolinensis*				25	12-14	12-14	P
White-crowned Sparrow	*Zonotrichia leucophrys*				25	11-14	12-14	F
White-throated Sparrow	*Zonotrichia albicollis*				25	11-14	12-14	F
White-winged Crossbill	*Loxia leucoptera*				25	12-14	12-14	P

Species	Scientific Name	SARA (schedule & status)	COSEWIC (status & date assessed)	Habitat	Minimum Suggested Buffer (Meters)	Incubation Time (days)	Estimated Time to Leaving Nest or Fledging after hatching (Days)	**Jurisdiction for Birds** (F=Federal migratory, P=Provincial year-round resident), Nests = Provincial legislation for Herons, Eagles and others
Whooping Crane	*Grus americana*	Endangered-1	Endangered	Staging Area	750			F
Willow Ptarmigan	*Lagopus lagopus*				25	21-22	1-4	P

Appendix E-6 Manitoba Hydro Breeding Bird Buffer Guidelines

Key	
(red)	Manitoba Conservation Data Centre specified
(green)	100-200 m Buffer
(orange)	50 m Buffer
(white)	25 m Buffer

Species	Scientific Name	SARA (schedule & status)	COSEWIC (status & date assessed)	Habitat	Minimum Suggested Buffer (Meters)	Incubation Time (days)	Estimated Time to Leaving Nest or Fledging after hatching (Days)	**Jurisdiction for Birds** (F=Federal migratory, P=Provincial year-round resident), Nests = Provincial legislation for Herons, Eagles and others
Wilson's Phalarope	*Phalaropus tricolor*			Open water wetlands or riparian	25	18-21	1-4	F
Wilson's Snipe	*Gallinago delicata*			Emergent-dominated wetlands; riparian areas and forest	25	18-21	1-4	F
Wilson's Warbler	*Cardellina pusilla*			Shrubland or young forest	25	11-14	12-14	F
Winter Wren	*Troglodytes hiemalis*				25	12-16	12-14	F
Yellow Rail	*Coturnicops noveboracensis*	1-Special Concern (Jun 2003)	Special Concern (Nov 2009)	Emergent-dominated wetlands	350	16-18	1-4	F
Yellow Warbler	*Setophaga petechia*			Forest, deciduous; young/disturbed; riparian; willow	25	11-14	12-14	F
Yellow-bellied Flycatcher	*Empidonax flaviventris*				25	12-16	12-14	F
Yellow-bellied Sapsucker	*Sphyrapicus varius*				25	11-14	25-29	F
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*			Open water wetlands or riparian	25	11-14	12-14	F
Any other federal or provincially bird species not listed					25			

Appendix F

Reptile and Amphibian Protection Document

Reptile and Amphibian protection document

Habitat identification

Amphibians should be assumed to be present in all wetland or shallow water areas supporting emergent vegetation (cattails, bulrushes, lily pads) during the amphibian emergence and breeding period (April 1st to August 15th).

When sampling the habitat, a qualified biologist, contractor, or consultant should investigate the shallow water zone (to rubber - boot depth), the waterline and the shore zone (within 3 meters of the waterline) when possible. In this way, other age classes of leopard frogs may be observed, such as egg masses and larvae (depending on the time of year). Both flowing and standing water can be surveyed in this fashion.

Visual encounter survey

Visual Encounter Surveys, to be completed by the contractor, are an effective method of locating frogs and egg masses during the breeding season (See excerpt from Kendell, 2002 below for survey procedure). Egg masses are easily detected when walking the shorelines and other shallow sections of a pond. Also, adult frogs are fairly active in the breeding season and are often found near egg masses, so that many can be located during visual searches. As a general rule, surveys conducted at various times of day are the single most effective method for removing frogs of all life stages during the active seasons.

Survey protocol should follow the steps outlined in Kendell (2002), which outlines:

- The habitat should be walked at a constant speed that is conducive to observing frogs under the given habitat characteristics at the site. For example, open habitats with sparse and low vegetation can be walked at a greater speed because the observer is less likely to overlook frogs obscured by vegetation. In contrast, a slower walking speed is required if the habitat possess - thicker and taller vegetation. In either case, the observer should walk in a systematic fashion to cover all favorable habitats both thoroughly and equally.
- A good self-test, to ensure that the proper speed and diligence is being used while surveying a habitat, is as follows: The individual conducting the survey should be able to spot less obvious animal life underfoot and within peripheral vision. For example, the individual may observe or hear a mouse scurrying through the grass, a young garter snake basking on a rock, other amphibian

species and large insects on the ground, vegetation, water or below the surface of the water.

- Report survey results to Manitoba Hydro environment officer.

Kendell, K. 2002. Survey protocol for the northern leopard frog. Alberta Sustainable Resources Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 43. Edmonton, Alberta. 30 pp.

Mitigation measures

- Restrict access to shallow water areas to protect breeding ponds and their vegetation from trampling and other disturbances. In areas directly impacted by construction, and in which amphibians occur, all life stages of frogs should be captured and removed to areas outside of the construction area.
- Erect exclusion fencing (e.g., sedimentation fence) prior to activities occurring in areas of breeding habitat (e.g., wetland features, low-lying ephemeral ponds) to minimize the risk of frogs entering the work area: Exclusion fencing height should be a minimum of 50 cm and the bottom of the fabric must be buried 10-20 cm down with an additional fabric lip extending outwards 90 degrees another 15 cm, the fabric lip must be backfilled and compacted to ensure it does not become exposed. Bury support stakes for exclusion fencing a minimum of 30 cm into the ground on the activity side of the fence; leave an overhang or lip on the exterior to prevent frogs from jumping into the fenced off area.

Appendix G

Species of Concern Contingency Measures

Species of Concern contingency measures

The following procedures provide contingency measures for the discovery of species of concern prior to and during a construction project. Species of concern can include rare vascular plants, rare non-vascular plants, and rare wildlife species.

Plant Species of Concern Discovery Prior to Construction

If rare plants are discovered during future vegetation studies along the transmission line, the plant or plant community will be assessed by a Manitoba Hydro vegetation specialist and appropriate mitigation measures will be determined prior to construction within the area of plant discovery. Mitigation measures will be determined following an assessment, which will include the following:

- the position of the plant or plant community on the construction right-of-way
- the relative rarity of the plant or plant community (regionally, nationally, etc.)
- the local abundance of the plant or plant community

Mitigation options to be implemented by the Contractor or Manitoba Hydro may include, however, are not limited to the following:

- narrowing down the proposed area of disturbance and protecting the site using fencing or clearly marking the site using flagging and signage (Contractor)
- informing project staff of access restrictions within in the vicinity of flagged or fenced sites (Contractor)
- temporarily covering the site with geotextile pads, flex net, mats or equivalent (Contractor)
- adjusting centerline access trail to avoid or limit potential effects on the plant or plant community (Contractor)
- adjusting tower location to avoid the plant or plant community (Manitoba Hydro);
- salvaging and transplanting portions of sod and surrounding vegetation Transplanted materials may be moved to a suitable location off right-of-way (Manitoba Hydro)
- other site-specific procedures to avoid disturbance to rare plants or plant communities, as recommended by the vegetation specialist (Contractor/Manitoba Hydro)

The Manitoba Hydro environmental officer will be responsible for making the final decision on mitigation measures to be applied, in consultation with a qualified biologist, project engineer and when uncertainty exists, the appropriate provincial or federal regulatory authorities. All mitigation measures for sites within the project development area will be described in the Construction Environmental Protection Plan.

Wildlife Species of Concern Discovery Prior to Construction

In the event that wildlife species of concern or their site-specific habitat are discovered within the project area, the discovery will be assessed, and appropriate mitigation measures will be determined by Manitoba Hydro. The wildlife or habitat will be assessed based on the following criteria:

- the location of the wildlife or habitat feature with respect to the project development area
- the presence of topographic features or vegetation to effectively screen the wildlife or habitat from construction activities
- the existing level of disturbance and ongoing sensory disturbance at the site
- the timing of construction versus the critical timing constraints for the species; and
- the potential for an alteration of construction activities to reduce or avoid sensory and/or physical disturbance
- the wildlife species, its conservation status and specific habitat needs relative to the area of development

The mitigation measures to be implemented by the Contractor or Manitoba Hydro may include, but are not limited to, the following:

- abide by reduced risk timing windows within the recommended setback/buffer distances (Contractor)
- narrow down the proposed area of disturbance and protect the site using fencing or clearly mark the site using flagging (Contractor)
- alter or delay construction activities to avoid sensory disturbance (e.g., no burning) Contractor)
- inform project staff of access restrictions in the vicinity of flagged or fenced sites (Contractor)
- adjust tower locations to avoid the site (Manitoba Hydro)
- install nest boxes or platforms, or otherwise replace or enhance habitat during reclamation or restoration
- with the appropriate approval, relocate species (i.e., amphibians) or features (i.e., unoccupied stick nests)(Contractor), if practical

The Manitoba Hydro environmental officer will be responsible for making the final decision on mitigation measures to be applied, in consultation with a qualified biologist, project engineer and when uncertainty exists, the appropriate provincial or

Federal regulatory authorities. All sites and associated mitigation measures within the Project development area will be added to the Construction Environmental Protection Plan.

Species of concern discovery during project construction

If rare plants or wildlife species are identified or suspected along the construction right-of-way during construction (e.g., during survey activities, prior to clearing and construction), contractor staff are to follow the measures outlined below:

- Suspend work immediately in the vicinity of any newly discovered species of concern. Work at that location may not resume until the measures below are conducted
- Notify Manitoba Hydro environmental officer / inspector
- Flag or fence the area until the plant, wildlife species or community can be confirmed. MH environmental officer / inspector may enlist a qualified biologist to assist with confirmation

Implement protection measures based on specific site conditions and criteria found in reference ii - CEnvPP Appendix D (buffers and setbacks) and or Appendix E (avian protection).

The Manitoba Hydro environmental officer will be responsible for making the final decision on mitigation measures to be applied, in consultation with a qualified biologist, Project Engineer and when uncertainty exists, the appropriate Provincial or Federal regulatory authorities. Mitigation measures generally fall into categories previously identified above.

Appendix H

Biosecurity Management Plan

Pointe du Bois to Whiteshell Station 115kV Transmission Line (PW75)

Biosecurity Management Plan

June 2023

Prepared by Manitoba Hydro

Transmission & Distribution Environment and Engagement Department

Project Management Division

Preface

This document presents the Biosecurity Management Plan (the Plan) for the construction of the Pointe du Bois to Whiteshell station 115kV transmission line (the Project) and is based on Manitoba Hydro's Biosecurity Policy and Transmission Standard Operating Procedures. It is intended to provide information and instruction to Manitoba Hydro employees and contractors. The Plan presents a Project-specific implementation plan and actions required to protect biosecurity on agricultural lands on which the Project will be constructed. Inspection and compliance along with monitoring and evaluation programs are described to confirm adherence to required actions including documentation and record-keeping. Environmental Management Practices and field forms are included in the Appendices.

Manitoba Hydro employees and contractors are encouraged to contact the onsite Manitoba Hydro Environmental Inspector/Officer if they require information, clarification, or support. Regulators and the Public are to direct any inquiries about this Plan to:

Manitoba Hydro
Transmission & Distribution Environment and Engagement Department
360 Portage Avenue
Winnipeg, MB
Canada R3C 0G8
1-877-343-1631

Projects@hydro.mb.ca

Document Owner
Transmission & Distribution Environment and Engagement Department
Manitoba Hydro

Version – Final 1.0

List of Revisions

Number	Nature of revision	Location	Revised by	Date

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Definitions

Accumulation – an amount of something that has been collected such as: soil, plant material or crop debris

Agricultural Land – land zoned for agricultural use by the provincial government, a municipality, planning commission or planning district.[1]

Biosecurity – the protection of crops and livestock systems and natural environments against the threats of weeds, disease, pests, including invasive species.[1]

Controlled Access Point (CAP) – Visually-defined (i.e. signed) entry point where vehicles, equipment and workers enter into and exit from a Project work area identified as a controlled/restricted access zone.

Controlled Access Zone (CAZ) – Agricultural land parcel requiring prescribed and/or specific actions to protect against a biosecurity risk. Two levels of controlled access zones are defined:

- Controlled access zone – low risk: a controlled access zone where a low level risk is identified.
- Controlled access zone – high risk: a controlled access zone where a high level risk is identified.

Frozen Soil Conditions – environmental conditions which result in the top layers of soil being completely frozen and able to support vehicle, equipment and pedestrian travel without rutting or accumulation of soil.

Frozen and Snow-Covered Soil Conditions – environmental conditions which result in the top layers of soil being completely frozen and able to support vehicle, equipment and pedestrian travel without rutting or accumulation of soil, and snow cover is sufficient such that bare soil is not visible including when traversed by vehicles or equipment (i.e., snow prevents direct tire or track contact with the soil surface).

[1] Modified from Manitoba Hydro Agricultural Biosecurity Policy

Invasive Species – Invasive species are plants, animals or other organisms that are growing outside of their country or region of origin and are out-competing or even replacing native organisms

Noxious Weed – means a plant that is designated as a tier 1, tier 2 or tier 3 noxious weed in Manitoba's The Noxious Weeds Act and includes the seed of a noxious weed, whether it is still attached to the noxious weed or is separate from it.

Non-Frozen, Bare Soil Conditions – ground conditions that are not frozen adequately to support equipment travel without transfer of dirt, debris, or mud. Soil moisture content or wetness play an important role in soil accumulating on vehicles, equipment, and boots:

- Dry conditions – soil surface is dry and the potential for soil sticking to vehicles, equipment and boots is reduced; a field check to confirm dry soils is if your pants are dry after kneeling on the soil surface for 10 seconds.
- Moist/wet conditions – soil surface is moist to wet and the potential for soil sticking to vehicles, equipment and boots is increased; a field check to confirm moist or wet soils is if your pants show wetness after kneeling on the soil surface for 10 seconds.

Plan, the – the Biosecurity Management Plan

Project, the – the Pointe du Bois to Whiteshell Transmission Project

Restricted Access Zone (RAZ) – Area where access is restricted. Vehicles, equipment, or workers should not enter a restricted zone or area unless under special circumstances and with prior approval of the landowner/producers and a Manitoba Hydro Environmental Officer.

Rough cleaning - Use of brushing, scraping, and/or compressed air to remove most surface soil, plant material, and foreign matter from clothing, vehicles, and equipment.

OR

Remove to the extent possible accumulated soil, plant material or crop debris from openings, tracks, tires, and wheels using a hand scraper, shovel, broom, brush, or compressed air.

Topsoil – the uppermost layer of soil, which typically contains elevated levels of organic matter. Topsoil is the portion of the soil environment that is of the most concern for biosecurity as it contains weed seeds, pathogens, and other pests. It is also the most important soil layer for crops as it contains all nutrients and moisture required for growth.

Transition Zone – Visually-defined (i.e., signed) designated areas between controlled access zones (e.g., between "low risk" and "high risk" fields within a land section). Transition Zones are where workers stop prior to entering an adjacent controlled access, and review and implement required actions. The requirement for Transition Zones between controlled access zones can be mitigated by permitting access from opposing sides of CAZ and not crossing the Transition Zone, choosing a direction of travel that moves from low-risk area to high-risk area, or the use of continuous matting throughout CAZ.

Work Area – the work area on the right-of-way, approach driveways, marshalling yards, temporary work areas and access trails or other areas approved by Manitoba Hydro. The work area includes agricultural field access approaches and undeveloped road allowances. The work area excludes developed municipal and provincial roads (gravel and paved road surfaces) which may be used to travel to the work area.

1.0 Introduction

1.1 Purpose and objectives

This Biosecurity Management Plan (the plan) has been developed for the Pointe du Bois to Whiteshell station 115kV transmission line (the project) to provide guidance to Manitoba Hydro staff and contractors to prevent the introduction and spread of weeds and other pests, including invasive species, through project pre-construction and construction activities.

Development of the plan fulfills the requirements of Manitoba Hydro's Corporate Biosecurity Policy. The purpose of the corporate policy is to ensure that Manitoba Hydro staff and contractors take necessary precautions to protect the health and sustainability of the agricultural sector. The plan provides required actions specific to the project and a detailed implementation plan. This includes direction to individuals who may be required to enter agricultural lands, such as the level of cleaning necessary to reduce the likelihood of soil and manure transport of organisms of concern (diseases, weeds, and other pests, including invasive species). An overview of these two layers in Manitoba Hydro's biosecurity program for the project is provided in Figure 1.

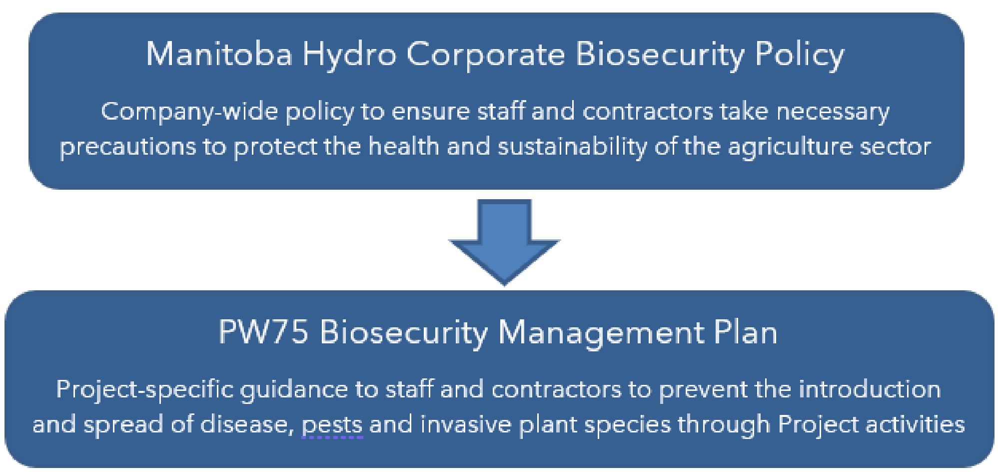

Figure 1: Manitoba Hydro biosecurity program components relevant to the project

1.2 Roles and responsibilities

This section outlines the major roles and responsibilities of those involved in the implementation of the plan. The plan forms a component of the Environmental Protection Program (EPP), which provides the framework for the delivery, management and monitoring of environmental and socio-economic protection measures for the project. A visual reference for how the plan fits into the overall EPP organization structure is provided in Figure 2.

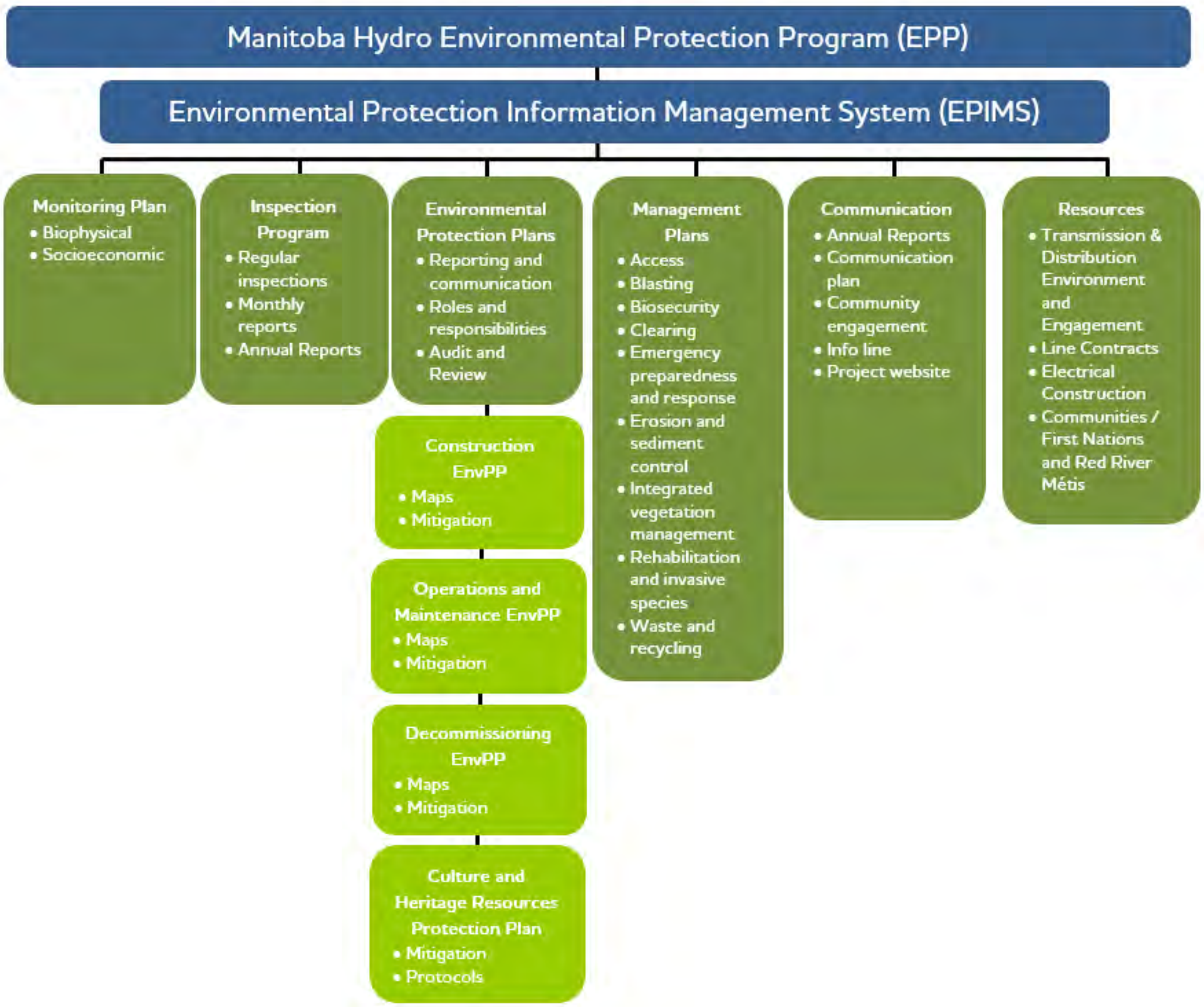

Figure 2: Environmental protection program components

A summary of roles and key responsibilities is found in Table 1. Communication and reporting on environmental issues, monitoring and compliance will be as outlined in Figure 3.

Table 1: Roles and responsibilities

Role	Key Responsibilities
Manitoba Hydro	• Determine potential biosecurity risk locations through consultation with landowners, Manitoba Agriculture, and field assessments/soil testing, if necessary. • Conduct a pre-construction weed survey and document baseline weed occurrences observed on the project right-of-way. • Conduct pre-construction clubroot sampling on private lands not owned by MH under cultivation along the project right-of-way. • Identify and map biosecurity control zones with identified pests such as clubroot, and noxious and invasive weeds, on or adjacent to agricultural lands along the project right-of-way. • Select appropriate equipment cleaning station locations and types based on identified risk levels along the project right-of-way. • Obtain approval of the landowner/producers for access to Restricted Access Zones. • Follow Biosecurity Management Plan including employee training, implement cleaning stations, prescribed actions, signage and submit all required cleaning documentation. • Implement post-construction weed management in areas identified with weed occurrences, as per the plan. • Conduct post construction monitoring and reporting as per Environmental Monitoring Plan using the pre-construction survey report for baseline comparison. • Continue to implement post-construction weed management in areas with unresolved weed occurrences, as per the plan. • Continue to monitor and report as per environmental monitoring plan using the pre-construction survey report for baseline comparison.
Contractor	• Shall adhere to Biosecurity Management Plan including employee training, implement cleaning stations, prescribed actions, signage and submit all required cleaning documentation. • Respond and act promptly to resolve if any activities are identified as not in compliance with the BMP or any regulatory requirements. • Supply and maintain all required, signage, cleaning equipment, approved disinfectants.

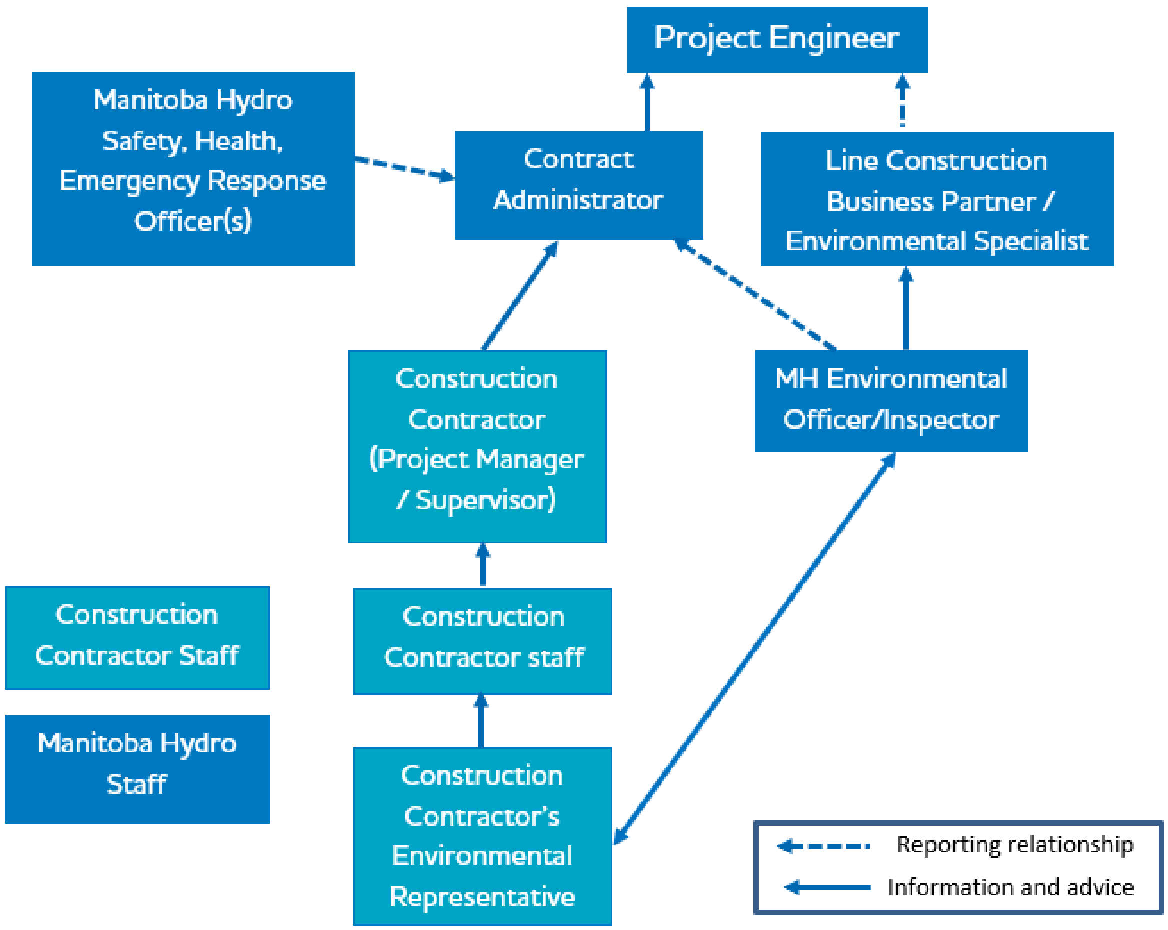

Figure 3: Environmental communication reporting structure

2.0 Biosecurity implementation

The intent of this section is to provide for implementation instructions to Manitoba Hydro and contractor project staff. The four key steps to implementing the plan are shown in Figure 4.

Once risks are identified through various means (Section 2.1), control areas are identified (Section 2.2), then risks will be classified into a risk level (Section 2.3), which will in turn be used to determine the nature of actions to be undertaken to manage the risk (Section 2.4). Mitigative actions will be determined and undertaken; the objective of which is to prevent the introduction, establishment, and spread of pests (i.e., weeds and diseases). Prescribed or issue-specific actions will be determined based on assessment of the biosecurity issue.

The implementation of the plan utilizes a stepwise process; however, these steps will be undertaken at various times throughout the pre-construction and construction phases of the project. The plan is founded on a principle of adaptive management – if aspects of the plan are found to require modifications for improved effectiveness or if new information becomes available (e.g., more effective control actions, pest outbreaks in the project area) the plan and actions will be updated.

Figure 4: Implementation steps for biosecurity management plan

2.1 Biosecurity risk identification

Manitoba Hydro will conduct assessments appropriate to the area in which there is a biosecurity concern based on the results of consultation with Manitoba Agriculture and Resource Development and/or individual landowners or producers, identified risks of spreading weeds and invasive species or disease pests of concern, and regulatory requirements. Specific actions to be undertaken, as necessary, will include:

- pre-construction meetings and discussion with landowners, including the identification of reasonable site-specific biosecurity concerns, if any
- pre-construction soil sampling program for the presence of clubroot on the ROW, access routes and any other project infrastructure such as marshalling yards located on cultivated agricultural lands
- pre-construction weed surveys for determination of location and type (i.e., tier 1, tier 2, or tier 3) of weed concerns
- pre-construction inventory of livestock operations to identify risk areas associated with livestock and manure
- pre-construction inventory of waterbodies with aquatic invasive species present

2.1.1 Pre-construction sampling protocol

2.1.1.1 Benchmark sampling for clubroot

Soil sample collection methodology

The soil sampling collection methodology as describe below was developed from methods established by Manitoba Agriculture.

1. Soil samples should be a composite of one cup scoops of soil taken at each of five points in one field. As clubroot concentration have been found to be the highest at field approaches in infected fields, the samples should be taken within the vicinity of where vehicles, equipment and pedestrians would usually enter the field. Samples may also be collected when there is a significant change in cropping practice and/or potential for additional field entry. Travelling in a “W” pattern, stop at the five points of the “W” keeping each of these five points at least 20 metres from each other and at least 20 metres from the field edge.
2. Clear away residue from the soil surface, and scoop approximately one cup of the top zero to 10 cm of soil at each site (approximately one litre from all five points combined).

Document collection location with following information:

- Biosecurity Zone reference number
- legal description of land parcel
- sample reference number
- GPS location of last sampling point
- name of the person who collected the sample
- date of sampling

3. Air-dry soil samples in paper boxes and send them to an approved laboratory for testing.

<u>Sample testing methodology</u>

Soil samples will be submitted to an independent third-party laboratory, such as Pest Surveillance Initiative or Manitoba Agriculture Labs (each a “testing laboratory”). The selection of the testing laboratory will be at the discretion of Manitoba Hydro. The selected testing laboratory will perform conventional Polymerase Chain Reaction analysis on each composite sample submitted for testing, with a view to identifying the presence of clubroot DNA to a confidence level of 103 (1000 spores/gram).

<u>Test results</u>

Manitoba Hydro will keep all test results in confidence but will have the right to disclose test results:

(i) to the landowner to whose property they pertain
(ii) to those persons authorized by the landowner to whose property the test results pertain
(iii) to Manitoba Hydro and to contractors who will be undertaking work on the property
(iv) to the Pest Surveillance Initiative
(v) to Manitoba Agriculture or other regulatory authorities

<u>Sampling crew protocol</u>

- If it is reasonably practicable and safe, sampling crews will avoid parking motorized vehicles in field accesses.
- Sampling crews will travel by foot on lands to be sampled.
- Sampling crews will either spray all footwear using an approved disinfectant solution prior to crossing a change in Controlled Access Zone, or wear disposable boot covers over footwear, which will be changed between each sampling site.
- Disposable gloves will be worn for soil sampling and will be changed at each sampling site.

- Hand tools used during the sampling process will be rough cleaned and sprayed with a 1% Virkon solution upon leaving each sampling site.

2.1.1.2 Weed surveys

The weed survey methodology as described below was developed from methods established by Adams et al. (2009).

Weed survey data collection methodology

- Species will be recorded in field books, and GPS coordinates and photographs will be captured at each location.
- Environmental monitoring of these sites will involve recording species composition and determining species densities if movement occurs into the Project right of way from roadside ditches.
- Weed density distribution will follow Adams et al. (2009) and involve a quantitative description of species abundance. Species abundance codes range from none to continuous occurrence of plants with a distinct linear edge.
- All legislated weeds and invasive plant species will be documented, and phenology will be recorded (i.e., flowering, fruiting, seeding, vegetative).
- A site sketch will be completed for infestations into the Project right of way and photographs will be taken.

Sampling crew protocol

- If it is reasonably practicable and safe, sampling crews will avoid parking motorized vehicles in field accesses.
- Sampling crews will travel by foot on lands to be sampled.
- Sampling crews will either spray all footwear using an approved disinfectant solution, or wear disposable boot covers over footwear, which will be changed between each sampling site on agricultural land.
- At selected sites along the right of way, pre-construction roadside surveys will be conducted (e.g., bordering agricultural lands) to establish a baseline for future monitoring comparison.
- From the roadside, ditches will be traversed on foot to document species presence and record infestations into adjacent lands.

2.1.1.3 Livestock operations

Various types of livestock operations were identified during the environmental assessment process (Manitoba Hydro, 2015). The location and type of these have been inventoried and mapped and will be used by Manitoba Hydro to determine biosecurity risk areas and levels related to livestock operations.

2.2 Agricultural land parcel zoning and access control

Manitoba Hydro has developed a construction environmental protection plan mapbook, including the identification of controlled access points, transition zones and the classification of control and restricted zones for agricultural land parcels.

Different levels of access restriction and required actions, are assigned to controlled access zones and restricted access zones. Controlled access points are visually identifiable (i.e., signed) points used as access points into controlled/restricted access zones in Project work areas, and are used to control entry into and exit from these zones. Transition Zone are designated areas between controlled access zones (e.g., between "low risk" and "high risk" fields within a land section). These zones and controls are further defined in Table 2.

Table 2: Biosecurity zones and control points

Zone or point identification	**Definition**
Controlled Access Point	Visually-defined (i.e., signed) entry point where vehicles, equipment and workers enter into and exit from a Project work area identified as a controlled/restricted access zone.
Transition Zone	Visually-defined (i.e., signed) designated areas between controlled access zones (e.g., between “low risk” and “high risk” fields within a land section). Transition zones are where workers stop prior to entering an adjacent controlled access, and review and implement required actions.
Controlled Access Zone	Agricultural land parcel requiring prescribed and/or specific actions to protect against a biosecurity risk. Two levels of controlled access zones are defined: • Controlled access zone – low risk: a controlled access zone where a low level risk is identified. • Controlled access zone – high risk: a controlled access zone where a high level risk is identified.
Restricted Access Zone	Area where access is restricted. Vehicles, equipment, or workers should not enter a restricted zone or area unless under special circumstances and with prior written approval of the landowner/producers and a Manitoba Hydro Environmental Officer.

The requirement for Transition Zones between controlled access zones can be mitigated by permitting access from opposing sides of CAZ and not crossing the Transition Zones, choosing a direction of travel that moves from low-risk area to high-risk area, or the use of continuous matting throughout CAZ.

A conceptual diagram of controlled access points, transition zones and controlled access zones (low and high risk) is presented in Figure 5.

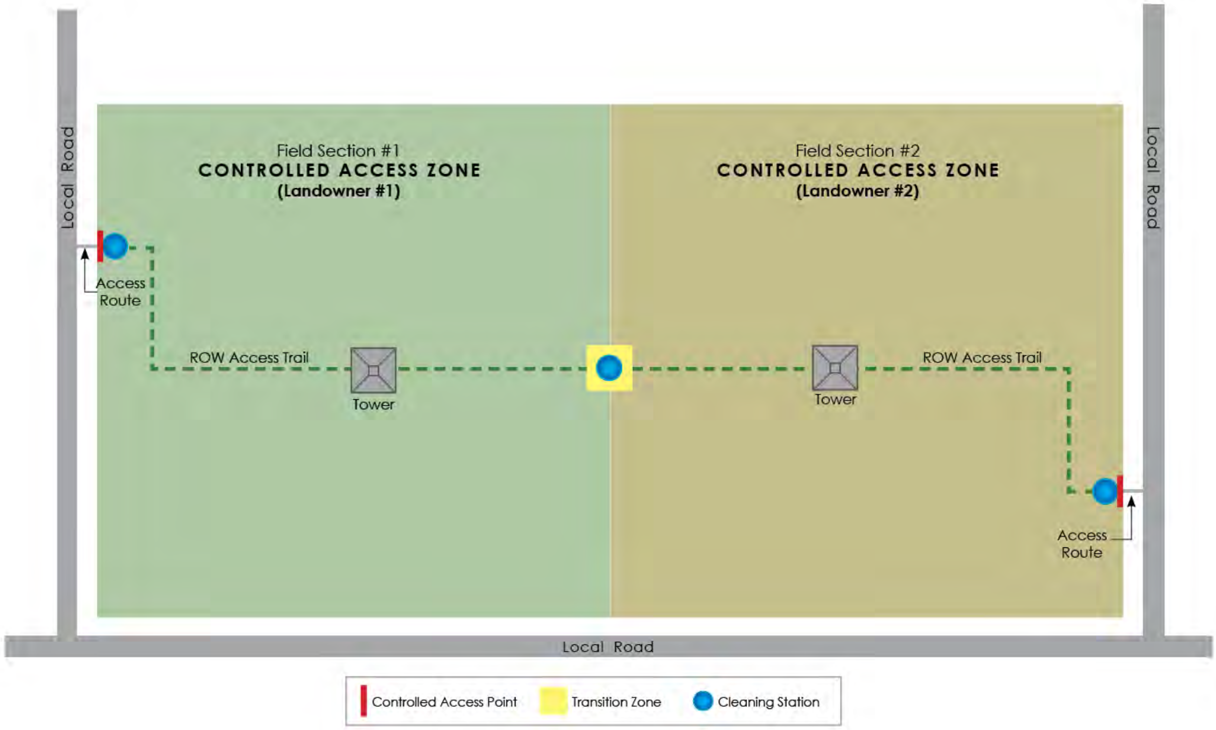

Figure 5: Conceptual diagram of controlled access zones, control access points and transition zones

2.3 Biosecurity risk classification

Manitoba Hydro will conduct a classification of the identified biosecurity risks for the project based on the level of risk, in terms of the potential consequences associated with not undertaking risk mitigation actions. Risks will be classified as low or high, according to the definitions provided in Table 3. Generally, the risk of soil borne biosecurity issues (i.e., weed seeds in soil, soil borne pathogens [e.g., clubroot, anthrax]) decreases according to the following soil conditions: non-frozen, bare soil – moist/wet > non-frozen, bare soil – dry > frozen, bare soil > frozen, snow-covered soil.

Potential biosecurity risks for the project are listed in Table 4, including the classified risk level for each identified risk. Any mapping produced will not be labelled with the name of the specific concern (i.e., clubroot, PED, Anthrax) for the controlled access zone to protect confidentiality concerns.

Weeds designated as tier 1, tier 2, and tier 3 noxious weeds under the Noxious Weeds Regulation (42/2017) is found in Appendix A.

Table 3: Biosecurity risk levels

Risk level	Risk definition
Low	A low risk to biosecurity is one in which may result in the introduction of new concerns or increased prevalence where concerns already exist if appropriate mitigative actions are not undertaken. In the case of low risks, the potential introduction or increased prevalence of a biosecurity concern is not anticipated to result in immediate or substantive damage to crops or livestock.
High	A high risk to biosecurity is one in which immediate and/or substantive damage could occur to crops or livestock if appropriate mitigative actions are not applied. These damages may occur from the introduction of new pests or the increase in prevalence of existing pests in a given area.
WC (Risk level modifier)	Winter Conditions (WC) is a risk level modifier that may be applied (when directed by Manitoba Hydro) to low or high-risk sites where the activity is less likely to result in the introduction of new concerns or increased prevalence where concerns already exist when the soil is frozen or frozen, snow-covered. This risk level modifier only applies to activities that are not likely to create subsurface disturbance such as pedestrian, vehicle and equipment travel activity, if any soil accumulates on the boots, vehicles or equipment the applicable low or high-risk cleaning procedures apply. This risk level modifier does not apply to construction activities that create subsurface disturbance such as grubbing, excavation, drilling, foundation installation, clearing, conductor stringing, etc.

Table 4: Biosecurity risk classification matrix

<table>
<tr><th rowspan="2">Biosecurity issue</th><th colspan="3">Risk level</th></tr>
<tr><th>Non-frozen soil</th><th>Frozen soil</th><th>Frozen, snow-covered soil</th></tr>
<tr><td>Agricultural lands where no weeds, soil borne crop diseases, manure spreading, or active livestock settings have been identified that present a substantial risk to biosecurity</td><td>Low</td><td>WC[1]
Low[2]</td><td>WC[1]
Low[2]</td></tr>
<tr><td>Specific sites identified as Tier 1 Noxious weeds as defined in the Noxious Weeds Regulation.</td><td>High</td><td>High</td><td>Low</td></tr>
<tr><td>Specific sites identified as Tier 2 or 3 Noxious weeds as defined in the Noxious Weeds Regulations and present a substantial biosecurity risk that the project activities will transfer the identified issue from one area to another.</td><td>Low</td><td>Low</td><td>Low</td></tr>
<tr><td>Laboratory testing has indicated clubroot spores are present</td><td>High</td><td>WC[1]
High[2]</td><td>WC[1]
High[2]</td></tr>
<tr><td>Manitoba Hydro will designate an operation with an existing and established biosecurity management plan as High risk. Manitoba Hydro will strive to meet the existing farm level biosecurity measures in these instances.</td><td colspan="3">High</td></tr>
<tr><td>Manitoba Hydro will designate active livestock settings (e.g., ILOs, active grazing areas) as High risk.</td><td colspan="3">High</td></tr>
<tr><td>Agricultural lands on which manure has been spread.</td><td>High</td><td>High</td><td>WC[1]
High[2]</td></tr>
</table>

Table 4: Biosecurity risk classification matrix
Note 1: This risk level modifier only applies to activities that create **no** subsurface disturbance such as vehicle travel, inspection, surveying, etc.
Note 2: This risk level applies to activities that create subsurface disturbances such as grubbing, excavation, drilling, foundation installation, clearing, conductor stringing, etc.

2.4 Risk mitigation actions

2.4.1 Project mobilization

The contractor must ensure that all equipment shall arrive at the project work area clean of soil and plant material to the satisfaction of the Manitoba Hydro Environmental Inspector/Officer. Any equipment that arrives dirty will not be permitted entry into the project work area or adjacent lands until it has been cleaned at a Manitoba Hydro. The Vehicle and Equipment Cleaning Field Log (Appendix B - Field Activity and Inspection Forms) will be completed for all equipment entering the work site. See Section 2.3.4 for more information on equipment cleaning requirements.

2.4.2 Prescribed actions

Prescribed actions to prevent or reduce the potential for an increased biosecurity risk because of project activities are listed below according to the assessed risk level.

2.4.2.1 Winter conditions modifier (WC)

No prescribed mitigative actions are required for pedestrians, vehicles and equipment travelling through controlled access zones when the WC risk level modifier is applied to low or high-risk sites, however if any soil, manure, plant material and foreign matter accumulates on the boots, vehicles, or equipment the applicable low or high risk prescribed actions (as described below) apply. The applicable low or high risk prescribed actions (described below) apply to construction activities that create subsurface disturbance such as grubbing, excavation, drilling, foundation installation, clearing, conductor stringing, etc.

Low risk

The following are prescribed mitigative actions for controlled access zones classified as low risk:

1. Ensure clothing, matting, vehicles, and equipment is clean of soil, manure, plant material and foreign matter prior to entering agricultural lands.
2. When leaving agricultural lands, visually inspect clothing, matting, vehicles, and equipment for seeds, soil, or manure and if required, rough-clean all surfaces prior to leaving the land. Rough cleaning (i.e, brushing, scraping, and/or compressed air) will remove most surface soil, plant material, and foreign matter from clothing, vehicles, and equipment.
3. Complete the Biosecurity Cleaning Record (Appendix B).

Table 5: Low risk equipment cleaning requirements

Equipment	**Cleaning requirements**
Footwear	Rough clean
Vehicles	Rough clean
Matting	Rough clean
Equipment	Rough clean

High risk

The following are prescribed actions for controlled access zones classified as high risks:

1. If possible, avoid the immediate area of the biosecurity risk (e.g., use alternate access to avoid active livestock grazing areas, identified weed infestations, avoid travelling through high risk-controlled access zones).
2. If possible, schedule activities to occur when ground conditions are more favourable (i.e., frozen, or frozen and snow-covered or utilize matting and geotextile underlayment).
3. Ensure clothing, matting, vehicles, and equipment is clean of soil, manure, plant material and foreign matter prior to entering controlled access zones.
4. When leaving the controlled access zone, visually inspect clothing, matting, vehicles and equipment for soil, manure, plant material or foreign matter and if required, rough-clean all surfaces prior to leaving the land. Brushing and/or

scraping will remove most surface soil, plant material, and foreign matter from clothing, matting, vehicles, and equipment.

5. Matting, vehicles, and equipment may require fine cleaning to remove remaining soil, manure, plant material and foreign matter (see Table 6). Fine cleaning will be conducted using high pressure water, steam, or compressed air to remove remaining soil, manure, plant material and foreign matter.
6. Fine cleaning and disinfecting of matting and equipment only, may be completed off site, if the matting or equipment is transported directly to a Manitoba Hydro approved or commercial wash facility.
7. In cases where there is a risk of spreading soil to agricultural lands (such as vehicle or equipment tires/tracks), pressure washing/steaming/compressed air cleaning must occur before leaving the controlled access zone.
8. After fine cleaning, disinfection of matting, vehicles, and equipment using an approved disinfectant spray that is applied to all surfaces that have been in contact with soil, manure, plant material and foreign matter is required.
9. Only disinfectants approved by Manitoba Hydro are to be utilized.
10. To clean footwear, use a brush or scraper to remove soil, manure, plant material and foreign matter. Apply disinfectants approved by Manitoba Hydro. Alternatively, use disposable footwear booties or change dirty footwear for clean footwear when leaving the controlled access zone.
11. Complete the Biosecurity Cleaning Record as required by Manitoba Hydro departmental or contract requirements.

Table 6: High risk equipment cleaning requirements

Equipment	**Cleaning requirements**
Footwear	Rough clean and disinfectant spray
Vehicles	Rough, fine clean and disinfectant spray
Matting	Rough, fine clean and disinfectant spray
Equipment	Rough, fine clean and disinfectant spray

Cleaning requirements for high-risk areas must be carried out before moving between controlled access zones (i.e., landowner boundaries with a change in biosecurity risk and/or risk level or change in land use). If there are continuous controlled access zones classified as high risk and where equipment will travel continuously along the right-of-way, the requirement will be to fine clean and spray with a disinfectant at the established controlled access point of the entire defined high-risk area, and to complete the specified type of cleaning in designated transition zones between controlled access zones, if applicable. Controlled access points and transition zones are identified in the Biosecurity Management Plan Mapbook and any subsequent amendments.

Additional details on cleaning and cleaning areas/stations are found in Section 2.4.4.

2.4.3 Specific actions

As part of the adaptive management planning, it is understood that currently unknown and site-specific biosecurity issues and concerns yet to be identified may require assessment and action to manage risk associated with project activities. For example, if during the construction phase a "new" biosecurity issue or threat is determined to occur in the project area, the issue or threat will be reviewed by Manitoba Hydro and changes will be made to the plan to appropriately protect against biosecurity risk. It is not possible to consider all potential situations or risks, therefore actions may need to be developed, as required and as appropriate, in these situations. In these cases, Manitoba Hydro Environmental Officer will discuss with the contractor environmental representative and an appropriate course of action will be developed. The issue and specific actions required will be documented by Manitoba Hydro and will need to be followed up by the contractor(s) and their personnel.

If existing agricultural operation biosecurity measures exist, project staff and contractors will strive to meet the requirements of the agricultural operation when access is required. Again, these specific actions will be documented by Manitoba Hydro and will need to be implemented by contractor(s) and their personnel.

In the event of an emergency situations (e.g., injured personnel, etc.), project work areas may have to be accessed by emergency response personnel without adherence to mitigation actions.

2.4.4 Equipment cleaning requirements

Equipment cleaning is a critical component of the biosecurity management plan. Vehicles and equipment being used in agricultural fields during all project phases (i.e., pre-construction, clearing, construction, commissioning) must arrive at site clean and free of aquatic invasive species, soil, vegetative matter, and require cleaning during work on the project, as discussed above, and described in further detail below.

2.4.4.1 Types of cleaning

Different types of cleaning of matting, vehicles and equipment are required as determined by the level of risk and the nature of the concern. The different types of cleaning that are required for the project are presented in Table 7.

Table 7: Description of cleaning types

Cleaning type	Description
Rough clean	Remove to the extent possible accumulated soil, plant material or crop debris from openings, tracks, tires, and wheels using a hand scraper, shovel, broom, brush, or compressed air. This level of cleaning must occur on-site before leaving the selected cleaning location or the work area. Personnel cleaning the equipment must complete a visual inspection for accumulated soil and plant material prior to leaving the cleaning station.
Fine clean	Fine clean means high pressure water wash, high pressure air wash or high-pressure steam wash to remove accumulated soil, plant material or crop debris. Wash matting, vehicles, and equipment paying extra attention to areas where soil or plant debris is likely to accumulate (i.e., tires or undercarriage). For hydrovac trucks, cleaning includes the inside of the tank and any implement in contact with soil. Prior to fine cleaning, matting, vehicles, and equipment should receive a rough clean.
Disinfectant spray	Use disinfectant spraying as the final cleaning phase when working on controlled access zones where there is a confirmed high risk of encountering and spreading viruses, diseases that can be effectively treated with a disinfectant spray. Spray tracks, openings, tires, wheels, and implements that may contact soil, plant material or crop debris with an approved disinfectant solution. Disinfectant sprays should be used in accordance with label directions and applied according to the information presented in **Section 2.3.4**. Foot traffic may also utilize disposable boots. Hydrovac truck cleaning includes the inside of the tank and any implement that contacts soil or plant material or crop debris.

2.4.4.2 Cleaning stations

Cleaning area/station locations (see Figure 6 below) will be identified prior to construction by Manitoba Hydro and be established by the contractor(s) at applicable controlled access points and transition zones. Cleaning stations will be established to address the determined risk level and the associated type of cleaning prescribed. There are two types of cleaning stations:

1. Low risk cleaning station – contains equipment for rough cleaning and when required disinfecting spray.
2. High risk cleaning station – contains equipment for rough and fine cleaning along with disinfecting spray.

Cleaning stations will have signs placed appropriately onsite by the contractor(s) to notify project personnel of the cleaning station location and type of cleaning that should be conducted. Sediment released from the washing process will be fully contained (i.e., sump pit, berm).

When cleaning station sump pits, sump materials (dirt, water, and disinfectant solution from washing activities) must be disposed of at an MH approved disposal facility.

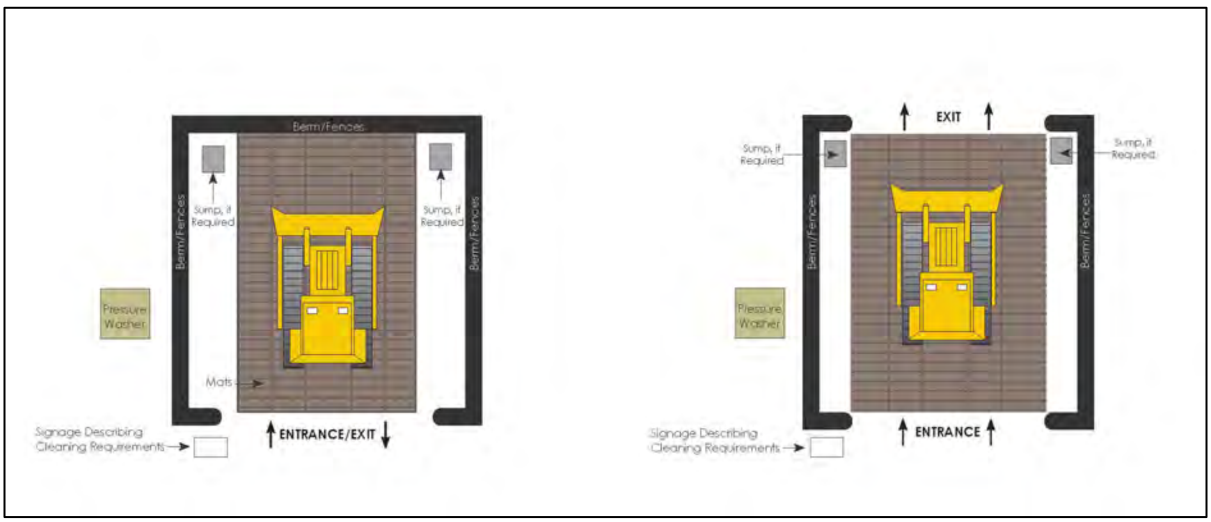

Figure 6: Conceptual diagram of a cleaning station

2.4.4.3 Disinfectants

Manitoba Hydro approves the use of disinfectants on Manitoba Hydro projects. Approved disinfectants for this project include Virkon, Accel and Synergize. Mixing and use of these disinfectants are discussed below.

Virkon

Virkon is approved by Manitoba Hydro, for use in the prevention of the transport of invasive organisms in soil and manure onto or off agricultural land. Please refer MSDS sheets prior to use for safe handling procedures. For disinfection, staff and contractors are to use Virkon 5 gram tablets, mixed and applied in accordance with the manufacturer's specifications. Virkon is biodegradable and no further treatment of the waste solution is required. The process for cleaning equipment and disinfecting is as follows:

a) Scrape off all heavy soil accumulations and utilize pressure washing, steaming or compressed air to clean all surfaces that have been in contact with the soil.
b) Virkon disinfectant is to be mixed as one tablet for every 500 ml of water for above freezing weather conditions.
c) Virkon disinfectant is to be mixed as one tablet for every 500 ml of solution (400 ml of water and 100 ml of propylene glycol, pre-mix prior to adding disinfectant) for below freezing weather conditions.
d) To ensure maximum effectiveness, mixed solution has a 7-day shelf life or when pink color fades and solution begins to appear milky.
e) Virkon must be applied by spraying or the use of a mop, sponge, or cloth to evenly apply onto the equipment surface that has been in contact with the soil. A minimum wetted contact time of 10 minutes is required for all surfaces that have been in contact with soil.
f) Any waste solution associated with disinfection is to remain on the field where it was used. It must be disposed of at least ten metres from a drain or drainage ditch.
g) Do not re-use a solution which has been used to soak contaminated tools or equipment.

Accel

Accel is approved by Manitoba Hydro, for use in the prevention of the transport of invasive organisms in soil and manure onto or off agricultural land. For disinfection, staff and contractors are to use Accel mixed and applied in accordance with the manufacturer's specifications. Please refer MSDS sheets prior to use for safe handling procedures. Accel is biodegradable and no further treatment of the waste solution is required. The process for cleaning equipment and disinfecting is as follows:

a) Scrape off all heavy soil accumulations and utilize pressure washing, steaming or compressed air to clean all surfaces that have been in contact with the soil.
b) Accel disinfectant is to be mixed at 1:40, 100 ml of concentrate per 4 L of water for above freezing weather conditions. A minimum wetted contact time of 5 minutes is required for all surfaces that have been treated.
c) For below freezing weather conditions, Accel is not recommended due to 40 minute minimum wetted contact time.
d) To ensure maximum effectiveness, mixed solution has a 30-day shelf life.
e) Accel must be applied by spraying or the use of a mop, sponge, or cloth to evenly apply onto the equipment surface that has been in contact with the soil.
f) Any waste solution associated with disinfection is to remain on the field where it was used. It must be disposed of at least ten metres from a drain or drainage ditch.
g) Do not re-use a solution which has been used to soak contaminated tools or equipment.

Synergize

Synergize is approved by Manitoba Hydro, when requested by the landowner for use in the prevention of the transport of invasive organisms in manure.

Synergize has known aquatic environmental impacts on aquatic fish and invertebrates. The application of the product will be contained in the field away from any watercourses to mitigate environmental impacts. Disinfecting with this product shall be done on the field away from any watercourse and leftover product will be disposed of at an approved facility. Please refer MSDS sheets prior to use for safe handling procedures. The process for cleaning equipment and disinfecting is as follows:

a) Scrape off all heavy soil accumulations and utilize pressure washing, steaming or compressed air to clean all surfaces that have been in contact with the soil.
b) Synergize is to be mixed with a ratio of 4 ml Synergize to 1 L water for above freezing weather conditions.

c) Synergize is to be mixed with a ratio of 8 ml Synergize to 1 L solution (900 ml of water and 100 ml of propylene glycol, pre-mixed prior to adding disinfectant) for below freezing weather conditions.
d) To ensure maximum effectiveness, mixed solution has a maximum 7-day shelf life.
e) Synergize must be applied by spraying or the use of a mop, sponge, or cloth to evenly apply onto the equipment surfaces that have been in contact with the soil. A minimum wetted contact time of 10 minutes is required for all surfaces that have been treated.
f) Do not re-use a solution which has been used to soak contaminated tools or equipment.
g) Any leftover product will be disposed of at an approved facility.

Propylene glycol

For the use of above-described solutions during freezing weather conditions, pure United States Pharmacopeia (USP) or food-grade propylene glycol must be utilized in the disinfectant solution. Propylene glycol improves spraying by preventing freezing of solution at low temperatures and fragmenting the solution drops into smaller particles, allowing for a better distribution and coverage of the sprayed surface. Propylene glycol is biodegradable, water-soluble, and is safe for humans.

2.5 Signage

Contractors will be required to supply and install signage prior to commencement of pre-construction and construction activities to notify and inform contractor's field personnel and Manitoba Hydro staff of controlled access zones. Signage will be installed at all controlled access points where personnel are required to enter and exit from a controlled access zone, signage will have to differentiate between a Controlled Access Zone and a Restricted Access Zone. Controlled Access Point(s) or transition zone(s) will be established with signage installed to inform personnel of cleaning requirements. Signage will prompt workers to review additional information on the biosecurity risk and requirements in project documentation (i.e., Biosecurity Risk Map Book and Information spreadsheet).

Signage is required as follows:

- Controlled Access Point or Transition Zone signage must contain:
  - Indication to stop

- Cleaning requirements as applicable to current Controlled Access Zone risk rating
- Risk rating (low, high)

2.6 Training

Manitoba Hydro and the contractor(s) each have responsibility to ensure that their respective personnel are appropriately trained to carry out their role in the protection of biosecurity, and that proper documentation and communication is being conducted throughout the project. Manitoba Hydro has prepared Environmental Management Practices Guides (Appendix C) for variety of topics covered in this plan for use by project field staff.

Manitoba Hydro will hold a Contractor Environmental Pre-Construction Orientation meeting to review project specifics and environmental requirements with all its contractors at a supervisory level. A summary of this Biosecurity Management Plan, implementation requirements, roles and responsibilities, and Manitoba Hydro's expectations will be presented at that time.

Manitoba Hydro will also hold a separate pre-construction environmental meeting to provide the opportunity for Manitoba Hydro and contractor environmental representatives to discuss project specifics and environmental requirements in more depth.

It is a mandatory requirement that the contractor(s) provide all personnel involved in construction work in the field or involved in supervision of those personnel (i.e., project manager, supervisors) project-specific Biosecurity Management Plan orientation training prior to starting work. This training will present the objectives of the plan, roles and responsibilities, biosecurity issues and required actions, and documentation requirements. A training attendance record must be maintained by the contractor(s) and submitted to Manitoba Hydro Environmental Protection Information Management System.

2.7 Documentation

Once the matting, vehicles and equipment has been cleaned in accordance with the assigned risk level, the Cleaning Record Form will be filled out and signed off by the contractor personnel managing the cleaning station or the operator completing the cleaning. All cleaning records will be digitized into an excel spreadsheet and submitted by the contractor on a weekly basis to the Manitoba Hydro Environmental Protection Information Management System by the Contractor. Contractor will maintain all original copies until project completion and will be transferred to Manitoba Hydro upon request.

3.0 Communication

In addition to the plan, mapbook and accompanying landowner information spreadsheet form critical components of communicating biosecurity requirement to personnel working on the project. Manitoba Hydro will provide the contractor(s) the construction environmental protection plan mapbook visually identifying biosecurity information:

- Identified controlled access zones, and preliminary risk levels, as appropriate.
- Proposed access locations, controlled access points and transition areas, where cleaning areas/stations will be located.

Locations of controlled access points, transition areas and cleaning station areas/stations will be finalized by Manitoba Hydro in conjunction with the contractor(s). Any contractor-proposed additions, location modifications or plan requirement revisions will be submitted in writing to Manitoba Hydro and include a map containing legal land description and GPS location. Any Manitoba Hydro-required revisions to the plan will be communicated to the contractor's project manager for distribution to project staff.

4.0 Monitoring and follow-up

Manitoba Hydro will monitor the work carried out under the plan. Each contractor's work will be monitored to assess public and worker safety, permitting requirements and approvals, environmental concerns, completion schedules and adherence to, and compliance with, commitments made in the plan.

Manitoba Hydro environmental inspectors / officers and construction inspectors will be responsible for conducting inspections and reviewing the cleaning records and logs to ensure that prescribed actions and measures identified within this plan are being followed.

Inspections will involve assessing all vehicles, equipment and pedestrian access at controlled access points or transition areas using the cleaning standards assessment guide in Appendix D. Inspections will also include reviewing logs, along with assessing cleaning equipment availability and disinfectant at the cleaning stations. If the inspection determines that documentation, adherence to prescribed actions, cleaning station equipment and/or setup or any other activity is not to the satisfaction of Manitoba Hydro or does not meet the minimum expectations of this plan, measures to remedy the deficiencies will be communicated directly to onsite contractor staff. If deficiencies are not remedied in a timely manner according to Manitoba Hydro, measures will be implemented through corrective action report, environmental improvement or stop work orders to ensure compliance and overall project success.

5.0 References

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Manitoba Agriculture. No date [a]. Biosecurity Management on Agricultural Land for the Energy and Transportation Industries. Available from https://www.gov.mb.ca/agriculture/crops/biosecurity-energy-and-transportation.html (accessed December 2017).

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Manitoba Government. 2017. The Noxious Weeds Act. URL: http://web2.gov.mb.ca/laws/statutes/ccsm/n110e.php.

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Appendix A

Noxious Weeds Regulation Species List

Appendix A: Noxious weeds regulation species list

Designated Tier 1 Noxious Weeds		
Common name	**Scientific name**	**Area for which Designation applies**
Amaranth, Palmer	*Amaranthus palmeri*	All areas of the province outside the Municipality of Bifrost-Riverton and the Rural Municipalities of Armstrong, Fisher, Gimli, Rockwood, St. Andrews and St. Clements
Bartsia, red	*Odontes vernus*	Whole province
Crupina, common	*Crupina vulgaris*	Whole province
Cupgrass, woolly	*Eriochloa villosa*	Whole province
Goatgrass, jointed	*Aegilops cylindrical*	Whole province
Hawkweed, orange	*Hieracium aurantiacum*	Whole province
Hogweed, giant	*Heracleum mantegazzianum*	Whole province
Hound's-tongue	*Cynoglassum officinale*	Whole province
Knapweed, diffuse	*Centaurea diffusa*	Whole province
Knapweed, Russian	*Acroptilon repens*	Whole province
Knapweed, spotted	*Centaurea stoebe*	Whole province
Knapweed, squarrose	*Centaurea virgata*	Whole province
Knotweed, Japanese	*Fallopia japonica*	Whole province
Mile-a-minute weed	*Persicaria perfoliata*	Whole province
Mustard, garlic	*Allaria petiolata*	Whole province
Patterson's curse	*Echium plantagineum*	Whole province
Pigweed, smooth	*Amaranthus hybridus*	Whole province
Saltcedar	*Tamarix spp.*	Whole province
Star-thistle, yellow	*Centaurea solstitialus*	Whole province
Tussock, serrated	*Nassella trichotoma*	Whole province
Waterhemp, tall	*Amaranthus turbriculatus*	Whole province

Designated Tier 2 Noxious Weeds		
Common name	**Scientific name**	**Area for which Designation applies**
Alyssum, hoary	*Berteroa incana*	Whole province
Baby's-breath	*Gypsophila paniculata*	Whole province
Bartsia, red	*Odontes vernus*	Municipality of Bifrost-Riverton and the Rural Municipalities of Armstrong, Fisher, Gimli, Rockwood, St. Andrews and St. Clements
Bouncingbet	*Saponaria officinalis*	Whole province
Brome, downy	*Bromus tectorum*	Whole province
Brome, Japanese	*Bromus japonicas*	Whole province
Campion, bladder	*Silene vulgaris*	Whole province
Chamomile, scentless	*Matricaria perforata*	Whole province
Common reed, invasive	*Phragmites australis australis*	Whole province
Daisy, ox-eye	*Leucanthemum vulgare*	Whole province
Nutsedge, yellow	*Cyperus esculentus*	Whole province
Scabious, field	*Knautia arvensis*	Whole province
Spurge, Cypress	*Euphorbia cyparissias*	Whole province
Spurge, leafy	*Euphorbia esula*	Whole province
St. John's-wort	*Hypericum perforatum*	Whole province
Tansy, common	*Tanacetum vulgare*	Whole province
Thistle, nodding	*Carduus nutans*	Whole province
Toadflax, Dalmatian	*Linaria dalmatica*	Whole province

Designated Tier 3 Noxious Weeds		
Common name	**Scientific name**	**Area for which Designation applies**
Absinth	*Artemisia absinthum*	Whole province
Barberry	*Berberis vulgaris*	Whole province
Barley, foxtail	*Hordeum jubatum*	Whole province
Bellflower, creeping	*Campanula rapunculoides*	Whole province
Buckthorn, European	*Rhamnus frangula*	Whole province
Burdock, common	*Arctium minus*	Whole province
Burdock, greater	*Arctium, lappa*	Whole province
Burdock, woolly	*Arctium, tomentosum*	Whole province
Campion, biennial	*Silene dioica*	Whole province
Catchfly, night-flowering	*Silene noctiflora*	Whole province
Cleavers	*Galium aparine*	Whole province
Cleavers, false	*Galium spurium*	Whole province
Cockle, white	*Silene alba*	Whole province
Dandelion	*Taraxacum officinale*	Whole province
Dodder	genus *Cuscuta*	Whole province
Fleabane, Canada	*Conyza canadensis*	Whole province
Flixweed	*Descurainia Sophia*	Whole province
Hawk’s-beard, narrow-leaved	*Crepis tectorum*	Whole province
Hemlock, poison	*Conium maculatum*	Whole province
Hemp-nettle	*Galeopsis tetrahit*	Whole province
Hoary-cress	*Cardaria draba*	Whole province
Jimsonweed	*Datura stromonium*	Whole province
Kochia	*Kochia scoparia*	Whole province
Lamb’s quarters	*Chenopodium album*	Whole province
Lettuce, prickly	*Lactuca seriola*	Whole province
Milkweed, common	*Asclepias syriaca*	Whole province
Milkweed, showy	*Aslepias speciosa*	Whole province
Mustard, wild	*Sinapis arvensis*	Whole province
Nightshade, American black	*Solanum americanum*	Whole province
Nightshade, cutleaf	*Solanum triflorum*	Whole province
Nightshade, hairy	*Solanum sarachoides*	Whole province
Parsnip, wild	*Pastinaca sativa*	Whole province
Ragweed, common	*Ambrosia artemisifolia*	Whole province

Designated Tier 3 Noxious Weeds		
Common name	**Scientific name**	**Area for which Designation applies**
Ragweed, false	*Iva xanthifolia*	Whole province
Ragweed, giant	*Ambrosia trifida*	Whole province
Sow-thistle, annual	*Sonchus oleraceus*	Whole province
Sow-thistle, perennial	*Sonchus arvensis*	Whole province
Sow-thistle, spiny annual	*Sonchus asper*	Whole province
Stinkweed	*Thlaspi arvense*	Whole province
Stork’s bill	*Erodium cicutarium*	Whole province
Thistle, bull	*Cirsium vulgare*	Whole province
Thistle, Canada	*Circium arvense*	Whole province
Thistle, Russian	*Salsola pestifer*	Whole province
Toadflax, yellow	*Linaria vulgaris*	Whole province
Water hemlock, bulb-bearing	*Cicuta bulbifera*	Whole province
Water hemlock, northern	*Cicuta virosa*	Whole province
Water hemlock, spotted	*Cicuta maculate*	Whole province
Water hemlock, western	*Cicuta douglasii*	Whole province
Whitetop, hairy	*Cardaria pubescens*	Whole province
Whitetop, lenspod	*Cardaria chalepensis*	Whole province

Appendix B

Field Activity and Inspection Forms

Biosecurity Cleaning Record

Vehicle and Equipment Cleaning Field Log

Appendix B: Field activity and inspection forms

Agricultural Biosecurity Checklist

INSTRUCTIONS

1. Complete Agricultural Biosecurity Checklist (page 1). Required fields indicated with ' * '.
2. If Elevated Risk or recording multiple cleaning sites, see Equipment Cleaning Record (page 2).
3. Once complete, click 'Email' icon and send to AgriculturalBiosecurity@hydro.mb.ca (default email address).

Date of Visit*		Company (if not * MH)	
Name of Recorder*		Project ID, work order #, etc.*	
Reason for Visit*			

Name of Customer/Landowner (who authorized entry into property) *	
Date/time of Customer/Landowner Communication	
Details of Communication/Notification with Customer/Landowner *	
Did a biosecurity procedure already exist for the property? (Yes/No). If Yes please indicate additional steps required.	

Fill in at least one of the Location identifiers. *

Legal land location	
Project/Site Name	
GPS (start)	
GPS (end)	

Powerline ID:	Structure # (Start)	Structure # (End)

Biosecurity Cleaning Record								
Location Reference (min one entry required)	Elevated Risk Area? (See SOP)	Risk Level Modifier	Type	Cleaning Type	Disinfectan t			
Legal Land Description/ Structure # / Access ID /UTM Coordinates	Yes/No	Winter Condition s (WC)	Boots/tools, Vehicle, Equipment (if applicable include unit #)	Mechanical cleaning (M) Pressure Washing (P) No Cleaning Required (NC)	Virkon (V), Lysol (L) Accel (A) Synergize (S),	Name (Print)	Date YYYY-MM-DD	Comments

Once complete, send to AgriculturalBiosecurity@hydro.mb.ca

Appendix C

Environmental Management Practices Guides

CLEANING STATION ID

Description

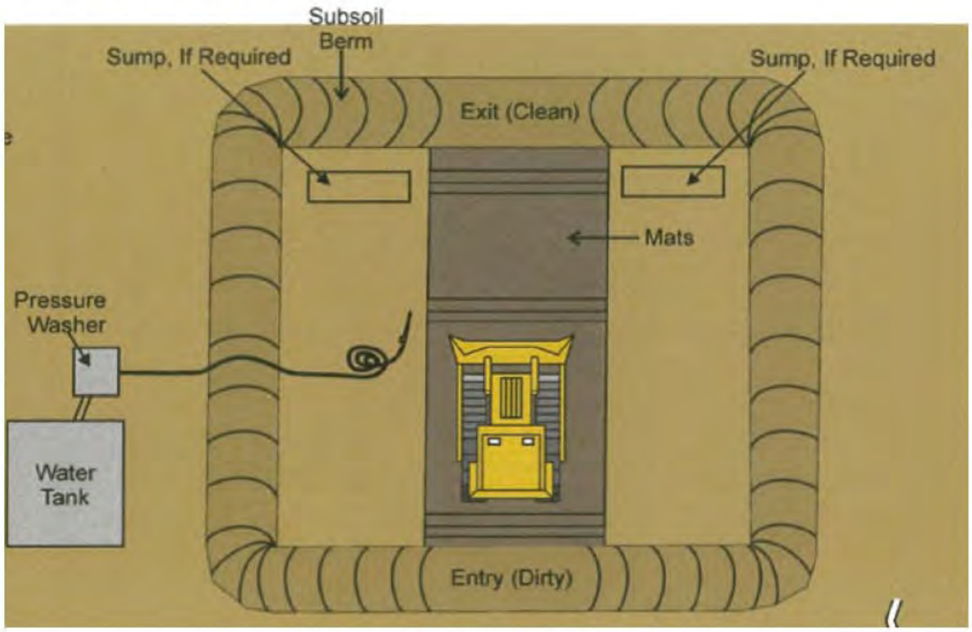
Cleaning Station: facilities that are located at designated Controlled Access Points or Transition Areas for the purposes of cleaning footwear, matting, vehicles and equipment of soil, manure, plant material and foreign matter

Wash Facility: facilities that are located outside of a controlled access zone and may be of two types: commercial wash facility or a washing facility developed by the contractor at a location and design that has been approved by Manitoba Hydro (MH)

Implementation Activities and Requirements

- To be established at all designated Controlled Access Points and Transition Areas identified in the latest version of the Biosecurity Management Plan Map Book
- Signage must be installed that describes cleaning requirements
- All Project staff must stop and review required cleaning requirements, implement required actions and initiate documentation requirements prior to entering a controlled access zone
- Cleaning Log Book entries must be completed for all pedestrian, matting, vehicles and equipment cleaning and/or inspection activities
- Sediment released from the washing process will be contained by berms or other containment to prevent surface run-off to another field or water course
- Only MH approved disinfectants are permitted to be used (See Disinfectants EMP)
- Sediment materials (dirt, water and disinfectant solution from cleaning activities) must be either buried on-site at a minimum depth of 2 m (requires written landowner permission and approval by MH) or, disposed of at an MH approved disposal facility
- Geotextile must be placed under matting or cleaning area to facilitate clean-up and disposed of at an MH approved disposal facility

Example Cleaning Stations



Cleaning Station Design

Disinfection at Cleaning Station

Compressed Air Cleaning Station at Controlled Access point

See Also

- Controlled Access Points/Transition Areas
- Disinfectants
- Risk Level Determination
- Cleaning Requirements
- Cleaning Standards

INSPECTION AND CLEANING REQUIREMENTS

ID

Description

Inspection and cleaning requirements are determined by accumulation of soil, manure, plant material or foreign matter on footwear, mats, vehicles and equipment and current risk level assigned to controlled access zone.

Implementation Activities and Requirements

- All Project staff must stop and review required cleaning requirements, implement required actions and fulfill documentation requirements prior to entering or exiting a controlled access zone
- Foot traffic may utilize disposable boot covers that are replaced/cleaned before entering additional controlled access zones
- Personnel cleaning the equipment should complete a visual inspection post cleaning for accumulated soil, manure, plant material or foreign matter prior to leaving the cleaning station
- Only MH approved disinfectants are permitted to be used (See Disinfectants EMP)
- Footwear, matting, vehicles are equipment are considered clean when they meet the cleaning standards (See Cleaning Standards EMP) as required by the current Risk Level assigned to the controlled access zone
- Manitoba Hydro Environmental Officer or designate determines if cleaning standards have been achieved

Steps for Inspection and Cleaning

Steps	Description
1- Inspection	• Inspect all footwear, matting, vehicles and equipment prior to exiting or entering a controlled access zone at designated controlled access points and transition areas for soil, manure, plant material or foreign matter
2- Rough Clean	• Remove clumps of soil, manure, plant material or foreign matter from mats, footwear, vehicle and equipment openings, tracks, tires and wheels using a hand scraper, shovel, broom or wire brush • This step in cleaning of mats, vehicles and equipment must occur on-site before leaving the controlled access zone to a Wash Facility (See Cleaning Station EMP)
3- Fine Clean	• Fine clean means high pressure water wash, high pressure air wash or high pressure steam wash. Wash matting, vehicles, and equipment paying extra attention to areas where soil, manure, plant material or foreign matter can accumulate (i.e., tires or undercarriage) • For hydrovac trucks, cleaning includes the inside of the tank and any implement in contact with soil • Prior to fine cleaning, matting, vehicles and equipment should receive a rough clean
4- Disinfectant Mist	• Use disinfectant misting as the final cleaning step when working in controlled access zones where the current risk rating is High • Spray footwear, tracks, openings, tires, wheels and implements that may come in contact with soil, manure, plant material or foreign matter with an approved disinfectant solution (See Disinfectants EMP) • Hydrovac truck cleaning includes disinfecting inside of the tank and any implement in contact with soil, manure, plant material or foreign matter • Prior to disinfecting. matting, vehicles and equipment should receive a fine clean

See Also

- Controlled Access Points/Transition Areas
- Disinfectants
- Risk Level Determination
- Cleaning Stations
- Cleaning Standards

BIOSECURITY RISK CLASSIFICATION ID

Description

Risks will be classified as Low or High, according to the definitions provided in Risk Classification Matrix. Winter Conditions (WC) is a risk level modifier implemented only when approved by Manitoba Hydro.

Implementation Activities and Requirements

- All Project staff must stop and review required cleaning requirements, implement required actions and fulfill documentation requirements prior to entering or exiting a controlled access zone
- Manitoba Hydro Environmental Officer or designate has final determination of risk level

Risk Classification Matrix

Biosecurity risk classification matrix

Biosecurity issue	Risk level		
	Nonfrozen soil	Frozen soil	Frozen, snow-covered soil
Agricultural lands where no weeds, soil borne crop diseases, manure spreading or active livestock settings have been identified that present a substantial risk to biosecurity	Low	WC[1] Low[2]	WC[1] Low[2]
Specific sites identified as Tier 1 Noxious weeds as defined in the Noxious Weeds Regulation.	High	High	Low
Specific sites identified as Tier 2 or 3 Noxious weeds as defined in the Noxious Weeds Regulations and present a substantial biosecurity risk that the project activities will transfer the identified issue from one area to another.	Low	Low	Low
Laboratory testing has indicated clubroot spores are present	High	WC[1] High[2]	WC[1] High[2]
Manitoba Hydro will designate an operation with an existing and established biosecurity management plan as High risk. Manitoba Hydro will strive to meet the existing farm level biosecurity measures in these instances.	High		
Manitoba Hydro will designate active livestock settings (e.g., ILOs, active grazing areas) as High risk.	High		
Agricultural lands on which manure has been spread.	High	High	WC[1] High[2]

Note 1: This risk level modifier only applies to activities that create **no** subsurface disturbance such as vehicle travel, inspection, surveying, etc.

Note 2: This risk level applies to activities that create subsurface disturbances such as grubbing, excavation, drilling, foundation installation, clearing, conductor stringing, etc.

See Also

- Controlled Access Points/Transition Areas
- Disinfectants
- Risk Level Determination
- Cleaning Stations
- Cleaning Standards

Appendix D

Cleaning Standards Assessment Guide

Appendix D: Cleaning standards assessment guide

BIOSECURITY MONITORING
CLEAN EQUIPMENT/VEHICLE GUIDELINE

Grade	Pass/Fail	Definition
1	Fail	No effort was made to clean the vehicle/equipment/footwear. Vehicle/equipment/footwear has clumps of mud and/or seeds attached to it. When travelling on public roadways, muddy tracks are left on the road. **No vehicles/equipment should be permitted to enter OR leave any site in this condition, regardless of Risk.*
2	Fail	Vehicle/equipment/footwear was mechanically cleaned but there are still clumps of mud and/or seeds attached. No disinfectant was used. *****At Low Risk site ONLY****, may be permitted to leave site for off-site cleaning, though no vehicles/equipment may enter site in this condition.*
3	Pass	Vehicle/equipment/footwear was mechanically cleaned, with no sign of clumping wet soil/seeds/debris remaining. Any small pockets of dirt/debris that cannot be removed have been disinfected. ****High Risk Site:** All vehicle/equipment surfaces that have come in contact with soil **MUST** be disinfected when exiting, to pass inspection.*
4	Pass	Vehicle/equipment/footwear is clean. No clumps of mud or seeds are present. ****High Risk Site:** All vehicle/equipment surfaces that have come in contact with soil **MUST** be disinfected when exiting, to pass inspection.*

When working in agricultural areas, all reasonable effort must be made to ensure that all equipment, vehicles and clothing going from one property to another is not transporting any invasive species or pathogens. Above is the scale that will be used by Manitoba Hydro to grade the cleanliness of vehicles, equipment and footwear entering and leaving work sites in agricultural or invasive species areas on the project.

BIOSECURITY MONITORING
CLEAN EQUIPMENT/VEHICLE GUIDELINE

Grade 1 (Fail)

-No effort made to clean vehicle; clumps of wet mud/seeds stuck to surfaces.

-No equipment/vehicles should be permitted to enter OR leave a site in this condition, regardless of Low or High Risk area.

BIOSECURITY MONITORING
CLEAN EQUIPMENT/VEHICLE GUIDELINE

Grade 2 (Fail)

-Mechanical cleaning, but still clumps of wet mud/seeds in wheel wells/tracks/boot treads. No disinfectant used.

-**At low risk site, may be permitted to leave site for off-site cleaning, though no vehicles/equipment may enter site in this condition.*

BIOSECURITY MONITORING
CLEAN EQUIPMENT/VEHICLE GUIDELINE

<u>Grade 3 (Pass)</u>

-Mechanical cleaning, with only minimal sign of dirt with no clumps/seeds/debris remaining. Pressure wash and/or disinfectant applied to any surfaces where dirt clumping remains.

-ALL vehicles/equipment leaving High Risk site MUST be disinfected upon exit.

BIOSECURITY MONITORING
CLEAN EQUIPMENT/VEHICLE GUIDELINE

Grade 4 (Pass)

-Equipment/Vehicle/Footwear is clean. No signs of soil/seeds/debris on any surfaces.

-All vehicles/equipment entering a job site should be at this level.





Appendix I

Erosion and Sediment Control Plan

Pointe du Bois to Whiteshell station 115kV Transmission Line (PW75)

Biosecurity Management Plan

June 2023

Prepared by Manitoba Hydro

Transmission & Distribution Environment and Engagement Department

Project Management Division

Preface

This document presents the Erosion and Sediment Control Plan (ESCP; the Plan) for the construction of the Pointe du Bois to Whiteshell station 115kV transmission line (the Project). It is intended to provide information and instruction to Contractors and Manitoba Hydro employees as well as information to regulators and members of the public. The Plan provides general considerations and guidance pertinent to erosion and sediment control during the development of the Project. More importantly it presents a Project-specific implementation plan and actions required to prevent and mitigate erosion and sedimentation as a result of construction of the Project. Inspection and compliance along with monitoring programs are described to confirm adherence to required actions including documentation and record-keeping. Environmental Management Practices guidance sheets are provided for the installation and maintenance of erosion and sedimentation control measures in the Appendices.

Manitoba Hydro employees and contractors are encouraged to contact the onsite Manitoba Hydro Environmental Inspector/Officer if they require information, clarification or support. Regulators and the Public are to direct any inquiries about this Plan to:

Manitoba Hydro
Transmission & Distribution Environment and Engagement
360 Portage Avenue
Winnipeg, MB
Canada R3C 0G8
1-877-343-1631

Projects@hydro.mb.ca

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Figures

Definitions

Erosion - occurs when energy (wind or water) is applied to a soil surface causing the detachment, suspension and transfer of soil particles from a stable mass.

Sedimentation – The process whereby the energy of wind or water carrying soil particles is reduced down to the point that those suspended particles are allowed to settle out and be deposited, creating a build-up of sediment at that location.

Deleterious – The federal *Fisheries Act* defines it as "Any substance that, if added to water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use of by man of fish that frequent that water" (Canadian *Fisheries Act*).

1.0 Introduction

Consistent with its corporate Environmental Management Policy, Manitoba Hydro has committed within the Pointe du Bois to Whiteshell (the Project) Construction Environmental Protection Plan to developing an Erosion and Sediment Control Plan (ESCP) as part of a larger suite of mitigation measures to minimize potential negative environmental and socio-economic effects. This document outlines the procedures to be employed by contractors to mitigate the potential for erosion and sediment transport during the activities related to transmission project construction. With an advance review of the project locations and topography, the Contractor can identify areas at risk of erosion during the different construction activities.

This document identifies some of the common erosion and sediment control (ESC) materials and environmental management practices. This document also includes detailed design drawings that indicate correct installation methods for ESC materials to help ensure effectiveness and reduce maintenance.

Note that the methods presented here are not exhaustive and alternative methods may be proposed by the Contractor but would require approval from a Manitoba Hydro Environmental Officer prior to implementation.

Manitoba Hydro's Environmental Protection Program (EPP) provides the framework for the delivery, management and monitoring of environmental and socio-economic protection measures that satisfy corporate policies and commitments, regulatory requirements, environmental protection guidelines and best practices, and input during the Public Engagement Process (PEP) and First Nation and Red River Metis Engagement Process (FNMEP). The Program describes how Manitoba Hydro is organized and functions to deliver timely, effective, and comprehensive solutions and mitigation measures to address potential environmental effects. This ESCP is a component of the EPP as illustrated in Figure 1.

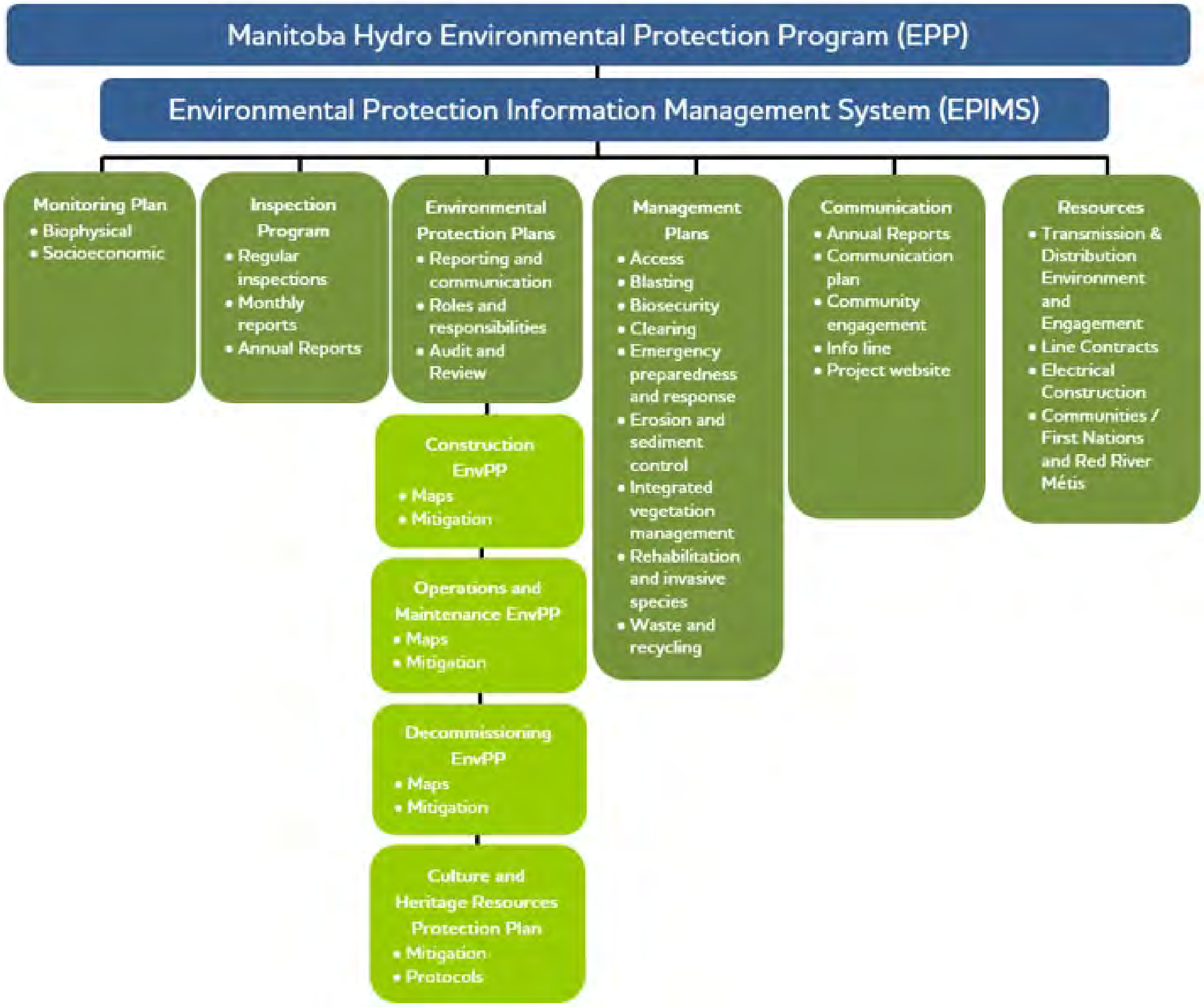


Figure 1: Transmission Environmental Protection Program

1.1 Commitment to environmental protection

Manitoba Hydro integrates environmentally responsible practices in all aspects of our business. Environmental protection can only be achieved with the involvement of Manitoba Hydro employees, consultants, contractors, Indigenous communities and organizations and the public at all stages of the Project from planning and design through construction and operational phases.

The use of an ESCP is a practical and direct implementation of Manitoba Hydro's environmental policy and its commitment to responsible environmental and social stewardship. It is a proactive approach to manage potential effects of access related to the construction of a new transmission line.

Manitoba Hydro is committed to implementing this ESCP and requiring Contractors to follow the terms of this and other applicable plans within the Environmental Protection Program.

1.2 Purpose and objectives

This Erosion and Sediment Control Plan is intended to be used as a reference document in the field, during construction activities to addresses sediment transport and erosion concerns while ensuring compliance with Manitoba Hydro's Construction Environmental Protection Plan requirements, industry best practices, and Provincial/Federal regulations and legislation. In order to effectively mitigate the potential effects of erosion and sedimentation due to construction activities, a variety of ESC measures are available for implementation. The appendix outlines standard erosion and sediment control techniques along with a description of the situations where each technique may be employed and directions for correct implementation. Should a contractor wish to deviate from the control techniques or implementation described in this document they must first obtain approval from a Manitoba Hydro Environmental Officer.

The objectives of this erosion and sediment control plan are as follows:

- To establish a process prior to the start of construction that can be used to identify erosion prone sites and where necessary, implement, monitor and maintain erosion and sediment controls. This process will meet regulatory requirements, industry standards and best practices with regards to ESC during construction activities.
- To provide guidance on the correct implementation and installation of erosion and sediment control measures.

1.3 Background

Construction activities associated with the Project will involve vegetation removal as well as disturbed soil/ground which may alter and increase water runoff in some areas. Excessive runoff has the potential to cause flooding as well as a rapid increase in natural erosion and sedimentation rates that, if left uncontrolled, can irreparably harm the environment and aquatic habitats.

Wind is not considered to be a major contributing factor to erosion on transmission construction projects due to the limited instances of exposed soil and the short term duration in which they are exposed. For this reason management practices controlling water erosion are the primary focus of this manual. While several of the water erosion control methods are also effective at reducing wind erosion, specific mitigations are addressed in the Erosion and Sediment Control Management Practices in Section 3.0.

1.4 Potential effects of erosion and sedimentation

The importance of erosion and sedimentation control is primarily to reduce the potential impact that erosion has on watercourses such as creeks, streams, rivers and lakes etc. Soil consists of many components, the majority of which are organic material, sand, silt and clay. It is the silt and clay that are the most damaging to watercourses as they are comprised of small particles that can be carried for long distances while suspended in water. Small silt and clay particles can cloud the water making it difficult for fish to find food, and also block sunlight reaching aquatic plants. When small silt and clay particles settle on the bottom they can smother fish and amphibian eggs. There is an added risk that eroded soil may carry hard metals, traces of petroleum product or other pollutants from land into a watercourse.

The effects of sedimentation in watercourses can be profound enough to be considered deleterious (harmful or damaging) to fish. Failure to prevent erosion and sedimentation of watercourses is considered a reportable offence under section 35 of the *Fisheries Act*.

1.5 Roles and responsibilities

This section outlines the major roles and responsibilities of those involved in the implementation of the Plan.

A summary of key roles and responsibilities is found in Table 1.

Table 1: Key roles and responsibilities

Role	Key responsibilities
Manitoba Hydro	• Approves ESC planning, design, implementation, inspection, monitoring, maintenance, operation, and decommissioning. • May delegate this responsibility to other design and construction professionals to construct/implement, maintain and inspect/monitor for the duration of the undertaking. • Signs agreements, approvals, permits and Authorizations to which compliance is legally binding. • Ensures ESC measures are installed, maintained or restored by the contractor. • Appoints an Environmental Inspector/Officer or delegate to confirm that regulatory criteria are being met by the ESCP. • The Manitoba Hydro Environmental Inspector/Officer or delegate will inspect erosion and sediment control measures to confirm effectiveness.
Construction Contractor	• Will communicate erosion and sediment control information/training to all project staff and will ensure a copy of the ESCP is available at the project site. • Responsible for installation, maintenance and decommissioning of erosion and sediment control installations to ensure continued effectiveness. • Confirm with an MH Environmental Inspector\Officer that regulatory criteria are being met by the ESCP. • Respond and act promptly to resolve if activities are not in compliance with the ESCP or any regulatory requirements. • Responsible for sourcing ESC materials and maintaining a sufficient readily available stockpile onsite. • Responsible for modifying and maintaining erosion and sediment control installations to ensure continued effectiveness through regular monitoring performed by their Environmental Representative. • Responsible to monitor and report to MH on ESC implementation effectiveness including any need for repair and maintenance. • Stabilize and re-vegetate disturbed areas as soon as practicable or where deemed necessary by Manitoba Hydro , rehabilitation is not to be deferred until construction is complete

2.0 Regulatory context

Federal and Provincial Acts and regulations govern activities that have the potential to cause harm to the environment. This erosion and sediment control plan will provide the contractor with a required process to mitigate erosion and sedimentation to be in compliance with Provincial/Federal regulations and legislation. One of the most pertinent Acts involving construction activities and erosion and sedimentation is the federal *Fisheries Act*.

The *Fisheries Act* prohibits serious harm to fish which is defined in the Act as "the death of fish or any permanent alteration to, or destruction of, fish habitat."

The purpose of the *Fisheries Act* is to protect the productivity of commercial, recreational and Aboriginal fisheries and it prohibits activities that deposit deleterious substances (damaging substances) of any type into water or that create conditions that allow deleterious substances to be deposited into water frequented by fish. Sediments are considered to have a deleterious effect on aquatic habitats.

Construction activities are required to take every precaution to prevent deposition of sediments into aquatic habitats and there is a duty to notify and take corrective action on any incidences of incidental deposition.

Manitoba Hydro staff and contractors must comply with all regulatory requirements relating to the construction of a project. Specific regulatory requirements for the Project may also be listed in regulatory work permits and/or Department of Fisheries and Oceans letters of advice/authorizations.

3.0 Implementation

The intent of this section is to provide implementation instructions to the Contractor. The key steps to implementing the plan are outlined below:

1) Erosion risk identification
2) Planning
3) General mitigation measures for susceptible construction activities
4) Specific erosion control measures
5) Specific sediment control measures

The implementation of the Plan utilizes a step-wise process; however, these steps will be undertaken at various times throughout the pre-construction and construction phases of the Project. The plan is founded on a principle of adaptive management meaning if aspects of the plan are found to require modifications for improved effectiveness or if new information becomes available (e.g., more effective control actions, pest outbreaks in the Project area) the Plan and actions will be updated.

3.1 Erosion risk identification

There are a number of different methods to be conducted by the Contractor including desktop evaluation, pre-construction surveys, and onsite evaluations that will be used to identify areas that are at risk of erosion. Contractors are required to plan ahead and have an understanding of what mitigations will be necessary.

3.1.1 Desktop evaluation

A desktop evaluation of aerial/satellite imagery as well available Geographical Information System (GIS) data will provide Contractors information on site conditions in the project right of way. Elevation or contour data of an area will help to identify the slope of elevation changes and drainage to determine where erosion risk may be higher. Soil information is also available to help understand where fine textured soil types are as they are at a higher risk from erosion.

3.1.2 On-site evaluation

The initial stage of construction involves clearing vegetation along a centerline down the middle of the transmission right of way. That initial clearing of the centerline allows access to areas prior to the remainder of clearing and construction activities.

Ground surveys will be completed by the Contractor when access is available that could identify areas that are at a higher risk of erosion or ground disruption.

There are numerous distinct construction activities for the development of a transmission project some of which have a higher susceptibility to cause erosion and sedimentation. These include:

- Vegetation clearing
- Earthworks and stock piles
- Draining and Dewatering
- Watercourse crossing

3.1.3 Weather

The effects of wet weather during construction activities can have a significant impact on ground conditions and can change otherwise stable soils into soils that are affected by erosion and sedimentation. The effects of wet weather during construction activities can have a significant impact on ground conditions and can change otherwise stable soils into soils that are affected by erosion and sedimentation. Freeze thaw cycles during the spring can also expose stable soils to an unstable condition overnight and throughout the day.

3.2 Erosion and sediment control management strategy

The Contractor will implement an erosion and sediment control management strategy that will focus on pre-planning, scheduling and preventing erosion as a result of its construction activities. If erosion is not preventable, mitigation measures that prevent sedimentation will be implemented.

3.2.1 Pre-construction planning

In many cases the need for erosion and sediment control can be avoided by considering erosion mitigation during the planning stages of a project or prior to construction activities. For instance, access routes should be planned to avoid steep grades, unstable soils and avoid close proximity to a watercourse or topography that could direct run-off to a watercourse. The Contractor must continuously review their planned construction activities and evaluate the need for ESC measures, while considering weather, soil conditions, identified environmentally sensitive sites within CEnvPP, and any newly disturbed areas for risk of erosion.

3.2.2 Scheduling

The contractor, when developing schedules for construction activities that have the potential to cause erosion and sedimentation, must consider seasonal climate, identified environmentally sensitive sites within CEnvPP, and any newly disturbed areas.

Including erosion and sedimentation as a consideration in the scheduling of activities, is the first step in preventing effects to the environment. Through the use of scheduling, construction activities that are required in erosion prone areas such as adjacent to watercourses can be mitigated by timing those activities during frozen or dry soil conditions. Where possible, work should be scheduled so that construction activities that remove vegetation or disrupt the soil surface happen in short duration before erosion control measures can be installed so that the amount of time soil surface is exposed is minimized.

3.3 General mitigation measures

General mitigation measures that are particular to preventing erosion and sedimentation during construction activities are found in the Construction Environmental Protection Plan, General mitigation tables:

- EI-3 Erosion protection and sediment control
- PC-1 Access roads and trails
- PC-2 Borrow pits and quarries
- PA-5 Draining
- PA-8 Grubbing
- PA-10 Stripping

3.4 Specific erosion control mitigation measures

Chosen erosion and sediment control measures should not be permanent in nature but designed with long term protection in mind (until re-vegetation takes place). Temporary ESC's are those that are in place during the construction phase, or a portion thereof, when exposed soils are vulnerable to erosion with nearby water courses at risk of sedimentation. Permanent solutions would only be considered under extraordinary circumstances and would require MH and regulatory approval.

Control of erosion and sedimentation is most efficient and cost effective when it can be recognized and prevented early. A basic understanding of the erosion and sedimentation processes will help with this early detection and application of mitigation measures and controls. Due to the varying conditions of the work site, the Contractor will be responsible for determining which protection measures should be installed in each work area in consultation with Manitoba Hydro. Table 2 below show examples of frequently employed erosion controls that are currently approved by MH for use by the Contractor(s).

Table 2: Erosion Controls

EROSION CONTROLS					
Method	Application		Location	Description	BMP
Vegetation retention and replacement	Flat Ground	Y	Any location with potential for exposed soil	Natural regeneration, seeding, planting, sodding	ID-EC_01
	Sloping Ground	Y			
	Stockpiles	Y			
	Ditches	Y			
Surface Cover	Flat Ground	Y	Any location of exposed soil, seeded or not	Organic- Weed free straw, mulch, natural fiber erosion control blankets. Inorganic- geotextile, sheeting, rock	ID-EC_02
	Sloping Ground	Y			
	Stockpiles	Y			
	Ditches	N			
Erosion Control Blankets	Flat Ground	Y	Exposed soil on flat or sloping ground, stockpiles and ditches	Variety of products manufactured into "blankets" placed tight to the ground in a matrix to cover soil and reduce surface erosion	ID-EC_03
	Sloping Ground	Y			
	Stockpiles	Y			
	Ditches	Y			
Impermeable Sheeting	Flat Ground	Y	Large areas of exposed soil, steep terrain, stockpiles	Impermeable sheeting (Polyethylene plastic, or tarps) prevents impact and saturation of soil from rainfall	ID-EC_04
	Sloping Ground	Y			
	Stockpiles	Y			
	Ditches	Y			
Organic Fiber Rolls (Wattles)	Flat Ground	N	Steep slopes, stepped terraces	Rolls of organic material (usually straw) that reduce erosion by reducing slope and the energy of overland flow	ID-EC_05
	Sloping Ground	Y			
	Stockpiles	N			
	Ditches	N			
Ditch Check Dams	Flat Ground	N	For use on drainage ditches or large diversions but not natural watercourses	Decreases the grade and water flow velocities	ID-EC_06
	Sloping Ground	N			
	Stockpiles	N			
	Ditches	Y			
Water Diversion	Flat Ground	N	Areas with large amount of exposed soil, worksite or stock pile	Diversion ditching or berms to direct overland flow around a worksite	ID-EC_07
	Sloping Ground	Y			
	Stockpiles	Y			
	Ditches	Y			
Matting	Flat Ground	Y	Flat ground at risk of erosion or	Diversion ditching or berms to direct overland flow around a worksite	ID-EC_08
	Sloping Ground	N			
	Stockpiles	N			
	Ditches	N			
Wind Erosion	Flat Ground	Y	Any location with exposed soil	Watering the surface, using impermeable sheeting (Polyethylene plastic, or tarps) or any surface cover	ID-EC_09
	Sloping Ground	Y			
	Stockpiles	Y			
	Ditches	Y			

3.5 Specific sediment control mitigation measures

It is important to understand that sedimentation controls themselves are only employed as a second line of defence. Sedimentation controls are designed to provide a place for water to slow down and allow the particles to be deposited that the primary erosion controls were unable to prevent. Sediment fencing does not "filter" the water but rather are meant to slow down the water and allow fine soil particles or other potentially deleterious materials to settle behind it. Even perfectly constructed sediment controls will not be sufficient if a construction site lacks adequate erosion controls. Sediment controls are most effective under low input flow conditions. Listed in Table 3 below are examples of frequently employed sediment controls that are currently approved by MH for use by the Contractor(s).

Table 3: Sediment Controls

SEDIMENT CONTROLS					
Method			Application	Description	BMP
Sediment fencing	Flat Ground	Y	Anywhere low flow runoff is a concern and retention of sediment	Geotextile fabric, buried at the bottom and suspended vertically by wooden stakes	ID-SC_01
	Sloping Ground	Y			
	Stockpiles	Y			
	Ditches	Y			
Sediment Retention Berm	Flat Ground	Y	Anywhere low flow runoff is a concern and retention of sediment	Constructed of rock, wood chips, compost, soil and topsoil or similar materials	ID-SC_02
	Sloping Ground	Y			
	Stockpiles	Y			
	Ditches	Y			

3.6 Education and training

Education and training form a critical component of the implementation plan. Manitoba Hydro and the contractor(s) each have responsibility to ensure personnel are appropriately trained to carry out their role in the prevention of erosion and sedimentation, and that proper documentation is being conducted throughout the Project. Manitoba Hydro has prepared Erosion and Sediment Control Environmental Practices found in appendices which guides the implementation of controls, for use by Project field staff.

Manitoba Hydro will hold a Contractor Environmental Pre-Construction Requirements Orientation meeting to review Project specifics and key environmental requirements with all of its Contractors at a supervisory level. A summary of this Plan, implementation requirements, roles and responsibilities, and Manitoba Hydro's expectations will be presented at that time.

Manitoba Hydro will also hold a separate pre-construction environmental meeting to provide the opportunity for Manitoba Hydro and Contractor environmental representatives to discuss Project specifics and environmental requirements in more depth.

It is a mandatory requirement that all contractor(s) provide Project-specific erosion and sedimentation control orientation training to all personnel involved in construction activities susceptible to erosion and sedimentation or involved in supervision of those personnel (i.e., project manager, supervisors) prior to starting work. This training will present the objectives of the plan, roles and responsibilities, erosion and sedimentation issues and prevention actions, and documentation requirements. A training attendance record must be maintained by the contractor(s) and submitted to Manitoba Hydro Environmental Inspector/Officer or delegate, for upload to the Environmental Protection Information Management System.

3.7 Monitoring and maintenance

Monitoring, inspection and adaptive management are necessary to ensure the effectiveness of the plan. It provides confirmation of proper implementation and effectiveness of erosion and sediment control measures. Monitoring will take place until the concern of erosion and sedimentation no longer exists. It is the duty of the Contractor to ensure that the erosion and sediment control measures are properly installed, well maintained and functioning as intended.

The effectiveness of the ESCP depends directly on the frequency of monitoring and what actions are taken to address any failures that may occur. A tracking document will be maintained by the Contractor's Environmental Representative indicating location, timing of construction activities and reason for implementation. This document will be submitted to Environmental Protection Information Management System (EPIMS) to ensure that all installed ESCP measures can be tracked for continued maintenance, monitoring and decommissioning\removal.

Components of monitoring, maintenance and decommissioning to be conducted by the Contractor will include:

- A monitoring schedule will be drawn up to include times, areas and individual(s) responsible for monitoring. (Will be included in the Contractor's environmental inspection reports submitted to MH).
- Inspect and assess effectiveness of ESC control structures regularly and after storms, and repair, replace or upgrade, as required. If shortcomings are identified, the contractor must take immediate action to restore their proper function.

- All employees are required to report any ineffective erosion and sedimentation control measures or those in need of repair.
- Sediment control measures may require accumulated sediment to be removed to function properly or to not overload the structure. It is important to remove sediment from the area completely and take it to landfill or relocated where it is no longer at risk of being washed into a watercourse.
- Any maintenance of ESC should be recorded and reported to MH to help identify failure prone sites or areas requiring reinforced measures.
- Weather forecasts should be monitored as weather events have the potential to play a part in erosion sedimentation risk during construction activities.
- During inactive construction periods, where the site is left alone for 30 days or longer monthly monitoring should be conducted.

3.7.1 ESCP removal

The Contractor will stabilize sites as soon as feasible after construction activities causing surface disruptions are complete. The site will then be assessed and re-vegetated in accordance with the Rehabilitation and Invasive Species Management Plan. Temporary erosion and sediment control measures will remain intact and maintained until:

- The MH Environmental Inspector/Officer determine that there are no longer erosion and sedimentation concerns in an area, or
- Either natural vegetation is established and stable or permanent measures are established.

Although work may be conducted in the winter months, care must be taken to ensure that materials are not left to degrade the surrounding waterways when the spring thaw arrives. When sediment control systems are removed by the Contractor, accumulated sediment must be removed and taken to landfill or relocated where it is no longer at risk of being washed into a watercourse.

3.7.2 Environmental shutdown/ contingency measures

The contractor has a responsibility to recognize and prevent working in adverse weather conditions that would increase erosion potential and overwhelm designed erosion and sediment control systems. Construction activities in areas with high erosion risk should be scheduled to take place during favourable weather conditions. Activities should be stopped in these areas when they have encountered periods of significant melt or prolonged precipitation and surface runoff cannot be sufficiently managed. Conditions that cannot be mitigated through contingency measures in areas of high erosion risk will require a shutdown of activities until conditions improve or there is modification of work practices.

Suitable work conditions will be established and agreed upon between the Contractor and Manitoba Hydro. Work modification or weather shut down to mitigate erosion and sedimentation may be considered if:

- During extended periods of adverse conditions (for rain is considered greater than 5 mm of rain in a 24 hour period)
- more than 50 mm of rain/5 cm of wet snow in the preceding 5 days; or
- the forecast calls for more than 50% certainty of 5 mm of rain/or 5 cm of wet snow in the next 24 hours
- If extreme wet weather conditions result if erosion is resulting in sedimentation of adjacent waterbodies due to compromised erosion control measures.

3.7.3 Environmental shutdown

Should a weather shutdown be deemed necessary it will be communicated to the Contractor in writing through the MH Line Contracts representative. Once the shutdown is in place, the Contractor may propose Work Modifications to Manitoba Hydro that prevent further damage or employ mitigation measures. Once conditions improve or changes are approved by Manitoba Hydro the weather shut-down will be released by Manitoba Hydro. Some of the possible work modifications include: placement of matting, geotextile installation or change of work hours (working in the morning with frozen ground conditions).

3.7.4 Contingency measures

Should an extreme weather event result in a breach of existing erosion and sediment controls and sediment laden water is able to flow and reach a watercourse the following contingency measures may be employed by the Contractor to mitigate the breach:

- Install additional sediment fencing, or construct a containment berm to create a containment area for runoff and prevent it flowing to watercourses and wetlands.

- Excavate a cross ditch or diversion berm to divert water away from watercourses and wetlands and into a vegetated area, sump or containment area.
- Place sandbags to raise the height of banks, preventing flooding of nearby areas or of run-off into watercourses.

4.0 Environmental management practices

Below is a list of environmental management practices used for sediment and erosion control. An appendix is provided for each that provides the description, application, implementation and installation of each.

4.1 Erosion controls

- EC_01 Vegetation Retention and Replacement
- EC_02 Surface Cover
- EC_03 Erosion Control Blankets
- EC_04 Impermeable Sheeting
- EC_05 Organic Fibre Rolls (Wattles)
- EC_06 Ditch Check Dams
- EC_07 Water Diversion
- EC_08 Timber Matting
- EC_09 Wind Erosion Control

4.2 Sediment controls

- SC_01 Sediment Fencing
- SC_02 Sediment Retention Berm

5.0 References

Manitoba Stream Crossing Guidelines For The Protection of Fish and Fish Habitat (DFO and MNR 1996). Available at: https://www.gov.mb.ca/waterstewardship/fisheries/habitat/sguide.pdf.

Minister of Justice. 1985. *Fisheries Act*. Available at: http://laws-lois.justice.gc.ca/PDF/F-14.pdf.

Appendix A: EC_01 Vegetation Retention and Replacement

Appendix B: EC_02 Surface Cover

Appendix C: EC_03 Erosion Control Blankets

Appendix D: EC_04 Impermeable Sheeting

Appendix E: EC_05 Organic Fibre Rolls (Wattles)

Appendix F: EC_06 Ditch Check Dams

Appendix G: EC_07 Water Diversion

Appendix H: EC_08 Timber Matting

Appendix I: EC_09 Wind Erosion Control

Appendix J: SC_01 Sediment Fencing

Appendix K: SC_02 Sediment Retention Berm

Appendix A

EC_01 Vegetation Retention and Replacement

Description

Retention- Retain as much vegetation as possible for as long as possible as it naturally reduces erosion potential. Vegetation reduces the energy of wind or water on the soil surface, lessening its impact. Vegetation also extends the amount of time water is in contact with the soil, allowing more time for absorption rather than it flowing across the surface. It also naturally reduces the sediment load of overland flow by reducing the energy of water and wind, providing an opportunity for soil particles to settle out.

Replacement- Areas disturbed by construction activities may have areas of exposed soil. Once assessed these areas will likely require seeding to aid natural re-vegetation (hydro-seeding, broadcast seeding, hand seeding, transplanting). Seeding of disturbed areas should be completed as soon as possible after construction activities or travel has stopped in each work area. Areas that have steeper slopes prone to producing sheet flow run off may require erosion control blankets to help stabilize the soil and protect seed while it establishes. See below for more information on seeding design best practice.

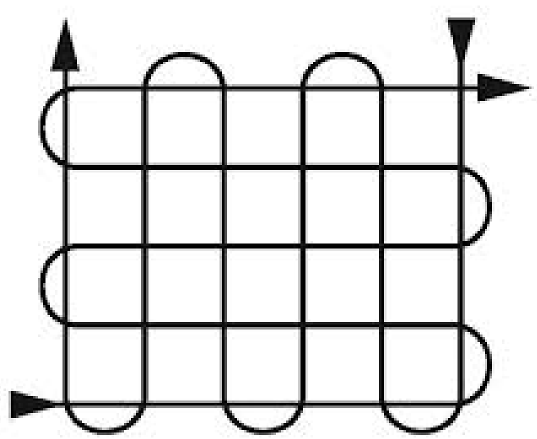
Application

Flat Ground	Y	Any location with potential for exposed soil
Sloping Ground	Y	
Stockpiles	Y	
Ditches	Y	

Implementation

Seeding- Several application methods are acceptable for seeding (Hand Broadcast, Hand-operated rotary seeders, cyclone seeders). Other methods such as drill seeding and Hydraulic seeding may be appropriate. Refer to the "REHABILITATION AND INVASIVE SPECIES MANAGEMENT PLAN for MANITOBA HYDRO TRANSMISSION PROJECTS" for direction on selecting the appropriate seed mix, seeding method and rates and other important considerations for an area. Please refer to installation diagram below for criss-cross seeding pattern used when seeding by hand.

Installation



Criss-cross seeding pattern helps to ensure adequate and even distribution of seed.
Diagram credit: https://www.seedsuperstore.com/how-to-plant-new-lawn/

References

- REHABILITATION AND INVASIVE SPECIES MANAGEMENT PLAN for MANITOBA HYDRO TRANSMISSION PROJECTS March 2016

Also See

- ID-EC_02 Surface Cover
- ID-EC_03 Erosion Control Blankets

Appendix B

EC_02 Surface Cover

Photo Credit: https://www.todayshomeowner.com/benefits-of-spreading-straw-or-mulch-over-grass-seed/

Description

The most effective long term erosion control is to establish vegetation, it is often necessary to protect the soil surface while this is occurring. Covering the soil surface controls erosion by buffering the impact rainfall which protects the surface and seeds until vegetation can establish. Biodegradable materials such as weed free straw (not hay), organic mulch can be used for cover on gentle slopes, where natural fibre erosion control blankets can be used on steeper slopes. Inorganic materials such as geotextile, impermeable sheeting can also be used temporarily but will have to be removed prior to re-vegetating.

Application

Flat Ground	Y	Any location with potential for exposed soil, seeded or not
Sloping Ground	Y	
Stockpiles	Y	
Ditches	N	

Installation

Straw: Weed free straw bales can be broken up and spread over the surface to cover it until vegetation is established, or it can be blown on by machine. Weed free straw must be provided by a local source approved by an MH Environmental Officer. The depth of the spread straw is important to its function.

VOI Training Group’s Erosion and Sediment Control Practitioner (ESCP) Participant’s Manual provides the following recommended specification for spreading straw:

“If site **will be seeded** and straw is a temporary mulch to control soil erosion until a stabilizing vegetation develops:
-Place/apply straw evenly in a 20-40 mm thick layer.
Bulk application rate is 3300 to 4500kg/ha.
Straw should cover 80 to 90% of the soil surface.

If site **will not be seeded** and straw is a temporary mulch to control soil erosion:
-Place/apply straw evenly in a 40-60 mm thick layer.
Bulk application rate is 4500 to 6700kg/ha.
Straw should cover >90% of the soil surface.”

Wood chips: Typically sourced through project mulching operations. While wood chips are resistant to movement and is good erosion protection, caution should be used as dense applications can inhibit subsequent vegetation establishment.

Clearing debris: Tree tops, branches and limbs from clearing operations in the area can be manually spread, covering and protecting the soil surface. This method has the additional benefit of potentially providing a seed source to aid in natural regeneration of vegetation.

References

- REHABILITATION AND INVASIVE SPECIES MANAGEMENT PLAN for MANITOBA HYDRO TRANSMISSION PROJECTS March 2016
- VOI Training Group's Erosion and Sediment Control Practitioner (ESCP) Participant's Manual

Also See

- ID-EC_01_VegRetention And Replacement
- ID-EC_03_Erosion Control Blankets
- ID-EC_04_Impermeable Sheeting

Appendix C

EC_03 Erosion Control Blankets

EROSION CONTROL BLANKETS ID–EC_03

Description

Applied to flat or sloping ground, in drainage ditches (not fish bearing) or over stock piles to provide temporary erosion protection allowing permanent vegetation to be established. These products typically consist of a biodegradable material that is sandwiched between a netted material to form a “blanket” and supplied in rolls. These rolls are then installed tight to the ground in a matrix protecting the surface. Produced from a wide range of materials that are either biodegradable, photo-degradable, or designed for permanent long term use. On Manitoba Hydro projects only products that are %100 biodegradable will be accepted for use. Biodegradable products are considered to be temporary as they will naturally decompose and permanent vegetation will be able to establish through it.

Application

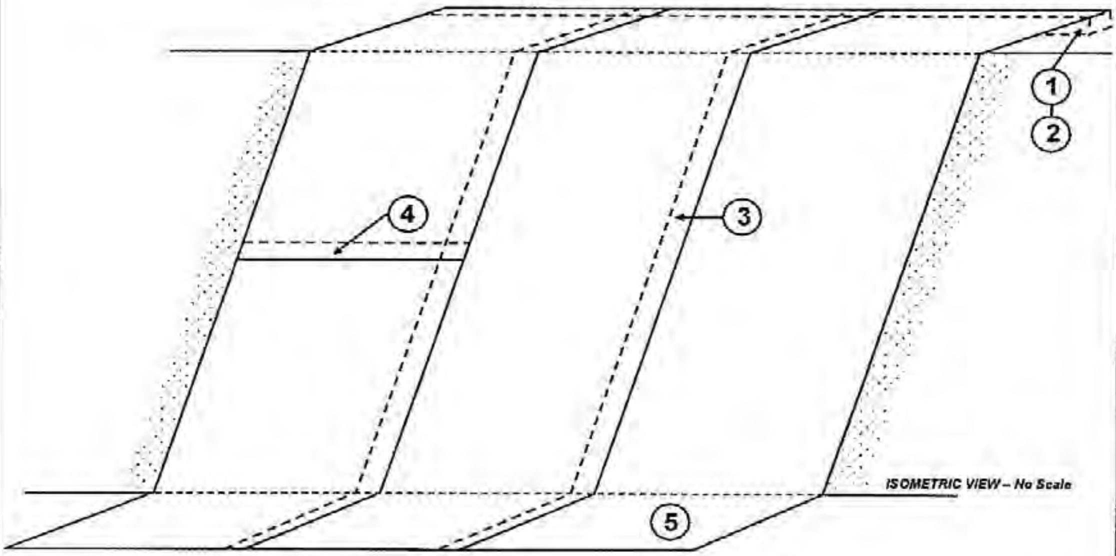
<table>
<tr><td>Flat Ground</td><td>Y</td><td rowspan="4">Exposed soil on flat or sloping ground, stockpiles and ditches</td></tr>
<tr><td>Sloping Ground</td><td>Y</td></tr>
<tr><td>Stockpiles</td><td>Y</td></tr>
<tr><td>Ditches</td><td>Y</td></tr>
</table>

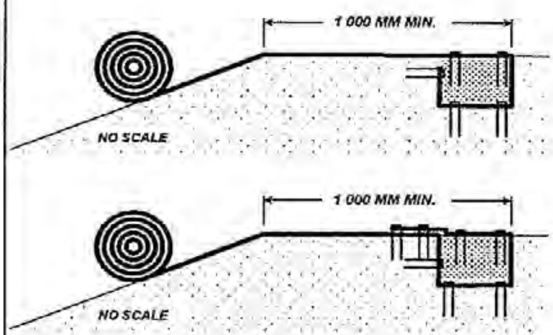
Implementation

Has shown to be very effective at reducing surface soil erosion if installed correctly. Loose weave blankets should be used to allow for vegetation to regenerate through it while preventing wildlife becoming trapped or entrained in the netting. Can be used for erosion protection on a variety of locations, to protect stockpiles and used in conjunction with other erosion and sediment control products

Installation

Weight and peg erosion control blankets so that blankets are in full contact with ground; spaces and gaps under blankets will result in increased erosion rendering this measure ineffective.
The following installation instructions should be followed in the absence of manufacturer's installation instructions. VOI Training Group's Erosion and Sediment Control Practitioner (ESCP) Participant's Manual provides the following two diagrams provide recommended specification for installing Erosion control blankets:

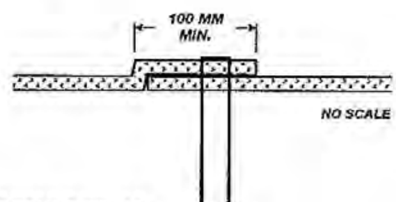




① & ② TOP SLOPE ANCHOUR TRENCH

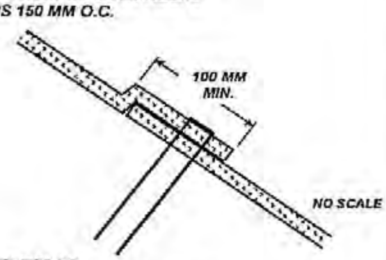
1. EXCAVATE 300 MM X 200 MM TRENCH
2. LAY RECP THROUGH TRENCH
3. STAGGERED ANCHOURS 300 MM O.C. IN TRENCH
4. BACKFILL & LIGHTLY COMPACT FILL
5. SEED / SOIL APPLY AMENDMENTS
6. STAGGERED ANCHOURS 300 MM O.C. AT SURFACE

NOTES:
1. PREPARED SOIL SURFACE SHOULD BE RELATIVELY SMOOTH (NO SHARP DEPRESSIONS OR HUMMOCKS).
2. REMOVE ALL MATERIALS THAT MAY PREVENT RECP CONTACT WITH THE SOIL SURFACE.
3. APPLY TOPSOIL IF SPECIFIED OR AVAILABLE.
4. SEED AREA WITH SPECIFIED SEED MIXTURE AT SPECIFIED SEEDING RATE. APPLY SOIL AMENDMENTS, IF PRESCRIBED.
5. INSTALL RECP WORKING DOWNSLOPE. ENSURE RECP IS NOT STRETCHED OR UNDER TENSION. RECP MUST CONFORM TO SOIL SURFACE.
6. DO NOT WALK ON RECP DURING OR FOLLOWING INSTALLATION.
7. RECP SHOULD NOT BE INSTALLED ACROSS SLOPE.
8. INSTALL SUFFICIENT ANCHOURS TO MAINTAIN RECP CONTACT WITH SOIL AND PREVENT RECP DISPLACEMENT BY WATER / WIND.
9. ANCHOR DENSITY SHOULD BE DETERMINED BY SITE SPECIFIC CONDITIONS. CONSIDER GENERIC ANCHOR DENSITY / SPACING RECOMMENDATIONS TO BE MINIMUM ANCHOURING REQUIREMENT.
10. CONSULT QUALIFIED PROFESSIONAL REGARDING SITE-SPECIFIC RECP SELECTION AND INSTALLATION.



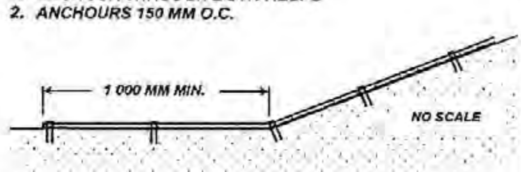
③ SIDE SEAM OVERLAP

1. ANCHOUR THROUGH BOTH RECPS
2. ANCHOURS 150 MM O.C.



④ END ROLL OVERLAP

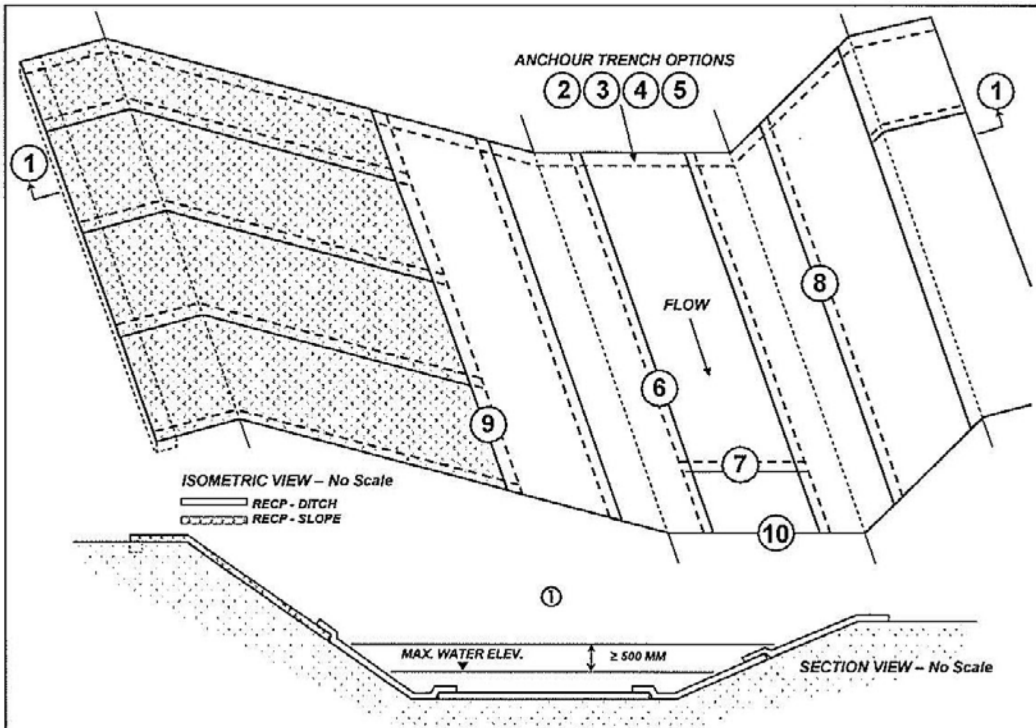
1. ANCHOUR THROUGH BOTH RECPS
2. ANCHOURS 150 MM O.C.

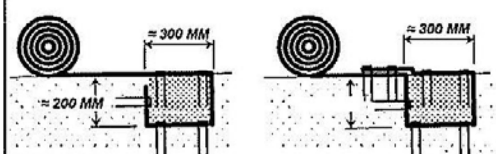


⑤ BOTTOM OF SLOPE TERMINATION

1. ANCHOURS 150 MM O.C. AT TERMINAL END OF RECP
2. ANCHOURS 150 MM O.C. AT SLOPE TRANSITION

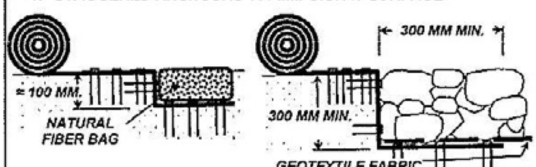
ROLLED EROSION CONTROL PRODUCT OPEN SLOPE APPLICATIONS





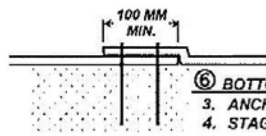
② & ③ - ANCHOUR TRENCH FOR ECB (ONLY) RECPS

1. STAGGERED ANCHOURS 300 MM O.C. IN TRENCH
2. BACKFILL & LIGHTLY COMPACT FILL
3. SEED / APPLY AMENDMENTS
4. STAGGERED ANCHOURS 150 MM O.C. AT SURFACE



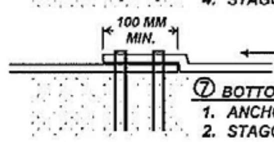
④ & ⑤ ANCHOUR TRENCH FOR ECB & TRM RECPS

1. STAGGERED ANCHOURS 300 MM O.C. IN TRENCH
2. INSTALL NATURAL FIBER BAGS FILLED WITH SEED-INNOCULATED COARSE COMPOST (Left) or FABRIC AND ROCK (Right – See EC BMP – ROCK-LINED DITCH)
3. STAGGERED ANCHOURS 150 MM O.C. AT SURFACE



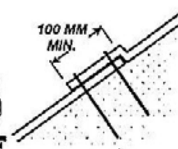
⑥ BOTTOM SIDE-SEAM OVERLAP

3. ANCHOUR THROUGH BOTH RECPS
4. STAGGERED ANCHOURS 150 MM O.C.



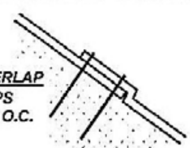
⑦ BOTTOM END-SEAM OVERLAP

1. ANCHOUR THROUGH BOTH RECPS
2. STAGGERED ANCHOURS 150 MM O.C.



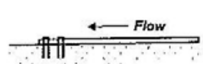
⑧ SLOPE SIDE-SEAM OVERLAP

1. ANCHOUR THROUGH BOTH RECPS
2. STAGGERED ANCHOURS 150 MM O.C.



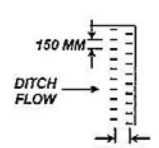
⑨ SLOPE RECP TO DITCH RECP OVERLAP

1. ANCHOUR THROUGH BOTH RECPS
2. STAGGERED ANCHOURS 150 MM O.C.



⑩ RECP TERMINATION

1. 2 ROWS ANCHOURS 150 MM O.C.
2. ANCHOUR CLOSE TO RECP EDGE



RECP SEAM & TERMINATION ANCHOUR PATTERN

1. 2 ROWS ANCHOURS 150 MM O.C.
2. ALIGN ANCHOURS WITH FLOW

PLAN VIEW

NOTES:

1. SOIL SURFACE SHOULD BE RELATIVELY SMOOTH.
2. REMOVE ALL MATERIALS THAT MAY PREVENT RECP CONTACT WITH THE SOIL SURFACE.
3. APPLY TOPSOIL IF SPECIFIED OR AVAILABLE.
4. SEED. APPLY SOIL AMENDMENTS (IF PRESCRIBED).
5. INSTALL RECP WORKING DOWNDITCH. ENSURE RECP IS NOT STRETCHED OR UNDER TENSION. RECP MUST CONFORM TO SOIL SURFACE.
6. INSTALL SUFFICIENT ANCHOURS TO MAINTAIN RECP CONTACT WITH SOIL AND PREVENT RECP DISPLACEMENT BY WATER.
7. DO NOT WALK ON RECP DURING/AFTER INSTALLATION.
8. CONSULT QUALIFIED PROFESSIONAL REGARDING SITE-SPECIFIC RECP SELECTION AND INSTALLATION.

ROLLED EROSION CONTROL PRODUCT DITCH/CHANNEL APPLICATIONS

References

- VOI Training Group's Erosion and Sediment Control Practitioner (ESCP) Participant's Manual

Also See

- ID-EC_01_Vegetation Retention And Replacement
- ID-EC_02_Surface Cover

Appendix D

EC_04 Impermeable Sheeting

Photo Credit: VOI Training Group's Erosion and Sediment Control Practitioner (ESCP) Participant's Manual

Description

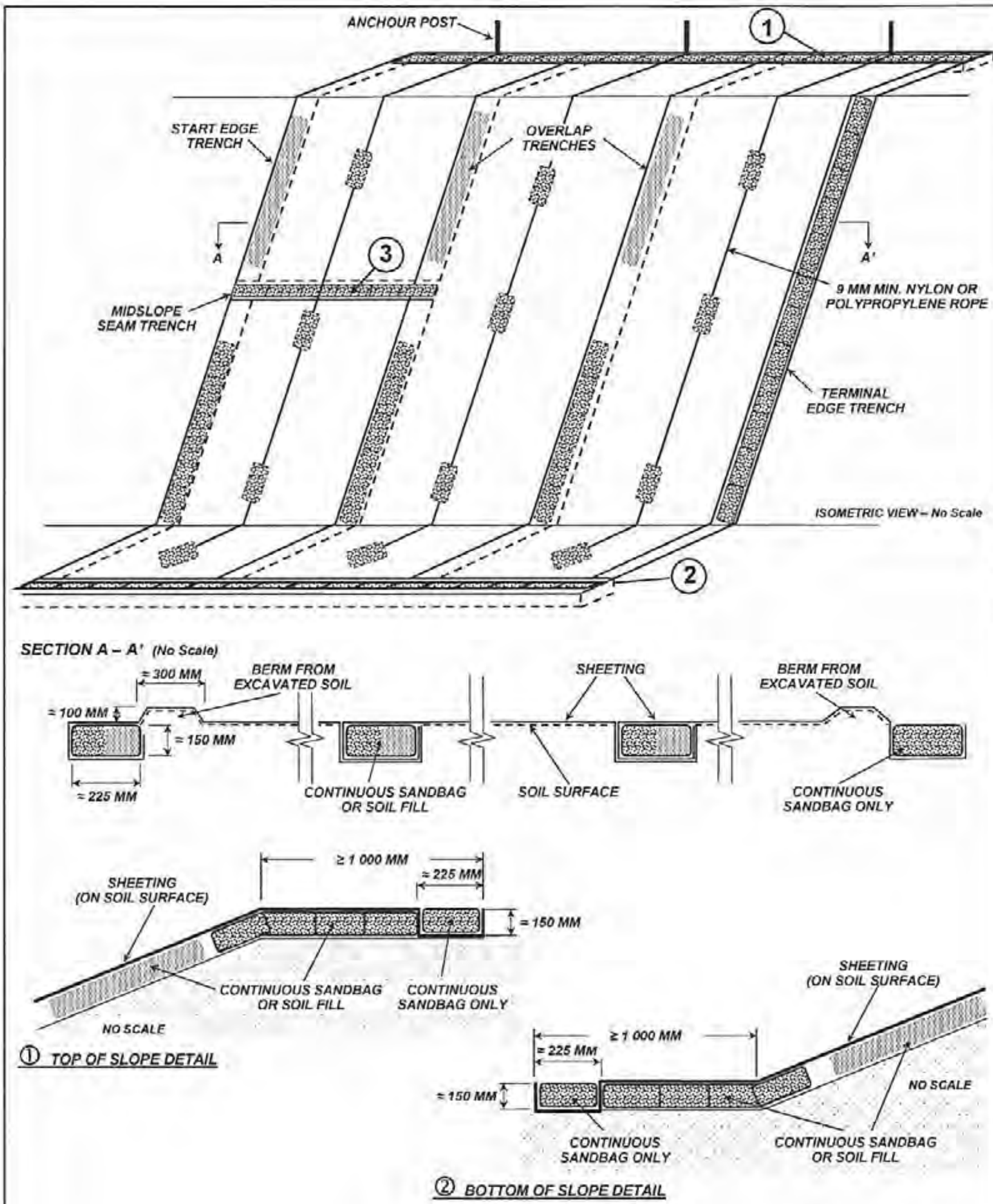
Impermeable sheeting can be used to cover erosion prone areas that require immediate and temporary short term protection, such as a stock pile or erodible soil prior to use or re-vegetation. Typically polyethylene (plastic) sheets or impermeable tarps which will later be removed and reused or recycled after use.

Implementation

Used for short term protection from erosion, and can be applied in most applications. Caution has to be exercised when using this method as the downslope side of the impermeable sheeting can receive high velocity and concentrated flows resulting in erosion. Precautions may have to be taken to prevent undercutting or increased erosion at the downslope extent of the sheeting.

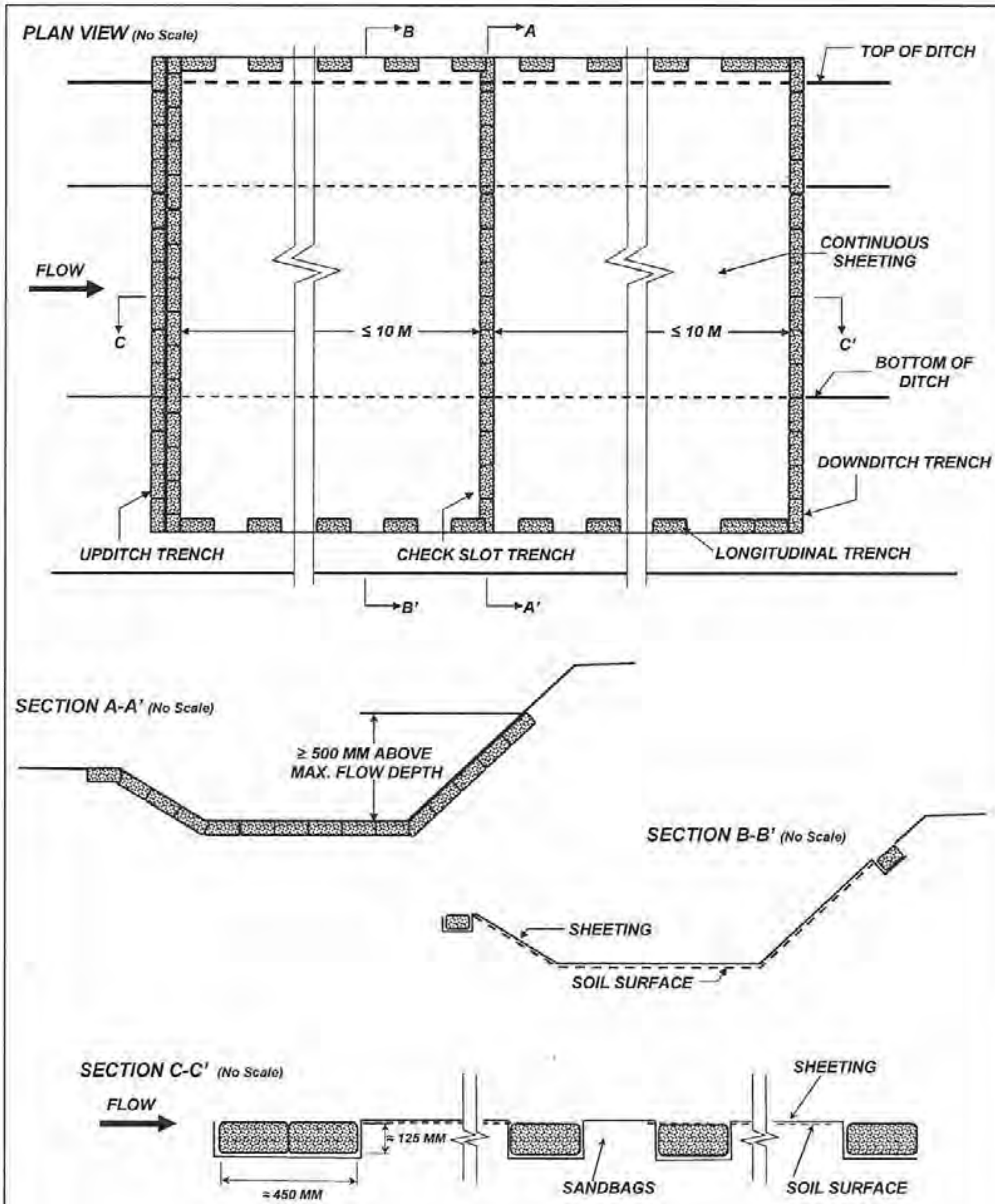
Application

Flat Ground	Y	Large areas of exposed soil, steep terrain, stockpiles
Sloping Ground	Y	
Stockpiles	Y	
Ditches	Y	



NOTES:
1. SOIL SURFACE SHOULD BE FREE OF DEBRIS THAT CAN ABRADE OR PUNCTURE SHEETING.
2. USE CONTINUOUS SANDBAGS FOR TOP, BOTTOM, TERMINAL EDGE AND MIDSLOPE SEAM TRENCHES.
3. USE CONTINUOUS SANDBAGS FOR SLOPE TRENCHES IF BACKFILL SOIL WILL SLIDE DOWN TRENCH DURING BACKFILLING AND DISPLACE SHEETING.
4. BACKFILL OR PLACE SANDBAGS IN SLOPE TRENCHES STARTING FROM BOTTOM OF SLOPE.
5. DO NOT WALK ON SHEETING DURING OR AFTER INSTALLTION.
6. PLACE SUFFICIENT SURFACE WEIGHTS.
7. FIGURE IS PROVIDED FOR REFERENCE ONLY. CONSULT QUALIFIED PROFESSIONAL FOR SITE-SPECIFIC DESIGN.

IMPERMEABLE SHEETING OPEN SLOPE APPLICATIONS



NOTES:

1. SOIL SURFACE SHOULD BE FREE OF DEBRIS THAT CAN ABRADE OR PUNCTURE SHEETING.
2. UNDERLAY SHEETING WITH NON-WOVEN GEOTEXTILE IF PUNCTURING OR ABRASION OF SHEETING IS A CONCERN.
3. FILL SANDBAGS WITH SUITABLE MATERIAL THAT WILL NOT CONTRIBUTE TO SEDIMENT LOADING OF RUNOFF IN DITCH.
4. USE CONTINUOUS SANDBAGS FOR UPDITCH, DOWNDITCH AND CHECK SLOT TRENCHES.
5. USE CONTINUOUS OR DISCONTINUOUS SANDBAGS FOR LONGITUDINAL TRENCHES.
6. ENSURE ALL TRENCHES ARE RECTANGULAR IN SECTION TO STABLIZE PLACED SANDBAGS.
7. CHECK SLOT SPACING ≤ 10 M.
8. DO NOT WALK ON SHEETING DURING OR AFTER INSTALLTION.
9. FIGURE IS PROVIDED FOR REFERENCE ONLY. CONSULT QUALIFIED PROFESSIONAL FOR SITE-SPECIFIC DESIGN.

IMPERMEABLE SHEETING DITCH/CHANNEL APPLICATIONS

References

- VOI Training Group's Erosion and Sediment Control Practitioner (ESCP) Participant's Manual

Also See

- ID-EC_02_Surface Cover

Appendix E

EC_05 Organic Fibre Rolls (Wattles)

Photo credit: http://www.earth-savers.com/

Description

Organic fibres (straw, woodchips etc.) are encased in a photodegradable plastic net casing that form a tube or roll used for erosion control but sediment control as a secondary use. Installed perpendicularly across a slope it reduces erosion by shortening the slope length by providing grade breaks. They are also effective at slowing flow velocity of overland flow and retaining sediment that accumulates behind the roll instead of migrating down slope. These locations also help to retain seed and other organics that would otherwise be washed away.

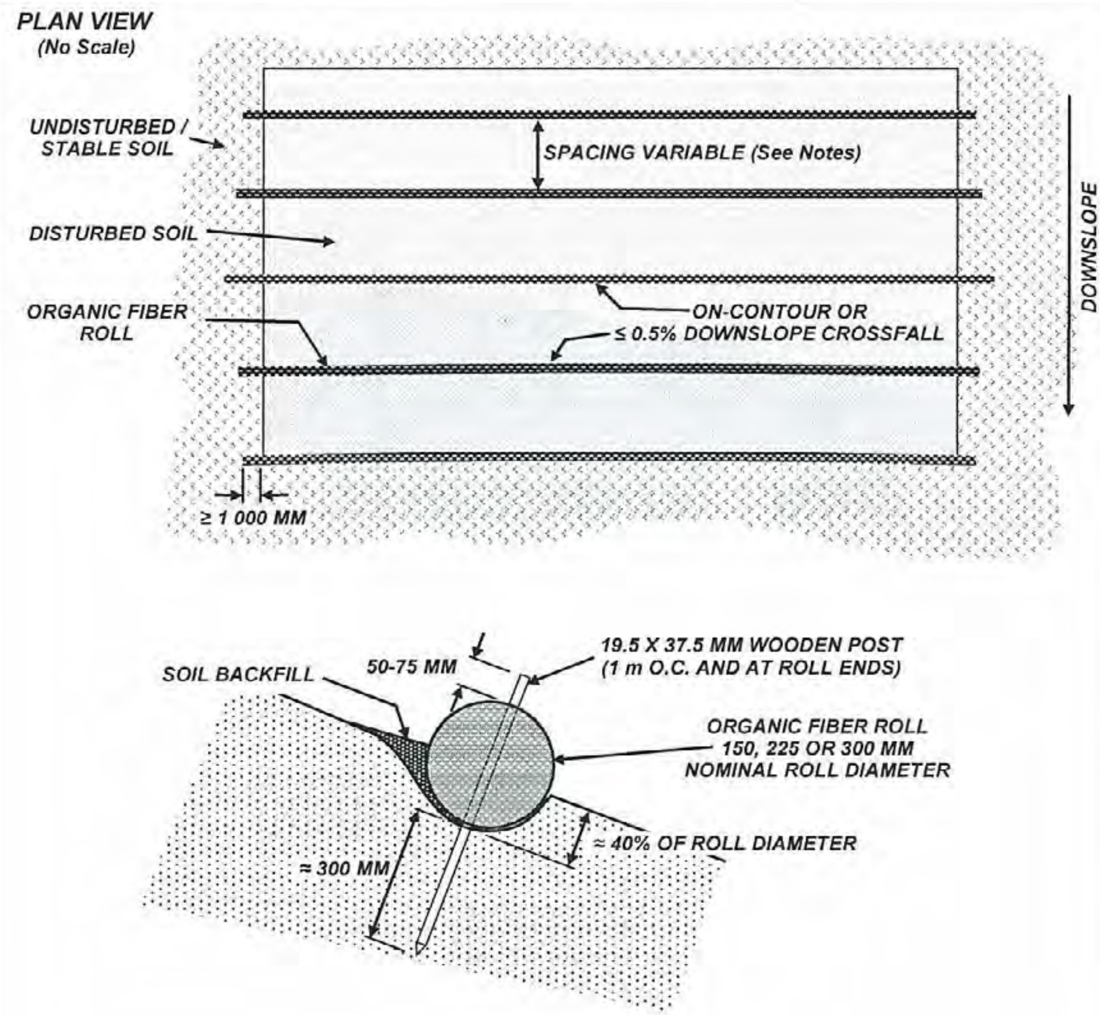
Implementation

Organic fibre rolls are typically used on steep slopes where the surface has been disturbed and at a risk of erosion. Advantageous on steep slopes as they can be installed by hand in remote sites and can be combined with other methods such as erosion control blankets to optimize protection. Intended to be used temporarily until slope is re-vegetated. The rolls cannot be installed across ditches, swales or natural water flow paths.

Application

Flat Ground	N	Steep slopes, stepped terraces
Sloping Ground	Y	
Stockpiles	N	
Ditches	N	

Installation



NOTES:

1. NOMINAL POST LENGTH = ROLL DIAMETER + 350 MM.
2. ROLL SPACING VARIABLE:
   - 1H:1V @ ≈ 3 M
   - 2H:1V @ ≈ 6 M
   - 3H:1V @ ≈ 9 M
   - 4H:1V @ ≈ 12 M
   - DECREASE SPACING AND INCREASE ROLL DIAMETER FOR HIGHLY ERODIBLE SITES
3. PREPARE SOIL AND SEED IMMEDIATELY FOLLOWING FIBER ROLL INSTALLATION
4. FIGURE IS PROVIDED FOR REFERENCE ONLY. CONSULT QUALIFIED PROFESSIONAL FOR SITE-SPECIFIC DESIGN.

ORGANIC FIBER ROLLS

References

- VOI Training Group’s Erosion and Sediment Control Practitioner (ESCP) Participant’s Manual

Also See

- ID-EC_01_VegRetentionAndReplacement
- ID-EC_03_Erosion Control Blankets
- ID-EC_04_Impermeable Sheeting

Appendix F

EC_06 Ditch Check Dams

Photo Credit: FP Innovations https://fpinnovations.ca/media/presentations/Documents/Presentation-handbook-Gillies-Erosion_and_sediment_control.pdfPhoto

Description

Installed as a series of concave dams used in ditches (not fish bearing) natural swales, or overland flow paths that are carrying sediment. Used as a longer term solution to reduce erosion over the duration of onsite activities. By decreasing the grade of a ditch and decreasing flow velocities, this erosion control also has a secondary function in the capture and storage of larger sized sediments.

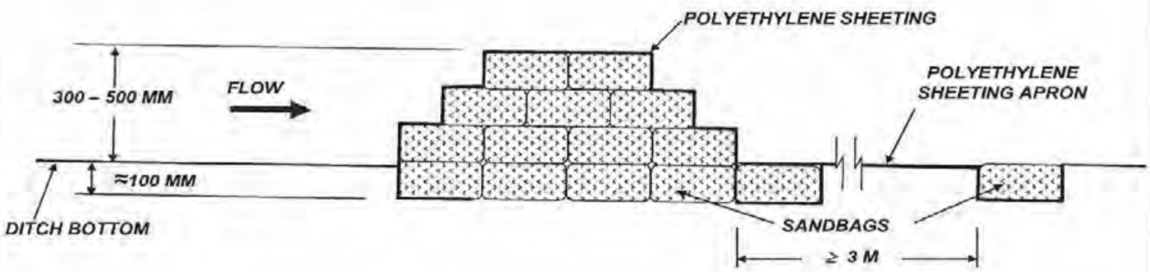
Application

Flat Ground	N	For use on drainage ditches or large diversions but not natural watercourses
Sloping Ground	N	
Stockpiles	N	
Ditches	Y	

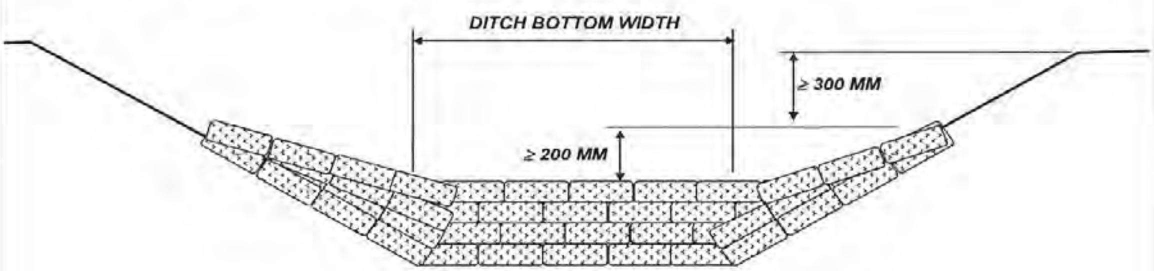
Implementation

Ditch check dams are installed in a series , with steeper slopes requiring a closer spacing to maintain a reduction in the velocity of flowing water. Check dams are most effective where drainage area is relatively small, with low velocity flow and with a low gradient or slope angle. Typically installed in ditches where water flow is eroding and scouring a channel in finer textured soils. Attention to specifications is required for effective installation, poor installation can cause undercutting and increase erosion. Can be combined with other methods such as erosion control blankets.

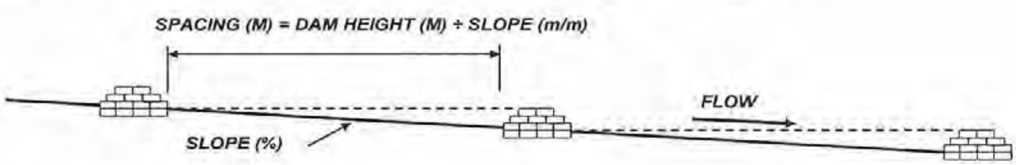
SECTION VIEW THROUGH DAM (No Scale)



SECTION VIEW ACROSS DITCH (No Scale)



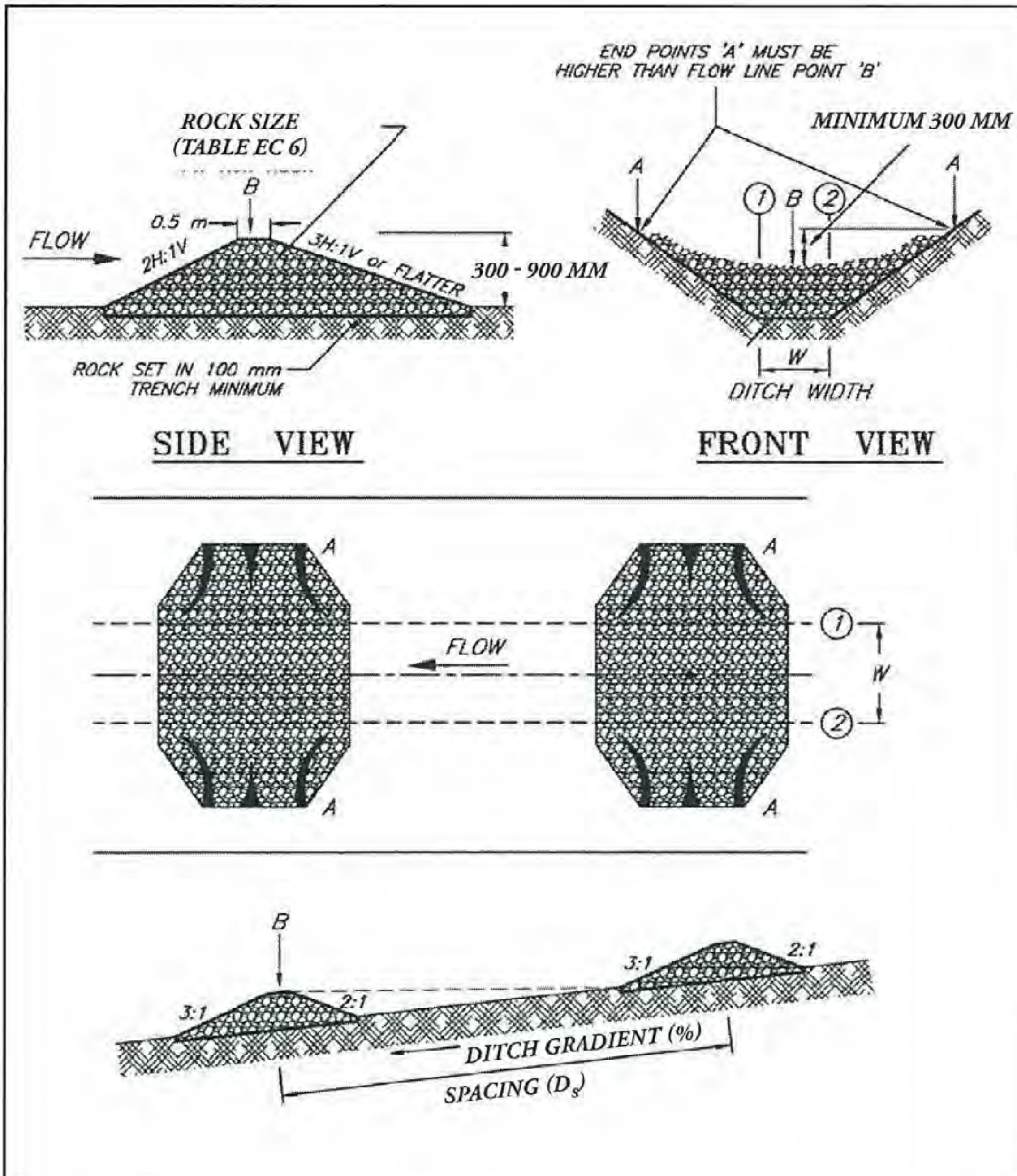
PROFILE VIEW AND TYPICAL SPACING FOR SANDBAG DAMS IN DITCH (No Scale)



NOTES:

1. EXCAVATE NOMINAL 100MM DEEP TRENCH FOR FULL DAM FOOTPRINT.
2. INCREASE/DECREASE WIDTH, HEIGHT AND CONFIGURATION OF CHECK DAM TO MEET MINIMUM AND MAXIMUM DAM HEIGHT REQUIREMENT. RESULTING STRUCTURE MUST BE HYDRAULICALLY STABLE.
3. WRAP DAMS WITH POLYETHYLENE SHEETING AND EXTEND 3 M DOWNDITCH (MIN.) OF DAMS. IF SHEETING IS NOT INSTALLED, ALTERNATIVE EROSION RESISTANT APRON MUST BE PLACED.
4. POLYETHYLENE SHEETING 6 MIL (MIN.) THICKNESS AND OF SUFFICIENT WIDTH TO COVER ENTIRE WIDTH OF DAM.
5. DITCH MUST HAVE SUFFICIENT DEPTH TO ENSURE ALL FLOW REMAINS WITHIN DITCH.
6. DITCH SLOPE ≤5%.
7. CONTRIBUTING DRAINAGE AREA ≤2 HA.
8. REMOVE ACCUMULATED SEDIMENT WHEN SEDIMENT DEPTH IS ≤ ½ OF DAM HEIGHT.
9. FIGURE IS PROVIDED FOR REFERENCE ONLY. SITE SPECIFIC DESIGN SHOULD BE OBTAINED FROM QUALIFIED PROFESSIONAL.

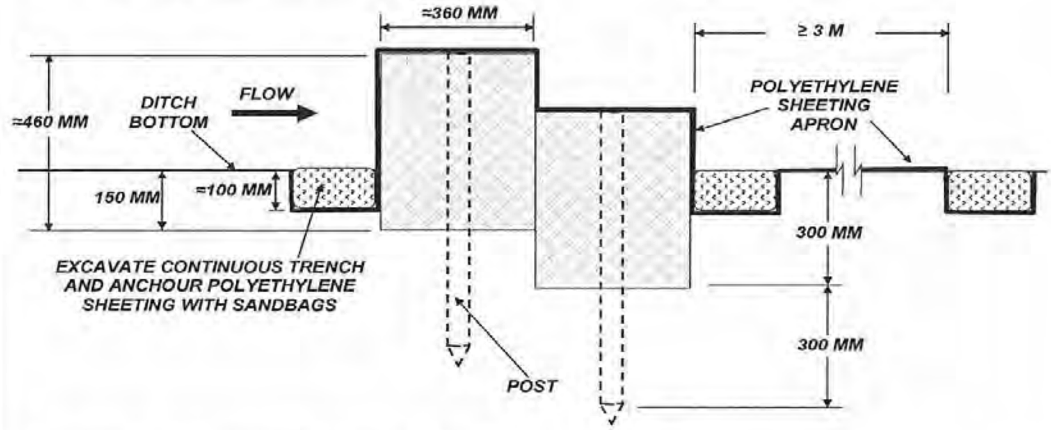
SANDBAG CHECK DAM



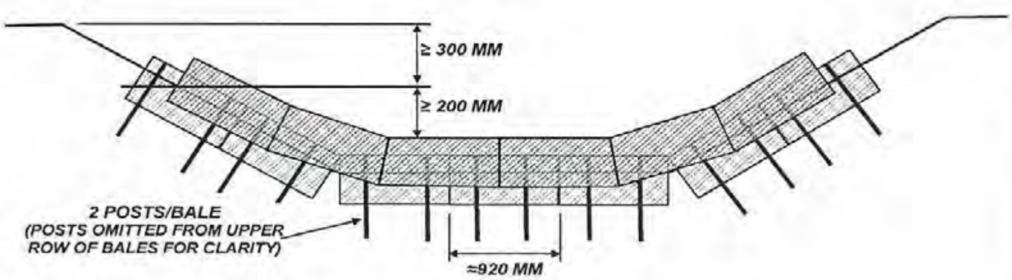
1. NOTES:
2. FLOW VELOCITY ≤ 1.5 M/S.
3. DRAINAGE AREA ≤ 4 HA.
4. DITCH GRADIENT ≤ 8%.
5. EXTEND ROCK APRON MIN. 3 M DOWNDITCH OF EACH CHECK DAM.
6. FIGURE IS PROVIDED FOR REFERENCE ONLY. SITE SPECIFIC DESIGN SHOULD BE OBTAINED FROM QUALIFIED PROFESSIONAL.

ROCK CHECK DAM

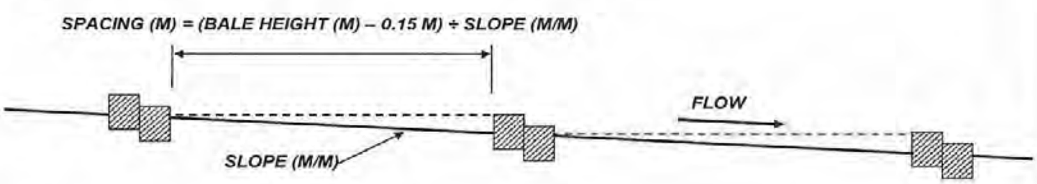
SECTION VIEW THROUGH DAM (No Scale)



SECTION VIEW DOWNDITCH ACROSS DITCH (No Scale)



PROFILE VIEW AND TYPICAL SPACING FOR DAMS IN DITCH (No Scale)



NOTES:

1. ASSUMED BALE DIMENSIONS = 920 MM X 460 MM X 360 MM.
2. CONSTRUCT DAM ONE BALE HIGH (ONLY). MAXIMUM EFFECTIVE DAM HEIGHT IS 310 MM.
3. WRAP DAMS WITH POLYETHYLENE SHEETING AND EXTEND 3 M DOWNDITCH (MIN.) OF DAMS. IF SHEETING IS NOT INSTALLED, ALTERNATIVE EROSION RESISTANT APRON MUST BE PLACED.
4. POLYETHYLENE SHEETING 6 MIL (MIN.) THICKNESS AND OF SUFFICIENT WIDTH TO COVER ENTIRE WIDTH OF DAM.
5. ANCHOUR POSTS – 25 MM X 25 MM X 800 MM WOODEN STAKE, 19 MM X 800 MM REBAR, OR 800 MM STEEL T-BAR.
6. DITCH MUST HAVE SUFFICIENT DEPTH TO ENSURE ALL FLOW REMAINS WITHIN DITCH.
7. DITCH SLOPE ≤5%.
8. CONTRIBUTING DRAINAGE AREA ≤2 HA.
9. REMOVE ACCUMULATED SEDIMENT WHEN SEDIMENT DEPTH ≤100 MM.
10. FIGURE IS PROVIDED FOR REFERENCE ONLY. SITE SPECIFIC DESIGN SHOULD BE OBTAINED FROM QUALIFIED PROFESSIONAL.

STRAW BALE CHECK DAM

References

- VOI Training Group's Erosion and Sediment Control Practitioner (ESCP) Participant's Manual

Also See

- ID-EC_03_Erosion Control Blankets
- ID-EC_04_Impermeable Sheeting

Appendix G

EC_07 Water Diversion

WATER DIVERSION ID-EC_07

Description

Constructed temporary drainage that is used to collect and direct sediment laden surface water run off away from water courses, water bodies and wetlands and to a desirable location for sediment control. Can be constructed around the perimeter of where work is occurring. Location of drainage should consider existing topography and utilize drainage patterns where possible.

Application

Flat Ground	N	Areas with large amount of exposed soil, worksite or stock pile
Sloping Ground	Y	
Stockpiles	Y	
Ditches	Y	

Implementation

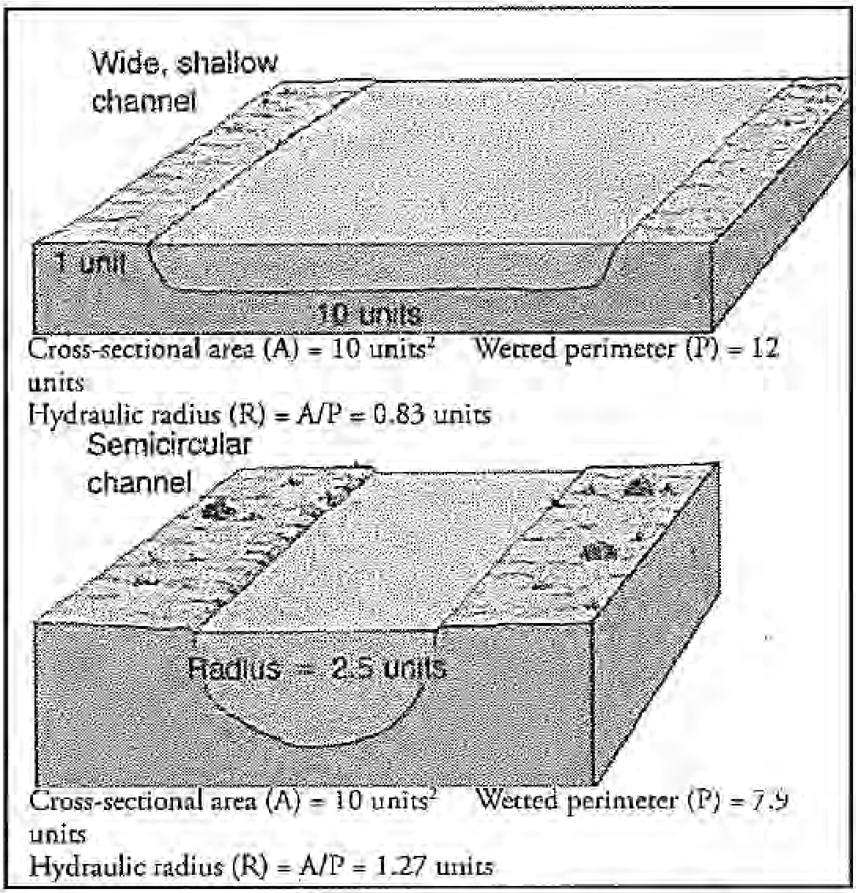
Ditching-

Can be constructed around or through active construction sites. In order to prevent erosion in areas of fine soils, the ditch may need to be lined with either, or a combination of rock (armouring), polyurethane sheeting, or geotextile fabric. Should be combined with other methods such as retention or settling ponds. These catchment areas can be created with retention berms or sediment fabric.

Berms-

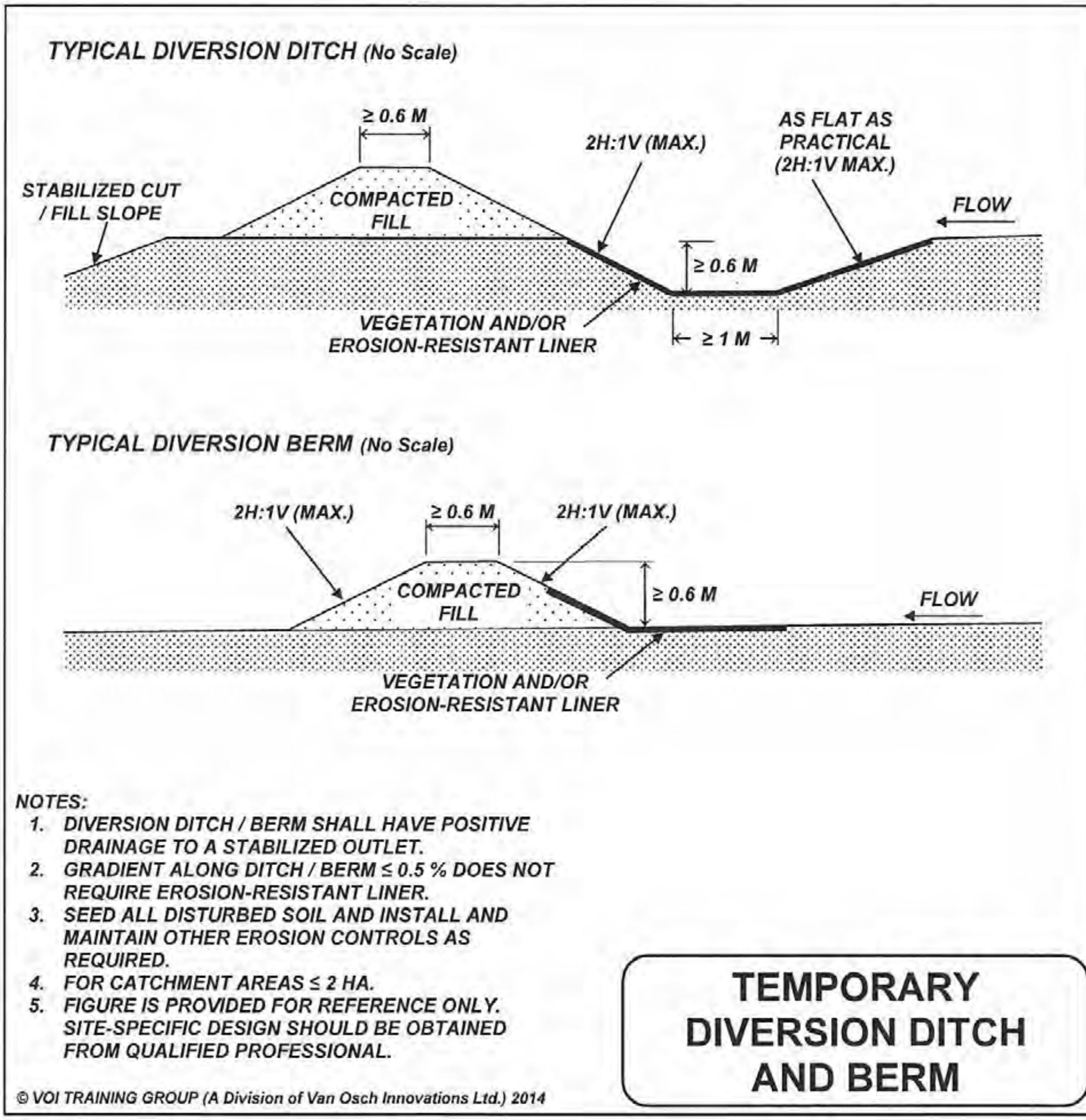
Constructed using compacted lifts from soil or materials found on site, using heavy equipment. Must be inspected on a regular basis (or after rainfall) to identify any failure points that need repair. Berms must be stabilized after construction and should not be used as the primary erosion control measure, and should incorporate other erosion and sediment control methods to optimize performance.

Installation



Channel shape influences hydraulic radius and applied shear stress at the channel boundary. A channel shape that decreases hydraulic radius will have deeper flow and higher channel boundary applied shear stress. Channels that decrease hydraulic radius will have shallower flow and lower channel boundary applied shear stress (adapted from **Tarbuck, E.J. and F.K. Lutgens. 1990.** *The Earth*. 3rd ed. Columbus, Ohio: Merrill Publishing Company.

Channel design instructions diagram provided by: VOI Training Group's Erosion and Sediment Control Practitioner (ESCP) Participant's Manual



References

- VOI Training Group's Erosion and Sediment Control Practitioner (ESCP) Participant's Manual

Also See

- ID-EC_03_Erosion Control Blankets
- ID-EC_04_Impermeable Sheeting
- ID-EC_06_Ditch Check Dams

Appendix H

EC_08 Timber Matting

Description

Timber mats (Rig mats, swamp mats) are portable mats that are constructed of non-treated wood or plastic which are placed over an area in a network to create a work platform or structural roadway. Matting reduces ground pressure and compaction from heavy equipment by increasing the surface area. This allows for passage or work to take place over sensitive or unstable ground while protecting it and minimizing ground surface disruption. Matting minimizes the amount of compaction and rutting that takes place which can predispose to erosion.

Implementation

Can be utilized in any area of concern such as in areas with thawing or unfrozen ground conditions, riparian areas and other environmentally sensitive sites. Can be used to prevent soil compaction, rutting and as a tool for biosecurity mitigation as it help to minimize ground surface disruption and soil contact.

Application

Flat Ground	Y	Flat ground at risk of erosion due to sensitivities or weather conditions
Sloping Ground	N	
Stockpiles	N	
Ditches	N	

Installation

- Verify that mats are clean and free of soil, debris and plant material when they arrive for use on site.
- Mats cannot be constructed of chemically treated wood products.
- In wetlands three mats is the maximum number that can be stacked and used in one location.
- Follow the biosecurity management plan for cleaning washing and disinfecting matting prior to moving it to a new project location.
- Matting should not impede or redirect natural drainage patterns or water courses.
- Mat removal will take place from the existing mat road, working in a backwards fashion (from work site to initial access point).
- When mat removal is complete all remaining matting debris will be cleaned, up and transported to an approved waste disposal facility
- When matting is removed any compaction of soils will have to be rehabilitated

References

- VOI Training Group’s Erosion and Sediment Control Practitioner (ESCP) Participant’s Manual

Also See

- ID-EC_03_Erosion Control Blankets

Appendix I

EC_09 Wind Erosion Control

Description

Wind can be a mechanism of erosion, particularly for dry, finely textured soils with low organic content that is exposed by construction activities. Wind erosion can influence local air quality on the project site and be a source of sediment for water bodies. Areas of potential wind erosion are roads, stockpiles, exposed soil and helicopter landing pads.

Mitigation Implementation

Wind erosion can be minimized by reducing the factors that cause it, by covering susceptible soils or reducing the amount and duration of exposure.

- The most common method of chemical free dust control approved by Manitoba Hydro is the periodic application of water to the surface.
- If stockpiles are retained for an extended period or during high wind events they can be wetted and or covered with impermeable sheeting.
- Longer term retention of stockpiles could also reduce erosion by packing them with equipment and or converting them to low profile berms.
- Erosion control blankets, impermeable sheeting, surface cover, as well as vegetation retention and replacement are effective ways to stabilize soil and prevent wind erosion in the majority of situations.

Also See

- ID-EC_04_Impermeable Sheeting
- ID-EC_03_Erosion Control Blankets
- ID-EC_01_Vegetation Retention And Replacement
- ID-EC_02_Surface Cover

Appendix J

SC_01 Sediment Fencing

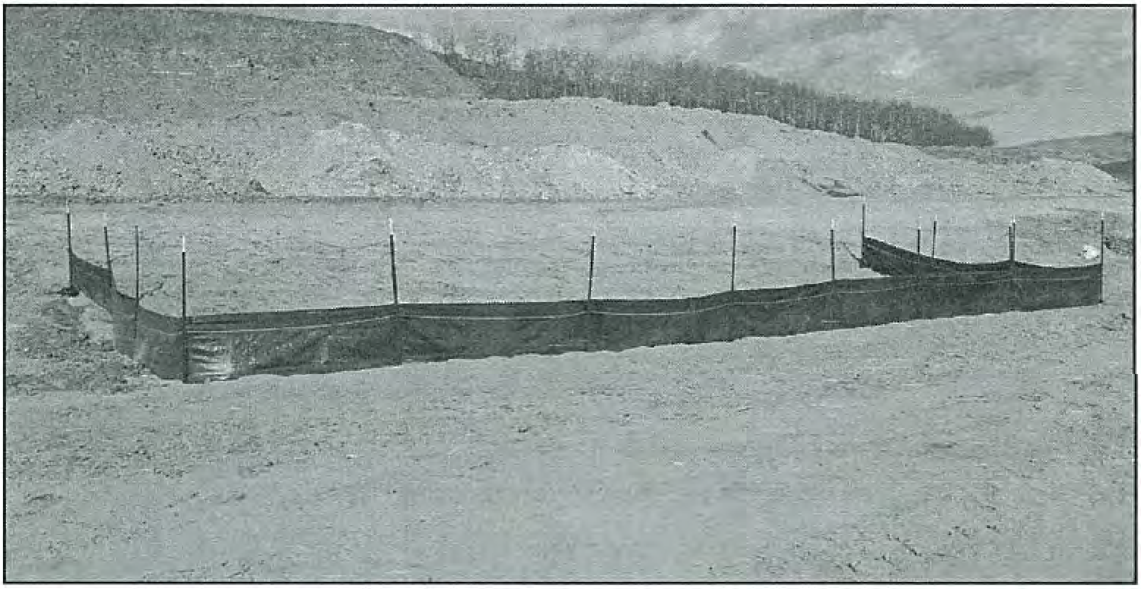


Photo Credit: VOI Training Group's Erosion and Sediment Control Practitioner (ESCP) Participant's Manual

Description

Permeable geotextile fabric installed vertically, supported by posts with the bottom of the fabric buried in a trench at the bottom. Designed to prevent transport of sediment off site. Sediment fencing is designed to be used as a sediment catch basin but not as a "filter" which is commonly thought. It acts as an above ground settling pond to provide an area of catchment where water can remain still and allow sediment to settle out. Sediment fencing requires frequent monitoring and maintenance to remain effective.

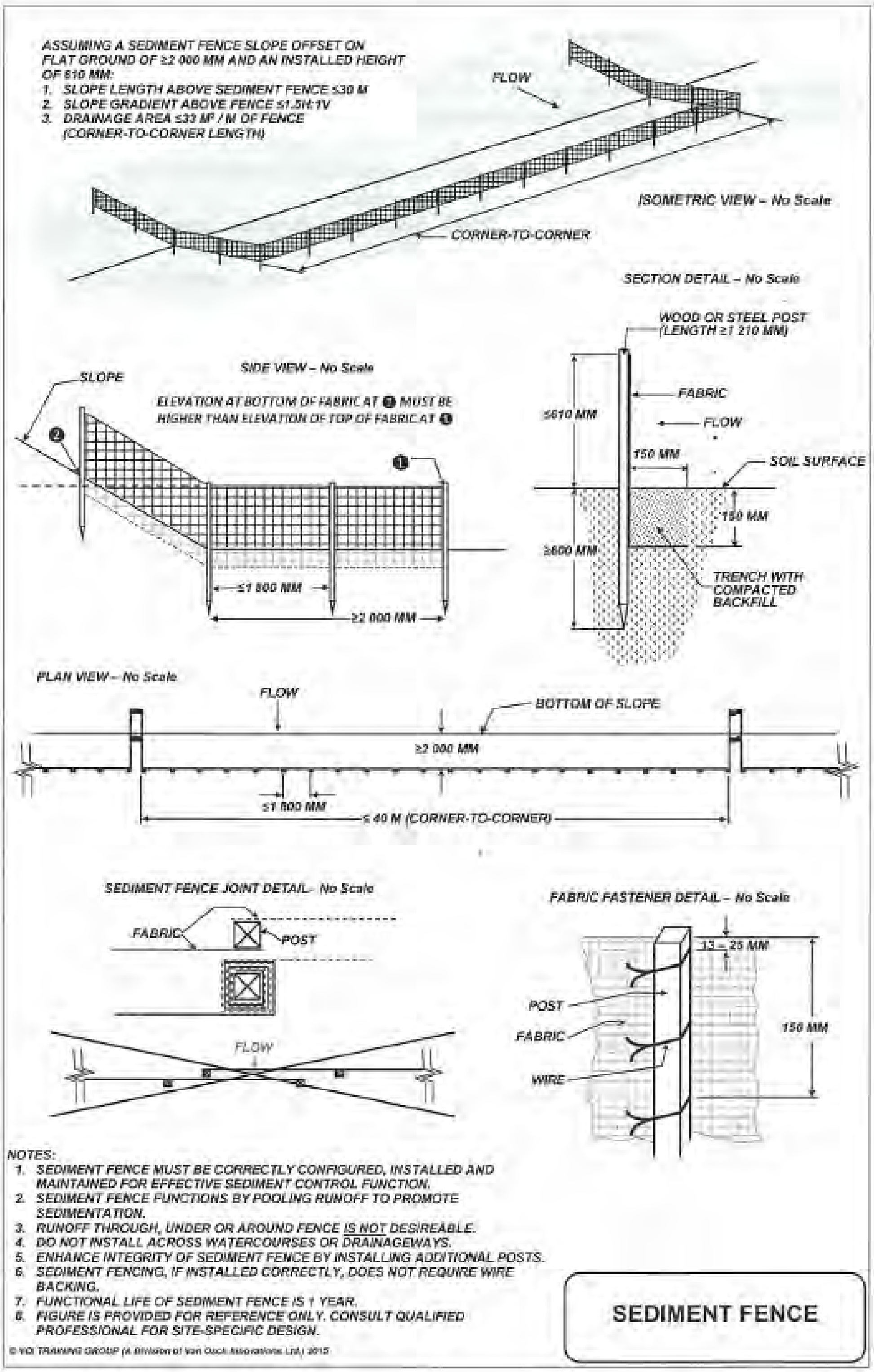
Implementation

Note that correct installation of this sediment control measure is crucial to its effectiveness and the level of maintenance it will require. Installed downslope from construction activities, and used with other control measures (such as straw wattles/roles, or sediment check dams). Should follow the contour of the slope with have sides going upslope making the shape of a "U" or a "smile" to trap water. Minimize the amount of joints if any in the fabric. Regular inspections of the fence should occur, especially after rain events.

Application

Flat Ground	Y	Anywhere low flow runoff is a concern and retention of sediment
Sloping Ground	Y	
Stockpiles	Y	
Ditches	Y	

Installation



References

- VOI Training Group's Erosion and Sediment Control Practitioner (ESCP) Participant's Manual

Also See

- ID-EC_07_Water Diversion
- ID-SC_02_Sediment Retention Berm

Appendix K

SC_02 Sediment Retention Berm

SEDIMENT RETENTION BERM

ID–SC_02

Description

Berms are constructed with heavy equipment using wood chips, soil or bulk material found on site. Purpose of retention berm is to force low volumes of overland flow to pool, allowing sediment to settle out of suspension. Must be inspected on a regular basis (or after rainfall) to identify any failure points that need repair. Berms should not be used as the primary erosion control measure, and should incorporate other erosion and sediment control methods to optimize performance.

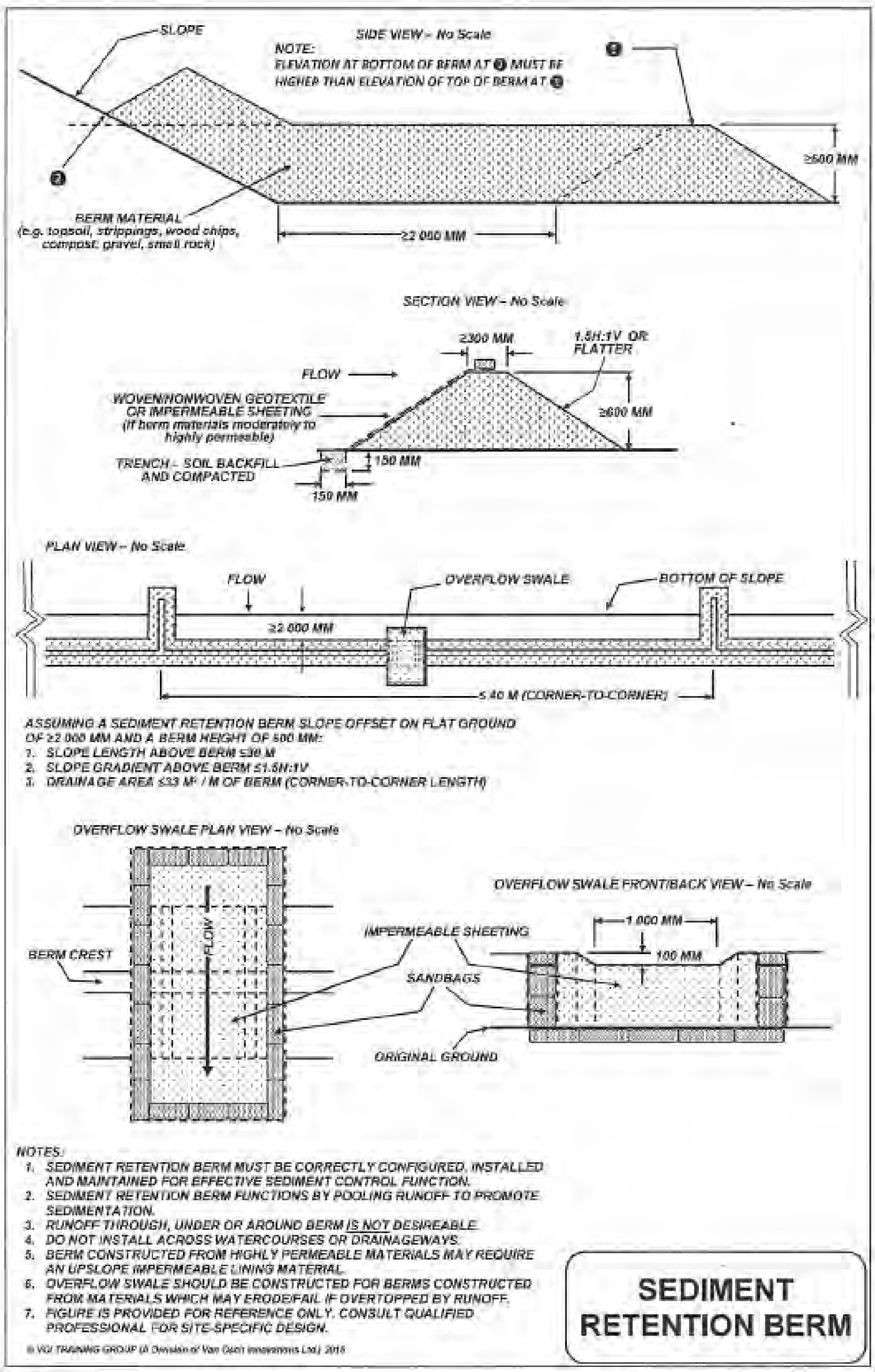
Implementation

Located on the downslope of construction activities where a sediment pond or catch basin has been designed to contain site run off. Layout of the berm should follow the site contour and forming a “U” shape or a “smile” configuration with the ends going upslope. Do not install across a drainage ditch or watercourse.

Application

Flat Ground	Y	Anywhere low flow runoff is a concern and retention of sediment
Sloping Ground	Y	
Stockpiles	Y	
Ditches	Y	

Installation



References

- VOI Training Group's Erosion and Sediment Control Practitioner (ESCP) Participant's Manual

Also See

- ID-EC_04_Impermeable Sheeting
- ID-EC_07_Water Diversions
- ID-SC_01_Sediment Fencing

Appendix J

Saturated/Thawed Soils Operating Guidelines

Pointe du Bois to Whiteshell station 115kV Transmission Line (PW75)

Saturated / Thawed Soils Operating Guidelines

June 2023

Prepared by Manitoba Hydro

Transmission & Distribution Environment and Engagement Department

Project Management Division

Table of Contents

Figures

1.0 Intent and implementation

These operating guidelines define contractor requirements with respect to saturated and/or thawed soils, including trigger conditions, assessment criteria, potential work modification options, thresholds for work shutdown, and plan submittal requirements.

These operating guidelines are applicable to all project components including but not limited to the access roads/trails, right of way, marshalling yards (i.e., laydown yards, fly-yards) and temporary structures (i.e., stringing sites).

The process for utilization of these operating guidelines is:

1. The contractor monitors site conditions against trigger conditions
2. The contractor assesses criteria to determine if work modification is required
3. The contractor determines the work modification (if applicable) that will be applied and submit their plan to Manitoba Hydro for review.
    a. Plan submittal shall occur promptly.
    b. Unless the work modification chosen is stoppage of work, the work may proceed (with work modifications implemented) prior to Manitoba Hydro providing review comments to the contractor.
    c. The contractor shall notify Manitoba Hydro each time when/if the contractor determines that any specific work modification is no longer required.
4. If the threshold for a particular land cover type is exceeded:
    i. The contractor shall reassess criteria and submit a revised work modification plan to Manitoba Hydro for review. Plan resubmittal shall occur promptly. Unless the work modification chosen is stoppage of work, the work may proceed (with work modifications implemented) prior to Manitoba Hydro providing review comments to the contractor.
    ii. Manitoba Hydro may issue an Environmental Improvement Order or an Environmental Stop Work Order depending on the severity of the non-compliance, in accordance with the contract.
5. A record of the location, timing, and reason for implementation of work stoppages, work resumptions, and work modifications will be maintained by the contractor environmental representative and submitted to Manitoba Hydro in the Weekly Environmental Report.

2.0 Consideration of guidelines when planning work

The contractor shall plan, sequence, and schedule work activities in a manner that reduces environmental impact risks and the need for work modifications by reducing the activities occurring in saturated/thawed soil conditions. The contractor is responsible for developing any related protocols to facilitate the implementation of these guidelines.

Site-specific work modifications will be developed by the contractor and proposed to Manitoba Hydro (MH) representatives for review.

3.0 Potential effects

The effects of wet weather during construction activities can have a significant impact on ground conditions and can change otherwise stable soils into soils that are affected by erosion and sedimentation. Freeze thaw cycles during the spring can also expose stable soils to an unstable condition overnight and throughout the day. Variations in soil conditions, construction activities, weather conditions, soil types and land cover are all contributing factors when considering working conditions and potential impacts to soil during saturated or thawed conditions. Potential effects to various types of land cover include:

- Compaction, which is considered the primary mechanism of effect to soil productivity and can affect re-vegetation success and crop performance
- Rutting and admixing (mixing of topsoil and subsoils)
- Increased risk of water erosion and sedimentation in riparian areas affecting water quality and fish habitat
- Access restrictions for traditional resource users, farmers, and the public due to road or trail rutting

4.0 Weather parameters

Weather plays an integral role in the planning of work activities. Conditions such as spring thaw, shorter term warmer temperature periods, and heavy precipitation may require implementation of work modification, including localized work stoppage until ground conditions improve. The following weather events will trigger assessment for work modifications:

- Melting conditions indicated by rising air temperatures above -5^{O} Celsius
- During extended periods of adverse conditions (for rain is considered greater than 5 mm of rain in a 24 hour period)
- more than 50 mm of rain/5 cm of wet snow in the preceding 5 days; or
- the forecast calls for more than 50% certainty of 5 mm of rain/or 5 cm of wet snow in the next 24 hours

5.0 Rutting and admixing identification

A rut is a depression made into the soil surface by the passage of a vehicle or equipment. Figure 1 illustrates how a rut is measured. Admixing – examples of rutting can be found in Figure 2 which shows the beginning of soil admixing and Figure 3 shows advanced stages of admixing from continued travel.

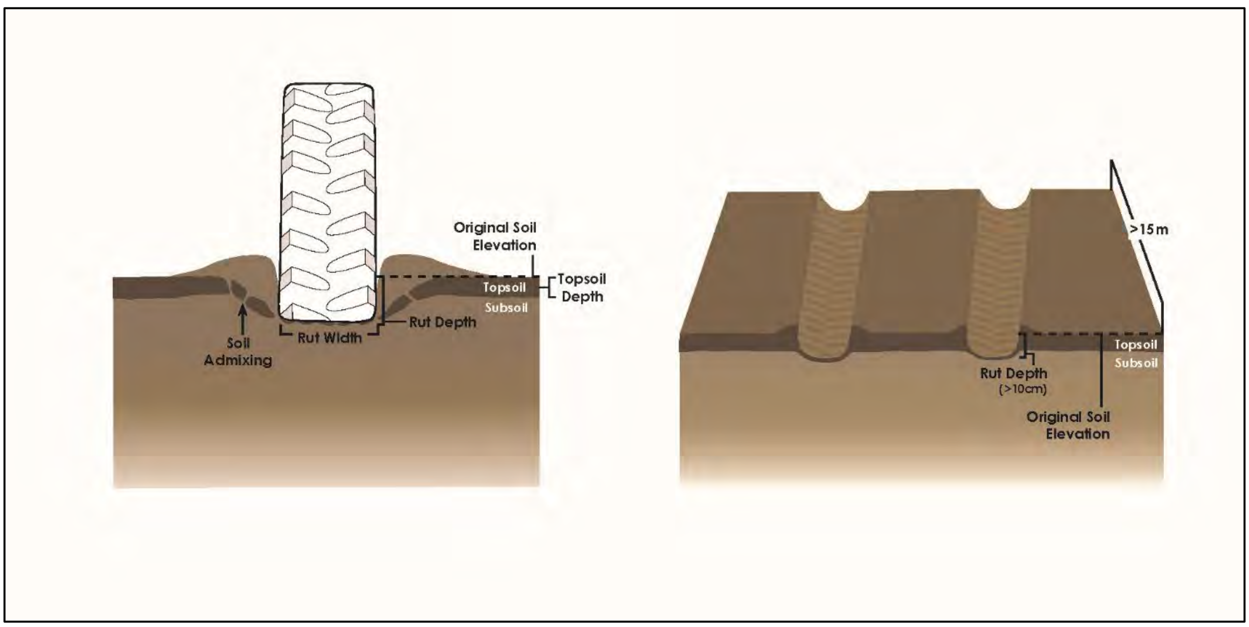


Figure 1: Rut measurement guide

Figure 2: Beginning of admixing

Figure 3: Advanced soil admixing

6.0 Remediation

The level and type of disturbance at each individual site will dictate the amount of remediation necessary. Re-vegetation and/or erosion and sediment controls are site-specific conditions to be considered when planning remediation activities. Refer to the Erosion and Sediment Control Management Plan and the Rehabilitation and Invasive Species Management Plan for further guidance for each disturbed site.

7.0 Guidelines by land cover

7.1 Wetlands

Trigger(s) for the assessment for work modification by contractor

- When air temperature is projected to exceed -5°C that day or when ground conditions cannot support equipment without rutting and compaction; or
- MH Environmental Officer advises contractor of requirement for potential work modification

Criteria to be assessed by the contractor (Manitoba Hydro may conduct its own assessment)

- current and forecasted weather
- current ground conditions
- work schedule
- nature of work activities (i.e., pedestrian traffic vs heavy equipment)
- safety concerns

Potential work modifications (site-specific work modifications will be developed by the contractor and proposed to Manitoba Hydro for review)

- placement of matting or snow
- low(er) ground pressure equipment
- reduced scope of work
- aerial work methods
- change of work hours
- change of work location
- stoppage of work
- other modifications as approved by Manitoba Hydro

Thresholds for immediate implementation of work modification(s):

- When the depth of rutting exceeds 10 cm for more than 15 m in length;
- Admixing (mixing of topsoil and subsoils); or
- MH Environmental Officer advises contractor of requirement for work modification.

If thresholds continue to be exceeded, either due to inadequate work modifications or lack of work modification, Manitoba Hydro may issue an Environmental

Improvement Order or an Environmental Stop Work Order depending on the severity of the non-compliance, in accordance with the Contract.

7.2 Riparian areas and areas in proximity to water

Trigger(s) for the assessment for work modification by contractor

- Any excessive soil disturbance within riparian area including disturbance on the access trail crossing, ground conditions unable to support equipment without rutting and compaction; or
- MH Environmental Officer advises contractor of requirement for work modification.

Criteria to be assessed by contractor (Manitoba Hydro may conduct its own assessment)

- current and forecasted weather
- current ground and aquatic conditions
- work schedule
- nature of work activities (i.e., pedestrian traffic vs heavy equipment)
- accessibility to Project site(s)
- safety

Potential work modifications (site-specific work modifications will be developed by the contractor and proposed to Manitoba Hydro for review)

- placement of matting or snow
- ice bridge
- low(er) ground pressure equipment
- reduced scope of work
- aerial work methods
- closure of access trail within riparian area
- change of work hours
- change of work location
- stoppage of work
- other modifications as approved by Manitoba Hydro

Thresholds for immediate implementation of work modification(s):

- Any construction activity that affects surface water drainage directly into a water body (watercourse and/or wetland) without sufficient erosion and sediment control measure in place;
- Admixing (mixing of topsoil and subsoils); or
- MH Environmental Officer advises contractor of requirement for work modification.

If thresholds continue to be exceeded, either due to inadequate work modifications or lack of work modification, Manitoba Hydro may issue an Environmental

Improvement Order or an Environmental Stop Work Order depending on the severity of the non-compliance, in accordance with the contract.

7.3 Cultivated lands

Trigger(s) for the assessment for work modification by contractor

- When the depth of topsoil is rutted to 50% of the depth of topsoil for more than 15 m in length; or
- MH Environmental Officer advises contractor of requirement for potential work modification

Criteria to be assessed by contractor (Manitoba Hydro may conduct its own assessment)

- current and forecasted weather
- current ground conditions
- current crop and farming practices
- depth of topsoil
- salinity
- work schedule
- nature of work activities (i.e., pedestrian traffic vs heavy equipment)
- accessibility to project site(s)
- safety

Potential work modifications (site-specific work modifications will be developed by the contractor, and proposed to Manitoba Hydro for review with the landowner)

- placement of matting or snow
- lower ground pressure equipment
- reduced scope of work
- aerial work methods
- change of work hours
- change of work location
- stoppage of work
- other modifications as approved by Manitoba Hydro

Thresholds for immediate implementation of work modification(s):

- When rutting depth of topsoil exceeds 80% of the topsoil depth for more than 15 m in length
- Admixing (mixing of topsoil and subsoils); or
- MH Environmental Officer advises contractor of requirement for immediate work modification

If thresholds continue to be exceeded, either due to inadequate work modifications or lack of work modification, Manitoba Hydro may issue an Environmental

Improvement Order or an Environmental Stop Work Order depending on the severity of the non-compliance, in accordance with the Contract.

7.4 Access routes and trails

Trigger(s) for the assessment for work modification by contractor

- When access route or trail conditions caused by the Project create additional risk of damage or barriers to movement to vehicles of other users; or
- MH Environmental Officer advises contractor of requirement for potential work modification

Criteria to be assessed by contractor (Manitoba Hydro may conduct its own assessment)

- current and forecasted weather
- current ground conditions
- work schedule
- nature of work activities (i.e., pedestrian traffic vs heavy equipment)
- accessibility to Project site(s)
- safety

Potential work modifications (site-specific work modification(s) will be developed by the contractor, and proposed to Manitoba Hydro for review with the landowner)

- placement of matting or snow
- lower ground pressure equipment
- closure of access route to Project traffic
- aerial work methods
- change of work hours
- change of work location
- stoppage of work
- other modifications as approved by Manitoba Hydro

Thresholds for immediate implementation of work modification(s):

- Any evidence of access route/trail structure damage occurring, such as admixing, or the creation of ruts that impedes local vehicle traffic; or
- MH Environmental Officer advises contractor of requirement for immediate implementation of work modification.

If thresholds continue to be exceeded, either due to inadequate work modifications or lack of work modification, Manitoba Hydro may issue an Environmental

Improvement Order or an Environmental Stop Work Order depending on the severity of the non-compliance, in accordance with the Contract.

7.5 Forest, tame pasture and grasslands

Trigger(s) for the assessment for work modification by contractor

- When rutting depth exceeds 10 cm for more than 15 m in length; or
- MH Environmental Officer advises contractor of requirement for immediate implementation of work modification(s).

Criteria to be assessed by contractor (Manitoba Hydro may conduct its own assessment)

- current and forecasted weather
- current ground conditions
- work schedule
- nature of work activities (i.e. pedestrian traffic vs heavy equipment)
- accessibility to Project site(s)
- safety

Potential work modifications (site-specific work modifications will be developed by the contractor, and proposed to Manitoba Hydro for review with the landowner)

- placement of matting or snow
- lower ground pressure equipment
- reduced scope of work
- aerial work methods
- change of work hours
- change of work location
- stoppage of work
- other modifications as approved by Manitoba Hydro

Thresholds for immediate implementation of work modification(s):

- When rutting depth exceeds 30 cm for more than 15 m in length;
- Admixing (mixing of topsoil and subsoils); or
- MH Environmental Officer advises contractor of requirement for immediate implementation of work modification.

If thresholds continue to be exceeded, either due to inadequate work modifications or lack of work modification, Manitoba Hydro may issue an Environmental Improvement Order or an Environmental Stop Work Order depending on the severity of the non-compliance, in accordance with the Contract.

Appendix K

Rules for Externally Reportable Releases

Externally Reportable Releases

IMPORTANT – Internal reporting is required for all quantities released!

Use the following rules when determining if external reporting to the regulator is required. If any of the rules apply, the release **MUST** be externally reported.

RULES FOR EXTERNALLY REPORTABLE RELEASES (FOR ANY TYPE OF HAZARD)

To determine if a release should be reported to the regulator:

1) First determine if any of the rules apply. If so, an Emergency Report must be made by phone to Manitoba Environment, Climate and Parks.

Rule 1	• **Any volume released to a waterway**
Rule 2	• **Any volume released to an environmentally sensitive area**
Rule 3	• **Any volume released that poses or may pose a threat to human health or the environment**

2) If no rules apply, check to see if the release meets or exceeds the quantities on the '*Externally Reportable Quantities for Releases*' table (on page 2 and 3 of this document). If so, report to Manitoba Environment, Climate and Parks.

Emergency reporting in Manitoba to regulators for all notifications *(Manitoba Environment, Climate and Parks, Environment and Climate Change Canada and Transport Canada)* requires calling the Environmental Emergency Reporting Line at (204) 944-4888.

Externally Reportable Quantities for Releases

Regulated			
Hazard	**TDG Class** (If Applicable)	**Reportable Quantity by Regulation**	**Reportable Quantity for Notification Purposes**
Explosives (i.e. Dynamite)	1	Any Quantity	—
Compressed Gas			
Flammable (i.e. Aerosols, Propane)	2.1	100 L Container Capacity (refers to water capacity)	—
Flammable — Natural Gas Underground Lines	—	—	Any quantity that causes death, injury, fire, explosion, evacuation, threatens safety of public, highly visible and notable, > 2" diameter lines and >550 kPa (80 psig), or has harmed the environment
Non-Flammable, Non-Toxic (i.e. Anhydrous Ammonia, Fire Extinguishers)	2.2	100 L Container Capacity (refers to water capacity)	—
Toxic (i.e. Hydrogen Sulphide; Chlorine)	2.3	Any Quantity	—
Corrosive (i.e. Hydrogen Chloride)	2.3	Any Quantity	—
Flammable Liquids (i.e. Gasoline, Acetone, Diesel Fuel, Methanol)	3	100 L	—
Flammable Solids, Spontaneous Combustible and Water-Reactive Substances (i.e. Sulphur, Zinc Dust)	4	1 kg	—
Oxidizing Substances			
Packing Groups I & II (i.e. Sodium Peroxide, Potassium Permanganate)	5.1	1 kg or 1 L	—
Packing Groups III (i.e. Potassium Nitrate)	5.1	50 kg or 50 L	—
Organic Peroxides (i.e. Methyl Ethyl Ketone Peroxide)	5.2	1 kg or 1 L	—
Toxic Substances			
Packing Group I (i.e. Acrylonitrile, Hydrogen Sulfide)	6.1	1 kg or 1 L	—
Packing Group II & III (i.e. Pesticides, Wood Preservative)	6.1	5 kg or 5 L	—

Regulated

Hazard	TDG Class (If Applicable)	Reportable Quantity by Regulation	Reportable Quantity for Notification Purposes
Infectious Substances **(i.e. Infectious Substances affecting humans)**	6.2	Any Quantity	—
Radioactive Materials (i.e. Nuclear Densometers)	7	Any discharge or radiation exceeding 10 mSv/h at the package surface and 0.2 mSv/h at 1m from the package surface	—
Corrosive (i.e. Hydrofluoric Acid, Battery Fluid, Mercury)	8	5 kg or 5 L	—
Miscellaneous Products, Substances or Organisms (i.e. Lithium Cells & Batteries, Asbestos)	9	50 kg	—
Polychlorinated Biphenyls			
PCB or PCB Contaminated Oil IN USE	9	1 gram	—
PCB Containing Equipment IN STORAGE	9	Any Quantity ≥ 2 ppm	—
Ozone Depleting Substances (i.e. R-11 Refrigerant) *Report using MOPIA form	—	10 kg	—

Non Regulated

Hazard	TDG Class (If Applicable)	Reportable Quantity by Regulation	Reportable Quantity for Notification Purposes
Petroleum Products			
Engine Oil	—	—	30 L
Insulating Oil	—	—	100 L
Lubricating & Hydraulic Oil	—	—	50 L
Pesticides (Non-TDG Regulated)			
Concentrate	—	—	10 L
Solutions, Mixtures	—	—	100 L
Antifreeze (Non-TDG Regulated) (Propylene & Ethylene Glycol)	—	—	50 L
Sewage (Solid Sludge or Liquid)	—	—	500 kg or 500 L

CALCULATION FOR PCB GRAMS PER DAY

Determine the number of grams released in PCB spills by multiplying the volume (litres) released, by the concentration (parts-per million) of PCBs in the release, by the density (kilograms/litre) of 0.9 kg/L, and then divide that value by 1000.

$$\frac{\text{(Volume Released (L) x Concentration of PCBs (ppm) x 0.9(kg/L)}}{1000} = \text{PCBs Released (g)}$$

Example: A 90L release of insulating oil with a concentration of 10ppm PCBs from a transformer in use.

$$\frac{(90\text{L} \times 10\text{ppm} \times 0.9\ \text{kg/L})}{1000} = 0.81$$

Therefore this release ***would not*** be reportable to the regulator.

PCB Concentration / Volume of Oil that equates to 1 gram of PCBs being released	
Concentration of PCBs in Released Oil	**Volume of Oil that equates to 1 gram of PCBs being released**
5 ppm	222 litres
10 ppm	111 litres
20 ppm	55 litres
40 ppm	27 litres
45 ppm	24 litres
100 ppm	11 litres

RULES FOR EXTERNALLY REPORTABLE RELEASES OF DANGEROUS GOODS IN TRANSPORT (SURFACE)

To determine if a release of dangerous goods in transport should be reported to the regulator:

1) First determine if the dangerous goods are being transported using the 150 kg Gross Mass Exemption. If not, follow additional steps below. If Gross Mass Exemption is being used, no reporting of a TDG release is required.
2) If the release endangers or could endanger public safety **AND** meets or exceeds the quantities on the 'TDG Externally Reportable Quantities for Releases' table (on page 5 of this document). If so, an Emergency Report must be made by phone to Manitoba Environment, Climate and Parks.
3) If the Emergency Report under #2 is made, **AND** any of the following rules apply, submit a Release Report by phone to CANUTEC, the consignor (shipper), and the Canadian Nuclear Safety Commission (if Class 7 is involved). A written 30-Day Follow-up Report must also be submitted to Transport Canada (contact Enterprise Environment).

Rule 1	• Death or injuries that require treatment by a health care professional
Rule 2	• An evacuation/closure of a facility, road, mail railway line, or main waterway
Rule 3	• Integrity of the means of containment is compromised

Emergency reporting in Manitoba to regulators for all notifications (Manitoba Environment, Climate and Parks, Environment and Climate Chane Canada and Transport Canada) requires calling the Environmental Emergency Reporting Line at (204) 944-4888.

Release reporting to CANUTEC's 24-hour Emergency Telephone (613) 996-6666
Canadian Nuclear Safety Commission duty officer Emergency Line (613) 995-0479

TDG Externally Reportable Quantities for Releases		
Class of Dangerous Good	**Packing Group or Category**	**Quantity**
1	II	Any quantity
2	Not applicable	Any quantity
3, 4, 5, 6.1 or 8	I or II	Any quantity
3, 4, 5, 6.1 or 8	III	30 L or 30 kg
6.2	A or B	Any quantity
7	Not applicable	A level of ionizing radiation greater than the level established in section 39 of the "Packaging and Transport of Nuclear Substance Regulations, 2015"
9	II or III or without packing group	30 L or 30 kg

Appendix L

Cultural and Heritage Resources Protection Plan

CULTURAL AND HERITAGE RESOURCES PROTECTION PLAN

Manitoba Hydro

Document Owner
Transmission & Distribution Environment and Engagement
Project Management Division
Manitoba Hydro

Version - Final

List of Revisions

Number	Nature of Revision	Section(s)	Revised By	Date

Key messages for construction

Workers in the field should remain vigilant to watch for and report any discoveries. Manitoba Hydro expects workers to report any findings to the Manitoba Hydro On-Site Supervisor or designate.

If human remains, a cultural and/or heritage site are found, activities stop at that location.

The Manitoba Hydro Transmission & Distribution Environment and Engagement (T&DEE) is prepared to offer the required support to On-Site Supervisors including archaeological services, to preserve and protect cultural and heritage resources. T&DEE can be contacted at 1-877-343-1631 or projects@hydro.mb.ca.

Potential fines

Under The Heritage Resources Act, any person who contravenes or fails to observe a provision of this Act or a regulation, order, by-law, direction, or requirement made or imposed thereunder is guilty of an offence and liable, on summary conviction, where the person is an individual, to a fine of not more than $5,000. for each day that the offence continues and, where the person is a corporation, to a fine of not more than $50,000. for each day that the offence continues.

Preface

This standard Cultural and Heritage Resources Protection Plan outlines protection measures and protocols that Manitoba Hydro, its contractors and/or consultants will undertake in the event of the discovery of previously unrecorded cultural and **heritage resources** during construction, maintenance, or operation of an electrical or gas transmission line or facility.

The intent for this document is to be a straightforward and practical reference document for use by the Manitoba Hydro On-Site Lead, Environmental Inspector and/or Indigenous Communities and Organizations. Manitoba Hydro - Transmission & Distribution Environment and Engagement Department encourages anyone to provide feedback on this document and will review this plan on an annual basis. Feedback can be provided to projects@hydro.mb.ca.

Some words in the text are in **bold face** the first time they occur in the document and definitions are included in the glossary in section 3.0.

Table of Contents

1.0 Introduction

Manitoba Hydro understands and appreciates the value that Manitobans place on cultural and heritage resources and the rich legacy found throughout our Province. Manitoba Hydro's commitment to safeguarding these resources has led to the development of this Cultural and Heritage Resources Protection Plan (CHRPP). The CHRPP will provide clear instructions if Manitoba Hydro, its contractors and/or consultants, discover or disturb a cultural or heritage resource and will determine the ongoing protection measures for the resources through processes outlined in this document.

1.1 Commitment to environmental protection

Protecting the environment is an integral part of everything Manitoba Hydro does. Manitoba Hydro accomplishes this by integrating environmentally responsible practices in all aspects of our business. Environmental protection can only be achieved with the full cooperation of Manitoba Hydro employees, consultants, and contractors at all stages of the Project from planning and design through construction and operational phases.

The use of a Cultural and Heritage Resources Protection Plan (CHRPP) is a practical and direct implementation of Manitoba Hydro's environmental policy and its commitment to responsible environmental and social stewardship. It is a proactive approach to manage potential discoveries of **human remains**, cultural and heritage resources.

Manitoba Hydro is committed to implementing this CHRPP. Manitoba Hydro will also require companies that contract with us to follow the terms of this and other applicable plans.

1.2 Regulatory and policy setting

Legislation that commonly applies to cultural and heritage resources for construction, maintenance or operation of transmission lines or facilities includes: ***The Heritage Resources Act*** *(The Act)* and the ***Province of Manitoba Policy Concerning the Reporting, Exhumation and Reburial of Found Human Remains (Burials Policy)***. This CHRPP is consistent with and does not replace the above. In effect, the CHRPP builds on the protective measures afforded by *The Act and policy*.

1.3 Implementation

The goal of the CHRPP is to act as a reference manual to describe key actions in the event of discovery of cultural or heritage resources or human remains. Manitoba Hydro will inform relevant employees and contractors working on the project of the contents of applicable regulatory specifications, guidelines, licenses, authorizations and permits, and of this plan, and copies will be available from the on-site lead office.

The plan also allows for adaptive management to include new and evolving strategies, protocols, and information to support and protect culture and heritage resources. Appendix B includes a protocol template that interested communities and organizations can complete to augment and enhance this CHRPP.

This protocol could provide feedback on items such as:

- Whether the community/organization wants Manitoba Hydro to contact them upon discovery of unrecorded cultural or heritage resources
- Who and how to contact the community representative(s) upon discovery of unrecorded cultural or heritage resources
- When the community representative(s) would like to be contacted
- Description of the Area of Interest the community feels may contain heritage and **cultural resources** important to them
- General types of cultural and heritage resources that may be in Area of Interest
- Ceremonial or spiritual activities the community would like conducted prior to construction
- Any other concerns the community may have regarding cultural and heritage resources
- Whether the community has received a copy of this standard CHRPP

Upon the discovery of unrecorded cultural or heritage resources, Manitoba Hydro will follow the steps outlined in section 1.8 in conjunction with the applicable attached Protocols.

1.4 On-site project management structure

Manitoba Hydro staff and consultants will be required to undertake activities, steps, procedures and measures set out in the Figure 1-1 and Figure 1-2 should cultural or heritage resources or human remains be discovered during the construction, operation or maintenance of the project. There is a potential to discover cultural and heritage resources in many different locations and workers in the field should remain vigilant to watch for and report any discoveries. Manitoba Hydro expects workers to report any findings to the Manitoba Hydro On-Site Supervisor or designate.

The Manitoba Hydro Transmission & Distribution Environment and Engagement Department is prepared to offer the required support to On-Site Supervisors including archaeological services, to preserve and protect cultural and heritage resources. T&DEE can be contacted at 1-877-343-1631 or projects@hydro.mb.ca.

To conduct any type of archaeological or heritage resource investigation, a Heritage Permit is required from the Historic Resources Branch (HRB) (Manitoba Sport, Culture and Heritage Department). The HRB is responsible for the issuance and management of heritage permits. Permits can only be issued to Registered Archaeologists; T&DEE has access to archaeologists to support any investigation.

1.5 Human remains

The Heritage Resources Act (1986), Section 43 (1) states that "human remains" means:

> *"remains of human bodies that in the opinion of the minister have heritage significance and that are situated or discovered outside a recognized cemetery or burial ground in respect of which there is some manner of identifying the persons buried therein."*

Manitoba Hydro will not disturb or remove human remains from their original resting place unless removal is unavoidable and necessary. Out of respect for the remains, all work related to the remains will be conducted as much as possible out of the public eye. **Funerary (grave) goods** found with human remains will accompany human remains at all times. No reports related to any such find and its analysis will be published unless the Community Representative(s) consents to such publication, other than such reports provided to Manitoba Hydro and the Historic Resources Branch or other agencies as may be required by law. The following describes the practices that Manitoba Hydro would follow if **skeletal remains** believed or known to be human remains and/or accompanying grave goods are discovered or disturbed:

Figure 1-1 Discovery of human remains

Discovery of Human Remains

	On Site Lead	Transmission & Distribution Environment and Engagement (T&DEE)	Archaeologist	Manitoba Historic Resources Branch (HRB)	RCMP
Step 1	STOP activities at location				
Step 2	Immediately mark discovery location with flagging tape and cordon off with temporary fencing (minimum buffer distance 35 m radius from centre of discovery)			Size of buffer may be adjusted once archaeologist, in consultation with HRB, examine site [i.e., on a case-by-case basis].	
Step 3	Contact T&DEE →	Contact archaeologist and communities/ organizations with protocols →	Contact HRB		
Step 4			Determine whether human remains are present →	If remains human, contact RCMP	
Step 5				For human remains, if not already known, confirm whether RCMP and/or the Chief Medical Examiner have an ongoing interest in remains under *The Fatalities Inquiries Act.*	
Step 6				If remains are **non-forensic** and their removal is required to protect remains, lead exhumation of human remains.	If remains are **forensic** in nature or cannot be immediately determined whether remains are forensic, RCMP and Chief Medical Examiner have jurisdiction over area of find and human remains

Discovery of Human Remains					
	On Site Lead	Transmission & Distribution Environment and Engagement (T&DEE)	Archaeologist	Manitoba Historic Resources Branch (HRB)	RCMP
Step 7		If human remains are left in place where discovered, Community Representative(s) may arrange for and facilitate an appropriate ceremony	HRB and/or archaeologist directs cautious investigation of surrounding surface prior to exhumation of remains to determine if other human remains or artifacts are in area		
Step 8			Locate and document human remains with GPS, record relevant data and submit with reports to HRB, construction supervisor and Community Representative(s)	Oversee basic non-invasive physical anthropological techniques, including drawings, sketches and initial measurements to assist in determining basic information about individual	
Step 9	Construction activities in vicinity of site that will not impact artifacts or related archeological activities may proceed	T&DEE would work with communities to decide whether and what type of analysis would be done on remains	No construction activities within buffer until archaeologist has completed archaeological investigation		

1.6 Heritage resources

Heritage resources are the physical remains of past cultures. They are the product of human art, workmanship, or use, including plant and animal remains that have been modified by or left behind due to human activities.

The *Manitoba Heritage Resources Act* (1986) defines "Heritage Resource" as:

(a) a heritage site

(b) a heritage object

(c) any work or assembly of works of nature or of human endeavour that is of value for its archaeological, palaeontological, pre-historic, historic, cultural, natural, scientific, or aesthetic features, and may be in the form of sites or objects or a combination thereof (Section 1)

There are two types of heritage resources, **artifacts,** and features. Heritage objects (artifacts) can be as small as a single stone flake (a product from stone tool production) or as large as a shipwreck. Other types of artifacts can include butchered animal bones, pottery, and historic materials such as nails, bottle glass, beads that are at least 75 years or older. Features are in situ (or in place) objects or changes to the landscape that are non-portable, meaning that they cannot be easily removed from their original location. Examples of features include petroforms (stones that have been placed in a shape or design and may be an effigy of an animal or thunderbird nest). Stones were also used as waymarkers or could indicate a food cache or burial location.

All heritage resources, whether a single isolated find (such as single artifacts) or a site with numerous artifacts and/or features, are protected under the Act. These physical remains can provide some evidence of specific activities such as campsites, workstations, quarries, kill sites, and post-contact settlement, industry, and events. Deliberate destruction or disturbance of heritage resources is considered an offence. Certain heritage resources have special consideration such as pictographs, petroforms or ceremonial sites and represent a connection to First Nation and Metis to the landscape.

1.7 Cultural resources

For the purposes of this plan, Manitoba Hydro defines cultural resources as an object, site, or location of a traditional or cultural practice that is the focus of traditional or contemporary use and is of continuing importance to people. Some examples include important resource gathering areas, sites of spiritual significance or ceremonial sites.

Although there are some commonalities, each community has a unique interpretation of what the cultural resource value represents.

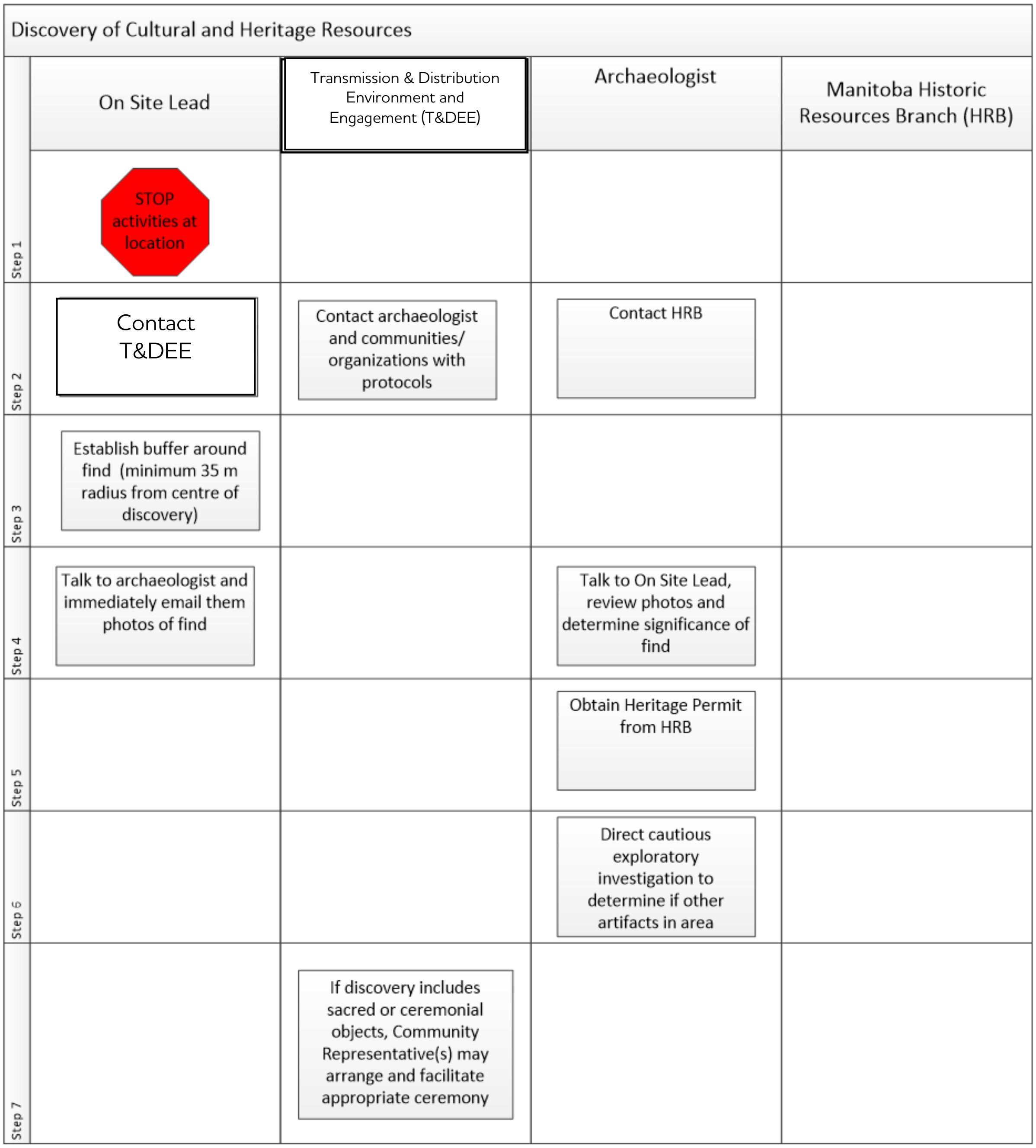
1.8 Practices Manitoba Hydro will follow if cultural and heritage resources are found

Manitoba Hydro and its contractors will leave all artifacts **in situ**, that is, in the same position and will not remove objects from the site until advised by the archaeologist. There will be no activities within the buffer until the archaeologist has completed their archaeological investigation. No reports related to any such find and its analysis will be published, other than such reports provided to Manitoba Hydro and the Historic

Resources Branch or other agencies, as may be required by law.

The following describes the practices that Manitoba Hydro will follow if cultural and heritage resources are found:

Figure 1-2: Discovery of cultural and heritage resources



Discovery of Heritage Resources

	On Site Lead	Transmission & Distribution Environment and Engagement (T&DEE)	Archaeologist	Manitoba Historic Resources Branch (HRB)
Step 7			Undertake: extended surface reconnaissance; - shovel tests at regular intervals perpendicular and parallel to artifact deposit; - controlled collection of data about artifacts, including mapping using global positioning system or chain and compass; and - test excavations, if necessary	
Step 8			Locate and document finds with GPS, record relevant data	
Step 9			Collect and place artifacts in protective container include date, project, contents, coordinates and other information, including site classification	
Step 10				Evaluate heritage resource site and findings presented by archaeologist to determine if further mitigative action is necessary before construction in site vicinity may continue
Step 11	Construction activities in vicinity of site that will not impact artifacts or related archeological activities may proceed		If MH cannot avoid site based on progress of construction, direct site's removal by standard and most appropriate excavation methods.	No construction activities will take place at site until HRB is satisfied that site removal is complete and meets provincial standards
Step 12			Submit copies of technical data and reports to HRB and MH	

2.0 Reporting and follow-up

The archaeologist will establish and maintain a record for each discovered or disturbed heritage object and of any human remains found during construction. Information will include the **provenience**, artifact chain of custody, as well as a conservation and /or identification plan for the heritage resource or resources associated with each record. This is a requirement of *The Heritage Resources Act*. The Province of Manitoba manages a descriptive inventory regarding the physical location and composition of archaeological sites. All artifacts and field-collected data such as notes, photographs and geo-referenced information is provided to the HRB who has ownership of heritage resources found in the province.

The archaeologist will prepare an annual report, as well as updated summaries and technical reports as are necessary, to the HRB as partial fulfillment of the Heritage Permit and to Manitoba Hydro who in turn will share with the applicable Community Representative(s). The report will provide the following information:

- A record of the human remains found. This will include the reporting, exhumation, and reburial of the found human remains per the provincial policy, the date of the report and the process by which Manitoba Hydro managed, honored, and reinterred the remains.
- A record of archaeological investigations and finds documented throughout each year.
- A summary of any directions provided by the Community Representative(s) regarding permission granted to conduct specialized analysis (where such permission is required).
- A record of the heritage objects that Manitoba Hydro found and the process by which they managed the heritage objects.
- Any additional information concerning matters of significance related to heritage resources.

Manitoba Hydro will treat information shared by Indigenous communities regarding burial sites, sacred sites and other sites traditionally and presently used for cultural and ceremonial purposes as confidential and may only be shared with the province or other authorities if agreed upon by the community to which the resource is associated.

Specific information regarding details or locational information of these cultural or ceremonial sites will not be included in the recording or reporting processes nor included in the HRB's site database.

Manitoba Hydro appreciates that this is sensitive information; the reports will be treated as confidential, unless otherwise authorized or specified by the Community Representative(s), if applicable, in discussion with the HRB.

The archaeologist will prepare an overview of the annual report and provide it T&DEE to review with the on-site supervisor. The overview report will not contain confidential information but will include information required by the on-site supervisor to fulfill regulatory and managerial responsibilities.

If requested, the archaeologist will meet with the applicable Community Representative(s), HRB and the Manitoba Hydro Transmission & Distribution Environment and Engagement Department to review the reports.

3.0 Glossary of terms

Artifacts	Any object made or modified by a human being.
Caches	Rock features in which supplies were stored.
Cultural Resource	An object, site or location of a traditional or cultural practice that is the focus of traditional or contemporary use and is of continuing importance to people.
Diagnostic	Any artifact that provides information as to cultural affiliation or age.
Exhumation	The act of removing a buried, or once buried, human body from the grave or found location.
Funerary goods	Items placed with a person at the time when they were buried. Often referred to as Grave Goods, these items are treated no differently than the person's actual skeletal remains.
Forensic	Of interest to law enforcement or Office of Chief Medical Examiner.
Heritage Resource	The Manitoba Heritage Resources Act (1986) defines "Heritage Resource" as: (as) a heritage site; (b) a heritage object, and; (c) any work or assembly of works of nature or of human endeavour that is of value for its archaeological, palaeontological, pre-historic, historic, cultural, natural, scientific or aesthetic features, and may be in the form of sites or objects or a combination thereof (Section 1).
Human Remains	The remains of human bodies, normally referring to those recovered in the skeletal form. This may range from a single bone or tooth to complete skeletons.
Identification	Refers to the process of examining human skeletal remains in order to determine jurisdiction and disposition of the remains. The may be done by archaeologists trained in human osteology, or physical anthropologists. Age at death, sex, height, general health, relative age: recent, early contact or ancient age may be possible along with ethnic identification.
In situ	An artifact is found in the exact spot that it was probably deposited at some time in the past.
Manitoba's Burials Policy (1987)	Short name of: '*Province of Manitoba Policy Concerning the Reporting, Exhumation, and Reburial of Found Human Remains*.' This is the 1987 Provincial Cabinet approved policy based on *The Heritage Resources Act* (1986) governing and directing the actions, responsibilities, duties and task to be undertaken upon the discovery of found human remains in Manitoba.

Matrix	The consistency and quality of the soil.
Morphology	The form, structure, and method by which an object is created.
Non-Forensic	Not of interest to law enforcement or Office of Chief Medical Examiner.
Ochre	An earthy clay colored by iron oxide – usually red but can be yellow.
Provenience	The original place of an artifact. Can be measured by two or three-points.
Stratum	A layer of soil that is distinct and separate from that above and below it.
Skeletal Remains	Skeletal remains are all that is left of a corpse after nature has taken its course and has disposed of skin, tissue, and any other organ that may cover the skeletal frame.
The Heritage Resources Act (1986)	The Provincial legislation (law) governing the physical heritage of all Manitobans, located in Manitoba on either provincial crown lands or private lands within the province of Manitoba.
Way-markers	A sign or feature that marks a portage or trail or announces a change in direction.

Appendix A: Resources Identification Guide

Examples of cultural and heritage resources of potential interest

The following are some examples of surface or sub-surface heritage objects or features that may be encountered in the field that have the potential to be of archaeological interest or cultural significance. These descriptions are provided for information only. When the features described in these examples are encountered in the field, or when it is otherwise believed that a site potentially may be of archaeological interest, a Manitoba Hydro On-Site Supervisor/delegate or Environmental Inspector/Officer must be notified**.**

In situ artifacts

Projectile points, pottery, historic trade goods and thousands of other types of artifacts have been recovered from across the province. Before collection, the artifact will be photographed, and the surrounding vegetation and soils described in detail. If a **diagnostic** artifact is found during a controlled surface collection, the recovery of the artifact will not take place until mapping is complete.

Often metal objects are found abandoned along old portage routes, former trails and at long-forgotten cabin sites. This old, blue enameled kettle was found in the hollow of a tree with tin cups nestled inside. The way that metal tins were constructed can be dated. Glass fragments can also be identified as belonging to a certain time period. The morphology and markings on bottles help archaeologists to date sites.

Pre-contact pottery sherd

Historic period kettle and tin cups

Projectile point (left) and lithic flake (right)

Soil Staining

Discolourations in the soil may indicate an archaeological site. The following examples are common colours associated with artifacts, features that have been found within the province.

Red or yellow **Ochre** or rust stains can be found in the soil. They can be the result of oxidized metal fragments or nails; red or yellow ochre nodules may indicate a burial or ceremonial activity.

Soil staining can also be found in the form of charcoal flecks and white ash from a hearth or fire pit. Black soil stains may indicate human activity and organic materials or a living floor. Cultural strata can vary in depths depending on the length of occupation at the site. The presence of burned bone, fire-cracked rock, stone chips, pottery, and other objects may be found in association with soil discolouration and would confirm the soil staining is a cultural layer.


Ash and organic soil staining of a hearth

Animal Bone

Animal Bone (mammal, bird, fish) at a site can indicate the kinds of resources that were being used as food as well as indicate seasonality of occupation.

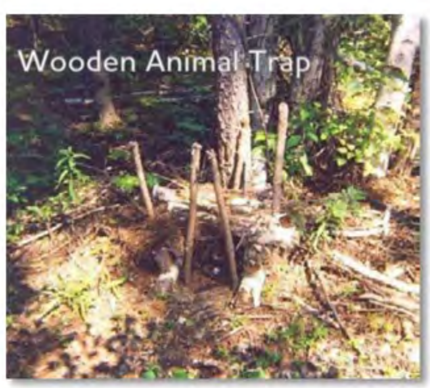
Bone was also an important material for tool manufacturing. Common bone tools include fleshers and beamers fashioned from large mammal long bones, barbed spear points and harpoons, awls, and needles. Bones at a site can indicate the kinds of animals that were being used as food. The ulna of swans, eagles and other large birds were used for bird whistles.


Animal Long Bone with red staining

Key features to look for on bones to determine if they have been deposited by humans include signs of cut-marks or burning or staining which may indicate human modification by various butchering or processing techniques.

Culturally modified trees

Occasionally evidence of cultural practices is found in the form of modified trees such as the birch trees noted in this photograph. Birch bark was used for many purposes such as storage baskets, canoes and more recently, birch-bark biting crafts. Cut wood has been used to construct an animal trap, as a material for building or for firewood and indicates that humans have been in the area.



Stone features

There are many kinds of stone alignments that have been constructed by humans: **Way-markers**, **caches**, ceremonial sites, building foundations, tepee rings and burials are the major rock features that are found during archaeological investigations. These can be on or above the ground surface or buried features.


Petroform in the shape of a turtle


Rock Cairn

Ground or Structural Features

It is especially important to note unusual ground features. Depressions or mounds that are out-of-place from the surrounding landscape may indicate an underlying structure or possible burial. The way structural features are constructed can be dated.

Appendix B: Cultural and heritage resource protection protocol

Community/Organization: ____

1. Do you want Manitoba Hydro to notify your community/organization about cultural and heritage discoveries?

   Yes ☐ No ☐

2. If yes, we would like to be notified about the following type of discoveries:

Human remains	Yes	☐	No	☐
Heritage/cultural resources (pictographs, petroforms, bone tools)	Yes	☐	No	☐

3. Leadership have chosen ____________________________as the community representative that Manitoba Hydro should contact for heritage or cultural resources discoveries

Phone number: ____

Cell phone: ____

Email address: ____

Preference for contact ____

(i.e.: cell phone, email)

4. Should a previously unrecorded heritage or cultural resource be encountered, would your community like to conduct a ceremonial or spiritual activity?

   Yes ☐ No ☐

5. Could you please draw the area of interest to your community for cultural and heritage resources on the attached map? This information can be kept confidential.

6. Are you aware of recent discoveries of the following in the area near the project:

Human remains	Yes	☐	No	☐
Heritage/cultural resources	Yes	☐	No	☐

7. Have you received a copy of the Cultural and Heritage Resources Protection Plan?

   Yes ☐ No ☐

Date: ____________________

Filled out by (Please print): ____________________

Signature ____________________

Appendix M

Access Management Plan

Pointe du Bois to Whiteshell station 115kV Transmission Line (PW75)

Construction Access Management Plan

June 2023

Prepared by Manitoba Hydro

Transmission & Distribution Environment and Engagement Department

Project Management Division

Manitoba Hydro

Preface

This document presents the Construction Access Management Plan (the Plan) for the construction of the Pointe du Bois to Whiteshell station 115kV transmission line (the Project). It is intended to provide information and instruction to Manitoba Hydro employees as well as contractors, regulators, and members of the public. The Plan provides regulatory context as well as general considerations and guidance pertinent to how Manitoba Hydro will access the Right of way (ROW) during the construction phase in the Project area within Manitoba. Manitoba Hydro employees and contractors are encouraged to contact the onsite Manitoba Hydro Environmental Inspector/Officer if they require information, clarification, or support. Regulators and the Public are to direct any inquiries about this Plan to:

Manitoba Hydro

Transmission & Distribution Environment and Engagement
360 Portage Avenue
Winnipeg, MB
Canada R3C 0G8
1-877-343-1631

Projects@hydro.mb.ca

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Definitions

Approach: These are either temporary or permanent structures to allow access through a ditch or drain.

Access Point: These are locations where the ROW intersects and existing road, highway, or trail.

Access Route: These are roads, and trails that facilitate access from a Provincial Road or Highway, they are primarily existing, however new access routes may be developed, new developed access routes are primarily trails less than 15 m in width construction.

Right of Way Access Trail: This access trail is along the entire length of the ROW and is approximately 15m in width, typically centered in the ROW to accommodate construction activities and allow access around towers and stringing equipment. The ROW access trail is not a continually active road and not constructed (no cut and fill, soil storage or use of gravel base) or maintained as such during operations.

By-Pass Trail: This type of trail is typically outside the ROW and less than 15m in width and vary in length depending on obstacle on the ROW being avoided (e.g., unfrozen wetland, steep slope). A By-Pass Trail is not a continually active road and not constructed (no cut and fill, soil storage or use of gravel base) or maintained as such during operations.

List of Acronyms

AC	Alternating current
AMP	Access Management Plan
IK	Indigenous Knowledge
ATV	All-terrain Vehicle
CEnvPP	Construction Environmental Protection Plan
ESS	Environmentally Sensitive Site
kV	Kilovolt
ORV	Off-road Vehicle
PR	Provincial Road
PTH	Provincial Trunk Highway
RCMP	Royal Canadian Mounted Police
ROW	Right-of-way
MH	Manitoba Hydro

1.0 Introduction

Consistent with its corporate Environmental Management Policy, Manitoba Hydro has committed within the Construction Environmental Protection Plan to managing construction access as part of a larger suite of mitigation measures to minimize potential negative environmental and socio-economic effects. This access management plan (AMP) is designed to accomplish this goal. General and site-specific access management mitigation strategies are detailed in the Pointe du Bois to Whiteshell (PW75) Construction Environmental Protection Plan (CEnvPP).

Manitoba Hydro's Environmental Protection Program (EPP) provides the framework for the delivery, management and monitoring of environmental and socio-economic protection measures that satisfy corporate policies and commitments, regulatory requirements, environmental protection guidelines and best practices, and input during the Public Engagement Process (PEP). The Program describes how Manitoba Hydro is organized and functions to deliver timely, effective, and comprehensive solutions and mitigation measures to address potential environmental effects. This AMP is a component of the EPP as illustrated in Figure 1.

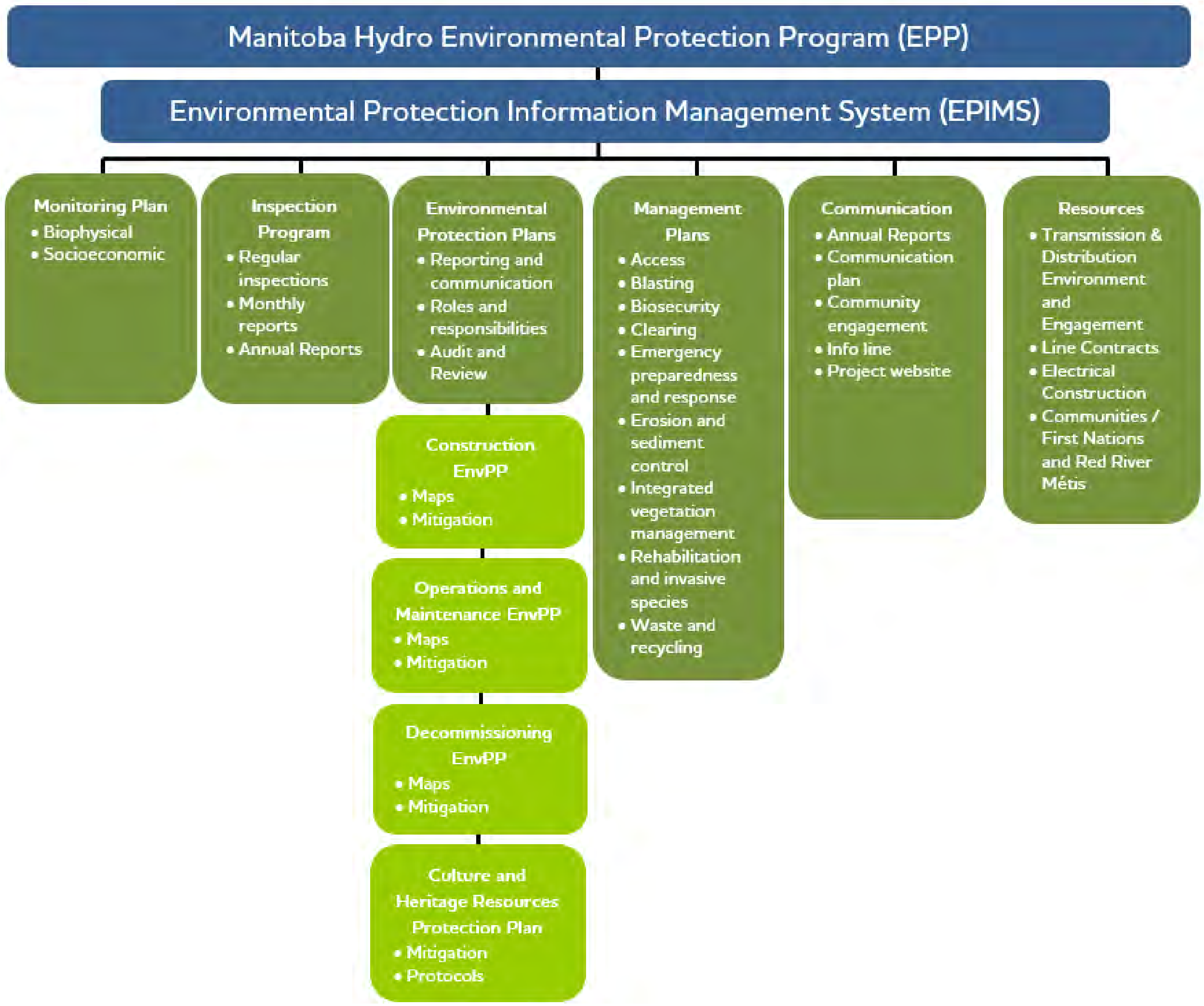

Figure 1: Transmission Environmental Protection Program

In this document access management for the project is considered only during the construction phase of the development. The implementation of this AMP requires the performance of tasks prior to and during construction.

1.1 Commitment to environmental protection

Manitoba Hydro integrates environmentally responsible practices in all aspects of our business. Environmental protection can only be achieved with the involvement of Manitoba Hydro employees, consultants, contractors, Indigenous communities and organizations and the public at all stages of the project from planning and design through construction and operational phases.

The use of an AMP is a practical and direct implementation of Manitoba Hydro's environmental policy and its commitment to responsible environmental and social stewardship. It is a proactive approach to manage potential effects of access related to the construction of a new transmission line and minimizes the needs for site rehabilitation and invasive species management as well as minimizing the impacts on cultural and heritage resources.

Manitoba Hydro is committed to implementing this AMP and requiring contractors to follow the terms of this and other applicable plans within the Environmental Protection Program.

1.1 Purpose and objectives

The AMP is intended to address concerns regarding the preservation of environmental, socio-economic, cultural and heritage values within the projects' area of direct impacts. The focus of this AMP is on the construction phase of the project.

The objectives of the AMP are to:

- Provide for safe, coordinated access onto and along the project construction site for project workers
- Support sustainable use through the protection of natural resources within the Project area
- Support the preservation of socio-economic, cultural, spiritual and heritage values within the Project area
- Allow Manitoba Hydro staff and contractors to construct the project year-round (where applicable)
- Provide security for project personnel and property.
- Prescribe strategies and mitigation measures to minimize potential negative direct and indirect effects of project access.

1.2 Roles and responsibilities

A successful construction program requires commitment and cooperation from all participants. Instrumental for those involved is to fully understand their roles, responsibilities, and lines of communication within the project. For purposes of implementing this AMP, responsibilities rest with Manitoba Hydro's Project Engineer, Line Contact Administrator, Line Construction Business Partner/Environmental Specialist, Environmental Officer/ Inspectors, and the construction contractors' Project Manager/Supervisor, and environmental representative. The communication and reporting structure is detailed in Figure 2. Their key responsibilities are shown in Table 1.

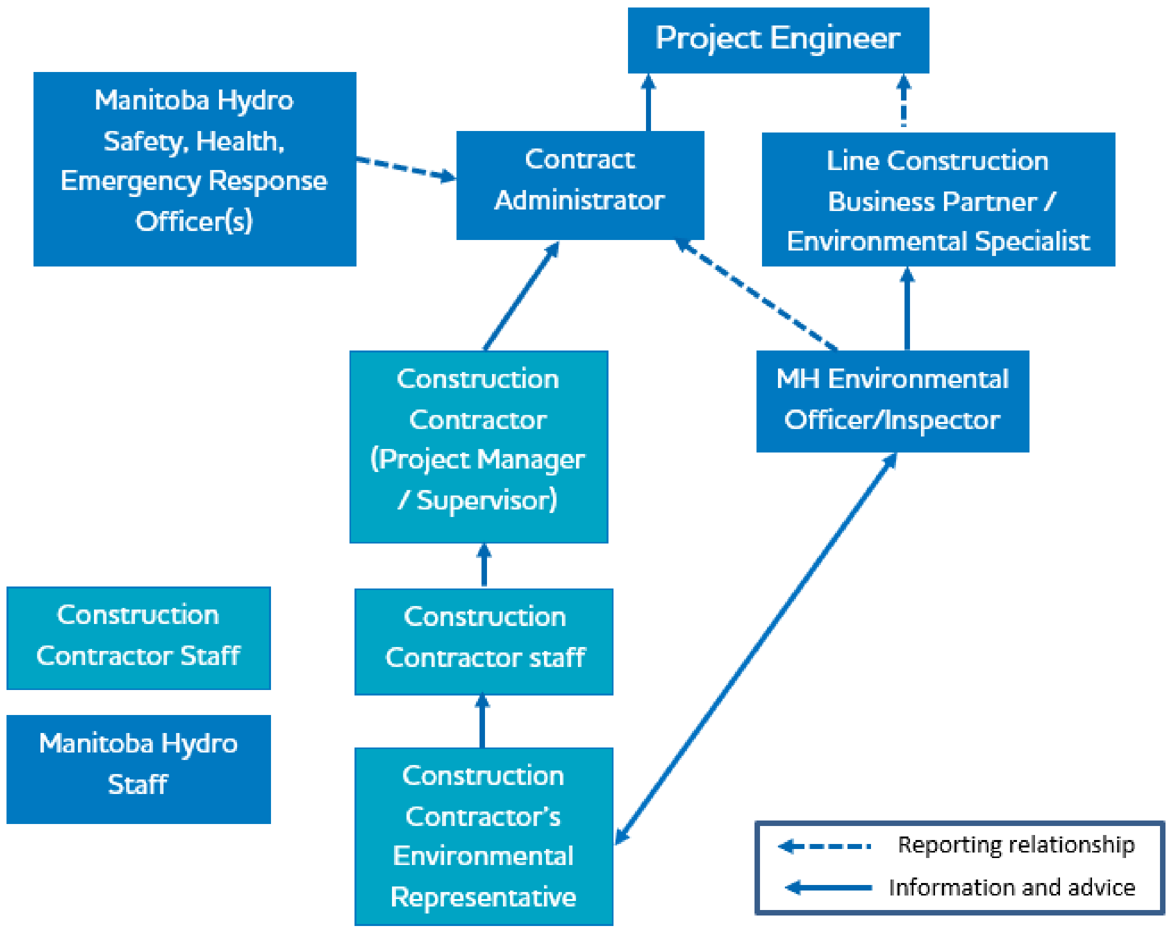

Figure 2: Environmental communication reporting structure

Table 1: Key roles and responsibilities

Role	Key responsibilities
Manitoba Hydro	• Provides advice and guidance on access management and environmental protection matters • Issues environmental improvement and stop work orders as required for non-compliance issues • Responsible for the inspection of compliance with CEnvPP • Seeks approval for any access routes or by-pass trails from landowner. • Liaises with regional regulatory authorities and other regulatory authorities where required or applicable • Responsible for implementing compliance inspection to ensure consistent and accurate reporting into EPIMS • Responsible for MH project staff compliance with Access Management Plan • Ensures construction contractor(s) implementation of remedial actions, responses to non-compliance situations or incidents are implemented as required • Ensures that appropriate authorities are notified in emergency or incident situations • Implement invasive species management treatment options where required

Table 1: Key roles and responsibilities

Role	Key responsibilities
Construction contractor(s)	• Accountable for all regulatory and environmental prescriptions (i.e., follow CEnvPP and mitigation measures prescribed) • Ensure all contractor project staff are adequately trained/informed of pertinent access requirements of the Project related to their position • Report any discoveries of non-compliance, accidents or incidents to the Line contracts representative and environmental inspector/officer • Ensure that all remedial actions are carried out as per Manitoba Hydro instruction • Ensures contractor staff utilize only approved access as per Construction Environmental Protection Plan Mapbook • Ensures all discoveries of heritage resources, human remains, paleontological finds, environmentally sensitive sites, etc. are reported to supervisor or contractor's environmental representative • Responsible for implementation, coordination, and verification of pre-project employee environmental orientation • Ensures that the contractor employees adhere to all aspects of the AMP • Sign and/or flag all access approaches, points, routes, bypass trails in the field as per flagging and signage standards • Communicate any access related issues and/or concerns to Manitoba Hydro Environmental Officer

2.0 Implementation

This section discusses the proposed access strategies for construction purposes and describes the proposed access routes to be used for construction.

2.1 Construction access management plan coverage

From a geographic perspective the scope of this AMP includes the project's transmission construction site (i.e., rights-of-way, camps, marshalling yards, borrow pits and access trails specifically constructed for project purposes). Public access restrictions are primarily limited to the "active" construction site, for reasons of safety, and will generally not interfere with traditional traffic patterns.

This AMP also addresses project specific issues relating to existing provincial and municipal roads and concerns relating to private lands within Manitoba Hydro's control. Manitoba Hydro will minimize damage to infrastructure and private lands from its activities, and where possible, limit third party access to the active construction site. Of greatest concern are areas with environmental sensitivities, and areas of work force concentrations (e.g., camps, marshalling yards).

2.2 Identification of potential construction access opportunities

Manitoba Hydro has conducted a survey along the final preferred route to identify all potential construction access opportunities to the ROW using existing roads and trails.

These access opportunities outlined in Construction Environmental Protection Plan Mapbook have been selected based on the following criteria:

- To provide reasonable and safe entrance and egress to the transmission line ROW while minimizing disruption to provincial, municipal, and private roads along with trails and private property
- To ensure that there a minimum of one access point to get to any given location on the ROW
- To provide good visibility for upcoming traffic at each access point turn off from existing roads and trails

- To minimize the number of new access ditch crossings and potential culverts where the ROW intersects existing roads or trails by utilizing existing crossings if available within the ROW. If there is an existing crossing outside of the ROW within reasonable distance from the ROW, obtain permission to utilize crossing from owner
- Minimize the use of existing access routes in heavily populated residential areas
- Minimize the use of private roads and trails

2.3 Transmission line construction access opportunities

Manitoba Hydro and its contractors will use existing roads, trails, and linear features where possible for accessing the project construction site. To facilitate this, Manitoba Hydro has identified existing strategic access routes relative to the construction site and major roads to guide construction planners and contractors.

The Construction Environmental Protection Plan Mapbook illustrates the existing access opportunities (i.e., intersections between the proposed ROW and existing highways, roads, trails, and linear features) that minimize the need for new access development to access the ROWs. The AMP will restrict Manitoba Hydro and its contractors to use the identified access options, thereby minimizing project effects as they relate to access.

2.4 Access mitigation measures

Manitoba Hydro, its personnel, contractors, and consultants will adhere to the access management measures (AMMs) outlined in Section 5.0 (Table Access Roads and Trails PC-1) in the Construction Environmental Protection Plan (CEnvPP).

2.5 By-pass routes and trails

Manitoba Hydro and its contractors will be accessing the ROW through existing trails and access points to the extent feasible. However, in some instances there may be a requirement for a by-pass trail located outside, but along the ROW, or the creation of a new access route to the ROW. In those situations where a new by-pass trail/access route would be required, Manitoba Hydro would undertake the following process to:

1) site the by-pass trail/access route
2) evaluate location for environmental and cultural sensitivities

3) ensure any new by-pass trails/access routes follow the applicable mitigation measures as outlined in the Construction Environmental Protection Plan (CEnvPP).

Figure 3 illustrates the process and details of the steps are provided to operationalize the process.

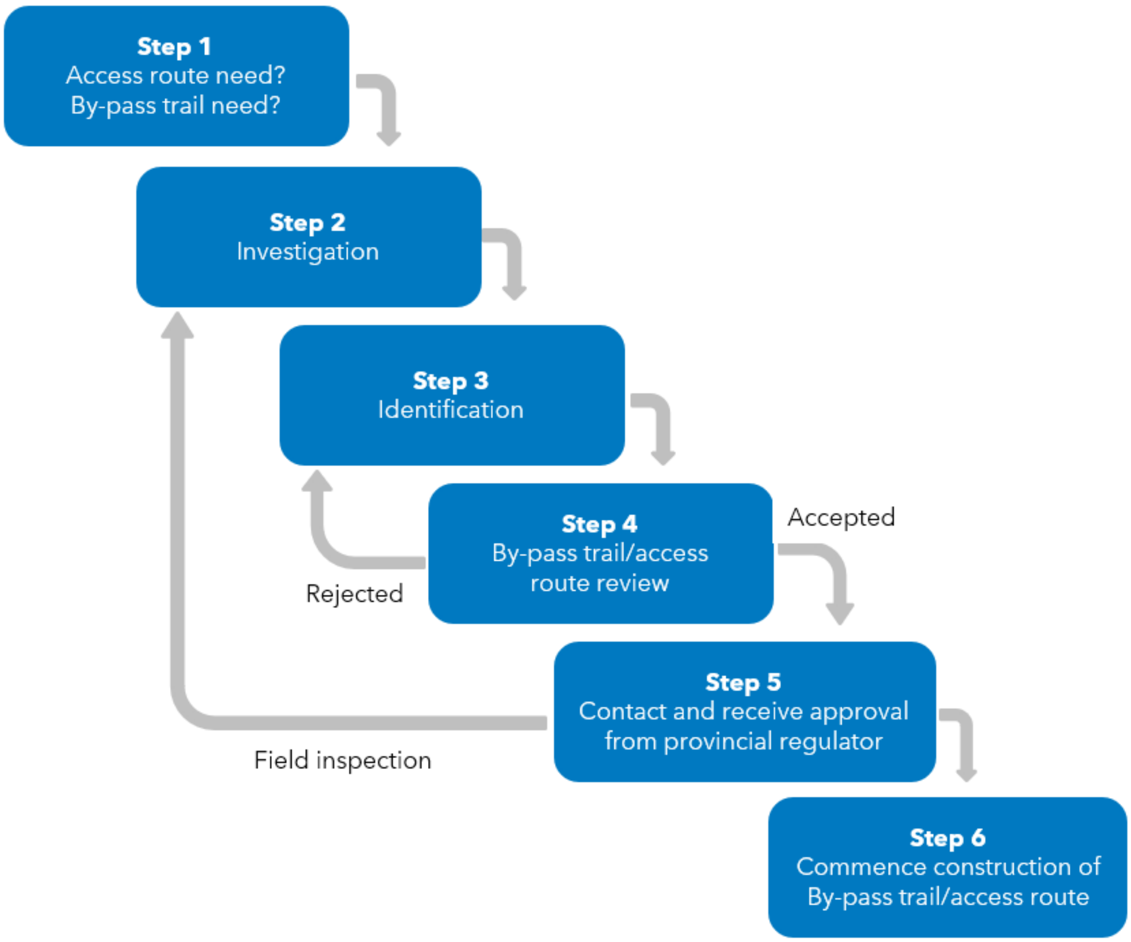

Figure 3: By-pass trail/access route siting and approval process on Crown land

Step 1: Determine by-pass trail/access route need: Manitoba Hydro in conjunction with the contractor identifies the need for a by-pass trail or new access route (i.e., unfrozen wetlands, impassable terrain) outside of the approved access routes and the potential by-pass areas identified in this plan. If any new access routes or by-pass trail is required on private land, MH will seek written approval from the landowner.

Step 2: Investigation: Manitoba Hydro and contractor will assess potential by-pass area/access route area on foot for a viable location. In some instances, an overflight may be required.

Step 3: Identification: Manitoba Hydro Environmental Officer/Inspector will review the by-pass trail/access route for the presence of environmentally sensitive sites, invasive species, or any other biosecurity concerns. If none are found they will identify and verify the location of the by-pass trail/access route and sensitive sites by recording GPS coordinates and flagging the centerline, buffers and/or boundaries.

Step 4: By-pass trail/access route review: Manitoba Hydro Line Construction Business partner or Environmental Officer will review by-pass trail/access route and evaluate against known Environmentally Sensitive Sites (ESS) as well as sensitive sites identified by the Environmental Inspector's site investigation. **If rejected**, by-pass trail/access route alternatives will be suggested for field assessment (Return to Step 3) and the process of submitting "unplanned infrastructure" through EPIMS will be restarted. **If accepted**, proceeds to Step 5 or 6 for approval.

Step 5: Contact and receive approval from provincial regulator: If by-pass trail/access route is accepted in Step 4, it will be added to the AMP and appropriate CEnvPP including any ESS sites and sent to the provincial regulator for approval.

Step 6: Commence construction of by-pass trail/access route: Implement mitigation and commence construction. Manitoba Hydro will identify and document any by-pass trails/access routes that may be required post construction for line maintenance activities and incorporate into the Operations and Maintenance Environmental Protection Plan.

2.6 Traffic safety and access management mechanisms overview

Manitoba Hydro and its contractors will rely extensively on the provincial and municipal existing road infrastructure to transport vehicles, personnel, equipment, and materials to the Project construction site. In the interests of safety, Manitoba Hydro expects that all personnel and those of its contractors and consultants will adhere to all traffic laws while engaged in project related activities and while commuting back and forth between their residences/camps/offices and the construction site.

Safety is of primary concern during the construction phase for construction workers, stakeholders, and the public. During the clearing and construction process, a seasonal access trail will be constructed on the rights-of-way to facilitate the transportation of construction materials, equipment, and workers. Manitoba Hydro and its contractors will restrict non-project traffic on and along the active construction site during this period.

Where Manitoba Hydro and its contractor staff encounter non-project related traffic on the active construction site, safety advisory information will be provided, and individuals will be asked to vacate the area for reasons of safety.

Signs may be placed at road/rights-of-way crossings and other locations in the active construction area to discourage/minimize access and to outline safety concerns.

Various types of signage may be used to convey safety or educational information, including:

- No hunting/shooting
- Guy wire shields/sleeves (brightly colored and/or reflective), where appropriate
- Reflective tape on tower legs and other obstructions
- Access restrictions to specific infrastructure sites (e.g., transformer, converter, repeater stations)
- Access restrictions to hazardous materials and petroleum storage sites
- Warning signs on vehicles transporting hazardous materials and petroleum products
- Private land
- Directional guidance signs
- High risk wildlife collision areas
- Speed limit postings
- Road/trail hazard warning signs
- Bollards, signage at water wells, petroleum storage areas, etc.
- Other

Manitoba Hydro will determine the type and quantity of signage required for the contractor to supply and install.

2.6.1 Access allowance

During the construction phase of the project, one of Manitoba Hydro's concerns is safety for workers and others who may access the active construction site. Access and safety issues will be monitored by the construction contractor, the Manitoba Hydro Line contracts representative, and the Environmental Officer/Inspector.

All intersecting trails/roads will be kept clear of debris so as not to impede existing travel routes. Manitoba Hydro will limit/restrict access to the active construction site as safety is a primary consideration.

Those authorized to access the active construction site (including work camps) are noted in Table 3. Manitoba Hydro and its contractors will carefully monitor for safety and security issues and, if problems warrant, are prepared to limit access to only those directly associated with the project.

Table 2: Access allowance and authorization in active construction areas

User	Type of user	Authority
Project traffic	Manitoba Hydro staff	No conditions
	Contractor personnel	
	Government (provincial and federal) personnel	Line contracts representative
	Research and monitoring personnel	
	Emergency vehicles/personnel	No conditions
Resource harvesters	Licensed outfitters/rights-based hunters	Line contracts representative or delegate
Non-project traffic	Public	Restricted
Others	Community officials, Manitoba Hydro staff/ officials/ contractors/ consultants, employee family members	Line contracts representative or delegate
	School and public tours, media, etc.	

2.6.2 Recreational vehicles

Project personnel will not be permitted to transport, use, or store their personal off-road vehicles (ORV) (e.g., snowmobiles, all-terrain vehicles, boats, etc.) on the construction site where the intent of use is not project work related. This condition will form part of the condition of employment and will be conveyed to all personnel at the time of hire. Breach of the condition will be grounds for disciplinary action, including dismissal. Manitoba Hydro and contractor ORV equipment shall be used exclusively for project work related purposes.

2.6.3 Temporary work camp sites, marshalling yards and borrow pits

Temporary work camp sites, marshalling yards and borrow pits used for project purposes form part of the construction site. All project related access management measures shall apply to these sites. When any of the new sites are no longer required for project purposes, and if not required by other non-project parties (e.g., Manitoba Environment and Climate, Manitoba Transportation and Infrastructure, etc.), access into such sites may be decommissioned and all project personnel will be restricted from entering such sites. Access decommissioning could include the placement of impediments (e.g., berms, boulders, debris, etc.) to restrict public access.

2.6.4 Compliance

Manitoba Hydro Environmental Officers/Inspectors will regularly inspect all aspects of the clearing and construction work to ensure compliance with the Environment Act licence, work permits, regulations, applicable guidelines and the applicable CEnvPP. Manitoba Hydro and its' contractor personnel will limit/restrict non-project related vehicles and personnel on the construction site with particular emphasis on the active construction site. Information about safety, firearms/weapons rules will be distributed, as required, through:

- Signage at access points and on the construction site
- Orientation of all workers

Breach of stated employment conditions (e.g., ORV, weapons, fishing) by Manitoba Hydro employees or contractor staff will result in disciplinary action, including potential dismissal from employment.

Clear communication of restrictions and safety measures, included in the construction access management plan, to workers, resource harvesters, stakeholders and local Aboriginal communities will contribute to safe work practices and the prevention of conflicts.

2.7 Education and training

Training and communication form a critical component of the implementation plan. Manitoba Hydro will hold a contractor environmental pre-construction requirements orientation meeting to review project specifics and key environmental requirements with its contractors at a supervisory level. A summary of this Access Management Plan, implementation requirements, roles and responsibilities, and Manitoba Hydro's expectations will be presented at that time.

2.8 Access rehabilitation

Transmission development on the landscape often requires the creation of or improving of existing access roads and trails to facilitate construction and operation of the development. Manitoba Hydro's preference is to utilize existing roads and trails to the extent possible prior to development of any new access routes. The use of existing access routes may result in vegetation removal and road base improvements. Where access is not required for operations those access routes may require decommissioning activities such as trenching and mounding and/or vegetation rehabilitation to ensure that areas previously inaccessible are returned to that state. Prior to access route development the route will be assessed for existing access restrictions, including details such as trail width, vegetation, presence of previous decommissioning activity.

Appendix N

Example Environmental Pre-Work Orientation Record

Pointe du Bois to Whiteshell 115kV transmission line (PW75)

Line Contracts Contractor Commencement Meeting

Environmental Requirements Orientation

The following Manitoba Hydro Contractor Environmental Requirements Orientation will be reviewed by Manitoba Hydro at the Contractor Commencement Meeting. All individuals in attendance at the Contractor Commencement Meeting will be recorded and the attendance list will be attached to the signed copy of this document

Division:	**Construction Division**
Department:	**Line Contracts Department**
Project Name:	**Pointe du Bois to Whiteshell 115kV T/L (PW75)**
Contract Number:	**TBD**
Work Location:	
Meeting Date:	**YYYY/MM/DD**
Contractor:	

Manitoba Hydro Contact Information (To Be Determined)
Manitoba Hydro Project Engineer: Name First and Last, email; (204) 123-4567 address; ___, Manitoba; A1B 2C3 **Manitoba Hydro Project Engineer:** Name First and Last, email; (204) 123-4567 address; ___, Manitoba; A1B 2C3

Manitoba Hydro Environmental Specialist:
Name First and Last, email; (204) 123-4567
360 Portage Avenue (18); Winnipeg, Manitoba; R3M 3T1
Manitoba Hydro Line Construction Business Partner:
Name First and Last, email; (204) 123-4567
360 Portage Avenue (18); Winnipeg, Manitoba; R3M 3T1
Manitoba Hydro Environmental Officer:
Name First and Last, email; (204) 123-4567
360 Portage Avenue (18); Winnipeg, Manitoba; R3M 3T1
TBD Environmental Inspectors:
Primary: Name First and Last, email; (204) 123-4567
Alternate: Name First and Last, email; (204) 123-4567

Contractor:	**(ALL To Be Determined)**
Contractor Project Manager: ________________________Email: ______________________________________ Address: ____ Phone Numbers: Office (________)____________________________Cell (________)______________________	
Contractor Construction Manager: ________________________________Email: __________________________ Address: ____ Phone Numbers: Office (________)____________________________Cell (________)_______________________	
Contractor Environmental Supervisor: ____Email:______________________________ Address: ____ Phone Numbers: Office (________)____________________________Cell (________)_______________________	

Contractor Environmental Representative:
____Email:__________________________________
__

Address:
____
__

Phone Numbers: Office (_________)______________________________Cell
(_________)_________________________

List Sub-Contractors:

1. ____

2. ____

3. ____

4. ____

5. ____

6. ____

7. ____

Contractor Commencement Meeting- Key Environmental Requirements Checklist:

Topic	Key Environmental Requirements	Discussed
Regulatory Requirements & Environment Act Licence TBD EAL 1234 is in Appendix B of the Construction Environmental Protection Plan Text (pages _ to _)	All work on the project must be completed in accordance with regulatory requirements including applicable federal and provincially legislated regulations as well as municipal bylaws All work on the project must be completed in accordance with conditions identified in the provincial Environment Act Licence 1234	
PW75 Environmental Protection Plan Part 1 TBD CEnvPP text document	All work on the project must be completed in accordance with general environmental information as well in accordance with general environmental mitigation requirements identified in the CEnvPP text document (5 categories): • <u>1) Management Measures</u> Management Measures key environmental requirements include: • TBD • <u>2) Project Activities</u> Blasting and Exploding key environmental requirements include: • TBD Construction Matting key environmental requirements include: • TBD Demobilizing and cleaning up key environmental requirements include: • TBD Directional drilling key environmental requirements include: • TBD Draining key environmental requirements include: • TBD Drilling key environmental requirements include: • TBD	

Topic	Key Environmental Requirements	Discussed
	Grading key environmental requirements include: • TBD Grubbing key environmental requirements include: • TBD Rehabilitating and Re-vegetation key environmental requirements include: • TBD Stripping key environmental requirements include: • TBD 3) Project Components Access Roads and Trails key environmental requirements include: • TBD Borrow pits and quarries key environmental requirements include: • TBD Marshaling yards key environmental requirements include: • TBD Rights-of-way key environmental requirements include: • TBD Transmission towers and conductors key environmental requirements include: • TBD Water Crossings key environmental requirements include: • TBD 4) Environmental Components Agricultural areas key environmental requirements include: • TBD Built-up and populated areas protection key environmental requirements include: • TBD Fish protection key environmental requirements include: • TBD Groundwater key environmental requirements include: • TBD	

Topic	Key Environmental Requirements	Discussed
	Heritage Resources key environmental requirements include: • TBD Wetlands key environmental requirements include: • TBD Wildlife protection key environmental requirements include: • TBD 5) Environmental Issues Hazardous materials key environmental requirements include: • TBD Petroleum products key environmental requirements include: • TBD Potable water key environmental requirements include: • TBD Soil contamination key environmental requirements include: • TBD Vehicle and equipment maintenance key environmental requirements include: • TBD Waste Management key environmental requirements include: • TBD Wastewater key environmental requirements include: • TBD Aircraft use key environmental requirements include: TBD	

Topic	Key Environmental Requirements	Discussed
PW75 Environmental Protection Plan Part 2 TBD CEnvPP Mapbook	Construction Environmental Protection Plan Mapbook All work on the project must be completed in accordance with site specific mitigation requirements for Environmentally Sensitive Areas identified in the CEnvPP mapbook All access on the project must be completed in accordance access identified in the CEnvPP mapbook. Proposed alterations or additions to access identified in the mapbook can typically be approved fairly quickly if requested by email including details of the request and a map All work on the project must be completed in accordance with the biosecurity management plan cleaning requirements for the applicable biosecurity risk level identified in the CEnvPP mapbook.	
PW75 Environmental Protection Plan Appendix A- Contact List Template	A project contact list template is provided in Appendix A of the CEnvPP text document	
PW75 Environmental Protection Plan TBD Appendix B- Environmental licenses, approvals, and permits information	General information about project environmental licenses, approvals, and permits are provided in Appendix B of the CEnvPP text document. Note: Depending on contractor activities other permits may apply ie provincial fuel tank permits, provincial septic install registration, RM approvals, etc	
PW75 Environmental Protection Plan TBD Appendix C- Timing Windows	Project wildlife reduced risk timing windows are provided in Appendix C of the CEnvPP text document	
PW75 Environmental Protection Plan TBD Appendix D- Buffers and Setbacks	Project Buffer and Setback distances are provided in Appendix D of the CEnvPP text document	

Topic	Key Environmental Requirements	Discussed
PW75 Environmental Protection Plan TBD Appendix E- Avian Protection Documents	All work on the project must be completed in accordance with any applicable requirements identified in the Avian Protection Documents in Appendix E of the CEnvPP text document	
PW75 Environmental Protection Plan TBD Appendix F- Reptile and Amphibian Protection Document	All work on the project must be completed in accordance with any applicable requirements identified in the Reptile and Amphibian Protection Document in Appendix F of the CEnvPP text document	
PW75 Environmental Protection Plan TBD Appendix G- Species of Concern Contingency Measures	All work on the project must be completed in accordance with any applicable requirements identified in the Species of Concern Contingency Measures in Appendix G of the CEnvPP text document	
PW75 Environmental Protection Plan TBD Appendix H- Biosecurity Management Plan	All work on the project must be completed in accordance with the requirements identified in the Biosecurity Management Plan in Appendix H of the CEnvPP text document	
PW75 Environmental Protection Plan TBD Appendix I- Erosion and Sediment Control Plan	All work on the project must be completed in accordance with any applicable requirements identified in the Erosion and Sediment Control Plan in Appendix I of the CEnvPP text document	
PW75 Environmental Protection Plan TBD Appendix J- Saturated and Thawed Soils Operating Guidelines	All work on the project must be completed in accordance with the Saturated and Thawed Soils Operating Guidelines in Appendix J of the CEnvPP text document Potential for ground disturbance is a significant risk on this project for any work activities occurring on unfrozen ground if mud is saturated	

Topic	Key Environmental Requirements	Discussed
PW75 Environmental Protection Plan TBD Appendix K- Rules for Externally Reportable Releases	Rules for Externally Reportable Releases is provided in Appendix K of the CEnvPP text document	
PW75 Environmental Protection Plan TBD Appendix L- Cultural and Heritage Resources Protection Plan	All work on the project must be completed in accordance with the requirements identified in the Cultural and Heritages Resources Protection Plan in Appendix L of the CEnvPP text document	
PW75 Environmental Protection Plan TBD Appendix M- Access Management Plan	All work on the project must be completed in accordance with the requirements identified in the Access Management Plan in Appendix M of the CEnvPP text document All gates must be kept closed other than for access	
PW75 Environmental Protection Plan TBD Appendix N- Example Environmental Requirements Orientation	A template for the Environmental Requirements Orientation is provided in Appendix N of the CEnvPP text document	
PW75 Environmental Protection Plan TBD Appendix O- Rehabilitation and Invasive Species Management Plan	All rehabilitation work on the project must be completed in accordance with the requirements identified in the Rehabilitation and Invasive Species Management Plan in Appendix O of the CEnvPP text document	
PW75 Environmental Protection Plan TBD Appendix P- Waste and Recycling Management Plan	All waste generated by project activities must be managed in accordance with the requirements identified in the Waste and Recycling Management Plan in Appendix P of the CEnvPP text document	
PW75 Environmental Protection Plan TBD Appendix Q- Ice Thickness Chart	An ice thickness chart is provided in Appendix Q of the CEnvPP text document	

Topic	Key Environmental Requirements	Discussed
Contractor Environmental Management Plan	All work on the project must be completed in accordance with the requirements identified in the Contractor Environmental Management Plan (unless there is a conflict between the Contractor EMP and the Manitoba Hydro CEnvPP in which case the Manitoba Hydro document will supersede)	
Contractor Weekly & Final Environmental Report	The contractor shall prepare and submit a Weekly Environmental Report as part of the Weekly Progress Report that will include environmental information, descriptions, and statistics for the contractor's site activities. A Final Environmental Report will be submitted after the completion of construction activities.	
Compliance with Environmental Requirements	1) Environmental Corrections 2) Environmental Non-Conformance Reports 3) Environmental Improvement Orders 4) Environmental Stop Work Orders	
Other TBD		

<u>Additional notes:</u>

Schedule a Pre-job Environmental Meeting

The above items have been discussed and understood. ***(Note: This Environmental Requirements Orientation is a summary of some of the key environmental requirements of this project but is not intended to be a comprehensive review).*** Any questions relating to these items or any other project environmental requirements may be further discussed at the project pre-job environmental meeting or during the course of the contract.

"Original Signed by First Last name"

____ ______________

MANITOBA HYDRO REPRESENTATIVE (SIGN) YYYY MM DD

____ ______________

CONTRACTOR'S REPRESENTATIVE (SIGN) YYYY MM DD

Contractor Commencement Meeting Environmental Orientation Attendance List

Name (print)	Company	Signature

Appendix O

Rehabilitation and Invasive Species Management Plan

Pointe du Bois to Whiteshell station 115kV Transmission Line (PW75)

Rehabilitation and Invasive Species Management Plan

June 2023

Prepared by Manitoba Hydro

Transmission & Distribution Environment and Engagement Department

Project Management Division

Preface

This document presents the Rehabilitation and Invasive Species Management Plan (the Plan) for the construction of the Pointe du Bois to Whiteshell station 115kV transmission line (the Project). It is intended to provide information and instruction to Manitoba Hydro employees as well as contractors, regulators and members of the public. The Plan provides regulatory context as well as general considerations and guidance pertinent to the post construction rehabilitation of project sites and management of invasive species within the Project footprint.

Manitoba Hydro employees and contractors are encouraged to contact the onsite Manitoba Hydro Environmental Inspector/Officer if they require information, clarification, or support. Regulators and the Public are to direct any inquiries about this Plan to:

Manitoba Hydro

Transmission & Distribution Environment and Engagement Department
Manitoba Hydro
360 Portage Avenue

Winnipeg, MB

Canada R3C 0G8

1-877-343-1631

Projects@hydro.mb.ca

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Tables

1.0 Introduction

Consistent with its corporate Environmental Management Policy, Manitoba Hydro has committed within the Pointe du Bois to Whiteshell station 115kV transmission line (the project) Construction Environmental Protection Plan to developing a Rehabilitation and Invasive Species Management Plan (RISMP) as part of a larger suite of mitigation measures to minimize potential negative environmental and socio-economic effects.

Manitoba Hydro's Environmental Protection Program (EPP) provides the framework for the delivery, management and monitoring of environmental and socio-economic protection measures that satisfy corporate policies and commitments, regulatory requirements, environmental protection guidelines and best practices, and input during project engagement. The program describes how Manitoba Hydro is organized and functions to deliver timely, effective, and comprehensive solutions and mitigation measures to address potential environmental effects. This RISMP is a component of the EPP as illustrated in Figure 1.

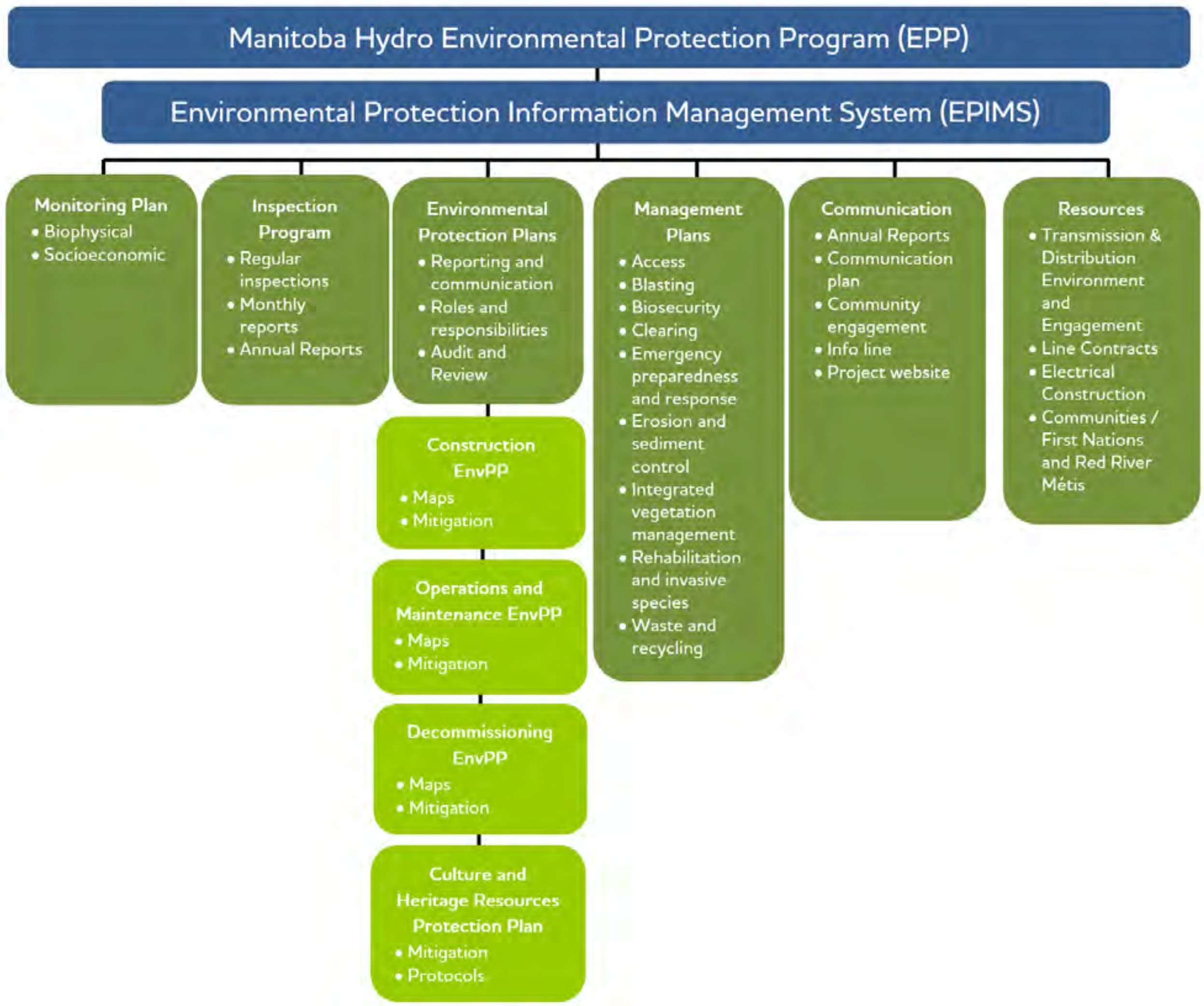

Figure 1: Transmission Environmental Protection Program

1.1 Commitment to environmental protection

Manitoba Hydro integrates environmentally responsible practices in all aspects of our business. Environmental protection can only be achieved with the involvement of Manitoba Hydro employees, consultants, contractors, Indigenous communities and organizations and the public at all stages of the Project from planning and design through construction and operational phases.

The use of an RISMP is a practical and direct implementation of Manitoba Hydro's environmental policy and its commitment to responsible environmental and social stewardship. It is a proactive approach to manage potential disturbance of access related to the construction of a new transmission line.

Manitoba Hydro is committed to implementing this RISMP and requiring contractors to follow the terms of this and other applicable plans within the Environmental Protection Program.

1.2 Purpose and objectives

The purpose of this Rehabilitation and Invasive Species Management Plan (RISMP) is to provide information that will guide contractors and Manitoba Hydro staff through project construction, maintenance, and decommissioning in a manner that meets Manitoba Hydro's Environmental Management Policy and project commitments.

Rehabilitation is the process of returning the land in a project area to a condition compatible to its former state after development has disturbed the land. As there has already been a large amount of habitat degradation and increasing pressures on the surrounding areas, Manitoba Hydro seeks to enhance habitat and biodiversity on the ROW through the implementation of rehabilitation measures that consider traditional resource use along with wildlife habitat. Manitoba Hydro has participated in endeavours with researchers to measure and enhance the biodiversity of its ROW's. Manitoba Hydro continues to be open to discussing opportunities for research and collaboration with researchers from universities and Indigenous communities and organizations.

Invasive species management is the process of managing the invasive species growing in the project area through a variety of methods. Invasive species are plants, animals or other organisms that are growing outside of their country or region of origin and are out-competing or even replacing native organisms. They have a distinct advantage over our native species whose populations are kept in check by native predators, competitors, or disease.

Reasons for rehabilitation and invasive species management may include:

- Reducing the risk of erosion
- Controlling the spread of invasive plants
- Reducing access
- Reclaiming land
- Improving aesthetics
- Restoring ecosystem function

1.3 Roles and responsibilities

This section outlines the major roles and responsibilities of those involved in the implementation of the plan.

A summary of roles and key responsibilities is found in Table 1. Communication and reporting on environmental issues, monitoring and compliance will be as outlined in Figure 2.

Table 1: Key roles and responsibilities

Role	Responsibilities
Manitoba Hydro	• Identifying Invasive species locations in Biosecurity Management Plan Mapbook • Monitoring rehabilitation measure success • Review Contractor developed site-specific rehabilitation measures • Implement Invasive Species Management Treatment Options where required
Contractor	• Shall adhere to Rehabilitation and Invasive Species Management Plan including employee training, implement rehabilitation measures prescribed actions, signage and submit all required assessment documentation. • Respond and act promptly to resolve if any activities are identified as not in compliance with the RISMP or any regulatory requirements. • Conducting assessment of project sites for rehabilitation • Develop and propose site specific rehabilitation measures as per guidelines • Implement site specific rehabilitation measures • Prevent the spread of Invasive plant species • Rehabilitate disturbed areas as soon as practicable or when deemed necessary by Manitoba Hydro. Rehabilitation is not to be deferred until construction is complete

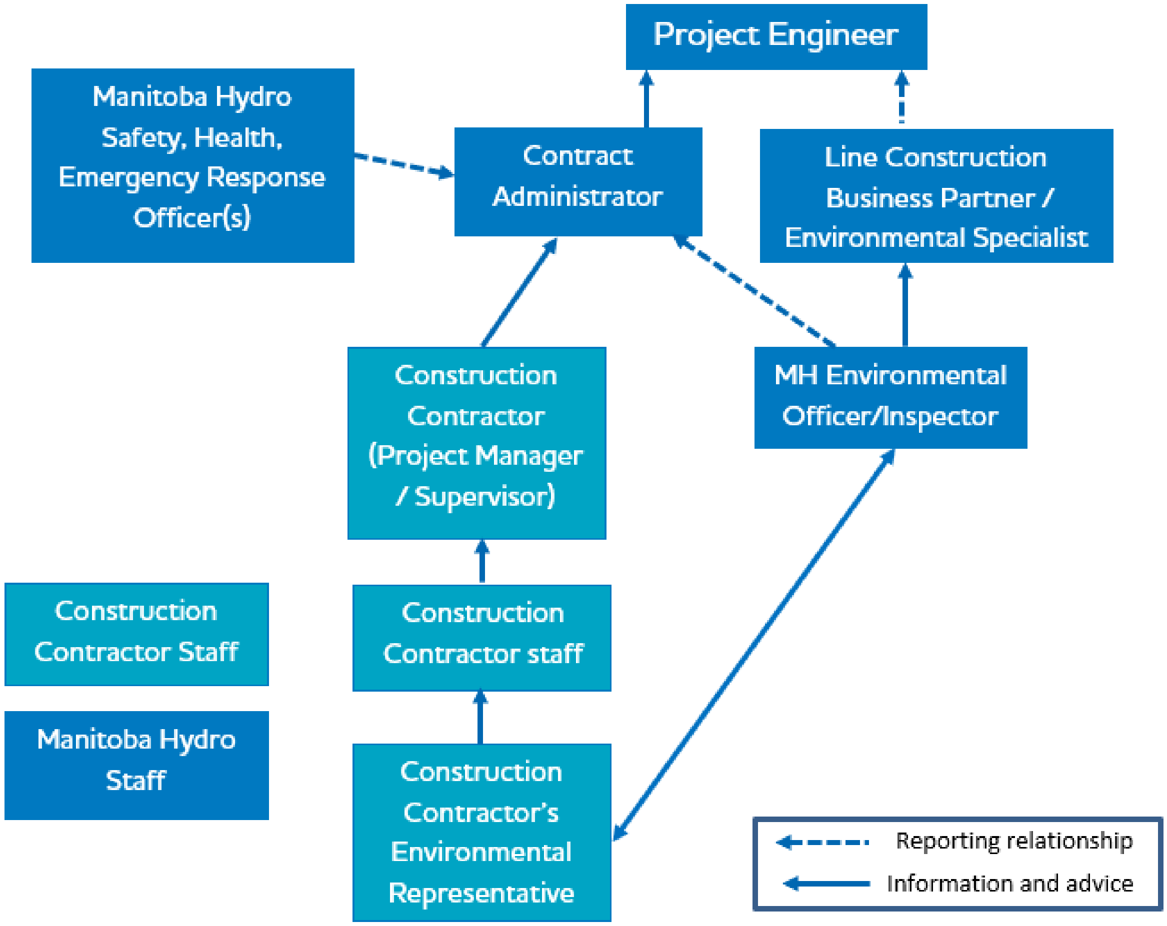

Figure 2: Environmental communication reporting structure

2.0 Regulatory context

In Manitoba, the control of noxious weeds is regulated by The Noxious Weeds Act, C.C.S.M. c. N110 (including amendments from The Noxious Weeds Amendment Act, S.M. 2015, c. 38) and the Noxious Weeds Regulation (42/2017). Through recent amendments to the Act, the list of regulated noxious weeds has been updated and noxious weeds have been designated as tier 1, tier 2, or tier 3 noxious weeds based on prevalence, distribution, and invasiveness.

The list of weeds designated as tier 1, tier 2, and tier 3 noxious weeds under the Noxious Weeds Regulation (42/2017) is found in Appendix G.

3.0 Implementation

The intent of this section is to provide for implementation instructions to Manitoba Hydro and contractor project staff. The main project components that may require rehabilitation and invasive species management include the following:

- Right-of-way (RoW)
- Access routes and by-pass trails
- Borrow pits and quarries
- Marshalling yards (material and/or equipment storage, fly yards)
- Construction camps
- Station sites

3.1 Assessment

The contractor shall conduct a rehabilitation assessment as described in the guidelines of rehabilitation by land cover below. The assessment will be documented though the use of the rehabilitation assessment checklist (Appendix A).

3.2 Timing

The timing of when rehabilitation activities occur is key to preventing erosion, invasive species establishment, and preventing damage to rehabilitation measures. The contractor is required to implement rehabilitation measures as soon practicable or as required by MH Environmental Inspector/Officer, rehabilitation is not to be deferred until construction is complete.

3.3 Guidelines for rehabilitation by land cover

3.3.1 Wetlands and riparian areas

Trigger(s) for the assessment for rehabilitation by contractor:

- Any construction activity that affects surface water drainage directly into a water body (watercourse and/or wetland) without sufficient erosion and sediment control measure in place
- When the depth of rutting exceeds 10cm for more than 15m in length
- Admixing (mixing of topsoil and subsoils)

- Any excessive soil disturbance within wetland outside of tower footprint and stringing corridor
- Removal of riparian buffer shrub and understorey vegetation
- Debris from clearing or stream crossing below high-water mark

Criteria to be assessed by contractor (Manitoba Hydro may conduct its own assessment):

- Proximity to weed seed source
- Current ground and aquatic conditions
- Existing erosion and sediment control measures
- Accessibility to project site(s)
- Safety
- Adjacent land use
- Timing of rehabilitation activities

Rehabilitation measures may include (site-specific rehabilitation measures will be developed by the contractor and proposed to Manitoba Hydro for review):

- Flag or place barriers to mitigate further disturbance
- Implementation of erosion and sediment control measures where required
- Allow for passive revegetation
- Implement active revegetation through planting or seeding of native/traditional species
- Flag or place barriers after rehabilitation measures implemented to mitigate further disturbance
- Debris removal
- Other rehabilitation measures as approved by Manitoba Hydro

3.3.2 Cultivated lands

Trigger(s) for the assessment for rehabilitation by contractor:

- Sites that exceed threshold for work modification(s) as described in the Saturated/Thawed Soils Operating Guidelines
- Any excess construction materials (granular, clay, waste)
- Any travel off designated access routes
- Disturbance to existing in-field drainage
- Installation of tower or poles

Criteria to be assessed by contractor (Manitoba Hydro may conduct its own assessment):

- proximity to weed seed source
- Current ground conditions
- Current crop and farming practices
- Existing erosion and sediment control measures
- Accessibility to Project site(s)
- Safety
- Adjacent land use
- Timing of rehabilitation activities

Rehabilitation measures may include (site-specific rehabilitation measures will be developed by the contractor and proposed to Manitoba Hydro for review with landowner):

- Flag or place barriers to mitigate further disturbance
- Implementation of erosion and sediment control measures where required
- Cultivation to remove ruts and compaction
- Restore drainage to pre-existing condition
- Implement active revegetation through seeding of native/crop species acceptable to landowner within tower footprint
- Addition, spreading or removal of topsoil
- Flag or place barriers after rehabilitation measures implemented to mitigate further disturbance
- Construction material removal
- Other rehabilitation measures as approved by Manitoba Hydro

3.3.3 Access routes and trails

Trigger(s) for the assessment for rehabilitation by contractor:

- Any evidence of access route / trail structure damage occurring, such as admixing, or the creation of ruts that impedes local vehicle traffic
- Any excess construction materials (granular, clay, waste) within route/trail or ditches including rider pole installations
- Removal of snow fill approaches within access route / trail right of way prior to spring thaw

Criteria to be assessed by contractor (Manitoba Hydro may conduct its own assessment):

- Proximity to weed seed source
- Current ground conditions
- Current access route / trail use
- Existing erosion and sediment control measures
- Accessibility to project site(s)
- Safety
- Adjacent land use
- Timing of rehabilitation activities

Rehabilitation measures may include (site-specific rehabilitation measures will be developed by the contractor and proposed to Manitoba Hydro for review):

- Flag/sign or place barriers to mitigate further disturbance
- Implementation of erosion and sediment control measures where required
- Allow for passive revegetation
- Implement active revegetation through planting or seeding of native/traditional species
- Back blading or grading to remove ruts/level surface
- Construction material and debris removal
- Adding or replacing gravel surface material
- Contouring or re-sloping
- Flag/sign or place barriers after rehabilitation measures implemented to mitigate further disturbance
- Excess construction material removal
- Other rehabilitation measures as approved by Manitoba Hydro

3.3.4 Forest, tame pasture and grasslands

Trigger(s) for the assessment for rehabilitation by contractor:

- When rutting depth exceeds 30 cm for more than 15 m in length
- Any travel off existing designated access routes
- Any excess construction materials (granular, clay, waste)
- Disturbance to existing in-field drainage
- Installation of tower or poles

Criteria to be assessed by contractor (Manitoba Hydro may conduct its own assessment):

- Proximity to weed seed source
- Current ground conditions
- Current farming practices
- Existing erosion and sediment control measures
- Accessibility to project site(s)
- Safety
- Adjacent land use
- Timing of rehabilitation activities

Rehabilitation measures may include (site-specific work modifications will be developed by the contractor and proposed to Manitoba Hydro for review):

- Flag/sign or place barriers to mitigate further disturbance
- Implementation of erosion and sediment control measures where required
- Allow for passive revegetation
- Implement active revegetation through planting or seeding of native/traditional species
- Back blading or grading to remove ruts
- Construction material and debris removal
- Flag/sign or place barriers after rehabilitation measures implemented to mitigate further disturbance
- Addition, spreading or removal of topsoil
- Other rehabilitation measures as approved by Manitoba Hydro

3.3.5 Borrow pits and quarries

Trigger(s) for the assessment for rehabilitation by contractor:

- When borrow pits or quarries are no longer required for foundation installation

Criteria to be assessed by contractor (Manitoba Hydro may conduct its own assessment):

- Proximity to weed seed source
- Current ground conditions
- Existing erosion and sediment control measures
- Safety

- Adjacent land use
- Timing of rehabilitation activities

Rehabilitation measures may include (site-specific work modifications will be developed by the contractor and proposed to Manitoba Hydro for review):

- Contouring or re-sloping
- Implementation of erosion and sediment control measures where required
- Allow for passive revegetation
- Implement active revegetation through planting or seeding of native/traditional species
- Back blading or grading to remove ruts
- Addition of topsoil
- Construction material and debris removal
- Flag/sign or place barriers after rehabilitation measures implemented to mitigate further disturbance
- Other rehabilitation measures as approved by Manitoba Hydro

3.4 Erosion and sediment control

Project activities may result in the disturbance or removal of topsoil and modification of the landscape. Where possible, removal of ground plant cover and soil disturbance should be minimized during project activities. Vegetation provides a protective cover for underlying soil and reduces surface runoff. Removal of vegetation cover exposes soil and can result in soil losses from wind and water erosion. In locations of rapid run-off, rills may develop. Soil erosion near watercourses can reduce water quality by causing sedimentation, resulting in a reduction of aquatic ecosystem health.

Erosion control of disturbance sites may be necessary prior to re-establishment of vegetation. Erosion control prescriptions will vary considerably based on the conditions found at the site. Refer to the Erosion and Sediment Control Plan for any measures that may need to be put in place prior to rehabilitation.

3.5 Site preparation

Site preparation for rehabilitation may vary with site conditions. Site preparation methods will depend largely on the degree of disturbance, soil conditions, and existing vegetation remaining and regenerating in sites.

Site preparation options include the following:

- **Contouring** – Site preparation may involve contouring of an area where a disturbance has occurred (e.g., borrow pits) prior to implementing other efforts.
- **Addition or removal of topsoil** – Where topsoil has been removed for project activities, site preparation should involve the replacement of topsoil. The salvage of topsoil is a priority that should be considered in the planning stages of a project. Topsoil is the uppermost layer of soil that is important for nutrient cycling and is a source for native plants. The amount of topsoil required for replacement should ideally match the depth of topsoil as to what was there before, or a minimum depth of 30 cm. Effective topsoil management is an essential component of rehabilitation success. Note: that should the addition of topsoil be required onsite, refer to the Biosecurity Management Plan to minimize biosecurity risk.
- **Grading of ground material** – Site preparation may involve grading of soils where a disturbance has occurred (e.g., rutting). On terrain with slopes, it is recommended that grading occur across a slope to reduce erosion, and grading of materials should not result in slopes steeper than a 5:1 ratio.
- **Soil de-compaction** – Equipment continually driving over an area may result in compaction. Soil compaction is the squeezing together of soil particles, reducing the space available for air and water which could reduce the capacity of the soil to support desired vegetation. Site preparation may involve treatment for soil compaction prior to re-establishment of vegetation by light discing or tilling to avoid loss of soil moisture and soil structure.
- **Seedbed Preparation** – Site preparation may also include preparing the seedbed prior to revegetation to enhance germination success. Seeding options discussed below.

3.6 Revegetation

Revegetation is the process of plants growing again on land previously disturbed. This may be a passive process by plant colonization and succession or an active accelerated process (e.g., seeding, planting) designed to repair a disturbance to the landscape.

3.6.1 Passive

Passive revegetation is a viable means of rehabilitation by natural seeding, sprouting, suckering or layering of vegetation. Where conditions are ideal regarding seedbank, propagules, topography, slope, moisture, time of year, and condition of surrounding vegetation, natural regeneration will occur.

3.6.2 Active

Where conditions are not ideal for passive revegetation such as lack of seedbank or propagules, rehabilitation should involve active revegetation by planting or seeding.

3.6.2.1 Planting options

Options for rehabilitation by planting include the following:

- Tree seedlings – Tree seedlings may be obtained as either bare root or containerized stock. Bare root stock needs to be handled carefully while in storage and during planting, and exposed roots can dry out quickly. Containerized stock provides root protection and increased flexibility as to timing of planting. Spacing for seedlings can be variable. Seedlings are recommended for large-scale plantings. Common seedlings for rehabilitation may include jack pine and red pine, white and black spruce.
- Transplanting – Transplanting is a form of artificial regeneration where plants are removed from one location and planted in another. Transplanting is a useful means of re-establishing native species quickly. Preferably, transplanting should occur from similar habitats and nearby sources to increase growing success. Vegetation transplanted in disturbed sites may increase the rate of natural regeneration by capturing seeds and organic material from surrounding plant cover. Transplanting is a recommended method for vegetation rehabilitation near watercourse crossings. Species such as hybrid poplar and willow cuttings are commonly planted because of their good rooting ability and fast growth rate.

- **Sprigging** – Plant sections cut from rhizomes or stolons that include the vegetation crowns and roots. Sprigging can be an effective method for disturbed and erodible stream crossing sites.

3.6.2.2 Seeding options

Options for rehabilitation by seeding include the following:

- **Drill Seeding** – Drill seeding involves a tractor-pulled seed drill. In larger areas, equipment can furrow soil, plant seed and pack soil over seed in one pass. Native seed drills are most efficient and accurate at placing seed. Drill seeding should be done into well-cultivated soil, free of lumps and debris, and firmly roller packed.
- **Broadcast seeding** – Broadcast seeding is accomplished by dispersing seed by machine or hand. Broadcasting is effective where the access of large machinery is not possible or recommended, although requires the use of more seed. An attempt should be made to incorporate the seeds into the soil as an additional step after broadcasting.
- **Hydroseeding** – Hydroseeding is a method that uses a slurry of seed, mulch, water and tackifier which is transported by a water tank that may be mounted on a truck or trailer and sprayed over prepared ground. Hydroseeding is an alternative to traditional broadcasting or drilling seeding.

3.7 Other important considerations and options

3.7.1 Ecological context

Rehabilitation prescription needs to be appropriate for the site under consideration. Manitoba is comprised of six ecozones representing large generalized ecological units characterized by interactive and adjusting abiotic and biotic factors. Selecting vegetation for rehabilitation needs to be suitable to the site. Appendix C identifies characteristic vegetation of Manitoba’s ecozones.

3.7.2 Using native/traditional use species

Native species are plants occurring within their historic range bounded by the dispersal potential of the plant. These native/traditional use species are favoured for rehabilitation for several reasons, including resource use, ecological compatibility, palatability, and adaptation to local soils and climate. Native/traditional plant material will be used for rehabilitation of a disturbance area where the goal is to re-establish a native/traditional plant community. Appendix B is a selection of commercially available traditional plant species.

3.7.3 Seed mix recommendations

This section identifies native seed mixes for disturbances in Manitoba. Establishing long-term plant communities requires forethought as to appropriate species to use. Actual amounts of species present in a seed mix may vary depending upon seed availability. The best adapted species will result from seed collections in the region. If seed availability is an issue, it would be preferable to use the correct species, rather than the prescribed seed rates. Species listed in Appendix D can be chosen as a baseline mix and are generally commercially available. Both upland and lowland mixes are provided for northern, west central, and southern Manitoba. Species listed in Appendix E are commercially available in Manitoba and may be added for diversity.

3.7.4 Commercial seed and plant providers

Purchasing native seed from commercial providers is a practical option for large rehabilitation sites. Where seed will be purchased, the following information should be considered:

- Species selection for seeding should be undertaken in conjunction with recommended seed mixes, generally with a dominance of native graminoids and subdominant native broadleaf herbs.
- Seed acquisition should be determined through consultation with a vegetation specialist, using readily available native local seed, wherever possible.
- Forage grasses should not be seeded as they are developed for maximum forage production and may destroy habitat by taking over native plant communities.
- The genetic origin of the seeds should be from Manitoba or nearby provinces, from a region with similar ecological conditions.
- Commercial seed providers should produce certificates of analysis from an accredited laboratory that provides seed purity and germination values.

3.7.5 Seeding dates

There are two timing windows for seeding. The preferred time to seed occurs during the spring as soon as the ground has reached a desirable temperature (5°C) and the danger of a killing frost has past. The second and less successful time is dormant seeding in the fall once the ground temperature has lowered to 5°C, where seeds will germinate the following growing season. For sites with a high risk of erosion, seeding could occur at anytime.

3.7.6 Rates for seeding

Seeding rates can vary depending on method of seeding and applicator. Seeding rates may need to be adjusted for wind loss, animal consumption, slope, seed weight, germination rate, annual survivorship, and intended density of mature plants. General seeding rates include the following:

- Drill seeding <15 kg/ha
- Broadcast seeding 30 to 85 kg/ha
    - broadcast seeding involves scattering of seed manually by hand (or hand-held seeder) or mechanically.
- Hydroseeding 75 to 100 kg/ha
- Cover crops 2.2 to 5.5 kg/ha (seeded lightly to reduce competition with native species)

The seeding rate calculation for a species that occupies 10% of a seed mix (e.g. 84 kg/ha) includes the following: 84 kg/ha x 0.10 = 8.4 kg/ha.

3.7.7 Rates for planting tree seedlings

Spacing of tree seedlings can be variable within disturbance areas. In general, spacing to achieve about 2,500 seedlings per hectare requires spacing of 2.1 m between rows and 1.8 m between seedlings.

Transplanting cuttings such as poplar or willow species can be used. Cuttings should be a minimum length of 30 cm and buried in the ground at least half its length. Cuttings are most successfully transplanted in the spring and fall. Both poplar and willow species have good propagation success because of their rooting ability and are desirable for erosion control.

3.7.8 Fertilizers

Fertilizers can be added to the soil to supply one or more plant nutrients essential to the growth of plants that may be lacking in the soil at the site prescribed for rehabilitation. Fertilization may improve productivity of a rehabilitation effort during early growth stages. Applying excessive amounts of fertilizer can have negative environmental effects (e.g. seed damage, run-off, encourage invasive species, etc.). The storage, handling, and application of fertilizers are legislated in Manitoba (*The Water Protection Act*, *The Pesticides and Fertilizers Control Act*). This legislation is intended to protect Manitoba's water quality. It is important to consult this legislation prior to applying nutrients to rehabilitation sites.

4.0 Invasive species management

Many Invasive species in Manitoba are so common now that they are often mistakenly considered native, these species have become widely naturalized through intentional and accidental introductions. Invasive species reduce biological diversity and threaten native ecosystems. Examples of invasive species in Manitoba include purple loosestrife, ox-eye daisy and leafy spurge. Plants listed by the Invasive Species Council of Manitoba are provided in Appendix F.

Once invasive species become established control measures can be costly to implement. Therefore, a successful invasive species management should involve taking preventative measures, early detection, and rapid management response.

The management of invasive species must consider the ownership of the land. The responsibilities for management on different ownership types are described below:

- ROW on private/municipal lands: As Manitoba Hydro has only an easement the responsibility of invasive species management lies with the landowner. If invasive weeds are introduced to the right-of-way as a direct result of Manitoba Hydro activities it will work with the landowner to implement control options.
- ROW on railway, road allowance or highway lands: As Manitoba Hydro does not have an easement the responsibility of invasive species management lies with the landowner. If invasive weeds are introduced to the right-of-way as a direct result of Manitoba Hydro activities it will work with the landowner to implement control options.
- ROW on Manitoba Hydro-owned lands: Manitoba Hydro is responsible for invasive species management to comply with the *Manitoba Noxious Weeds Act*.
- ROW on Crown lands (including lands with third-party interests): As Manitoba Hydro has only an easement the responsibility of invasive species management lies with the Crown (landowner) or the third-party interest. If invasive weeds are introduced to the right-of-way as a direct result of Manitoba Hydro activities Manitoba Hydro would consult with local weed supervisors and Manitoba Agriculture and/or Environment and Climate departments to implement control options.

4.1 Prevention

An initial step in controlling invasive plant species is preventing their establishment. Prevention is relatively cost-effective when compared to invasive species control and management efforts. Detailed biosecurity measures are outlined in the biosecurity management plan for the project. Preventative measures may include the following:

- Education on how to identify invasive species and infestations.
- Avoid driving or walking through areas of invasive species.
- Clean and wash equipment and boots before entering and leaving a site to prevent transport of seeds.
- Design seed mixes with species that have differing growth forms to occupy the variety of niches available, and seed native species that are known to be competitive.
- Record early detection of invasive species problem areas on adjacent lands.
- A combination of promoting natural re-vegetation and re-establishment of vegetation cover, where required, using species suited to the post-construction land use to provide competition for germinating weeds.

4.2 STEP 1: Weed management thresholds and priority levels

Weed management conducted prior to and during construction will focus on managing weeds identified during pre-construction surveys, as necessary, as well as occurrences identified during construction.

The management thresholds for weed species for the project are as follows:

- Invasive weed species (Appendix G of Reference i) must be maintained or reduced to a density and distribution level equivalent to or less than levels observed on adjacent lands with equivalent or similar land use and land management. The comparison should be made to the invasive weed conditions found during pre-construction surveys and as compared to adjacent lands during/after construction.
- Weeds must be treated and managed in compliance with the Manitoba Noxious Weeds Act and Regulation. Under the regulation, a person must:
    - destroy all tier 1 noxious weeds as listed in the Regulation that are on land that the person owns or occupies

- destroy all tier 2 noxious weeds as listed in the Regulation that are on land that the person owns or occupies if the area colonized by the weeds is less than five acres
- control all tier 2 noxious weeds as listed in the Regulation that are on land that the person owns or occupies if the area colonized by the weeds is five acres or more
- control a tier 3 noxious weed as listed in the Regulation that is on land that the person owns or occupies if the weed's uncontrolled growth or spread is likely to negatively affect an aspect of Manitoba's economy or environment in the land or the well-being of residents in proximity to the land

The priority for managing sites where the threshold as described above has been reached will be determined by the level of risk of increasing the density and distribution of weed species. Criteria for the site priority levels are outlined in Table 2.

Table 2: Priority levels for weed management

Priority level	Purpose or intent
High	To destroy Tier 1 and Tier 2 noxious weeds (<5 acres) currently threatening non-infested or highly susceptible sites within Project footprint.
Moderate	To control Tier 2 noxious weeds (>5 acres) and invasive species on sites in less susceptible areas of the Project footprint. This includes areas adjacent to lands such as treed pasture lands that have a well-established vegetation cover and, therefore, are less susceptible to weed species introduction.
Low	To control a tier 3 noxious weed on within the Project footprint if the weed's uncontrolled growth or spread is likely to negatively affect an aspect of Manitoba's economy or environment in the area of the land or the well-being of residents in proximity to the land

4.3 STEP 2: Determine whether management threshold has been reached

Compare the density and distribution of each weed species observed on the construction right-of-way to the density and distribution of the same species off-site or as outlined in the pre-construction weed survey report, to determine whether the management threshold has been reached.

4.4 STEP 3: Review treatment criteria

Choose an appropriate management option (i.e., mechanical, biological, or chemical) or a combination of treatments that will provide effective weed management, based on the data collected at weed occurrence sites. The criteria used to select a treatment method that balances the potential environmental impacts while providing adequate and cost-efficient weed management are:

- Effectiveness of previous treatments
- Biology of target weed species, area, and density
- Existing land use
- Land ownership
- Proximity of organic farms, water sources, bodies of water and environmentally sensitive sites
- The possibility of adverse impacts to wildlife, fish, surrounding land, workers, and adjacent residents
- Economic impacts of weeds on surround land use
- Timing of treatment
- Existing soil type
- Site accessibility
- Cost and availability of treatment options
- The consequences of no treatment

4.5 STEP 4: Select weed management treatment method

4.5.1 Manual / mechanical treatment option

Manual/Mechanical treatments are preferred for weeds located adjacent to cultivated or agricultural lands, organic farmlands and near waterbodies (e.g., drainages, wetlands). Manual/Mechanical options include:

- Mowing: mowing of weeds before weeds go to seed. Mowing may be combined with a pre-mowing herbicide treatment, ensuring that the herbicide has had sufficient time to absorb into the plants.
- Burning: targeted burning of weeds with torches or prescribed controlled burns
- String trimmers: to cut weeds at the ground surface to remove herbaceous vegetation at locations where access limits the use of larger equipment.
- Hand pulling: pulling of weeds in riparian and environmentally sensitive locations for annual and certain perennial weeds where all roots can be easily removed and weed density is sufficiently low enough to make hand pulling effective.
- When selecting a treatment, consideration should be made for the cultural, medicinal, or commercial value of a plant to local communities.

Manual/Mechanical treatment options may be considered for use within 30 m of a watercourse, wetland, or MH's ESSs.

4.5.2 Biological / cultural / native treatment option

Biological/cultural/native treatments are an alternative option near watercourses, within pastures, public recreation areas; where chemical application is not approved; or where manual/mechanical methods may not be effective. Biological options include:

- Biological insects and fungi: Canadian Food Inspection Agency approved insects and fungi might be considered to manage weed infestations where other methods have not proven successful.
- Grazing: High intensity livestock grazing has also proven an effective method for limiting weed infestations in select applications.
- Revegetation and erosion control: The use of erosion control measures such as blankets or the establishment of competitive vegetative cover on disturbances to stabilize soils and provide competition to weeds.

Biological/cultural/native treatment options may be considered for use within 30 m of a watercourse, wetland, or MH's ESSs.

4.5.3 Chemical treatment option

Chemical treatments may be a necessary option when:

- Weed density and distribution has reached levels that other management options are not viable to control the weed infestation
- Weed management in areas where mechanical and biological methods are not feasible or practical
- Where chemical management is the preferred option of the landowner or Weed Supervisor as designated under the Manitoba Noxious Weeds Act regulations

Chemical treatments may be considered for use within 30 m of a MH's ESSs, but NOT within 30 m of watercourses or wetlands.

4.5.4 No control management option

In some instances, the implementation of a "no control" option and ongoing monitoring is the most practical and environmentally responsible course of action. In instances where "no control" is being considered as the treatment option, discussions with landowner and government regulators will occur. The No Control option may be considered for use within 30 m of a watercourse, wetland, or MH's ESSs.

4.6 Treatment options for common species

The following identifies an overview of treatment options for some common invasive species.

4.6.1 Leafy spurge

- Manual control (hand-pulling) is effective for small infestations
- Mechanical control (mowing) will reduce the plants' ability to seed but has little long-term effect on the plant
- Chemical control is effective in spring and fall
- Biological control is considered a long-term management strategy
- A combination of control measures in an integrated approach is recommended for this species

4.6.2 Common tansy

- Manual control (hand-pulling) is effective for small infestations
- Mechanical control (mowing) will reduce seed production but requires repeat treatment
- Chemical control is effective
- Biological control is anticipated to be an effective measure for this species in the future
- Native species competition has been effective for small infestations

4.6.3 Scentless chamomile

- Manual control (hand-pulling) is effective for small infestations
- Mechanical control (mowing) is effective but requires repeat treatment
- Chemical control is effective. Earlier applications have greater success
- Biological control has had some success
- Native species competition has been effective
- A combination of control measures in an integrated approach is recommended for this species

4.6.4 Purple loosestrife

- Manual control (hand-pulling) is effective for small infestations
- Chemical control is effective in uplands. No herbicides are currently approved in Canada for treatment near or in water
- Biological control is the most effective measure for large infestations near water

4.6.5 Ox-eye daisy

- Manual control (hand-pulling) is effective for small infestations if the roots are removed
- Mechanical control (mowing) stimulates shoot growth and requires repeat treatment
- Chemical control is effective

4.6.6 Sweetclover

- Manual control (hand-pulling) is effective for small infestations if the roots are removed
- Mechanical control (mowing) should occur before seed production

- Chemical control is effective
- Native species competition has been effective as part of a management strategy including native seeding, burning, and mowing

4.6.7 Canada thistle

- Manual control (hand-pulling) is effective for small infestations if the roots are removed
- Mechanical control (mowing) is effective but requires repeat treatment
- Chemical control is effective

4.7 Training and documentation

Training, documentation, and communication form a critical component of the implementation of this plan. Manitoba Hydro and the contractor(s) each have responsibility to ensure that their respective personnel are appropriately trained to carry out their role in rehabilitation, and that proper documentation and communication is being conducted throughout the project.

Manitoba Hydro will hold a Contractor Environmental Pre-Construction Requirements Orientation meeting to review project specifics and key environmental requirements with all its contractors at a supervisory level. A summary of this plan, implementation requirements, roles and responsibilities, and Manitoba Hydro's expectations will be presented at that time. Manitoba Hydro will also hold a separate pre-construction environmental meeting to provide the opportunity for Manitoba Hydro and contractor environmental representatives to discuss project specifics and environmental requirements in more depth.

5.0 Monitoring and follow-up

Monitoring and follow-up are an important component for rehabilitation and invasive species management. Monitoring will verify the implementation and effectiveness of rehabilitation measures and invasive species management. Successful rehabilitation of disturbed areas will be defined by the establishment of native species, no evidence of erosion, and resilience to the disturbance. The following should be completed during monitoring of disturbance areas:

- Disturbance areas should be inspected frequently in the first year and monitored annually thereafter until vegetation re-established.
- Monitoring may include an assessment of erosion control.
- Monitoring will include an assessment of vegetation to measure plant growth.
- Monitoring will be conducted by Manitoba Hydro Environmental Officer and/or vegetation specialists.

Environmental monitoring will determine if follow-up maintenance activities are required. Maintenance activities may include additional erosion control, re-seeding or further plantings, protection from browsing, and invasive species control.

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Appendix A

Rehabilitation checklist

Appendix A: Rehabilitation checklist

Date (yyyy mm dd)	
Name of recorder	Company (*if different from Manitoba Hydro*)
Location GPS Coordinates *(UTM 14N)*	
Closest Structure Number if applicable #	
Description of disturbance (*type, size, sensitivity i.e. riparian area*)	
Proximity to weed sources *(closest invasive weed ESS)*	
Severity of disturbance *(e.g., erosion is occurring, disturbance is stable)*	
Slope of site (level 0-0.5%, nearly level 0.5-2.5%, very gentle to gentle 2-9%, moderate 10-15%, strong 16-30%, very strong to steep 31-100%)	
Current Ground conditions (*dry, moist, wet*)	
Timing of rehabilitation activities *(Immediate/once surface disturbance activities are complete and ground conditions allow)*	
Post disturbance vegetation conditions (*e.g., vegetation is removed, or little is remaining*)	
Surrounding vegetation (*e.g. grassland, forest, riparian, wetland*) and predominant species if known	
Adjacent land uses (*e.g. agriculture/forest/residence*)	
Safety *(Are there any safety concerns?)*	
Accessibility *(Is the site accessible year-round/winter/summer, is there alternate access to avoid site)*	
Existing Sediment and Erosion Control Measures *(silt fence, blanket)*	

Appendix B

Selection of traditional plant species commercially available for rehabilitation

Appendix B: Selection of traditional plant species commercially available for rehabilitation					
Provincial Scientific Name	Traditional Use Plant Name	Provincial Rank	Commercial Availability	Rehabilitation Potential	Location of Use
Abies balsamea	balsam fir	S5	yes	yes	forest
Achillea millefolium	yarrow	S5	yes	low	forest, grassland
Acorus americanus	weke	S5	yes	yes	wetland
Actaea racemosa	black snakeroot	not listed by MBCDC	plant unknown	unknown	unknown
Actaea rubra	baneberry	S5	potential to transplant	low	forest
Agastache foeniculum	giant hyssop	S5	yes	low	moist meadow, forest
Alnus incana	speckled alder	S5	yes	yes	riverbank, moist forest
Amelanchier alnifolia	saskatoon berry	S5	yes	yes	forest
Apocynum androsaemifolium	dogbane	S5	potential to transplant	low	forest
Aquilegia sp.	columbine	–	yes	low	forest
Aralia nudicaulis	wild sarsaparilla	S5	yes	low	forest
Arctostaphylos uva-ursi	common bearberry	S5	yes	yes	forest
Artemisia sp.	sage	–	yes	low	grassland
Asarum canadense	wild ginger	S3S4	yes	low	moist forest
Asclepias incarnata	swamp milkweed	S4	yes	low	wetland
Asclepias syriaca	common milkweed	S4	potential to transplant	low	riverbank, grassland
Betula papyrifera	paper birch	S5	yes	yes	forest
Caltha palustris	marsh marigold	S5	yes	low	wetland
Campanula sp.	harebell	–	yes	low	grassland, forest
Cannabis sativa	hemp	SNA	potential to transplant	low	forest
Chamerion angustifolium	fireweed	S5	yes	yes	forest
Conyza canadensis	Canada fleabane	S5	potential to transplant	low	grassland
Cornus canadensis	bunchberry	S5	yes	low	forest
Cornus sericea	red osier dogwood	S5	yes	yes	forest
Corylus americana	American hazelnut	S4	yes	yes	forest

Appendix B: Selection of traditional plant species commercially available for rehabilitation

Provincial Scientific Name	Traditional Use Plant Name	Provincial Rank	Commercial Availability	Rehabilitation Potential	Location of Use
Corylus cornuta	beaked hazelnut	S5	yes	yes	forest
Corylus sp.	hazelnut	–	yes	yes	forest
Cratagus sp.	hawthorn	–	yes	yes	forest
Dasiphora fruticosa	shrubby cinquefoil	S5	yes	yes	forest
Fragaria virginiana	wild strawberry	S5	yes	low	forest
Geranium bicknellii	Bicknell's geranium	S5	potential to transplant	low	forest
Geum aleppicum	yellow avens	S5	potential to transplant	low	moist meadow, forest
Heuchera richardsonii	alumroot	S5	yes	low	grassland, forest
Hierochloe odorata	sweet grass	S5	yes	yes	grassland, forest
Hypericum perforatum	St. John's wort	SNA	yes	low	moist meadow, forest
Larix laricina	tamarack	S5	yes	yes	forest, wetland
Rhododendron groenlandicum	Labrador tea	S5	potential to transplant	low	forest
Lilium philadelphicum	wood lily	S4	yes	low	grassland, forest
Lycopus uniflorus	northern bugle-weed	S5	potential to transplant	low	wetland
Maianthemum canadense	Canada mayflower	S5	potential to transplant	low	forest
Mentha sp.	wild mint	–	yes	low	moist meadow
Oenothera flava	yellow evening primrose	SNA	potential to transplant	low	grassland, riverbank
Polygala senega	Seneca	S4	potential to transplant	low	grassland, forest
Populus balsamifera	balsam poplar	S5	potential to transplant	yes	forest
Potentilla arguta	tall cinquefoil	S5	potential to transplant	low	grassland
Prenanthes sp.	rattlesnake root	–	potential to transplant	low	forest
Prunella vulgaris	self-heal	S4	potential to transplant	low	grassland, forest
Prunus nigra	Canada wild plum	S4	yes	yes	forest
Prunus pensylvanica	pin cherry	S5	yes	yes	forest
Prunus pumila	sand cherry	S4	yes	yes	grassland, forest
Prunus sp.	plum	–	yes	yes	grassland, forest

Appendix B: Selection of traditional plant species commercially available for rehabilitation					
Provincial Scientific Name	Traditional Use Plant Name	Provincial Rank	Commercial Availability	Rehabilitation Potential	Location of Use
Prunus virginiana	choke cherry	S5	potential to transplant	yes	forest
Pyrola sp.	wintergreen	–	potential to transplant	low	forest
Quercus macrocarpa	bur oak	S5	yes	yes	forest
Ribes americanum	wild black currant	S5	yes	yes	forest
Ribes oxyacanthoides ssp. *oxyacanthoides*	northern gooseberry	S5	potential to transplant	yes	forest
Rosa arkansana	prairie rose	S4	potential to transplant	yes	grassland
Rosa sp.	wild rose	–	yes	yes	grassland, forest
Rubus pubescens	dewberry	S5	potential to transplant	low	forest
Rubus sp.	blackberry	not listed by MBCDC	potential to transplant	low	forest
Rubus idaeus	raspberry	–	yes	yes	forest
Rubus sp.	wild raspberry	–	yes	yes	forest
Sibbaldiopsis tridentata	three-toothed cinquefoil	S5	potential to transplant	low	forest
Solidago canadensis	Canada goldenrod	S5	yes	low	grassland
Solidago gigantea	smooth goldenrod	S5	potential to transplant	low	grassland, forest
Spiraea alba	meadowsweet	S5	yes	yes	forest
Stachys palustris	marsh hedge-nettle	S5	potential to transplant	low	moist meadow
Symphoricarpos albus	snowberry	S5	yes	yes	forest, grassland
Thuja occidentalis	cedar	S4	yes	yes	forest
Trifolium pratense	red clover	SNA	yes	yes	forest, grassland
Vaccinium sp.	blueberry	–	yes	low	forest
Viburnum opulus	highbush cranberry	S5	yes	yes	forest
Viburnum rafinesquianum	downy arrow-wood	S4	yes	yes	forest
Vitis riparia	wild grapes	S3S4	yes	low	forest
Zizania palustris	wild rice	S4	yes	low	wetland

Appendix B: Selection of traditional plant species commercially available for rehabilitation

Provincial Scientific Name	Traditional Use Plant Name	Provincial Rank	Commercial Availability	Rehabilitation Potential	Location of Use

Notes:
1. A list of suppliers is available upon request
2. Traditional use plant names taken from the *Aboriginal Traditional Knowledge Study Community Report* submitted by Black River First Nation, Long Plain First Nation, and Swan Lake First Nation for the Manitoba-Minnesota Transmission Project (Manitoba Hydro 2015).

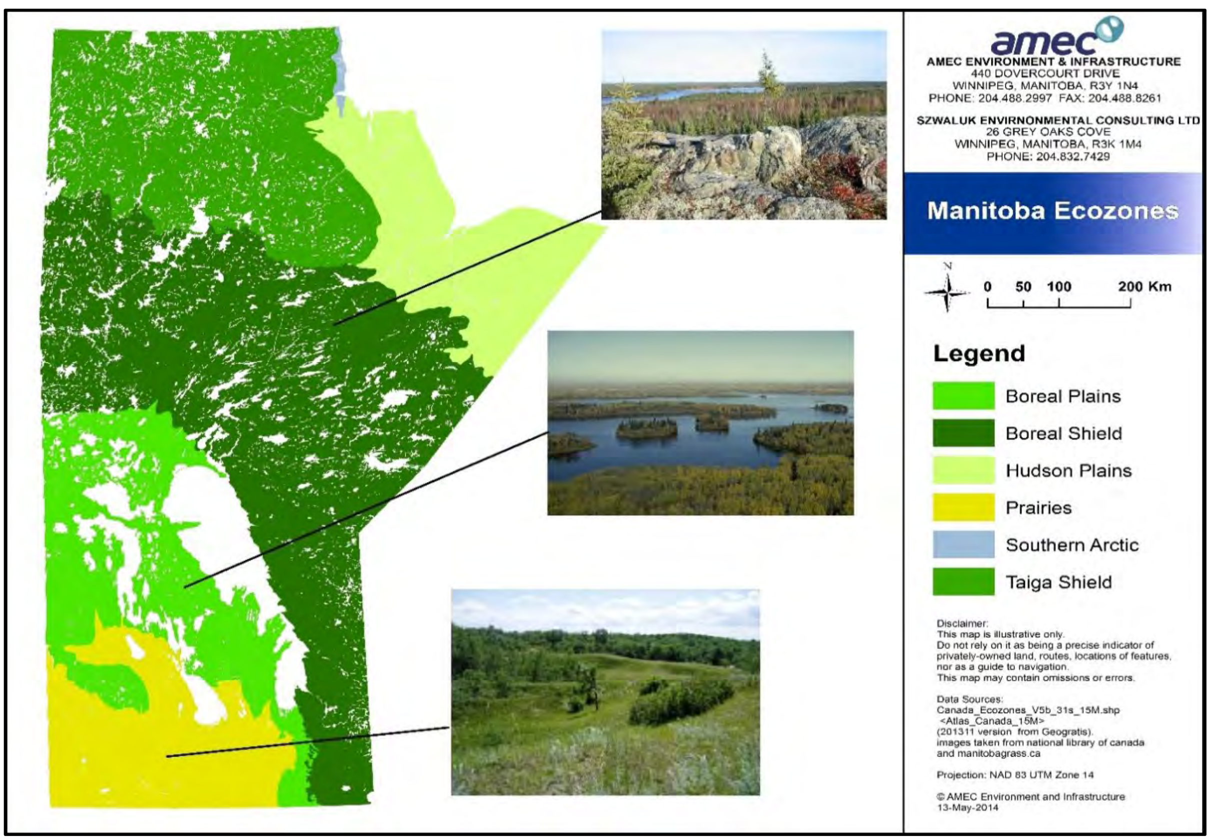
Appendix C

Characteristic vegetation of Manitoba's ecozones

Appendix C: Characteristic vegetation of Manitoba's ecozones

Manitoba ecozone	Characteristic vegetation
Southern Arctic	Occasional forest stands, dwarf birch, willows, ericaceous species, various herbs, mosses and lichens.
Hudson Plains	Black spruce, white spruce, tamarack, ericaceous shrubs, sedges, mosses and lichens. Closer to the coast there are marine marshes, shallow fens, and extensive mud flats with little vegetation.
Taiga Shield	Black spruce, white spruce, tamarack, and ground cover of dwarf birch, willows, northern Labrador tea, cotton grass, mosses, and lichens. Paper birch, balsam poplar and trembling aspen may be found. Bog and fen complexes are present.
Boreal Shield	Single-species forest stands, or mixed stands of white and black spruce, balsam fir, tamarack and jack pine. White birch, trembling aspen, and balsam poplar can be found. Understory is dominated by shrubs, forbs and lichen cover over bedrock outcrops.
Boreal Plains	White spruce, black spruce, jack pine and tamarack are the main coniferous species, while deciduous trees include white birch, trembling aspen and balsam poplar
Prairies	Predominantly agricultural crops and rangeland. Stands of trembling aspen, balsam poplar and bur oak occur.

Source: Smith et al. (1998)



Appendix D

Recommended Baseline Native Seed Mixes

Appendix D: Recommended baseline native seed mixes		
Common name	Scientific name	Percent in mix (total 100%)
Northern Manitoba – upland mesic to dry soils		
Short-leaved Fescue	*Festuca brachyphylla*	10
Canada Wild Rye	*Elymus cananadensis*	20
Tickle-grass	*Agrostis scabra*	10
Hairy Wild Rye	*Leymus innovatus*	20
June Grass	*Koeleria macrantha*	10
Rocky Mountain Fescue	*Festuca saximontana*	10
Richadson Needle Grass	*Achnatherum richardsonii*	15
Common Vetch	*Vicia americana*	5
Northern Manitoba – lowland wet meadow soils		
Fowl Blue Grass	*Poa palustis*	30
Marsh or Northern Reed Grass	*Calamagrostis canadensis or C. stricta*	10
Slough Grass	*Beckmannia syzigachne*	50
Tufted Hairgrass	*Deschampsia caespitosa*	10
West Central Manitoba – upland mesic to dry soils		
Tickle-grass	*Agrostis scabra*	10
Big Bluestem	*Andropogon gerardii*	20
Purple Prairie Clover	*Dalea purpurea var. purpurea*	5
Canada Wild Rye	*Elymus canadensis*	30
Hairy Wild Rye	*Leymus innovatus*	10
Rocky Mountain Fescue	*Festuca saximontana*	5
Awned Wheatgrass	*Elymus trachycaulus spp. subsecundus*	10
June Grass	*Koeleria macrantha*	5
Common Vetch	*Vicia americana*	5
West Central Manitoba – lowland wet meadow soils		
Slough Grass	*Beckmannia syzigachne*	50
Marsh or Northern Reed Grass	*Calamagrostis canadensis or C. stricta*	5
Tufted Hairgrass	*Deschampsia caespitosa*	30
Baltic Rush	*Juncus arcticus var. balticus*	5
Fowl Blue Grass	*Poa palustis*	10
Southern Manitoba – upland mesic to dry soils		
Awned Wheatgrass	*Elymus trachycaulus spp. subsecundus*	10
Big Bluestem	*Andropogon gerardii*	30

Appendix D: Recommended baseline native seed mixes		
Common name	**Scientific name**	**Percent in mix (total 100%)**
White Prairie-clover	*Dalea candida*	5
Purple Prairie Clover	*Dalea purpurea var. purpurea*	5
Canada Wild Rye	*Elymus canadensis*	20
June Grass	*Koeleria macrantha*	5
Little Bluestem	*Schizachyrium scoparium*	10
Indian Grass	*Sorghastrum nutans*	10
Common Vetch	*Vicia americana*	5
Southern Manitoba – lowland wet meadow soils		
Slough Grass	*Beckmannia syzigachne*	50
Marsh or Northern Reed Grass	*Calamagrostis canadensis or C. stricta*	10
Tufted Hairgrass	*Deschampsia caespitosa*	10
Fowl Blue Grass	*Poa palustis*	10
Prairie Cord Grass	*Spartina pectinata*	20

Appendix E

Selection of plant species commercially available for rehabilitation

Appendix E: Selection of plant species commercially available for rehabilitation

Note: A list of suppliers is available upon request

Scientific name	Common name	Seed	Seedling
Abies balsamea	Balsam Fir		X
Achnatherum hymenoides	Indian Rice Grass	X	
Achnatherum richardsonii	Richardson Needle Grass	X	
Agrostis scabra	Tickle-grass	X	
Andropogon gerardii	Big Bluestem	X	
Arctagrostis latifolia	Polar Grass	X	
Astragalus canadensis	Canada Milkvetch	X	
Beckmannia syzigachne	Slough Grass	X	
Bouteloua curtipendula	Side-oats Grama	X	
Bouteloua gracilis	Blue Grama	X	
Bromus anomalus	Nodding Brome	X	
Bromus ciliatus	Fringed Brome	X	
Buchloe dactyloides	Buffalo Grass	X	
Calamagrostis canadensis	Marsh Reed Grass	X	
Calamagrostis stricta ssp. inexpansa	Northern Reed Grass	X	
Calamolvilfa longifolia	Sand Grass	X	
Carex bebbii	Bebb's Sedge	X	
Dalea candida	White Prairie-clover	X	
Dalea purpurea var. purpurea	Purple Prairie Clover	X	
Deschampsia caespitosa	Tufted Hairgrass	X	
Distichlis spicata	Alkali Grass	X	
Elymus alaskanus ssp. latiglumus	Alaska Wild Rye	X	
Elymus canadensis	Canada Wild Rye	X	
Elymus glaucus	Smooth Wild Rye	X	
Elymus lanceolatus ssp. lanceolatus	Thickspike Wheatgrass	X	
Elymus lanceolatus ssp. psammophilus	Sand-dune Wheatgrass	X	
Elymus trachycaulus	Slender Wheat Grass	X	
Elymus trachycaulus spp. subsecundus	Awned Wheatgrass	X	
Elymus virginicus	Virginia Wild Rye	X	
Festuca brachyphylla	Short-leaved Fescue	X	

Appendix E: Selection of plant species commercially available for rehabilitation

Note: A list of suppliers is available upon request

Scientific name	Common name	Seed	Seedling
Festuca halii	Plains Rough Fescue	X	
Festuca saximontana	Rocky Mountain Fescue	X	
Glyceria grandis	Tall Manna Grass	X	
Helianthus maximiliani	Narrow-leaved Sunflower	X	
Hesperostipa comata ssp. comata	Spear Grass	X	
Hesperostipa curtiseta	Western Porcupine Grass	X	
Juncus arcticus var. balticus	Baltic Rush	X	
Koeleria macrantha	June Grass	X	
Leymus innovatus	Hairy Wild Rye	X	
Nassella viridula	Green Needle Grass	X	
Panicum virgatum	Switch Grass	X	
Pascopyrum smithii	Western Wheat Grass	X	
Picea glauca	White Spruce		X
Picea mariana	Black Spruce		X
Pinus banksia	Jack Pine		X
Pinus resinosa	Red Pine		X
Pinus strobus	Eastern White Pine		X
Poa alpina	Alpine Blue Grass	X	
Poa glauca	Glaucous Spear-grass	X	
Poa palustris	Fowl Blue Grass	X	
Poa secunda ssp. secunda	Curly Bluegrass	X	
Populus spp.	Hydbrid Poplar		X
Pseudoroegneria spicata ssp. spicata	Bluebunch Wheat Grass	X	
Quercus macrocarpa	Bur Oak		X
Salix spp.	Hybrid Willow		X
Schizachyrium scoparium	Little Bluestem	X	
Scolochloa festucacea	Sprangletop	X	
Sorgastrum nutans	Indian Grass	X	
Spartina gracilis	Alkali Cord Grass	X	
Spartina pectinata	Prairie Cord Grass	X	

Appendix E: Selection of plant species commercially available for rehabilitation *Note: A list of suppliers is available upon request*			
Scientific name	Common name	Seed	Seedling
Sporobolus cryptandrus	Sand Dropseed	X	
Thuja occidentalis	Eastern White Cedar		X
Trisetum spicatum	Spike Trisetum	X	
Vicia americana	Common Vetch	X	

Appendix F

Invasive species listed by the Invasive Species Council of Manitoba

Appendix F: Invasive species listed by the Invasive Species Council of Manitoba Refer to Invasive Species Council of Manitoba Field Guide (2013) and website for identification	
Scientific name	Common name
Alliaria petiolata	Garlic Mustard
Arctium minus	Common Burdock
Berteroa incana	Hoary Alyssum
Bromus japonicus	Japanese Brome
Bromus tectorum	Downy Brome
Butomus umbellatus	Flowering Rush
Campanula rapunculoides	Creeping Bellflower
Carduus nutans	Nodding Thistle
Cirsium arvense	Canada Thistle
Cirsium vulgare	Bull Thistle
Convolvulus arvensis	Field Bindweed
Cynoglossum officinale	Hound's Tounge
Echium vulgar	Blue Weed
Eichhornia crassipes	Water Hyacinth
Euphorbia esula	Leafy Spurge
Fallopia japonica	Japanese Knotweed
Gypsophila paniculata	Baby's Breath
Heracleum mantegazzianam	Giant Hogweed
Hesperis matronalis	Dame's Rocket
Hieracium aurantiacum	Orange Hawkweed
Hypericum perforatum	St. John's Wort
Impatiens glandulifera	Himalayan Balsam
Jacobaea vulgaris	Tansy Ragwort
Knautia arvensis	Field Scabious
Leucanthemum vulgare	Ox-eye Daisy
Linaria dalmatica	Dalmatian Toadflax
Linaria vulgaris	Yellow Toadflax
Lychnis alba	White Cockle
Lythrum salicaria	Purple Loosestrife
Matricaria perforata	Scentless Chamomile
Odontites serotina	Red Bartsia
Onopordum acanthium	Scotch Thistle
Phalaris arundinacea	Reed Canary Grass
Phragmites australis spp. australis	Invasive Phragmites
Ranunculis acris	Tall Buttercup
Rhamnus cathartica	European Buckthorn

Appendix F: Invasive species listed by the Invasive Species Council of Manitoba

Refer to Invasive Species Council of Manitoba Field Guide (2013) and website for identification

Scientific name	Common name
Saponaria officinalis	Bouncing Bet
Saponaria vaccaria	Cow Cockle
Sonchus arvensis	Perennial Sow Thistle
Tanacetum vulgare	Common Tansy
Tribulus terrestris	Puncture Vine
Typha angustifolia and Typha x glauca	Narrow-leaved and Hybrid Cattail
Vicia cracca	Bird Vetch

Note: Listed species are category 2 species (localized presence in Manitoba) listed by the Invasive Species Council of Manitoba. Invasive species also are listed under The Noxious Weeds Act of Manitoba.

Appendix G

Noxious Weeds Regulation Species List

Appendix G: Noxious Weeds Regulation Species List

Designated Tier 1 Noxious Weeds		
Common name	Scientific name	Area for which Designation applies
Amaranth, Palmer	*Amaranthus palmeri*	All areas of the province outside the Municipality of Bifrost-Riverton and the Rural Municipalities of Armstrong, Fisher, Gimli, Rockwood, St. Andrews and St. Clements
Bartsia, red	*Odontes vernus*	Whole province
Crupina, common	*Crupina vulgaris*	Whole province
Cupgrass, woolly	*Eriochloa villosa*	Whole province
Goatgrass, jointed	*Aegilops cylindrical*	Whole province
Hawkweed, orange	*Hieracium aurantiacum*	Whole province
Hogweed, giant	*Heracleum mantegazzianum*	Whole province
Hound's-tongue	*Cynoglassum officinale*	Whole province
Knapweed, diffuse	*Centaurea diffusa*	Whole province
Knapweed, Russian	*Acroptilon repens*	Whole province
Knapweed, spotted	*Centaurea stoebe*	Whole province
Knapweed, squarrose	*Centaurea virgata*	Whole province
Knotweed, Japanese	*Fallopia japonica*	Whole province
Mile-a-minute weed	*Persicaria perfoliata*	Whole province
Mustard, garlic	*Allaria petiolata*	Whole province
Patterson's curse	*Echium plantagineum*	Whole province
Pigweed, smooth	*Amaranthus hybridus*	Whole province
Saltcedar	*Tamarix spp.*	Whole province
Star-thistle, yellow	*Centaurea solstitialus*	Whole province
Tussock, serrated	*Nassella trichotoma*	Whole province
Waterhemp, tall	*Amaranthus turbriculatus*	Whole province

Designated Tier 2 Noxious Weeds		
Common name	Scientific name	Area for which Designation applies
Alyssum, hoary	*Berteroa incana*	Whole province
Baby's-breath	*Gypsophila paniculata*	Whole province
Bartsia, red	*Odontes vernus*	Municipality of Bifrost-Riverton and the Rural Municipalities of Armstrong, Fisher, Gimli, Rockwood, St. Andrews and St. Clements
Bouncingbet	*Saponaria officinalis*	Whole province
Brome, downy	*Bromus tectorum*	Whole province
Brome, Japanese	*Bromus japonicas*	Whole province
Campion, bladder	*Silene vulgaris*	Whole province
Chamomile, scentless	*Matricaria perforata*	Whole province
Common reed, invasive	*Phragmites australis australis*	Whole province
Daisy, ox-eye	*Leucanthemum vulgare*	Whole province
Nutsedge, yellow	*Cyperus esculentus*	Whole province
Scabious, field	*Knautia arvensis*	Whole province
Spurge, Cypress	*Euphorbia cyparissias*	Whole province
Spurge, leafy	*Euphorbia esula*	Whole province
St. John's-wort	*Hypericum perforatum*	Whole province
Tansy, common	*Tanacetum vulgare*	Whole province
Thistle, nodding	*Carduus nutans*	Whole province
Toadflax, Dalmatian	*Linaria dalmatica*	Whole province

Designated Tier 3 Noxious Weeds		
Common name	Scientific name	Area for which Designation applies
Absinth	*Artemisia absinthum*	Whole province
Barberry	*Berberis vulgaris*	Whole province
Barley, foxtail	*Hordeum jubatum*	Whole province
Bellflower, creeping	*Campanula rapunculoides*	Whole province
Buckthorn, European	*Rhamnus frangula*	Whole province
Burdock, common	*Arctium minus*	Whole province
Burdock, greater	*Arctium, lappa*	Whole province
Burdock, woolly	*Arctium, tomentosum*	Whole province
Campion, biennial	*Silene dioica*	Whole province
Catchfly, night-flowering	*Silene noctiflora*	Whole province
Cleavers	*Galium aparine*	Whole province
Cleavers, false	*Galium spurium*	Whole province
Cockle, white	*Silene alba*	Whole province
Dandelion	*Taraxacum officinale*	Whole province
Dodder	genus *Cuscuta*	Whole province
Fleabane, Canada	*Conyza canadensis*	Whole province
Flixweed	*Descurainia Sophia*	Whole province
Hawk's-beard, narrow-leaved	*Crepis tectorum*	Whole province
Hemlock, poison	*Conium maculatum*	Whole province
Hemp-nettle	*Galeopsis tetrahit*	Whole province
Hoary-cress	*Cardaria draba*	Whole province
Jimsonweed	*Datura stromonium*	Whole province
Kochia	*Kochia scoparia*	Whole province
Lamb's quarters	*Chenopodium album*	Whole province
Lettuce, prickly	*Lactuca seriola*	Whole province
Milkweed, common	*Asclepias syriaca*	Whole province
Milkweed, showy	*Aslepias speciosa*	Whole province
Mustard, wild	*Sinapis arvensis*	Whole province
Nightshade, American black	*Solanum americanum*	Whole province
Nightshade, cutleaf	*Solanum triflorum*	Whole province
Nightshade, hairy	*Solanum sarachoides*	Whole province
Parsnip, wild	*Pastinaca sativa*	Whole province
Ragweed, common	*Ambrosia artemisifolia*	Whole province
Ragweed, false	*Iva xanthifolia*	Whole province
Ragweed, giant	*Ambrosia trifida*	Whole province
Sow-thistle, annual	*Sonchus oleraceus*	Whole province

Designated Tier 3 Noxious Weeds		
Common name	Scientific name	Area for which Designation applies
Sow-thistle, perennial	*Sonchus arvensis*	Whole province
Sow-thistle, spiny annual	*Sonchus asper*	Whole province
Stinkweed	*Thlaspi arvense*	Whole province
Stork's bill	*Erodium cicutarium*	Whole province
Thistle, bull	*Cirsium vulgare*	Whole province
Thistle, Canada	*Circium arvense*	Whole province
Thistle, Russian	*Salsola pestifer*	Whole province
Toadflax, yellow	*Linaria vulgaris*	Whole province
Water hemlock, bulb-bearing	*Cicuta bulbifera*	Whole province
Water hemlock, northern	*Cicuta virosa*	Whole province
Water hemlock, spotted	*Cicuta maculate*	Whole province
Water hemlock, western	*Cicuta douglasii*	Whole province
Whitetop, hairy	*Cardaria pubescens*	Whole province
Whitetop, lenspod	*Cardaria chalepensis*	Whole province

Appendix P

Waste and Recycling Management Plan

Pointe du Bois to Whiteshell Station 115kV Transmission Line (PW75)

Waste and Recycling Management Plan

June 2023

Prepared by Manitoba Hydro

Transmission & Distribution Environment and Engagement Department

Project Management Division

PREFACE

This document presents the Waste and Recycling Management Plan (WRMP; the plan) for the construction of the Pointe du Bois to Whiteshell station 115kV transmission line (the project). It is intended to provide information and instruction to contractors and Manitoba Hydro employees as well as information to regulators and members of the public.

The plan provides general considerations and guidance pertinent to waste and recycling management during the development of the project. More importantly it presents a project-specific implementation plan and actions required to proactively address the issue of waste management because of construction of the project.

Manitoba Hydro employees and contractors are encouraged to contact the onsite Manitoba Hydro Environmental Inspector/Officer if they require information, clarification, or support. Regulators and the public are to direct any inquiries about this plan to:

Manitoba Hydro
Transmission & Distribution Environment and Engagement
360 Portage Avenue
Winnipeg, MB
Canada R3C 0G8
1-877-343-1631

Projects@hydro.mb.ca

Document Owner
Transmission & Distribution Environment and Engagement
Project Management Division
Manitoba Hydro

Version

List of Revisions

Number	Nature of revision	Section(s)	Revised by	Date

Table of contents

Figures

Tables

1.0 Introduction

Consistent with its corporate Environmental Management Policy, Manitoba Hydro has committed within the Pointe du Bois to Whiteshell station 115kV transmission line (the project) Construction Environmental Protection Plan to developing a Waste and Recycling Management Plan (WRMP) as part of a larger suite of mitigation measures to minimize potential negative environmental and socio-economic effects. This document outlines the procedures to be employed by contractors to proactively address the issue of waste management.

This document is intended to provide measures to manage waste during the construction of the project. Waste generated during the construction activities of a transmission project will be collected, sorted, isolated, stored and disposed of or recycled. This document identifies some of the common waste materials generated during different construction activities.

Note that the methods presented here are not exhaustive and alternative methods may be proposed by the contractor but would require approval from a Manitoba Hydro environmental officer prior to implementation.

1.1 Commitment to environmental protection

Manitoba Hydro integrates environmentally responsible practices in all aspects of our business. Environmental protection can only be achieved with the involvement of Manitoba Hydro employees, consultants, contractors, Indigenous communities and organizations and the public at all stages of the project from planning and design through construction and operational phases.

The use of a WRMP is a practical and direct implementation of Manitoba Hydro's environmental policy and its commitment to responsible environmental and social stewardship. It is a proactive approach to manage potential effects of access related to the construction activities of the transmission line project.

Manitoba Hydro is committed to implementing this WRP and requiring contractors to follow the terms of this and other applicable plans within the Environmental Protection Program.

1.2 Purpose and objectives

This plan is intended to be used as a reference document in the field, during construction activities to addresses waste management while ensuring compliance with Manitoba Hydro's Construction Environmental Protection Plan requirements, industry best practices, and Provincial/Federal regulations and legislation. To effectively manage waste during construction activities, a variety of methods are available for implementation. The appendix outlines waste management techniques along with a description of the situations where each technique may be employed and directions for correct implementation.

Should a contractor wish to deviate from the techniques or implementation described in this document they must first obtain approval from a Manitoba Hydro Environmental Officer.

The objectives of this Plan are as follows:

- To establish a process prior to the start of construction that can be used to identify potential waste streams and plan for proper handling and disposal. This process will meet regulatory requirements, industry standards and best practices with regards to waste management during construction activities.
- To provide guidance on the correct handling and management of waste.

1.3 Potential effects of waste

The project has potential to generate significant amounts of waste of various types. To manage and reduce waste from the project, Manitoba Hydro requires all contractors to utilize the Waste and Recycling Management Plan (WRMP) to reduce the volume of materials going to landfill and facilitate reuse and recycling. Where applicable, this WRMP will also address wastes developed in the operation of construction camps.

1.4 Roles and responsibilities

This section outlines the major roles and responsibilities of those involved in the implementation of the plan. The plan forms a component of the Environmental Protection Program (EPP), which provides the framework for the delivery, management, and monitoring of environmental and socio-economic protection measures for the project. The EPP describes how Manitoba Hydro is organized and functions to deliver timely, effective, and comprehensive solutions and mitigation measures to address potential environmental effects from project activities. A visual reference for how the plan fits into the overall EPP organization structure is provided in Figure 1.

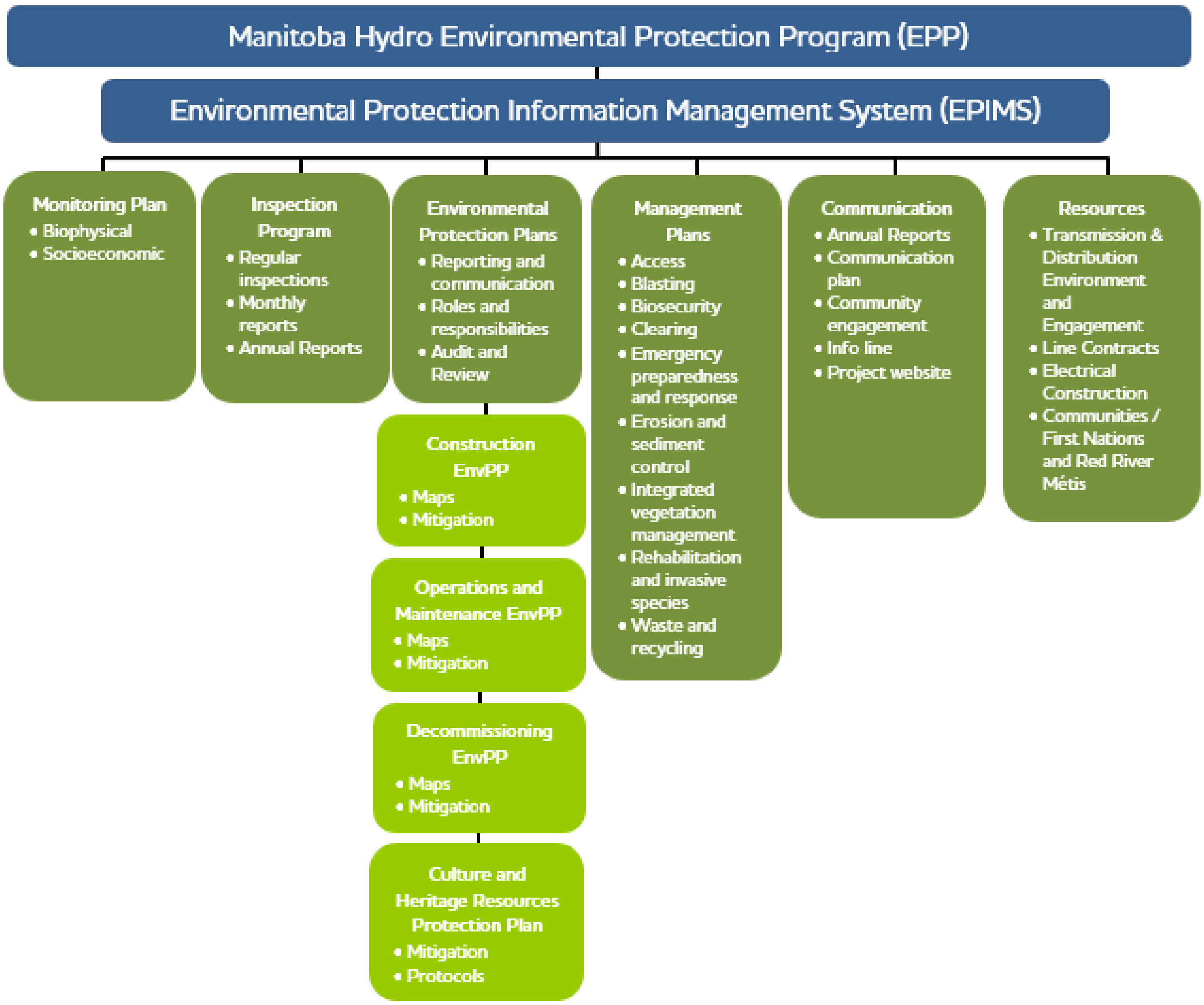


Figure 1: Transmission Environmental Protection Program

A summary of roles and key responsibilities is found in Table 1. Communication and reporting on environmental issues, monitoring and compliance will be as outlined in Figure 2.

Table 1: Roles and responsibilities

Role	Key Responsibilities
Manitoba Hydro	• Develops and amends the WRMP. • May delegate this responsibility to other construction professionals to implement, maintain and inspect /monitor for the duration of the undertaking • Signs agreements, approvals, permits and authorizations to which compliance is legally binding • Ensures contractors are aware of their responsibilities • Appoints an environmental inspector/officer to confirm that regulatory criteria are being met • The Manitoba Hydro environmental inspector/officer will regularly inspect waste management measures to confirm effectiveness.
Construction contractor(s)	• Ensure that all activities comply with the requirements of the WRMP. • Ensure that all activities comply with applicable regulatory requirements. • Responsible for acquiring any applicable regulatory permits related to waste management and submitting copies to MH. • Responsible for implementation, coordination and verification of pre-project employee environmental orientation. • Ensure all contractor project staff are adequately trained/informed of pertinent requirements and of the project related to their position. • Ensure that only adequately trained personnel are permitted to handle hazardous materials. • Ensure that hazardous material storage areas are only accessible to adequately trained personnel. • Ensure all staff will be trained in Work Hazardous Materials Information Systems (WHMIS) and have access to MSDS sheets. • Report any discoveries of non-compliance, accidents or incidents to MH. • Respond and act promptly to resolve if any activities are identified as not in compliance with the WRMP or any regulatory requirements.

Table 1: Roles and responsibilities

Role	Key Responsibilities
	• Ensure that adequate equipment and materials are on hand to safely store, segregate and manage waste products • Ensure that all documentation is maintained and copies submitted to MH in a timely manner. • Responsible for implementation of the emergency response and hazardous materials plans, and other related topics. • Ensure that food waste is carefully sorted and stored in wildlife proof containers. Seek clarification from environmental inspector/officer and/or hydro field safety officers as necessary.

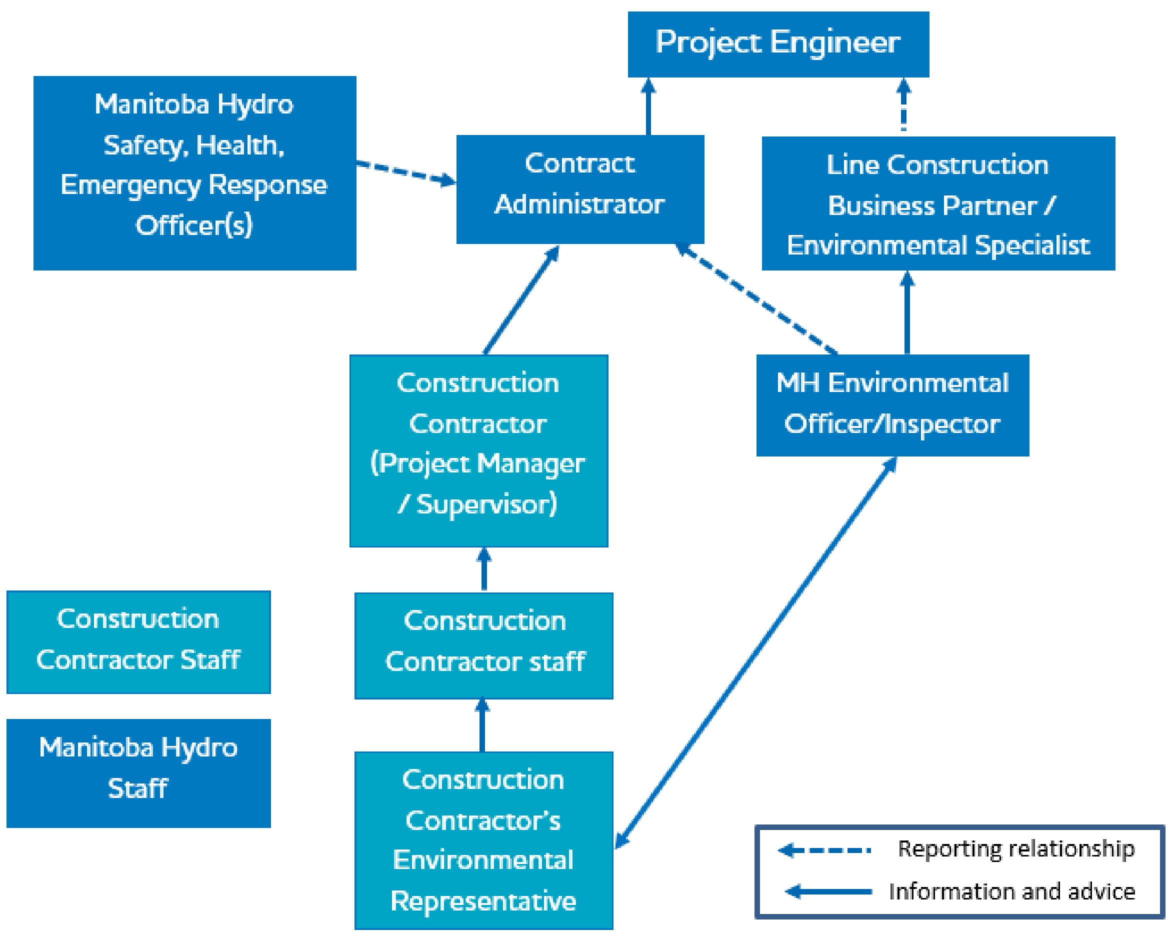


Figure 2: Environmental communication reporting structure

2.0 Regulatory context

Below is a list of the applicable legislation regarding waste and recycling practises:

Provincial

- The Workplace Health and Safety Act and Regulations
- The Waste Reduction and Prevention Act and Regulations
- The Ozone Depleting Substance Act
- The Dangerous Goods Handling and Transportation Act
    - Dangerous Goods Handling and Transportation Regulation
    - Hazardous Waste Regulation
- Environment Act (C.C.S.M. E125)
    - MR 37/2016 Waste Management Facilities Regulation
    - MR 83/2003 Onsite Wastewater Management Systems Regulation
    - MR 92/88R Litter Regulation

Federal

- Transportation of Dangerous Goods Act
- Fisheries and Oceans Regulations and Legislation

3.0 Implementation

3.1 Waste identification

Waste will be categorized and segregated by the contractor, examples of waste that are expected to be produced by the Project and be covered by this plan are found in Table 2 (Note: this is not an exhaustive list).

Table 2: Examples of commonly produced waste during construction

Category	Items
Hazardous waste	Motor oils, fuels, solvents, coolants, lead-acid batteries, hydraulic fluid, oil filters, pesticides, solids, and liquids (water/snow, soils, clean-up materials) contaminated by petroleum products or other hazardous materials, other chemicals
Construction materials	Wood, aluminum, copper, steel, cardboard, plastic
Food services	Beverage containers (aluminum, plastic, and glass), cardboard, boxboard, plastics, newsprint, office paper
Domestic solid waste	Organic material, non-recyclable waste
E-waste	Computers, circuitry, general purpose batteries (lithium, nickel-cadmium)
Construction equipment	Rubber tires, equipment parts etc.
Wastewater	Sewage, grey water

3.2 Waste management

This Waste and Recycling Management Plan takes a hierarchical approach to waste management. The purpose of the hierarchy is to assess each waste item for opportunities to avoid waste, then opportunities to reuse, followed by opportunities to recycle prior to disposal. This hierarchy will be as follows:

- Compliance with federal and provincial waste management legislation (i.e., Acts and Regulations)
- Waste avoidance

- Waste re-use
- Waste recycling
- Waste disposal (as a final option)

Prior to the start of construction, the contractor must ensure that the local waste management facilities are willing and have the capacity to accommodate the projected waste volume. Only waste management facilities that are approved by MH may be used by the contractor.

3.3 Training

As part as their pre-job training and site orientation, work crews must participate in formal training. Prior to starting work on the project, staff and subcontractors must have training in:

- Workplace Hazardous Materials Information Systems (WHIMIS)
- When applicable, the Transportation of Dangerous Goods (TDG)
- Environmental awareness (environmental orientation)
- Waste management procedures
- Spill response procedures

3.4 General mitigation measures

General mitigation measures that are particular to waste management and construction activities are found in the Construction Environmental Protection Plan, General mitigation tables:

- EI-13 Concrete wash water and waste
- EI-4 Hazardous materials
- EI-5 Petroleum products
- EI-10 Waste management
- EI-12 Wastewater

3.5 Documentation

The list below outlines the documentation requirements that the contractor is responsible for as part of the implementation of the plan.

- Submit a copy of a valid hazardous waste generator licence to MH.

- Maintain an accurate and detailed inventory of various hazardous waste types being generated and submit a copy to MH on a bi-weekly basis.
- Submit all copies of manifests and waste receipts related to transport and/or disposal of hazardous waste materials to MH
- Complete required reporting to regulatory agencies and either copy MH on all correspondence or provide copies of all correspondence to MH in a timely manner
- Submit copies of all valid TDG certificates to MH for all contractor staff that require.
- Submit to MH in writing the valid Sewage Haulers Provincial Registration Number for any individuals/companies completing this service for the contractor.
- Submit in writing to MH the name/company of any subcontractors involved in transport of project related recycling and/or waste transport to recycling and/or disposal sites and notify MH in writing if any changes are made.
- Receive approval from MH prior to hauling of project related waste to a recycling and/or disposal site and submit a request to MH in writing if would like to propose any changes.

4.0 Communication

Any contractor-proposed additions, location modifications or plan requirement revisions will be submitted in writing to Manitoba Hydro and include a map containing legal land description and GPS location. Any Manitoba Hydro-required revisions to the plan will be communicated to the contractor's project manager for distribution to project staff.

5.0 Monitoring and follow-up

Monitoring, inspection, and adaptive management are necessary to ensure the effectiveness of waste management and the Waste and Recycling Management Plan. It is the duty of the contractor to ensure that the storage requirements and processes described in this plan are being followed. Regular monitoring of worksites and storage facilities will take place to track and document compliance. To accomplish this, the contractor's environmental representative will conduct monitoring that includes the following:

- Ensure that proper general housekeeping practices are being followed and that any unnecessary waste/mess at work and/or storage sites is being cleaned up daily
- Ensure waste is not exceeding the capacity of containers and coordinating transport/disposal as required
- Ensure that general waste, recycling, and hazardous waste are being appropriately segregated and labelled
- Ensure that general waste, recycling, and hazardous waste containers are very clearly signed accordingly
- Ensure that all hazardous waste storage has adequate secondary containment.
- Ensure that all hazardous waste storage is adequately covered and protected from precipitation
- Ensure that all hazardous waste storage areas are appropriately ventilated
- WHMIS procedures are being followed and MSDS sheets are accessible
- Check the capacity of containers, determining and reporting on levels and determine if transport to a waste management facility is needed
- Ensure tracking documentation is being completed by site personnel

6.0 Environmental management practices

Below is a list of environmental management practices applicable to waste and recycling. An appendix is provided for each that provides material examples, methods, reduction techniques, applicable legislation for each.

- WR_01 Hazardous materials handling
- WR_02 Hazardous materials – storage and facility requirements
- WR_03 Construction waste
- WR_04 Wastewater
- WR_05 Concrete waste
- WR_06 Biosecurity waste

Appendix A

Environmental Management Practices

HAZARDOUS MATERIALS – Handling ID–WR_01

Material Examples

Motor oils, oil filters, lead-acid batteries, hydraulic fluid, fuels, solvents, coolants, pesticides, soil and water impacted by hazardous materials, other chemicals and their containers

Waste management method

Materials will be shipped to an approved Recycling facility or Hazardous waste management facility

Waste reduction technique

•Where possible order hazardous materials in a container type that can be returned to the vendor when emptied.
•Non-hazardous products will be used in place of hazardous substances to the extent possible. Such as the use of Industrial soaps can be used instead of solvents when similar results can be achieved

Applicable Legislation

•Waste Management Facilities Regulation 37/2016, Feb 23, 2016)
•Transportation of Dangerous Goods Act and Regulations
•The Workplace Health and Safety Act and Regulations
•The Ozone Depleting Substance Act
•Fisheries and Oceans Regulations and Legislation
•Hazardous Waste Regulation (MR 195/2015)

Handling

•Contractor personnel will be trained in emergency response procedures in accordance with provincial legislation.
•Contractor personnel will receive WHMIS training in accordance with provincial legislation. Controlled substances will be labeled in accordance with WHMIS requirements.
•Hazardous substances management procedures will be communicated to all project staff and a copy will be made available at the project site.
•Orientation for Contractor and Manitoba Hydro employees working in construction areas will include hazardous substance awareness.
•For instruction on handling and disposal of soil and water impacted by soil see the "Guidance document for the Identification and Management of soils, surface waters or groundwater suspected to be impacted by Hazardous Materials" Found in Appendix G of the CEnvPP
•All Batteries (lithium, nickel-cadmium and lead-acid) will be segregated and stored.

Treatment

•Waste materials will be categorized and segregated Non-Hazardous and Hazardous
•In the even that hazardous and non-hazardous material are mixed, the entire mixture must be managed as hazardous material.
•Rags, cloths and clean up debris that have been used to apply or remove hazardous materials are also considered to be hazardous waste and should be treated as such.
•Sludge from solvent parts cleaning must be shipped with the solvent being recycled
•Used oil storage tanks or drums will be clearly marked as "Used Oil" with nothing else added to them including waste solvents and antifreeze
•Waste Oils, fluids and filters from vehicle maintenance will be stored in drums
•Used oil filters removed from equipment while still warm will be punctured and placed on a drain rack, once drained will be placed in a labeled drum and shipped for recycling
•Containers will be weatherproof

Transportation and Disposal

•Waste oil will be transported by licensed carriers to licensed or approved waste oil recycling facilities.
•Empty hazardous waste containers will be removed to a licensed or approved disposal site by the contractor.
•All Batteries (lithium, nickel-cadmium and lead-acid) will be transported to licensed or approved waste recycling facilities.
•Transportation of Hazardous materials off-site is to be performed by licensed regulated waste transporter and disposal off-site should be accommodated by a regulated waste receiver, for recycling or proper disposal.
•Material Safety Data Sheets (MSDS) will be available for transportation

Record Keeping

•Record kept of amounts of waste generated
•Manifesting transportation of wastes
•Inventory and account for hazardous waste leaving collection areas.

HAZARDOUS MATERIALS - STORAGE FACILITY REQUIREMENTS

ID–WR_02

Facility Design

•Hazardous substances storage areas will be located a minimum of 100 m from the ordinary high water mark of a waterway and above the 100-year flood level.
•Temporary hazardous material storage containers will be located on level ground and within a structure that is covered by roofing preventing precipitation from entering the storage area or the secondary containment system
•Indoor storage of flammable and combustible substances will be in fire resistant and ventilated enclosed storage area or building in accordance with national codes and standards.
•Bulk waste oil will be stored in approved aboveground tanks provided with secondary containment in accordance with provincial legislation.
•Hazardous materials shall be stored in a secondary a containment system that is designed to contain at least 110% of the volume stored
•Access to hazardous materials storage areas will be restricted to authorized and trained Contractor and Manitoba Hydro personnel.
•Ensure Emergency response provisions are available and employees working with Hazardous Materials are trained in Emergency response
•The contractor employees will monitor the level of used oil in storage tanks or drums to ensure that the container isn’t at risk of overflow.

Documentation

•An inventory of WHMIS controlled substances and their Material Safety Data Sheets (MSDS) will be prepared by the Contractor and maintained at each project site and updated as required by provincial legislation.
•Hazardous materials storage sites will be secured, and signs will be posted that include hazard warnings, as well as contacts in case of a release, access restrictions and under whose authority the access is restricted.

Treatment

•Hazardous waste materials will be segregated and stored by type in approved containers within a secondary containment system.
•Pesticide storage will be in accordance with provincial legislation and Manitoba Hydro guidelines.
•Hazardous waste can be stored temporarily for no longer than 30 days before removal to a licensed or approved disposal site.
•All batteries will be segregated by type.

Monitoring

•The Contractor will monitor containers of hazardous substance containers regularly for leaks and to ensure that labels are legible and prominently displayed.
•The MH Environmental Inspector\Officer will make routine inspections of hazardous substance storage facilities to confirm that environmental protection measures are implemented and effective.
•Hazardous materials storage facilities will undergo regular inspections to inspect storage containers and records of inspections be maintained by the contractor

Applicable Legislation

•Waste Management Facilities Regulation 37/2016, Feb 23, 2016)
•Transportation of Dangerous Goods Act and Regulations
•The Workplace Health and Safety Act and Regulations
•The Ozone Depleting Substance Act
•Fisheries and Oceans Regulations and Legislation
•Hazardous Waste Regulation (MR 195/2015)

CONSTRUCTION WASTE ID-WR_03

Material examples	• Aluminum, copper, steel, scrap conductors • Cardboard packing and boxes • Plastic bags and plastic packaging
Waste management method	Collected and segregated on-site, transported for off-site recycling.
Waste reduction technique	Observe the 4 R's (reduce, reuse, recycle and repurpose). Minimize waste by producing or using only the amount necessary. Where possible, be re-used or re-purposed and recycle.
Material examples	• Wood - timber off cuts, pallets, wooden boxes
Waste management method	Off cuts and pallets to be burnt on-site or disposed of in landfills licensed by Sustainable Development with capacity to accept and separate construction wastes.
Material examples	• Equipment and vehicle tires
Waste management method	Tires that cannot be returned to the vendor will be sent to the local receiving waste management facility where it will be collected for recycling
Material examples	• Electronic Wastes, Computers, circuitry appliances
Waste management method	Electronic waste will be stored and transported off-site to a licensed e-waste receiver for recycling or disposal.

Applicable Legislation

•Waste Management Facilities Regulation 37/2016, Feb 23, 2016)

Material examples	• Sewage or grey water
Waste management method	• Sewage and grey water will be collected in holding tanks and chemical toilets. • In remote locations, an appropriate number of portable toilets will be made available to ensure that each crew has ready access to washroom facilities. The facilities will be serviced and cleaned regularly, and will be adequately secured. All site personnel are to use portable toilets, as provided. • On-site disposal of septic waste if employed, must be in accordance with the on-site waste disposal systems regulation (MR 83/2003). • Wastewater holding tanks will be installed as per provincial legislation and regulation and a minimum of 100 m from the ordinary high water mark of any waterbody. • Wastewater will be removed from holding tanks when they are no more than 90% full by a registered sewage hauler and disposed of at a licensed wastewater treatment facility. • All sewage haulers will be registered with the Manitoba Sustainable Development. A copy of the hauler registration will be provided to MH environmental inspector/officer upon request. • Septic and solid wastes from work sites must be disposed of at *Environment Act* licensed wastewater treatment facilities and waste disposal grounds that have sufficient capacity to accept the waste stream.
Applicable legislation	• On-site waste disposal systems regulation (MR 83/2003).

CONCRETE WASTE ID-WR_05

Material examples	• Concrete wash water (water remaining from the process of washing concrete from equipment) • Remaining cured or partially cured concrete
Waste management method	• Wash water will not be discharged onto the ground at the project site, washout pits will be constructed to cure concrete and settle out wash water. • All water from chute washing activities will be contained in leak proof containers or in an approved settling pond that are situated at least 100 meters from a waterbody. • Contain wash out in a temporary plastic-lined (10-mil polyethylene minimum) pit • Maintain at least 4" (aboveground) or 12" (below ground) of freeboard in pits • All water that has been used for wash out purposes and associated activities will be disposed in an appropriately sized settling pond(s) treated to meet turbidity (total suspended solids [TSS]) and pH requirements prior to discharge. Turbidity will be treated by settlement or filtration; pH will be treated by use of acid, dry ice, carbon dioxide gas or other methods. • All water that has been used for wash out purposes and associated activities will be treated to meet the Manitoba Water Quality Standards, Objectives, and Guidelines (Tier 1) for municipal wastewater effluents of 25 mg/L TSS prior to discharge. • All water that has been used for wash out purposes and associated activities will be treated to meet the Manitoba Water Quality Standards, Objectives, and Guidelines (Tier 3) for the protection of aquatic life for pH 6.5-9.0, prior to discharge into a watercourse.

CONCRETE WASTE ID-WR_05

Material examples	• Remaining cured or partially cured concrete
Waste management method	• Cured or partially cured concrete will not be discharged onto the ground at the project site, washout pits will be constructed to cure concrete and settle out wash water. • High density polyethylene geomembrane liners (10-mil polyethylene minimum) and either earth or physical berms may be used for a temporary concrete washout for uncured or partially cured concrete. • Pits should be of sufficient volume for site requirements • Maintain at least 4" (aboveground) or 12" (below ground) of freeboard in pits • Regularly break-up cured concrete can be transported in non-hazardous waste containers and disposed of at a licensed facility. • Any uncured and partly cured concrete will be kept isolated from watercourses/ditches.
Waste Reduction Technique	• Minimize waste by producing only the amount necessary.
Applicable legislation	• Fisheries and Oceans Regulations and Legislation • Waste Management Facilities Regulation 37/2016, Feb 23, 2016)

BIOSECURITY WASTE ID–WR_06

Material examples	• Waste disinfectants, waste water from biosecurity cleaning
Waste management method	Sediment released from the washing process will be fully contained (i.e., sump pit, berm). When cleaning station sump pits, sump materials (dirt, water and disinfectant solution from washing activities) must be either: • Disposed of at an MH approved disposal facility; • Or remain on the field where it was used; mixed and buried on-site at a minimum depth of 2 m (requires landowner permission) at least ten metres from a drain or drainage ditch.
Waste Reduction Technique	• Minimize waste by producing only the amount of disinfection solution necessary to be used prior to solution expiry.

Appendix Q

Ice Thickness Chart

Ice Thickness Chart

***Estimated Bearing Capacity of Blue Ice Chart**

Ice Thickness			Estimated Weight Bearing Capacity		Ice Thickness			Estimated Weight Bearing Capacity	Ice Conditions
1 in	2.5 cm	=	100	lbs	21 in	53.3 cm	=	44103 lbs	**Blue Ice** is clear in texture and has the
2 in	5.1 cm	=	400	lbs	22 in	55.9 cm	=	48403 lbs	maximum allowable bearing capacity of all ice
3 in	7.6 cm	=	900	lbs	23 in	58.4 cm	=	52904 lbs	
4 in	10.2 cm	=	1,600	lbs	24 in	61.0 cm	=	57604 lbs	**Flood Ice or White ice** is considered to have
5 in	12.7 cm	=	2,500	lbs	25 in	63.5 cm	=	62505 lbs	only 50% of the load bearing capacity of
6 in	15.2 cm	=	3,600	lbs	26 in	66.0 cm	=	67605 lbs	Natural Blue Ice & the maximum flood should
7 in	17.8 cm	=	4,900	lbs	27 in	68.6 cm	=	72905 lbs	not exceed 2"
8 in	20.3 cm	=	6,400	lbs	28 in	71.1 cm	=	78406 lbs	
9 in	22.9 cm	=	8,101	lbs	29 in	73.7 cm	=	84106 lbs	**Slush or white ice** is white in texture and is
10 in	25.4 cm	=	10,001	lbs	30 in	76.2 cm	=	90006 lbs	considered to have only 50% of the bearing
11 in	27.9 cm	=	12,101	lbs	31 in	78.7 cm	=	96107 lbs	capacity of natural Blue Ice
12 in	30.5 cm	=	14,401	lbs	32 in	81.3 cm	=	102407 lbs	
13 in	33.0 cm	=	16,901	lbs	33 in	83.8 cm	=	108908 lbs	**Grey Ice, Crystallized ice or Honeycomb**
14 in	35.6 cm	=	19,601	lbs	34 in	86.4 cm	=	115608 lbs	ice indicates the presence of water running
15 in	38.1 cm	=	22,502	lbs	35 in	88.9 cm	=	122509 lbs	thru the ice & should not be trusted as a load
16 in	40.6 cm	=	25,602	lbs	36 in	91.4 cm	=	129609 lbs	bearing surface
17 in	43.2 cm	=	28,902	lbs	37 in	94.0 cm	=	136910 lbs	
18 in	45.7 cm	=	32,402	lbs	38 in	96.5 cm	=	144410 lbs	**Imperial & Metric Conversions**
19 in	48.3 cm	=	36,103	lbs	39 in	99.1 cm	=	152111 lbs	**Inches x 2.54 = cm Lbs x .4535 = kg**
20 in	50.8 cm	=	40,003	lbs	40 in	101.6 cm	=	160011 lbs	**Cm x 0.3937 = In Kg x 2.205 = lbs**

*NOTE: Given the many variables involved in the development of ice crossings and roads, these values are intended to be used as an approximation and Manitoba Hydro assumes no responsibility for loss or damage of property

Appendix R

Clearing Management Plan

POINTE DU BOIS UNIT REPLACEMENT PROJECT – GREENHOUSE GAS MITIGATION ASSESSMENT

Resource Planning Department
Integrated Resource Planning

PREPARED BY:

K. M. SHAW, P. ENG.

PROVINCE OF MANITOBA
2021/02/16
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DATE: FEBRUARY 2021

REPORT: **IRPD 20_08**

Manitoba Hydro

Final Version

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1 ATTESTATION OF COMPLETENESS

I the undersigned attest that this Greenhouse Gas Mitigation Assessment was undertaken using recognized assessment tools and approaches (e.g., World Resources Institute's Electricity Project Guidelines and ISO Standard 14064-2), conducted by a qualified professional, and complies with the Climate Lens and any relevant sector-specific technical guidance issued by Infrastructure Canada for use under the Climate Lens.

Prepared by: ______________________ 2021/02/16

Kevin Michael Shaw, P.Eng. February 16, 2021

Validated by: ______________________ 2021/02/16

Kevin Michael Shaw, P.Eng. February 16, 2021

2 EXECUTIVE SUMMARY

The Pointe du Bois Unit Replacement Project ("PdB Project") is a 52 MW (rated capacity) hydroelectricity project. It involves enhancing the existing Pointe du Bois hydroelectric generation station ("PdB") by installing eight new units. PdB is the oldest hydroelectric generating station still in operation in Manitoba ("MB"), generating renewable electricity since 1911. As PdB is an existing development, the PdB Project has limited negative environmental impacts as well as the potential for supporting substantial greenhouse gas ("GHG") emission reductions.

Without the PdB Project the station's rated capacity (median head conditions) will drop to 20 MW by 2029 as most existing units are either approaching their end of life or are already non-operational. By installing eight new units, PdB's rated capacity will become 72 MW (2029-2055) and produce an average of 380 GWh/year more non-emitting electricity between 2024 and 2055, when PdB is assumed to cease generating electricity. Incremental capital investments required to move forward with the PdB Project are estimated to be approximately $270M[1] (2020 Canadian dollars).

As MB is seeking federal funding under the Investing in Canada Infrastructure Program, a GHG mitigation assessment was undertaken to fulfill the requirements of Infrastructure Canada's Climate Lens. ISO 14064-2 is the required standard under the Climate Lens; this standard was followed along with other recognized resources, with emphasis appropriately placed on the World Resources Institute's *Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects*.

This assessment forecasts the net GHG reductions resulting over the entire assumed life (2024-2055) of the PdB Project. The boundaries of this assessment incorporate all significant "GHG effects" of the PdB Project; assessment boundaries are not restricted by the physical boundaries of PdB, Manitoba Hydro's system, or Canada's borders. However, results segregate Canadian impacts as per Climate Lens requirements.

This assessment relied on the use of "GSPRO", the suite of modelling tools used by Manitoba Hydro for generation expansion planning, production costing, and related pre- and post-processing tasks. Assumptions and modelling methodology are consistent with other Manitoba Hydro analyses. This assessment demonstrated that the most appropriate methods for

[1] Note: Incremental cost estimates presented herein were the best available as of the date of this assessment. This includes incremental capital O&M investments, but there is no incremental change in the assumed operational O&M budget. Costs that are considered "ineligible", such as financing costs and land acquisition costs, are excluded. Detailed cost information is available in other documentation submitted as part of the ICIP application.

evaluating the impact of new renewable energy in MB consider Manitoba Hydro's entire system, including its interactions with neighbouring power markets.

Manitoba Hydro's electricity sector is practically non-emitting and is forecast to continue producing over 99.8% of all its electricity from renewable sources in both the "Baseline Scenario" and "Project Scenario" (average of all flow-cases). As Manitoba Hydro must plan for "low-flow" conditions, during most "flows" the system produces more non-emitting electricity annually than required by Manitobans. Manitoba Hydro therefore exports a substantial quantity of electricity to neighbouring provinces and states, displacing GHG emissions ("emissions") in their electricity sectors; the primary GHG effect of the PdB Project is that it will build on this environmentally beneficial system characteristic (Table 1).

The majority of emission reductions resulting from the PdB Project are expected to occur in the United States of America ("U.S."); incrementally, greater reductions could occur in Canada, if additional transmission was built between MB and adjacent provinces. As this GHG assessment used the performance standard approach for non-MB GHG effects, Baseline Scenario emission values shown in Table 1 represent the impact of net exports from MB on surrounding electricity markets (average of all flow-cases); they are not a projection of total future sectoral emissions in the U.S. and Canada (this is outside the scope of this assessment). Emission values are presented in kilotonnes ("kt") of carbon dioxide equivalent ("CO_2e").

Table 1 Emission Reductions Resulting from Net MB Electricity Exports (kt of CO_2e)

	Canada	**U.S.**	**Global**
Baseline Scenario (2024-2055)	20,359	106,867	127,226
Project Scenario (2024-2055)	20,767	113,704	134,471
Net Increase in Reductions (2024-2055)	**408**	**6,837**	**7,245**
Baseline Scenario (2030 only)	506	4,439	4,946
Project Scenario (2030 only)	518	4,695	5,214
Net Increase in Reductions (2030 only)	**12**	**256**	**268**

Because the Baseline Scenario forecasts minimal fossil-fuel generation in MB (i.e., it forecasts over 99.8% renewable generation on average), there is limited opportunity for the PdB Project, or any other future renewable electricity project in MB, to further reduce emissions specifically within MB's electricity sector. This lack of opportunity is a direct result of MB's historical investments in renewable energy and minimal investment in fossil-fuel electricity generation. The PdB Project does, however, reduce Manitoba Hydro's reliance on the Brandon fossil-fuel generation station during low-flow periods. The beneficial impact of the PdB Project during these low-flow periods is inherently captured within the results presented in Table 2 as they are an average of all 107 historical flow-cases. The PdB Project is projected to lower MB's electricity generation emissions by less than 2% on average.

Table 2 Manitoba's Grid-Connected Electricity Generation Emissions (kt of CO_2e)

	2024-2055	2030
Baseline Scenario Emissions	3,844	23.4
Project Scenario Emissions	3,780	22.7
Net Change in Emissions	**-64**	**-0.7**

The Baseline Scenario assumes new fossil-fuel generation being built in MB in 2044 (and new renewable generation being built in 2042); prior to 2044, cumulative Baseline and Project Scenario emissions were both less than 600 kt. The bulk of Baseline and Project Scenario emissions shown in Table 2 occur in the 2044-2055 period. Projected cumulative emissions from the 2044-2055 period are a result of the Baseline Scenario's assumed generation expansion sequence and are only intended to provide a baseline on which to estimate the plausible net impact of the PdB Project. This assessment does not intend to suggest that new fossil-fuel generation resources in MB are a certainty. Cumulative MB electricity generation emissions from the entire 2024-2055 period would likely be under 1 megatonne ("Mt") if no new emitting generation resources (e.g., natural gas generating units) are ever built in MB; this is noticeably less than the 3.8 Mt presented in Table 2.

The PdB Project is estimated to have negligible net direct construction emissions (including worker transportation), around 3 kt over the entire assumed life of the PdB Project; this is less than 0.04% of the entire global emissions reductions (2024-2055) resulting from the PdB Project and does not materially impact this assessment's results. Construction emissions were not broken down by year, due to their negligibility, but assumed to occur prior to 2030; there will therefore be no net construction emissions in 2030. Incremental operations and maintenance ("O&M") emissions as the result of the PdB Project are minimal (<0.05 kt per year) and do not materially affect 2030 emissions.

In addition to incremental direct on-site construction emissions, Table 3 also incorporates supply-chain emissions, O&M emissions, and land use change emissions in line items B. Land use change emissions as a result of the PdB Project are estimated to be 22.5 kt of CO_2e and result from the permanent clearing of a right-of-way required for the construction of a new transmission line (line PW75); this is the most significant source of construction related emissions.

Upstream fossil-fuel emissions, indirectly resulting from the combustion of fossil-fuels in electric power plants, were not incorporated into the Baseline Scenario totals in Table 1 or Table 2.

However, the incremental impact of incorporating these secondary effects are presented as the upper limit of net emission reductions resulting from the PdB Project in Table 3 and Table 4. Totals are rounded to give a better representation of the level of accuracy of the results. Line item A in Table 3 and Table 4 presents all “generation effects”, including both emission reductions resulting from net MB electricity exports (Table 1) and the reduction of electricity generation emissions in MB (Table 2).

Table 3 Cumulative 2024-2055 PdB Project Net Emission Reductions (kt of CO_2e)

	Canada	**Global**
(A) Net Reductions - Generation Effects	472.4	7,309
(B) Construction Emissions (Including Global Supply-Chain)	3.1	15.7
(B) O&M Emissions	1.5	1.5
(B) Land Use Change Emissions	22.5	22.5
(C) Net Reductions - Indirect Generation Effects	141.7	1,531
Overall Net Reductions (range is from (A-∑B) to (A-∑B+C))	**445 to 590**	**7,270 to 8,800**

To demonstrate how the PdB Project aligns with Canada's GHG reduction commitment under the Paris Agreement specific 2030 data has been presented in Table 4. However, these emission reductions are an average of all 107 historical flow-cases and actual reductions in 2030 will depend heavily on flows during the 2029 to 2030 period.

Table 4 PdB Project Net Emission Reductions in 2030 (kt of CO_2e)

	Canada	**Global**
(A) Net Reductions - Generation Effects	12.5	268.6
(B) Construction Emissions (Including Global Supply-Chain)	0.0	0.0
(B) O&M Emissions	<0.05	<0.05
(B) Land Use Change Emissions	0.0	0.0
(C) Net Reductions - Indirect Generation Effects	3.8	42.5
Overall Net Reductions (range is from (A-∑B) to (A-∑B+C))	**12.5 to 16.3**	**270 to 310**

Table 5 provides the total PDB Project cost-per-tonne. On a global emission reduction basis, the cost-per-tonne is comparable to current GHG pricing in MB; however, when only considering Canadian emission reductions the cost is an order of magnitude higher. While the PdB Project requires substantially more investment capital than the Baseline scenario, there is expected to be even more substantial economic benefits resulting from the increases in electrical revenue due to the additional renewable energy produced at PdB during its remaining operational life. On a more holistic cost-benefit analysis basis, the PdB Project’s net cost-per-tonne is expected to be negative over its full operational life.

Table 5 Cost-per-Tonne of Emission Reductions – Capital Investment Costs Only (2020 Canadian dollars)

Canadian Emission Reductions Only	\$460 to \$610 (per tonne CO_2e)
Global Emission Reductions	\$31 to \$37 (per tonne CO_2e)

The reason that the PdB Project is excluded from the Baseline Scenario is not because it is uneconomic, it is because of the “barrier” created by the project’s upfront capital costs. Since the PdB Project is expected to both provide net economic benefits and reduce emissions, it can be considered an ideal emissions reduction project. Federal financial support of the PdB Project, and similar MB projects, will allow MB to continue helping both Canada and the world move towards a low-carbon future.

Key take-aways from this GHG assessment are as follows:

- The PdB Project will result in a cumulative net reduction in emissions within Canada of approximately 0.5 Mt through 2055.
- The PdB Project could potentially have a greater impact on Canadian emissions if additional transmission was built between MB and adjacent provinces.
- The PdB Project will contribute in a small way to Canada’s Paris Agreement commitment.
- The PdB Project cost-effectively contributes to both emission reductions and an increase in Canada’s renewable energy portfolio.
- The PdB Project will result in an overall reduction in global emissions upwards of 9 Mt through 2055. For comparison, MB’s total annual emissions in 2018 were 22 Mt; therefore, in the MB context, 9 Mt is a relatively large amount.

3 INTRODUCTION

This report summarizes the Greenhouse Gas ("GHG") Mitigation Assessment performed for the Pointe du Bois Unit Replacement Project ("PdB Project"). The Manitoba ("MB") government, as the PdB Project proponent, is requesting federal funding on behalf of Manitoba Hydro; to appropriately support this request this report has been prepared in accordance with Infrastructure Canada's Climate Lens requirements.

3.1 PURPOSE OF THE ASSESSMENT

Table 1 of the Climate Lens [Infrastructure Canada, 2019][2] directs that a GHG Mitigation Assessment must be submitted along with an application to the Investing in Canada Infrastructure Program ("ICIP"). The main purpose of this assessment is to fulfill that requirement. A GHG Mitigation Assessment estimates the GHG effects, primary and secondary, of climate change mitigation projects ("GHG projects").[3] The primary purpose of a GHG Mitigation Assessment is to both quantify a project's "GHG effects" and determine whether those GHG effects are a net benefit compared to a relative Baseline Scenario.

The identification of GHG mitigation opportunities is optional [Infrastructure Canada, 2019][4] and will not be included in this assessment due to negligible relevance; Manitoba Hydro does not intend to implement a monitoring plan for GHG emissions ("emissions") related to the PdB Project were it to move forward, and Manitoba Hydro is also not seeking to turn GHG reductions resulting from the PdB Project into a saleable commodity (e.g., generate emission reduction credits) based on the results of this assessment. At a corporate level, Manitoba Hydro will continue to report direct emissions from its operations and estimate the corporation's overall impact on global GHG reductions [Manitoba Hydro, 2020b].

3.2 NOMENCLATURE

The following is a list of report specific nomenclature. Some terms are adopted from various reference documents. All terms in the Climate Lens Annex I Glossary apply, except where indicated otherwise, and some are repeated here for clarity.

AC means alternating current.

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[2] Climate Lens – Subsection 1.3 (*Applicable Programs and Submission*)

[3] Note: The Climate Lens requires a GHG mitigation assessment for many projects that are not GHG projects as well.

[4] Climate Lens – Subsection 2.5.v (*Optional identification of GHG mitigation opportunities*)

accredited capacity means the load that can be reliably served by a generator. The accredited capacity value of dispatchable resources (e.g., fossil-fuel powered, reservoir hydro) is typically a much higher portion of the maximum tested generator output than resources with limited dispatchability (e.g., wind, solar photovoltaic, and run-of-river hydro), often at the maximum output value. This is because dispatchable resources typically demonstrate high levels of availability under system peak load conditions. When considering Manitoba Hydro's Capacity Criterion (Section 4.2.3), accredited capacity refers specifically to the maximum amount of energy that can be relied upon and delivered at the time MB load is at its maximum.

Assessment Period means the 2024 to 2055 temporal period; this is the specific period of time over which GHG effects are estimated in this GHG mitigation assessment. This choice is detailed in Section 4.1. As per the Climate Lens, the Assessment Period incorporates both the assumed construction and O&M phases.

Barrier means ***"…**anything that would discourage a decision to try to implement the project activity or baseline candidates."* [WRI & WBCSD, 2005][5]

Baseline Scenario means "*the reference case for the project activity*." [WRI & WBCSD, 2005][6] It is a hypothetical description of what would occur in the absence of the Project Scenario (i.e., in the absence of the PdB Project).

build margin means "*the incremental new capacity displaced by a project activity, and its associated generation…Build margin emissions are estimated from the GHG emission rates of recent capacity additions, or in some cases, planned and under-construction capacity*" [WRI, 2007][7]. (Section 4.1.1.2)

build-out means a specific generation expansion sequence. (Section 4.3.3)

Brandon means the Brandon fossil-fuel generating station.

CCGT means combined-cycle gas turbine.

Climate Change Report means the document entitled *Manitoba Hydro's Climate Change Report,* published March 2020 by Manitoba Hydro [i.e., Manitoba Hydro, 2020a].

Climate Lens means the evergreen document entitled *Climate Lens - General Guidance* published by Infrastructure Canada [i.e., Infrastructure Canada, 2019].

[5] Project Protocol – Chapter 8.1.1 (*Identifying Barriers to the Project Activity and Baseline Candidates)*, p.51

[6] Project Protocol – Chapter 2.8 (*Baseline Scenario*), p.12

[7] Electricity Project Guidelines – Chapter 2.4 (*The Build Margin (BM)*), p.13

CO_2e means carbon dioxide equivalent. The universal unit of measurement used to indicate the global warming potential of GHGs. CO_2e is used to evaluate the impacts of releasing (or avoiding the release of) different GHGs. (As listed in Table 9, **CO_2** means carbon dioxide, **CH_4** means methane, **N_2O** means nitrous oxide, **CF_4** means carbon tetrafluoride, and **SF_6** means sulphur hexafluoride.)

Corporate Accounting Standard means the document entitled *A Corporate Accounting and Reporting Standard,* Revised Edition, published March 2004 by the WRI and WBCSD [i.e., WRI & WBCSD, 2004]. It is one of two modules in the GHG Protocol.

DC means direct current.

ECCC means Environment and Climate Change Canada.

EF means emission factor.

Efficiency Manitoba means the crown corporation established by the Efficiency Manitoba Act.

EIA Data means data obtained from the U.S. Energy Information Association's *State Electricity Profiles 2018* [i.e., U.S. EIA, 2020].

ELF means Manitoba Hydro's 2019 Electric Load Forecast.

Electricity Project Guidelines means the document entitled *Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects*, published August 2007 by the WRI. This document is a supplement to the Project Protocol [i.e., WRI, 2007].

Emissions means GHG emission.

energy means specifically electric energy, unless indicated otherwise, such as in the instance of the EPF.

EPA means the U.S. Environmental Protection Agency.

EPA EFs means marginal average EFs from U.S. EPA [2020].

EPF means Manitoba Hydro's 2019 Energy Price Forecast.

Final Preferred Route means the Final Preferred Route generated for the PdB Transmission Project EAR. [Manitoba Hydro, 2014a][8] This may not be the final route of PW75, but, for the

[8] PdB Transmission Project EAR – Chapter 2 – Map 2-1 (*Project Description – Pointe du Bois Transmission Project Final Preferred Route*), p.25

purposes of this assessment, it has been assumed to match the eventual route of PW75 for emission estimation purposes.

flow means the volume of water per unit of time (i.e., m^3/s) as specified in the LTFD, unless it is specifically referring to "energy flow". Flow can represent hydrologic conditions at a specific point in space (e.g., the Winnipeg River Basin) and time (e.g., January) or can be aggregated among multiple sub-basins (e.g., for the entire Nelson-Churchill Watershed) and for coarser temporal representation (e.g., annual). The terms "high-flow" and "low-flow" are used generally herein to describe longer-term (e.g., annual) hydrological conditions that result in higher or lower levels of electricity production at Manitoba Hydro's hydroelectric generating stations. Since Manitoba Hydro has generation on multiple river systems and flow conditions can vary in space, it is recognized that flow-years with similar aggregated flows in the Nelson-Churchill Watershed may result in different levels of total hydroelectric energy production, depending on where (i.e., which sub-basin) the flows are occurring.

flow-case means one of 107 flow-cases used in energy modelling, each with a different starting year (fiscal year) from the LTFD record. The chronology of flows in each flow-case is preserved, with a carousel approach that loops data back to the start of the LTFD record when the end of the LTFD record is reached.

flow-year means flow data from one of the 107 years of data in the LTFD; **worst-case**, **median-case**, and **best-case** flow-years and directly related **lowest-flow**, **median-flow** and **highest-flow** conditions are defined in Section 4.2.6.

full path firm transfer means "*full path firm transfer transmission service of the highest priority that may not be interrupted unless all lower priority levels of service have already been interrupted*" [Manitoba Hydro, 2020c].

g means grams (and **kg** means kilograms), a unit of mass.

generation effect means the PdB Project's "GHG effects" on short-term and long-term generation emissions within the interconnected region. "Generation effect" is used for clarity in this report as impacts on combustion emissions from grid-connected power plants would be considered "upstream" or "downstream" of PdB, but in the context of the PdB Project they are primary, not secondary, effects (Section 4.1.1).[9] "Generation effect" was adopted from Madrigal & Spalding-Fecher [2010]. Generation effects include both build margin and operating margin effects and are the "primary effect" of the PdB Project.

[9] Note: The Climate Lens currently defines "Upstream and Downstream Effects" as secondary.

GHG means greenhouse gas (and **GHGs** means greenhouse gases).

GHG effect means "*changes in GHG emissions, removals, or storage caused by a project activity. There are two types of GHG effects: primary effects and secondary effects."* [WRI & WBCSD, 2005][10] The primary and secondary effects of the PdB Project are defined in Sections 4.1.1 and 4.1.2 respectively. "Generation effects" are a sub-category of GHG effects.

GHG project means a climate change mitigation project (defined as "Project" in the Climate Lens).

GHG Protocol means the Greenhouse Gas Protocol Initiative. This is a multi-stakeholder partnership of businesses, nongovernmental organizations, governments, academics, and others convened by the WBCSD and the WRI. Launched in 1998, the Initiative's mission is to develop internationally accepted GHG accounting and reporting standards and/or protocols, and to promote their broad adoption.

GSPRO means the suite of Generation system Simulation, Planning and Resource Optimization (GSPRO) modelling tools used by Manitoba Hydro for generation expansion planning, production costing, and related pre- and post-processing tasks*.* SDDP and OptGen are in the GSPRO suite (Section 4.2).

GWP means the specific Global Warming Potential of different GHGs set out in Annex C (*Global Warming Potentials for GHG Mitigation Assessments*) of the Climate Lens.

ha means hectare, a unit of area which is equivalent to 0.01 km^2.

HVDC means high voltage direct current.

ICIP means the Investing in Canada Infrastructure Program.

IESO means Independent Electricity System Operator (IESO). The IESO operates and settles Ontario's wholesale electricity markets and is an Organized Power Market.

IPCC means the Intergovernmental Panel on Climate Change.

ISO 14064-2 means the ISO Standard 14064-2 published by the International Organization for Standardization in 2006 entitled *Greenhouse gases - Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements* [i.e., International Organization for Standardization, 2006].

[10] Project Protocol – Chapter 2.4 (*GHG Effects)*, p.11

Keeyask LCA means the document entitled *Keeyask Generating Station – A Life Cycle Assessment of Greenhouse Gases and Select Criteria Air Contaminants*, prepared for Manitoba Hydro by The Pembina Institute and published in February 2012 (i.e., Switzer, 2012).

kWh means kilowatt-hour (and **MWh** means megawatt-hour and **GWh** means gigawatt-hour), a unit of energy.

kt means kilotonnes (and **Mt** means Megatonnes). When used in this report they refer specifically to units of CO_2e emitted, unless indicated otherwise.

kV means kilo-volt, a unit of voltage.

L means litre (and **kL** means kilolitre), a unit of volume.

LCA means life cycle assessment.

LTFD means Long-Term Flow Dataset. LTFD encompasses 107 years (1912 through 2018) of historical inflow data (either observed or estimated) for the Nelson-Churchill Watershed that have been adjusted to reflect present-use conditions. LTFD is disaggregated into sub-basins that align with Manitoba Hydro's generating infrastructure. (Section 4.2.6)

m means metre (and **km** means kilometre), a unit of distance.

MB means Manitoba.

MISO means the Midcontinent Independent System Operator region (Figure 8), regional transmission system, Organized Power Market, and/or organization; the terms are often interchangeable. Manitoba Hydro is a coordinating member of MISO.

MISO-N means the MISO North, a subregion of MISO.

MMTP means the Manitoba-Minnesota Transmission Project, a recently completed 500-kV transmission line. It connects across the U.S. border with the Great Northern Transmission Line.

MN means Minnesota.

MROW means Midwest Reliability Organization/West. It is the "*eGRID*" [U.S. EPA, 2020] regional description of the "Upper Mid-West" and is comparable to MISO-N but includes some additional regions, including South Dakota and Nebraska. The EPA EF for the MROW region is assumed comparable to the MISO-N region for the purposes of this assessment (Section 4.5.2.5).

MW means megawatt, a unit of power or capacity.

ND means North Dakota.

Need Year means the year in which Manitoba Hydro is projected to require new resources to meet MB's capacity and/or energy needs (Section 4.2.3). This assessment assumes a Baseline Scenario Need Year of 2042.

NIR means the document entitled *National Inventory Report 1990-2018: Greenhouse Gas Sources and Sinks in Canada (Canada's Submission to the United nations Framework Convention on Climate Change)*, published April 2020 by ECCC [i.e., ECCC, 2020].

O&M means operation & maintenance.

Off-Peak Period means "*the following hours in a week, during which the market load is typically lower than the weekly average load: overnight - 7 days x 8 hours per day; weekends - 2 days x 12 hours per day; total = 80 hours per 168-hour week*" [Manitoba Hydro, 2020c].

ON means Ontario.

On-Peak Period means the 88 hours per 168-hour week not included in the Off-Peak Period.

operating margin means "*electricity generation from existing power plants whose output is reduced in response to a project activity. [Operating Margin] emissions are estimated using methods that attempt to approximate the emissions from the specific power plants whose operation is displaced.*" [WRI, 2007][11] For this assessment "existing power plants" includes any plant operating in both the Baseline and Project Scenarios, even if it does not currently exist. (Section 4.1.1.1)

OptGen means PSR's commercially available model for generation expansion planning. A description of OptGen is included in Section 4.2.2. OptGen is a component of the GSPRO suite of tools.

Organized Power Market means a "*centrally operated market which collects generation offers and dispatches generation to meet forecast loads, including exports from the market region, and which will provide physical energy to external market participants such as Manitoba Hydro on a non-discriminatory basis"* [Manitoba Hydro, 2020c]. Independent system operators such as MISO and IESO operate Organized Power Markets.

PdB means the Pointe du Bois hydroelectric generating station.

[11] Electricity Project Guidelines – Chapter 2.5 (*The Operation Margin (OM)*), p.13

PdB Project means the PdB Unit Replacement Project. In this report the term is often interchangeable with Project Scenario.

PdB Transmission Project EAR means the Pointe du Bois Transmission Project Environmental Assessment Report prepared by Manitoba Hydro in 2014 [i.e., Manitoba Hydro, 2014a; Manitoba Hydro, 2014b; Manitoba Hydro, 2014c]. While they have not been finalized, the Pointe du Bois Transmission Project's design and requirements are anticipated to be similar to the transmission upgrades required for the PdB Project.

PPA means Power Purchase Agreement.

proficiency runs means operation of generation resources according to protocols to verify capacity accreditation (i.e., accredited capacity) to a regulatory authority.

project activity(ies) means "[electric generation] p*roject activities that supply electricity to the grid. These project activities generate electricity and deliver it into the power grid, in effect displacing electricity from other sources. GHG reductions occur where the emission rate of the project activity is lower than that of displaced sources."* [WRI, 2007][12]

Project Scenario means the hypothetical description of what will occur should the PdB Project occur; in a generic sense "project scenario" could be applied to any GHG Project. The similar terms "project activity" and "GHG project" are used in the Project Protocol, Electricity Project Guidelines, and ISO 14064-2 and are often interchangeable with "project scenario" or, for the specific purposes of this assessment, "Project Scenario".

power means electrical power.

Project Protocol means the document entitled *The GHG Protocol for Project Accounting* published November 2005 by the WRI and WBCSD [i.e., WRI & WBCSD, 2005]. It is one of two modules in the GHG Protocol.

PSR means PSR Soluções e Consultoria em Energia Ltda (i.e., PSR Inc.); PSR is a Brazil-based global provider of technological solutions and consulting services in the areas of electricity and natural gas since 1987.

PW75 means the proposed 46.5km 115 kV transmission line from PdB to Whiteshell (Figure 7).

ROW means a transmission line right-of-way, generally the PW75 ROW.

[12] Electricity Project Guidelines – Chapter 2.1 (*Grid-Connected Project Activities*), p.11

SCGT means simple-cycle gas turbine.

SDDP means PSR's commercially available Stochastic Dual Dynamic Program model. A description of SDDP is included in Section 4.2.1. SDDP is a component of the GSPRO suite of tools.

Selkirk means the Selkirk fossil-fuel generating station.

SK means Saskatchewan.

Slave Falls means the Slave Falls hydroelectric generating station.

t/GWh means tonnes of CO_2e emitted per GWh produced, a unit of GHG emission intensity (per unit of electricity production).

T&D means transmission and distribution.

tonne C/ha means tonnes of carbon content per ha.

U.S. means the United States of America.

WBCSD means the World Business Council for Sustainable Development.

Whiteshell means the Whiteshell Transmission Substation, unless referring specifically to the Whiteshell Provincial Park.

WRI means the World Resources Institute.

3.3 ISO AND GHG PROTOCOL REPORTING PRINCIPLES

As directed by the Climate Lens, "*The (GHG effect) quantification process should adhere to the following principles identified in both the ISO 14064-2 standard and the GHG Protocol for Project Accounting:*

- ***Relevance:*** *The data and GHG quantification procedures most appropriate to the project should be selected. The levels of accuracy and uncertainty associated with the quantification process should reflect the intended use of the data and the objectives of the project. As such projects in the Climate Change Mitigation sub-stream should strive for higher levels of accuracy and lower levels of uncertainty.*
- ***Completeness:*** *All relevant GHG emissions and removals should be included, along with information to support criteria and procedures.*
- ***Consistency:*** *All data, methods, criteria, and assumptions shall be applied consistently to ensure meaningful comparisons between the baseline and project scenario.*

- ***Accuracy:*** *Estimates and calculations should be unbiased, and uncertainties should be reduced as far as practical. Calculations should be conducted in a manner that minimizes uncertainty.*
- ***Transparency:*** *All assumptions, methods, calculations, and associated uncertainties should be explained to allow for the intended users to make decisions with reasonable confidence.*
- ***Conservativeness:*** *Where there are uncertainties, the values used to quantify GHG emissions should err on the side of underestimating potential reductions."* [Infrastructure Canada, 2019][13]

3.4 PROJECT OVERVIEW

The proposed PdB Project being assessed is the outcome of Manitoba Hydro's evaluation of life cycle alternatives for the PdB Powerhouse (Section 4.3.1). The PdB Project entails the installation of eight new, larger, and more reliable hydroelectric units to replace eight units that are either approaching their economic end of life or already decommissioned. The primary purpose of the project is to add renewable "energy" and capacity to Manitoba Hydro's system and, as a result, to the interconnected grid. These eight units would increase the rated capacity (median head conditions) of the Manitoba Hydro system by 52 MW (Table 10) and increase the annual amount of renewable energy produced by 380 GWh per year, on average, between 2024 and 2055. The proposed timeline assumed in this assessment has these units being installed between 2024 and 2026 (Table 10).

Manitoba Hydro's evaluation of life cycle alternatives for the PdB Powerhouse (Section 4.3.1) determined that the resulting net levelized cost of the energy produced via all Pointe du Bois hydroelectric generating station ("PdB") life extension options, including the Baseline and Project Scenarios, is expected to be comparable or lower than other generation resource options available to Manitoba Hydro, such as new wind "power" or solar power projects. As detailed in Section 4.3, Manitoba Hydro has committed to implementing PdB powerhouse life extension upgrades.

While the PdB Project requires substantially more investment capital than the Baseline Scenario, there is expected to be even more substantial economic benefits resulting from the increases in electrical revenue due to the additional renewable energy produced at PdB during its remaining operational life. In addition to these net economic benefits, the PdB Project's non-fossil-fuel energy contributes to emission reductions by "*reducing combustion emissions from grid-*

[13] Climate Lens – Subsection 2.5.ii (*Required Information and General Instructions - Asset's estimated GHG emissions calculations*)

connected power plants" [WRI, 2007][14]. Therefore, on a cost-benefit analysis basis, the PdB Project's net cost-per-tonne is expected to be negative, making it an ideal emission reduction project (Section 5.5).

3.5 COMPANY INFORMATION

Manitoba Hydro is the "person responsible" for, and owner of, PdB. Manitoba Hydro (Table 6), a vertically integrated provincial Crown Corporation, has charge and management of PdB. The governance of Manitoba Hydro is through the Manitoba Hydro-Electric Board.

Table 6 Company Information

Legal Name	Manitoba Hydro
Civic Address	360 Portage Avenue, Winnipeg (Manitoba), R3C 0G8, Canada
Canada Revenue Agency Business Number	122063779

Manitoba Hydro is one of the largest integrated electricity and natural gas distribution utilities in Canada. Over the long-term 99.8% of the electricity Manitoba Hydro produces is renewable energy generated at 15 hydroelectric generating stations on the Nelson, Winnipeg, Saskatchewan ("SK"), Burntwood, and Laurie rivers. Manitoba Hydro can also use the following resources to meet MB demand:

- 2 Manitoba Hydro operated fossil-fuel generating stations ("Brandon" & "Selkirk");
- 4 Manitoba Hydro operated remote diesel generating stations;
- wind power purchases from independent wind farms in MB;
- electricity imported from interconnected regions.

Manitoba Hydro physically[15] trades electricity within three wholesale markets in the United States of America ("U.S.") and Canada (Section 3.7). A system map which includes the location of PdB is shown in Figure 2.

3.6 FACILITY DESCRIPTION

PdB is the oldest hydroelectric generating station still in operation in MB, generating renewable electricity since 1911. It operates with a head of 14 m. It was built by City Hydro, later known as Winnipeg Hydro, and bought by Manitoba Hydro in 2002. PdB is located on the Winnipeg River

[14] Electricity Project Guidelines – Chapter 4 (*Defining the GHG Assessment Boundary*), p.26

[15] Note: Manitoba Hydro is also capable of participating in Organized Power Markets it isn't physically connected to. For example, Manitoba Hydro is a Southwest Power Pool market participant.

approximately 150 km northeast of Winnipeg near the Ontario ("ON") border and just inside the western boundary of the Whiteshell Provincial Park (Figure 7). Table 7 lists some key facility details.

Table 7 Facility Details

Facility Name	Pointe du Bois Generating Station
Location	Pointe du Bois, Division No. 1, MB (At the East end of Provincial Road 313)
Physical Coordinates	(50.303611°N, -95.54°E)
Primary North American Industry Classification System (NAICS) Code	221111 (Hydroelectric Power Generation)
Inservice Year	1911
Access	Direct Road (Rail access prior to 1950)
Current Rated Capacity	42 MW (median flow conditions)
Historical Nameplate Capacity	77 MW
Original Cost	$3.25 million
Installed Turbines	16
Active Turbines	9
Powerhouse Length	135 m
Head	14 m
Transmission Connections	69 kV to Winnipeg (P3/P4); 138 kV to Slave Falls (R1/R2);

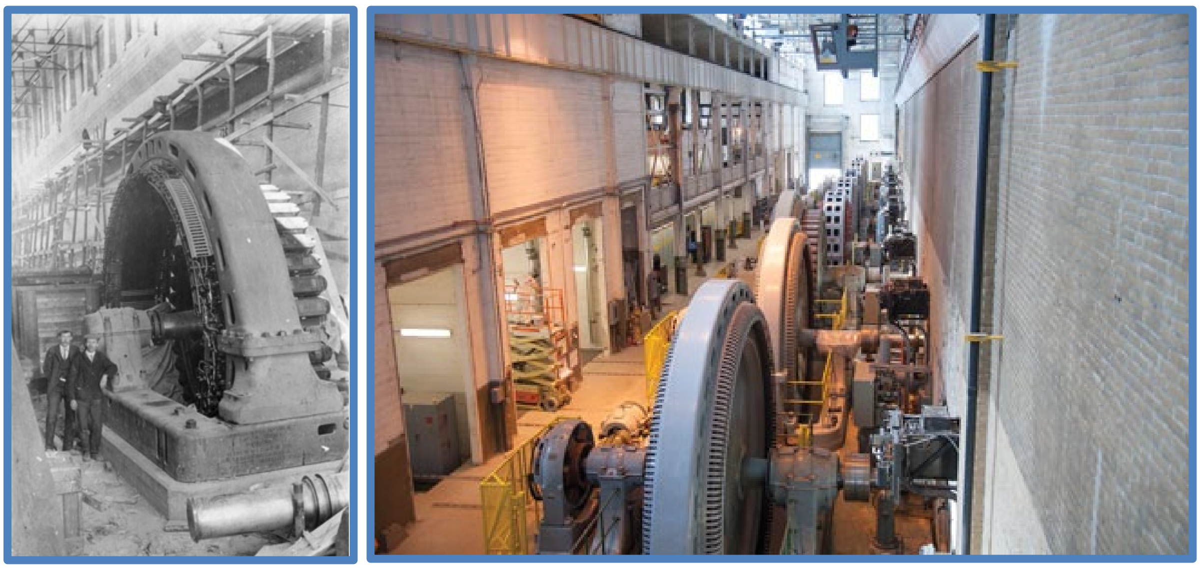
PdB was constructed in two phases, with the first phase (Units 1, 2, 3, 4, and 7) commissioned in 1911 and the next eleven units phased in by 1926 (Figure 1). The original 16 units were all horizontal shaft Francis turbines with a combined nameplate capacity of 77 MW. Nine units are currently operational with a total rated capacity (median head conditions) of 42 MW and average annual generation of 313 GWh. Only units 1, 15, and 16 are expected to operate beyond 2029, with a total rated capacity (median head conditions) of 20 MW. The status of the 16 PdB units are:

- Currently Operational Units:
    - Unit 1: New STRATFLO turbine unit installed and commissioned in 1999.
    - Units 15 & 16: Units 15 and 16 were overhauled and re-runnered by GE-Hydro and returned to service in 2004 and 2006 respectively. Additional repairs by Voith Hydro were completed in 2013 for both units. Unit 16 is currently offline for maintenance but is assumed to be back in service by 2023 (Table 10). However, following Unit 16's return to service, it is assumed that Units 15 and 16 could run indefinitely with regular maintenance and minor upgrades.
    - Units 6, 9, and 10: Repaired units with minimal expected remaining life.
    - Units 12-14: Refurbished units that are expected to be operational to 2029.

- Currently Non-Operational Units:
    - Units 2, 4, 8: Units on perpetual forced outage requiring repairs.
    - Units 3, 5, 7, and 11: Units decommissioned and removed in 2016.

In 2015 Manitoba Hydro completed the *Pointe du Bois Spillway Replacement Project*[16] which saw construction of a new spillway and earth dam to comply with dam safety requirements. These improvements addressed concerns with aging structures, personnel safety, increase reliability, and increase spill capacity to handle larger floods on the Winnipeg River. In addition to the new spillway, concerns related to operational safety and dam safety have been addressed through other improvements such as ongoing structural and safety improvements in the powerhouse facility.

Figure 1: Unit 1, post-1910 installation (left); Current-Day Francis Turbines (Right)[17]



3.7 MANITOBA HYDRO INTERCONNECTIONS

Manitoba Hydro has multiple interconnections with SK, ON, and the U.S. The benefits of these interconnections "*can be summarized as:*

- *improving reliability by enabling imports during (low-flow) conditions and under supply contingencies (e.g., temporary loss of supply due to equipment outages);*

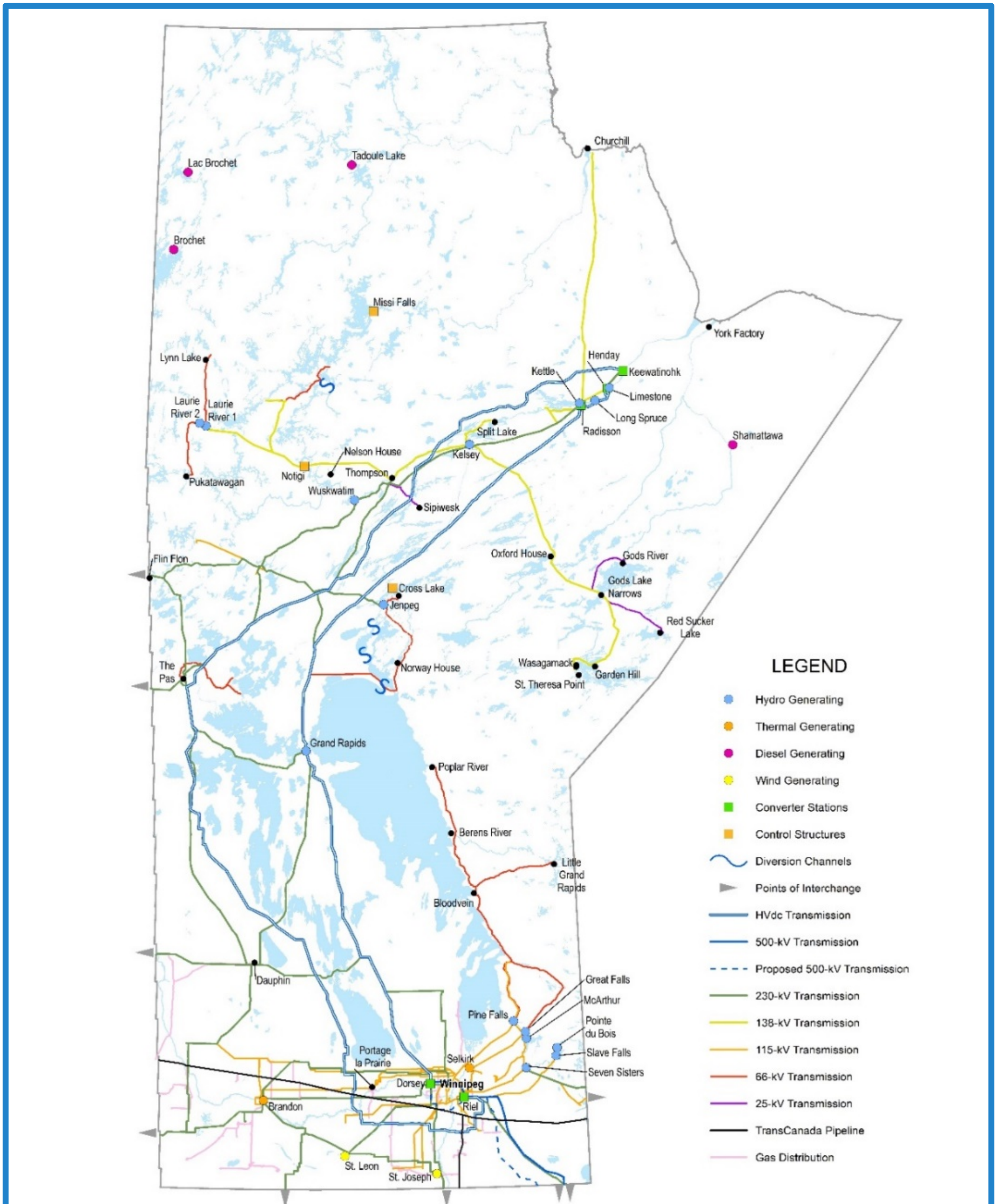
[16] [Manitoba Hydro, 2011]
[17] [Owen, 2016]

- *increasing revenues by enabling the export of surplus hydro power and import of market energy at costs lower than the cost of fossil resources available within Manitoba."* [Manitoba Hydro, 2013]

The Manitoba Hydro system currently has 13 cross border interconnections. Of these, three 230 kV and two 500 kV lines interconnect the Manitoba Hydro system to the U.S. (i.e., with "MISO"), three 230 kV and two 115 kV lines interconnect to SK, and two 230 kV and one 115 kV lines interconnect to ON. With the future completion of a 14th interconnection, the Birtle-Tantallon line (MB to SK; 230 kV), the "full path firm transfer" export (import) capability will be 2,983 MW to MISO (1,398 MW from MISO), 150 MW to ON (0 MW from ON), and 351 MW to SK (60 MW from SK).[18] These are representative quantities of firm transfer capability (net of reliability margin and reserves); actual capability varies with power system conditions.

[18] Note: 2,983 MW includes 150 MW of reserve delivery that exists between MB and the U.S. 60 MW of the 351 MW capability to SK is to the northern SK region, which can be considered distinct, transmission wise, from the southern region.

Figure 2: Map - Manitoba Hydro's System[19]



4 METHODOLOGY

4.1 ASSESSMENT BOUNDARIES AND BASIS OF ANALYSIS

The boundaries of this assessment incorporate all significant GHG effects of the PdB Project; they are not restricted by the physical boundaries of PdB, Manitoba Hydro's system, or Canada's borders. *"Primary and significant secondary effects are considered within the GHG assessment boundary, irrespective of whether they occur near the project, or at GHG sources or sinks owned or controlled by the project participants. Under the Project Protocol, it is not necessary to define a project boundary based on a GHG project's physical dimensions or according to what is owned or controlled."* [WRI, 2007][20]

"*Baseline candidates provide a product or service identical (or nearly identical) to that of the project activity. To identify baseline candidates, it is therefore important to first clearly define the product or service provided by the project activity. The product or service can take many forms, depending on the type of project activity, and in some cases may not be intuitively obvious*." [WRI, 2007][21] In the case of the PdB Project the product is intuitively electric energy (i.e., GWh) being added to the interconnected grid with the primary effect being the "*reduction in combustion emissions from generating grid-connected electricity*", similar to other renewable energy projects. [WRI, 2007][22]

This assessment quantifies the GHG effects of the PdB Project based on projections of generation and load in MB, cross-border electricity trade, and the evolution of the export power market. Determining the impact of the PdB Project requires comparing a Project Scenario against a hypothetical Baseline Scenario where the PdB Project does not occur. While several alternative projects were considered in Manitoba Hydro's evaluation of life cycle alternatives for the PdB Powerhouse (Section 4.3.1), only the replacement of eight units (i.e., the PdB Project) was analyzed in this assessment; amongst alternatives that included unit replacement(s), the PdB Project is considered the preferred option. Methods employed in this assessment were designed to fulfill the requirements of the Climate Lens and to follow the ISO 14064-2 Principles (Section 3.3).

[20] Project Protocol – Chapter 2.5 (*GHG Assessment Boundary*), p.12

[21] Project Protocol – Chapter 7.1 (*Defining the Product or Service Provided by the Project Activity*), p.39

[22] Project Protocol – Table 7.1 (*Examples of the product or service and baseline candidates for some types of project activities*), p.40

To assess the impact of emissions on long-term global climate change, this assessment uses the Intergovernmental Panel on Climate Change ("IPCC") 100-year baseline model to calculate tonnes of carbon dioxide equivalent ("t"). For consistency with Climate Lens and other federal requirements, IPCC's Fourth Assessment Report GHG Global Warming Potentials ("GWPs") were applied[23]. In developing its approach, Manitoba Hydro drew on guidelines from the "WRI" and the "WBCSD".

Manitoba Hydro is planning to make the necessary capital investments to continue operation of PdB until 2055 (Section 4.3.1), whether or not the PdB Project proceeds. This matches the end of Manitoba Hydro's 35-year planning horizon (2020-2055). As it cannot be predicted precisely when PdB can no longer be operated safely, reliably, and economically, the actual end of life of PdB may not occur exactly in 2055. For the purpose of this assessment it was deemed reasonable, and mildly conservative, to assume that PdB is decommissioned and ceases to generate electricity after 2055. In the Project Scenario construction timeline, no units are replaced until 2024, so the chosen Assessment Period of this GHG mitigation assessment is 2024 to 2055.[24] In addition, the Climate Lens directs that specific reporting is required for 2030 to align with Canada's GHG reduction commitment under the Paris Agreement.[25]

The chosen Assessment Period is lengthy, but appropriate and relevant. A key reason for applying the Climate Lens is to "*provide meaningful insight into the climate impacts of individual projects*" [Infrastructure Canada, 2019][26], and that is best done by evaluating the entire assumed life of the PdB Project. As the generating life of PdB, with or without the PdB Project, is presumed to be limited, the economics of unit replacements worsen as time passes, making a similar project occurring further off in the future less likely. While the new units themselves would be expected to last beyond 2055, the remaining life of PdB powerhouse is not dependent on the installation date of any new units (e.g., choosing a 2030 year for first unit replacement does not mean that as a result of the later in-service date the PdB powerhouse could operate an additional six years to 2061). It is therefore reasonable to assume the Baseline Scenario, without any additional unit replacements, persists for the entire length of the assessment and, similarly, that the GHG effects of the PdB Project also persist for the entire Assessment Period. If it is deemed safe and

[23] Note: Canada has not adopted the Fifth Assessment Report's GWPs. The IPCC is in their sixth assessment cycle and are producing their Sixth Assessment Report.

[24] Note: GSPRO was designed to make evaluations in terms of Manitoba Hydro's fiscal year (e.g., "2030" is April 1, 2030 through March 31, 2031). Due to the lengthy time scale of this assessment it was deemed reasonable to consider fiscal year results equal to calendar year results (for the purposes of this assessment).

[25] Climate Lens – Section 2.4 (*Timescale / Forecast Window*)

[26] Climate Lens – Section 1.2 (*Why implement a Climate Lens?*)

economical to reliably operate PdB beyond 2055, and defer decommissioning, the GHG benefits of the PdB Project could potentially continue to persist.

All the significant GHG effects of the PdB Project are indirect and outside the fence line of the PdB generating station; i.e., all the significant GHG effects of the PdB Project are Scope 3, and potentially border on "*optional information*" [WRI & WBCSD, 2004][27] as defined in the Corporate Accounting Standard. Results are therefore categorized by "effect significance" and "effect category", as per Table 8, instead of by "scope".

This categorization method is consistent with the Project Protocol where emphasis is placed on whether effects are primary or secondary and not whether they are direct or indirect. The categorization of project effects into Scopes 1, 2, or 3 is not discussed in ISO 16046-2, the Project Protocol, or the Electricity Project Guidelines. The three scopes are instead emphasized in the Corporate Accounting Standard, the other standard of the GHG Protocol, which relates to company, not project, reporting. Notwithstanding the above, this assessment will still consider all direct (i.e., Scope 1) project effects as required by the Climate Lens[28]; rationale is provided when the PdB Project's impact on a direct emission source is assumed nil (Table 8).

[27] Corporate Accounting Standard – Chapter 9 (*Reporting GHG Emissions*), p.63
[28] Climate Lens – Section 2.3 (*Assessment Boundary*)

Table 8 Categorization of PdB Project GHG Effects

Effect Description	PdB Project Contribution	Effect Significance	Effect Category	Location of Effect
Reduced Fossil-fuel Generation	Provides more energy to the grid	Primary (4.1.1.1)	Generation (Indirect)	MB, ON, SK, & MISO
Potentially Alters Generation Expansion Sequences	Provides more "accredited capacity" to the grid	Assumed Insignificant (Section 4.1.1.2)	Generation (Indirect)	MB
		Assumed Nil (Section 4.1.1.2)	Generation (Indirect)	ON, SK, & MISO
Reduced Non-Emitting Generation	Provides more energy to the grid	Assumed Nil (Section 4.5.2.2)	Generation (Indirect)	MB, ON, SK, & MISO
Reduced Fuel Production, Processing, and Transportation Emissions	Resulting upstream from the project's "generation effects"	Secondary (4.1.2.4)	Indirect	Global
On-Site Construction Emissions	Fuel required during construction	Secondary (4.1.2.1)	Direct	MB
Supply-chain Emissions	Material required for unit replacements	Secondary (4.1.2.1)	Indirect	Global
Land use Change Emissions	ROW clearing will permanently remove above ground biomass	Secondary (Section 4.1.2.2)	Direct	MB
Reservoir Emissions	PdB uses an existing reservoir	Assumed Nil (Section 4.1.2.3)	Direct	MB
Operation & Maintenance ("O&M") Emissions	Fuel required during O&M	Secondary (Section 4.1.2.1)	Direct	MB
	Material required for O&M	Excluded (Section 4.1.2.1)	Indirect	Global
Decommissioning Emissions	Emissions related to unit decommissioning	Excluded (As per Climate Lens)	Direct	MB

4.1.1 PRIMARY GHG EFFECTS

The Electricity Project Guidelines directs that "*the primary effect for grid-connected project activities will be reducing combustion emissions from grid-connected power plants.*" [WRI, 2007][29] This is because the "*intended change*" [WRI & WBCSD, 2005][30] of the PdB Project is adding non-fossil capacity and energy to the regional grid. The most significant GHG effect of the

[29] Electricity Project Guidelines – Chapter 4.2 (*Identifying Primary Effects*), p.27

[30] Project Protocol – Chapter 2.4 (*GHG Effects*), p.11

PdB Project will be how it impacts the use of fossil-fuel generating units in the interconnected region.

4.1.1.1 OPERATING MARGIN GHG EFFECTS

The Electricity Project Guidelines directs that "*The operating margin refers to electricity generation from existing power plants whose output is reduced in response to a project activity.*" [WRI, 2007][31] For this assessment "existing power plants" includes any plant operating in both the Baseline and Project Scenarios, even if it does not currently exist; as noted in Section 4.1.1.2, the PdB Project is not expected to influence any generation expansion planning decisions.

Manitoba Hydro's interaction with the interconnected system results in "operating margin" GHG effects during two flow-dependent circumstances: when the Manitoba Hydro system is being used as a "source of economic supply", that is for the "export of surplus renewable energy", and when Manitoba Hydro is using the interconnected system for "the importation of energy during low-flow conditions or extreme supply loss in MB". The PdB Project will increase the exportation of surplus renewable energy, decrease the importation of energy, and decrease the use of MB's fossil-fuel resources[32]. The two flow-dependent (Section 4.2.6) circumstances are defined as follows:

1. **Source of economic supply and export of surplus renewable energy** - Under typical hydrologic conditions Manitoba Hydro uses reservoir storage to economically supply energy to the interconnected grid preferentially during the On-Peak Period. In such circumstances, On-Peak Period generation outside MB, which is nearly always fossil based ("*Fossil is virtually always on the margin in operation*"[33]), is displaced resulting in a reduction in global emissions.[34] Figure 3demonstrates how surplus energy can be available over a large range of flow conditions. The PdB Project will increase the amount of surplus renewable energy available.

   Manitoba Hydro's interconnections (Section 3.7) and intra-provincial transmission networks, in combination with reservoir management activities, are generally capable of exporting all surplus hydroelectricity, with minimal spill at hydroelectric facilities due to transmission constraints (spill can be unavoidable when reservoirs are at their upper limit due to generation limits). As shown in Figure 3, on an annual[35] basis Manitoba Hydro's

[31] Electricity Project Guidelines – Chapter 2.5 (*The Operating Margin*), p.13
[32] [Manitoba Hydro, 2013]
[33] [Murphy et al., 2013]
[34] Climate Change Report – Chapter 3.4 (*Global Emission Reductions*), p.79
[35] Note: this is generally true for sub-annual (e.g., monthly) time blocks as well, but to a lesser extent.

system will often export surplus hydroelectricity and function as a source of economic supply (imports occur even though there is already sufficient annual hydroelectricity to meet total commitments).

In some circumstances, Manitoba Hydro's export activity results primarily in a timing shift for fossil-fuel generation in non-MB markets, rather than a straightforward displacement. This occurs when the displacement of On-Peak Period fossil-based generation by Manitoba Hydro exports requires the release of water from storage, which is then no longer available to generate Off-Peak Period exports. The net GHG effect from this generation shifting effect will depend upon whether there is a consistent differential between On-Peak Period and Off-Peak Period marginal emission rates outside MB. Analyzing this differential is outside the scope of this assessment.

In general, Manitoba Hydro's system is capable of shifting the timing of system-wide generation dispatch when MB's hydro reservoirs are operating within their licensed ranges. Shifting capability in distinct flow conditions is as follows:

- Shifting can occur over a wide range of flow conditions, but in different quantities. Shifting is not mutually exclusive from either the exportation of surplus renewable energy or the importation of energy during "low-flow"/extreme supply loss conditions.
- "High-flow" conditions reduce, or even eliminate, the system's capability of shifting due to high reservoir levels (when no additional On-Peak Period generation and export is feasible, and no more water can be stored).
- Low-flow conditions (and emergencies) reduce, or even eliminate, the system's capability of shifting by limiting the system's ability to produce surplus generation (no Off-Peak Period generation is available to be shifted to the On-Peak Period).

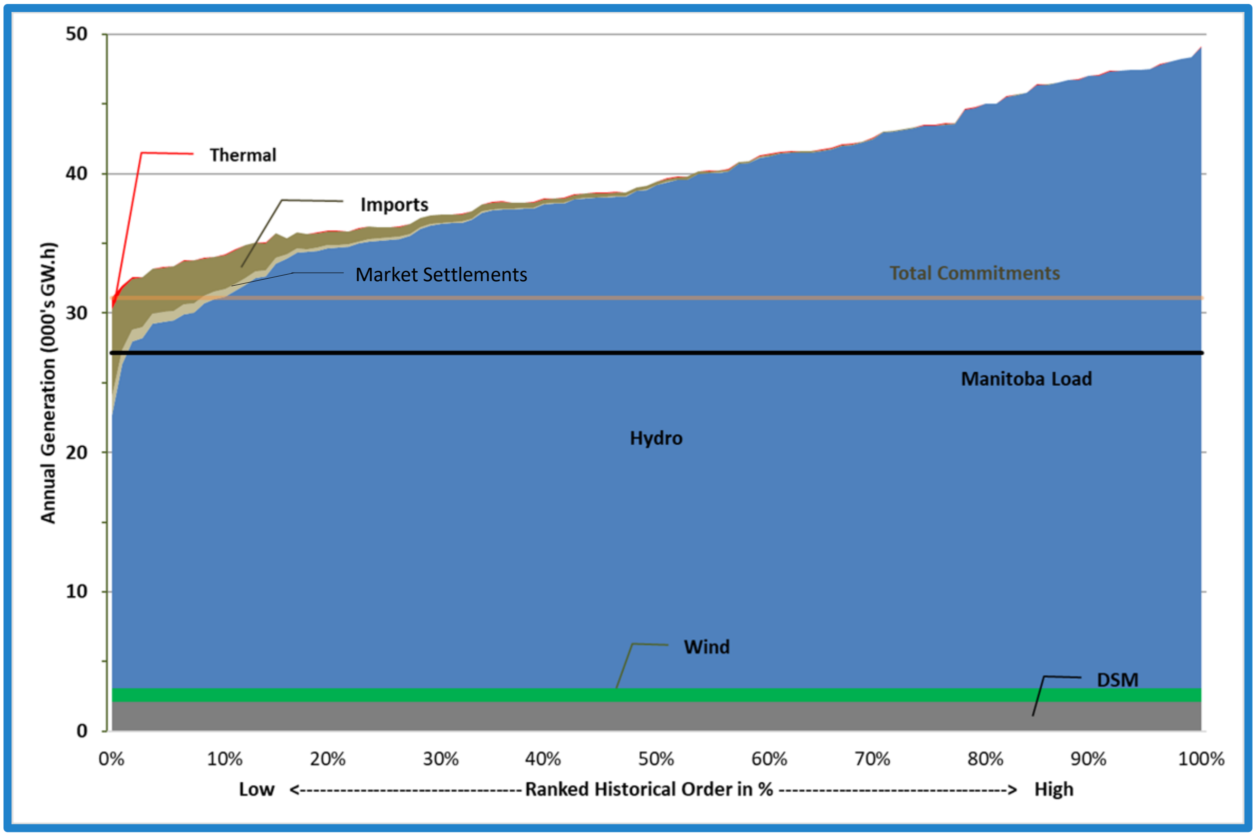
In any event, as PdB is typically operated as a run-of-river plant with generation output having a diurnal cycle only when water flows are low; the PdB Project will typically displace fossil generation rather than shifting it to other time periods. In summary, as a source of economic supply, the PdB project will increase the exportation of surplus renewable energy.

2. **The importation of energy during low-flow conditions or extreme supply loss in MB** - Under low-flows, Manitoba Hydro may require the use of imported, or even fossil-fuel (Section 4.2.7), energy to meet its electrical load commitments; in this circumstance renewable generation in MB is not sufficient to meet electrical load and these alternative sources are required to satisfy that load. The PdB Project will lower Manitoba Hydro's imported energy and MB fossil-fuel generation requirements during low-flow years (Section 4.2.6). The GHG effect will depend on the marginal regional generation unit, but,

as shown in Figure 3imported energy is generally dispatched[36] ahead of MB fossil-fueled generation. The effect of extreme supply loss in MB is similar to the effect of low-flows on the system in that Manitoba Hydro must rely upon imported and/or fossil-fuel energy.

In summary, the PdB project will decrease the use of MB's fossil-fuel resources during supply shortages due to low-flows or supply loss. But, in most operating conditions the PdB Project will have no effect on MB's fossil-fuel generating resources as there is already sufficient surplus renewable energy available. Quantifying the GHG benefits of the PdB Project during extreme supply loss situations is outside the scope of this assessment as PdB's availability to supply load during an emergency is unknown. Potential GHG benefits during extreme supply loss situations is considered a qualitative benefit.

Figure 3: Annual Generation by Resource Type Over a Range of Ranked Flow Conditions in 2030[37]



[36] Note: Within GSPRO, and actual operations, imported energy functions as a dispatchable resource, with some limitations.

[37] Note: Dark beige is physically delivered imports; Light beige is market settlements (i.e., non-physical imports which represents the financial buying back of firm exports). Flow conditions are ranked (approximately) by system-wide hydroelectric generation. 'DSM' represents the impact of demand side management on reducing MB Load.

4.1.1.2 BUILD MARGIN GHG EFFECTS

> *"**Is the project activity considered as a source of new capacity?** Some project activities may be implemented for reasons having nothing to do with the grid's need for new capacity. These can include electricity-reduction project activities (see Chapter 3) whose primary purpose is to avoid the need for grid-based power at a particular site. If grid operators give no consideration to the project activity in determining their capacity requirements, then the project activity may not displace new capacity. Once again, the appropriate value for w[38] would be zero. In some cases, project activities involving certain types of "small" power plants may fall into this category, although the possible cumulative effects of small plants on capacity demand should still be considered."* [WRI, 2007][39]

The Electricity Project Guidelines directs that "*The incremental new capacity displaced by a project activity, and its associated generation, are referred to as the build margin." [WRI, 2007][40]* The Baseline Scenario assumes new capacity is built in MB starting in 2042. The PdB Project adds only 52 MW (rated capacity) to the Baseline Scenario, which is less than a year's load growth in the 2042 time-frame. "OptGen" analysis indicates that the PdB Project could either have no effect on the "Need Year" or it could push the Need Year by one year to 2043. For conservativeness, model output with no change in Need Year was used for primary results (Section 5.1.2). PdB is assumed to cease generating electricity in 2055 in both the Baseline and Project Scenarios. Residual "build margin" effects beyond 2055 are outside the scope of this assessment, though presumably negligible as well.

The PdB Project results in 180 GWh of net renewable energy added to the Manitoba Hydro system in the worst-case flow-year (for comparison, Manitoba Hydro's system-wide worst-case flow-year (Section 4.2.6) hydro generation in 2030 would be 19,600 GWh, two orders of magnitude larger). Due to its relatively small size, it is anticipated that PdB Project firm energy would not be tied to any new export contracts and that it would not affect resource development plans (i.e., not have any build margin effect) outside MB. Similarly, it was assumed that the PdB

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[38] Note: Equation 1 of the Electricity Project Guidelines stipulates that the overall emissions rate is a combination of the build margin EF multiplied by "w" and the operating margin EF multiplied by "(1-w)". Thus, when "w" is zero, the overall emissions rate equals the operating margin EF: "*Per Equation 1 in Section 2.3, this means assigning a value to w for the BM, and (1-w) for the OM."* [WRI, 2007]

[39] Electricity Project Guidelines – Chapter 2.6 (*Determining Relative Build Margin and Operating Margin Effects*), p.14

[40] Electricity Project Guidelines – Chapter 2.4 (*The Build Margin*), p.13

Project will not directly influence the decommissioning, or capacity reduction, of any MB generation asset (Section 4.2.4.2) throughout the Assessment Period.

While build margin effects were considered in this assessment, it was concluded that they would be insignificant relative to operating margin effects and not included in the quantitative results. As noted above, for this assessment the operating margin definition of “existing power plants” is modified to include lower emitting power plants that may not currently exist, so long as they are assumed to exist in both the Baseline and Project Scenarios. As such, generation effect emission factors (“EFs”) were assumed to decrease over time (Section 4.5). This mitigates the limitation of neglecting long-term changes in the electricity market by only considering operating margin effects related to currently operational power plants.

4.1.1.3 GENERATION EFFECTS IN MANITOBA

The operation of Manitoba Hydro’s system will adjust to accommodate the new generation capacity and energy provided by the PdB Project. These adjustments are modelled via “GSPRO” and based on embedded modeling assumptions (Section 4.2). The net impact on emissions in MB can be estimated by comparing the net change in MB fossil-fuel generation between the Baseline and Project Scenarios. GSPRO generation output values, on an annual basis, are provided for distinct fossil-fuel-generation sources: Selkirk units, Brandon units, and new fossil-fuel generating units. Each source has its own EF (Section 4.5.1). SDDP determines when each of these units is functioning as a marginal unit (i.e., which specific unit is on the cusp of being ramped up or down).

The net change in hydroelectric generation is modeled at a system level, not a plant level. The dispatch of existing hydroelectric generation will adjust to accommodate the additional capacity at PdB, but the total net hydroelectric energy production is minimally altered due to the relatively small size of the additional capacity provided by the PdB Project. PdB adjacent transmission will be enhanced as a component of the PdB Project (Section 4.3.4); with these enhancements net additional energy resulting from the PdB Project will be accommodated by existing transmission/interconnection infrastructure. Contracted wind energy is assumed to be must-take in both the Baseline and Project Scenarios (Section 4.2.4.2). “Proficiency runs” at existing and future natural gas generating stations are also not impacted. All MB generation effects (i.e., all emission impacts related to MB fossil-fuel generators) occur during years with low-flow conditions.

4.1.1.4 GENERATION EFFECTS OUTSIDE MANITOBA

As noted in Section 4.1.1.2, generation effects outside of MB are assumed to only be operating margin effects, not build margin effects. Energy flow across Manitoba Hydro's interconnections will adjust to accommodate the new generation capacity and energy provided by the PdB Project. These adjustments are modelled via GSPRO, based on embedded modeling assumptions (Section 4.2). The net impact on emissions can be estimated by comparing the net change ("Δ") in exports between the Baseline and Project Scenarios. GSPRO data represents "Δ Net Exports" using the three values shown in Equation A. Δ Net Exports are disaggregated into six categories: On-Peak Period and Off-Peak Period energy between MB and each of SK, ON, and MISO.

Equation A: Δ Net Exports = Δ Exported Energy - Δ Imported Energy – Δ "Unserved"[41] Firm Exports

MB, MISO, SK, and ON are all interconnected (directly and/or indirectly) with each other and surrounding regions. However, for this assessment it is assumed that the Δ Net Exports for each of MISO, SK, and ON results in generation effects which are localized to those regions. In reality, generation effects can partially cascade into surrounding markets as well. But such minor secondary effects are outside the scope of this assessment. The electricity grid emission profiles in MISO, SK, and ON are quite different from each other and segregated evaluation of these three regions is warranted.

4.1.1.5 SYSTEM LOSS GHG EFFECTS

While the PdB Project won't impact end-use electricity load, it could potentially impact both the energy consumption within the electrical transmission and distribution ("T&D") system itself and resulting system loss emissions. System loss emissions are indirect emissions associated with generated energy lost through the T&D process; they indirectly occur within the physical boundary of T&D infrastructure making them a distinct generation effect sub-category. As with GHG effects related to other forms of electric consumption, these indirect impacts depend on both the embedded emissions of the net electricity being physically transmitted and other indirect generation effects.

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[41] Note: Firm export contracts are primarily met with physical energy. However, it is sometimes necessary to fulfill contractual obligations by directly purchasing electricity within the export region (i.e., by directly calling on a dispatchable resource in MISO to sink energy into MISO to replace energy which Manitoba Hydro was contracted to supply). This energy is termed "unserved".

High system losses do not result in high embedded system loss emissions[42] if the electricity source is renewable (i.e., non-emitting), but they do diminish the amount of renewable energy which is delivered to load, which indirectly affects generation elsewhere in the interconnect region. For example, line loss emissions along Manitoba Hydro's high voltage direct current ("HVDC") system are assumed to be zero as the electricity source is 100% hydroelectricity. However, if the HVDC system were to be made more efficient, then more hydroelectricity could be exported from MB, potentially lowering fossil-fuel generation in the interconnected region.

The PdB Project will impact system losses by both increasing the level of energy flowing in the system and, to a lesser extent, modifying the timing of energy flow and the resulting timing of the losses and indirect GHG effects. The accurate calculation of system losses is complex; Section 4.2.4.5 describes how GSPRO incorporates MB system losses. As net energy changes in MB and flows at the border depend on the GSPRO model, incremental system loss variations within MB are inherently included in the assessment results.

From a transmission loss perspective, the PdB Project will cause a net increase in physical exports from MB, a decrease in physical imports, and potential variations in the timing of energy flow. Therefore, the PdB Project will affect system loss emissions outside of MB as well. System losses between the MB border and the non-MB end load may be different than the losses between the Baseline Scenario alternative non-MB energy source and the same non-MB end load. Modelling of non-MB system losses is outside of the capability of GSPRO and also outside the scope of this assessment. This assessment will therefore assume there are no transmission grid losses, or limits, outside of MB. This "copper plate" assumption is standard in electricity transmission modelling.[43] This simplification results in the non-quantification of the following non-MB GHG effects:

- The PdB Project will reduce the quantity of physical energy imported during low-flows. Typically, this would be associated with a reduction in non-MB system losses, and non-MB system loss emissions, associated with energy delivered to MB. This typical reduction in non-MB system loss emissions is considered a qualitative net benefit of the PdB Project and will not be quantified.
- For simplicity, this assessment assumes that a MWh of energy delivered to the MB border has the same ability to meet a non-MB load as a non-MB energy source (i.e., the copper-plate assumption). That is, no net system losses, beyond those which are modeled within

[42] Note: For corporate reporting, system loss emissions are a Scope 2 emission assigned to the utility that owns the transmission or distribution system where the losses occur.
[43] [E.g., Ortner & Kruijer, 2014; Cao et al, 2018]

MB, are calculated. Such a simplification could result in an overestimate of the net benefit of the PdB Project, but an underestimation is comparably probable.

4.1.2 SECONDARY GHG EFFECTS

The PdB Project's primary effects will far outweigh its secondary effects. Therefore, this assessment will follow the Electricity Project Guidelines which suggest that "*It is not necessary to conduct a full life-cycle analysis of a project activity's net impacts on GHG emissions*." [WRI, 2007][44] However, some secondary effects will be considered because they are potentially significant and/or required to be assessed by the Climate Lens.

4.1.2.1 CONSTRUCTION AND ON-SITE O&M RELATED EMISSIONS

Generation effects during the operation & maintenance ("O&M") phase of the PdB Project are significant and the primary focus of this assessment. Comparatively, the PdB Project requires modest net construction and on-site O&M activity. As such, it is expected that construction and on-site O&M related emissions are not significant. However, the Climate Lens directs that "*Mitigation assessments will assess each project across the construction (excluding supply-chain) and operations and maintenance (O&M) phases. The assessment should not seek to estimate construction emissions associated with the asset's future major rehabilitative maintenance or decommissioning. Assessments should include estimates of a project's cumulative construction and O&M emissions over the useful lifespan of the infrastructure, i.e., annual emissions for each year from the start year of the project to the end of its useful life."* [Infrastructure Canada, 2019][45]

To fulfill this Climate Lens obligation a high-level estimate of construction related emissions was completed (Sections 4.6 and 5.2) as part of this assessment. A high-level estimate of O&M related emissions was also completed (Section 4.6.5).

The Climate Lens notes that the "*quantification of supply-chain emissions is not required given the complexities associated with both sourcing and quantifying these emissions."* [Infrastructure Canada, 2019][46] However, experience with the GHG assessment of other Manitoba Hydro projects (Figure 4) has shown that for projects that require significant portions of pre-manufactured materials, embedded emissions in "Building Materials" substantially outweigh the emissions directly attributable (Scope 1) to their installation ("On-Site Activities"). Indirect

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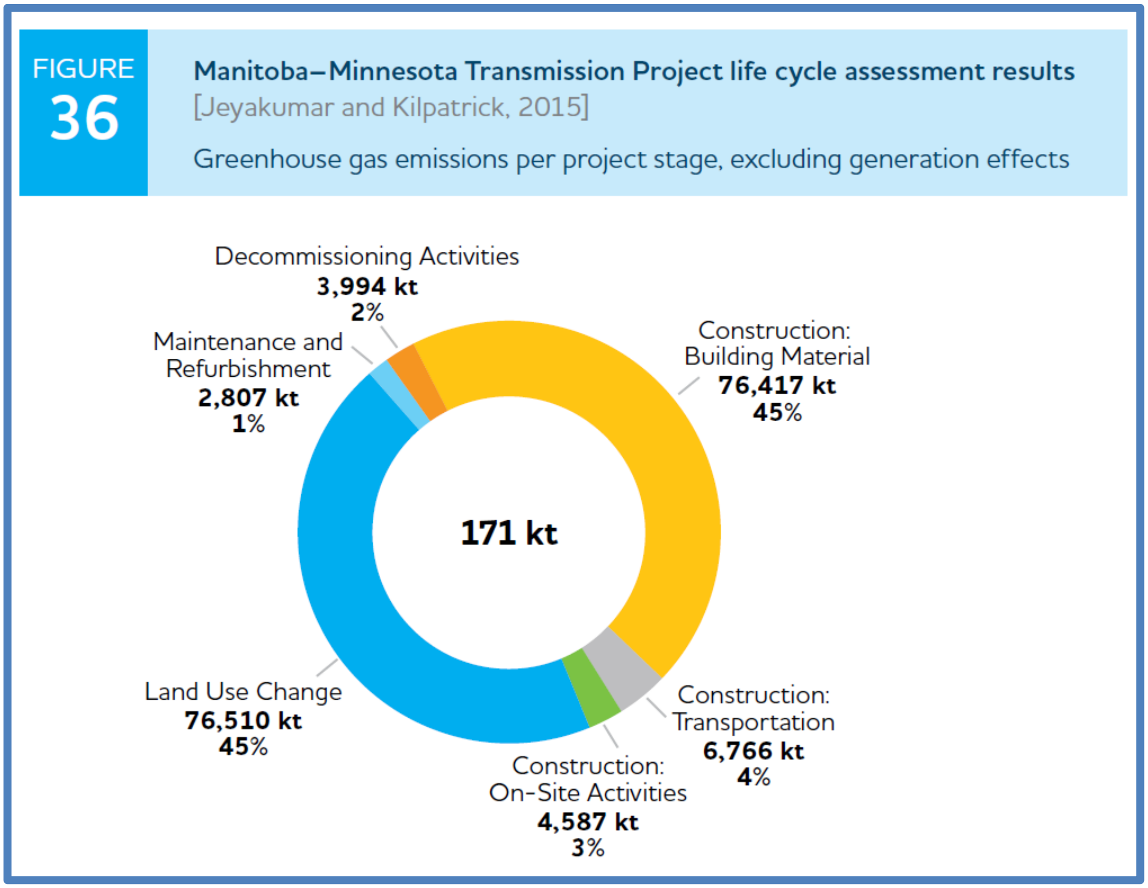
[44] Electricity Project Guidelines – Chapter 4.3.2 (*Upstream and Downstream Effects*), p.28
[45] Climate Lens – Section 2.4 (*Timescale / Forecast Window*)
[46] Climate Lens – Section 2.4 (*Timescale / Forecast Window*)

construction emissions resulting from the "Transportation" of construction materials are often higher than the direct emissions resulting from their installation as well. A high-level estimate of global supply-chain emissions related to the construction phase of the PdB Project has been completed (Sections 4.6 and 5.2), to provide a point of comparison with direct construction emissions. However, as material required for O&M will be negligible, compared to construction material, no high-level estimate was completed for global supply-chain emissions related to O&M material.

Figure 4: Figure 36 from the Climate Change Report – "MMTP" LCA results[47]



4.1.2.2 PW75 LAND USE CHANGE EMISSIONS

The PdB Project will require the construction of a new 46.5 km transmission line ("PW75") from PdB to the Whiteshell Transmission Substation ("Whiteshell"). PW75 will require the permanent expansion of existing right-of-ways ("ROWs") and the establishment of new ROWs. PW75 ROWs

[47] [Manitoba Hydro, 2020a]

will cross forestland that is assumed to be permanently[48] disturbed with a resulting permanent reduction of above ground carbon content.

An estimate of land use change emissions was done (Sections 4.6.4 and 5.2.1) as part of this assessment. While the actual transmission route is not final, the Final Preferred Route [Manitoba Hydro, 2014a][49] from the Pointe du Bois Transmission Project Environmental Assessment Report ("PdB Transmission Project EAR") was assumed for this assessment.

The PdB Project will also require temporary land disturbances (e.g., borrow pits, temporary access roads, marshalling yards). However, net emissions from these temporary disturbances are assumed to be zero within the Assessment Period, unless they are also within the ROW. Temporary disturbances are assumed to return their original state, from a carbon content perspective.

4.1.2.3 RESERVOIR EMISSIONS

Electricity Project Guidelines note that "*One type of "upstream" effect that will generally be significant for reservoir hydroelectric project activities involves methane emissions from organic decomposition on land areas flooded by the reservoir. Estimating such emissions can be difficult and subject to uncertainty."* [WRI, 2007][50] Hydroelectric reservoirs produce net CO_2 emission as well. In the case of the PdB reservoir, it is both mature and exists in both the Baseline and Project Scenarios. "*Overall, our reservoir monitoring efforts indicate the "reservoir effect" for our mature reservoirs and the recently created Wuskwatim reservoir has subsided and emission rates are similar to those of natural lakes and rivers."* [Manitoba Hydro, 2020a][51] Net reservoir emissions resulting from the PdB Project are therefore assumed to be nil.

4.1.2.4 FUEL PRODUCTION, PROCESSING, AND TRANSPORTATION EMISSIONS

Primary effects relate to the combustion of fossil-fuels within grid-connected power plants (Section 4.1.1). However, experience has shown that emissions resulting from the production, processing, and transportation of combusted fossil-fuels, especially natural gas, can be significant (Figure 4). Life cycle assessment ("LCA") work contracted by Manitoba Hydro showed the median

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[48] Note: The assumption of permanence focuses on the Assessment Period. However, ROW impacts can be expected to persist beyond 2055 as well.
[49] PdB Transmission Project EAR – Chapter 2 – Map 2-1 (*Project Description – Pointe du Bois Transmission Project Final Preferred Route*), p.25
[50] Electricity Project Guidelines – Chapter 4.3.2 (*Upstream and Downstream Effects*), p.28
[51] Climate Change Report – Section 2.2 (*Direct Emissions Sources – Reservoir Emissions*), p.68

impact of upstream emissions (producing, processing, and transporting fuel) related to natural gas generating stations was around 22% of total life cycle emissions (Figure 5), or 30% of the level of on-site combustion emissions. Scientific studies and assessments[52] have also raised concern about the underestimation of upstream natural gas emissions, with a focus on choice of the appropriate metric to gauge the impacts of leaked and vented methane ("CH_4") emissions on global climate change.

As a counterpoint, the Electricity Project Guidelines note that "*Most grid-connected project activities will either reduce or cause no increase in fuel extraction and transportation GHG emissions, so changes in these emissions can often be ignored as secondary effects.*" [WRI, 2007][53] In a similar context, Madrigal & Spalding-Fecher [2010] does not recommend incorporating fuel supply stages into the LCA of T&D projects, only direct combustion emissions at fossil-fuel generators inter-connected to the T&D project in question: "*Given that all the grid power Clean Development Mechanism methodologies consider only combustion emissions at the power plant, and not upstream, this study proposes to limit the project boundary for assessing net impacts to only the power generation stage*." [Madrigal & Spalding-Fecher, 2010] However, Madrigal & Spalding-Fecher [2010] incorrectly calculated that the upstream impacts (producing, processing, and transporting natural gas) were only 0.4% of total life cycle emissions at natural gas generating stations; the actual percentage, based on their base assumptions[54], was 12%. While 12% is lower than the 22% determined by the Pembina Institute, it is still significant (and, much higher than 0.4%). A wide range of estimates in regard to upstream natural gas emissions, especially as they relate to CH_4 leaks, is typical[55] in the industry.

Recognizing that fuel production, processing, and transportation emissions are relevant, it was decided to include them in this assessment to fulfill the principle of completeness. However, for both transparency and conservativeness the quantification of these emissions will be kept separate from primary generation effects and net overall PdB Project emissions are presented as a range with and without these specific secondary GHG effects.

[52] [E.g., Howarth, 2014; Marchese et al., 2015; Switzer, 2012]

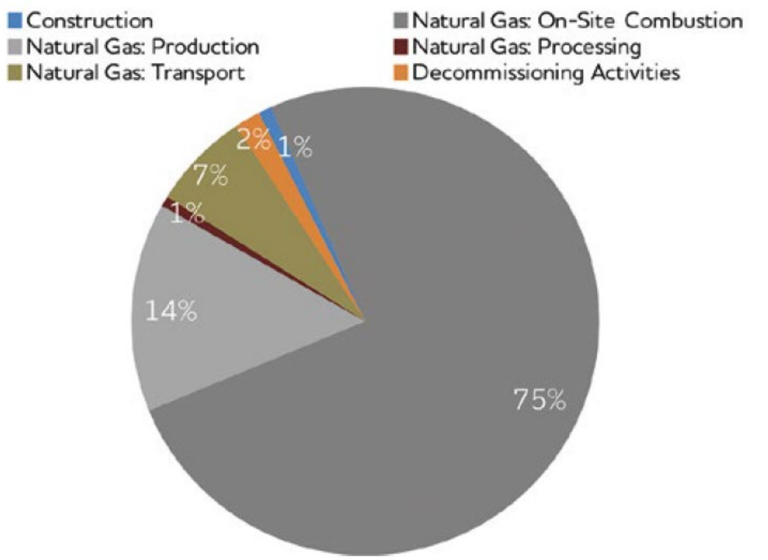
[53] Electricity Project Guidelines – Chapter 4.3.2 (*Upstream and Downstream Effects*), p.28

[54] Note: Madrigal & Spalding-Fecher [2010] assumed combustion emissions of 0.0561 tone of CO_2e/gigajoule of natural gas and upstream emissions of 0.296 kg of CH_4/gigajoule of natural gas. With a GWP of 25, 0.296 kg converts to 0.0074 tonnes of CO_2e /gigajoule, or 11.65% of 0.0635 tonnes of CO_2e/gigajoule (from both life cycle stages combined). Details are on page 54 of their report under sub-section "*Recommended Project Boundary*" in Section 6 "*Recommended Approach*".

[55] [E.g., Howarth, 2014; Marchese et al., 2015; Switzer, 2012; Madrgial & Spalding-Fecher, 2010]

Figure 5: Figure 38 from Manitoba Hydro [2015]

FIGURE 38: NATURAL GAS COMBINED CYCLE PLANT: LITERATURE SURVEY OF LCAs – GHG EMISSIONS PER PRIMARY ACTIVITY [PEMBINA INSTITUTE, 2013]



4.1.3 GREENHOUSE GASES CONSIDERED

All primary GHG effects of the PdB Project are related to the combustion of fossil-fuels to generate electricity (i.e., they are all generation effects). Carbon dioxide ("CO_2") is by far the most significant GHG produced by combustion, however CH_4 and nitrous oxide ("N_2O") are also produced. Results will be presented in carbon dioxide equivalent ("CO_2e"), and not disaggregated by GHG, due to the dominance of CO_2 in the results. This is consistent with the Climate Lens that requires that "*Emissions must be converted into CO_2 equivalent (CO_2e) using the Global Warming Potentials identified in the most up-to-date version of Canada's National Inventory Report (see Annex C) and reported in tonnes (t), kilotonnes (kt), or megatonnes (Mt).*" [Infrastructure Canada, 2019][56]

Where GHG specific emissions are calculated IPCC's Fourth Assessment Report GWPs (Table 9) will be used to aggregate the results into CO_2e, consistent with federal reporting guidelines, including the Climate Lens. Other GHGs were indirectly considered in three of the secondary effect categories (fuel production, processing, & transportation emissions, O&M emissions, and

[56] Climate Lens – Section 2.3 (*Relevant Greenhouse Gases*)

supply-chain emissions) as they are incorporated in some LCA EFs and station breakers. Otherwise, other GHGs are "*deemed insignificant*" [Infrastructure Canada, 2019][57].

Table 9 Global Warming Potentials of Select Gases[58]

Gas	Molecular Formula	GWP
Carbon Dioxide	CO_2	1
Methane	CH_4	25
Nitrous Oxide	N_20	298
Carbon Tetrafluoride	CF_4	7,390
Sulphur Hexafluoride	SF_6	22,800

4.2 GSPRO MODELLING & ASSUMPTIONS

GSPRO was used for generation expansion planning and production costing throughout this assessment. Incremental analyses were performed based on OptGen and SDDP model results for the Baseline and Project Scenarios. OptGen was used to identify optimal generation expansion sequences for both the Baseline and Project Scenarios, subject to a series of assumed load, market, and system characteristics.

Detailed SDDP model results informed a stand-alone analysis prepared for this assessment, providing insights into net changes in Manitoba Hydro's generation resource use, electricity market participation, and overall system operations. SDDP provides production costing information based on the stochastic optimization of energy generation dispatch decisions under flow uncertainty. The SDDP model is fully integrated with OptGen and provided critical operational cost information for generation expansion planning optimization.

The GSPRO model evolves, and embedded assumptions are updated, on an ongoing basis. Modelling work undergone for this assessment was completed prior to September 2020. This section is intended to describe modelling configuration details specifically applicable to this assessment.

[57] Climate Lens – Section 2.3 (*Relevant Greenhouse Gases*)
[58] Climate Lens – Annex C (*Global Warming Potentials for GHG Mitigation Assessments*)

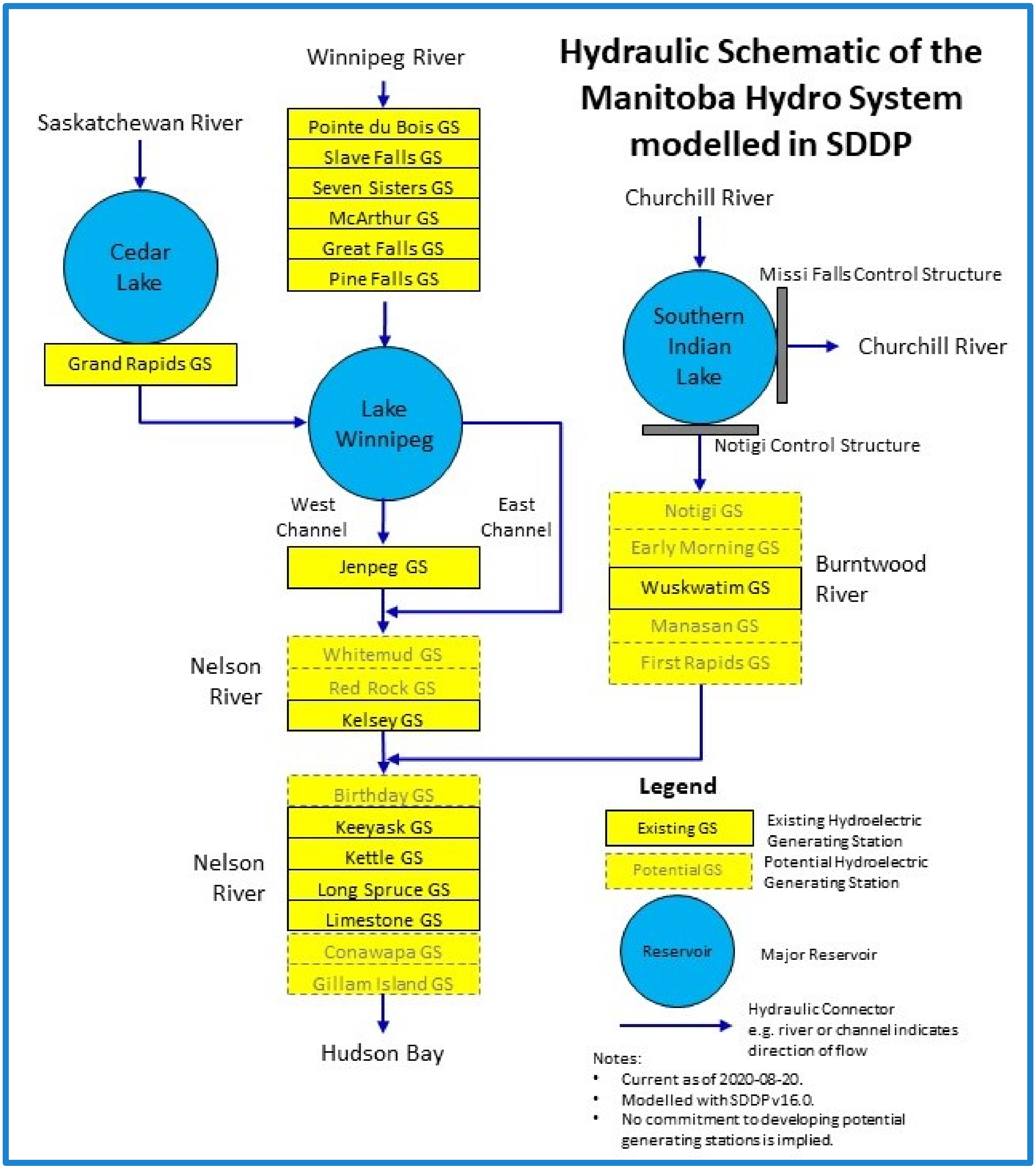
4.2.1 DESCRIPTION OF SDDP

SDDP has been a global reference for many years and is currently applied in more than seventy countries in the Americas, Europe, Asia-Pacific, and Africa, in systems with a wide variety of installed capacity (including some of the largest in the world, such as NordPool, Western U.S., Canada, and Brazil) and levels of market designs/economic development (for example, Scandinavia and New Zealand; Latin America and East Asia; and countries in Africa). SDDP uses stochastic dual dynamic programming to optimize the dispatch of energy generation resources within a modeled system, for long, medium, and short-term operation studies. The model calculates the least-cost operation policy of a generation system while considering details such as the following:

- Operating details of hydroelectric plants: hydraulic characteristics, including flow limitations through generators and flow varying tailwater elevation curves; turbine characteristics, including installed capacity, turbine flow versus efficiency curves, and maintenance outages; and reservoir storage characteristics, including storage versus elevation curves and operational constraints. Ice effects and seasonal variations in generator efficiency are captured through these details.
- Operating details of other types of renewable generation in the system, including installed capacity, time-varying capacity factor profiles, and outages and maintenance schedules.
- Operating details of thermoelectric plants, including installed capacity, fuel, and specific consumptions details, and outages and maintenance schedules.
- The representation of the transmission network, including system limits and losses.
- The representation of load duration curves based on a block definition and using a monthly time step.
- The representation of contractual obligations and market interactions, including market prices.
- The representation of hydrological uncertainty through the evaluation of 107 historical flow-cases, based on Long-Term Flow Dataset (“LTFD”) inputs.

Figure 6 illustrates how Manitoba Hydro’s hydraulic network has been represented in SDDP. Note that only hydro stations with major reservoirs are assumed to have storage capacity, with all other stations assumed to be run-of-river in SDDP.

Figure 6: Hydraulic Schematic of the Manitoba Hydro System Modelled in SDDP



4.2.2 DESCRIPTION OF OPTGEN

OptGen (which is fully integrated with SDDP) optimizes resource selection and timing (i.e., generation expansion planning) by minimizing investment and net operating costs, while ensuring that system accredited capacity and energy requirements are met. Limitations on project selection are captured in OptGen through project-specific association, exclusivity, precedence, and maximum and minimum installed capacity constraints.

4.2.3 GENERATION EXPANSION PLANNING METHODOLOGY

OptGen ensures generation expansion sequences provide a supply of accredited capacity adequate for the needs of the province based on current assumptions. This aligns with Manitoba Hydro's mandate to expand its system as needed in order "*To provide for the continuance of a supply of energy to meet the needs of the province and to promote economy and efficiency in the development, generation, transmission, distribution, supply, and end-use of power.*" [The Manitoba Hydro Act] As a predominately hydro system, Manitoba Hydro fulfills its mandate by having an Energy Criterion in addition to a Capacity Criterion. Together, the Capacity Criterion and Energy Criterion provide the basis for determining when new resources are required to ensure an adequate supply of capacity and energy for MB. Manitoba Hydro relies on both GSPRO and supplemental analysis to ensure generation expansion sequences fulfill both criteria:

- **Capacity Criterion: "***Manitoba Hydro will plan to carry a minimum reserve against breakdown of plant and increase in demand above forecast of 12% of the Manitoba forecast peak demand each year plus the reserve required by any export contract in effect at the time."*
- **Energy Criterion: "***Manitoba Hydro will plan to have adequate energy resources to supply the firm energy demand in the event that the lowest recorded coincident water supply conditions are repeated. Imports may be considered as dependable energy resources provided they utilize [full path firm transfer] Service and are sourced from either an Organized Power Market or a bilateral contract. The total quantity of energy considered as dependable energy from imports shall be limited to that which can be imported during the Off-Peak Period. Energy from imports which may be available in the On-Peak Period shall not be considered dependable energy, but rather be considered a reserve for energy contingencies."* [Manitoba Hydro, 2020c]

4.2.4 GENERAL MODELLING ASSUMPTIONS

This section summarizes the model input assumptions that drive the results from GSPRO. These assumptions remain constant in both the Baseline and Project Scenarios, though their impacts can vary. This section is not a detailed list of all modelling inputs but allows "*intended users to make decisions with reasonable confidence.*" [Infrastructure Canada, 2019][59]

4.2.4.1 MANITOBA ELECTRIC LOAD FORECAST

The need for generation expansion (Section 4.2.3) is primarily driven by the forecast of future load in MB. This includes load forecasts for energy, capacity, and coincident peaks. Manitoba Hydro's internally generated 2019 Electric Load Forecast ("ELF") is used for this assessment. It provides Manitoba Hydro's forecast of MB's electric load. The ELF reflects the best estimate of future load growth and is produced with the expectation that there is a 50% chance that the actual load will be higher or lower than forecast.

Net MB load is calculated by deducting demand-side management (i.e., DSM) from forecast electric load. The Efficiency Manitoba Act requires that "s*hortfalls or surpluses in annual net savings carry forward during the 15-year period under subsection (1) such that at the end of the period Efficiency Manitoba must demonstrate that the cumulative total of the annual percentage savings in the consumption of (a) electrical energy is 22.5%"* [The Efficiency Manitoba Act] The demand side management forecast was based on a forecast provided to Manitoba Hydro by Efficiency Manitoba as well as the stated goals of the Efficiency Manitoba Act. To produce the final forecast used in GSPRO, Manitoba Hydro extended the incremental demand-side management program-based savings for forecast years 4 to 20, then further extrapolated the incremental demand-side management savings for forecast years 21 to 35 based on an exponential smoothing extrapolation methodology (consistent with the extrapolation methodology applied to the MB load forecast).

The ELF is shaped within GSPRO on an hourly and seasonal basis and incorporates a winter peak. This shaping is based on historic load and remains constant throughout the forecast. No adjustments are made based on potential changes in customer load patterns over time.

4.2.4.2 EXISTING ELECTRICITY GENERATION ASSUMPTIONS

Generation expansion (Section 4.2.3) is driven by the demand for electricity as well as the ability of the existing system to supply accredited capacity and firm energy to meet this demand. Within GSPRO all existing (non-PdB) generation owned by, or whose output is under contract to, Manitoba Hydro is assumed to remain in full service through 2055 except for Selkirk and existing Wind Power Purchase Agreements (PPAs). The following assumptions are incorporated into both

[59] Climate Lens – Subsection 2.5.ii (*Required Information and General Instructions - Asset's estimated GHG emissions calculations*)

the Baseline and Project Scenarios and decisions related to non-PdB generation assets, or PPAs, are assumed to be unimpacted by potential investment in the PdB Project:

- Combined hydroelectric plant rated capacity remains approximately constant at 5,900 MW, following the completion of the Keeyask hydroelectric generating station. This is based on the 2019/20 Nominal Net Interconnected Capability values that have been updated to reflect the most recent generator capability test results.
- Selkirk[60] will not operate beyond March 31, 2030. This is an outdated assumption; Selkirk is now anticipated to cease operations in 2021.[61] The implications of this change are minor, though emissions calculations were slightly modified accordingly (Section 4.5.1).
- Keeyask[62] generating station will be fully online prior to 2024. Once all units are operational, it is anticipated there will be a net addition of 630 MW for summer peak, 653 MW for winter peak, and 3,050 GWh of annual dependable energy.
- Manitoba Hydro has PPAs with two wind producers, Algonquin Power and Pattern Energy Group, totaling 258 MW. These PPAs have the potential to be extended/re-negotiated beyond their current expiry dates (in whole or in part). For consistency with Manitoba Hydro's planning assumptions, GSPRO assumes contracted purchases of wind generation are not renewed and will expire in the 2030s as per the agreements[63]. The accredited capacity of the Wind PPAs is 52 MW, therefore this assumption moved the Need Year forward by at most one year (Section 4.1.1.2), versus assuming the PPAs last indefinitely.
- Due to the uncertainty regarding planned generation outages over the longer term, OptGen assumes long-term planned generation outage placeholders of 135 MW for winter peak and 285 MW for summer peak. These place holders are larger than the increase in hydro system's rated capacity resulting from the PdB Project; this further justifies the build margin assumptions made for this assessment (Section 4.1.1.2).

By assuming nearly all existing generation remains in service, it is inherently assumed that sufficient maintenance and investment in rehabilitation will continue to sustain the generating capability of existing resources throughout the planning period. Any additional investment expected for the existing system is included in the Integrated Financial Forecast through the capital expenditure forecast. As with any long-lived asset, there is an inherent risk that maintenance undertaken may not be sufficient to maintain existing generating capability. In addition, imposed, but currently unknown, environmental restrictions could require operational

[60] Note: The Selkirk generating station first began producing electricity in 1960.

[61] Note: Modelling runs for this assessment were complete prior to the fall of 2020.

[62] Note: The Keeyask generating station is located upstream of the Kettle Generating Station on the lower Nelson River with seven units having a maximum rated total generation capacity of 695 MW, which occurs when Stephens Lake is drawn down.

[63] Note: It is also assumed these wind farms will not be directly servicing MB load once the PPAs expire.

changes reducing effective output or could require additional major capital investment to continue generation at these sites. Overall reduced availability of existing generation assets, including the effects of early retirement, may advance the Need Year. A qualitative benefit of the PdB Project is that it helps to mitigate such risks.

4.2.4.3 ENERGY PRICE FORECAST

Manitoba Hydro's 2019 Energy Price Forecast ("EPF") is used to develop key pricing inputs for GSPRO's SDDP model. Within GSPRO the electrical energy market price forecast is further detailed using historical hourly price shapes. The EPF was done by consensus, using four proprietary[64] independent price forecast consultant reports, and provides the following:

- Electrical energy (On-Peak Period and Off-Peak Period) and capacity prices for the MB and Minnesota ("MN") Hubs of the MISO market; and
- Natural Gas prices at a number of key gas hubs in North America.

As with all general modelling assumptions, the electricity and gas price forecasts are identical in both the Baseline Scenario and Forecast Scenario; as this assessment quantifies incremental impacts, this approach limits the impact of forecast uncertainty. Forecast price inputs influence GSPRO model optimizations substantially, however: MISO Market prices are the primary driver of how much revenue Manitoba Hydro receives for its electricity exports and the cost of imports, which may be used as a source of supply, particularly during low-flow conditions. Several variables will contribute to variations in future long-term MISO energy price trends, including the following: natural gas prices, MISO system resource mix, regional load growth, supply resource capital costs, environmental policies, government incentives and directives, and transmission system capabilities and constraints.

Within GSPRO, the uncontracted (Section 4.2.4.4) price of exported and imported electricity is based on the EPF, which is based on MISO region pricing. For simplicity, the same export price is applied to MISO, ON, and SK.[65] As Manitoba Hydro's physical capacity to trade with MISO far outweighs the other regions (Section 3.7) this is a reasonable simplification.

[64] *"As has been discussed in previous proceedings, Manitoba Hydro purchases external price forecasts from a number of forecastors in order to create Manitoba Hydro's consensus forecast…Manitoba Hydro is under a contractual obligation to treat the forecasts as confidential as public disclosure of the forecasts would results in a substantial financial loss to the creators of the forecasts. The forecasts cannot be provided to third parties without prior written consent. Manitoba Hydro has sought consent to provide the forecasts to the PUB and consent has been granted provided they be held in confidence."* [Manitoba Hydro, 2019]

[65] Note: Manitoba Hydro is also a Southwest Power Pool (SPP) market participant; but there are no direct physical connections between MB and the SPP and any incremental changes in trading with SPP are outside the scope of this assessment.

Within GSPRO the price for importing electricity is modelled slightly higher than the EPF MISO price to account for losses and market transaction charges; the price adder for imports from SK is higher than the adder for imports from MISO. These price adders represent that energy transactions involve both effort and some uncertainty and were found to result in a better representation of market interactions when comparing SDDP results with historical data during calibration exercises.

Forecast natural gas prices are incorporated into the variable dispatch cost of MB natural gas generating units in addition to a GHG price forecast[66], variable O&M cost assumptions, and natural gas transportation/distribution costs. The application of Energy Price Forecast assumptions to imported energy results in MB fossil-fuel units being, generally, last in the dispatch order.

4.2.4.4 EXISTING EXPORT/IMPORT CONTRACTS

"*In an interconnected system, surplus power can be exported at the value obtained by negotiated contract prices or at the current market value."* [Manitoba Hydro, 2013] Long-term export contracts provide Manitoba Hydro with higher price certainty than more volatile market prices (Section 4.2.4.3).

Existing Manitoba Hydro Export contracts (specific terms of these contacts are considered commercially sensitive information[67]) with firm capacity and dependable energy obligations are modelled in GSPRO. Dependable export obligations refer to sales of capacity and dependable energy that must be served under all historic water supply conditions including the lowest recorded coincident water supply conditions. Long term export obligations under dependable flow conditions may be less than the obligation under higher flow conditions and are governed by the terms of each individual contract. Consistent with energy market design, GSPRO allows Manitoba Hydro to help fulfill its contractual obligations with market settlements, in addition to the physical delivery of energy (Figure 3).

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[66] Note: The GHG price forecast was based on existing federal legislation (i.e., Greenhouse Gas Pollution Pricing Act) and regulation (i.e., Output-Based Pricing System Regulations) in place during 2020. This is consistent with Manitoba Hydro's Integrated Financial Forecast.

[67] "*Manitoba Hydro has never disclosed pricing or other information related to specific terms of its export contracts in a public forum. Disclosure of specific terms related to contracts negotiated by Manitoba Hydro would harm the Corporation's relationship with the counterparty and cause reputational harm to Manitoba Hydro. Manitoba Hydro's relationship with counterparties has been established by building trust over many years and Manitoba Hydro has consistently acted in good faith and with the understanding of the intent under which these contracts and agreements were negotiated."* [Manitoba Hydro, 2019]

Manitoba Hydro's existing long-term contracts include contracts with SK that could last beyond 2050. By 2022, Manitoba Hydro will be supplying up to 290 MW of hydroelectricity to southern SK based on assumed contractual obligations, leaving little room on the interconnection for additional energy sales (Section 4.2.5).

4.2.4.5 SYSTEM LOSSES

SDDP captures three distinct categories of losses in MB: DC system losses, AC system losses, and import/export losses. Losses account for the supply of station service demands and transmission outages as appropriate. Loss assumptions are based on both analysis of historical data and consideration of future system configurations and are different for each loss category. Distribution-level transmission losses are not modeled in SDDP as they are directly incorporated into the ELF.[68]

For this assessment modelled total system losses varied between approximately 1,400 and 3,200 GWh/year depending on system load and water conditions. Absolute losses generally increase as overall hydroelectric generation increases: the lowest absolute level of losses occurred during "lowest-flow" conditions and the highest during "highest-flow" conditions. However, as a function of total system supply[69], annual losses ranged from less than 4% to more than 7%; on a system wide basis, modelled losses are not linearly proportional to the total energy being supplied to the transmission system.

4.2.5 MODELLING OF INTERCONNECTIONS

While actual transmission capacity varies with power system conditions, within GSPRO transmission capacity is fixed over the Assessment Period and generally matches full path firm transfer capability following the completion of the Birtle-Tantallon line (Section 3.7). Some key GSPRO modelling details are as follows:

- Transmission capacity with ON matches its full path firm transfer capability: 150 MW to ON, but no import capability.
- The U.S. export limit is set at 2,733 MW, instead of 2,983 MW, as the 150 MW reserve delivery is excluded and 100 MW more is excluded as a hedge against transmission capacity variation due to changes in electricity system conditions. The import limit matches the firm capability of 1,398 MW.

[68] Note: "*Manitoba Load at Common Bus is the total load metered at all the substations in the province that supplies Manitoba Hydro's non-Diesel customers and includes Distribution Losses and Construction Power*." [Manitoba Hydro, 2018]

[69] Note: "Total system supply" includes MB fossil-fuel, hydroelectric, and wind generation, as well as imported energy and a small level of market settlements; but it does not include DSM.

- While 60 MW of firm transmission capacity exists between MB and the small northern SK electricity system, only the interconnections between MB and the much larger southern SK electricity system are modeled in GSPRO: the export limit is set to 291.5 MW, instead of 351 MW.
- While there is no firm import capacity from southern SK, 150 MW is assumed within GSPRO to model potential economic sales. This capacity is only available during overnight portions of the Off-Peak Period.

Several transmission projects expected to be online within the modelling study horizon, or recently completed, have been included in GSPRO. Most of the projects are dictated by the need to expand the transmission system to reliably serve growing loads, transmit energy to the export market, improve safety, improve import capability, increase efficiency, and connect new generation. The two most significant new interconnection projects are a 500 kV line between MB and MN and a 230 kV line between MB and SK:

- The new 500 kV US interconnection (the MMTP) went into service June 1, 2020 and is capable of providing firm transmission service of 698 MW for imports and 883 MW for exports. The in-service date coincides with the start of the related long-term contracts with Minnesota Power. The interconnection will provide transmission services, improve system reliability, and reduce total interconnection losses.
- A new 230 kV line[70] from Birtle, MB to Tantallon, SK will come into service in 2021 and will provide improved transmission service capability between MB and SK. This line is required in order to deliver 290 MW of contracted energy to southern SK.

4.2.6 HYDRO GENERATION MODELLING

Manitoba Hydro's generation is greatly affected by variability in water supply; the impact of variability is incorporated into GSPRO using the LTFD; the LTFD encompasses 107 years (1912 through 2018) of historical inflow data (either observed or estimated) for the Nelson-Churchill Watershed that have been adjusted to reflect present-use conditions. The LTFD is disaggregated into sub-basins that align with Manitoba Hydro generating infrastructure. When performing a full modeling run in SDDP, 107 distinct flow-cases are evaluated: Each flow-case assumes a different starting year from the historical flow record. The chronology of flows in each flow-case is preserved, with a carousel approach that loops data back to the 1912 (start of the LTFD record) flows when 2018 flows (end of the LTFD record) are reached.

[70] Note: This line received ICIP funding.

The 1940 flow-year, based on the 12-month period from April 1940 to March 1941, is the annual period of “lowest-flow” conditions and is the “worst-case” flow-year for energy production; the 2005 flow-year is the annual period of “highest-flow” conditions and is the “best-case” as it consistently results in maximum system wide energy production. The 1963 flow-year represents the “median-case” (i.e., “median-flow” conditions) for hydroelectric energy production. As an example of the range of variability: in 2030, GSPRO Baseline Scenario output projects that hydro generation will range from 19,600 GWh under lowest-flow conditions when making use of available storage, to 46,000 GWh under the highest-flow conditions. This variability results in uncertainty regarding the year-over-year generation levels of the Manitoba Hydro system, and how the corresponding generation and transmission assets will be operated.

This assessment is based on the average results from the 107 flow-cases (the LTFD). GSPRO re-evaluates the value of stored hydroelectric energy monthly, considering the range of possible future flows; however, GSPRO does not have foreknowledge of specific flows beyond the current month when making hydroelectric dispatch decisions. As this assessment uses averages of simulation results, the actual quantity, and location, of GHG effects in any given month or year in the future can be expected to vary noticeably from the averaged simulation results. However, aggregate GHG effects over the entire Assessment Period have much less uncertainty. Section 5.1.1 provides context for the impact of this variation.

Manitoba Hydro’s generating stations are dispatched as a cohesive system to meet demand both within GSPRO and in actual operation. On a short-term (e.g., hourly/daily) basis incremental generation increases at PdB can affect other generators in the system, but on a longer-term basis (e.g., annual) net increases in electricity production at PdB, due to the PdB Project, should generally match system-wide generation increases. For this assessment, net hydroelectric generation is presented on a system-wide basis, not “at” PdB. The value of applying this methodology is highlighted in Section 5.1.1.

Manitoba Hydro recognizes that climate change has the potential to impact future flows in the Nelson-Churchill Watershed and utilizes Global Climate Models and hydrologic modelling to explore these impacts.[71] Changing streamflow in the Winnipeg River basin could affect the net energy production resulting from the PdB Project, where increased energy production would likely increase global GHG reductions resulting from the project. Historical flow records within GSPRO were not adjusted for this GHG Mitigation Assessment, but future climate projections will

[71] Note: The Climate Change Report summarizes Manitoba Hydro’s climate change studies.

be evaluated in the Climate Resilience Assessment. As such, these potential GHG benefits remain qualitative for now.

4.2.7 FOSSIL-FUEL GENERATOR MODELLING

GSPRO dispatches resources based on economics while respecting transmission constraints. Due to cost (Section 4.2.4.3), Manitoba Hydro's existing and future natural gas generators are generally last on the dispatch order both operationally, and within GSPRO (Figure 3). This is the inherent result of a generation portfolio that is predominantly low variable cost renewable energy interconnected with regions with relatively low electricity market prices (Section 4.2.4.3).

If new gas generators come on-line within MB (not until at least 2042 in any generation expansion sequence ("build-out"), if ever), then they are dispatched before the existing Brandon units due to higher operational efficiencies. GSPRO always models a minimum level of fossil-fuel generation in a year for proficiency runs to confirm capacity accreditation to regulatory authorities, but this minimum level would not be impacted by the PdB Project. Fossil-fuel generation is only required to supply need during a small percentage of the 107 flow-years (Section 4.2.6). And, as shown in Figure 3, even in those years the overall annual contribution of MB fossil-fuel generation is quite low.

4.3 BASELINE SCENARIO

"*The project proponent shall demonstrate equivalence in type and level of activity of products or services provided between the project and the baseline scenario and shall explain, as appropriate, any significant differences between the project and the baseline scenario*." [International Organization for Standardization, 2006][72] Section 4.3 and Section 4.4 describe the "*significant differences*" (between the Baseline and Project Scenarios) in how electric energy produced in MB is being added to the interconnected grid.

4.3.1 POINTE DU BOIS POWERHOUSE – EVALUATION OF LIFE CYCLE ALTERNATIVES

Due to its condition, the PdB powerhouse requires upgrades to extend its life to support the continued generation of renewable energy into the future. In recent years, Manitoba Hydro evaluated a broad range of life cycle alternatives to establish a long-term plan for the powerhouse. Alternatives included early decommissioning and a range of life extension alternatives including running existing units to failure, repairing existing units, and replacing old

[72] ISO 14064-2 – Section 5.4 (*Determining the Baseline Scenario*), p.10

units with new units. The alternatives, including associated transmission upgrades, were evaluated based on total life cycle costs, revenue, and economic metrics such as net present value and levelized cost of energy. Mitigation of environmental impacts and associated costs were also considered for each alternative. Based on this evaluation, Manitoba Hydro is implementing powerhouse life extension upgrades to enable continued operation of the generating station using the existing generating units (Baseline Scenario). The Baseline Scenario would see PdB rated capacity reduce to 20 MW by late 2020s (Table 10) as six of the existing units are expected to reach end of life and cease operation (Section 4.3.2). Ramping generation down to 20 MW balances total investment and revenue while still providing a source of renewable energy over the Assessment Period.

Manitoba Hydro has considered, analyzed, and deemed economically attractive the replacement of PdB units. Replacing units would provide substantially more revenue but would also require substantially more capital investment to implement. The primary reason that the PdB Project would not move forward is due to limitations on available capital (i.e., the main project "*barrier*" [WRI & WBCSD, 2005][73] is up front capital cost). While unit replacements have been deemed economically attractive, capital constraints could push investment funding into the future. As noted in Section 4.1, *"...the economics of unit replacements worsen as time passes, making a similar project occurring further off in the future less likely."* It is therefore reasonable to assume that the Baseline Scenario incorporates a permanent delay in capital investment; if PdB units are not replaced in the near-term it is reasonable to assume, as a Baseline Scenario, that they will not be replaced in the long-term either.

4.3.2 FACILITY BASELINE

For this assessment the Baseline Scenario assumes that existing units that are uneconomical to put back into service remain on forced outage and that over time other units reach their economic end of life and go on forced outage. The result is ramping down PdB capacity until only units 1, 15, and 16 remain in operation; from 2029 to the end of the Assessment Period (i.e., 2055) the rated capacity of PdB is 20 MW. Table 10 shows the rated capacity of PdB in both the Baseline and Project Scenarios; the Scenarios are shown side by side for ease of comparison.

[73] Project Protocol – Chapter 8.1 (Performing a Comparative Assessment of Barriers), p.50

The Baseline Scenario unit assumptions are as follows:

- Units 2-5, 7, 8, and 11 remain on forced outage.
- Units 6, 9, and 10 are assumed to go on forced outage in 2023.
- Units 12-14 are assumed to go on forced outage in 2029.
- Units 1, 15, and 16[74] remain in operation over the entire Assessment Period. Unit 1 (Straflo unit) was first installed in 1999 while units 15 and 16 underwent overhauls in 2003 and 2006 respectively.

[74] Note: Unit 16 is currently offline for repair but is assumed to be back in service by 2023.

Table 10 PdB Rated Capacity by Unit (Project Scenario Additions Highlighted in Blue)

	Generating Unit – Rating Capacity (MW – Median[75] Head Conditions)																**Baseline Scenario**	**Project Scenario**
FYB	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**		
2020	8.88					4.76			4.29	4.30		4.99	4.95	4.54	5.44		42.14	**42.14**
2021	8.88					4.76			4.29	4.30		4.99	4.95	4.54	5.44		42.14	**42.14**
2022	8.88					4.76			4.29	4.30		4.99	4.95	4.54	5.44		42.14	**42.14**
2023	8.88											4.99	4.95	4.54	5.44	5.48	34.28	**34.28**
2024	8.88		6.54				6.54					4.99	4.95	4.54	5.44	5.48	34.28	**47.35**
2025	8.88		6.54		6.54		6.54				6.54	4.99	4.95	4.54	5.44	5.48	34.28	**60.43**
2026	8.88		6.54		6.54		6.54	6.54	6.54		6.54	4.99	4.95	4.54	5.44	5.48	34.28	**73.50**
2027	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54	4.99	4.95	4.54	5.44	5.48	34.28	**86.58**
2028	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54	4.99	4.95	4.54	5.44	5.48	34.28	**86.58**
2029	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2030	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2031	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2032	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2033	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2034	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2035	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2036	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2037	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2038	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2039	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2040	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2041	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2042	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2043	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2044	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2045	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2046	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2047	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2048	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2049	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2050	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2051	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2052	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2053	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**
2054	8.88	6.54	6.54	6.54	6.54		6.54	6.54	6.54		6.54				5.44	5.48	19.81	**72.11**

[75] Note: The rated capacities in this table are based on a long-term median head condition (13.75m) from 1977 to 2018. Table is for illustrative purposes as no O&M outages are shown.

4.3.3 GENERATION BUILD-OUTS

Development of this assessment's methodology was, in part, an iterative process. OptGen results provided insight into probable generation expansion sequences and were necessary to consider the best assessment approach for build margin effects (Section 4.1.1.2). As such, this section discusses some modelling results, though more fulsome results are presented in Section 5.

Modelling work undertaken for this assessment produced specific generation expansion sequences based on methodology detailed in Section 4.2, including the planning criteria described in Section 4.2.3. The preparation of these specific sequences is intended to demonstrate the incremental emission impacts of the PdB Project. These sequences are intended to be plausible examples of possible future generation expansion sequences in order to assess the incremental impacts of the PdB Project. Manitoba Hydro's actual future generation build-out is uncertain and sequences presented herein should not be used outside the context of this GHG assessment; projections of absolute emissions in both the Baseline and Project Scenarios are intended for incremental comparisons and caution should be taken when considering each scenario in isolation.

The OptGen configuration inherently has a limited quantity and variation of resource options. The current configuration incorporates simple-cycle gas turbine ("SCGT"), combined-cycle gas turbine ("CCGT"), wind, solar photovoltaic, and select hydroelectric options. However, some plausible options, such as market capacity purchases or battery storage options, are not included in the model. While this is an assessment limitation, it is not a significant limitation as incremental, not absolute, GHG effects are being assessed.

When OptGen's resource selection is not constrained, a fossil-fuel (i.e., natural gas generation) build-out is preferred whether or not the PdB Project takes place. The "All Gas" build-out in Table 11 shows what units OptGen selected in an unconstrained build-out scenario. While this OptGen run only selected SCGT units, a mix of SCGT and CCGT units was selected during similar runs. This indicates that the economics between the two options is close in the post 2042 time-frame. Incorporating CCGT's into a Baseline Scenario would lead to larger net GHG reductions in MB when also included in the Project Scenario.

When fossil-fuel builds were constrained in OptGen, OptGen first built as many new natural gas units as it was permitted and then wind resources were added to the system prior to new hydroelectric options. The "Mostly Wind" plan in Table 11 shows a representative build-out prepared where new wind farms fulfill nearly all of the Energy Criterion and a significant proportion of the Capacity Criterion (Section 4.2.3). This build-out is intended to be an example of a plausible sequence where climate change policy has substantial influence on new electricity resource selection decisions.

The total accredited capacity of both the “All Gas”’ build-out and “Mostly Wind” build-out are comparable as the accredited capacity of wind generation is assumed to be 20% of its nameplate capacity. The default size for SCGTs in OptGen are 215 MW and Wind is built in 100 MW increments resulting in the regular increments shown in Table 11. Other sizes are plausible, but not currently included in the GSPRO model.

Table 11 Build-Out Schedules (‘*resource option’* – ‘*nameplate capacity*’) – Baseline Scenario

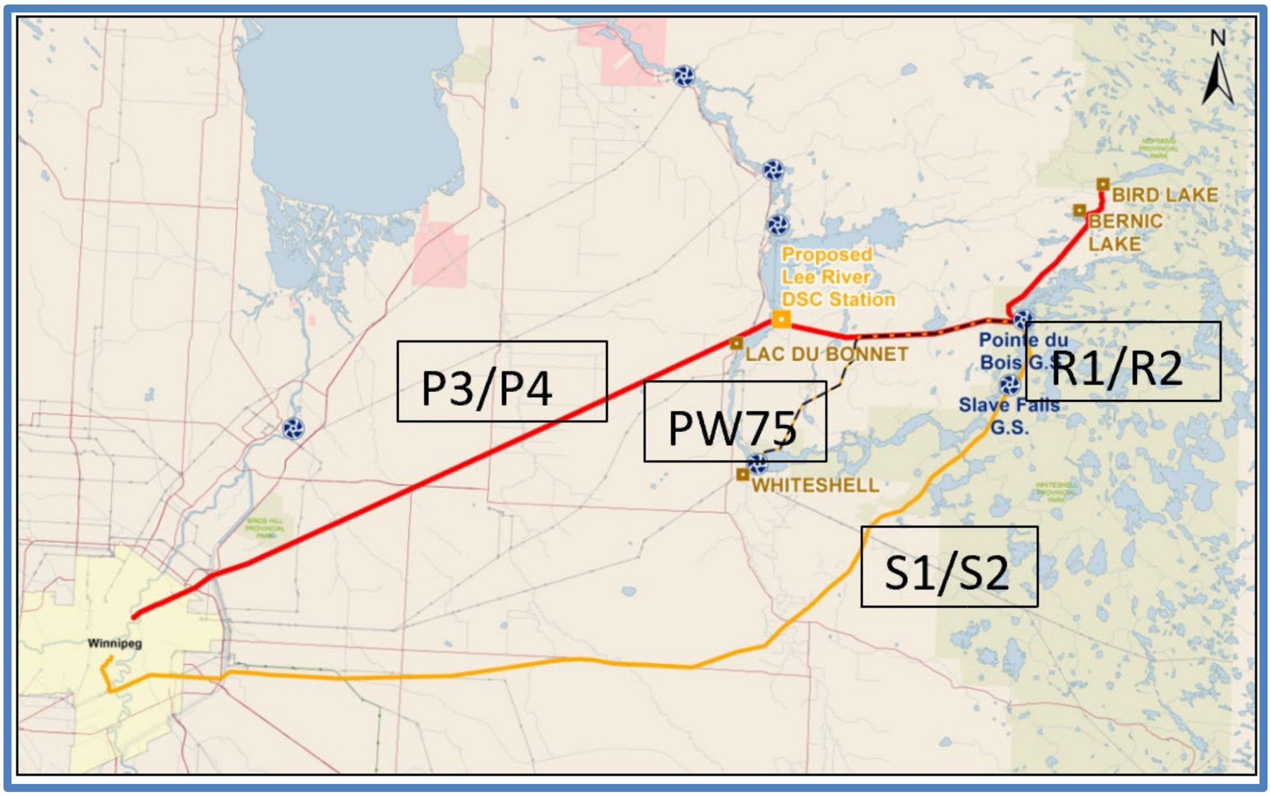
In-Service Date Year	“All Gas”	“Mostly Wind”
2042	SCGT – 215 MW	Wind – 200 MW
2043	-	Wind – 400 MW
2044	-	SCGT – 215 MW
2045	SCGT – 215 MW	-
2046	-	-
2047	SCGT – 215 MW	Wind – 400 MW
2048	-	SCGT – 215 MW
2049	-	
2050	SCGT – 215 MW	Wind – 100 MW
2051	-	SCGT – 215 MW
2052	SCGT – 215 MW	
2053	-	Wind – 100 MW
2054	-	Wind – 400 MW; SCGT – 215 MW
2055	SCGT – 215 MW	-
Total Nameplate Capacity (MW)	**1,290**	**2,460**
Total Accredited Capacity (MW)	**1,290**	**1,180**

4.3.4 TRANSMISSION FROM FACILITY BASELINE

Slave Falls hydroelectric generating station (“Slave Falls”) and PdB are connected to the transmission system using a series of transmission lines to Winnipeg (Figure 7). The transmission lines that connect PdB with Winnipeg (“P3/P4” lines) are nearing their end of life, which is assumed to be 2030 or earlier. The Baseline Scenario assumes that post-2030 the P3/P4 lines are out of service and no replacement transmission upgrades take place.[76]

The transmission lines between PdB and Slave Falls ("R1/R2" lines), as well as the transmission lines between Slave Falls and Winnipeg ("S1/S2" lines), are expected to continue operation into the 2050s, with continued maintenance and upgrades. Once the P3/P4 lines are out of service, the remaining S1/S2 lines will continue to provide sufficient transmission capacity for the PdB and Slave Falls generation produced in the Baseline Scenario. But, the S1/S2 lines won't provide sufficient transmission capacity for the PdB and Slave Falls generation produced under the Project Scenario; under the Project Scenario, PW75 (the new 115 kV transmission line from PdB to Whiteshell) would need to be constructed.

Figure 7: PdB and Slave Falls Generating Station Transmission System



[76] Note: While the P3/P4 lines could possibly be reconstructed, reconstruction is not needed for the PdB Project due to the assumption of PW75 line construction (Section 4.4).

4.4 PROJECT SCENARIO

For consistency, nearly all modelling assumptions remain constant in both the Baseline and Project Scenarios. The Project Scenario differs in three specific ways:

1. The year over year capacity of PdB changes, as per the 8-unit replacement schedule (Table 10).
2. The Project Scenario assumes that sufficient transmission upgrades are made to the system so that there is no significant constraint on the full operation of PdB with the 8-unit replacement. Assumed incremental transmission upgrades are:
   - PdB switchyard upgrades, including a new Bank 8 transformer.
   - Upgrades at Whiteshell.
   - The construction of PW75.[77]
3. The incorporation of the 8-units into the system delays the need for new energy and accredited capacity by less than one year. Depending on small adjustments to modelling parameters, OptGen selected new resources in both 2042 and 2043 for the Project Scenario. For conservativeness and consistency (Section 4.1.1.2), it was deemed appropriate for the generation expansion sequences in the Project Scenario to assume a 2042 first new unit ISD, matching the Need Year of the Baseline Scenario (Table 11).

4.5 GENERATION EFFECT EMISSION FACTORS

Analysis of generation effects is accomplished by multiplying generation and energy flow values, in GWh, by EFs in tonnes of CO_2e per GWh ("t/GWh"). EFs vary depending upon the location and timing of the net GHG impact.

4.5.1 MANITOBA GENERATOR EMISSION FACTORS

"*The ideal method to estimate operating margin (OM) emissions would be to identify precisely which power plants on a grid are backed down in response to the project activity's operation.*" [WRI, 2007][78] While based on several assumptions (Section 4.2), the GSPRO energy output data provides just that within MB. Natural gas combustion EFs for fossil-fuel generation are derived from MB specific natural gas composition and methods outlined in ECCC [2019b]:

[77] Note: Upgrades to the S1/S2 lines would be a plausible alternative to the construction of PW75 (and upgrades at Whiteshell). However, Manitoba Hydro analysis (Section 4.3.1) has deemed PW75 to be the option likely to be implemented. PW75 will also result in higher construction GHG emissions, making it the more conservative assumption, in addition to the most appropriate assumption.

[78] Electricity Project Guidelines – Chapter 10 (*Estimating the Operating Margin Emission Factor*), p.54

- CO_2 EF = 1,921.072 g of CO_2/m^3 of natural gas[79]
- CH_4 EF = 0.49 g of CH_4/m^3 of natural gas[80]
- N_2O EF = 0.049 g of N_2O /m^3 of natural gas[81]
- Aggregate CO_2e EF = 1,947.924 g of CO_2e /m^3 of natural gas

GSPRO output is disaggregated based on fossil-fuel generating unit (Table 12); each fossil-fuel unit has an assumed monthly average heat rate based on either operational history (Selkirk and Brandon) or technical specifications (new SCGT and new CCGT). As partway through this assessment it was announced that Selkirk station would be cease operations in 2021 (Section 4.2.4.2), the Brandon EFs will be applied to generation from both Brandon and Selkirk. This emulates Brandon operating more, in place of Selkirk, during the 2024-2029 period. Brandon (280 MW nameplate capacity) is larger than Selkirk (132 MW nameplate capacity) and is rarely operated at a high capacity factor, even in low-flow conditions. Also, the 2024-2029 period is relatively brief and well before the Need Year. Due to these reasons, this simplification is reasonable and has negligible impact on assessment results.

Table 12 CO_2e Combustion EFs for MB natural gas generating units

Natural Gas Unit	Average Heat Rate	Natural Gas Consumption Rate[82]	CO_2e EF
	GJ/MWh	m^3/MWh	t/GWh
Brandon	12.90	336.03	654.55
~~Selkirk~~	~~12.82~~	~~333.90~~	~~650.41~~
SCGT	10.48	273.06	531.91
CCGT	7.05	183.51	357.46

As a secondary effect, fuel production, processing, and transportation emissions related to generator fuel combustion are based on LCA work produced by the Pembina Institute: "*The comparison technology intensities are based on the results of a literature survey of published life cycle values*." [Switzer, 2012][83] This work indicated that, as a median, indirect natural gas use

[79] Note: The EF from Table A6.1-1 of ECCC [2020], is based on older data from McCann [2000]. This custom factor was derived by applying equation 2-8, for 1 m^3 of natural gas, from ECCC [2019b] requirements and using a representative sample of 2019 natural gas supplied to Brandon generating units. Note that since the consumption rate is derived from the very same assumed higher heating value (i.e., HHV) and composition of gas this is the most appropriate method.
[80] Table 2-4 from ECCC [2019b], "Electric Utilities" EF from SGA Energy (2000).
[81] Table 2-4 from ECCC [2019b], "Electric Utilities" EF from SGA Energy (2000).
[82] Note: Assumed gas higher heating value of 38.3945 MJ/m^3 based on the composition of natural gas supplied to MB in 2019.
[83] Keeyask LCA – Section 4.4 (*Comparison Technologies*), p.18.

emissions were equivalent to around 30% of the combustion emissions. There is a large range of estimates regarding the upstream emission rate of natural gas use but undergoing a life cycle study of natural gas delivered to MB throughout the Assessment Period is not within the scope of this assessment. To provide an idea of the potential upper level of this secondary effect a 30%[84] adder for upstream fossil-fuel emissions is assumed for all units (Table 13). While there is no coal generation in MB, the same study suggests a 5% adder would represent the same secondary effect for non-MB coal generation.[85]

Table 13 CO_2e Upstream fossil-fuel EFs for MB natural gas generating units

Natural Gas Unit	Indirect
	t/GWh
Brandon	196.37
~~Selkirk~~	~~195.12~~
SCGT	159.57
CCGT	107.24

4.5.2 MISO EMISSION FACTORS

While EFs for evaluating generation effects in MB are based on specific fossil-fuel generating units, this is not the case outside of MB as GSPRO only models MB generation. Therefore, grid-wide EFs will be used for the assessment of emissions outside of MB. As noted in Section 4.1.1.4, it is assumed that non-MB generation effects resulting from the "Δ Net Exports" between MB and MISO specifically occur in MISO and not in any secondary markets.

4.5.2.1 METHOD DESCRIPTION

Year-specific EFs for the MISO region were generated as follows:

1. The ratio of coal ("%C") to natural gas ("%NG"), where %C + %NG = 100%, was based on the average of the four forecasts used for the EPF. (Figure 9)
2. The assumed direct combustion EF for a MISO coal and natural gas plant was based on the 2016-2018 average of generation in MN and North Dakota ("ND"). (Table 14)
3. Year-specific direct combustion EFs were estimated by applying the following formula: EF = (%C*1,091 t/GWh) + (%NG *485 t/GWh). (Table 15)

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[84] Note: As described in Section 4.1.2.3 a 30% adder is equivalent to indirect effects being 22% of total life cycle emissions. Upstream emissions could be higher or lower than 30%, but 30% is in the upper range of industry estimates.

[85] Note: Coal generating stations are often "mine-mouth" with limited transportation emissions. Also, methane leaks during transportation are a relatively negligible issue for coal versus natural gas.

4. Year-specific direct combustion EFs resulting from the application of the above formula were modified downwards so that the 2019 EF was 806 t/GWh; this matches the Energy Star 2018 Marginal Average for "MROW". (Table 16)
5. Year-specific upstream fossil-fuel EFs were determined using steps 1 to 4 as well, but modifying step 3 to be: upstream fossil-fuel EF = (%C*1,091 t/GWh*0.05%) + (%NG *485 t/GWh*0.30%) as per the Pembina Institute's LCA work. (Section 4.5.1)

4.5.2.2 CHOICE OF METHOD

The PdB Project will increase the overall capacity and energy produced by Manitoba Hydro's system, which operates under two distinct circumstances (Section 4.1.1.1). Which specific plant in the MISO region is most likely to be "backing-down" depends on the state of the grid and its resources and is difficult to predict. Chapter 10 of the Project Protocol lays out multiple EF estimation methods but leaves the choice of method up to the assessor, to be based on application of the GHG reporting principles (Section 3.3). The method selected for this assessment incorporates elements of prescribed methods 1 (average load-following), 2 (average marginal), and 4 (marginal modeled), but does not incorporate all elements of each: Manitoba Hydro used modified modelled dispatch projections from EPF data to determine a variable annual average grid fossil-fuel EF. Following the principle of conservativeness this projected variable annual EF was adjusted downwards (Section 4.5.2.7). This method has the following key benefits:

1. **It uses readily available modelled data:** Procuring additional modelling work was not practicable nor was it necessary to fulfill the purpose of this assessment (Section 3.1). "*Generally, the farther out into the future one tries to project "what would have happened", the more uncertain this projection becomes.*" [WRI & WBCSD, 2005][86] While a detailed daily/hourly assessment of the export regions' grid, matched on a daily/hourly basis to the incremental shifts produced by the PdB Project, may increase accuracy over the initial couple years, in terms of the assumed "backed-down" unit, over the entire length of the study this added accuracy disappears and can even become misleading. It is not currently possible to capture these disaggregated incremental shifts with sufficient accuracy via GSPRO due, mainly, to the relatively small net energy produced by PdB (1.05% of Reference Scenario hydroelectric production).

   Customized EPF data is procured by Manitoba Hydro annually. Multiple external modelers forecast future pricing and generation levels based on their models of MISO-North regions ("MISO-N"). As with the incorporation of other elements of the EPF (Section

[86] Project Protocol – Chapter 2.11 (*Valid Time Length for the Baseline Scenario*), p.14

4.2.4.3) into Manitoba Hydro's analysis, a consensus average of modelling information from the four independent forecasts was applied.

2. **It excludes negligibly impacted resources:** While build margin effects can easily impact non-emitting resources, this is less likely when considering operating margin effects. It is reasonable to assume the vast majority of backed-down units, on an operating margin basis, will be fossil-fuel units. "*MWh from intermittent or non-firm power sources such as wind, hydro, or solar should be excluded from this [dispatch order] ranking, since these sources will have low capacity factors but will not be displaced at the margin.*" [WRI, 2007][87] Incorporating renewables into the EF would result in more conservative results but this would not be as accurate, relevant, or consistent.

   Occasionally, intermittent renewable generation, such as wind or solar photovoltaic, are curtailed due to over-supply or congestion issues. However, the PdB Project is increasing the capacity of MB's hydroelectric system which incorporates energy storage reservoirs, making the use of the capacity addition to the system very flexible, and it is unlikely that the PdB Project would increase curtailment of renewable resources within MB or within MISO.

3. **It covers the MISO-N region:** It is appropriate to evaluate EFs for the independent system operator within which Manitoba Hydro operates rather than using more general (e.g., U.S.) or targeted (e.g., MN-only) EFs.

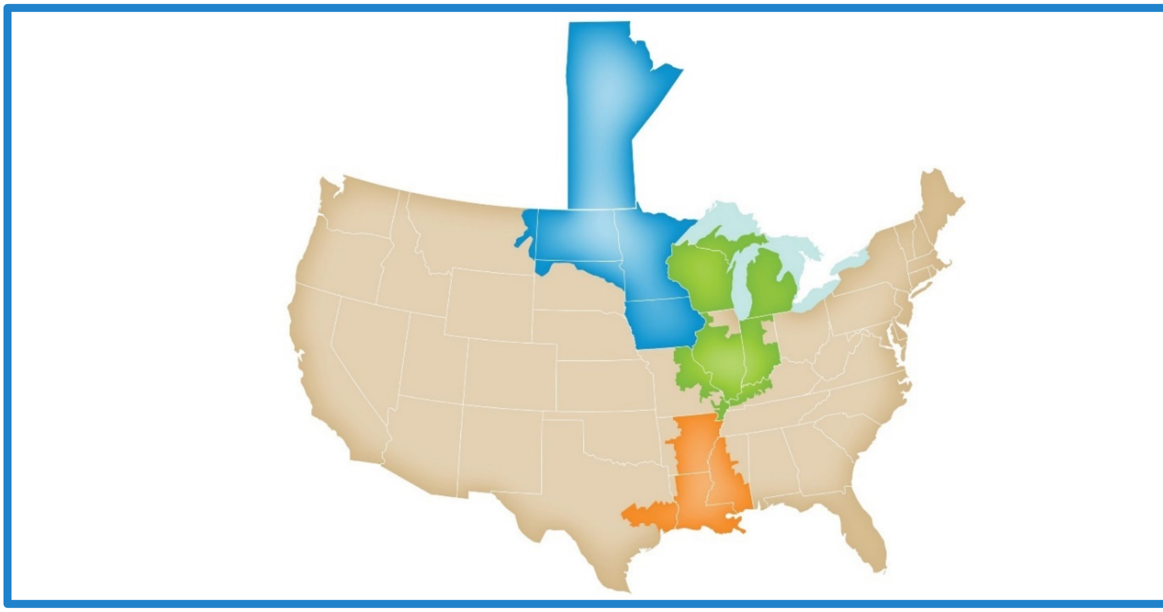
4. **The EFs are dynamic:** Many methods for the calculation of operating margins and build margins for GHG EFs use static baseline EFs that do not change over time which, for grids that become greener during the Assessment Period, may over-estimate the benefits of the project being assessed. Indeed, over the Assessment Period the U.S. grid will change significantly. While the future is uncertain, the selected methodology provides some insight into the impacts of future grid changes via the use of decreasing variable annual EFs.

4.5.2.3 DIRECT COMBUSTION EMISSION FACTORS

Border states, MN and ND, are two of Manitoba Hydro's primary trading areas and, of all the regions in MISO-N (Figure 8), their emission profiles are the most relevant in an assessment of the effects of the PdB Project.

[87] Electricity Project Guidelines – Chapter 10.4.2 (*Operating Margin Method #1: Average Load-Following Emissions*), p.59

Figure 8: MISO Map (MISO-N in Blue)[88]



EIA Data provides emissions information for primary fossil-fuel generation technologies. Table 14 shows the fossil-fuel technology breakdowns for MN and ND in 2018. The method used in this assessment focuses on the proportion of coal and gas, but petroleum and "other" fuels are shown as well. These fuels have a much less significant presence on the grid and generally are impacted much less by variations in cross-border trade. [89]

Table 14 EIA Data – 2018 Fossil-fuel Combustion Technology Emission Rates for MN and ND

	Minnesota			North Dakota		
	GWh	Emissions (kt of CO_2e)	t/GWh	GWh	Emissions (kt of CO_2e)	t/GWh
Coal	23,455	25,176	1,073	27,541	30,620	1,112
Gas	8,555	4,012	469	1,019	621	609
Petroleum	47	44	945	38	33	861
"Other"	406	573	1,411	52	8	154
All Fuel	32,463	29,805	918	28,650	31,282	1,092

[88] [MISO, 2020]

[89] Note: "Other" includes non-biogenic municipal solid waste, batteries, chemicals, hydrogen, pitch, purchased steam, sulfur, tire-derived fuels, waste heat and miscellaneous technologies. Petroleum generation is significantly more expensive to run than natural gas and coal.

The fossil-fuel generation profiles of both MN and ND remain dominated by coal, however natural gas has been increasing its proportion over time. Over the past 10+ years the average emission rate of MISO-N coal generators has been very consistent (Table 15). As more efficient gas has come online the average emission rate has dropped, but it has been consistent for the last few years as well. As a simplification, petroleum and “other” fossil-fuel generation, were not included in determination of the year-specific EFs for this assessment. Table 14 demonstrates how coal and natural gas dominate the fossil-fuel generation profiles of the region.

Table 15 EIA Data – Gas and Coal Emission Rates for MN and ND (Combined)

	ND and MN - Coal			ND and MN - Gas		
	GWh	kt of CO_2e	t/GWh	GWh	kt of CO_2e	t/GWh
2009	58,934	64,069	1,087	2,863	1,624	567
2010	56,545	61,188	1,082	4,357	2,293	526
2011	55,368	60,007	1,084	3,371	1,910	567
2012	50,937	55,308	1,086	7,110	3,545	499
2013	50,996	55,737	1,093	6,355	3,188	502
2014	55,351	60,265	1,089	4,104	2,189	533
2015	52,432	57,127	1,090	8,100	3,833	473
2016	49,787	54,089	1,086	9,999	4,841	484
2017	49,538	54,159	1,093	7,384	3,607	489
2018	50,996	55,796	1,094	9,575	4,633	484
2016-2018	**150,321**	**164,044**	**1,091**	**26,957**	**13,081**	**485**

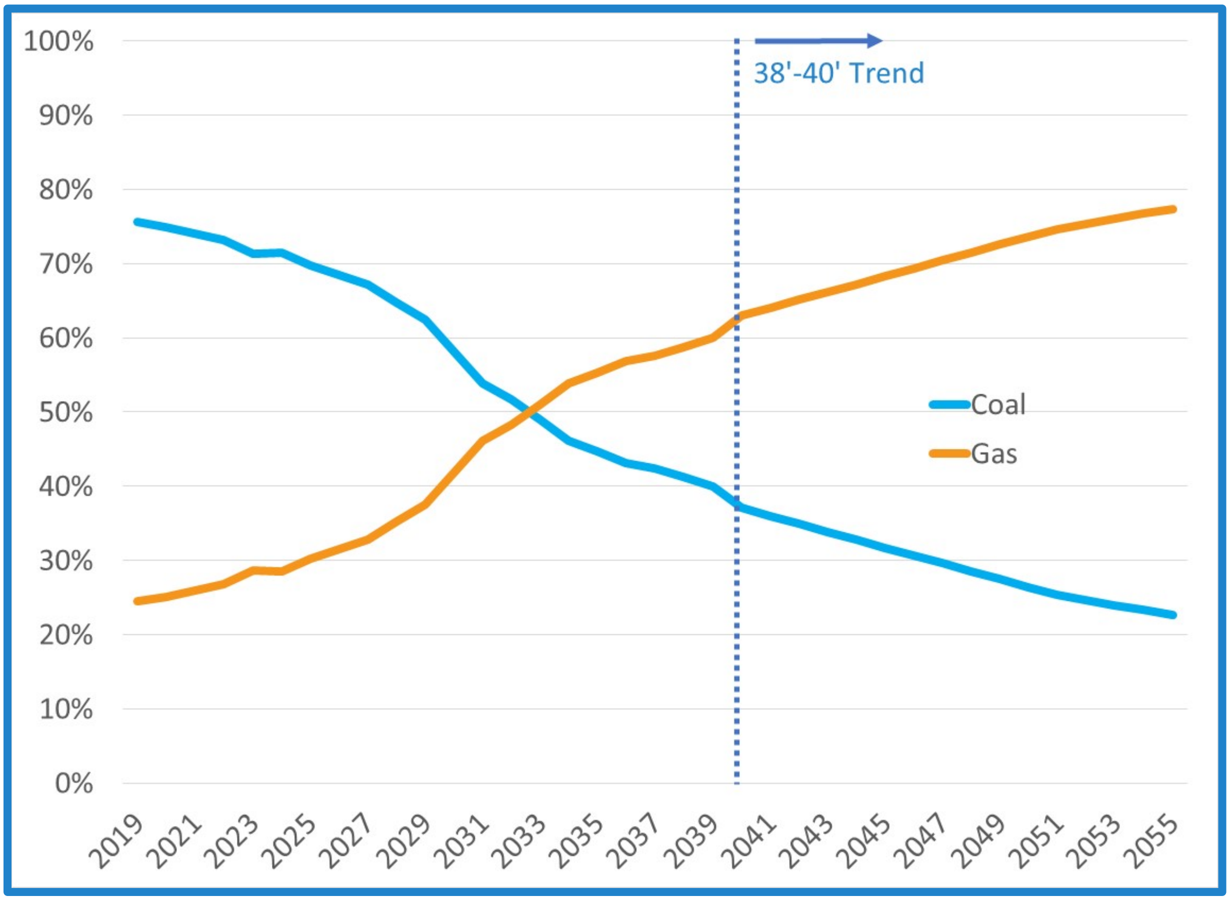
4.5.2.4 EPF FORECAST EMISSION FACTORS

The dispatch order outside MB determines what sources of electricity are on the margin which, in turn, determines the market price, and the corresponding emissions intensity (Section 4.5.2). In a locational marginal price electricity market such as MISO’s, the marginal unit is the resource which is either producing incremental exports (i.e., imports to MB) or is being displaced by incremental imports (i.e., exports from MB). Electricity price forecasts are important considerations in the creation of industry resource development plans, including choices related to new generation, decommissioning timelines, T&D development, and long-term contracts between entities.

The MISO EF forecast is based on data from Manitoba Hydro’s internal EPF which is an average of four forecasts (Section 4.2.4.3). For this assessment, we focus on the trend in coal to gas generation proportions (Figure 9). In MISO-N “*coal and gas can have similar economics, often* "*crossing over" in the economic ordering, but have very different emissions*." [Murphy et al., 2014] Slightly different system conditions can cause switching between coal and gas making it inappropriate to assume only gas units will be on the margin.

At the start of the Assessment Period (i.e., 2024) the ratio of coal to gas is approximately 4:1; at the end this relationship has flipped to 1:4. As EPF data only projects to 2040, the rate of change over the last 2 years of the forecast are assumed to continue until the end of the Assessment Period (i.e., 2055). This approach reduces the beneficial GHG effect of the PdB Project compared with an alternative assumption that the ratio stays constant throughout the remainder of the study and is therefore a more conservative approach.

Figure 9: Forecast (Consensus Average) of MISO-N % of total coal/gas generation



4.5.2.5 MISO MARGINAL AVERAGE

U.S. EPA [2020]'s consideration of "*Avoided Emissions from Green Power*" is very comparable to the generation effects resulting from the PdB Project and aligns with the "*Average Marginal Method*" described in the Electricity Project Guidelines. "*To compute the avoided emissions* *benefit, we use a different factor, which is called the "marginal" or "non-baseload" factor. This factor looks specifically at the generation facilities that are operated coincident with peak demands. These units are the first to shut off when demand is reduced, and therefore better estimate the emissions benefits of reductions in grid supplied electricity use*." [U.S. EPA, 2020] For the purposes of this study the MROW region EF from U.S. EPA [2020] is considered applicable to the MISO-N region (Figure 10).

Figure 10: MROW Region

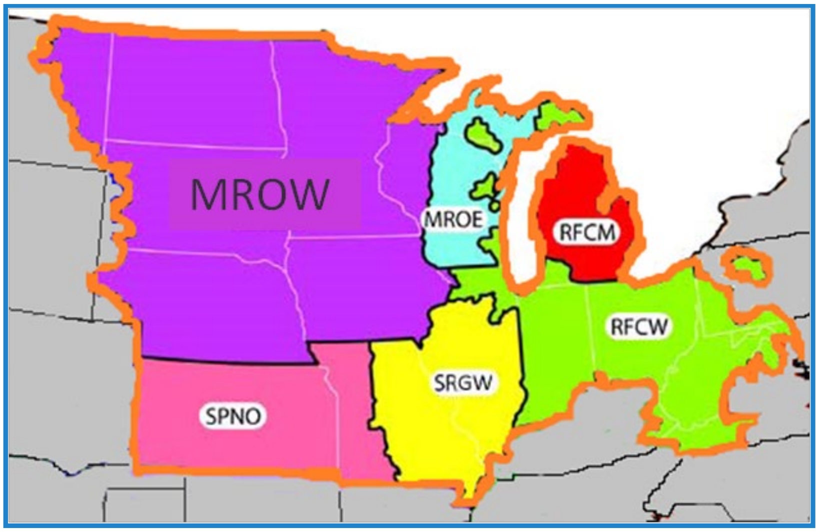


Table 16 compares marginal average EFs from U.S. EPA [2020] ("EPA EFs") with those derived from EPF data. EPA EFs incorporate all fossil-fuels, further minimizing the impact of the simplification made in Section 4.5.2.4.

Table 16 EIA – Non-Baseload Factors used for Avoided Emissions (t/GWh)

Region	EPA EF [90]	EPF 2019 Avg	EPF 2030 Avg	"NIR"[91] 2018 Avg
MROW[92]	806	943	838	N/A
SK	521	N/A	N/A	831
ON	394	N/A	N/A	401

[90] Figure 8 (p.14) and Figure 9 (p.15) from U.S. EPA [2020].

[91] Refer to Table 14 and Table 15.

[92] Note: MROW (Midwest Reliability Organization/West) is the "eGRID" [U.S. EPA, 2020] regional description of the "Upper Mid-West" and is comparable to MISO-N but includes some additional regions, including South Dakota and Nebraska.

4.5.2.6 APPLICABILITY OF THE MARGINAL AVERAGE

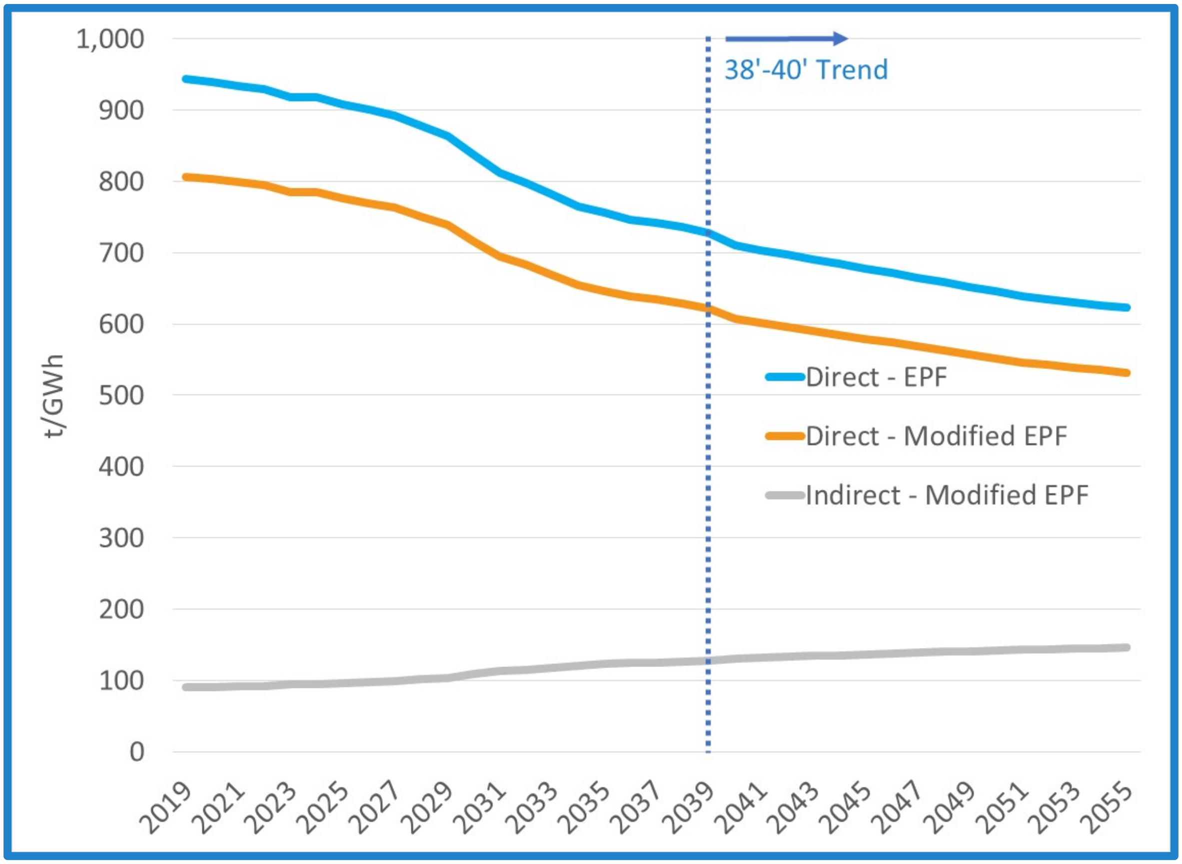
The use of marginal average EFs would assume that only non-baseload fossil-fuel units are displaced by incremental activity resulting from the PdB Project. While this is generally true, incremental cross-border trade is expected to impact baseload and mid-merit fossil-fuel plants, as well as peakers. For example, imports are often timed when market prices are low and baseload plants are on the margin. It is also appropriate to be cautious when making blanket assumptions regarding the difference between Off-Peak Period and On-Peak Period coal/gas mixes in marginal averages. Expectations are that "*shifting energy between peak and off-peak period means trading one mix of coal and gas energy for a somewhat different mix, for only a modest overall effect.*" [Murphy et al., 2014]

There is substantial complexity and uncertainty in determining what the long-term average marginal EFs are, in relation to incremental PdB Project activity, as marginal emission rates change continually: Minute-to-minute, On-Peak Period to Off-Peak Period, day-to-day, and season-to-season. The actual marginal EF during cross-border trade events depends heavily on what Manitoba Hydro's current watershed flow conditions are and how the electricity system is being used because these variables will affect the quantity and timing of cross-border energy transactions (Section 4.1.1.1). The average marginal EF in MISO-N weighted based on the timing of cross-border trade with MB would therefore not match the average annual marginal EF of MISO-N (i.e., the Table 16 MROW value).

The complexity of determining a weighted marginal average within MISO, based on Manitoba Hydro's exports/import activity, is greatly increased by Manitoba Hydro's system's hydrologic variability. Were it to be calculated, instead of being aggregated, then the output from each of the 107 flow conditions modelled in GSPRO would need to be assigned 107 distinct marginal average EFs and assessed at very fine levels of granularity. This would be both unnecessarily complex and outside the accuracy capabilities of GSPRO.

4.5.2.7 MODIFICATION OF THE EPF DATA

Figure 11: Forecast of Combustion EFs for MISO-N



Notwithstanding the limitations (Section 4.5.2.7) of using the Table 16 MROW value, it is used in this assessment as a starting point for the downward trend in the MISO EF. Due to data availability and practical limitations, the unmodified trended EFs are not strictly marginal averages. The generation and emissions from baseload, mid-merit, and peaker coal and gas fossil plants were all averaged to generate the export region's projected average combustion EFs. This is an assessment limitation, as ideally these EFs would reflect an average of what fossil-fuel power plants were actually on the margin during specific cross-border trade activities. It is precisely to mitigate this limitation that the EPF data based EF forecast ("Direct - EPF" in Figure 11) is adjusted downward approximately 16%, so that the 2019 EF becomes 806[93] t/GWh ("Direct – Modified

[93] Note: For simple analysis Manitoba Hydro currently employs a 750 t/GWh EF to calculate the implications of its significant net exports and corresponding GHG displacement outside of MB. As demonstrated by the 806 t/GWh factor, this EF is conservative (when evaluating emission reductions or "benefits"). However, as demonstrated by Figure 11 it will likely not be conservative if applied over the entire Assessment Period.

EPF" in Figure 11) and matches the Table 16 MROW EF. The principle of conservativeness was applied in choosing the lower starting point for the forecast.

Figure 11 also displays the projected indirect EFs due to the production, processing, and transportation of the fuel consumed in the impacted generating stations. This factor increases over time as the indirect implications of natural gas combustion are assumed to be significantly higher than those of coal combustion (4.5.1). For conservativeness, this EF ("Indirect – Modified EPF" in Figure 11) was modified downward approximately 16% as well.

4.5.2.8 MISO-N TRENDS

As indicated in Figure 9, the ratio of coal to gas is declining in MISO-N. Coal retirements are expected to continue and are likely to accelerate. Despite attempts to protect coal units, retirements during the Trump administration were higher than during the last 4 years of the Obama administration.[94] Beyond government policies and regulations, coal units are increasingly retiring as the economics of both gas plants and ever increasing renewables chisel away at coal plant profitability causing "economic" retirements.[95]

Renewable-heavy generation expansion sequences are being pushed by economics as state policies, such as renewable portfolio standards, have often been reached and exceeded. Customer choice is also pushing utilities to decrease carbon intensity of generation.[96] While renewables will continue to alter energy markets in the long term, the current record low natural gas prices are driving coal increasingly to the margins and out of market. The inclusion of gas generation in future generation expansion sequences will depend on economics around renewable alternatives (including battery storage) and on local and national climate regulations.

4.5.2.9 ADDITIONALITY OF REDUCTIONS IN MISO (MROW)

The Climate Lens does not discuss the concept of additionality. However, it is discussed in the Project Protocol: "*The concept of additionality is often raised as a vital consideration for quantifying project-based GHG reductions. Additionality is a criterion that says GHG reductions should only be recognized for project activities that would not have "happened anyway." While there is general agreement that additionality is important, its meaning and application remain open to interpretation. The Project Protocol does not require a demonstration of additionality per*

[94] (E.g., Storrow, 2020]
[95] [E.g., St. John, 2020]
[96] [E.g., Farrell, 2018]

se. Instead, additionality is discussed conceptually in Chapter 2 and in terms of its policy dimensions in Chapter 3. Additionality is incorporated as an implicit part of the procedures used to estimate baseline emissions (Chapters 8 and 9), where its interpretation and stringency are subject to user discretion." [WRI & WBCSD, 2005][97]

This assessment applies the performance standard approach to additionality outside of MB. "*Under this approach, the presumption is that any project activity will produce additional GHG reductions if it has a lower GHG emission rate than the performance standard."* [WRI & WBCSD, 2005][98] This is an accurate presumption as PdB's direct emission rate is zero. A reasonable choice of performance standard outside of MB, in this case within MISO, is therefore paramount in the estimation of emission reductions. "*The challenge is to set the performance standard at a sufficiently stringent level to ensure that, on balance, only additional GHG reductions are quantified."* [WRI & WBCSD, 2005][99] The applications of the following conservative approaches, noted within Section 4.5.2, makes it more probable that the performance standard is sufficiently stringent:

1. The lower of two proposed 2019 EFs was chosen: The EPA EF versus the unadjusted EPF derived EF (Table 16).
2. The direct EFs reduce yearly to avoid over-estimation of future reductions (Figure 11).

Climate change policy that puts a legislated limit on emissions in a region can make it arguable as to whether any one specific GHG project produces additional reductions, unless it can be shown reductions go beyond those legislated limits. There are currently no direct caps on electricity sector emissions in MISO, however future limits, such as those proposed under the cancelled Clean Power Plan, could be enacted. MISO states do however have Renewable Portfolio Standards (MN has a Renewable Portfolio Standard; ND has a voluntary renewable energy objective) which obligate or encourage utility companies to meet mandatory renewable energy targets. Manitoba Hydro produced Renewable Energy Credits, including PdB Renewable Energy Credits, can be used for Renewable Portfolio Standard compliance by companies, however qualifying renewable technologies differ by state and program type.

It is beyond the scope of this assessment to model the additionality of MISO reductions under various energy policy futures. Renewable Portfolio Standard targets in the U.S. have often been voluntarily/naturally exceeded (Section 4.5.2.8), in which case additional supply of renewable energy is truly additional. Also, GHG caps/targets are adjusted over time as a response to changes

[97] Project Protocol, Chapter 1.5 (*Project Protocol Treatment of Additionality), p.8*
[98] Project Protocol, Chapter 2.14 (*Additionality), p.16*
[99] Project Protocol, Chapter 2.14 (*Additionality), p.16*

in emissions levels, which means that over the long term most reduction measures (e.g., new renewable generation projects) are additional (partially or in full) as, in aggregate, they allow for future caps/targets to be more stringent.

This assessment assumes that net emission reductions in MISO are fully additional, but it is acknowledged that future policy measures enacted in the U.S. could potentially disprove that assumption. This approach will help "*provide meaningful insight*" [Infrastructure Canada, 2019][100] regarding the potential benefits of the PdB Project.

4.5.3 SASKATCHEWAN GRID EMISSION FACTORS

As noted in Section 4.1.1.4, it is assumed that non-MB generation effects resulting from the change in net exports between MB and SK specifically occurs in SK and not in any secondary markets. As with the U.S. factor, an "average marginal" EF is used to assess the generation effects within SK as a result of the PdB Project. Manitoba Hydro does not model the export price in SK and ON as they do with MISO (Section 4.2.4.3), and therefore similar modelled generation projections are not available.

4.5.3.1 PROVINCIAL GRID TRENDS

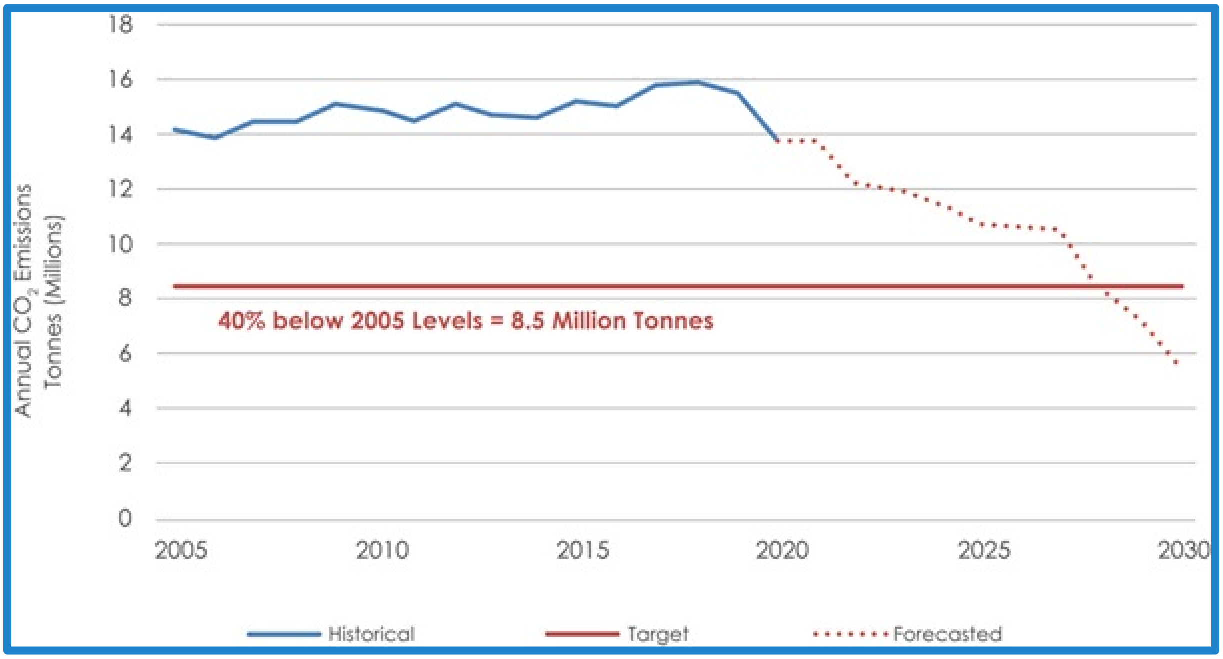
SaskPower (SK's equivalent of Manitoba Hydro) has a goal of reducing emissions by 40% by 2030 (Figure 12). This aligns with federal regulations limiting the use of coal generation which were committed to by SK in an equivalency agreement[101] with the Canadian government. Non-carbon capture and storage coal generation after 2030 is assumed to be zero as per the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations.[102] SaskPower's current fossil generation mix (on an energy basis) is approximately half gas and half coal. The resulting combustion intensity is around 800 t/GWh (Table 17).

[100] Climate Lens, Section 1.2 (*Why Implement the Climate Lens?)*
[101] [ECCC, 2019a]
[102] [Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations, 2012]

Table 17 Grid Combustion EFs for SK (Combustion Generation Only)[103]

	SK		
	GWh	Emissions (kt of CO_2e)	t/GWh
2014	14,760	15,200	1,030
2015	19,080	16,100	844
2016	20,270	16,000	789
2017	20,650	16,500	799
2018	19,370	16,100	831

Figure 12: SaskPower Emission Trend[104]



4.5.3.2 SASKATCHEWAN MARGINAL AVERAGE

U.S. Environmental Protection Agency ("EPA") analysis [U.S. EPA, 2020] suggests that SK's current average marginal EF is around 521 t/GWh (Table 16), quite a bit less than its combustion average of 831 t/GWh in 2018. This marginal EF is only about 10% higher than SK's recent natural gas emission rate of 471 t/GWh (Table 18).

Following the principle of conservativeness, this assessment will incorporate the EPA EF of 521 t/GWh (plus 156 t/GWh for indirect effects using the 30% assumption noted in Section 4.5.1)

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103 Table A13–9 (*Electricity Generation and GHG Emission Details for Saskatchewan*) from ECCC [2020].

104 [SaskPower, 2020]

from the start of the assessment through 2029. From 2030 to the end of the assessment it will be assumed that the average marginal EF in SK will match that of ON (Section 4.5.4.1), which currently has no coal generation.[105]

Table 18 Combustion Technology EFs for SK[106]

	Coal			Gas		
	GWh	kt of CO_2e	t/GWh	GWh	kt of CO_2e	t/GWh
2014	10,220	12,600	1,233	4,530	2,580	570
2015	12,090	12,600	1,042	6,990	3,520	504
2016	12,040	12,200	1,013	8,220	3,780	460
2017	11,980	12,500	1,043	8,660	4,030	465
2018	10,350	11,700	1,130	9,020	4,400	488
2016-2018	**11,457**	**12,133**	**1,059**	**8,633**	**4,070**	**471**

4.5.3.3 ADDITIONALITY OF EMISSION REDUCTIONS IN SASKATCHEWAN

As with the MISO region (Section 4.5.2.9), it is beyond the scope of this assessment to model future SK electricity sector emissions. Emissions from electricity generation in SK until 2030 are controlled by a federal equivalency agreement (4.5.3.1). *"As part of this Agreement, it is recognized that the MRGG regulations include the following mandatory greenhouse gas emissions limits for the electricity sector in Saskatchewan for the years 2018 to 2029:*

a. for the calendar years 2018 to 2019, not greater than 33.5 Mt of carbon dioxide equivalent, and
b. for the calendar years 2020 to 2024, not greater than 77 Mt (or 82 Mt if a carbon capture and storage system is installed at Boundary Dam units 4 & 5) of carbon dioxide equivalent, and
c. for the calendar years 2025 to 2029, not greater than 64.5 Mt of carbon dioxide equivalent." [ECCC, 2019a]

If, during the Assessment Period up to 2030 (i.e., 2024-2029), the electricity sector emissions in SK are at those limits, then it could be argued any emission reductions in SK as the result of the PdB Project are not additional as they would otherwise have been obtained by alternative methods. However, the SK government voluntarily agreed to the equivalency agreement under the expectation they would surpass these limits and SaskPower expects to surpass its long term

[105] Note: net energy flows to and from both SK and ON are relatively small and depend on system representation. From a GSPRO perspective it is beneficial to apply the same EF to each region and consider the GHG effects in both in aggregate.
[106] Table A13–9 (*Electricity Generation and GHG Emission Details for Saskatchewan*) from ECCC [2020].

reduction goal (Figure 12). As a purpose of the Climate Lens is to "*provide meaningful insight*" [Infrastructure Canada, 2019][107], and an assumption of "no additional impact" (i.e., a reduction EF of 0 t/GWh) would not support this purpose, the reasonable assumption will be made that emissions in SK are below mandatory limits so that contributions from PdB Project GHG effects in SK are in fact beneficial and "additional".

4.5.4 ONTARIO GRID EMISSION FACTORS

As noted in Section 4.1.1.4, it is assumed that non-MB generation effects resulting from the change in net exports between MB and ON specifically occurs in ON and not in any secondary markets. This is a more limiting simplification for ON as the IESO actively participates in inter-regional electricity trade, whereas SK is comparatively much more 'islanded'. As ON's combustion EF is lower than most of the region (i.e., MROW's EF), this simplification results in conservative results.

4.5.4.1 ONTARIO MARGINAL AVERAGE

ON hasn't had coal generation since 2014 due to provincial legislation[108]. As a result, natural gas is the dominant combustion source on the grid. The intensity of its average gas unit has been fairly consistent, around 422 t/GWh from 2016-2018. This is approximately 7% higher than the EPA EF of 394 t/GWh for marginal average (Table 16).

Table 19 Combustion Technology EFs for ON[109]

	Natural Gas			Other Fuels[110]		
	GWh	kt of CO_2e	t/GWh	GWh	kt of CO_2e	t/GWh
2014	14,700	6,810	463	780	120	154
2015	15,300	6,170	403	460	80	174
2016	12,700	5,420	427	900	120	133
2017	5,900	2,420	410	870	140	161
2018	10,200	4,320	424	850	130	153
2016-2018	**9,600**	**4,053**	**422**	**873**	**130**	**149**

107 Climate Lens, Section 1.2 (*Why Implement the Climate Lens?).*

108 [Ending Coal for Cleaner Air Act, 2015]

109 Table A13–7 (*Electricity Generation and GHG Emission Details for Ontario*) from ECCC [2020].

110 Note: Includes emissions from the combustion of refined petroleum products (light fuel oil, heavy fuel oil, and diesel), petroleum coke, still gas and other fuels not easily categorized.

If a natural gas unit is the assumed marginal unit, then the resulting EF cannot be much lower than 394 t/GWh. For example, the assumption for a MB CCGT is a rate of 357 t/GWh (Table 12) and it is unrealistic to assume that the only marginal gas units are CCGTs, and not SCGTs. A more probable future scenario, that results in a lower EF than 394 t/GWh, is one where biomass generators become significant contributors to the average marginal emission rate. This assessment will incorporate a flat 394 t/GWh EF for ON generation effects (plus 118 t/GWh for indirect effects) throughout but acknowledges the limitation of excluding the effects of substantial biomass generation on marginal emissions.

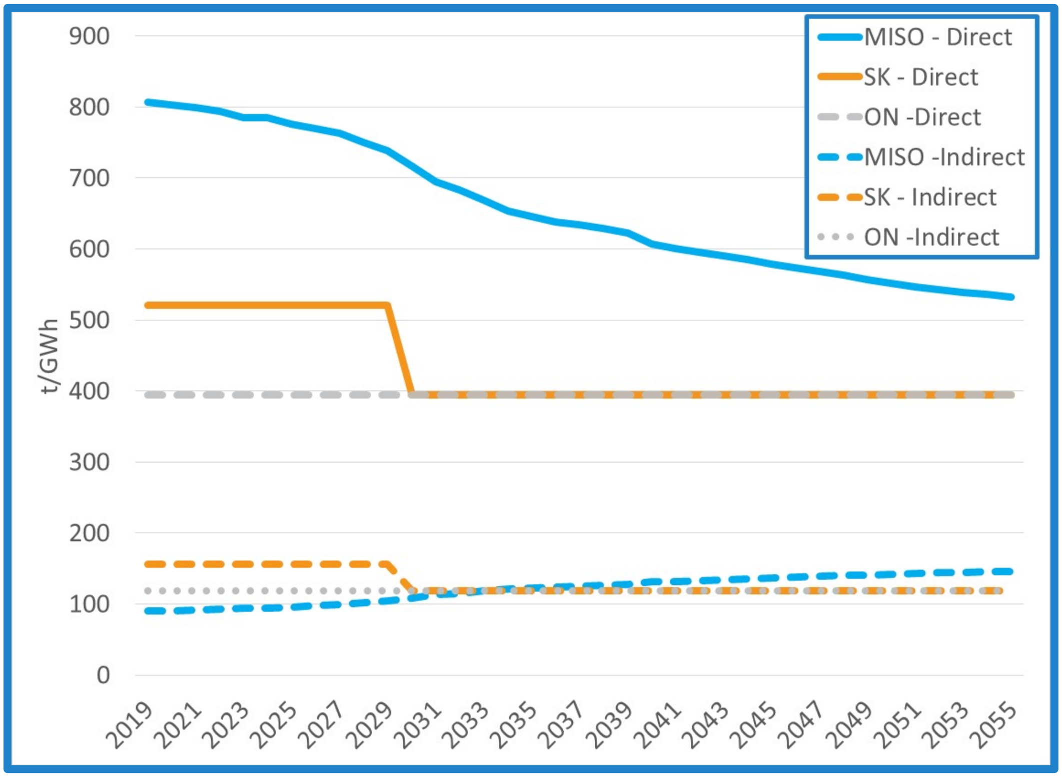
4.5.4.2 ADDITIONALITY OF REDUCTIONS IN ON

Effective July 3, 2018, the ON government cancelled their cap and trade regulation. There is currently no legislated cap on emissions provincially or federally. Therefore, as with MISO (Section 4.5.2.9) and SK (Section 4.5.3.3), reductions in ON as a result of the PdB Project will be presented as beneficial and additional.

4.5.5 COMPARISON OF NON-MB EMISSION FACTORS

Figure 13 contrasts the EFs used to assess the generation effects in non-MB regions. As a result of coal generation impacts, the MISO direct EF is significantly higher at the start of the Assessment Period (i.e., 2024) but trends towards the SK and ON EF values by the end of the Assessment Period. Progressive GHG regulations have lowered the baseline emissions within Canadian jurisdictions.

Figure 13: Average Marginal EFs (non-MB Effects)[111]



The upstream fossil-fuel EFs converge near the end of the Assessment Period (i.e., 2055); for this assessment it is assumed that the upstream implications of natural gas combustion, on a percentage basis (30% adder), will be comparable in the U.S. and Canada, however Canada's more progressive methane regulations [112] make it likely that natural gas upstream effects will be less, per GWh, in Canada than in the U.S. As noted in Section 4.1.2.4 these EFs are meant to provide insight into the potential upper range of generation effects. Comprehensive analysis of upstream effects, and potential differences between regions, was outside the scope of this assessment.

4.6 CONSTRUCTION RELATED EMISSIONS

Excluding the eight new units at PdB, the other new MB generating units built during the Assessment Period in both the Baseline and Project Scenarios are assumed to be identical (Section 4.3.3). Determining any difference in resulting post-2041 system-wide construction emissions is outside the scope of this assessment; assessment of construction emissions will

[111] Note: With the Assessment Period starting in 2024, the 2019-2023 period is shown only as a comparative reference.

[112] [Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector), 2018]

focus on the PdB Project itself. On-site fossil-fuel combustion emissions at the PdB Powerhouse will be minimal due to the following:

- These are replacement units which do not require construction of a new powerhouse.
- The new units will be manufactured off-site.
- On-site construction energy will be primarily provided by electricity sourced from non-emitting hydropower.
- Upgrades to the powerhouse will be required in both the Baseline and Project Scenarios. Only a portion of these future upgrades is additional.

Construction emissions will result from needed additions and upgrades to Manitoba Hydro's transmission infrastructure (Section 4.4) in addition to the life extension upgrades at PdB. Construction emissions related to transmission infrastructure are expected to be far more substantial than emissions on-site at PdB itself, but still minimal relative to the primary effects of the PdB Project.

Combined on-site construction emissions (at PdB, Whiteshell, and PW75) will be small compared to embedded supply-chain emissions. While the need for an estimate of supply-chain emissions is explicitly excluded from Climate Lens' mandatory requirements, supply-chain emissions have been estimated at a high-level to provide a useful point of comparison with direct on-site construction emissions at PdB, Whiteshell, and PW75.

The estimate of construction emissions incorporated into this assessment does not have a high-level of accuracy. As construction emissions are minimal for the PdB Project this was deemed an appropriate approach; it was deemed reasonable to use readily available construction information and LCA EFs and not undertake any comprehensive additional analyses. However, where detailed construction information was readily available it has been incorporated.

Assumptions related to the needed additions and upgrades to Manitoba Hydro's transmission infrastructure are based primarily on an older project scope presented in the PdB Transmission Project EAR [Manitoba Hydro, 2014a]. Design details for the construction of PW75 and upgrades to Whiteshell and the PdB switchyard are expected to be similar to this older project scope, but the final design and PW75 route could change from what was assumed herein. "*The final transmission line design will vary based on the final approved route, more detailed investigation of site conditions, contract requirements, and evolving standards and regulations.*" [Manitoba

Hydro, 2014a][113] Construction assumptions incorporated into this assessment are intended for emissions estimation purposes only.

4.6.1 CONSTRUCTION ACTIVITIES

For this assessment the PdB Project has been broken down into seven major construction activities:

1. Removal of existing units (excluded)
2. Manufacture of new units (supply-chain)
3. Manufacture of new station equipment (supply-chain)
4. Manufacture of PW75 components (supply-chain)
5. Transportation of construction materials (supply-chain)
6. Upgrade stations and construct PW75
7. Installation of new units

1. Removal of Existing Units (excluded)

Units 3, 5, 7, and 11 have already been dismantled and the material taken away for scrap. The PdB Project assumes that Units 2, 4, 8, and 9 will be similarly removed. Emissions from this process would be relatively minimal and this construction activity would also be required at some point whether or not the PdB Project proceeds (i.e., it would occur in the Baseline Scenario as well). Thus, this activity has been excluded from the construction emissions estimate. This is consistent with the Climate Lens' direction to not seek an estimate of decommissioning emissions.

2. Manufacture of New Units (supply-chain)

The new units may be manufactured in Canada or internationally. Possible product sources range from nearby in the U.S.[114] to Asia (e.g., India or China), South America (e.g., Brazil), or Europe (e.g., the Czech Republic). Each unit has an estimated total weight of 200 tonnes. Each unit has a horizontal axis, approximately 60 feet long with a maximum diameter of about 20 feet. While the units will not be entirely made of steel, for emission estimation purposes they are assumed to be entirely made of steel. For this assessment, India was selected as the presumed source location because application of that assumption results in higher emissions; but, the actual source location of the units is unknown at this time.

[113] PdB Transmission Project EAR – Chapter 2.2.1 (*Project Description – Project Components - Pointe du Bois to Whiteshell Stations 115 kV Transmission Line (PW75)*), p.1
[114] Note: Unit mass estimates are based on a proposal from a manufacture in the U.S.

The units will be made primarily of steel plates, some steel forgings, with relatively small amounts of copper and some stainless-steel castings. The manufacture of the units will require multiple processes including, but not limited to: steel making and rolling, electric welding, machining, grit blast cleaning, painting, forging, casting, punching, and plasma arc or water jet cutting. As an approximation of the entire process LCA, EFs for both the production of galvanized steel sheets and the forging of steel bars were applied to the entire weight of the units (Table 20).

3. Manufacture of Station Equipment (supply-chain)

Material estimates for required station equipment (Table 23) are based on the older project scope presented in the PdB Transmission Project EAR [Manitoba Hydro, 2014a][115] and recent equipment specifications. Approximately 75% of the overall weight of material is due to the new Bank 8 power transformer, which is assumed to be approximately 90 tonnes (filled with oil)[116]. The sourcing options for the Bank 8 transformer, and other station equipment, are likely Canada, the U.S., or Germany; but as the transformer could come from any number of locations around the world, for consistency and conservativeness, India will be the presumed source location. As with the new generating units, multiple manufacturing processes will be required. Uniform material specific EFs will be applied separately to the weight of copper (wire EF), aluminum (wire EF), steel (bars EF), and insulating oil [Table 20]. EFs for other materials (e.g., ceramics) will be based on the overall average of these four main materials. This same approach for estimating supply-chain emissions was applied to the "Manufacture of PW75 Components".

"*The existing grounding system which is currently used for this station will be used for grounding the new equipment additions. The ground grid will be adjusted to ensure safety criteria are met with the new fault levels while ensuring a bond to all the new equipment. The ground grid will be expanded to accommodate new equipment additions to the station."* [Manitoba Hydro, 2014a][117] No estimate of additional copper for grounding has been incorporated into this assessment. Expected quantities would be small, on a mass basis, compared with the rest of the station upgrades, and negligible compared with the overall weight of manufactured material [Table 20].

It is assumed some new concrete foundations will be required to support the new transmission equipment being installed at the PdB and Whiteshell. A high-level estimate of weight was based on ratios used for PW75 construction, which is likely very conservative.

[115] PdB Transmission Project EAR – Chapter 2.2.2 (*Project Description – Project Components - Station Components*), pp.10-12
[116] Note: Transformer mass breakdown is: 32 tonnes steel; 27 tonnes copper; 26 tonnes oil; and, 5 tonnes other material.
[117] PdB Transmission Project EAR – Chapter 2.2.2 (*Project Description – Project Components - Station Components*), p.12

4. Manufacture of PW75 Components (supply-chain)

Material estimates for PW75 components (Table 23) are based on the older project scope presented in the PdB Transmission Project EAR and general transmission design guidelines. Key assumed design elements are as follows:

1. PW75 will be 46.5km long. [Manitoba Hydro, 2014a][118]
2. "*Line PW75 is designed for three 795 MCM 26/7 ACSR "Drake" type conductors, 28 millimetres (mm) in diameter, to be carried by the structures.*"[Manitoba Hydro, 2014a][119] Each conductor is assumed to be 5% longer than the length of the line to account for jumpers, wastage, sag, and maintenance spares.
3. The PdB Transmission Project EAR indicated that PW75 will include "*Two ground wires will be strung at the tops of the structures…typically galvanized steel stranded conductors approximately 7 mm in diameter."* [Manitoba Hydro, 2014a][120] However, 9 mm has been standard for recent transmission projects and is assumed for this assessment.
4. The average tower span will be 450 m as "*The spans between the structures will be approximately 420 to 480 m."* [Manitoba Hydro, 2014a][121]
    a. "*Heavy angle and dead-end structures will be required at specific locations to accommodate line redirection and to terminate the transmission line into the stations."* [Manitoba Hydro, 2014a][122] Based on the number of directional changes in the Final Preferred Route, 13 dead-end towers (including 2 terminal towers) will be self-supporting lattice structures. While they may not all be "F Structures", the strongest and heaviest dead-end structures, for conservativeness their weights were all assumed to be 13.6 tonnes. This weight was based on recent 115 kV projects.
    b. The remaining 91 towers will be typical suspension towers, either guyed lattice or self-supporting. As the final design is unknown, all towers were assumed to weigh 5.9 tonnes, the weight of the heavier typical self-supporting suspension towers in recent 115 kV projects (assumed weight of the guyed towers is 4.5 tonnes).
5. "*Mat foundations are typically 3 m x 3 m and 3 m deep. Where soil conditions permit, pile foundations are augured cast-in-place piles, generally about 0.9 m in diameter extending*

[118] PdB Transmission Project EAR – Chapter 2.1 (*Project Description – Project Overview*), p.1

[119] PdB Transmission Project EAR – Chapter 2.2.1.2 (*Project Description – Project Components - Pointe du Bois to Whiteshell Stations 115 kV Transmission Line (PW75) - Conductors*), p.4

[120] PdB Transmission Project EAR – Chapter 2.2.1.4 (*Project Description – Project Components - Pointe du Bois to Whiteshell Stations 115 kV Transmission Line (PW75) – Ground Wires*), p.4

[121] PdB Transmission Project EAR – Chapter 2.2.1.1 (*Project Description – Project Components - Pointe du Bois to Whiteshell Stations 115 kV Transmission Line (PW75) - Structures*), p.2

[122] PdB Transmission Project EAR – Chapter 2.2.1.1 (*Project Description – Project Components - Pointe du Bois to Whiteshell Stations 115 kV Transmission Line (PW75) - Structures*), p.2

about 10 m deep. Heavy angle or dead-end structures can also require mat or pile foundations, with mat foundations being about 4 m x 4 m mats constructed 3 m deep. Pile foundations for heavy or dead-end structures consist of four 1.2 m diameter concrete piles extending about 12 m deep. Dimensions are subject to detailed design and will vary according to specific ground conditions." [Manitoba Hydro, 2014a][123]

a. As mat foundations are heavier, it was assumed all dead-end towers would require 4 mat foundations (461 tonnes[124] per tower), one for each tower leg. For conservativeness, it was assumed the location of these towers may not be adjustable to ensure piled foundations could be used.
b. The weight of one 3 m x 3 m mat foundation (65 tonnes) is slight larger than four 0.9 m in diameter pile foundations (61 tonnes). It was assumed that the final design would only select self-supporting suspension towers (requiring four foundations) on terrain where soil conditions permitted pile foundations, otherwise a guyed lattice tower with one mat foundation would be chosen. For conservativeness, the higher 65 tonne value was the assumed for all suspension towers.

6. Based on general transmission design guidelines it was assumed each dead-end tower would require 54 insulators and each suspension tower would require 21 insulators. Based on recent Manitoba Hydro projects, each dead-end insulator was assumed to be 7 kg and each suspension insulator is assumed to be 4 kg.
7. For consistency and conservativeness, India will be the presumed source location for all above ground transmission components.
8. The original source for cement is assumed to be Edmonton, based on recent projects and Canadian availability. It is assumed that concrete will be mixed near or on-site and aggregate will be obtained from near or on-site: "*Aggregate material will be required for tower foundation construction. This material will generally be obtained from within the ROW and existing licensed borrow areas. In the event that additional borrow area locations are developed, it is expected that these areas will be very small in size and situated close to existing access."* [Manitoba Hydro, 2014b][125]

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[123] PdB Transmission Project EAR – Chapter 2.2.3.1 (*Project Description – Project Components – Project Construction – PW75 115 kV Transmission Line*), p.15

[124] Note: Assumed concrete density of 2.4 tonnes/m^3. Comparatively, four piles would weigh 130 tonnes.

[125] PdB Transmission Project EAR – Chapter 7.2.1.1 (*Effects Assessment and Mitigation – PW75 115 kV Transmission Line – Physical Environment - Physiography*), p.2

5. Transportation of Components (supply-chain)

As noted above, for conservativeness, India is the assumed manufacture location for estimating transportation emissions for steel, aluminum, and copper materials. Metal-based materials and equipment will be assumed to be transported by ocean to Vancouver, then by rail to Winnipeg, and then by road to site. Cement is assumed to be transported by rail from Edmonton to Winnipeg and then by road to site. Transportation emissions for diesel (and insulating oil) are embedded in the "Produce and Deliver Diesel" EF [Table 20]. Transportation emissions for aggregate are embedded in on-site emission calculations.

Alternative source locations (than India) for steel, aluminum, and copper would likely result in lower transportation emissions. However, Table 21 shows that transportation emissions make up less than 10% of overall life cycle emissions for these materials, even with this conservative assumption.

6. Upgrade Stations and Construct PW75

Estimated workforce requirements were assumed to match the older project scope presented in the PdB Transmission Project EAR:

- 842 person-months for the construction of PW75, including the mobilizing phase, clearing, construction, and demobilization. [Manitoba Hydro, 2014a].
- 48 person-months for overhead line and civil construction at Whiteshell and 48 person-months for electrical construction, commissioning, and energizing. [Manitoba Hydro, 2014a]
- 110 person-months for overhead line and civil construction at Whiteshell and 66 person-months for electrical construction, commissioning, and energizing. [Manitoba Hydro, 2014a]

"*It is expected that…existing local accommodations will be used for the most part for housing the transmission construction workforce*." [Manitoba Hydro, 2014a][126] The assumed housing location for the workforce is Beausejour due to its relative proximity to the site and hotel capacity. This is a slightly conservative assumption as there may be closer accommodation options.

[126] PdB Transmission Project EAR – Chapter 2.2.3.1 (*Project Description – Project Components – Project Construction – PW75 115 kV Transmission Line*), p.17

Construction equipment will include feller-bunchers, skidders, bulldozers, drill rigs, backhoes, excavators, cranes, trucks, and other equipment. [Manitoba Hydro, 2014a][127] For this assessment, it's been assumed that the typical construction vehicle would be an aerial device vehicle (e.g., a bucket truck) and that the vehicles would be left on-site while workers commuted from Beausejour on a daily basis. It is assumed that there will be one major construction vehicle for every three workers and that workers will arrive on site using one light duty truck for every three workers. Construction vehicles are assumed to consume, on average, twice the 3.4 L/hour rate of fuel required to continually idle without load over the course of 10 hours a day. The doubling incorporates a high-level estimate of average vehicle loading under various seasons and work requirements.

The first exception to the above assumptions is no heavy-duty construction vehicles are assumed for electrical construction, commission, and energizing at the stations as this is assumed to be mainly a manual process. A second exception is that, in addition to the assumed 6.4 L/hour average consumption rate throughout construction, additional fuel is assumed to be consumed for the two most energy intense construction activities:

- Based on assumptions from similar projects, 900 L of diesel fuel is consumed for every ha of forested area cleared on the ROW.
- While crane erection of the towers is presumed, for conservativeness it has been assumed that all towers are erected via heavy duty helicopter at a rate of 750 L of fuel per tower.[128]

<u>**7. Installation of New Units**</u>

The energy required to unload the components at site and move them to their installed position will be minimal. Most on-site work will be accomplished by an electric powerhouse-crane, with potential for the use of propane powered forklifts as well. Installation energy has been estimated to range from 100 kWh to 450 kWh per unit.[129] For simplicity, it was assumed that all on-site energy required for unit installation would be electrical energy. In order to not underestimate the global GHG effect of on-site energy use, the MROW factor of 806 t/GWh (Table 16) was applied. As this is a substantial EF, it mitigates the assumption that all energy is electrical as some energy would likely be the result of the combustion of fossil-fuels (e.g., propane forklifts).

[127] PdB Transmission Project EAR – Chapter 2.2.3.1 (*Project Description – Project Components – Project Construction – PW75 115 kV Transmission Line*), p.16

[128] Note: Assumed helicopter burn rate of 500 gallons of fuel per hour and erection rate of 25 towers per 10-hour day. For the purposes of this assessment, the full LC EF for diesel combustion was assumed equivalent to that of aviation fuel.

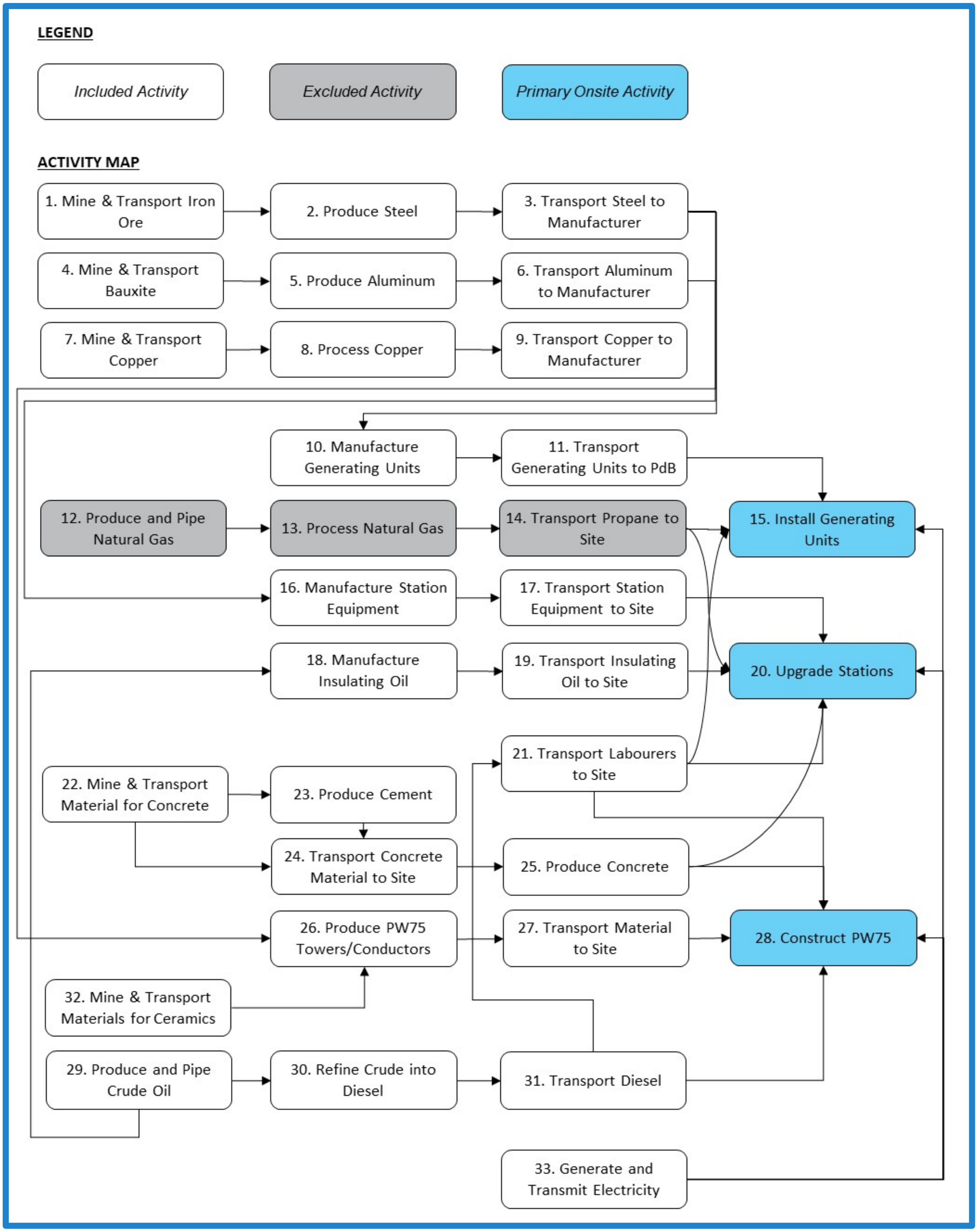
[129] Note: Energy estimate based on a 30 horsepower (approximately) main hoist motor on the powerhouse crane operating at a maximum of 30 minutes/day for 40 days over two months of assembly is roughly equivalent to 450 kWh. During actual operation the main hoist will only be used for a few very heavy lifts; the actual energy usage would likely be more around 100 kWh.

On-site work is assumed to take place over 2 months (i.e., 40 work-days), per unit, with an average of 12 workers per day. Worker accommodation and commuting assumptions are the same as for as those applied for "upgrade stations and construct PW75".

4.6.2 HIGH LEVEL CONSTRUCTION ACTIVITY MAP

Figure 14 lays out a high-level construction activity map for the PdB Project. Activities related to non-foundation materials other than steel, aluminum, copper, and insulating oil are not shown, except for ceramics for insulators, which are partially shown. As noted in Section 4.6.1, "*EFs for other materials (e.g., ceramics) will be based on the overall average of these four main materials*".

Figure 14: PdB Project High Level Construction Activity Map



4.6.3 KEY ASSUMPTIONS AND INPUTS

Table 20 lists the EFs applied for the assessment of construction emissions. These EFs were selected for the LCA of the MMTP[130] and reapplied for this high-level estimate.

Table 20 Life Cycle Activity EFs

Activity	CO_2e	Unit	Source[131]
Ocean Transport	15.84	g/tonne-km	NREL
Rail Transport	18.97	g/tonne-km	NREL
Road Transport	79.91	g/tonne-km	NREL
Mine Iron Ore	43.04	g/kg of ore	StatsCan
Produce Galvanized Steel Sheet	2,706.09	g/kg steel	NREL
Forge Steel into Bars/Wire/Other	354.61	g/kg steel	Chalmers University
Mine Bauxite	9,627.19	g/kg aluminum	NREL
Produce Aluminum Ingot			
Produce Aluminum Conductor	860.00	g/kg aluminum	CPM LCA Database
Mine Copper	1,424.62	g/kg copper	ICE and StatsCan
Process Copper	1,625.44	g/kg copper	ICE and StatsCan
Produce Copper Wire	3,192.00	g/kg copper	LCA of Copper Products
Produce Cement	928.39	g/kg of cement	LCI of Portland Cement
Produce and Deliver Diesel	979.29	g/L of diesel	GHGenius
Combust Diesel	2,803.53	g/L of diesel	[ECCC, 2019b]

To provide a more complete understanding of the impact of specific input assumptions, Table 21 presents EFs for aggregated activities closely aligned with the seven main activities laid out in Section 4.6.1. Table 21 includes references to the activity numbers listed in Figure 14. "g/kg material" EFs exclude concrete materials since, as noted in Section 4.6.1, "*It is assumed that concrete will be mixed near or on-site and aggregate will be obtained from near or on-site*"; supply side emissions for cement was incorporated into the "Full LC – Cement For Concrete Foundations" and "supply side" emissions for the extraction and transport of aggregate and water is incorporated into the calculation of direct onsite construction emissions.

[130] [Jeyakumar & Kilpatrick, 2015]

[131] "NREL" is the U.S National Renewable Laboratory; "ICE" is the "Inventory of Carbon and Energy (ICE) Version 1.6a" produced by the Sustainable Energy Research Team from the University of Bath in the United Kingdom; Copper Products LCA is the *European Update Study on Life Cycle Assessment of Copper Products*; "Chalmers University" is based on the 2002 master thesis "LCA Based Solution Selection" by Berg, H. & Haggstrom, S. from the Chalmers University of Technology and ; "CPM LCA Database" is the Centre for Environmental Assessment of Product and Materials System's LCA Database; "LCI of Portland Cement" is the "Life Cycle Inventory of Portland Cement Manufacture" report prepare by Marceau, M., Nisbet, M & Vangeem, M. in 2006; "GHGenius" is GHGenius 4.03a Modeling Software.

Table 21 Life Cycle EFs for Aggregated Activities

Activity	CO_2e	Unit	Activities Impacted
Transport from India to PdB	332.8	g/kg material	3, 6, 9, 11, 17
Transport from India to Whiteshell	328.8	g/kg material	3, 6, 9, 17
Transport from India to PW75	331.4	g/kg material	3, 6, 9, 27
Transport from Edmonton to PW75	35.2	g/kg material	19, 24
Full LC - Generating Units to PdB	3,437	g/kg steel	1-3, (4-9), 10-11
Full LC - Station Equipment to PdB	4,305	g/kg material	1-9, 16-19
Full LC - Station Equipment to Whiteshell	7,654	g/kg material	1-9, 16-19
Full LC - PW75 Material	4,671	g/kg material	1-6, (7-9), 26-27
Full LC - Cement for Concrete Foundations	145	g/kg concrete	22-24
Full LC - Diesel Combustion	3,783	g/L of diesel	20, 28, 29-31
Unit Installation Energy	362,700	g/unit	15, 33
Worker Transport to PdB	113,484	g/vehicle-day	15, 20, 29-31
Worker Transport to PW75	79,439	g/vehicle-day	28-31
Worker Transport to Whiteshell	45,394	g/vehicle-day	20, 29-31
Construction Vehicle Emissions	257,231	g/vehicle-day	20, 28-31

Table 22 lists the key assumptions used in the estimate of construction emissions. Rationale for the selection of these values are described in Section 4.6.1. Additional assumption detail is described in Section 4.6.1.

Table 22 Construction Emissions – Key Input Assumptions

Assumption	Value	Unit	Source
Regional Electricity Factor	806	t/GWh	EPA
Mass of Each Generating Unit	200	tonnes	Manitoba Hydro
Total # of Transmission Towers	104		Manitoba Hydro
Average Transmission Tower Mass	6.86	tonnes	Manitoba Hydro
Conductor Mass - Steel	0.51	tonnes/km	[Midal Cable, 2010]
Conductor Mass - Aluminum	1.12	tonnes/km	[Midal Cable, 2010]
Ground Wire Mass (Steel)	0.39	tonnes/km	[Super Metal, 2009]
Light Duty Truck Mileage	0.15	L/km	Manitoba Hydro
"Aerial Device" Mileage	0.50	L/km	Manitoba Hydro
"Aerial Device" vehicle idling (no load)	3.4	L/hour	Oak Ridge National Lab
ROW Clearing - Additional Energy	900	L/ha	Manitoba Hydro
Tower Erection - Additional Energy	750	L/tower	Manitoba Hydro
India to Vancouver by Ocean	17,500	km	sea-distances.org
Vancouver to Winnipeg by Rail	2,300	km	Google Maps

Edmonton to Winnipeg by Rail	1,300	km	Google Maps
Winnipeg to Whiteshell by Road	100	km	Google Maps
Winnipeg to PdB by Road	150	km	Google Maps
PdB to Whiteshell by Road	64	km	Google Maps
Beausejour to Whiteshell by Road	40	km	Google Maps
Beausejour to PdB by Road	100	km	Google Maps
Hours per Construction Day	10	hours	Manitoba Hydro
Construction Days Per Month	20	days	Manitoba Hydro
Vehicle Ratio (Commuting/Construction)	3	persons/vehicle	Manitoba Hydro
Construction Labour per Unit	480	person-days	Manitoba Hydro
Construction Labour for PW75	16,840	person-days	[Manitoba Hydro, 2014a]
Construction Labour for Station Upgrades - Civil/Overhead	3,160	person-days	[Manitoba Hydro, 2014a]
Construction Labour for Station Upgrades - Electrical/Commissioning	2,280	person-days	[Manitoba Hydro, 2014a]
Unit Install Energy (per unit) - Low	100	kWh	Manitoba Hydro
Unit Install Energy (per unit) - High	450	kWh	Manitoba Hydro
New PdB Units	8	new units	Manitoba Hydro

Table 23 summarizes the mass of construction materials required for the PdB Project. The majority of manufactured material is required for the generating units and PW75 towers and conductors.

Table 23 Construction Material - Mass Summary (tonnes)

Construction Material	PW75	Generating Units	PdB Equipment	Whiteshell Equipment
Aluminum	163.5	-	7.6	8.7
Steel	826.4	1,600.0	36.6	5.3
Copper	-	-	30.2	3.5
Insulating Oil	0.0	0.0	26.0	0.2
Other	14.5	-	5.9	0.9
Material Total (Excluding Foundation)	**989.3**	**1,600.0**	**106.2**	**18.5**
Concrete Foundation	11,887.2	0.0	1,257.4	218.9
Breaker CF_4	0.0	0.0	0.0215	0.0215
Breaker SF_6	0.0	0.0	0.0365	0.0365

4.6.4 PW75 LAND USE CHANGE EMISSIONS

For estimating land use change impacts, this assessment followed similar methods to those used for the LCA of the MMTP[132]. From a carbon content perspective, only forestland within the project ROW footprint is permanently[133] disturbed. It is assumed it will be converted to "Non-Treed" land (Table 24). While this land could convert to a variety of low-lying vegetation land-types the "Non-Treed" carbon content of 15 tonne C/ha (Table 24) was deemed a reasonable approximation of the final mix. "*Other areas of low-lying vegetation such as wetlands, peatland, agricultural, riparian and shrub lands along the ROW are assumed to be minimally disturbed and, when disturbed for construction, are assumed to return to their natural state within the project life."* [Jeyakumar & Kilpatrick, 2015] This assessment assumes only above ground carbon content is permanently disturbed: "*Carbon content of soils is assumed to be unchanged after clearing*." [Jeyakumar & Kilpatrick, 2015]

All forestland within the ROW is assumed to be completely cleared and converted to low-lying vegetation. While the actual transmission route is not final, 155.27 ha (Table 25) of forested land is assumed to be permanently disturbed, based on the Final Preferred Route [Manitoba Hydro, 2014a][134] from the PdB Transmission Project EAR. Some land will be permanently converted to concrete for tower foundations, but the total area covered will be less than 0.2 ha[135] and has been left out of land use change estimations due to the insignificance. Permanent land use change due to station upgrades will be insignificant as well.

The PdB Project will require temporary land disturbances (e.g., borrow pits, temporary access roads, marshalling yards); however, net emissions from these temporary disturbances are assumed to be zero/immaterial within the Assessment Period. Unless they are also within the ROW, they are assumed to return their original state, from a carbon content perspective.

This assessment follows IPCC (2003) direction on calculation methodology while using MB specific carbon contents, for different forestland types, from Shaw et al. (2005). Biomass assumptions in Table 24 are MB specific, not ROW footprint specific.

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[132][Jeyakumar & Kilpatrick, 2015]

[133] Note: The assumption of permanence focuses on the Assessment Period. However, ROW impacts can be expected to persist beyond 2055 as well.

[134] PdB Transmission Project EAR – Chapter 2 – Map 2-1 (*Project Description – Pointe du Bois Transmission Project Final Preferred Route*), p.25

[135] Note: Depending on foundation type, total foundation area could range from 0.03 ha to 0.17 ha.

Table 24 MB specific forest above ground biomass (tonne C/ha) [Shaw et al., 2005][136]

Dominant Stand Species	Stands in Sample	Total Live Tree Carbon
Non-Treed	**3**	**15.33**
Jack Pine	16	23.13
Black Spruce	19	32.37
White Spruce	2	88.50
Coniferous (i.e., Needle)	**37**	**31.41**
Balsam Popular	2	95.00
White Birch	3	50.67
Trembling Aspen	11	49.00
Deciduous (i.e., Broadleaf)	**16**	**55.06**
Mixed	**8**	**69.00**

Manitoba Hydro (2014c) provides a detailed breakdown of "*project footprint productive forestland*" covering 215 unique Forest Resource Inventory identification number regions. Table 25 simplifies the breakdown for carbon content estimation purposes, using the following guidelines:

1. Where 80%, or more, of a region had the same dominant stand species, 100% of the stand was assumed to be dominated by that species. If there were no stands dominated by that species in Shaw et al. (2005), then guideline 2 applied.
2. Where 80%, or more, of a region had dominant stand species that were either coniferous (i.e., balsam fir, black spruce, jack pine, tamarack larch, and/or white spruce) or deciduous (i.e., black ash, balsam poplar, bur oak, eastern cedar, trembling aspen, and/or white birch), 100% of the region was assumed to be dominant by that species category (i.e., either "Mixed Coniferous" or "Mixed Deciduous"), unless guideline 1 applied.
3. In all other cases the region was assumed to be "Mixed Deciduous/Coniferous."[137]

[136] Note: Based on data from 64 tree stand samples provided on pages 89-90 and 108-109 of Shaw et al. (2005). Above ground biomass includes stem wood, stem bark, branch, and foliage carbon. Shaw et al. (2005) listed both a dominant and co-dominant species for each tree stand. "Mixed" stands were stands where a coniferous species was dominant and a deciduous species was co-dominant, or vice versa.

[137] Note: The mixed stands in Shaw et al. (2005) had consistently higher above grounds carbon contents which is generally expected from more diverse forestlands.

Table 25 PW75 – Current State Forestry Breakdown Summary

Dominant Stand Species	Forestland Withdrawal (ha)	Above Ground Biomass (tonne C/ha)
Black Spruce	12.17	32.37
Jack Pine	6.17	23.13
Mixed Coniferous	17	31.41
Trembling Aspen	14.81	49.00
Mixed Deciduous	37.44	55.06
Mixed Deciduous/Coniferous	67.68	69.00
All Stands	**155.27**	**54.92**

Land use change emissions are estimated using Equation B. Equation B assumes all carbon is released as CO_2 as all biomass is combusted (either within the ROW or productively harvested for use elsewhere). CO_2 emissions are assumed to occur at, or soon after, the time of clearing; it is assumed that there is no significant decay[138]. These assumptions are consistent with mitigation measures outlined in Manitoba Hydro (2014b).

Equation B: CO_2e emissions (tonnes CO_2e) = Area Effected (ha) * [Original Carbon State (tonne C/ha) - Modified Carbon State (tonne C/ha)] * 44/12[139]

4.6.5 O&M EMISSIONS

O&M emissions are indirectly related to project components built during construction. In both the Baseline and Project Scenarios the PdB station will be operational throughout the O&M phase (2024-2055). Therefore, any net O&M emissions resulting from operating additional generation units can be reasonably assumed to be nil. Additional O&M combustion emissions due to assumed transmission upgrades at both the Whiteshell and PdB can similarly be assumed to be nil as both stations already exist and have O&M schedules in place.

In the Project Scenario it is assumed that PW75 will be constructed. This will require additional O&M:

1. *"The inspections of the transmission line will include air patrols, ground patrols and nonscheduled maintenance by air or ground in the event that unexpected repairs are required. Ground travel can include snowmobile, flex-track type or road vehicles. Regular*

[138] Note: The combustion of cleared debris is the preferable disposal method, compared with gradual decomposition, as the carbon is released as CO_2 and not CH_4, which has a higher GWP (Table 9).

[139] Note: 44/12 is the approximate ratio of the molecular weight of CO_2 (44) to that of carbon (12).

inspections will typically occur once per year by ground and can occur up to three times per year by air." [Manitoba Hydro, 2014a][140]

2. *Vegetation management within the ROW is required for public and employee safety, as well as the reliable operation of the line. The ROW will be maintained on an ongoing basis throughout the life cycle of operation. An integrated vegetation management approach will be undertaken to address undesirable and non-compatible vegetation issues within the ROW. Vegetation control methods on Manitoba Hydro's ROWs are achieved primarily through mechanical control (wheeled or tracked prime movers with drum or rotary cutters, mulcher, feller-bunchers, bulldozers with modified brush blades, etc.), herbicides, and manual control (chain saws, brush saws, and brush axes).* [Manitoba Hydro, 2014a][141]

Based on emissions from Manitoba Hydro's entire vehicle fleet (25 kt of CO_2e)[142] and the size of Manitoba Hydro's existing transmission (13,800 km) and distribution (75,500 km) infrastructure[143], at a high level additional O&M emissions due to PW75 are expected to be in the 10 to 30 tonnes of CO_2e per year range (including air patrols).

Table 23 indicates that 42.9 kg of carbon tetrafluoride ("CF_4") and 73.1 kg of sulphur hexafluoride ("SF_6") will be added to Manitoba Hydro's transmission system as a result of the PdB Project. If completely released into the atmosphere this would be equivalent to 1,619 tonnes of CO_2e. New breakers are expected to have an average release rate of <1%/year, which would be 0 to 16 tonnes of CO_2e per year.

As noted in Section 4.1.2.1, an assessment of supply-side emission related to O&M materials was excluded from this assessment and presumed to be relatively negligible. The quantity of material required to construct PW75 will be substantially higher than any material required for repairs.

At a high level, additional O&M emissions are expected to be less than 0.05 kt of CO_2e per year; an upper limit of 1.5 kt will be assumed for the entire Assessment period. Due to the relative insignificance of these emissions on an annual basis, they will not be included in the result tables in Section 5 that show annual breakdowns, but will be incorporated into overall project GHG effects.

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[140] PdB Transmission Project EAR – Chapter 2.2.4.1 (*Project Description – Project Components – Project Operations and Maintenance – PW75 115 kV Transmission Line*), p.20

[141] PdB Transmission Project EAR – Chapter 2.2.4.1 (*Project Description – Project Components – Project Operations and Maintenance – PW75 115 kV Transmission Line*), p.20-21

[142] [Manitoba Hydro, 2020b]

[143] [Manitoba Hydro, 2020d]

5 ASSESSMENT RESULTS & DISCUSSION

The PdB Project results in net decreases in emissions in MB, SK/ON, and the U.S. The majority of these decreases result from the PdB Project's generation effects. Upstream fossil-fuel implications of these effects may be the source of substantial additional GHG reductions as well. Direct incremental O&M and construction related emissions from the PdB Project are insignificant. All results are an average of 107 flow-cases unless indicated otherwise. Cumulative totals may not match values from individual years due to rounding.

5.1 PRIMARY GHG EFFECTS

All primary effects of the PdB Project are a result of the increase in system-wide hydroelectric generation within MB. Over the Assessment Period, the PdB Project results in an additional 12,240 GWh (380 GWh/year average) of hydroelectric generation within MB. This is 1.05% above the Baseline Scenario. The incremental increase averages 400 GWh/year once all eight units are replaced (i.e., no more replacement outages) and the system has adjusted. However, under the worst-case flow-year conditions the PdB Project only increases system-wide hydroelectric generation by 180 GWh/year (i.e., PdB Project dependable energy is less than 50% of its average energy).

As shown in Table 26, modelling indicates that the vast majority of increased hydroelectric energy from the PdB Project will result in a decrease in generation in the U.S.; representing the interconnection system differently within GSPRO resulted in the percentage effect in the U.S. increasing above 96%, thus 92% is considered on the lower end of expectations. Table 26 shows percentages up to 2041 to isolate pre-Need Year effects.

Table 26 PdB Project Incremental Energy Flow: 2024-2041 Percentage Breakdown[144]

MB Gas Generation Decrease	0.3%
Net Export Increase to Canada	7.3%
Net Export Increase to the U.S.	92.3%

From the Need Year (i.e., 2042) onwards, the effects in Canada are expected to increase absolutely and relatively, but whether these effects occur in or outside of MB depends on future generation expansion planning decisions. Table 27 presents a plausible range for the 2042-2055, from the Need Year onwards. The greatest reductions in MB will occur if gas generating stations

[144] Note: Modelling indicates a negligible increase in system losses. Losses impact the overall level of generation effects, which is incorporated in the results, but do not materially impact the percentage breakdown of net energy flows.

are built to meet energy and accredited capacity needs (e.g., the “All Gas” build-out). In the final years of the Assessment Period, the PdB Project has more opportunity to increase net exports to SK, as existing long-term firm contracts are assumed to have not been renewed.

Table 27 PdB Project Incremental Energy Flow: 2042-2055 Percentage Breakdown

Build-Out	**“All Gas”**	**“Mostly Wind”**
MB Gas Generation Decrease	18.4%	1.7%
Net Export Increase to Canada	3.4%	10.3%
Net Export Increase to the U.S.	78.2%	87.9%

Table 28 presents the primary GHG effects (i.e., generation effects) of the PdB Project using the “Mostly Wind” build-out post-2041 (Section 5.1.2). The primary incremental impact of the PdB Project is nearly 0.5 Mt of emission reductions in Canada over the life of the project and over 7 Mt globally.

Table 28 PdB Project Net Primary GHG Effects (Reductions) – Regional Breakdown (kt of CO_2e)

	MB	ON/SK	Canada	U.S.	Global
Cumulative Total	**64.1**	**408.3**	**472.4**	**6,837**	**7,309**
Annual Average	**2.0**	**12.8**	**14.8**	**214**	**228**
2024	0.1	3.7	3.8	65.8	70
2025	0.2	6.0	6.2	135.7	142
2026	0.2	7.8	8.0	204.4	212
2027	0.1	11.4	11.6	265.6	277
2028	0.1	12.6	12.7	261.8	274
2029	0.2	14.3	14.5	266.3	281
2030	0.7	11.9	12.5	256.1	269
2031	0.3	11.7	11.9	259.3	271
2032	1.3	12.4	13.7	252.9	267
2033	0.8	9.9	10.7	245.1	256
2034	1.0	10.8	11.8	238.1	250
2035	0.5	10.6	11.1	236.9	248
2036	1.7	10.7	12.4	235.8	248
2037	1.1	11.6	12.6	233.0	246
2038	1.4	11.0	12.4	229.6	242
2039	1.9	10.6	12.4	227.4	240
2040	1.5	13.9	15.4	223.1	239
2041	1.8	15.0	16.7	216.1	233
2042	1.2	13.5	14.7	210.1	225

2043	0.4	12.7	13.0	214.7	228
2044	2.6	13.4	15.9	213.0	229
2045	3.0	13.4	16.3	207.5	224
2046	2.9	14.4	17.3	201.4	219
2047	1.3	13.4	14.7	210.2	225
2048	5.1	13.9	19.0	200.0	219
2049	4.4	14.2	18.6	195.6	214
2050	3.2	12.7	15.8	197.1	213
2051	6.6	13.3	19.9	192.6	213
2052	6.0	21.7	27.8	182.8	211
2053	3.6	20.5	24.0	180.7	205
2054	4.4	19.5	23.8	184.5	208
2055	4.8	16.1	20.8	193.8	215

5.1.1 VARIATION FROM THE AVERAGE OF ALL FLOW-CASES

Section 4.2.6 notes how the maximum level of system-wide hydroelectric production in any given year is more than double the lowest expected level. Thus, while the cumulative totals in Table 28 are reasonable estimates of Assessment Period impacts, actual impacts in any specific year have a wide range of potential variation. To demonstrate this point, Table 29 shows how effects can vary depending on system-wide flow conditions. The 2030-2039 decade was chosen as a useful ten-year period to show effects after the new PdB units' operation is fully integrated into the system, but before new generation is built in MB. Section 4.2.6 defines "lowest-flow", "median-flow", and "highest-flow" conditions.

Table 29 PdB Project Average Annual Primary GHG Effects (2030-2039) – Specific Flow Conditions

	Generation Effects (kt of CO_2e reduced)					% of Effects	
	MB	ON/SK	Canada	U.S.	Global	Canada	U.S.
Average of all flow-cases	1.1	11.1	12.2	241.4	253.6	4.8%	95.2%
"Lowest-flows"	19.3	11.0	30.2	67.0	97.2	31.1%	68.9%
"Median-flows"	0.0	13.9	13.9	264.5	278.4	5.0%	95.0%
"Highest-flows"	0.0	1.6	1.6	251.4	253.0	0.6%	99.4%

There is no effect, or a negligible effect, on fossil-fuel generation in MB in 90% to 95% of all flow-years, depending on the assessment year under consideration. MB specific impacts are driven by the flow-years where the lowest levels of hydroelectricity are produced (i.e., low-flows); in most cases Brandon was not required to operate above proficiency run levels in either the Baseline

Scenario or the Project Scenario. While on average the PdB Project will have a minimal effect on MB fossil-fuel generation, it will noticeably mitigate provincial emissions in low-flow conditions.

Table 29 clarifies how the “median-flow” conditions are different than the “average of all flow-cases”; the GHG impact on MB fossil-fuel generators is only captured by evaluating the entire suite of 107 flow-cases as there is no impact during median-flows. Also, global GHG reductions during median-flows are around 10% higher than when averaged across all flow-cases. This comparison highlights the benefits of modelling the suite of flow-cases and not only focusing on median-flows.

Even though more system-wide hydroelectricity is produced, the incremental global impact of the PdB Project during high-flows is counterintuitively less than its impact during median-flows. During high-flows the transmission and interconnection system becomes strained, system operations become less flexible, and hydro generators can be forced to operate at lower efficiency points. This results in a smaller increase in incremental system-wide hydro energy production, compared with the Baseline Scenario, than under median-flows. This is an example of the importance of evaluating the PdB Project at a system level and not simply at a facility level. The most appropriate methods for evaluating the impact of new renewable energy in MB consider Manitoba Hydro’s entire system, including its interactions with neighbouring power markets.

5.1.2 GENERATION EXPANSION PLANNING CONSIDERATIONS

OptGen analysis indicated that the PdB Project may or may not delay the need for new MB generation by one year (Section 4.1.1.2). Results presented in Table 28 incorporated an identical post-2041 “Mostly Wind” build-out with no delay in Need Year. This is considered the more consistent approach for comparing the Baseline and Project Scenarios.

OptGen results indicated that, based solely on economics, natural gas generation would most likely be built to meet all of MB’s 2042-2055 (i.e., Assessment Period) needs. Under an “All Gas” build-out, the PdB Project could potentially reduce MB gas generator emissions by around 40 kt a year post-2041 (average of all flow-cases), though the impact on global emissions would be less as there would be a corresponding drop in U.S. reductions.

It was judged that with Canada’s net-zero by 2050 climate change goal the “All Gas” build-out was not appropriate for the purposes of this assessment. A “Mostly Wind” build-out was used as the Baseline Scenario for the reported results in this section (Section 4.3.3). The “Mostly Wind” build-out is where non-emitting energy is used to meet nearly all of MB's future energy needs and a substantial portion of MB's accredited capacity needs.

The "Mostly Wind" build-out is intended to be representative of many renewable-based generation expansion sequences and is considered a conservative choice, in terms of this GHG assessment, as more emission reductions occur during the Assessment Period when using the "All Gas" build-out. The sensitivity of the PdB Project's effects to the exact timing and sizing of new resources in renewable-based generation expansion sequences is mitigated by assuming an identical build-out (Table 11) for the Baseline and Project Scenarios.

Table 28 demonstrates that effects trends from 2042-2055 are consistent with those in the pre-2042 period. There is a relatively modest absolute increase in MB GHG reductions (the increase is 10% of the increase that occurs under the "All Gas" build-out), but global emission reductions continue to trend downwards.

An even more conservative approach would be to completely ignore the GHG reductions which occur after 2041 as the PdB Project is no longer considered completely surplus[145] in the post-2041 time-frame; the firm energy demand that the PdB Project would serve post-2041 could reasonably be met with an alternative quantity of matching non-emitting generation, over and above the firm energy provided by the "Mostly Wind" build-out. This approach was not taken for two reasons:

1. The primary purpose of this assessment is to fulfill the requirements of the Climate Lens (Section 3). Quantifying the potential benefits of the PdB Project throughout its assumed life (i.e., 2024-2055) is the most relevant approach and, in this context, outweighs the needs of conservativeness (Section 3.3)
2. This alternative approach assumes that MB would perpetually have policies that support building renewable energy (e.g., the "Mostly-Wind" build-out) over potentially more economic alternatives, while simultaneously not supporting more than the bare minimum of new renewable generation. These assumptions are at odds with each other: To meet its climate change commitments, Canada will need to continually build "surplus" renewable energy so that its fossil-fuel generating resources run at lower and lower capacity factors over time.

[145] Note: Over half the incremental hydroelectric generation produced as a result of the PdB Project is surplus energy, not dependable energy, and would persist until 2055 under any reasonable and consistent assumption. However, the dependable energy from the PdB Project could be used to meet firm demands beyond the Need Year.

5.1.3 POTENTIAL INCREASE IN THE PROPORTION OF CANADIAN REDUCTIONS

Table 26, Table 27, Table 28, Table 29, and Table 32 all make clear that the vast majority of generation effects resulting from the PdB Project occur in the U.S. This is the result of Manitoba Hydro's existing interconnection capabilities with the U.S. being an order of magnitude larger than with neighbouring Canadian provinces (Sections 3.7 and 4.2.5). Substantial existing firm contracts with SK restrict MB's ability to export additional renewable energy to Canada even further (Section 4.2.4.4). However, the environmental relevance of the climate change impact category is on a global basis and the location of sinks and sources is, generally, irrelevant in terms of global warming potential.

If an additional contract, or policy, existed which resulted in more of MB's surplus energy flowing to SK or ON, it would exist in both the Baseline and Project Scenarios. In this instance, the net incremental export to the U.S. percentage (Table 26 and Table 27) would actually increase[146]. As evidence, the opposite effect is displayed in Table 27 when the incremental net export to Canada percentage increases because less firm energy is being allocated to existing inter-provincial transmission infrastructure via contracted energy.

Analysis suggests that from 2024 to 2055 Manitoba Hydro's overall electricity exports (i.e., not only incremental PdB Project electricity exports) will help to reduce sector emissions by 21 Mt in Canada and 114 Mt in the U.S. (Table 34). A portion of these U.S. reductions could occur in Canada instead, if new transmission was built between MB and its neighbouring provinces. However, the construction of new interconnections is outside the scope of this assessment.

5.2 SECONDARY GHG EFFECTS – CONSTRUCTION RELATED EMISSIONS

Table 30 is intended to provide a high-level approximation of construction emissions, indicating the order of magnitude of potential emissions. While emissions are presented to the nearest tonne, this is only done for comparison purposes; it is not intended to imply that this level of accuracy was achieved in the assessment of construction emissions. The PdB Project is estimated to have negligible net direct construction emissions (including worker transportation), around 3 kt over the entire assumed life of the PdB Project; this is less than 0.04% of the entire global emissions reductions resulting from the PdB Project and does not materially impact this assessment's results. Construction related emissions are assumed to occur over the 2023-2026

[146] Note: An increase to the U.S. percentage would also occur if the import price from SK was assumed (Section 4.2.4.3) to be less than the MISO price or the export price to SK/ON was assumed to be higher than the MISO price. As noted in Section 4.2.4.3, such an assumption in GSPRO would result in less realistic market interactions, which is the rationale for GSPRO's actual configuration.

period but have not been broken down by year, due to both their negligible amounts and uncertainty related to the replacement timeline. It is assumed that there will be negligible (<0.05 kt) incremental O&M related emissions in 2030, or any year (Section 4.6.5).

Table 30 Summary of Construction Related Emissions

Construction Activity	t CO_2e	% of total
Full Generating Unit Supply Chain	5,499	34.8%
Full Station Upgrade Supply Chain	812	5.1%
Full PW75 Supply Chain	6,393	40.5%
Installation of new units: On-Site Energy	3	0.02%
Installation of new units: Worker Transport	145	0.9%
Installation of Station Upgrades: On-Site Energy	271	1.7%
Installation of Station Upgrades: Worker Transport	162	1.0%
PW75 Construction: On-Site Energy	2,054	13.0%
PW75 Construction: Worker Transport	446	2.8%
Material Supply Chain Total	**12,704**	**80.5%**
On-Site Energy (at PdB, Whiteshell, and PW75)	**2,328**	**14.7%**
Worker Transport (to PdB, Whiteshell, and PW75)	**753**	**4.8%**
Total	**15,785**	

A high-level estimate of material supply-chain emissions has been incorporated to demonstrate two relevant points:

1. Estimated supply-chain emission are over five times more substantial than on-site construction emissions.
2. Even when incorporating supply-chain emissions and O&M emissions, construction related emissions are less than 0.2% of the entire global emissions reductions resulting from the PdB Project (2024-2055).

As an estimate of supply-chain emissions was not required and they will mostly occur outside of Canada, they will only be included in the global emissions totals related to the PdB Project and not allocated to the Canadian totals required by the Climate Lens.

5.2.1 LAND USE CHANGE EMISSIONS

As they are a unique effect, land use change emissions are reported separately from other construction related emissions. Land use change emissions as a result of the PdB Project are estimated to be 22.5 kt of CO_2e; Table 31 summarizes the key inputs assumed for that estimate. For context, estimated land use change emissions outweigh direct on-site construction emissions by an order of magnitude. Assuming a 60 m ROW, 56% of the ROW will be permanently disturbed by the PdB Project.

Table 31 PW75 – ROW Land Use Change Summary

Land Use Change Component	Value	Unit
Area Affected (ha)	155.27	ha
Carbon Content - Original State	54.92	tonne C/ha
Carbon Content - Modified State	15.33	tonne C/ha
Permanent Carbon Change	39.59	tonne C/ha
Total GHG Released	145.16	tonne CO_2e/ha
Total GHG Released	**22.5**	**kt CO_2e**

5.3 SECONDARY GHG EFFECTS – UPSTREAM FOSSIL-FUEL EFFECTS

The primary effect of the PdB Project is a reduction in fossil-fuel combustion emissions from grid-connect power plants; but, as discussed in Section 4.1.2.4, emissions from the use of fossil-fuels do not solely result from their direct combustion. They result from their production, processing, and transportation as well. Section 4.5.1 notes that the EFs used for estimating upstream fossil-fuel effects are meant to represent an "*idea of the potential upper level of this secondary effect*". Overall results will therefore be presented as a plausible range, with and without this secondary effect. Table 32 projects that the PdB Project's secondary effects could reduce Canadian emissions by up to an additional 140 kt and global emission by an additional 1,500 kt.

Table 32 Upstream Fossil-Fuel Effects (Secondary GHG Effects)

	Canada	U.S.	Global
Cumulative Total	**141.7**	**1,389**	**1,531**
Annual Average	**4.4**	**43**	**48**
2024	1.1	7.9	9
2025	1.9	16.8	19
2026	2.4	25.9	28
2027	3.5	34.4	38
2028	3.8	35.4	39
2029	4.4	37.4	42
2030	3.8	38.7	42
2031	3.6	42.2	46
2032	4.1	42.7	47
2033	3.2	43.3	46
2034	3.5	44.1	48
2035	3.3	45.0	48
2036	3.7	45.9	50
2037	3.8	46.0	50
2038	3.7	46.1	50
2039	3.7	46.7	50
2040	4.6	48.1	53
2041	5.0	47.5	52
2042	4.4	47.0	51
2043	3.9	48.8	53
2044	4.8	49.3	54
2045	4.9	48.9	54
2046	5.2	48.3	54
2047	4.4	51.3	56
2048	5.7	49.7	55
2049	5.6	49.5	55
2050	4.8	50.8	56
2051	6.0	50.5	57
2052	8.3	48.6	57
2053	7.2	48.5	56
2054	7.2	50.1	57
2055	6.2	53.3	60

5.4 BASELINE AND PROJECT SCENARIOS TABLES

The Climate Lens requires that "*The assessment's Executive Summary should expressly identify the (Baseline Scenario) emissions in 2030 as well as cumulative (Baseline Scenario) emissions over the asset's lifespan.*" [Infrastructure Canada, 2019][147] While the scope of this assessment included estimating plant-specific fossil-fuel generation emissions in MB (i.e., a project specific procedure is used in MB), the performance standard approach was applied to non-MB generation effects and total future electrical industry emissions in SK, ON, and MISO were not explicitly estimated on an absolute basis (estimation of total future sectoral emission in Canada and the U.S. is outside the scope of this assessment). The PdB Project is expected to increase net exports to these three regions, which, in an average of all flow-cases, is already substantial.

Table 33 presents the generation effects of the entire Manitoba Hydro system in the Baseline Scenario as well as the expected percentage reduction in GHG emissions due to the PdB Project.

Table 34 present the generation effects of the entire system in the Project Scenario.

Table 35 presents the total emissions from all grid-connected MB fossil-fuel generators in both the Baseline and Project Scenarios. Projected emissions from the 2044-2055 period are a result of the chosen system generation expansion sequence (i.e., the "Mostly Wind" build-out) in the Baseline Scenario and are only intended to provide a baseline on which to estimate the plausible net impact of the PdB Project. This assessment does not intend to suggest that new emitting resources in MB are a certainty. Extrapolating emissions from the 2024-2043[148] period, cumulative emissions through 2055 are estimated to be under 1 Mt if no new directly emitting resources are ever built in MB.

[147] Climate Lens – Section 2.5.i (*Required Information and General Instructions – Baseline GHG emissions calculations*)
[148] Note: In the "Mostly Wind" build-out the first SCGT is built in 2044 (Table 11).

Table 33 Non-MB Generation Effects – Baseline Scenario Reductions Due to Exports

	Baseline Net Export Effects (kt of CO_2e reduced)			Additional emission reductions due to the PdB Project		
	ON/SK	U.S.	Global	ON/SK	U.S.	Global
Cumulative Total	**20,359**	**106,867**	**127,226**	**2.0%**	**6.4%**	**5.7%**
Annual Average	636	3,340	3,976	2.0%	6.4%	5.7%
2024	605	3,607	4,212	0.6%	1.8%	1.6%
2025	621	4,635	5,256	1.0%	2.9%	2.7%
2026	622	4,621	5,243	1.3%	4.4%	4.0%
2027	614	5,451	6,065	1.9%	4.9%	4.6%
2028	601	5,587	6,187	2.1%	4.7%	4.4%
2029	562	4,843	5,405	2.5%	5.5%	5.2%
2030	**506**	**4,439**	**4,946**	**2.3%**	**5.8%**	**5.4%**
2031	514	4,324	4,838	2.3%	6.0%	5.6%
2032	506	3,829	4,335	2.5%	6.6%	6.1%
2033	536	3,879	4,415	1.9%	6.3%	5.8%
2034	523	3,434	3,958	2.1%	6.9%	6.3%
2035	527	4,107	4,634	2.0%	5.8%	5.3%
2036	501	3,824	4,325	2.1%	6.2%	5.7%
2037	482	3,469	3,952	2.4%	6.7%	6.2%
2038	486	3,039	3,524	2.3%	7.6%	6.8%
2039	475	2,462	2,937	2.2%	9.2%	8.1%
2040	585	2,358	2,943	2.4%	9.5%	8.1%
2041	596	2,137	2,733	2.5%	10.1%	8.5%
2042	613	2,280	2,892	2.2%	9.2%	7.7%
2043	655	2,868	3,522	1.9%	7.5%	6.5%
2044	655	2,872	3,527	2.0%	7.4%	6.4%
2045	629	2,502	3,131	2.1%	8.3%	7.1%
2046	614	2,247	2,861	2.3%	9.0%	7.5%
2047	670	2,940	3,609	2.0%	7.1%	6.2%
2048	646	2,664	3,310	2.2%	7.5%	6.5%
2049	636	2,477	3,112	2.2%	7.9%	6.7%
2050	654	2,615	3,269	1.9%	7.5%	6.4%
2051	623	2,265	2,889	2.1%	8.5%	7.1%
2052	930	2,354	3,284	2.3%	7.8%	6.2%
2053	1,008	2,416	3,424	2.0%	7.5%	5.9%
2054	1,087	3,124	4,210	1.8%	5.9%	4.8%
2055	1,078	3,199	4,277	1.5%	6.1%	4.9%

Table 34 Non-MB Generation Effects – Project Scenario Reductions Due to Exports (kt of CO_2e)

	ON/SK	U.S.	Global
Cumulative Total	**20,767**	**113,704**	**134,471**
Annual Average	649	3,553	4,202
2024	609	3,673	4,282
2025	627	4,771	5,398
2026	629	4,825	5,455
2027	625	5,716	6,342
2028	613	5,848	6,461
2029	576	5,109	5,685
2030	518	4,695	5,214
2031	526	4,584	5,109
2032	518	4,082	4,600
2033	546	4,124	4,670
2034	534	3,673	4,207
2035	538	4,344	4,881
2036	512	4,059	4,571
2037	494	3,702	4,196
2038	497	3,268	3,765
2039	485	2,689	3,175
2040	599	2,581	3,180
2041	611	2,353	2,964
2042	626	2,490	3,116
2043	667	3,082	3,750
2044	668	3,085	3,753
2045	642	2,710	3,352
2046	629	2,448	3,077
2047	683	3,150	3,833
2048	660	2,864	3,524
2049	650	2,672	3,322
2050	666	2,813	3,479
2051	637	2,458	3,095
2052	952	2,537	3,489
2053	1,029	2,597	3,626
2054	1,106	3,308	4,414
2055	1,095	3,392	4,487

Table 35 MB Grid-Connected Electricity Generation Emissions (kt of CO_2e)

	Baseline Scenario	**Project Scenario**	**Relative Reduction**
Cumulative Total 2024-2055	**3,844**	**3,780**	1.7%
Cumulative Total 2024-2043	**591**	**575**	2.8%
Annual Average 2024-2043	**29.6**	**28.7**	2.8%
2024	41.6	41.5	0.3%
2025	36.8	36.6	0.5%
2026	35.7	35.6	0.4%
2027	36.4	36.3	0.4%
2028	35.4	35.4	0.2%
2029	36.1	35.8	0.6%
2030	**23.4**	**22.7**	**2.8%**
2031	23.1	22.9	1.1%
2032	25.3	24.0	5.2%
2033	24.4	23.6	3.3%
2034	25.3	24.4	3.9%
2035	23.7	23.2	2.2%
2036	25.4	23.7	6.8%
2037	25.2	24.1	4.2%
2038	30.6	29.2	4.6%
2039	30.2	28.4	6.1%
2040	29.1	27.7	5.1%
2041	31.9	30.2	5.5%
2042	27.3	26.1	4.5%
2043	24.3	23.9	1.4%
2044	108.2	105.7	2.4%
2045	116.9	114.0	2.5%
2046	141.7	138.8	2.1%
2047	160.5	159.2	0.8%
2048	220.4	215.3	2.3%
2049	244.8	240.4	1.8%
2050	269.6	266.5	1.2%
2051	355.4	348.8	1.9%
2052	383.3	377.2	1.6%
2053	389.5	385.9	0.9%
2054	430.6	426.2	1.0%
2055	432.2	427.4	1.1%

5.5 OVERALL PROJECT GHG EFFECTS

Table 36 presents the overall reductions resulting from the PdB Project. Overall Canadian emission reductions will be in the range of 0.5 Mt. However, the PdB Project will be most beneficial on a global basis with estimated emission reductions of nearly 9 Mt. Totals are rounded to give a better representation of the level of accuracy of the results. Totals are presented as a range, based on calculations with and without the inclusion of GHG reductions as a result of impacts on upstream fossil-fuel emissions. As actual upstream effects may not be as high as assumed, projected reductions are assumed to fall within that range, for the purposes of this assessment[149]. When reporting the impact of the PdB Project as a single value, such as the Business Case within the PdB Project ICIP submission, it is suggested the lower value is chosen for conservativeness.

Table 36 Cumulative Net PdB Project Reductions: 2024-2055 (kt of CO_2e)

	Canada	Global
(A) Net Reductions - Generation Effects	472.4	7,309.5
(B) Construction Emissions (Including Global Supply-Chain)	3.1	15.7
(B) O&M Emissions	1.5	1.5
(B) Land Use Change Emissions	22.5	22.5
(C) Net Reductions - Indirect Generation Effects	141.7	1,530.5
Overall Net Reductions (range is from (A-∑B) to (A-∑B+C))	**445 to 590**	**7,270 to 8,800**

To fulfill Climate Lens obligations[150], Table 37 presents an estimate of emission reductions in 2030. These reductions are an average of all flow-cases and actual reductions will depend heavily on the flows during the 2029-2031 period.

Table 37 Overall Net Reductions in 2030 (kt of CO_2e)

	Canada	Global
(A) Net Reductions - Generation Effects	12.5	268.6
(B) Construction Emissions (Including Global Supply-Chain)	0.0	0.0
(B) O&M Emissions	<0.05	<0.05
(B) Land Use Change Emissions	0.0	0.0
(C) Net Reductions - Indirect Generation Effects	3.8	42.5
Overall Net Reductions (range is from (A-∑B) to (A-∑B+C))	**12.5 to 16.3**	**270 to 310**

[149] Note: higher emission reductions are plausible, though upstream impacts would not be less than zero.
[150] Climate Lens – Section 2.5 (Required Information and General Instructions)

The Climate Lens requires a specific cost-per-tonne indicator of "*Total project cost (construction cost and O&M costs over lifetime) / cumulative GHG reductions over the asset's expected lifespan*" [151]. Incremental capital investments required to move forward with the PdB Project are estimated to be approximately 270 million dollars[152] (2020 Canadian dollars). Both the Baseline and Project Scenarios require capital investment costs and this incremental cost represents the difference between the two scenarios.

Table 38 provides the overall cost-per-tonne of the PdB Project using the emission reduction values from Table 36 and only considering the incremental costs of the PdB Project. On a global emission reduction basis, the cost-per-tonne is comparable to current GHG pricing in MB; however, when only considering Canadian emission reductions the cost is an order of magnitude higher.

Table 38 Cost-per-Tonne of emission reductions – Capital Investment Costs Only (2020 Canadian dollars)

Canadian Reductions Only	\$460 to \$610 (per tonne CO_2e)
Global Reductions	\$31 to \$37 (per tonne CO_2e)

The Climate Lens requires a second cost-per-tonne indicator: "*Federal dollars/GHG reductions in 2030 (non-cumulative)" [Infrastructure Canada, 2019]*[153]*.* While the precise amount of "federal dollars" is not set, the current draft proposal requests 135 million dollars. Based on Canadian GHG reductions of 12.5 kt in 2030 (Table 37) the cost indicator would be \$10,800/tonne CO_2e.

While the PdB Project requires substantial investment capital, there is expected to be substantial economic benefits resulting from the increases in electrical revenue due to the additional renewable energy produced at PdB during its remaining operational life. On a more holistic cost-benefit analysis basis, the PdB Project's net cost-per-tonne is expected to be negative over its full operational life.

[151] Climate Lens – Section 2.5.iv (*Required Information and General Instructions – cost-per-tonne calculations*)

[152] Note: Incremental cost estimates presented herein were the best available as of the date of this assessment. This includes incremental capital O&M investments, but there is no incremental change in the assumed operational O&M budget. Costs that are considered "ineligible", such as financing costs and land acquisition costs, are excluded. Detailed cost information is available in other documentation submitted as part of the ICIP application.

[153] Climate Lens – Section 2.5.iv (*Required Information and General Instructions – cost-per-tonne calculations*)

5.6 CONCLUSIONS

Key take-aways from this GHG assessment are as follows:

- The PdB Project will result in significant global emission reductions over the full Assessment Period (i.e., 2024-2055), approaching half the entire annual emissions of MB.
- The GHG reductions resulting from the PdB project will mostly occur outside of Canada.
- The PdB Project could potentially have a greater impact on Canadian emissions if additional transmission was built between MB and adjacent provinces.
- There is limited opportunity for the PdB Project, or any renewable electricity project in MB, to reduce MB emissions. The PdB Project will contribute in a small way to Canada's Paris Agreement commitment.
- The PdB Project will lower MB emissions that occur during low-flow periods.
- The PdB Project is excluded from the Baseline Scenario not because it is uneconomic, but because the up-front capital costs are the main project "barrier". Since the PdB Project is expected to both provide net economic benefits and reduce emissions, it can be considered an ideal emissions reduction project.
- The PdB Project cost-effectively contributes to both emission reductions and increasing Canada's renewable energy portfolio.

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POINTE DU BOIS UNIT REPLACEMENT PROJECT
CLIMATE CHANGE RESILIENCE ASSESSMENT

Water Resources Department
Integrated Resource Planning Division

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DATE: AUGUST 6, 2021

REPORT: IRPD 20_15

Manitoba Hydro

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MANITOBA HYDRO

INTEROFFICE MEMORANDUM

FROM Michael J.F. Vieira, M.Sc., P.Eng.
Hydroclimatic Studies Engineer
Hydrologic and Hydroclimatic Studies
Water Resources Department
Integrated Resource Planning
Asset Planning and Delivery

TO Marc E. St. Laurent, M.Sc., P.Eng.
Section Head
Generation System Studies
Energy Supply Planning Department
Integrated Resource Planning
Asset Planning and Delivery

DATE August 6, 2021

FILE **IRPD 20_15**

SUBJECT **Pointe du Bois Unit Replacement Project - Climate Change Resilience Assessment**

The attached climate change resilience assessment characterizes climate related risks associated with the proposed Pointe du Bois Unit Replacement Project. This assessment follows Infrastructure Canada's Climate Lens Guidance (Infrastructure Canada, 2018) for use in support of the Pointe du Bois Unit Replacement Project funding application to Infrastructure Canada's Investing in Canada Infrastructure Program (ICIP).

Available information on future climate change projections was leveraged to conduct this assessment. This includes studies conducted at Manitoba Hydro as well as information from published scientific literature. The assessment reflects efforts from multiple departments including those with expertise in resource planning, water resources, engagement, design, construction and operation of generation components and transmission lines as well as those with expertise in climate science.

To provide appropriate interpretation and guidance, please consult the Water Resources Department. I can be reached at 204-360-5293 or mvieira@hydro.mb.ca.

Best regards,

Michael J.F. Vieira, M.Sc., P.Eng

Cc. Smrita Rajbhandary, M.Sc., P.Eng.
Jon Kell, M.Sc., P.Eng.
Tim Lock, M.Sc., P.Eng.
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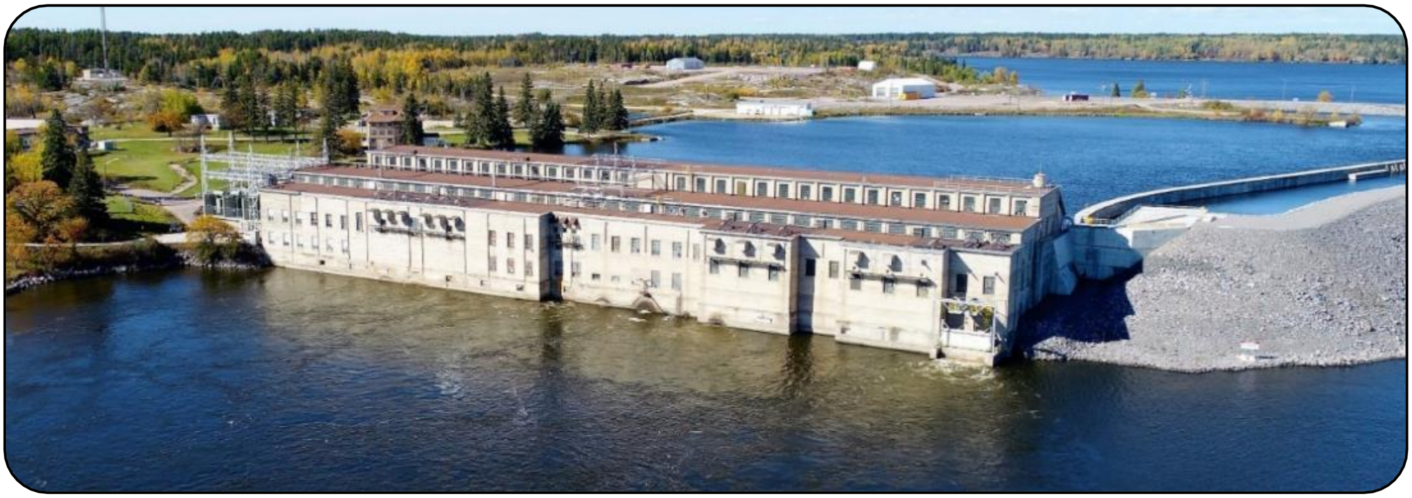

POINTE DU BOIS
UNIT REPLACEMENT PROJECT

Climate Change Resilience Assessment

Manitoba Hydro
August 6, 2021
Report IRPD 20_15

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ATTESTATION OF COMPLETENESS

I/we the undersigned attest that this Resilience Assessment was undertaken using recognized assessment tools and approaches (i.e., ISO 31000:2018 Risk Management - Principals and Guidelines) and complies with the General Guidance and any relevant sector-specific technical guidance issues by Infrastructure Canada for use under the Climate Lens.

Prepared by:

Michael J.F. Vieira, M.Sc., P.Eng. _________________________ Date: ________________
Responsibility: Water resources, climate change science, future projections

Smrita Rajbhandary, M.Sc., P.Eng. _________________________ Date: ________________
Responsibility: Energy supply impacts due to water supply projections

Jon Kell, M.Sc., P.Eng. _________________________ Date: ________________
Responsibility: Transmission design, line reliability and line resilience

Validated by:

Marc E. St. Laurent, M.Sc., P.Eng. _________________________ Date: ________________
Responsibility: Project planning

Kristina A. Koenig, M.Sc., P.Eng. _________________________ Date: ________________
Responsibility: Water resources

Resilience Assessments must be prepared, or at a minimum validated by, a licensed professional engineer, certified planner, or appropriately specialized biologist or hydrologist.

The above attestation follows the template in Annex E of Infrastructure Canada (2018).

EXECUTIVE SUMMARY

This Climate Change Resilience Assessment characterizes climate change impacts, risks, and mitigation measures for the Pointe du Bois Unit Replacement Project (the Project). The Project consists of eight new generating units installed in the existing Pointe du Bois hydroelectric generating station powerhouse on the Winnipeg River, a new 115 kV transmission line and other associated upgrades. The Project increases electrical generation capacity by 52 megawatts, 380 gigawatt-hours of energy per year on average, and reduces greenhouse gas emissions in Manitoba and interconnected regions (Manitoba Hydro, 2021a). Infrastructure Canada's Climate Lens (Infrastructure Canada, 2018) and complementary risk management guidelines were followed in development of the assessment.

Eighteen climate-related events were identified that could potentially impact the Project. These events are categorized as: atmospheric (8), terrestrial (2), hydrologic (6), and transitional (2). Future climate projections with respect to these events were obtained from existing data sources and scientific literature. From these events, forty-nine impact topics were identified and a three-category system (low, medium, high), consistent with Manitoba Hydro's corporate risk process, was adopted to assign probability, consequence, risk rating, and tolerance. Aggregated risk ratings (Direct, Indirect, and Systemic) show zero high-risk, nineteen medium-risk, and twenty-four low risk impacts. The Project also provides twelve opportunities to increase climate resilience:

Risk Type	Risk Rating					Sum
	High	Medium	Low	Opportunity	Not Assigned	
Direct Risk to Project	0	11	13	0	25	49
Indirect Risk to Project	0	6	10	3	30	49
Systemic	0	2	1	9	37	49

Demonstration of climate resilience includes stress testing of generation under future streamflow scenarios, assessment of the spillway constructed in 2014, selection of return period for design events, resiliency in design, storm response, transmission system capacity and flexibility, collaboration with external entities, and internal climate change initiatives. This Assessment finds the decision to proceed with the 8 unit upgrade option, addition of a new 115 kV transmission line, use of a 150-year design event for transmission civil design with provision to reduce cascading failure, and utilization of the relatively new spillway structure appropriate in a climate resilience context based on Project scope, vulnerability to climate change, and other factors. Manitoba Hydro's existing storm monitoring and response function is appropriately equipped to manage storm-related impacts and could be improved and/or expanded with time, as required. External activities with industry and research groups are identified as an ongoing initiative to increase understanding, develop tools and reduce scientific uncertainties which can obscure adaptation initiatives, especially when large investments are required to mitigate certain risks. Overall, the Project is found to be sufficiently resilient to climate change based on current scientific knowledge.

Table of Contents

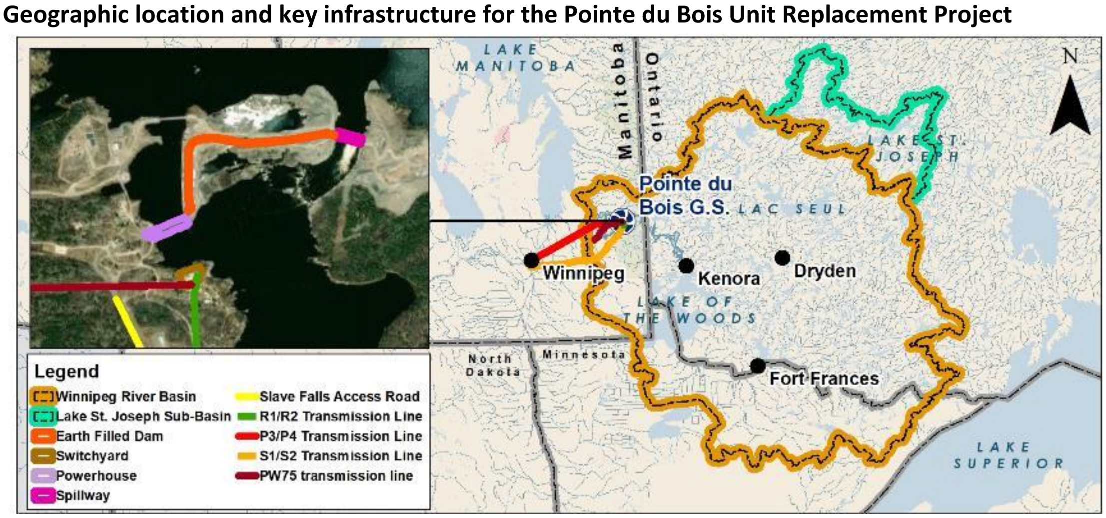
1.0 INTRODUCTION AND PROJECT OVERVIEW

The proposed Pointe du Bois Unit Replacement Project (the Project) primarily involves the installation of eight new Francis-type units into the existing powerhouse and a new 46.5 km 115 kV transmission line (PW75). New units will increase generation capacity by 52 megawatts (MW) and add 380 gigawatt-hours (GWh) of energy per year on average between 2024 and 2055. Electricity will be transmitted via PW75 and existing transmission lines R1/R2 and S1/S2. The Project includes upgrades to the powerhouse and transmission system to accommodate the eight new units. The Base Case plan to extend the life of the powerhouse (Manitoba Hydro, 2021b) includes upgrades beyond the Project scope which are required to maintain safe and reliable operation of the facility with existing generating units through the 2050's, after which decommissioning is expected to occur. Pointe du Bois, relevant transmission infrastructure, and the Winnipeg River Basin are shown in Figure 1.

Pointe du Bois saw first service in 1911 and remains Manitoba's oldest in-service hydroelectric generating station. To minimize environmental impacts, the Project utilizes existing infrastructure and segments of existing transmission corridors to generate and transmit clean, renewable, hydropower. The Project benefits from a recently constructed spillway and earth dam to comply with dam safety requirements (Manitoba Hydro, 2012). The spillway addressed concerns with aging structures and personnel safety while increasing reliability and capacity to handle larger floods on the Winnipeg River. Additional information about the Project, including rationale for the project and greenhouse gas (GHG) emissions, can be found in Manitoba Hydro (2021b) and Manitoba Hydro (2021a), respectively.

Following Climate Lens Guidance (Infrastructure Canada, 2018), this Climate Change Resilience Assessment characterizes climate-related risks and opportunities associated with the Project. The assessment reflects efforts from multiple departments including those with expertise in resource planning, water resources, engagement, design, construction, and operation of generation components and transmission lines, as well as those with expertise in climate science.

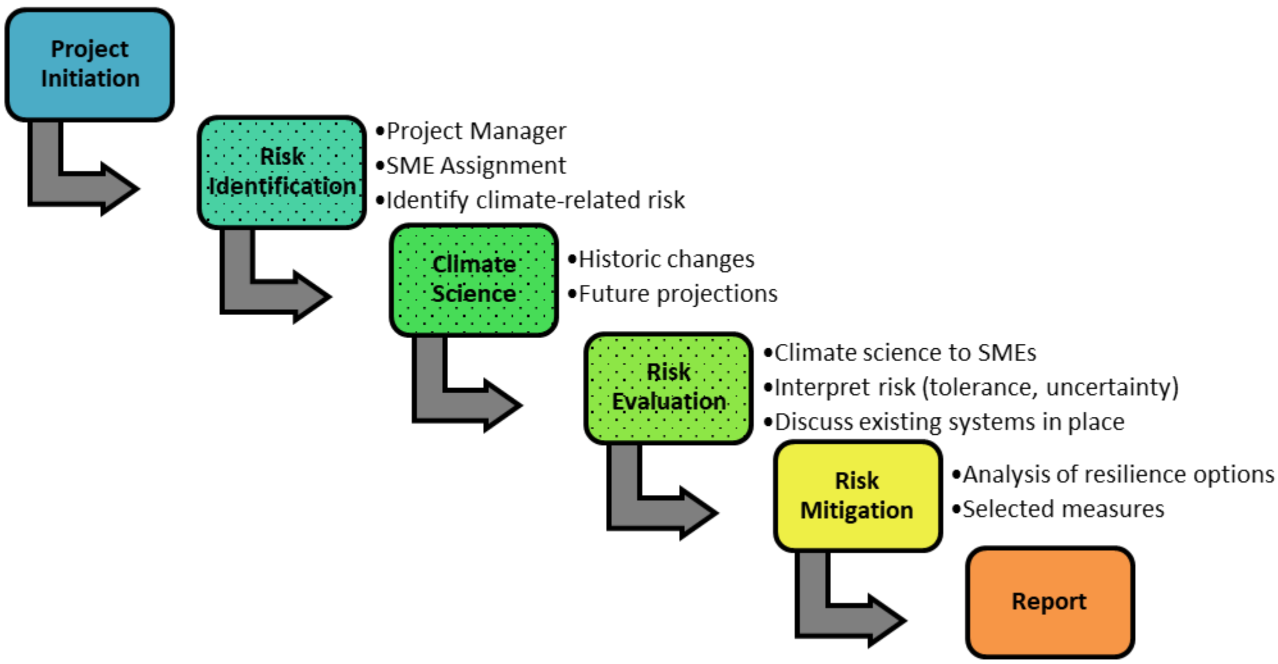
Figure 1 - Geographic location and key infrastructure for the Pointe du Bois Unit Replacement Project



2.0 RISK ASSESSMENT

The Climate Change Resilience Assessment follows a collaborative, multi-disciplinary, approach (Figure 2). Project staff, in conjunction with subject matter experts (SMEs), worked together to assess the Project's climate change resilience. This report discusses how resilience is considered in current practises as well as measures that mitigate climate risk for select events.

Figure 2 - High-level Climate Change Resilience Assessment process. Stippled elements identify steps associated with the Risk Assessment.



Following International Organization for Standardization (ISO) Risk Management Guidelines (ISO 31000:18; CSA, 2018), Section 2.0 addresses scope, risk identification, risk analysis, and risk evaluation. Risk treatment and subsequent risk assessment steps are covered in Section 3.0. A summary of the risk assessment findings can be found in Appendix A.

Risk Assessment follows guidelines used for Manitoba Hydro's corporate risk profiles with a modification to probability ratings that facilitates assessment of climate change risk. Probability descriptions are modified to represent an incremental change relative to current conditions (Table 1). The underlying assumption herein is that the existing probability without climate change (and the associated risk) is acceptable. As in the corporate risk profiles, consequence is based on five metrics: financial (e.g., income and capital), system reliability (e.g., domestic and interconnections), safety (e.g., employees and public), environment (e.g., air emissions and water management), and customer value (e.g., electricity rates, reliability, quality and reputation). A three-category rating system (low, medium and high) for probability and consequence were used to characterize three risk ratings specified in

Table 2. Qualitative measures of tolerance are also used and relate to existing controls and current capacity to accommodate risk.

Table 1 - Description of Probability Ratings

Rating	Description
Low	Change is unlikely to occur in the timeframe of interest
Medium	Change is as likely as not to occur in the timeframe of interest
High	Change is likely to occur in the timeframe of interest

Table 2 - Risk Evaluation Matrix

Consequence	**High**	Medium Risk	High Risk	High Risk
	Medium	Low Risk	Medium Risk	High Risk
	Low	Low Risk	Low Risk	Medium Risk
		Low	**Medium**	**High**
		Probability		

Depending on the nature of the climate event, the Climate Change Resilience Assessment views risk from various temporal and spatial aspects. For example, some climate events are more relevant for shorter term considerations (e.g., construction) while others are more relevant for longer term considerations (e.g., average water supply over the course of the asset life). Similarly, some climate events are more relevant for Project infrastructure (limited spatial domain) while others are more relevant to the larger upstream river basin (Figure 1) or Manitoba Hydro's electrical system. It is important to keep these views in mind to understand the nature of the risk ratings provided herein. Risk ratings have been classified in the following three groups:

- **Direct:** A risk to the Project that could directly impact construction or the generation and transmission of power from the new units.
- **Indirect:** A risk to Pointe du Bois Generating Station with impacts that may occur with or without the Project.
- **Systemic:** Risk that could impact Manitoba Hydro's broader system which may occur with or without the Project.

2.1 Scope, Timescale and Limitations of the Assessment

The scope of this assessment focusses primarily on the physical effects of climate (e.g., atmospheric and hydrologic) on structural and non-structural elements relating to Project infrastructure. These elements include engineering design, construction, operations, and maintenance of the Project with complementary consideration of effects on Manitoba Hydro's broader electrical system. Climate change effects have also been explored in the Pointe du Bois Spillway Replacement Project Environmental Impact Statement (Manitoba Hydro, 2011a) and Pointe du Bois Transmission Project

Environmental Assessment (Manitoba Hydro, 2014) but this present study contains greater detail, more recent climate science, and encompasses a broader scope.

In accordance with assumed powerhouse decommissioning in the 2050s and common practice in climate change studies, the 2050s future period (typically 2040-2069) is assessed relative to a 1981-2010 baseline period. Three caveats should be considered regarding these baseline and future periods:

- Environmental data considered in Project planning and design (e.g., streamflow) may utilize different historic periods, depending on data availability and/or standards and best practises.
- Some climate studies utilized in this report may present projections based on other future (e.g., 2070-2099; the 2080s) and baseline (e.g., 1986-2005) time periods.
- Construction is tentatively scheduled for completion before March 31, 2027 which aligns with the 2020s future period (typically 2010-2039).

Existing information as well as new analyses of future climate change projections were leveraged to conduct the assessment. This includes studies undertaken internally at Manitoba Hydro, as well as supplementary information from published scientific literature.

Authors of this assessment would like to underscore the importance of recognizing uncertainty in future climate scenarios. Climate change projections discussed herein are based on scenarios of future societal evolution and resulting GHG emissions (e.g., Representative Concentration Pathways; RCPs; van Vuuren et al., 2011) that are used to drive Global Climate Models (GCMs) which may subsequently be used to drive Regional Climate Models (RCMs). These models provide numerical representations of complex earth systems at coarse scales and typically contain biases. Where possible, an ensemble of climate model simulations is used to help understand uncertainty and quantify agreement on the direction of future change. The ensemble mean/median projection is typically presented as a "best guess", which lies within a wider range of uncertainty.

2.2 Risk Identification: Climate Events and Impacts

Climate events potentially impacting the Project are briefly summarized in Table 3. Events may pose risks or could lead to opportunities. The term event is used herein to generally describe a wide range of possible weather/climate-related phenomena that could have an impact on the Project. Events include physical hazards associated with acute extreme weather and chronic slow-onset changes to the climate system, as well as select transitional hazards associated with policy, market, and technology changes as societies decarbonize. The terms "physical", "acute", "chronic", and "transitional" are adopted from the Task Force on Climate Related Financial Disclosures (TFCD; Bloomberg, 2020; Deloitte, 2020).

Section 2.3 presents future projections related to each climate event including a brief description of the 49 potential individual impacts along with an assignment of probability. Remaining components of the risk analysis (consequence, tolerance, and overall risk score) are presented in Section 2.4. Some additional impacts were identified and are acknowledged in Sections 2.3 and 2.4 but may be omitted from Table 3 due to negligible consequence.

Table 3 - Summary of climate events and 49 potential project Impact Topics. Cell colours distinguish categorical events as follows: atmospheric in yellow; terrestrial in green; hydrologic in blue; transitional in orange.

	Climate Event	TCFD Category	49 Impact Topics(s)
1	Extreme Heat	Physical - Acute	Transmission line operation; conductor to ground clearances; workers; powerhouse equipment cooling
2	Winter Temperature	Physical - Chronic	Transmission line construction and refurbishment; transmission line access for operation and maintenance; powerhouse heating
3	General Air Temperature Increase	Physical - Chronic	Weather affected energy demand; transmission operation during peak demand
4	Wind Speed	Physical - Acute	Transmission structural and mechanical design; shoreline erosion; freeboard and wave action
5	Near Freezing Precipitation	Physical - Acute	Transmission structural and mechanical design; road travel safety
6	Convective Storms	Physical - Acute	Infrastructure damage; transmission line operation
7	Freeze-Thaw Cycles	Physical - Chronic	Concrete deterioration; movement of shallow foundations
8	Snow Accumulation	Physical - Acute	Design snow loads
9	Vegetation	Physical - Chronic	Transmission line operation and maintenance
10	Wildfire	Physical - Acute	Infrastructure damage; transmission line operation; site access
11	Water Temperature	Physical - Chronic	Equipment cooling efficiency; ice cover season duration; river ice processes; ice cover stability for resource usage; sturgeon spawning; fish community assemblage; ability to practise rights-based activities
12	System-Wide Water Supply	Physical - Chronic	System-wide energy production; transmission system operation; net revenue
13	Winnipeg River Streamflow	Physical - Chronic	Energy production; reservoir operation
14	Winnipeg River Drought	Physical - Acute	Energy production; powerhouse heating; aquatic habitat
15	Winnipeg River Flood	Physical - Acute	Freeboard and flood passage; reservoir levels and operational strategies; spillway operation, maintenance and access; public waterway safety
16	Other Overland Flooding	Physical - Acute	Site access; transmission line access; transmission line conductor clearances
17	Canadian Government Policy	Transitional	Demand for non-emitting electricity; electrification and/or fuel switching
18	U.S. Export Market Policy	Transitional	Demand for non-emitting electricity; funding for U.S. clean energy projects

2.3 FUTURE CLIMATE PROJECTIONS

A brief description of the event, impact, and projected future change is included below. This section combines existing sources of information (e.g., internal to Manitoba Hydro), new data analyses, and review of scientific literature which is cited for further reference. Consideration of historic observed climate is inherent in many cited studies which gauge future change relative to a baseline period. Additional historic context is provided where appropriate, but the primary objective of this section is to characterize future projected change and assign probability for use in risk assessment.

Probability assignments are in accordance with Table 1 which incorporate consideration of confidence and uncertainty in future climate projections. Such considerations are important for pragmatic use of available climate change information and is similarly achieved through assignment of tiers (one, two, or three) to various design-related climate variables in an assessment of climate change data for infrastructure design (Cannon et al., 2020). ISO 31000 Risk Management guidelines recognize challenges in quantifying highly uncertain events with larger consequences (CSA, 2018). For these cases, a medium probability is assigned which reflects that a change in a specific climate event is "as likely as not to occur in the timeframe of interest" (Table 1). This approach will associate highly uncertain climate events that have high consequence with a high risk rating (Table 2).

2.3.1 EXTREME HEAT

The number of hours or days where maximum temperature exceeds a threshold can affect multiple Project components. Transmission system operations can be affected by air temperatures exceeding 40°C due to reduced capability of the lines. Temperatures exceeding other thresholds (e.g., 30°C) can also impact the ability of staff to conduct outdoor field work and may affect cooling requirements for powerhouse equipment. Extreme heat is not expected to affect construction activities as schedules are of adequate duration to safeguard against days during which productivity may be impacted by warmer air temperatures. A large portion of construction is either planned to occur indoors (i.e., new unit installation) or during winter months (e.g., transmission line work). In general, there is good agreement among simulations that extreme heat events will increase, but the magnitude varies based on RCP and time period. Manitoba Hydro (2015a) projects Winnipeg daily maximum temperatures at the upper end of the distribution (66^{th} to 99^{th} percentile) to increase by 2.7°C in the 2050s. For the Prairies region, the multi-model median projection in Zhang et al. (2019) is +1.6°C (RCP2.6) to +2.5°C (RCP8.5) for annual maximum temperature, and, +4.5 (RCP2.6) to +7.2 (RCP8.5) hot days (where maximum temperature exceeds 30°C; 2031-2050 period). Under a scenario where global mean temperature increases by 2.1°C beyond preindustrial levels, Li et al. (2018) projects 10 to 20 additional hot days in southern Manitoba. Although there is high probability that days with temperature in excess of 30°C will increase, there is less evidence that days with temperature in excess of 40°C will increase substantially in the 2050s (ClimateData.ca, 2021) and a medium probability is assigned.

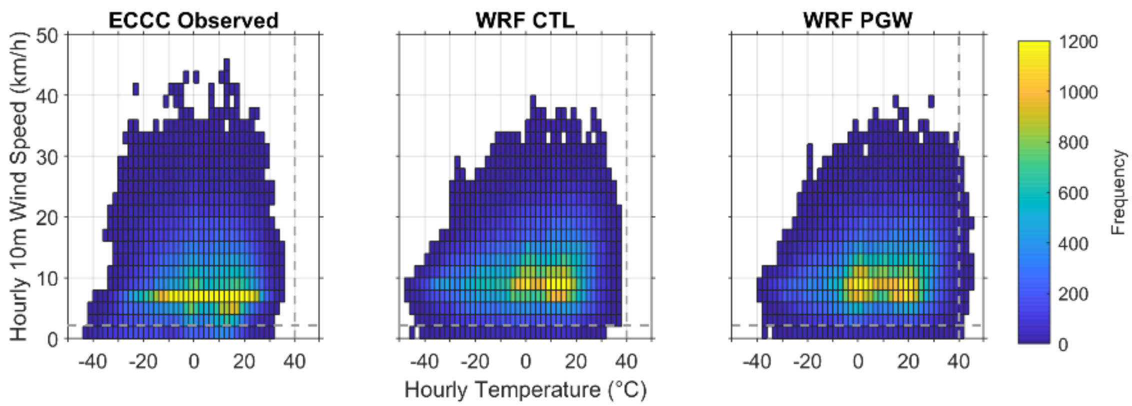
References to ClimateData.ca (2021) and ClimateAtlas.ca (2020) used throughout this report utilize an ensemble of 24 GCMs and two RCPs processed using the bias correction and statistical downscaling method known as Bias Correction/Constructed Analogues with Quantile mapping reordering (BCCAQv2; Werner and Cannon, 2016; Cannon et al., 2015; Li et al., 2018).

Impact Topic(s)	Probability the Event Will Change
Transmission line operation	Medium (T_{max}>40°C)
Conductor to ground clearances	Medium (T_{max}>40°C)
Workers	High (T_{max}>30°C)
Powerhouse equipment cooling	Medium (T_{max}>40°C)

Extreme temperature (e.g., >40°C) coincident with low winds (e.g., <2.2 km/h) can amplify transmission impacts. To provide support for line rating calculations, Morris (2014) used historic data in southern Manitoba to explore the joint frequency between temperature, wind, and solar irradiance. For the highest solar radiance bin (900 W/m^2 to 1,000 W/m^2) at Winnipeg, temperatures between 22°C and 30°C most frequently coincided with wind speeds between 4 m/s to 6 m/s. Morris (2016; Appendix B) presents joint frequency of wind and temperature for Pinawa and shows no occurrence of historic temperature exceeding 36°C (1998-2012). Limited hours with temperature exceeding 30°C were observed June through September but were not coincident with calm wind (0 m/s). Morris (2016) reports maximum historic hourly temperature coincident with calm wind of 29°C at Pinawa and 35°C at Winnipeg. Literature investigating combined calm wind and high temperature event, in the context of climate change for southern Manitoba, was not found.

In the absence of published literature, Manitoba Hydro explored hourly wind speed and temperature data pairs from Environment and Climate Change Canada (ECCC) observations and two Weather Research Forecast (WRF) model simulations (Liu et al., 2017). The Pinawa meteorological observation station (Climate ID 503B1ER) is located approximately 39 km southwest of Pointe du Bois (84 km northeast of downtown Winnipeg) and contains hourly observations coincident with the WRF data period (October 2000 to September 2013). Observations and WRF data (extracted from the point nearest Pinawa) are presented in Figure 3. Comparing observations to the reanalysis-driven WRF control (CTL) run, it is evident that WRF exhibits bias, simulating events that are both warmer and cooler than observed with less extreme wind. WRF pseudo global warming (PGW) runs are representative of a future climate under a high GHG emission scenario (RCP8.5) for the 2071-2100 period. Comparing WRF CTL to WRF PGW simulation provides a sense of how this single model realization projects the bivariate distribution of hourly surface temperature and wind speed to change in the future. The future distribution is shifted towards increased air temperatures which could see some infrequent occurrence of 40°C temperatures coinciding with less than 2.2 km/h wind speeds. Results from this single simulation provide some context but should not be viewed as definitive. Further analyses into sources of uncertainty is required to fully understand how hourly pairs of temperature and wind are projected to change in the 2050s time period. As such, medium probabilities assigned above remain appropriate

Figure 3 - Bivariate histograms for hourly surface air temperature (2 m above ground) and wind speed (10 m) extracted from observations and the Weather Research Forecast (WRF) Model (Liu et al., 2017). The left panel shows Environment and Climate Change Canada (ECCC) observations at Pinawa (Climate ID 503B1ER; Oct 2000 - Sep 2013), the middle panel shows WRF control simulation (CTL; Oct 2000 - Sep 2013) and the right panel shows WRF pseudo-global warming simulation (PGW; representative of 2071-2100 period under a high GHG emission scenario). All hourly values are shown with no seasonal filtering. WRF data is extracted from a single grid, nearest Pinawa. Dotted gray lines identify 40°C and 2.2 km/h values.



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2.3.2 WINTER TEMPERATURE

Warmer winters can reduce the duration in which transmission line work can be undertaken, may result in access challenges during operation and maintenance, and can affect the powerhouse heating requirements. Conversely, less extreme cold weather may facilitate some construction and operational/maintenance activities. In general, there is good agreement among simulations that winter temperature will increase, but the magnitude varies based on RCP and future time horizon. There is also scientific consensus that winter mean temperatures will increase more than other seasons due to factors including reduced snow cover and the associated loss of albedo, allowing for greater absorption of heat by land masses.

For construction and refurbishment related impacts, the 2020s time period (2010-2039) is of interest because work is planned in the nearer term. Manitoba Hydro (2015a) projects mean winter temperature to increase by +1.9°C in the 2020s and the average value of minimum temperatures in winter to increase by +2.1°C relative to the 1981-2010 baseline. However, since construction planning takes more recent (up to current) weather information into consideration, a portion of projected changes are inherently considered, and remaining signals are masked by noise due to natural climate variability. As such, changes to winter temperature that could impact construction activities are assigned a low probability since they are not likely to deviate strongly from the range of observed conditions already considered in construction planning.

The 2050s time period (2040-2069) is of greater importance for impacts related to access for operations and maintenance, as well as powerhouse heating. For this time period, mean winter temperature is projected to increase by 3.8°C and the average value of minimum temperatures in winter to increase by 4.2°C relative to the 1981-2010 baseline (Manitoba Hydro, 2015a). Projections also suggest a reduction in heating degree days (Zhang et al., 2019; Manitoba Hydro 2015c), freezing degree days (Zhang et al., 2019), and a limited ensemble of RCM simulations in Manitoba Hydro (2015a) suggest reduced number of frost days, icing days, and cold spell duration. Under a scenario where global mean temperature has increased by +2.1°C beyond preindustrial levels, Li et al. (2018; Supplementary Material) projects 10 to 20 additional frost-free days in southern Manitoba. All simulations available from ClimateAtlas.ca (2020) are in agreement that there will be fewer winter days with an ensemble median projection of 23 fewer days per year with minimum temperature below -15°C.

Impact Topic(s)	Probability the Event Will Change
Transmission line construction and refurbishment	Low
Transmission line access for operation and maintenance	High
Powerhouse heating	High

2.3.3 General Air Temperature Increase

It is virtually certain that Canada's air temperature has increased and will continue to increase in the future (Zhang et al., 2019) with greater change projected for winter relative to other seasons (Manitoba Hydro, 2020). Statistically significant mean temperature trends for all of Manitoba were found over the 1948-2014 period and mean annual temperature is projected to increase by about 2.5°C to 2.9°C in the Project area (Manitoba Hydro, 2020; Manitoba Hydro, 2015a; Manitoba Hydro, 2015c). The magnitude of change varies depending on the climate model ensemble, RCP, and downscaling technique.

As temperature increases, the weather affected portion of electrical loads will be impacted which may also result in transmission operation impacts during peak demand. In general, there is good agreement among simulations that winter (summer) energy demand used for heating (cooling) will decrease (increase), but the magnitudes vary based on RCP and time period. Neglecting changes in societal factors such as population growth, the ensemble average projection in Manitoba Hydro (2015c) suggests a minor reduction of 270 GWh (approximately 1.1%) in Manitoba's domestic mean annual electrical energy demand. Seasonal changes are more pronounced, showing an average reduction of 756 GWh (-176 MW) for heating and an increase of 486 GWh (+300 MW) for cooling. Changes to energy and peak demand patterns can impact the way Manitoba Hydro's generation and transmission system is planned and operated.

Impact Topic(s)	Probability the Event Will Change
Weather affected energy demand	High
Transmission operation during peak demand	High

2.3.4 WIND SPEED

Wind contributes to transmission line loads, can damage vegetation surrounding transmission lines, and can affect wave activity, shoreline erosion, freeboard, and dam safety. Using downscaled GCM data, Cheng et al. (2014) projected changes in the frequency of wind gusts across Canada. Results show potential for more frequent wind gusts in southern Manitoba by the end of the 21st century with considerable uncertainty for higher velocity gusts. Results also show variability depending on the season, gust speed, location, GCM, and GHG emission scenario which underscore some of the uncertainty in such projections. Using an RCM driven by two GCMs, Jeong and Sushama (2018) assessed how future (2071-2100) wind speed and design wind loads (50-year event) are projected to change across Canada. Results for southern Manitoba show variability depending on the driving GCM and GHG emission scenario with some showing increases and others show decreases. RCM simulations project the mean of annual maximum 3-hour wind speed to change anywhere from -4% to +4% with potentially larger changes (both positive and negative) to 50-year wind speed and 50-year wind pressures. Using a different climate model, Jeong and Sushama (2019) found similar disagreement among projections regarding changes to 50-year wind events in the 2071-2100 period. Minimal change is projected to annual maximum wind's direction.

In Jeong and Sushama (2019), seasonal results for a region that aggregates Manitoba and Saskatchewan suggest that summer mean wind speed will decrease while winter and spring mean wind speed will increase in the future. This finding is broadly consistent with provincial-scale findings from an ensemble of 40 GCM simulations in Manitoba Hydro (2020) where summer and winter exhibited more pronounced changes with arguably better agreement compared to other seasons. However, because of weak to negligible agreement in the Project area, a probability of medium is assigned to both changes in mean wind speed and extreme wind related impacts. Jeong and Sushama (2018) and Jeong and Sushama (2019) conclude that more information is required to understand uncertainties and support climate-resilience codes and standards.

Impact Topic(s)	Probability the Event Will Change
Transmission structural and mechanical design	Medium
Shoreline erosion	Medium
Freeboard and wave action	Medium

2.3.5 NEAR FREEZING PRECIPITATION

Precipitation occurring near 0°C has the potential to fall as freezing rain, freezing drizzle, wet snow, and other precipitation types which can lead to accretion of ice on surfaces. Radial ice on transmission line conductors contribute to increased transmission line loads and can lead to outages. On average, southern Manitoba sees 20 to 40 hours per year of freezing rain and freezing drizzle (Cortinas et al., 2004). In a more recent study, Mekis et al. (2020) reports an average of 100 to 150 hours per year where precipitation (multiple types) occurs near 0°C, but trend analysis on these events revealed no statistically significant trends.

Despite difficulties in simulating freezing rain events and projecting future changes (Stewart et al., 2019), several studies have explored this important topic further. Using one GCM, Lambert and Henson (2011) show potential for a slight increase in the average number of freezing rain events in the 2081-2100 period. For a large region that includes southern Manitoba, Cheng et al. (2011) projects more frequent freezing rain events in November to April accompanied with fewer events in October and May. Employing an RCM driven by three GCM simulations, Jeong et al. (2018) examined projected changes in extreme radial ice accumulation for transmission lines across Canada. Although the model is able to reproduce historic spatial patterns of freezing rain, future projections of ice loading over Manitoba were not in agreement. In a similar study, Jeong et al., (2019) shows that projected changes to design radial ice thickness in Manitoba are sensitive to natural climate variability. The average projection from a 50-member ensemble (one RCM driven by one GCM with 50 different initial conditions) shows most of Manitoba to experience a near-zero change in design ice thickness at various warming levels. However, the range in projections from the 50 members shows some potential increases and some potential decreases.

The combination of high wind speed and ice accretion on transmission lines may contribute to greater loads than wind speed or ice accretion on their own and as per CSA (2019), a combined loading scenario (wind speed plus ice) is specified for structural design. Using a RCM driven by three GCM simulations, Jeong et al. (2018) superposed projected changes in design ice thickness and wind pressure based on a 13% threshold (approximately the difference between the 50-year and 100-year design loads). In the Project area, the three simulations show no change in superposed ice and wind load design values. Due to limited models and disagreement, there remains significant uncertainty in these projections (medium probability).

Manitoba Hydro has been involved in recent research to help understand local near 0°C precipitation events and potential future changes. Through analysis of ten sample historic events, Tropea and Stewart (2021) found that events shifted northward in a warmer climate but did not explore new events that may have shifted into the southern Manitoba domain. Authors found that during these events, the fastest wind speeds occurred perpendicular to power lines aligned west to east, and found that local topography could influence these events, but no notable terrain elevation features were identified in the Project study area. Since a major wet snow event occurred in October 2019, Manitoba Hydro has initiated studies (Morris, 2020; Hanesiak et al., submitted) to better understand drivers of these wet snow events and how they may impact Manitoba Hydro's transmission and distribution infrastructure.

Impact Topic(s)	Probability the Event Will Change
Transmission structural and mechanical design	Medium
Road travel safety	Medium

2.3.6 CONVECTIVE STORMS

Convective storms can produce extreme weather patterns including intense precipitation, hail, high-wind, cloud-to-ground lightning, and tornadoes which can cause infrastructure damage. Although warming can enhance convective activity (e.g., increase surface heat fluxes), other atmospheric factors are expected to supress convection resulting in uncertainty surrounding future changes in summer convective activity (Stewart et al., 2019). Manitoba Hydro (2015a) summarized additional literature related to convective storms. Findings from this literature are included below for quick reference:

- Sills et al. (2012) identified southern Manitoba as historically prone to tornadoes.
- Climate change impacts on tornado occurrence are difficult to model.
- Convectively available potential energy (CAPE) and deep troposphere wind shear (SHR6) are important in formation of convective storms and tornadoes. Brooks (2013) projects an increase in CAPE and a decrease in SHR6. While decreases in SHR6 lead to lower occurrence of tornadoes, Diffenbaugh et al. (2013) found that the decreasing SHR6 occurs on days with low CAPE. Brooks (2013) and Diffenbaugh et al. (2013) suggest that increasing CAPE can lead to more favourable conditions for severe thunderstorms and tornadoes, however there remains a high degree of uncertainty in projections.
- Teshmont (2006) suggests a possible increase in southern Manitoba tornado frequency due to increasing summer and spring temperature.
- Morris (2014) states that, despite a low probability of tornado occurrence in Manitoba, there is a higher probability that tornadoes will cross transmission lines because of the long tracks. Considering simulated tornado paths in Morris (2016) and various transmission line segments with different orientations, we estimate return periods for a tornado (F1 to F5) intersection:
    - Segment A: 56 km R1/R2 and S1/S2 sections from Pointe du Bois to Whitemouth. In the absence of a SW-NE orientation in Morris (2016), we adopt a N-S orientation. Accounting for an annual tornado frequency of 1.1 (10,000 km^{-2} yr^{-1}; Cheng et al., 2013), and linearly interpolating between 50 and 75 km line lengths, yields an estimated return period of 61 years.
    - Segment B: 86 km from Whitemouth to Winnipeg (S1/S2) oriented E-W. Accounting for an annual tornado frequency of 1.4 (10,000 km^{-2} yr^{-1}; Cheng et al., 2013), and linearly interpolating between 75 and 100 km line lengths, yields an estimated return period of 48 years.
    - Segment C: 22 km from Pointe du Bois to Lee River Distribution Supply Centre (PW75) oriented E-W. Accounting for an annual tornado frequency of 0.9 (10,000 km^{-2} yr^{-1}; Cheng et al., 2013), we yield an estimated return period of 253 years.

- Segment D: 25 km from Lee River Distribution Supply Centre to Whiteshell Station (PW75) oriented N-S. Accounting for an annual tornado frequency of 1.1 (10,000 km^{-2} yr^{-1}; Cheng et al., 2013), yields an estimated return period of 140 years.
- Because of longer line lengths, tornado intersection return periods are reduced for the full transmission lines (i.e., Segment A+B and Segment C+D). However, if we conceptualize S1/S2 and PW75 as twin parallel lines separated by more than 10 km, the return period for a tornado intersecting both lines is considerably greater than for a single line.

- Burrows and Kochtubajda (2010) show that lightning activity is influenced by season length, proximity to cold water bodies, elevation, and diurnal heating and cooling cycles. On average, the Project area experiences approximately 0.75 to 1.25 flashes per km^2 per year with a lightning season spanning mid-March to mid-October. A large portion of the lightning typically occurs overnight as a result of dissipating thunderstorm activity drifting in from other regions.
- Aerosol composition, concentration, and distribution are important factors in lightning formation (Williams, 2005). Aerosol loads change the polarity of clouds, which may alter the amount of lightning that occurs in the future. Aerosol loads in the future are difficult to predict, as they relate to climate change as well as to human and societal behaviours. It is possible that a drier future climate results in an increase in suspended aerosol and areas that experience higher drying have more lightning (Price, 2009).
- Climate change projections show that there could be an increase in more explosive storms, with increasing occurrence of convective storms leading to the formation of lightning (Price, 2009). A double atmospheric carbon dioxide concentration scenario shows a 10% increase in lightning for every 1˚C of warming, however this value is highly regionalized (Price, 2013) with a majority of the increase projected to occur in the tropics. The Great Plains region of North America is also projected to experience increasing electrification, with the expectation that intense storms that lead to electrification, and therefore to lightning, will increase (Price, 2009).

Impact Topic(s)	Probability the Event Will Change
Infrastructure damage (multiple)	Medium
Transmission line operation	Medium

2.3.7 Freeze-Thaw Cycles

The repetitive transition from above 0°C to sub-freezing temperature is known as the freeze-thaw cycle. During the transition, small volumes of moisture can shift phase from liquid to solid which can exert forces and cause damage (e.g., within concrete cracks, or ground movement due to soil moisture). Palko and Lemmen (2017) suggest the frequency of freeze-thaw cycling will increase in certain parts of Canada and decrease in others. For the prairies, Sauchyn and Kulshreshtha (2008) suggest that freeze-thaw may increase in winter months if warm spells increase. There is less certainty in how the annual count of freeze-thaw cycles will change in a warmer climate since increases in the winter season may be offset by decreases in shoulder seasons.

The annual count of freeze-thaw days was explored using data from ClimateAtlas.ca (2020). Using daily data and a calculation process similar to Ho and Gough (2006), a freeze-thaw day was detected when daily maximum temperature was above 0°C and daily minimum temperature was below -1°C. For the grid point nearest Pointe du Bois, the ensemble median projects a decrease of 3.7 annual freeze-thaw days in 2040-2069 relative to 1981-2010. Considering the entire ensemble of 24 GCMs and 2 RCPs, projections range from a decrease of 19.7 freeze-thaw days per year to an increase of 7.8 freeze-thaw days per year on average. With 37 of 48 (77%) GCM simulations in agreement that annual freeze-thaw cycles will decrease, there is moderate evidence, and corresponding low probability, that annual freeze-thaw cycles will increase. However, it should be noted that projected changes are near-zero and may not deviate substantially from noise due to natural climate variability.

Impact Topic(s)	Probability the Event Will Change
Concrete deterioration	Low
Movement of shallow foundations	Low

2.3.8 Snow Accumulation

Snow accumulation and concurrent snow loading plays an important role in building design. The National Building Code of Canada (NBCC) published by the National Research Council (NRC, 2015) provides design-relevant information including 50-year snow and rain loads which are based on snow depths (measured at ground level), specific weight of snow, and additional load resulting from rain falling onto an existing snowpack.

Using daily snow water equivalent (SWE) output from a small ensemble of RCM simulations, Jeong and Sushama (2018) explore projected changes in 50-year ground snow loads in the 2071-2100 period compared to the 1981-2010 period. The authors found that simulations with large increases in future air temperature result in reduced ground snow loads over the Project region but acknowledge that rain-on-snow loads were not addressed. From a building design perspective, Cannon et al. (2020) characterizes snow load as a Tier 3 variable, meaning that there is low confidence in how snow (and rain) loads are projected to change into the future. Despite some confidence in the spatial pattern of decreasing snow accumulation (e.g., due to increased temperatures and shorter winter seasons), low confidence stems from the presence of large natural variability and challenges in quantifying model uncertainties (e.g., land surface schemes, snow models built into climate models, and complex terrain unresolved by climate models).

Impact Topic(s)	Probability the Event Will Change
Design snow loads on buildings	Medium

2.3.9 Vegetation

Greater atmospheric carbon dioxide concentrations, longer growing seasons, and potential for increased moisture availability can contribute to increased vegetation growth. Vegetation near transmission lines increases the risk of outages and damage during extreme weather events and requires regular vegetation management. Under a scenario where global mean temperature has increased by +2.1°C beyond preindustrial levels, Li et al. (2018) project 10 to 20 day longer growing seasons in southern Manitoba for warm weather and overwintering crops. Using a small ensemble of RCM simulations, Manitoba Hydro (2015a) also projects an increasing trend in growing season length.

Impact Topic(s)	Probability the Event Will Change
Transmission line operation and maintenance	High

2.3.10 WILDFIRE

Fires generate heat and smoke which can lead to equipment tripping, insulator flashovers, or heat damage to equipment. Most of the Project components are located in forested areas, with some portions of S1/S2 located alongside roadways and traversing land used for agriculture. Some portions of PW75 are located near backcountry use (e.g., snowmobiling) trails. Adopting terminology from Johnston et al. (2020), infrastructure located in forested areas may have higher exposure compared to infrastructure traversing agricultural lands which may classify as lower exposure (i.e., less vulnerable to ignition from heat transfer, but remain vulnerable to spotting and smoke-related impacts). Manitoba Hydro (2015a) summarized scientific literature related to forest fires which typically focus on boreal forest regions and may not be applicable to the entire Project area. Excerpts from Manitoba Hydro (2015a) are included below for quick reference:

- Although there is a lack of agreement about future forest fire regimes, historic analyses show that areas burned in the North American boreal forest have been increasing in the past 50 years, but still falls within long-term historic variability (Bergeron et al., 2010).
- Fires spread rapidly when fuel is dry and weather is warm, dry, and windy (Girardin and Mudelsee, 2008). The past 150 years have seen a lengthening of the fire cycle in parts of Manitoba which raises the risk of a large fire (Tardif, 2004; Flannigan et al., 2005a).
- Fire activity is influenced by weather, fuel, ignition agents, and human activity (Flannigan et al., 2005b). Weather is a key factor because it drives fuel moisture, soil moisture, lightning ignitions, and wind (Flannigan et al., 2005b). Area burned is linked to temperature (de Groot et al., 2013; Flannigan et al., 2005a), which is expected to rise into the future.
- Future severity and area burned are projected to increase (de Groot et al., 2013). Severity of fire weather is expected to increase across large portions of Canada, with an earlier start and lengthening of the fire season (de Groot et al., 2013). In southern Manitoba, a tripled atmospheric carbon dioxide concentration scenario projected 1.5 to 2 times greater burned area (Flannigan et al., 2005b). Lightning induced wildfires are expected to increase (Flannigan et al., 2005a; Flannigan et al., 2005b). For a moderate GHG emission scenario, wildfire occurrences fall within the range of the past 240 years (Girardin and Mudelsee, 2008).

Since 2015, several studies have contributed to the understanding of wildfire risk. Analyzing historic data, Hanes et al. (2019) report insignificant trends (1959-2015) in area burned and number of large fires for two fire-regime zones relevant to the Project. Significant trends (1980-2015) were found for decreasing number of human-caused fire (>200 hectares), an earlier end to the fire season, and a shorter fire season length in the Lake Winnipeg fire-regime zone. Conversely, a significant trend (1980-2015) was found for an earlier start to the fire season in the neighbouring Western Ontario fire-regime zone. For a broader, Boreal Shield West, region Coogan et al. (2020) show significant increasing trends in the number of fires (≥2 hectares; lightning- and human-caused) from 1959-2018, but trend direction is reversed (and insignificant) for the 1981-2018 time period. Coogan et al. (2020) also show humans to be the dominant cause of wildfire in the Project area which typically occur in spring (as opposed to lightning-caused fires which are more prevalent in summer). Human-caused fires show some evidence of decreasing trends (1981-2018).

Because of anthropogenic impacts like harvesting forests and climate change, Johnston et al. (2020) note that past fire risk may not appropriately represent future fire risk, and fire risk research is still in early stages in Canada. Recognizing there are some uncertainties, (e.g., projected magnitude of changes depending on location), Johnston et al. (2020) summarizes literature suggesting that climate change will bring more extreme weather, more frequent dry periods, and increased storm activity, which can increase wildfire risk. Similarly, Flannigan (2020) recognizes that increased temperature may lead to drier fuels, increased lightning, and a lengthening of the fire season. While projected precipitation increases may alleviate some warming-induced fire risk (i.e., due to drier fuels), this may not apply to all regions (Zhang et al., 2019). In addition to temperature and precipitation, Johnston et al. (2020) note that wind speed and relative humidity also form primary inputs to fire weather index systems. In the Project area, Manitoba Hydro (2020) shows strong agreement that temperature will increase and precipitation totals will increase in winter, spring, and fall, albeit there is less agreement surrounding projections to summer precipitation. The Project area is also projected to experience slightly reduced mean wind speeds in summer and fall, although this signal is not coincident with strong agreement. The balance of information reviewed herein suggests a high probability that wildfire activity will increase as a result of climate change.

Impact Topic(s)	Probability the Event Will Change
Infrastructure damage	High
Transmission line operation	High
Site access	High

2.3.11 WATER TEMPERATURE

Surface water temperature is related to atmospheric conditions (e.g., air temperature), inflows, topography, and the streambed (Caissie, 2006). In general, there is strong correlation between water temperature and air temperature, but the relationship can be more complex for deeper lakes with substantial heat storage (e.g., attenuation of diurnal and seasonal air temperature patterns) and in winter months when ice and snow can have an insulating effect. River and lake ice processes are closely linked to water and air temperatures and are discussed herein as both topics are of interest to the Project.

Long term, continuous, measurements of water temperature are less common than air temperature (e.g., Caissie, 2006; Islam, 2019). As part of the Pointe du Bois Sediment Management Plan, water temperature was collected near the powerhouse, but data is seasonal with gaps during ice formation (Fall) and melt (Spring). Because of missing data and the limited collection period, it is not meaningful to conduct trend analyses. Instead, multi-year averages are plotted to show a typical mean annual water temperature cycle (Figure 4). Like air temperature climatologies (e.g., Environment and Climate Change Canada's 'Climate Normals'), water temperature is greatest in July and August and coldest throughout winter months. Limitations in observed records and challenges with extended data collection in cold climates have prompted the use of numerical models to simulate water temperature. For example, using the physically based Air2Stream model, Islam et al., (2019), show that increasing water temperature trends (1950-2015) in western Canada were largely in response to increasing air temperature. The authors also note that further efforts are needed to explore future climate change impacts on water temperature that include changes to air temperature as well as streamflow. No such modelling exercise was undertaken herein, but it is likely that water temperature in the Project vicinity would behave in a similar fashion. Caissie (2006) discusses anthropogenic influences on water temperature and concludes that climate change will likely modify thermal river temperature regimes.

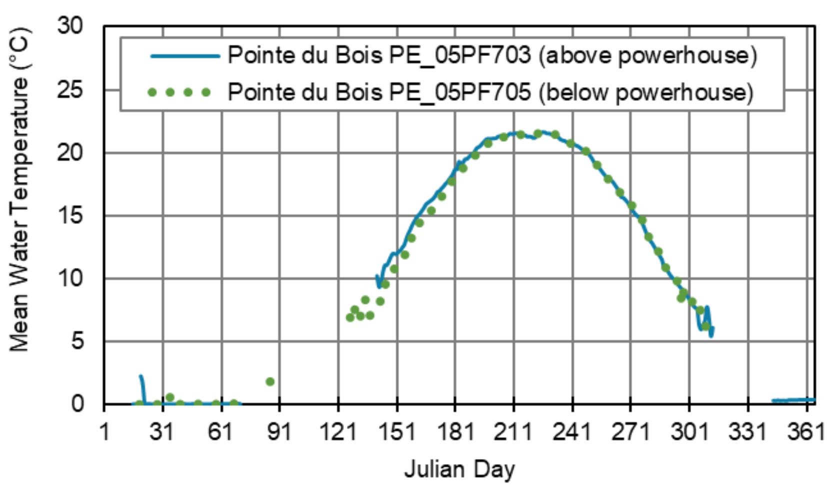


Figure 4 - Daily average water temperature measured at Pointe du Bois (2012-2019). Records are subject to considerable periods of missing data. As such, only days with at least two years of data are plotted.

Lake and river ice processes, which are in part a manifestation of water and air temperatures, have been the focus of other studies and often have longer records more suitable for trend analyses (e.g., Brown and Duguay, 2010). Later ice development, earlier ice breakup, and an overall reduction in the ice cover season duration has been observed across Canada with high confidence, but there is only medium confidence associated with future projections of earlier ice breakup and later fall freeze up

(Derksen et al., 2019). Medium confidence reflects uncertainty in snow accumulation projections, limitations of lake ice models, and generalization of lake characteristics such as depth. In the Project area, Derksen et al. (2019) show that future projections for a hypothetical 20 m deep lake would freeze eight to ten days later and breakup eight days earlier in 2041-2070 compared to 1961-1990 but this projection is based on a single regional climate model.

In the Project area, ice cover extent, thickness, and frequency of breakup events can impact travel (e.g., snowmobiling), recreation (e.g., ice fishing), and hydraulic structures (e.g., ice loads, frazil ice, operation of heating systems). Derksen et al. (2019) discuss some of the challenges in comprehensively understanding changing ice processes in the context of climate change due to uncertainties in seasonal flow regimes, snow cover changes (i.e., affect on ice thickness), and possibility for more frequent mid-winter breakup events. These challenges are echoed in Rokaya et al., (2018) who also show that watershed size and regulation play a role in historic trends of ice jam floods, although this is not a major concern for the Project due to predominantly lake-like conditions. While the science shows evidence that water temperature and duration of the ice cover season duration will change in response to future air temperature increases, there is less certainty how other ice processes (e.g., depth and frequency of mid-winter breakup events) are going to change. Probabilities are assigned accordingly.

Impact Topic(s)	Probability the Event Will Change
Equipment cooling efficiency	High
Ice cover season duration	High
River ice processes	Medium
Ice cover stability for resource usage	Medium
Sturgeon spawning	High
Fish community assemblage	High
Ability to practise rights-based activities	High

2.3.12 System-Wide Water Supply

Hydrological conditions within the Nelson-Churchill Watershed influence Manitoba Hydro's hydropower production. Wet conditions (i.e., higher inflows) provide opportunity for increased hydropower production while dry conditions (i.e., droughts) reduce hydropower production. In general, the average projection from ensembles of climate models show mean annual runoff in the Nelson-Churchill Watershed to increase slightly (Milly et al., 2005; Collins et al., 2013; Nohara et al., 2006; Sperna Weiland et al., 2012; Koirala et al., 2014; Manitoba Hydro, 2015b; Bonsal et al., 2019; Manitoba Hydro, 2020). While the climate model ensemble average typically indicates a runoff increase, it's important to note that not all projections agree on the direction of change which introduces some uncertainty. Furthermore, it can be challenging to find strong signals in regions with considerable noise due to natural climate variability.

Using internally simulated runoff from an ensemble of 40 GCM projections for the 2050s time period, Manitoba Hydro (2020) presents annual and seasonal runoff projections in the Nelson-Churchill

Watershed and its sub-basins. The ensemble median projects mean annual runoff to increase by +4.6% with 63% of the projections agreeing that runoff will increase. Projections from individual GCMs show a range from -20.5% to +52.8% with an interquartile range of -5.1% to +14.9%. Seasonally, there is moderate to strong GCM agreement that winter runoff will increase and weak to moderate agreement that spring runoff will decrease. This type of seasonal shift is a common finding in climate change studies for northern watersheds where warmer temperatures in combination with increased winter precipitation can increase mid-winter snow melt events and deplete the snowpack available for spring freshet. This seasonal shift is also apparent in hydrological modelling simulations using the WATFLOOD model (Manitoba Hydro, 2020).

Changes to annual and seasonal runoff is a reasonable indicator of overall water supply. However, from a hydropower production perspective, changes to flow quantiles that align with powerhouse capacities are of interest. These changes are more challenging to fully understand and require detailed hydrological modelling coupled with a water management model that incorporates the impact of reservoir operations. Climate changes to upper and lower flow quantiles that would occur in a naturalized river are expected to be somewhat attenuated through water management.

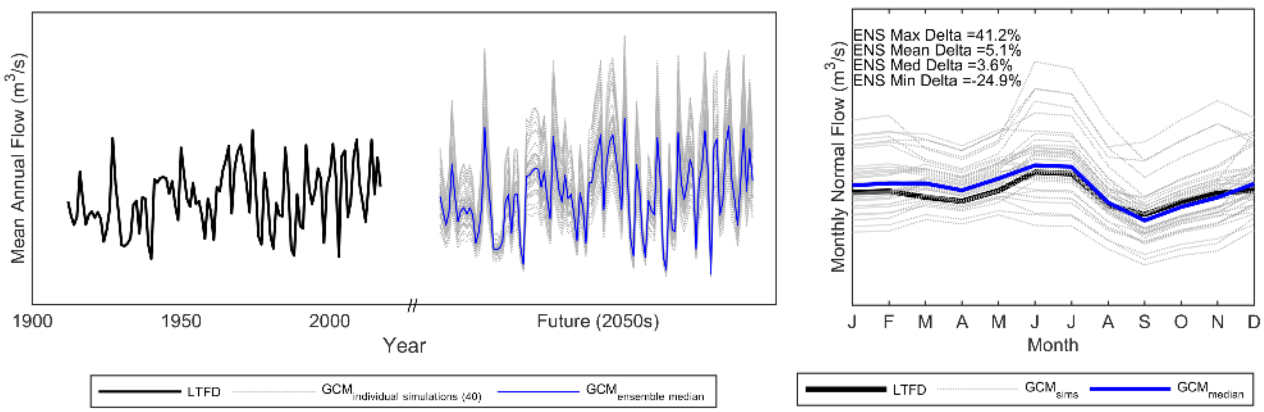
Impact Topic(s)	Probability the Event Will Change
System-wide energy production	Medium
Transmission system operation	Medium
Net revenue	Medium

2.3.13 Winnipeg River Streamflow

While system-wide water supply is relevant for broader climate resilience considerations, changes to Winnipeg River flow is of greater importance with respect to the Project. Manitoba Hydro uses a Long-Term Flow Dataset (LTFD) for resource planning activities including evaluation of Project economics (Manitoba Hydro, 2021a). LTFD is a monthly-resolution time series of inflows at key locations (i.e., sub-basins) in the Nelson-Churchill Watershed important to Manitoba Hydro's hydraulic generating system. LTFD is based on historic observations (1912-2017) and is adjusted to reflect present-day use (Manitoba Hydro, 2021a; Manitoba Hydro, 2013).

Working with the Ouranos Consortium, Manitoba Hydro used GCM temperature and precipitation projections, the WATFLOOD hydrological model, and post-processing techniques to generate 40 future LTFD scenarios (Fournier, 2020). GCM projections for 2040-2069 (relative to a 1981-2010 baseline) use an ensemble of 18 models and two future emissions scenarios (i.e., RCP4.5 and RCP8.5) which are described in Manitoba Hydro (2020). Future LTFD scenarios for the Winnipeg River are based on original LTFD time series, adjusted to account for seasonal climate change effects. Adjustments use a quantile-mapping technique such that extreme events (i.e., high and low flow) are corrected independent of median conditions and include a de-trending/re-trending step to preserve long-term climate change trends. Future LTFD scenarios for the Winnipeg River are illustrated in Figure 5 and were used to support more detailed production and economic modelling for the assessment of climate change resilience.

Figure 5 - Original Long-Term Flow Dataset (LTFD) and Future LTFD Scenarios for the Winnipeg River. Time series' of mean annual flows are shown on the left panel to illustrate sequencing of wet and dry years, monthly flow normals are shown in the right panel to illustrate seasonal changes.



Although there is some evidence that mean annual flow will increase (ensemble median change of +3.6%; Figure 5), an important consideration for energy production is how the distribution of flows are projected to change below thresholds corresponding to powerhouse flow capacity. The quantile mapping method facilitates this analysis and the flow quantiles of interest include: 183 m^3/s (capacity with only units 1, 15, and 16) and 650 m^3/s (capacity with units 1, 15, 16, plus 8 new units).

All 40 future LTFD scenarios developed for Fournier et al. (2020) show an increase in the percentage of time the Winnipeg River experiences mean monthly flow below 183 m^3/s, and 27 of 40 future scenarios show an increase in the percentage of time mean monthly flows are below 650 m^3/s. However, it is important to note that the WATFLOOD model excludes regulation and diversions including Lake of the Woods, Lac Seul, and Lake St. Joseph. It is conceivable that regulation could flatten the hydrograph (e.g., Déry et al., 2018) and attenuate some of the change to the upper and lower flow quantiles (i.e., storing water during higher flow periods, releasing during lower flow periods, and maintaining minimum reservoir outflow requirements). The effect of regulation in reducing streamflow variability is seen at the seasonal scale in Ferrazzi et al. (2019) but may be less apparent at finer temporal scales. Using baseline (1981-2010) and future (2040-2069) simulated mean monthly regulated flow on the Winnipeg River (data from Tefs et al., in revision), 13 out of 19 future scenarios project increasing time when regulated flows are less than 650 m^3/s. The median projection from the ensemble of future simulations suggests that mean monthly regulated flows less than 650 m^3/s may be experienced approximately 8% more frequently in the future. This finding is not entirely surprising as 11 of 19 simulations also project mean monthly flow to decrease (ensemble median decrease of 1%) and methods used to simulate regulation (Tefs et al., in revision) allow daily reservoir outflow adjustments to meet target reservoir water levels. This regulation approach is numerically pragmatic but may deviate from actual day-to-day operations where rapid outflow adjustments could be less desirable compared to more uniform discharge. Furthermore, it remains unclear how future upstream regulation practices may evolve in response to climate change, energy demand patterns, and other social factors.

For the purpose of this Climate Change Resilience Assessment, future LTFD scenarios are taken at face value to explore possible future flow scenarios. Because of uncertainties related to regulation effects, we assign medium probability that low flow quantiles will change in the future. Accordingly, there is medium probability associated with all listed impacts. Understanding climate change impacts on hydrology in greater detail is a work in progress and remains an area for further study to explore potential reduction of uncertainties.

Impact Topic(s)	Probability the Event Will Change
Energy production	Medium
Reservoir operation	Medium

2.3.14 WINNIPEG RIVER DROUGHT

Droughts can reduce hydroelectric production, require external heating sources to maintain temperature in a powerhouse during winter, and affect aquatic habitats. As such, drought is an important climate-related risk, however, it is critical to recognize that there are several drought types including meteorological, agricultural, hydrological, and socio-economic (Heim, 2002). Each type has unique characteristics such as the variables used in their definition (e.g., deficit of precipitation, soil moisture, streamflow, economic impact). And while it is understood that different drought types can be linked (e.g., meteorological drought could eventually manifest as hydrological drought), there are time (i.e., persistence) and space (i.e., extent) components that are specifically relevant for Manitoba Hydro and the Project. Here we refer to drought as sustained periods (e.g., ≥ one year) of low streamflow. While GCMs are skilled at reproducing average climatic conditions; there is less certainty in projections of future droughts (e.g., Trenberth et al., 2014; Bonsal et al., 2020). Understanding climate change impacts on extreme hydrological drought remains an area of interest and a topic for ongoing research at Manitoba Hydro.

Future LTFD scenarios (Section 2.3.13) project increasing mean annual streamflow in the Winnipeg River, but also show potential for an individual year in the future to be drier than an individual year in the historic period (e.g., Figure 5). Considering the driest historic year on record (1940; 444 m^3/s mean annual flow), the ensemble median of the 40 future LTFD scenarios suggests a repeated 1940 event could result in a mean annual flow of 402 m^3/s. For the 25th percentile historic year (1921; 755 m^3/s mean annual flow), the ensemble median future LTFD scenario suggests a repeated 1921 event could result in a mean annual flow of 782 m^3/s. Similar to discussion in Section 2.3.13, it is prudent to note that WATFLOOD modeling used to generate future LTFD scenarios did not include reservoir regulation and diversions which would likely mitigate some of the low flow conditions. At the sub-annual scale, Prudhomme, et al., (2014) and Giuntoli et al., (2015) show increasing number of days experiencing low flows in the Project area, but with negligible model agreement. In contrast, Koirala et al., (2014) show sub-annual low flows to increase in the future with moderate model agreement. Contrasting findings highlight some of the uncertainty associated with projecting future changes to low flow conditions.

Beyond the Winnipeg River, it is important to recognize that droughts occurring in the Nelson-Churchill Watershed can also impact Manitoba Hydro operations and are relevant in the context of climate change resilience. Manitoba Hydro's system is designed to meet projections of firm load (domestic load and contract export load) under a range of flow cases (more than 100 years) which include multi-year drought events. Based on historic data and ongoing review, the severity of the (system-wide) hydrologic drought of record has an estimated return period on the order of 150 to 400 years which is consistent with findings in Kubursi and Magee (2010), Akintuğ (2006), and DeWit (1995). Projecting changes in future drought is challenging due to the complex nature of multi-year, system-wide, drought and large uncertainties (Bonsal et al., 2019; Vieira, 2016).

Impact Topic(s)	Probability the Event Will Change
Energy production	Medium
Powerhouse heating	Medium
Aquatic habitat	Medium

2.3.15 WINNIPEG RIVER FLOOD

WATFLOOD simulations (Manitoba Hydro, 2020), LTFD scenarios (Section 2.3.13), existing published literature, and ongoing research on the topic contribute to the understanding of changes to floods on the Winnipeg River at Pointe du Bois. Winnipeg River floods can affect multiple Project components including spillway operations and dam safety. Winnipeg River flood events can also impact public safety by increasing water velocities, flooding shorelines and causing floating debris hazards. This can affect waterway recreation, travel, and resource harvesting, including harvesting by Indigenous peoples.

Using historic flow records from stations with good quality data and minimal anthropogenic influence (e.g., unregulated), Burn and Whitfield (2015) characterize flood regimes and explore trends in flood magnitude and timing. Unregulated gauges in the Winnipeg River Basin are characterized as having nival (snowmelt dominated) flood regimes. Most trends were statistically insignificant, and no consistent spatial signal was found. However, some gauges indicate reduced flood magnitude, later flood peak, longer durations of flows in the top 10%, and reduced frequency and duration of flows in the top 0.5%. For one unregulated station near the Project area, Cunderlik and Ouarda (2009) found insignificant trends in spring snowmelt flood magnitude and timing over the 1974-2003 period.

Using future LTFD scenarios, projected changes in extreme values of monthly mean flows were explored. We recognize that mean monthly flow may not capture the level of detail required to fully appreciate flood risk, as the common variable of interest relates to instantaneous (e.g., daily) flows, but the two are found to have strong correlation in large basins (e.g., Milly et al., 2002). Like previous sections, we also recognize limitations associated with the LTFD scenarios (monthly temperature and precipitation deltas from GCMs; no water management in WATFLOOD). However, we explored monthly data from Future LTFD scenarios to provide some indication of changing flood risk. Considering the highest flow month on record (July 2014; 2,495 m^3/s), the ensemble median of 40 future LTFD scenarios suggests a repeated event could result in mean monthly flow of 2,720 m^3/s (a 9% increase). From the ensemble, 70% of the scenarios agree there will be an increase (30% agree there will be a decrease) in maximum monthly flow.

Design floods of relevance to the Project are based on daily flows. In July 2014, daily flow peaked at 2,616 m^3/s which nearly matched the highest recorded flow of 2,618 m^3/s in October 1992. Both events lie well below the 1,000-year event (4,280 m^3/s) which marks the Spillway Design Flood (SDF). The station's Inflow Design Flood (IDF; 5,040 m^3/s) is calculated as one third of the way between the 1,000-year event and the Probable Maximum Flood (PMF; 6570 m^3/s) and selected due to "High" incremental consequence classification based on economic damage and loss of life estimates. The IDF must be safely passed without encroaching within allowable freeboard and considers surcharge due to flow balancing, wind generated waves, and ice. The SDF must be passed without surcharging the reservoir above normal full supply level of 299.1 m.

Climate change impacts to other spillway-related flow quantiles are also of interest. For example, during maintenance and inspections, a spillway gate is closed to stop water from entering the water passage, and a stoplog is placed near the downstream apron to protect the work area from water which may back-up from the downstream tailrace area. Stoplog heights were selected to protect the work area from the tailwater flows of 740 m^3/s. However, similar to other flow quantiles, there is a lack of confidence in projected change.

Using runoff data from an ensemble of 21 GCMs, Gaur et al. (2018) project static or increasing return periods for 100- and 250-year flood events in the Winnipeg River Basin for the 2061-2100 period relative to the 1961-2005 period. This finding suggests reduced risk of large floods in the future, but authors note results in northern Ontario and the Prairies region to be among the most uncertain. Fluixá-Sanmartín et al. (2018) show increasing return period for the 100-year flood in the Project area and discuss various sources of uncertainty. Koirala et al. (2014) found negligible to weak GCM agreement in the Project area for changes in high flow events (exceeded 5% of the time). Under a quadrupling atmospheric carbon dioxide concentration scenario, Milly et al. (2002) projects a 100-year flood event on the Nelson River (a much larger drainage area that includes the Winnipeg River) is projected to occur roughly every 11 years, however, authors did not find any significant changes in the 50-year flood events. Manitoba Hydro's LTFD scenario analysis and a sample of literature presented herein underscore considerable uncertainty in projecting changes to future extreme streamflow.

Impact Topic(s)	Probability the Event Will Change
Freeboard and flood passage	Medium
Reservoir levels and operational strategies	Medium
Spillway operation, maintenance, and access	Medium
Public waterway safety	Medium

2.3.16 OTHER OVERLAND FLOODING

Beyond flooding on the Winnipeg River (Section 2.3.15) localized flooding can result from intense precipitation that exceeds local drainage capacity or other mechanisms (e.g., snow accumulation, melt sequence, precipitation) that lead to flooding in other rivers of interest. Regardless of the cause, potential increases in flooding could inundate infrastructure (e.g., towers, stations) located near river crossings or in low lying areas. This may result in access issues, physical damage (e.g., from ice/debris), erosion to tower foundations, and reduced clearances and separations from electrical equipment. Manitoba Hydro (2015a) projects daily precipitation at the upper end of the distribution (66th to 99th percentile) to increase by 12.5% in the 2080s. Under a scenario where global mean temperature increases by +2.1°C beyond preindustrial levels, Li et al. (2018) projects 0 to 2 additional days where precipitation exceeds 10 mm in southern Manitoba. For the Prairies region, the multi-model median projection in Zhang et al. (2019) is +5.0% to +6.5% for annual mean precipitation, and, +6.1% to +10.0% to the 50-year event annual maximum 24-hour precipitation (2031-2050 period). Projected changes to other flood driving mechanisms are less certain. For example, a key message in Bonsal et al., (2019) states that "*Projected higher temperatures will result in a shift toward earlier floods associated with spring snowmelt, ice jams, and rain-on-snow events (medium confidence). It is uncertain how projected higher temperatures and reductions in snow cover will combine to affect the frequency and magnitude of future snowmelt-related flooding.*" Manitoba Hydro (2015a) summarized additional literature related to floods. Excerpts from Manitoba Hydro (2015a) are included below for quick reference:

- Challenges exist in characterizing historic and future floods due to different flood drivers (e.g., snowmelt, precipitation, ice jamming), complex terrain (e.g., non-contributing areas) and anthropogenic interaction (e.g., river diversions, withdrawals, drainage improvements).
- Precipitation is projected to increase on average within the Project area, but this does not necessarily correspond to increased flood risk. For example, while winter precipitation is projected to increase, warmer temperatures may lead to less snow accumulation which could result in lower spring melt and lower spring flood peaks (Whitfield, 2012).
- On a global scale, the Intergovernmental Panel on Climate Change (IPCC) has overall low confidence in observed trends and projections of floods (IPCC, 2013; IPCC SREX, 2012). The IPCC Special Report on Extremes (IPCC SREX, 2012) suggests that there is medium confidence that floods driven by heavy rainfall could increase into the future in some regions and that earlier spring peak flows are likely in snowmelt fed rivers; but there is low confidence on the projected magnitude of change.

Impact Topic(s)	Probability the Event Will Change
Site access	Medium
Transmission line access	Medium
Transmission line conductor clearances	Medium

2.3.17 CANADIAN GOVERNMENT POLICY

The Canadian energy sector is facing increasing regulation and legislation aimed at reducing GHG emissions. One driver for such change is the Paris Agreement (United Nations, 2015), under which Canada committed to reduce GHG emissions and achieve net-zero GHG emissions by 2050. Several policies are in place and more are developing that will discourage GHG emitting electricity generation and encourage electrification (e.g., transportation sector). Many of Manitoba Hydro's large customers face similar policy influences, with added pressure from investors, lenders, shareholders, and customers to apply Environmental, Social and Governance criteria in their decision-making and planning processes. In general, the development of non-emitting electricity sources, such as that provided by the Project, positions Manitoba Hydro and rate payers to respond to this transitional risk and take advantage of opportunity.

To support Paris Agreement commitments, Canada has introduced several plans, frameworks, acts and regulations including the Pan Canadian Framework on Clean Growth and Climate Change (ECCC, 2016), Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity regulations (Canada, 2021a), Regulations Limiting Carbon Dioxide Emissions from Natural Gas-fired Generation of Electricity (Canada, 2021b), and the Clean Fuel Regulation which is anticipated to come into force on December 2022 (Canada, 2020a). The Canadian Net-Zero Emissions Accountability Act was introduced on November 19, 2020 and would require national GHG emission reduction targets tabled and monitored in Parliament to promote transparency and accountability. While the bill has not yet become law, on December 11, 2020 the Minister of ECCC released A Healthy Environment and a Healthy Economy (ECCC, 2020), its strengthened climate strategy to exceed 2030 GHG emission reduction targets, including a goal to achieve net-zero GHG emissions in Canada's electricity generation industry before 2050.

The Throne Speech (Canada, 2020b) and Fall Economic Statement (Canada, 2020c) describe plans to simultaneously help economic recovery from the COVID-19 pandemic while accelerating decarbonization. In addition to exceeding GHG emission reduction targets, funding energy efficiency building retrofits, and making zero-emission vehicles more affordable, commitments were also made to support projects that connect surplus clean energy with regions transitioning away from fossil fuels, make Canada the most competitive jurisdiction in the world for clean technology companies, and invest in renewable energy, next generation clean energy, and technology solutions. Given the increasing trend within Canada towards policies that limit GHG emissions, accelerate electrification, and/or encourage switching to less GHG-intensive energy sources, it is highly probable that changes will occur in the timeframe of interest.

Impact Topic(s)	Probability the Event Will Change
Demand for non-emitting electricity	High
Electrification and/or fuel switching	High

2.3.18 U.S. Export Market Policy

Canada is not alone in pursuing legislation and related measures aimed at decarbonizing its economy. Notably, some of the world's largest economies have committed to achieving net-zero GHG emissions, including China (by 2060), Japan (by 2050), the United Kingdom (by 2050), France (by 2050), Sweden (by 2045), New Zealand (by 2050), Hungary (by 2050), and South Korea (2050). The European Union has also proposed a law that aims to reduce GHG emissions to net-zero by 2050, and U.S. ambitions aim to achieve the same.

Upon taking office, President Biden described climate change as one of the four historic crises facing the U.S. and issued Executive Orders aimed at increasing climate change mitigation ambition within and outside of the U.S. Among the many actions he outlined, President Biden set a goal to achieve a "carbon pollution-free" electricity sector by 2035 and design new regulations to limit GHG emissions from existing power plants through the U.S. Environmental Protection Agency. At the sub-federal level, many U.S. states and cities are also taking action to reduce their GHG emissions. For example, the Governors of Wisconsin and Minnesota have set goals to decarbonize their electricity sectors as well as reduce GHG emissions within their broader state economies. Recent announcements change in political administration, commitments at sub-federal levels, and overall global trends towards decarbonization suggest a high probability that changes will occur in the timeframe of interest.

Impact Topic(s)	Probability the Event Will Change
Demand for non-emitting electricity	High
Funding for U.S. clean energy projects	High

2.4 RISK ANALYSIS AND EVALUATION

This section characterizes the consequence of climate change for each impact topic considering the existing controls in place and the resulting tolerance. Existing controls include some that are inherent in Project design and others that stem from the Project's interconnectivity with Manitoba Hydro's existing generation and transmission network. In certain cases, project-specific (Direct) risks are complemented with Indirect and Systemic risks to Manitoba Hydro and where the Project provides opportunities to help mitigate risk. Probability (from Section 2.3) is included herein to assign risk ratings based on Table 2. When appropriate, tolerance, existing controls, and uncertainty in future climate projections are factored into risk ratings which may deviate from the matrix in Table 2. Each impact topic associates with a risk rating in at least one risk category (i.e., Direct, Indirect, Systemic) and N/A is used to denote categories where a risk rating was not assigned (e.g., out of scope). N/A is also used to denote when tolerance is not applicable (i.e., for an opportunity). Risk ratings are then used to compare and rank risks.

2.4.1 EXTREME HEAT

More frequent and/or warmer extreme temperature events can ultimately lead to temporary reductions in transmission line capacity due to an increase in conductor sag and resulting clearance violations. A large majority of Manitoba Hydro's electrical transmission system is planned and designed for a static summer ampacity with an ambient temperature of 40°C and 2.2 km/h wind (Swatek, 2004). The literature in Section 2.3.1 projects an increase of 10 to 20 additional hot days (where maximum temperature exceeds 30°C), but there is less expectation that days in excess of 40°C will increase substantially in the 2050s (ClimateData.ca, 2021). Furthermore, it is not well understood how many hours per day temperatures will remain above a given threshold or what wind conditions will be like during those hours. Understanding of sub-daily temperature changes is limited by available climate model data (and downscaling techniques) which are typically limited to daily maximum and daily minimum temperatures. With the given information and overall agreement among projections that future temperature will increase, it is fair to expect a slight increase in extreme heat events impacting the Project. These events may affect Project operation for a few hours during a few days per year on average and will likely occur during summer months.

Manitoba Hydro's transmission system is operated based on constraints that assume summer ambient conditions of 40°C and 2.2 km/h wind. If constraints are realized, System Control Centre (SCC) considers whether use of actual ambient conditions would provide a better rating and relieve constraints. If system constraints are not relieved by use of actual ambient conditions, then other mitigation strategies include generation re-dispatch, transmission reconfiguration (i.e., transferring load), or ultimately load shed. Treating risk through Project design parameters does not mitigate the risk completely as the transmission system is operated as a whole, and the Project could still be limited by extreme heat effects on other parts of the system. Instead, the risk is best mitigated through the continued practice of monitoring constraints and ambient conditions and operating accordingly. As weather forecast models from government agencies continue to improve, it is anticipated that transmission system operations will have better lead time warning for extreme heat events which will allow for improved planning. Furthermore, the existing generation capacity within Manitoba, or imported electricity from neighbouring regions, may be available to compensate for temporary rating reductions on Transmission facilities limiting generation output at Pointe du Bois.

Extreme heat events can also affect the health and safety of field crews and station staff. Isolated events (i.e., 10 to 20 additional hot days per year) can be accommodated in similar fashions to the way that hot days are currently accommodated. For example, staff are encouraged to take appropriate breaks (in air-conditioned spaces where available), limit exposure to heat, and increase water intake. If extreme heat conditions become exceptionally problematic, it is possible that work schedules could be revisited to align with cooler periods of the day and it is also possible to dispatch external cooling equipment (e.g., inside the powerhouse). The ability to manage impacts on workers results in low consequence and high tolerance to such events. Under extreme circumstances, additional portable cooling equipment inside the powerhouse could be deployed to manage heat generated by the hydroelectric units as is currently done at other facilities (e.g., Slave Falls Generating Station). The generating units are designed for ambient temperatures of 40°C and equipped with sensors for ongoing temperature monitoring.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Transmission line operation	Medium	Low	Low	N/A	N/A	High
Conductor to ground clearances	Medium	Low	Low	N/A	N/A	High
Workers	High	Low	Medium	N/A	N/A	High
Powerhouse equipment cooling	Medium	Low	Low	N/A	N/A	High

2.4.2 WINTER TEMPERATURE

Construction planning considers historic weather normals, variability, and the potential occurrence of a warm winter. A majority of the PW75 route will traverse terrain typical of the Canadian Shield, consisting of forested areas, rock outcrops, and intermittent swamp/muskeg. From an economic and environmental standpoint, it is expected to be most advantageous to complete construction during winter months as frozen ground conditions facilitate access through the swamp/muskeg areas. It is planned for the construction to occur across two winter construction seasons, which will help protect against access delays which could be experienced during a warmer than expected winter. Further risk mitigation can be achieved through deployment of temporary rig matting, specialized all-terrain equipment, and identifying work activities which can be advanced during unfrozen conditions. As a last resort, helicopter-assisted construction methods could be employed, but these are not preferred due to increased cost, schedule, and GHG emissions. Individual days with extreme temperature (cold or hot) are not expected to affect construction activities as these events are typically short duration and work can be scheduled accordingly.

Manitoba Hydro maintains an extensive network of transmission and distribution lines, which traverse a wide range of topography and terrain. Some of these lines are built through very wet swamp/muskeg areas, and access with traditional equipment can prove near impossible during unfrozen conditions. While major work activities in these areas are usually scheduled to take advantage of frozen ground conditions, Manitoba Hydro must be prepared with the ability to access and restore these lines during any season or weather condition. To facilitate such response, Manitoba Hydro has an extensive fleet of all terrain equipment, including tracked buckets, cranes, matting, and personnel movers. Helicopter-assisted work methods have also been developed for exceptionally hard to access locations. With current work methods and equipment fleet, which already take into account a high degree of variability in temperature and severe weather, it is not expected that climactic changes will pose too much of a hindrance to transmission line access for operational and maintenance purpose. Lower priority maintenance activities may need to be rescheduled in the event of warm weather impacting the ability to gain access on frozen ground, but critical work will still be possible by means of existing methods and fleet.

Increasing winter temperature is expected to decrease the need for powerhouse heating, on average. Heating the powerhouse is typically achieved using heat created by the operation of the existing hydroelectric generators which will increase once new units are installed. The combined effect of reduced heating requirements and additional heat generation available from the Project have low financial implications and provide an opportunity (e.g., reduced requirement for external heating) rather than a risk.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Transmission line construction and refurbishment	Low	Low	Low	N/A	N/A	High
Transmission line access for operation & maintenance	High	Low	Medium	N/A	N/A	High
Powerhouse heating	High	Low	N/A	Opportunity	N/A	N/A

2.4.3 General Air Temperature Increases

General air temperature increases that are expected to occur will contribute to decreasing annual energy demand into the future, however the seasonal affect is expected to be more pronounced. Looking at the weather affected load in isolation of other changes to energy demand, it is not expected to significantly alter the need and timing of new energy resources on Manitoba Hydro's system. The net impact of reduced winter energy demand (for space heating) and increased summer energy demand (for space cooling) could potentially change and is likely to defer the timing of new energy resources, but not cause an increase or decrease in total capital spending. The gradual change and scale of the timing of the heating and cooling electrical loads in comparison to Manitoba's total energy needs is tolerable and can be managed with continued long-term planning practice. These impacts occur with and without the Project and where the additional generation resulting from the Project provides an opportunity to partially mitigate these impacts.

In addition to changing energy demand, instantaneous peak demand is also influenced by weather and may change with climate. Currently, Manitoba Hydro's domestic load peaks in winter as cold temperatures drive space heating. In a winter peaking configuration, cold ambient temperatures offer improved transmission line capacity due to heat transfer from conductors and equipment to the surrounding air. As temperatures increase, electricity required for space heating in winter will decline and electricity required for air conditioning in summer will increase. Increasing summer loads coupled with less favourable (warmer) ambient conditions can create challenges from transmission operations and system planning perspectives. With respect to the Manitoba Hydro system, consequences are low (financial, system reliability, customer reputation) and projected system changes to summer peak demand for the 2050s (Manitoba Hydro, 2015) are within acceptable tolerance. From a broader perspective (e.g., longer term system planning), it is anticipated that this slow onset event can be accommodated (e.g., management of summer export commitments).

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Weather affected energy demand	High	Low	N/A	N/A	Opportunity	N/A
Transmission operation during peak demand	High	Low	Low[1]	N/A	Medium	High

[1]Assignment deviates from Table 2 risk matrix due to tolerance and professional judgment.

2.4.4 WIND SPEED

Extreme wind speeds that cause loading beyond the design can result in failure of Project assets (e.g., transmission towers, conductors, insulators; medium consequence) and momentary flashovers with negligible consequences. Older infrastructure (e.g., S1/S2, R1/R2) is arguably more susceptible to damage from wind due to age, wear, and earlier standards used in their design. Impacts are in part mitigated through inclusion of PW75 as part of the Project which provides a new, geographically separated, line built to current standards, to transmit electricity generated from the Project.

Design of PW75 will follow the applicable Canadian Standards Association (CSA) overhead transmission line design standards (e.g., CSA, 2019; CSA, 2020). CSA (2019) is based on an international standard by the International Electrotechnical Commission. Wind and ice loads in CSA (2019) include updated information prepared in 2009 through a Centre for Energy Advancement and Technical Innovation led project (CEATI, 2009). More recently, Manitoba Hydro commissioned studies to update wind and ice loads for Manitoba (e.g., Morris, 2016) which was then coupled with CSA climatic load scenarios for use in design. Manitoba Hydro follows a reliability-based design process such that the design event is associated with a probabilistic return period. The Project was designed to a 150-year event and includes failure containment loads to improve the resiliency of the transmission line by minimizing the probability of an uncontrolled propagation of failures (cascades) should a tower or section of line fail due to loads exceeding a 150-year event.

Changes to wind speed can affect wave action which in turn can play a role in the erosion process. Impacts on reservoir erosion have a low consequence and high tolerance due to a primarily bedrock shoreline and a mature reservoir (>100 years) where most of the erosion has already occurred. While a reduced ice cover season duration and changing flood events (Section 2.3.11 and Section 2.3.15) could also affect erosion, consequences remain low for the reasons stated. In an environmental assessment of a new spillway at Pointe du Bois, Manitoba Hydro (2011a; Chapter 8 "Potential Environmental Effects and Mitigation") concludes that there will be no change to shoreline or riverine erosion processes due to improved control of forebay water levels. The same finding applies to the current Project.

Available freeboard can be impacted by changes in sustained wind speeds. A slight tendency towards small magnitude reductions in summer mean wind speed (Section 2.3.4), uncertainty in climate projections and extreme winds, together with freeboard design practices align with an overall low consequence associated with climate change impacts on waves and freeboard. The freeboard requirements for embankment and concrete dams satisfy the highest combination of wave runup and wind setup on the forebay levels respective to the design conditions considered. Freeboard is also of concern during flood events and is further discussed in Section 2.3.15 and 2.4.15.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Transmission structural and mechanical design	Medium	Medium	Medium	N/A	N/A	High
Shoreline erosion	Medium	Low	N/A	Low	N/A	High
Freeboard and wave action	Medium	Low	N/A	Low	N/A	High

2.4.5 Near Freezing Precipitation

The Project's impacts, consequences, and tolerances to near freezing precipitation events are very similar to wind speed events (Section 2.4.4) with the primary concern being loading beyond design, resulting in physical damage to transmission assets (e.g., towers, conductors, insulators) and corresponding outages. Resulting consequences are characterized as medium (financial, reliability) and tolerance is high due to the inclusion of PW75.

Beyond infrastructure damage, near freezing precipitation can also restrict safe road travel to and from the Project site. Depending on storm magnitude, unsafe driving conditions can persist for hours or days with an associated low (financial) consequence. High tolerance to such events is achieved though the ability to monitor and operate and some parts of the station remotely, safe driver training, well maintained highways, and continuous staffing on site at all times.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Transmission structural and mechanical design	Medium	Medium	Medium	N/A	N/A	High
Road travel safety	Medium	Low	N/A	Low	N/A	High

2.4.6 Convective Storms

Convective storms characterize broader events that may include damaging wind, hail, localized heavy rainfall rates, lightning, and tornadoes. The consequence can range from more common, shorter term, outages (e.g., lightning strikes causing tripping) to more unlikely extended outages (e.g., if a tornado or downburst wind intersected the Project). Tripping/flashover related events are relatively minor and can be managed with minimal cost or service interruption. More severe impacts, such as those resulting from tornadoes, include wider spread infrastructure damage that may require replacement and/or repair of several structures (medium consequence).

To mitigate lightning risks, sky wires are installed on transmission towers above conductors. No existing controls are in place for hail as the potential for damage is very low. With respect to downburst winds and tornadoes, Manitoba Hydro crews are trained to respond to these types of events which helps to reduce the impact on customers. Two historic events are provided as an example (from Manitoba Hydro, 2011b). On September 5, 1996, nineteen Bipole I and II towers failed due to a downburst wind event near Winnipeg, Manitoba. One of the lines was restored in five days with full restoration of lines completed by late October 1996. Recognizing the extensive damage and amount of generation cut off from the system due to this event, it is noteworthy that customers were not affected as lost power was replaced by imports. On June 22, 2007, an F5 tornado near Elie, Manitoba resulted in thousands of customers without service. Over the course of two days, service was restored.

PW75 provides transmission system redundancy with geographic separation from existing lines. Design of PW75 incorporates consideration for localized, high impact, weather events like tornadoes. This is achieved through inclusion of failure containment loads where tower failure on one segment of the line does not propagate far beyond the point of failure. These security requirements will mitigate the risk of cascading failure and will improve the resilience of PW75 compared to older design philosophies such as those used for R1/R2 and S1/S2.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Infrastructure damage (multiple)	Medium	Medium	Medium	N/A	N/A	High
Transmission line operation	Medium	Medium	Medium	N/A	N/A	High

2.4.7 Freeze-Thaw Cycles

Section 2.3.7 presents some evidence that annual freeze-thaw cycles will decrease in the future. With this projected reduction in the freeze-thaw cycles, the concrete deterioration rate is expected to decrease, however there remains some uncertainty in freeze-thaw cycle projections. If the number of freeze-thaw cycles were to increase, there would be very low (financial) consequence which may include increased surveillance intervals and maintenance requirements. The powerhouse will be heated in the winter so that freezing of concrete does not occur within the powerhouse. Project concrete work beyond the powerhouse, including some PW75 foundations, exposed to freeze-thaw will be designed to consider freeze-thaw cycles, as was the concrete used in construction of the new spillway. Concrete resistance to freeze-thaw is achieved through admixtures such as air entrainment which protect against expansive forces as liquid water shifts phases to solid ice (Dolen et al., 2003). The condition of the concrete will be monitored into the future and would undergo further repairs, if required. Accelerated concrete deterioration is not an issue on R1/R2 and S1/S2 which utilize steel foundations.

In addition to freeze-thaw cycles, Alkali-Aggregate Reaction (AAR) processes are temperature dependent and could contribute to accelerated concrete deterioration. However, the change in reaction rate resulting from a 1°C to 3°C increase in mean annual temperature would likely be minimal and nearly impossible to measure on an annual basis. Over the course of 50 years, there may be an increase in damage associated with AAR, but it is unlikely to be much greater than the damage accrued without an increase in mean annual temperature. AAR damage allows for increased freeze-thaw damage as it allows for further ingress of water into the structure through fractures created in the AAR process. This process is on-going at Pointe du Bois and is predominantly dependent on the number of freeze/thaw cycles. Concrete repairs to extend the life of the powerhouse will mitigate existing AAR concerns through design, materials selection, and materials testing.

In certain conditions, freeze-thaw cycles may also affect the movement of shallow foundations. For this to occur, three things are needed: frost susceptible soils, moisture, and shallow foundations. Since R1/R2 and S1/S2 are not subject to these three conditions, impacts due to shallow foundation movement on these transmission lines are negligible (assigned low financial consequence).

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Concrete deterioration	Low	Low	N/A	Low	N/A	High
Movement of shallow foundations	Low	Low	Low	N/A	N/A	High

2.4.8 Snow Accumulation

While there are indications that snow cover extent could decrease with warmer temperatures, there remains considerable uncertainty in how design snow (and rain) loads may change in the future (hence medium probability in Section 2.3.8). Changes in snow and rain loads can have a resulting impact on existing project infrastructure including powerhouse roof sections where an increased loading scenario increases risk and a reduced loading decreases risk.

It is worth recognizing that the Pointe du Bois powerhouse has been in operation for over 100 years. And although there is limited local snow accumulation data over this period, it is understood that the existing roof has sustained a wide range of historic structural loading conditions. Should new information or observations surface that confidently indicate increasing snow accumulation and the roof structure found to have deficient snow load capacity then operational procedures such as partial or full removal of snow on roofs or structural modifications could be explored and implemented. While it is recognized that *snow removal by mechanical, thermal, manual, or other means shall not be used as rationale to reduce design snow loads* (NRC, 2015; Rule 4.1.6.14) such activities may provide some value in response to climate change impacts, should the need arise.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Design snow loads	Medium	Low	N/A	Low	N/A	High

2.4.9 VEGETATION

The rate of vegetation growth is expected to increase into the future which can impact the Project right-of-way and increase fuel sources for wildfires. Consequences associated with increased vegetation growth are relatively low as incremental changes are expected to be small and occur gradually over time; the transmission lines are regularly patrolled and inventoried for deficiencies and vegetation growth monitoring; and there is usually sufficient lead-time to accommodate changes, as required. There is potential for the other vegetation-related impacts, such as changes to insect and vegetation distribution and subsequent clearing restrictions. However, these types of restrictions typically take place over certain seasons and can be planned for.

Manitoba Hydro manages vegetation on transmission and distribution corridors by annual or long-term plans which include surveying the vegetation, developing management plans, and executing management plans by staff or external workforce. Vegetation management may include methods such as agricultural cultivation (crops), grazing, secondary land use agreements (e.g., public greenway), blading, brushing, pruning, cutting, mowing, and herbicide application. When warranted, right-of-way widening may also be considered as a vegetation management option (after securing appropriate regulatory approvals). Manitoba Hydro manages transmission corridors based on the design and operation standards applicable to that corridor (e.g., conductor sag and sway, wind, and temperature). New corridors for PW75 will utilize a right-of-way that is cleared to meet current standards. Similarly, portions of existing corridors (P3/P4) utilized for PW75 will be widened to meet current standards.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Transmission line operation and maintenance	High	Low	Medium	N/A	N/A	Medium

2.4.10 WILDFIRE

Heat and smoke generated from wildfires can have impacts including the potential for physical damage to infrastructure and could result in an increased risk of flashover on the transmission lines. If exposed to a major wildfire event, either of the two outlet transmission lines could experience an outage with minimal impact to customers or plant generation. Impacts of potential wildfires on transmission line operation would have a low consequence because the two outlet transmission lines provide redundancy and physical separation. It is unlikely that both transmission lines would be impacted by a wildfire at the same time.

Johnston (2020) found that with sufficient distance from flaming fronts (e.g., 30 m), structures are unlikely to ignite from heat transfer, but spotting (new ignition caused by wind-driven movement of sparks and embers beyond the wildfire's direct ignition area) can still pose a potential major impact. Compared to other Project infrastructure, transmission lines are more susceptible to wildfire damage due to their proximity to vegetation in remote areas. However, potential damage to steel towers is negligible and conductor damage from fires is not common. Other Project infrastructure is located in more accessible areas, at a greater distance from potential burn zones (i.e., forested areas), and often outfitted with fire protection equipment. For these reasons, a low consequence (financial, system reliability) is assigned to wildfire impacts related to infrastructure damage. Low (financial) consequence is also associated with wildfire impacts on site accessibility.

Fire conditions throughout the province are monitored through Manitoba Hydro's Corporate Emergency Management Program (CEMP). CEMP's mapping system utilizes provincial wildfire data to assist in determining wildfire position and proximity to critical assets. CEMP is used to notify internal stakeholders of wildfires in a timely fashion to facilitate assessment or monitoring of the event using the Wildfire Protocol. Major fires that could potentially impact the Project would be identified early and operations (two staff continuously on site) could respond accordingly. As more system-wide generation and transmission capacity is available during wildfire season (shoulder and summer seasons), than during the winter season, the impact of a loss of Project generation or transmission is lessened. Furthermore, addition of PW75 provides a geographically separated transmission outlet for the Project and offers some system redundancy offering increased tolerance to wildfire events from an operational perspective.

Fire management policies can reduce vulnerability to wildfire impacts (Johnston, 2020). Beyond Manitoba Hydro CEMP policies and vegetation management programs (Section 2.4.9), it is noteworthy that the Province of Manitoba monitors wildfire status and issues restrictions when warranted. This program is particularly active in the Whiteshell Provincial Park and it is not uncommon for the Province to issue burn restrictions and back country travel bans which reduces the risk of human-caused fire in the Project vicinity.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Infrastructure damage (multiple)	High	Low	Medium	N/A	N/A	Medium
Transmission line operation	High	Medium	Medium[1]	N/A	N/A	High
Site access	High	Low	Low[1]	N/A	N/A	High

[1]Assignment deviates from Table 2 risk matrix due to tolerance and professional judgment.

2.4.11 Water Temperature

Increasing water temperature can result in multiple impacts that are noteworthy in relation to the Project. Impacts are included for a more fulsome discussion of climate risk, but it is important to recognize that most impacts will occur with or without the Project and have little bearing on the Project function itself.

Increasing water temperature with the potential to impact equipment cooling would be most notable in July and August when water temperatures would be highest. New generators will be air cooled and therefore more sensitive to air temperature changes (Section 2.4.1) as opposed to water temperature changes. Bearings for new units will be oil or water cooled (submerged in a turbine pit) and have low (financial) consequences associated with changing intake water temperature. Changing water temperature is not expected to affect other equipment (e.g., transformers, bearings, air compressors). To increase tolerance, water temperature monitoring will be ongoing and if required, additional cooling (e.g., air movement) could be implemented to avoid impacts to the generating unit performance. Alternatively, generator output could be temporarily reduced to compensate for extreme ambient temperature conditions. Water temperature increases are unlikely to be large enough to impact equipment cooling and there is a high tolerance given that equipment will be monitored, and effects mitigated if required.

Reduced ice cover season duration and potential changes to other ice processes (e.g., delayed freeze-up, earlier spring breakup, thinner or less ice extent, increased frazil ice generation) can change ice dynamics and forces on hydraulic infrastructure (e.g., powerhouse, spillway, dams). Overall, consequences of such ice processes are low (financial), short term, and manageable. Medium tolerance is achieved through normal operating procedures used by site staff to manage ice. These procedures are often reviewed and modified accordingly. Should increased impacts result from changes in ice processes, these operating procedures can be revised. Furthermore, the spillway has heated gates to permit operation during winter months. If winter flows increase significantly, additional bays could be heated. At some facilities, a shorter ice cover season provides an opportunity to generate more energy due to less head loss or flow restrictions when there is no ice.

The Project is located within the Whiteshell Provincial Park which has considerable winter resource usage including ice travel (e.g., snowmobiling, cross-country skiing, snowshoeing), recreation (e.g., ice fishing) and safe passage of waterways for traditional pursuits. If ice cover stability were negatively impacted by climate change, consequences (safety, reputation) would classify as low or medium. However, it is important to note that impacts and consequences exist with or without the Project. Medium tolerance to such changes is assigned since on-ice recreational usage is reactive to conditions in any given year (e.g., determining when ice travel is safe) and would likely continue to adapt to slow onset changes through such measures as improved monitoring, notification of ice safety conditions, and trail management.

There are no predicted impacts to Lake Sturgeon spawning as a result of projected maximum seasonal water temperature increases. Increasing water temperature may, however, affect the timing of Lake Sturgeon spawning which would shift to remain within the optimal temperature window. Beyond Lake Sturgeon, increasing water temperature could result in the loss of cold-water fish species (e.g., Burbot, Lake Whitefish, and Cisco) which are currently caught in low abundance in the Project area. An increase in water temperature may also result in high water temperatures and reduced dissolved oxygen in shallow water and/or back bay habitats which are limited in the Slave Falls reservoir (immediately downstream of Pointe du Bois), reducing their suitability as aquatic habitat. Shallow water habitats are sensitive to water levels in the Slave Falls reservoir, but these are not anticipated to change as a result of the Project or climate change (Section 2.4.13). Overall, a low consequence (environmental) and medium tolerance are assigned.

Climate change impacts to water temperature, ice cover, fish communities, and streamflow can affect the ability of Indigenous communities to practice rights-based activities such as fishing, access to medicinal plants and food, and animal harvesting. Impacts could translate to fewer fish and animals to hunt thus making it increasingly difficult to harvest, forcing Indigenous peoples to buy expensive and less nutritious food (Human Rights Watch, 2020). While uncertainty surrounds some projected changes (e.g., ice cover stability and streamflow), there is higher probability that other changes will occur (e.g., increased water temperature and decreased duration of the ice cover season) which will have some effect on the ability to practice rights-based activities. Changes are expected to manifest slowly in time with potential safety, environmental, and reputational consequences. However, since the climate change impacts are expected to occur with or without the Project, consequences can ultimately be categorized as low. Existing processes in place (e.g., ice and fish community monitoring) coincide with medium tolerance to such events. In addition, Indigenous peoples are often able to draw on Indigenous Knowledge to find creative ways to interpret and react to the impacts of climate change in the form of solutions which may help society at large to cope with these changes. Developing an adaptive and inclusive Indigenous Engagement Process (IEP) for the Project (Manitoba Hydro, 2021b) that uses a variety of engagement tools and activities to seek such input on potential mitigations would contribute to tolerance for such events.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Equipment cooling efficiency	High	Low	Low[1]	N/A	N/A	High
Ice cover season duration	High	Low	N/A	Low[1]	Opportunity	High
River ice processes	Medium	Low	N/A	Low	N/A	Medium
Ice cover stability for resource usage	Medium	Medium	N/A	Medium	N/A	Medium
Sturgeon spawning	High	Low	N/A	Medium	N/A	Medium
Fish community assemblage	High	Low	N/A	Medium	N/A	Medium
Ability to practice rights-based activities	High	Low	N/A	Medium	N/A	Medium

[1]Assignment deviates from Table 2 risk matrix due to tolerance and professional judgment.

2.4.12 System-Wide Water Supply

Changes in system-wide water supply can result in opportunity (e.g., increased flow and generation) or risk (e.g., decreased flow and generation). Net revenue in any given year is influenced by inflow conditions and can fluctuate on the order of hundreds of millions of dollars based on the historic flow record (Manitoba Hydro, 2019). This natural variability is built into resource planning processes to consider a wide range of hydrologic conditions. Projected change in long term average flow across the entire system (i.e., ensemble interquartile projection range of -5.1% to +14.9%) lean slightly towards favourable conditions and would affect revenue (e.g., exports) but result in low financial consequence. Greater financial consequence could be realized if severe hydrological drought were to persist for several years in multiple river basins simultaneously. Winnipeg River drought events, which are of primary interest to the Project, are discussed in Section 2.4.14. From a system-wide drought perspective, additional generation available from the Project would offset some of the reduced total generation and thereby mitigates a (small) portion of the risk. This is especially relevant when drought conditions are experienced in other river basins but not on the Winnipeg River.

Transmission system operations can also be affected by water supply and generation. The projected changes in mean annual flow do not pose large impacts on transmission system operations and the consequence is low. If a severe hydrological drought were to materialize, Manitoba Hydro may rely on transmission import capabilities to serve domestic load and other commitments. Currently, Manitoba Hydro has ten interconnections to neighbouring, non-hydroelectric dominated systems. Interconnections include the recently constructed 230 kV Birtle Transmission Project to Saskatchewan and the 500 kV Manitoba-Minnesota Transmission Project (MMTP). Built in 2020, MMTP adds 700 MW of firm import capacity from the Midcontinent Independent System Operator (MISO) market in the United States. Transmission system capacity and flexibility aligns with high tolerance.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
System-wide energy production	Medium	Low	N/A	N/A	Opportunity	N/A
Transmission system operation	Medium	Low	N/A	N/A	Low	High
Net revenue	Medium	Low	N/A	N/A	Opportunity	N/A

2.4.13 WINNIPEG RIVER STREAMFLOW

Pointe du Bois is the first hydroelectric generating station on the Winnipeg River in Manitoba. It receives inflows from upstream sources in Ontario including Lake of the Woods, Lac Seul, and Lake St Joseph (Figure 1). Over the last decade, generation at Pointe du Bois has continued to decline due to aging units reaching the end of economic life. New units proposed as part of the Project add 52 MW of rated capacity and 380 GWh (on average) per year of clean, reliable, and renewable energy to the Manitoba grid which would otherwise be spilled (Manitoba Hydro, 2021a). The Project adds energy and capacity to the Manitoba Hydro system which supplies Manitoba customers and export customers, when surplus is available.

For the purpose of this Climate Change Resilience Assessment, a sensitivity analysis of future LTFD scenarios (Fourier et al., 2020; Section 2.3.13) were used to explore future energy generation at Pointe du Bois. Because of limitations in LTFD scenarios (e.g., exclusion of regulation and diversions from WATFLOOD) and other assumptions (e.g., no changes in load as assumed in Voisin et al., 2020) results are presented as a climate change informed sensitivity analysis rather than a more definitive forecast of future energy production conditions. Compared to the baseline LTFD, future LTFD scenarios show a potential for a small reduction in energy generation due to an increase in the percentage of time the Winnipeg River experiences flows below maximum powerhouse flow (650m^3/s). Changes to streamflow based on the future LTFD scenarios on the Winnipeg River would result in a small change in the average annual generation and a low financial consequence (Direct risk). The new units provide some opportunity to cycle the plant, providing additional generation during periods of the day when load is highest. The new units will also make the system more resilient to changes in Winnipeg River streamflow due to a 52 MW increase in total system generation capacity (Systemic opportunity). Understanding climate change impacts on hydrology and resulting impacts on energy production in greater detail is a work in progress at Manitoba Hydro and remains an area for further study.

Regarding impacts to reservoir operations, Pointe du Bois normally operates as run-of-river, that is, outflow is adjusted to match inflow while the reservoir level remains relatively stable. Normal operating levels are not anticipated to change as a result of climate change. However, future Winnipeg River inflow scenarios suggest an increase in mean annual flow which may result in increased total outflow. The Project will enable more water to be directed from the spillway and through the powerhouse for generation because of the increase to the plant discharge capacity resulting from the new generating units (Indirect opportunity).

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Energy production	Medium	Low	Low	N/A	Opportunity	High
Reservoir operation	Medium	Low	N/A	Opportunity	N/A	N/A

2.4.14 WINNIPEG RIVER DROUGHT

Persistent low flows on the Winnipeg River would result in reduced hydro generation which could impact operating costs and net revenue during a drought. As a predominately hydro system, Manitoba Hydro plans its system to ensure sufficient energy resources are available in the event of a severe drought. The region is well connected to the rest of the system which is comprised of hydro generating stations in other watersheds and other generating resources such as wind, thermal and imports from neighbouring power markets. Revenue impacts from potentially changing drought events are implicit in the energy modelling summarized in Section 2.3.13 which utilize future LTFD scenarios that incorporate climate change impacts on median and extreme (e.g., low) flow quantiles. Upstream regulation (Lake of the Woods, Lac Seul and Lake St. Joseph diversion) provides foresight of Winnipeg River flows which allows for proactive operations planning (e.g., timing maintenance schedules to reduce spill related costs). A low consequence is assigned to the climate change influenced low flows on the Winnipeg River because the magnitude of energy reduction and the associated financial consequence is small relative to Manitoba Hydro's total energy supply. By nature of an extreme event, the probability of an extreme drought is low. So, over the life of the new generating units, based on average water conditions, adequate generation is expected. The new units will make the system more resilient to drought on the Winnipeg River because the new units will generate more energy during drought events.

During a wide range of flow conditions without the Project, an additional heat source is needed in the powerhouse during cold months due to insufficient heat from the existing generating units. These heating sources are available and have been used in the past to maintain the temperature within the powerhouse during periods of lower generation. External heating equipment comes at a low (financial) consequence and provides sufficient tolerance to manage climate events where low streamflow conditions are coincident with cold temperatures. This risk occurs without the Project so the Project, to a degree, offers additional tolerance to such events compared to a baseline case (no new units at Pointe du Bois). The new units will generate additional heat which will avoid or reduce the amount of external heating sources depending on the severity of the drought.

Severe or more frequent low water conditions occurring in the Slave Falls reservoir (immediately downstream of Pointe du Bois) and resulting changes to the operation of the Project powerhouse and spillway during Lake Sturgeon spawning periods, could result in changes in the availability and suitability of spawning habitats. Prolonged drought periods or cycling may result in insufficient area to support the spawning Lake Sturgeon population in the area. Low water conditions could also result in dewatering and/or reduced dissolved oxygen in shallow water and/or back bay habitats which are important, limited, habitat types in the Slave Falls reservoir. A low consequence (environmental) is assigned, but if conditions become exceptionally problematic (i.e., greater consequences) in the future, impacts may be partially mitigated by consideration of operational constraints applied during the spawning season. However, it is important to note that impacts and consequences exist with or without the Project.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Energy production	Medium	Low	Low	N/A	Opportunity	High
Powerhouse heating	Medium	Low	N/A	Opportunity	N/A	N/A
Aquatic habitat	Medium	Low	N/A	Low	N/A	High

2.4.15 WINNIPEG RIVER FLOOD

Potential changes to Winnipeg River flood events can have multiple impacts, several of which fall under a broader category of dam safety and relate to how well extreme floods are assessed and handled at aging dams (e.g., Chen and Hossain, 2019). Examples of specific impacts include loss of freeboard, overtopping of the dam, reservoir levels, flood routing strategy, maintenance access, gate performance, failure modes, environmental & socio-economic, and public waterway safety. These impacts are broadly consistent with other assessments of climate change impacts on dam safety (e.g., Fluixá-Sanmartín et al., 2018). The relationship between climate change and associated extreme flood impacts are complex and can be influenced by non-climatic drivers including population, economic development, and upstream water management. It should also be noted that while we assign a medium probability to a change in the event occurring (i.e., due to climate change; Table 1) flood events of interest are rare in the historic context.

Failure of the dams (e.g., due to overtopping) and other critical infrastructure at Pointe du Bois can have high financial, social, and environmental consequences. Based on Canadian Dam Association guidelines (CDA, 2013) Pointe du Bois is classified as a high consequence dam due to loss of life, potential for significant loss or deterioration of important fish habitat, and very high economic losses affecting infrastructure, public transportation, and commercial activities. This classification applies to any structure with a permanent population at risk downstream, and whose failure may result in a loss of life of 10 people or less. Pointe du Bois is primarily operated as a run-of-river plant, such that the outer forebay is controlled at or near the target full supply level and outflows match inflows on a daily basis, and flows in excess of powerhouse capacity are discharged through the spillway. A new spillway (2014) provides improved reservoir control and discharge capacity to safely manage large magnitude floods. A potential flood 9% greater than the design flood (Section 2.3.15) could be accommodated by adopting certain operational strategies beyond the act of fully opening all spillway gates. Such strategies could include utilizing potentially available unit speed-no-load capacity (speed-no-load operability to be determined upon unit commissioning), taking steps to reduce unit and transmission vulnerability to large floods (i.e., allowing for full unit discharge rather than only speed-no-load) and confirming that additional forebay surcharge would be acceptable (CDA, 2013). Spillway gates are remotely operable from the powerhouse and utilize dedicated hoists for each gate, which are operated sequentially to adjust for varying river discharge conditions. Electrical supply for the spillway includes a feed from the powerhouse buried in the earth fill dam, a second feed from Pointe du Bois Distribution Supply Centre, and a dedicated diesel generator adjacent to the spillway which provides backup emergency power (Manitoba Hydro, 2011a). These redundant power supplies help ensure uninterrupted operation of the spillway. The spillway can protect the dam and reservoir against flood magnitudes up to a Maximum Safe Flood (MSF) of 5,255 m^3/s without encroaching on the freeboard. The MSF capacity marginally exceeds the IDF 5,040 m^3/s, which considers potential surcharge due to flow balancing, wind generated waves, and ice. Based on historic streamflow data, the MSF capacity at Pointe du Bois roughly corresponds to a 5000-year flow event on the Winnipeg River. Additionally, the spillway is capable of passing a 1000-year flood without surcharging the forebay above normal full supply level. As such, the recently built spillway provides the ability to manage climate risk associated with increased hydrologic load (see Section 3.3 for additional information) while the new units also offer some potential to increase the tolerance to this risk.

Impacts related to spillway operation, maintenance, and access are associated with low financial consequence (e.g., due to increased wear from more frequent operation). These impacts and consequences include those due to flow changes as well as temperature fluctuations which can expose mechanical equipment to thermal stress and eventually result in malfunction (Fluixá-Sanmartín et al., 2018). Existing operating procedures avoid small gate openings (reduce potential cavitation damage), and maintains required submergence of gates at all times which avoids gate vibration and possible drawing-down of ice during through the water passages during the winter, thereby reducing the risk of ice damaging the gates. Operating procedures can adapt to handle changes to climatic conditions and hydraulic loads to maintain the forebay within the existing normal operating range. Prolonged operations at small gate openings are avoided, as well as larger gate openings during the winter. There are heated gates to permit operation during winter months. If winter flow increases significantly, additional gate heating could be added. During dewatered maintenance and inspections (i.e., rollway downstream of spillway gates to stoplogs installed near the apron), the design value of 740 m^3/s (Section 2.3.15) allows for additional protection (freeboard) which could be utilized in conjunction with forecasts (precipitation, streamflow, wind) for maintenance decision making. If added flow protection becomes required for maintenance, additional stoplogs could be fabricated to provide greater protection from tailwater levels.

Potential changes to flood events could have impacts on waterway public safety both upstream and downstream of the Project. Concerns include debris from vegetation and structures (e.g., docks), bank erosion, unsafe boating, and waterway recreation. Areas of interest include homes and cottages in the Whiteshell Provincial Park which is located on Treaty 3 lands and within the Recognized Areas for Metis Natural Resource Harvesting. Impact to public water safety has the potential to affect both recreational use and resource use from a harvesting perspective. These risks occur with and without the Project.

Upstream of the Project, changes in frequency of high flow events could raise the risk of structural failure of the spillway safety boom due to accelerated wear and tear of connecting hardware or through activation of fuse links under increased loads. Such events could also cause unsafe work conditions during scheduled boom installation (spring) and removal (fall). Delayed installation could result in unrestricted public access to the designated dangerous waterway zone, whereas a delay in removal could result in letting the boom freeze in place, exposing it to damage during ice breakup. If problematic high flow events persist during normal boom installation and removal periods, there could be increased maintenance costs (low financial consequence) and public safety concerns. These risks occur with and without the Project.

While flood events can have high consequences related to public safety, risk is characterized as medium due to existing processes in place (i.e., high tolerance). These processes include the Public Safety Around Dams program (Manitoba Hydro, 2021d), Manitoba Hydro's public and Indigenous engagement process measures such as notifications of capital and maintenance projects and other communications, water level and flow information available through the Lake of the Woods Control Board, provisions to reduce Lake St. Joseph Diversion flows during high flow events (Lake of the Woods Control Board, 2014; Manitoba, 1958), adjusting boom installation/removal schedules, and exploring a more robust all-season boom. Manitoba Hydro's operating procedures for generating station reservoirs also support the high tolerance to such flood events.

From a broader system risk perspective, potential increases in Winnipeg River flows could have negative downstream impacts (Winnipeg River and Lake Winnipeg levels) during extremely high flows and contribute to stakeholder and environmental concerns (e.g., erosion, property damage; low consequence). While these impacts would be realized with or without the Project, it is noteworthy that some impacts can be mitigated through ongoing system wide operations planning and stakeholder communication. Reservoir operations planning considers a range of historical inflows. Flow conditions are reviewed and updated regularly, and system operating decisions are adjusted as needed. Expected flow and water level forecasts are distributed to stakeholders at least monthly, or anytime there is a significant change from a previous forecast. Short term water level changes along the Winnipeg River are communicated to stakeholders weekly during the recreational season (May to October). Lac Seul and Lake of the Woods outflow decisions are made by the Lake of the Woods Control Board (LWCB) and have a direct impact on Winnipeg River flows in Manitoba. Manitoba Hydro is a part of a LWCB interest group and communicates flow preferences to LWCB but has no decision making authority.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Freeboard and flood passage	Medium	High	Medium[1]	Medium[1]	N/A	High
Reservoir levels and operational strategies	Medium	Low	N/A	Low	N/A	Medium
Spillway operation, maintenance, and access	Medium	Low	N/A	Low	N/A	High
Public waterway safety	Medium	High	N/A	Medium[1]	Medium[1]	High

[1]Assignment deviates from Table 2 risk matrix due to tolerance and professional judgment.

2.4.16 OTHER OVERLAND FLOODING

Overland flooding on land and waterways outside of the Winnipeg River system could impact the ability to access Pointe du Bois (e.g., road travel). Consequences of such impacts are low with high tolerance as there are options for alternative means of access, temporary road repairs in an emergency, and remote site operation.

It is also conceivable that overland flooding could impact transmission line access and reduce conductor clearances. Impacts are assigned a low consequence but are expected to be negligible. Transmission line access is primarily of interest during construction and maintenance which is typically scheduled to occur during frozen conditions (i.e., winter months) where overland flooding does not pose a major vulnerability and consequences are minimal. Line routing through the Canadian Shield will inevitably cross some swampy areas where water levels could increase after a major precipitation event. However, any water level increases are not anticipated to be concerning and these areas are not widely used by the public. Clearances for water crossing on PW75 will follow CSA standards to ensure appropriate clearances are met. Clearance design for R1/R2 and S1/S2 predate CSA standards and could be impacted by changing flood conditions in the future. However, in most cases, towers are spotted well outside the ordinary high-water mark (OHWM) and there are limited crossings of water bodies used for recreation where the greatest concern lies (e.g., boat contact with conductors).

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Site access	Medium	Low	Low	N/A	N/A	Medium
Transmission line access	Medium	Low	Low	N/A	N/A	High
Transmission line conductor clearances	Medium	Low	Low	N/A	N/A	High

2.4.17 CANADIAN GOVERNMENT POLICY

As a non-emitting generator, the operation of the Project is not negatively impacted by regulations limiting GHG emissions in the electricity sector or changes in GHG pricing. Some impacts could be realized during construction, but these are relatively small (Manitoba Hydro, 2021a). Canadian government policy that accelerates electrification or increases production of hydrogen from electricity in Manitoba could change where the electricity generated by the Project is used, with a greater share of electricity used domestically than exported to other markets. As the Project increases availability of non-emitting electricity generation, changes in government policy generally present opportunities rather than risks.

Changes in GHG pricing (proposed to increase by $15 per tonne carbon dioxide equivalent each year from 2023 and reach $170 per tonne carbon dioxide equivalent in 2030; ECCC, 2020) can have broad operational and asset management impacts for electricity generation. However, economics of projects that enhance, add, or extend the life of non-emitting electricity generation, will become increasingly favourable. Outside of electricity generation, Manitoba Hydro's domestic customers who rely on fossil fuels will also be impacted by an increasing price signal to reduce their use of fossil fuels. To complement GHG pricing, the government also plans to provide funding to increase the energy efficiency of buildings and introduce new policies and funding to accelerate the electrification of transportation. The Clean Fuel Regulation, once finalized, is expected to increase the cost of liquid fuels (often used in transportation), while providing credit market opportunities to support switching to low-carbon fuels such as electricity and hydrogen with lower lifecycle emission profiles (such as electricity generated by the Project) producing greater credits.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Demand for non-emitting electricity	High	Low	N/A	N/A	Opportunity	N/A
Electrification and/or fuel switching	High	Low	N/A	N/A	Opportunity	N/A

2.4.18 U.S. Export Market Policy

As transitional risk increases for Manitoba Hydro's U.S. wholesale customers, there could be increasing demand for non-emitting electricity generation, such as the electricity available from the Project. Changes in U.S. policies that increase costs for GHG emitting power plants may put upward pressure on U.S. wholesale electricity market prices which creates an opportunity for Manitoba Hydro. Manitoba Hydro (2021a) shows that the Project is expected to result in GHG emission reductions in the U.S., and as such, can assist Manitoba Hydro's American wholesale customers in responding to transitional risk.

It is also relevant to note that U.S. policies could emerge that reduce costs for U.S.-based non-emitting electricity generation (such as production or investment tax credits for new non-emitting electricity generation), which could have a deflationary impact on market prices. While electricity export market revenues associated with the Project could be lower than anticipated, they will remain valuable in helping to reduce domestic rates for Manitobans. So, while this event could pose some risk, there is some tolerance.

Impact Topic(s)	Probability	Consequence	Risk Rating			Tolerance
			Direct	Indirect	Systemic	
Demand for non-emitting electricity	High	Low	N/A	N/A	Opportunity	N/A
Funding for U.S. clean energy projects	High	Low	Medium	N/A	N/A	Medium

3.0 RISK MITIGATION – ANALYSIS OF RESILIENCE

It's important to recognize that the adaptation process is not straightforward in the presence of large uncertainties and unclear trends (CEATI, 2018). Furthermore, it is not unusual for vulnerability ratings to change with time as more information becomes available (e.g., updated vulnerability ratings in Munday, Ristic and Westfall, 2018). This assessment identified a total of 49 impact topics associated with Direct, Indirect, and Systemic risks (Table 3). None of the impact topics coincide with a high risk rating, but several associate with multiple risk types. Twenty-four impact topics associated with a Direct risk to the Project include 11 medium risk and 13 low risk items. Nineteen impact topics associated with an Indirect risk to the Project include six medium risk and 10 low risk items as well as three opportunities where the Project increases climate change resilience. Eleven impact topics associated with broader Systemic risk include two medium risk and one low risk item as well as nine opportunities where the Project increases the resilience of the system to climate change. Table 4 summarizes the risk ratings.

Table 4 - Summary of Risk Ratings

Risk Type	Risk Rating					Sum
	High	Medium	Low	Opportunity	Not Assigned	
Direct Risk to Project	0	11	13	0	25	49
Indirect Risk to Project	0	6	10	3	30	49
Systemic	0	2	1	9	37	49

This section demonstrates how the Project is resilient to climate change and no Project alterations were required to mitigate climate change risks. Overall, the Project reduces GHG emissions (Manitoba Hydro, 2021a) and provides low cost non-emitting renewable energy (Manitoba Hydro, 2021b) that increases flexibility in Manitoba Hydro's generation and transmission system operations. The Project will provide benefits to Manitoba Hydro, its customers, and support Canada's GHG emission reduction targets.

In accordance with Climate Lens - Frequently Asked Questions (Infrastructure Canada, 2021), detailed and exhaustive economic analyses (e.g., cost-benefit, return on investment) are not provided herein. Furthermore, there are challenges in determining economic values for control measures that are inherently incorporated into project design and operational procedures, and challenges associated with the imbedded presence of commercially sensitive information. Manitoba Hydro (2021b) provides the rationale for the Project with benefits to Manitoba Hydro and its customers.

3.1 Replacement of Eight Generating Units

Due to its condition, the Pointe du Bois powerhouse requires upgrades to extend its life to support continued generation. In recent years, Manitoba Hydro evaluated a broad range of life cycle alternatives to establish a long-term plan for the powerhouse. Alternatives included early decommissioning and a range of life extension alternatives including running existing units to failure, repairing existing units, and replacing old units with new units. The alternatives were evaluated based on total life cycle costs, revenue, and economic metrics such as net present value and levelized cost of energy. Mitigation of environmental impacts and associated costs were also considered for each alternative. Based on this evaluation, Manitoba Hydro is proceeding with powerhouse life extension upgrades to enable continued operation of the generating station using the existing generating units (Base Case; Manitoba Hydro 2021b). This Base Case would see generation reduced to 20 MW by the late 2020s, as six of the existing units are expected to reach end of economic life. This option balances total investment and revenue over the next 35 years.

Subject to receiving approval for funding under the Investing in Canada Infrastructure Program, the life extension of the powerhouse provides an opportunity to add new generating units (space is available for up to 16 units) to increase electrical output of the existing powerhouse. Replacement of eight units adds 52 MW of capacity compared to the Base Case bringing total generation to 72 MW through to the 2050s. With considerably more generation compared to the Base Case, new units would provide substantially more revenue; however, it requires substantially more capital investment to implement. Additional generation capacity at Pointe du Bois also better utilizes available streamflow resources in the Winnipeg River for electrical generation rather than spilling the water. This electricity can contribute to broader system resilience during climate-related events such as loss of northern system generation/transmission or during hydrological conditions where drought is occurring outside of the Winnipeg River basin.

3.2 PW75 Transmission Line

Pointe du Bois and Slave Falls generating stations currently transmit their electricity via double circuit transmission lines P3/P4 (66 kV line between Pointe du Bois and Rover Station in Winnipeg), R1/R2 (115 kV line between the two generating stations), and S1/S2 (115 kV line between Slave Falls Generating Station and Stafford Station in Winnipeg). P3/P4 is approaching end of life, no longer considered a firm generation outlet in grid infrastructure planning, and anticipated to be retired in the near future, leaving S1/S2 as the single transmission connection between the two generating stations and the rest of Manitoba Hydro’s network. While upgrades to S1/S2 could accommodate electricity from the two generating stations (including new units as part of the Project), and an island configuration is possible to serve local load (Manitoba Hydro International, 2020), S1/S2 outages could affect energy supply and revenue associated with the two stations and the Project. S1/S2 outages could be a result of climate events such as those described in this report but also routine maintenance.

Risk of S1/S2 outage (e.g., reduced revenue and reliability) due to a climate change impacts would in part be mitigated by construction of a new 46.5 km, 115 kV transmission line (PW75) from Pointe du Bois to the Whiteshell Station (Manitoba Hydro, 2014). This new transmission line would provide a second, geographically separated, power outlet and would utilize a portion of the existing P3/P4 right-of-way and a new right-of-way. PW75 also provides additional benefits such as improved reliability for serving of local loads associated with a second transmission outlet. Having two transmission outlets mitigates risks associated with several climate events (Section 2.0) including near freezing precipitation, wind, convective storms, and wildfires. Ice and wind loads used in the design of PW75 will be guided by CSA (2019) and complemented with updated meteorological loading data (Morris, 2014; Morris, 2016).

The Project will be designed for failure containment load events which can occur when breakage of conductors, insulators, hardware, and/or structural failure creates load imbalances in the wires causing failure of the adjacent supports. This can occur due to weather events beyond the 150-year return period, mechanical impact from vehicles, or extreme events like tornadoes. Manitoba Hydro's design approach is to mitigate the potential cascading failure by providing longitudinal capacity at all structures by considering the post-failure loading condition. The objective of this philosophy is to limit cascading failures to a few spans/structures on each side of the initial failure or within the area that the event has occurred (outside of the 150-year weather event).

For the purpose of the Climate Change Resilience Assessment, a 150-year design, with provision to reduce cascading failure, is considered appropriate based on above stated rationale, the use of updated meteorological loading data, and uncertainties in climate change projections of extreme wind and icing events for the Project region. This continues to be an area of ongoing research (see Section 3.6).

3.3 Spillway Replacement Project

In 2014, Manitoba Hydro completed construction of a new spillway at Pointe du Bois to increase spill capacity, address concerns with the aging structures, and address personnel safety while continuing operation of the powerhouse. By doing so, capacity was increased for Pointe du Bois to handle larger and more frequent floods which may result from climate change, natural climate variability, and upstream regulation. Although climate change adaptation was not explicitly considered during design of the new spillway, the adaptive capacity to modify operations in a manner that responds to future climatic shocks and stresses has increased. Examples of this are design features that increase flood protection within the hydraulic zone of influence, enhance important sturgeon habitat, more effectively handle climate-induced ice processes, increase reliability due to reduced maintenance downtime, and provide the ability to improve the use of the water resources at this site. Reservoir fluctuations due to potential changes in climate, land use, and water demand are unlikely because of the ability to regulate the forebay level. For the reasons above, the recently built spillway provides resilience against climate change for Pointe du Bois (see Section 2.4.15 for additional information).

3.4 Storm Response

Storms that produce extreme weather are among several factors that can cause power outages. Manitoba Hydro places high priority on responding to unplanned outages and has systems in place to mitigate outage-associated risk, be it from extreme weather, tower collapse, fire, or other factors. Existing processes, relevant to the Project, are described in Chapter 7 “Effects Assessment and Mitigation” of the Pointe du Bois Transmission Project Environmental Assessment (Manitoba Hydro, 2014), Chapter 9 “Accidents, Malfunctions and Unplanned Events” of the Birtle Transmission Project Environmental Assessment (Manitoba Hydro, 2018), and Chapter 3 “Project Description” of the Pointe du Bois Spillway Replacement Project Environmental Impact Statement (Manitoba Hydro, 2011a). A summary of relevant items from these documents, complemented with additional information is provided herein. Processes include subscription to a weather monitoring service, in-house streamflow forecasting, constant transmission system monitoring, CEMP, public awareness, emergency stocks of materials, staff on standby outside of regular work hours, and mutual assistance agreements with other utilities.

Professional weather monitoring and in-house streamflow forecasting allows operators to understand approaching atmospheric and hydrologic conditions, predictions of storm severity, possibility of line outages, and to prepare contingency plans, if required. Road and travel conditions are also evaluated should field staff be required to travel or to support control centre relief. Through CEMP, Manitoba Hydro field crews also receive weather advisories for situational awareness. Transmission system monitoring enables detection of faults that result in tripping of a circuit breaker. When these types of events occur, Manitoba Hydro responds in accordance with CEMP policies and procedures. Upon detection of unexplained line trips, Line Maintenance is notified and initiates an emergency patrol. If an extended outage was anticipated after inspection of the equipment, CEMP incorporates Emergency Operation Centres (EOCs) to support first responders during emergency repairs to critical infrastructure. Manitoba Hydro also makes outage information (e.g., location, number of customers, expected restoration times) available on its external website for public awareness (https://www.hydro.mb.ca/outages/).

Storm prediction and response planning are identified in CEATI (2018) as short-term resilience measures which utilize weather forecasts to prepare (e.g., crews, equipment) to respond to damage or outages and restore service as quickly as possible. The concept behind storm prediction and response planning is not to negate risks entirely but rather to accelerate restoration of services and minimize interruptions. This concept is recognized by electrical company executives (Smart Cities Dive, 2019) and reflects the balance between electricity cost and customer expected reliability.

3.5 TRANSMISSION SYSTEM CAPACITY AND FLEXIBILITY

Manitoba Hydro's transmission system has a noteworthy degree of inherent capacity and flexibility that is relevant to Project resilience. The Project contributes to overall system resilience by providing additional generation and a new transmission line (PW75) that is geographically separated from existing transmission outlet lines from Pointe du Bois.

Within the Project's time frame, Manitoba Hydro's existing transmission system can be used to mitigate adverse effects if climate were to hinder delivery of electricity from the Project into Manitoba Hydro's network. This resilience comes from an extensive transmission system including ten interconnections that synchronously connect Manitoba Hydro's transmission with neighbouring markets in Ontario, Saskatchewan, and the U.S. Existing capacity provides temporary relief if the Project were impacted by a climate event.

3.6 COLLABORATION WITH EXTERNAL AGENCIES

In order to increase the understanding of climate change and maintain industry best practise, Manitoba Hydro works with external agencies on various topics as part of ongoing activities and climate change strategies (Manitoba Hydro, 2020). External agencies include research and industry groups. Groups relevant to the Climate Change Resilience Assessment are summarized below.

<u>Centre for Energy Advancement through Technical Innovation (CEATI)</u> Manitoba Hydro is a member of CEATI and participates in multiple interest groups. The Transmission Overhead Line Design & Extreme Event Mitigation Program (TODEM) undertakes work to advance industry practise with respect to design of overhead lines. CEATI (2018) summarizes the state-of-the-art climatological impacts on overhead line design recognizing challenges in incorporation of climate change into codes or standards for line design. Manitoba Hydro also participates on CEATI's Vegetation Management Task Force and co-chairs a climate change adaptation working group within the Hydropower Operations Planning Interest Group (HOPIG). The HOPIG working group has delivered numerous industry information sharing sessions, webinars featuring advanced research applications, and coordination of a project to develop streamflow assessment tools that facilitate understanding of climate change impacts (historic and future).

<u>Canadian Electricity Association (CEA)</u> Manitoba Hydro is a member of CEA and participates in the Climate Change Adaptation Committee (CCAC). Through the CCAC, Manitoba Hydro has worked with other Canadian electricity utilities to develop a practical guide for climate adaptation planning and will eventually utilize the guide to develop internal climate adaptation plans. This work aims to address the transmission, distribution, and generation side of Manitoba Hydro's business. Through the CEA, Manitoba Hydro participated on several CSA Task Groups exploring options to incorporate

climate change adaptation into the Canadian electrical code. As part of this work, five task groups (Floods & Droughts, Wildfires, Wind, Icing, Permafrost) submitted proposals for CSA technical committees to consider in future code updates. Among recommendations were ideas to improve the consideration of wind and ice loads in the context of climate change.

The Ouranos Consortium Manitoba Hydro is an affiliated member of the Ouranos Consortium (Huard et al., 2014), collaborating on projects to research and apply climate science in adaptation. Ouranos brings together hundreds of scientists and professionals from multiple disciplines to acquire and develop knowledge on climate change and inform decision makers about probable trends and adaptation strategies. Collaboration with Ouranos has helped build Manitoba Hydro in-house expertise on climate science through provision of training and datasets (e.g., GCMs, Canadian Regional Climate Model; CRCM). Manitoba Hydro's affiliation with Ouranos also provides opportunity to monitor and participate in projects that advance RCMs in a manner that improves their utility in practical climate change assessments (e.g., enable assessment of finer-scale atmospheric processes such as freezing rain). Although this is still a new and uncertain field of study, Manitoba Hydro continues to monitor progress through Ouranos' connections with the Université du Québec à Montréal (UQAM) who are responsible for CRCM development. Manitoba Hydro's collaboration with Ouranos includes exploring climate change impacts on forest fires (Ouranos, 2017), extreme floods (Ouranos, 2015; Ouranos 2019), wind power generation (Ouranos, 2018), and hydropower asset evaluation (Fournier et al., 2020).

Other Research Initiatives In addition to Ouranos programs, Manitoba Hydro partners with other organizations to study climate change. One example is the Global Water Futures (GWF) research program led by the University of Saskatchewan. Manitoba Hydro is a partner on the Climate-Related Precipitation Extremes sub-project within GWF that is led by Dr. Ron Stewart (University of Manitoba) and Dr. Francis Zwiers (University of Victoria; Pacific Climate Impacts Consortium). Within Phase I, the Weather Research and Forecasting (WRF) model was used to examine past icing events that have impacted Manitoba Hydro's overhead electrical system and explore how these events might change in a warmer climate (Tropea and Stewart, 2021). Within Phase II, researchers are exploring the atmospheric drivers behind the October 2019 wet snow event that affected Manitoba Hydro (Hanesiak et al., submitted), and will expand on earlier work using the WRF model. WRF (Liu et al., 2017) is a state of the art, convection permitting regional climate model run at 4 km resolution that is mentioned in the Adaptation Methods section of CEATI (2018). Jeong (2018) is another example of Manitoba Hydro's involvement in RCM research to understand climate change impacts on ice design loads. This work was led by Dr. Laxmi Sushama at UQAM and was later expanded on by Environment and Climate Change Canada (Jeong, 2019).

Lake of the Woods Control Board LWCB regulates the water levels of Lake of the Woods and Lac Seul, and the flows in the Winnipeg and English Rivers downstream of these lakes to their junction, for the long term benefit of all users and interests. The Board makes regulation decisions taking into account preferences from a number of specific interest groups, resource agencies, Indigenous communities, and other stakeholders. Manitoba Hydro does not have decision authority over LWCB controlled reservoirs but communicates flow preference information. Over the course of many years, Manitoba Hydro's involvement in LWCB has provided insight into operational practices which inform internal modeling of reservoir releases. These modelling efforts play a key role in forecasting Winnipeg River inflows and provide many benefits to Manitoba Hydro operations under normal conditions and extreme low/high flow conditions.

Climate Policy Manitoba Hydro has participated in the development and analysis of municipal, provincial, regional, national, and international climate change policies, advocating for practical policies that are environmentally effective and economically efficient. Manitoba Hydro engages with governments, industry, think tanks, research organizations, environmental non-governmental organizations, customers, and other climate policy stakeholders to understand the implications of various policy proposals and suggest changes to enhance environmental and/or economic outcomes. For more information, refer to Manitoba Hydro (2020).

3.7 Collaboration with Indigenous Communities

Manitoba Hydro has engaged with Indigenous communities and groups in the Pointe du Bois area through recent environmental assessments. For the Pointe du Bois Transmission Project, Manitoba Hydro (2014) was prepared to meet the Report Guidelines suitable for a Class II Development (Manitoba, 2018) as defined in the Environment Act Classes of Development Regulation (Manitoba, 1987; Manitoba, 1988). This work included a site selection process to identify a route for PW75 which considered a broad range of biophysical and socio-economic information, as well as two rounds of engagement. Similarly, Manitoba Hydro (2011a) was prepared for the Pointe du Bois Spillway Replacement Project in accordance with Manitoba (2018), Manitoba (1987) and Manitoba (1988). This work considered a range of information as well as an engagement process that included three rounds of public and Indigenous engagement. Issues relating to the changing environment were shared through workshops, meetings, key person interviews, and in Indigenous Knowledge studies. For a full list of comments and concerns and what measures were taken to reduce effects to communities, refer to the specific chapters dedicated to engagement and information throughout the environmental assessments:

- Chapter 6 "Public Engagement Program" in Manitoba Hydro (2014).
- Chapter 5 "Consultation and Communication" in Manitoba Hydro (2011a).

Although much of the engagement and assessment work noted above is dated and will be redone for the Project, key outcomes and impacts identified through these earlier processes has informed the analysis herein.

3.8 Internal Climate Change Initiatives

Manitoba Hydro recognizes the potential impacts of climate change on its business and has developed five strategies to shape its response (Manitoba Hydro, 2020). As part of the Adapt strategy, Manitoba Hydro has formed a Climate Change Opportunities Risks and Adaptation (CCORA) Working Group to address adaptation more comprehensively across the organization. CCORA includes members from various areas including transmission, distribution, and generation. CCORA is in early stages but provides the forum and organizational framework for Manitoba Hydro to pursue increasing climate change resilience throughout the organization.

3.9 Broader Resilience Considerations

Infrastructure Canada (2018) Annex F presents four guiding principles for assessing and managing climate risk: Proportionate Assessment, Systemic Analysis of Risk, Pursuit of Multiple Benefits, and Avoidance of Unintended Consequences. These principals have been considered as follows:

Report authors and reviewers find the level of detail presented to be commensurate to the Project's importance. However, in the absence of abundant examples for similar projects, it is difficult to compare the level of detail presented herein with similar studies or expectations. The engagement of (internal and external) subject matter experts with expertise in multiple fields and business areas contributes to the goal of conducting a holistic risk assessment and consideration of adaptation options that address the higher ranked risks, maximize benefits, and avoid unintended consequences.

4.0 RESILIENCE MEASURES

Resilience features of the Project and Manitoba Hydro's system are summarized in bullet form:

- Installation of eight new units in the existing powerhouse utilizes streamflow, that would have otherwise been spilled, to generate an additional 52 MW of capacity and 380 GWh of energy (on average by 2030). With eight new units, the powerhouse will utilize 3 to 4 times more of the river flow compared to the existing units in operation. The additional generation will contribute to broader system resilience during climate-related events such as loss of northern system generation/transmission or during hydrological conditions where drought is occurring outside of the Winnipeg River basin.

- Construction of a new PW75 transmission line provides a redundant outlet for the Project's electricity generation that is geographically separated from the existing R1/R2 and S1/S2 transmission lines. This redundancy and geographic separation mitigate several climate change risks associated with potential loss of a transmission line (e.g., freezing precipitation, wind, wildfire, convective storms). Furthermore, PW75 will utilize a 150-year design event (ice and wind) and include failure containment loads which minimize the probability of uncontrolled propagation of failures (cascades) which may extend beyond the failed tower or section of line due to loads exceeding a 150-year event.

- A new spillway commissioned in 2014 was designed using the latest standards to improve dam safety and increases the ability to pass potentially larger flood events at Pointe du Bois. Design considerations did not explicitly consider climate change but were such that the spillway can pass a Maximum Safe Flood (MSF) of 5,255 m^3/s which is roughly equivalent to a 5000-year event and exceeds the Inflow Design Flood. The Project may improve the capability to pass floods with more discharge through the new generating units.

- Continued utilization and improvement to Manitoba Hydro's Corporate Emergency Management Program (CEMP) provides a framework that enhances resiliency against current and emerging hazards. The goal of the program is to protect the health and safety of all people (employees, public and responders) and limit the damage to the environment, Manitoba Hydro, and third-party assets.

- Manitoba Hydro will continue to collaborate on (and monitor) research to improve weather forecasts, streamflow forecasts, and climate models, leading to improved understanding of climatic processes, reduced uncertainty, and improved lead times to facilitate operations planning. This approach is consistent with CEATI (2018) which states "Further research in the field of climate modelling, future climate projections and downscaling will continue to decrease the uncertainty involved".

5.0 DESCRIPTION OF KNOWLEDGE BASE

Information used for this assessment is a blend of environmental knowledge, historic data, scientific studies, modeling data (e.g., Global Climate Model simulations), and technical expertise within Manitoba Hydro. Most of the knowledge is based on existing studies, with a few supplementary analyses undertaken to support specific climate-related risks that were identified. For brevity, this report presents summaries of findings but includes extensive references (in-text and in Section 8.0) for further reading.

As the Project is not yet approved, formal engagement has not begun. However, Manitoba Hydro would undertake a Public Engagement Process (PEP) and Indigenous Engagement Process (IEP) related to both the generation and transmission aspects of the Project (Section 4.7 in Manitoba Hydro, 2021b). Engagement would be adaptive and flexible, with opportunities for input at every stage to meet the specific context of each engaged group, in order to understand concerns, develop mitigation measures to address concerns, and implement follow-up monitoring. Both engagement processes will work to address concerns shared by potential affected people and communities in the area. Manitoba Hydro will also work directly with participants to identify and document their concerns, preferences and recommendations, which may influence aspects of the final project and the assessment of potential Project effects. Due to differences in the nature of impacts, location and timing of the generation and transmission work, the generation work (unit replacements) and the transmission work will likely have different engagement processes. Manitoba Hydro intends to bolster information related to climate change and climate resilience mitigations by adding this as a topic of focus in the IK studies and in other IEP activities. At the second International Onjisay Aki Climate Summit held at Turtle Lodge in June 2017, participants agreed on 12 Onjisay Aki Climate Calls to Action (Courchene et al., 2017). There may be opportunities to further processes initiated as an outcome of the Summit.

Based on previous interest in the project area, known use of the Winnipeg River and the reach of the river where Pointe du Bois is located, and interest in previous Manitoba Hydro projects and activities in the area, Manitoba Hydro anticipates engaging with the following Indigenous communities and organizations to determine interest in the projects: Black River First Nation, Brokenhead Ojibway Nation, Hollow Water First Nation, Lake St. Martin First Nation, Manitoba Metis Federation, Peguis First Nation, Pinaymootang First Nation, Roseau River Anishinaabe First Nation, Sagkeeng First Nation, Sandy Bay First Nation, Swan Lake First Nation, Wabeseemoong Independent Nations, and Grand Council Treaty #3. Manitoba Hydro is prepared to engage with others not listed above if it comes to the Corporation's attention that others may have interest in this Project.

Manitoba Hydro also previously engaged with Indigenous communities through its Indigenous engagement processes for two earlier projects:

1. The Pointe du Bois Transmission Project IEP began in the spring of 2013 through to filing of the Environmental Assessment Report in spring 2014. Indigenous communities and groups included in the engagement process were: Black River First Nation, Brokenhead Ojibway Nation, Hollow Water First Nation, Lake St. Martin First Nation, Manitoba Metis Federation, Peguis First Nation, Pinaymootang First Nation, and Sagkeeng First Nation. Engagement included leadership meetings, community open houses, letters, and phone calls. One Indigenous community opted to access funding to support the development of an IK study for the project. As this study was developed for the Pointe du Bois Spillway Replacement Project, and not this Climate Change Resilience Assessment it was not done with a specific focus on climate change resilience, therefore is not quoted here. More information on Manitoba Hydro's principles and outcomes of engagement are provided in Chapter 6 "Public Engagement Program" of Manitoba Hydro (2014).
2. The Pointe du Bois Spillway Replacement Project IEP began in 2006 through to filing of the Environmental Assessment Report in summer 2011. Indigenous communities and groups included in the engagement process were: Black River First Nation, Manitoba Metis Federation, and Sagkeeng First Nation. Engagement included leadership meetings, open houses, letters, opinion surveys, phone calls, and funding to support the development of IK studies. The studies were developed for the Pointe du Bois Spillway Replacement Project, and not this Climate Change Resilience Assessment. As the studies were not done with a specific focus on climate change resilience, they are not quoted here. More information on Manitoba Hydro's principles and outcomes of engagement are provided in Chapter 5 "Consultation and Communication" of Manitoba Hydro (2011a).

5.1 MANITOBA HYDRO'S APPROACH TO INDIGENOUS KNOWLEDGE

Manitoba Hydro views Indigenous Knowledge (IK) as a part of a more comprehensive Indigenous engagement process that typically includes the development of an IK study, the discussion about the results from the IK study and what the results mean, written contributions to the environmental assessment from the Indigenous community, and additional dialogue between the respective Indigenous community and Manitoba Hydro through which additional IK may be shared. These are all important components of respecting and understanding IK systems.

Manitoba Hydro also promotes IK researcher best practices when it comes to obtaining informed consent, ensuring ownership remains with the community and/or individual, and addressing confidentiality and use of the information within a written agreement.

Manitoba Hydro applies IK where appropriate through the life of a project to inform project decisions and determine mitigation efforts and monitoring priorities. There are several criteria that Manitoba Hydro uses to assist with determining the requirement and appropriate scale of engagement, and IK, for any project such as regulatory requirements, potential project impacts on people, and previous or known interest to name few. The IK that is shared by Indigenous communities is typically project specific and is shared based on the understanding that the knowledge will not be applied to other projects.

6.0 CONCLUSION

Overall, the Project is found to be sufficiently resilient to climate change based on current scientific knowledge. Major Project-relevant features that facilitate climate change resilience include: The construction of a new, geographically separated, 115 kV transmission line (PW75) from Pointe du Bois; design approach used for transmission towers (reliability based design, updated environmental loads, and provision for failure containment loads); sensitivity testing of energy production with future streamflow scenarios; increased electrical generation with more effective use of available water resources; ability to reliably handle large flood events with a spillway commissioned in 2014; and a Corporate Emergency Management Program which helps respond to emergency situations including those related to climate and weather. Manitoba Hydro will continue to monitor scientific advances and industry progress to better understand uncertainties and evaluate opportunities to enhance climate resilience at both existing assets and future projects. From a systemic view, the Project increases resilience to climate change for Manitoba Hydro's generation and transmission system. The project will increase total system generation, provide more energy during droughts, and improves transmission operation with a new transmission line that provides redundancy.

Beyond physical climate risks, it is recognized that transitional risks for Manitoba Hydro and its customers will also change over time as national, sub-national, and municipal governments seek to mitigate the impacts of climate change by adopting policies that increasingly limit GHG emissions. The Project, and other projects that increase the availability of non-GHG emitting electricity generation, can help reduce transitional risk for Manitoba Hydro and its customers.

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APPENDIX A RISK ASSESSMENT SUMMARY

	Climate Event	Impact Topic(s)	Probability	Consequence	Risk Rating Direct[2]	Risk Rating Indirect[3]	Risk Rating Systemic[4]	Tolerance
1	Extreme Heat	Transmission line operation	Medium	Low	Low	N/A	N/A	High
		Conductor to ground clearances	Medium	Low	Low	N/A	N/A	High
		Workers	High	Low	Medium	N/A	N/A	High
		Powerhouse equipment cooling	Medium	Low	Low	N/A	N/A	High
2	Winter Temperature	Transmission line construction and refurbishment	Low	Low	Low	N/A	N/A	High
		Transmission line access for operation and maintenance	High	Low	Medium	N/A	N/A	High
		Powerhouse heating	High	Low	N/A	Opportunity	N/A	N/A
3	General Air Temp. Increase	Weather affected energy demand	High	Low	N/A	N/A	Opportunity	N/A
		Transmission operation during peak demand	High	Low	Low[1]	N/A	Medium	High
4	Wind Speed	Transmission structural and mechanical design	Medium	Medium	Medium	N/A	N/A	High
		Shoreline erosion	Medium	Low	N/A	Low	N/A	High
		Freeboard and wave action	Medium	Low	N/A	Low	N/A	High
5	Near Freezing Precipitation	Transmission structural and mechanical design	Medium	Medium	Medium	N/A	N/A	High
		Road travel safety	Medium	Low	N/A	Low	N/A	High
6	Convective Storms	Infrastructure damage (multiple)	Medium	Medium	Medium	N/A	N/A	High
		Transmission line operation	Medium	Medium	Medium	N/A	N/A	High
7	Freeze-Thaw Cycles	Concrete deterioration	Low	Low	N/A	Low	N/A	High
		Movement of shallow foundations	Low	Low	Low	N/A	N/A	High
8	Snow Accum.	Design snow loads	Medium	Low	N/A	Low	N/A	High
9	Vegetation	Transmission line operation and maintenance	High	Low	Medium	N/A	N/A	Medium
10	Wildfire	Infrastructure damage (multiple)	High	Low	Medium	N/A	N/A	Medium
		Transmission line operation	High	Medium	Medium[1]	N/A	N/A	High
		Site access	High	Low	Low[1]	N/A	N/A	High
11	Water Temperature	Equipment cooling efficiency	High	Low	Low[1]	N/A	N/A	High
		Ice cover season duration	High	Low	N/A	Low[1]	Opportunity	High
		River ice processes	Medium	Low	N/A	Low	N/A	Medium
		Ice cover stability for resource usage	Medium	Medium	N/A	Medium	N/A	Medium
		Sturgeon spawning	High	Low	N/A	Medium	N/A	Medium
		Fish community assemblage	High	Low	N/A	Medium	N/A	Medium
		Ability to practice rights-based activities	High	Low	N/A	Medium	N/A	Medium
12	System-Wide Water Supply	System-wide energy production	Medium	Low	N/A	N/A	Opportunity	N/A
		Transmission system operation	Medium	Low	N/A	N/A	Low	High
		Net revenue	Medium	Low	N/A	N/A	Opportunity	N/A
13	Winnipeg River Streamflow	Energy production	Medium	Low	Low	N/A	Opportunity	High
		Reservoir operation	Medium	Low	N/A	Opportunity	N/A	N/A
14	Winnipeg River Drought	Energy production	Medium	Low	Low	N/A	Opportunity	High
		Powerhouse heating	Medium	Low	N/A	Opportunity	N/A	N/A
		Aquatic habitat	Medium	Low	N/A	Low	N/A	High
15	Winnipeg River Flood	Freeboard and flood passage	Medium	High	Medium[1]	Medium[1]	N/A	High
		Reservoir levels and operational strategies	Medium	Low	N/A	Low	N/A	Medium
		Spillway operation, maintenance, and access	Medium	Low	N/A	Low	N/A	High
		Public waterway safety	Medium	High	N/A	Medium[1]	Medium[1]	High
16	Other Overland Flooding	Site access	Medium	Low	Low	N/A	N/A	Medium
		Transmission line access	Medium	Low	Low	N/A	N/A	High
		Transmission line conductor clearances	Medium	Low	Low	N/A	N/A	High
17	Canadian Gov't Policy	Demand for non-emitting electricity	High	Low	N/A	N/A	Opportunity	N/A
		Electrification and/or fuel switching	High	Low	N/A	N/A	Opportunity	N/A
18	U.S. Export Market Policy	Demand for non-emitting electricity	High	Low	N/A	N/A	Opportunity	N/A
		Funding for U.S. clean energy projects	High	Low	Medium	N/A	N/A	Medium

[1] Assignment deviates from Table 2 risk matrix due to tolerance and professional judgment.

[2] Direct risk to Project is a risk that could directly impact construction of the Project or the generation and transmission of power from the new units

[3] Indirect risk to Project is a risk to Pointe du Bois Generating Station with impacts that may occur with or without the Project

[4] Systemic risks include risks that could impact Manitoba Hydro's broader system which may occur with or without the Project

N/A: Risk rating not assigned (e.g., out of scope) or tolerance not applicable (i.e., for opportunities).