LAKE MANITOBA LAKE ST. MARTIN

OUTLET CHANNELS PROJECT

MANITOBA TRANSPORTATION AND INFRASTRUCTURE

Wetland Monitoring Plan

June 30, 2022

Manitoba Transportation and Infrastructure

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DISCLAIMER

This document was developed to support the Environmental Management Program (EMP) for the Lake Manitoba and Lake St. Martin Outlet Channels Project (the Project). It has been prepared by Manitoba Transportation and Infrastructure as a way to share information and facilitate discussions with Indigenous rights-holders, stakeholders and the public. It has been prepared using existing environmental and engineering information and professional judgement, as well as information from previous and ongoing public and Indigenous engagement and consultation. The contents of this document are based on conditions and information existing at the time the document was prepared and do not take into account any subsequent changes. The information, data, recommendations, and conclusions in this report are subject to change as the information has been presented as draft. This draft plan should be read as a whole, in consideration of the entire EMP, and sections or parts should not be read out of context.

Revisions to draft plans have been informed by and will be based on information received from the engagement and consultation process, the Environmental Assessment process, Project planning activities, and on conditions of provincial and federal environmental regulatory approvals received for the Project. As these will be living documents, any changes to the plans that occur after Project approvals are received will be shared with regulators, Indigenous rights-holders and stakeholders prior to implementation of the change. Either a revision number or subsequent amendment would be added to the specific environmental management plan to communicate the revision or change.

PREFACE

The Lake Manitoba and Lake St. Martin Permanent Outlet Channels Project (the Project) is proposed as a permanent flood control mitigation for Lake Manitoba and Lake St. Martin to alleviate flooding in the Lake St. Martin region of Manitoba. It will involve the construction and operation of two new diversion channels: the Lake Manitoba Outlet Channel (LMOC) will connect Lake Manitoba to Lake St. Martin and the Lake St. Martin Outlet Channel (LSMOC) will connect Lake St. Martin to Lake Winnipeg. Associated with these outlet channels are the development of bridges, control structures with power connections, a new realignment of Provincial Road (PR) 239, and other ancillary infrastructure.

Manitoba Transportation and Infrastructure is the proponent for the proposed Project. After receipt of the required regulatory approvals, Manitoba Transportation and Infrastructure will develop, manage and operate the Project. This Wetland Monitoring Plan (WetMP) is one component of the overall Environmental Management Program (EMP) framework, which describes the environmental management processes that will be followed during the construction and operation phases of the Project. The intent of the EMP is to facilitate the timely and effective implementation of the environmental protection measures committed to in the Environmental Impact Statement (EIS), the requirements and conditions of the provincial licence issued under *The Environment Act*, the federal Decision Statement issued under *The Canadian Environmental Act 2012*, and other approvals received for the Project. This includes the verification that environmental commitments are implemented, monitored, evaluated for effectiveness, and adjustments made if/as required. It includes a commitment that information is reported back in a timely manner for adjustment, if required.

A key component for the success of the EMP is environmental monitoring, such that environmental management measures are inspected and modified for compliance with environmental and regulatory requirements, including those set out in provincial and federal approvals received for the Project. As indicated, monitoring results will be reviewed and used to verify predicted environmental assessment conclusions and effectiveness of mitigation measures. If unanticipated effects occur, or if mitigation measures are inadequate, adaptive management measures and subsequent monitoring will be applied as described further in individual environmental management and monitoring plans.

Monitoring results and application of adaptive management measures will inform follow-up reporting to regulators and any required revisions to environmental management plans. Manitoba Transportation and Infrastructure has initiated discussions with Indigenous rights-holders and the Rural Municipality (RM) of Grahamdale in the Project area on the establishment of an Environmental Advisory Committee (EAC). The EAC would be a platform for sharing monitoring results and discussing issues of concern. In addition, Manitoba Transportation and Infrastructure anticipates that the EAC will coordinate Indigenous Environmental Monitors and communications during the construction period and will be working with Indigenous rights-holders and stakeholders on its structure and purpose.

Manitoba Transportation and Infrastructure remains committed to consultation and ongoing engagement with Indigenous rights-holders and stakeholders that are potentially impacted by the Project. Detailed EMP review discussions were incorporated into Indigenous group-specific consultation work plans. Engagement opportunities included virtual open house events, sharing draft environmental management and monitoring plans, sharing plan-specific questionnaires, and meetings to discuss related questions and recommendations. The intent has been to offer multiple avenues to share information about the Project so that rights-holders and stakeholders would be informed and could provide meaningful input into Project planning. The original draft EMP plans and questionnaires that were posted on the Project website for public review and comment are being replaced by the second draft of each plan as it becomes available. Feedback and recommendations received were used to update the current version of the draft plans, which are posted to the Project website at: https://www.gov.mb.ca/mit/wms/lmblsmoutlets/environmental/index.html.

Figure A displays a summary of the EMP process. The EMP provides the overarching framework for the Project Construction Environmental Management Program (CEMP) and the Operation Environmental Management Program (OEMP). These will be updated prior to Project construction and operation, respectively, and will consider applicable conditions of *The Environmental Act* provincial licence, *The Canadian Environmental Assessment Act 2012* federal Decision Statement conditions and other approvals, any other pertinent findings through the design and regulatory review processes, and key relevant outcomes of the ongoing Indigenous consultation and public engagement processes. Until such time, these plans will remain in draft form.

The purpose of the CEMP and OEMP is to guide how environmental issues will be addressed during construction and operation, respectively, and how adverse effects of activities will be mitigated. The CEMP is supported by several specific or targeted management plans that will guide Manitoba Transportation and Infrastructure's development of the Project's contract documents and subsequently, the Contractor(s) activities, in an environmentally responsible manner and to meet regulatory compliance in constructing the Project. The OEMP will include some of the same targeted plans developed to manage issues during construction, but prior to construction completion, they would be revised and adapted to suit the specific needs during the operation phase

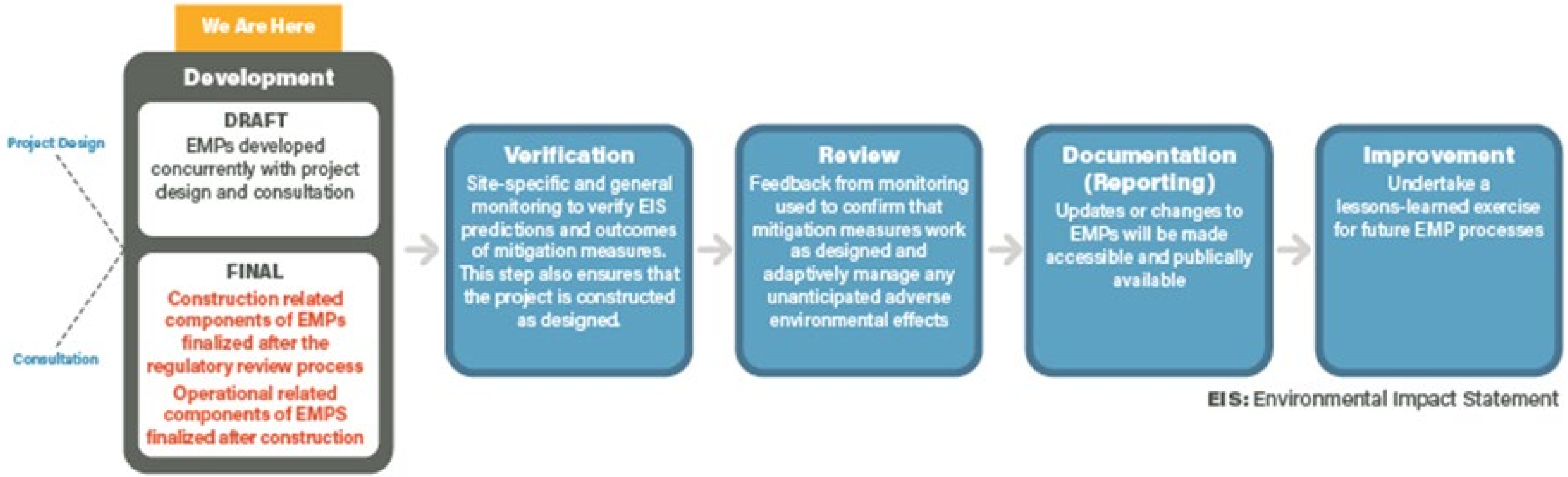


Figure A: EMP Process

LIST OF ACRONYMS AND GLOSSARY OF TERMS

Acronyms

%	Percent
ARU	autonomous recording units
BACI	Before-After-Control-Impact design
CDWQ	Guidelines for Canadian Drinking Water Quality
CEMP	Construction Environmental Management Program
cm	centimetre
DO	Dissolved Oxygen
EAC	Environmental Advisory Committee
EIS	Environmental Impact Statement
EMP	Environmental Management Program
EOC	Emergency Outlet Channel
GIS	Geographical Information System
GWMP	Groundwater Management Plan
ha	hectare
km	kilometre
km^2	square kilometre
KMP	Key Measurable Parameter
LAA	local assessment area
LMOC	Lake Manitoba Outlet Channel Project
LSMOC	Lake St. Martin Outlet Channel Project
m	metre
m^3/s	cubic metres per second
MB CDC	Manitoba Conservation Data Centre
mbgs	metres below ground surface
masl	metres above sea level
MSOF-FAL	MB Standards, Objectives, and Guidelines for the Protection of Freshwater Aquatic Life

OEMP	Operation Environmental Management Program
PDA	Project development area
PR	Provincial Road
the Project	Lake Manitoba and Lake St. Martin Permanent Outlet Channels Project
RAA	regional assessment area
RM	Rural Municipality
ROW	right-of-way
SAR	Species at Risk
SARA	*Species at Risk Act*
SOCC	Species of Conservation Concern
sp.	Species, one
spp.	Species, more than one
SWMP	Surface Water Management Plan
WCP	Wetland Compensation Plan
WCS	water control structure
WetMP	Wetland Monitoring Plan
WMP	Wildlife Monitoring Plan

Glossary of Terms

Alkalinity: A pH value of greater than 7.0 (pH is a way to measure the acidity or alkalinity of a solution).

Non-native Invasive Species and Weeds: Not native or not naturally occurring to a region/habitat. E.g., weed species such as Canada Thistle and introduced species such as Russian olive trees.

Baseline: Initial environmental conditions prior to construction or anthropogenic actions.

Benchmark: Degree of change from baseline conditions.

Contractor: Refers to the individuals, entities or groups contracted by Manitoba Transportation and Infrastructure to undertake specific Project construction, operation or maintenance activities, and includes all subcontractors and affiliates.

Discharge: Rate of outflow; volume of water flowing down a river, from a lake outlet, or man-made structure.

Dissolved oxygen: Oxygen molecules (O_2) dissolved in water.

Environmental Monitor: Refers to the individuals, groups or designated representatives engaged by Manitoba Transportation and Infrastructure to monitor, inspect, and document compliance with contractual and regulatory requirements associated with the construction activities and associated works for the Project. The monitor may also be an active member (or representative) of the Project's Environmental Advisory Committee.

Ericaceous shrubs: Shrub species that can tolerate growing in acidic conditions.

Groundwater: Water that occurs beneath the land surface and fills the pore spaces of soil or rock below the saturated zone.

Groundwater quality: Refers to the chemical composition of groundwater and its suitability for various uses and also varies widely depending upon the local geologic setting, hydrogeological conditions, and past/current land use practices that may contribute to anthropogenic effects.

Groundwater quantity: Refers to the availability of groundwater at a given rate for production and use, and it varies widely depending upon the local geologic setting, hydrogeological conditions, and past/current groundwater use.

Hydraulic Conductivity: Symbolized as K, is a property of vascular plants, soils and rocks that describes the ease with which a fluid (usually water) can move through pore spaces or fractures. It depends on the intrinsic permeability of the material, the degree of saturation, and on the density and viscosity of the fluid.

Hydrogeology: The study of the interrelationships of geologic materials and processes with water, especially groundwater.

Indicator species: A species (e.g., plant or wildlife) that can be used to assume conditions in a particular habitat.

Measurable parameter: A physical attribute/characteristic (e.g., temperature, water depth, plant abundance) that can be measured and used to compare against a standard or benchmark.

Minerotrophic: Referring to wetlands that contain water that is rich in dissolved minerals.

Ombrogenous: Referring to wetlands that rely on rainwater for dissolved minerals and are therefore nutrient-poor.

Orthoimagery: Geo-referenced images of the Earth's surface from satellite or airborne (planes, drones) sensors.

Peatland: Refers to:

(a) a bog, fen or swamp, and

(b) has waterlogged conditions that prevent plan material from fully decomposing, resulting in the production of organic matter exceeding its decomposition causing a net accumulation of peat.

Runoff: Surface water that flows into streams or back into the water source rather than seeping into the ground.

Standards: Established scientific limits.

Stewart and Kantrud system: A wetland classification system that identifies 5 classes of prairie wetlands (Manitoba Sustainable Development 2020). The class is determined by the length of time that the wetland holds surface water in a year of average moisture conditions and the associated vegetation and soils.

- Class I: short-lived wetlands (retains water for one week or less), mainly existing in spring after winter snow melts or big rains, typically supporting vegetation such as Kentucky bluegrass, goldenrod and forbes.
- Class II: short-lived wetlands (retains water for one week to one month), mainly existing in spring after winter snow melts or big rains, typically supporting vegetation such as fine stemmed grasses, sedges and forbs.
- Class III: semi-permanent or seasonal, meaning that it retains water for one month to three months, often dry by mid-June but may hold water for the entire year, often lasting fewer than five months; typically supporting shallow marsh vegetation such as emergent wetland grasses, sedges and rushes on gleysolic soils.
- Class IV: semi-permanent, meaning that it retains water for more than three months, holds some water year-round under wetter conditions but goes dry in below-average years, often lasting more than five months; typically supporting marsh vegetation and submerged aquatic vegetation such as cattails, bulrushes and pond weeds in the central area of the wetland as on gleysolic soils.
- Class V: permanent, meaning that it retains water year-round in average years with permanent open water in the central areas but may go dry in years with well below average moisture conditions; typically having a central area that is open water free of vegetation surrounded by a zone of submerged aquatic vegetation such as cattails, bulrushes and pond weeds on gleysolic soils.

Species at Risk: Species that are listed, tracked and protected under the *Species at Risk Act.*

Species of Conservation Concern: Species in addition to species at risk (SAR) that are listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC); for listing under *The Species at Risk Act* (SARA) as special concern, threatened or endangered (Government of Canada 2019a) or those listed by the Manitoba Conservation Data Centre (MB CDC) as provincially rare (i.e., S1 or S2 rankings; MB CDC 2018).

Surface water: Water that is on the Earth's surface, such as in a stream, river, lake, or reservoir.

Till: An unstratified, unconsolidated mass of boulders, pebbles, sand and mud deposited by the movement or melting of a glacier.

Turbidity: A measure of the relative clarity of water.

Wetland: Refers to:

(a) a marsh, bog, fen, swamp or ponded shallow water, and

(b) low areas of wet or water-logged soils that are periodically inundated by standing water and that are able to support aquatic vegetation and biological activities adapted to the wet environment in normal conditions.

1.0 INTRODUCTION

1.1 Purpose and Scope

The Project Environmental Impact Statement (EIS) completed for the Lake Manitoba and Lake St. Martin Outlet Channels Project (the "Project") identified that some direct loss of wetland habitat would occur during construction (Manitoba Infrastructure [MI] 2020). In addition, the Project EIS identified that wetlands adjacent to Lake St. Martin and Lake Manitoba might be indirectly affected by the management of flood waters during Project operation (i.e., flood conditions) as well as through alteration of hydrology due to changes in surface and groundwater flows under non-flood conditions (MTI 2022d). During operation, alterations to drainage flows will affect soil moisture regimes and hydrologic function upgradient and downgradient of the Lake Manitoba Outlet Channel (LMOC) and Lake St. Martin Outlet Channel (LSMOC) (MI 2002b).

Wetlands are an integral component of a watershed, providing numerous flood control and ecological benefits, including providing habitat for a wide variety of plant and wildlife species, many of which are of cultural importance to local Indigenous rights-holders. As such, wetlands were identified in the Project EIS as a valued ecosystem component. During a review of the Project EIS and supporting documents, Federal government agencies, Indigenous rights-holders and other stakeholders (e.g., Rural Municipality [RM] of Grahamdale) identified concerns that the Project would result in unavoidable direct and indirect impacts on wetlands within and adjacent to the channels. To address direct impacts to wetlands (i.e., wetland loss from channel and associated infrastructure development) and to meet federal recommendations (Federal Policy for Wetland Conservation, 1991) and provincial regulatory requirements (*The Water Rights Act* and associated Regulation), Manitoba Transportation and Infrastructure (formerly Manitoba Infrastructure) developed a Wetland Compensation Plan (WCP) (MTI 2022d) in support of the Project that provides offsetting for directly affected wetlands.

The Wetland Monitoring Plan (WetMP) has been prepared by WSP Canada Inc. for Manitoba Transportation and Infrastructure in response to comments received from governmental, Indigenous and other stakeholder groups and to provide a monitoring program that assesses potential indirect effects on wetlands, including changes to class/size of wetlands, surface and groundwater quality and quantity, vegetation cover (plant species compositions/abundance) and wildlife habitat from changes to groundwater and surface water regimes for those wetlands outside the Project footprint that do not receive compensation under the provincial system.

The purpose of the WetMP is to provide a comprehensive, integrated monitoring plan that tests the predictions of the Project EIS with respect to indirect wetland effects, determines the effectiveness of mitigation measures, and the requirement for, and nature of associated follow-up where required.

This document outlines the past work contributing to the Project EIS and wetland compensation discussions with federal and provincial regulators, the objectives of the WetMP, and the ecological context and available baseline information. This background information informed the approach to the WetMP, which is described in terms of program design and implementation.

1.2 Wetland Mapping Background

Pre-construction surveys (including a vegetation survey) and updated wetland mapping were completed in 2020 to supplement baseline environmental information previously collected and documented in background reports for the Project's EIS. The wetland mapping submitted as part of the Project EIS drew from coarse resolution regional mapping by other agencies. The updated wetland mapping was completed to improve the resolution and accuracy of previous mapping, both through digital mapping methods and with ground-ground-truthing (in conjunction with the pre-construction vegetation survey), and to fill the analysis gaps.

The updated mapping was completed using geographical information system (GIS)-based wetland and terrestrial land cover mapping techniques to improve past mapping exercises, focusing on the Project development area (PDA) and the immediately adjacent lands. Mapping was constrained in part by coverage of the input orthoimagery and LiDAR data available, which were limited to an area within 1.5 kilometres (km) of centreline (referred to as the modified local assessment area [Modified LAA]). However, this data was of a much finer resolution than what was used previously, which facilitated mapping of wetland and upland areas at 1:5,000 scale. This mapping in combination with ground-truthing, provided more accurate wetland and upland community delineation and characterization, resulting in impact predictions with higher confidence. For wetlands, the improved mapping allowed a more accurate assessment of the potential wetland impact, which aided in informing compensation value in terms of both area and ecological function of wetlands for the development of the WCP in support of the Project. The mapping also helped identify wetlands within the Modified LAA that might be indirectly affected by the construction and operation of the outlet channels. Those impacts could not be predicted with confidence. As such, this WetMP will facilitate confirming effects on wetland form and function within the modified LAA.

1.3 Study Areas

The LMOC and LSMOC study areas used during the previous environmental studies and in the Project EIS provide useful baseline data that can be helpful in monitoring for indirect effects on wetland water supply and ecological function. Wetlands are a unique habitat in that they rely on a water flood regime that in turn influences the vegetation and wildlife that use them. This WetMP focused on the previous work within the Modified LAA, including surface and groundwater surveys and vegetation, wetland, and wildlife assessments (refer to Figures 1 and 2). This information collected on wetlands within the Modified LAA allowed for determining wetland type (class), abundance, and dominant vegetation cover/wildlife habitat present. This information in turn aided in the selection of potential wetland monitoring sites representative of the wetland types as well as with the selection of key measurable parameter (KMPs) (e.g., indicator plant species groups) that facilitate the determination of functional changes in wetlands. Selection of potential monitoring sites where baseline sampling sites overlap offered good context of background data on which to track change for the initial establishment of monitoring sites during the initial year (baseline year),

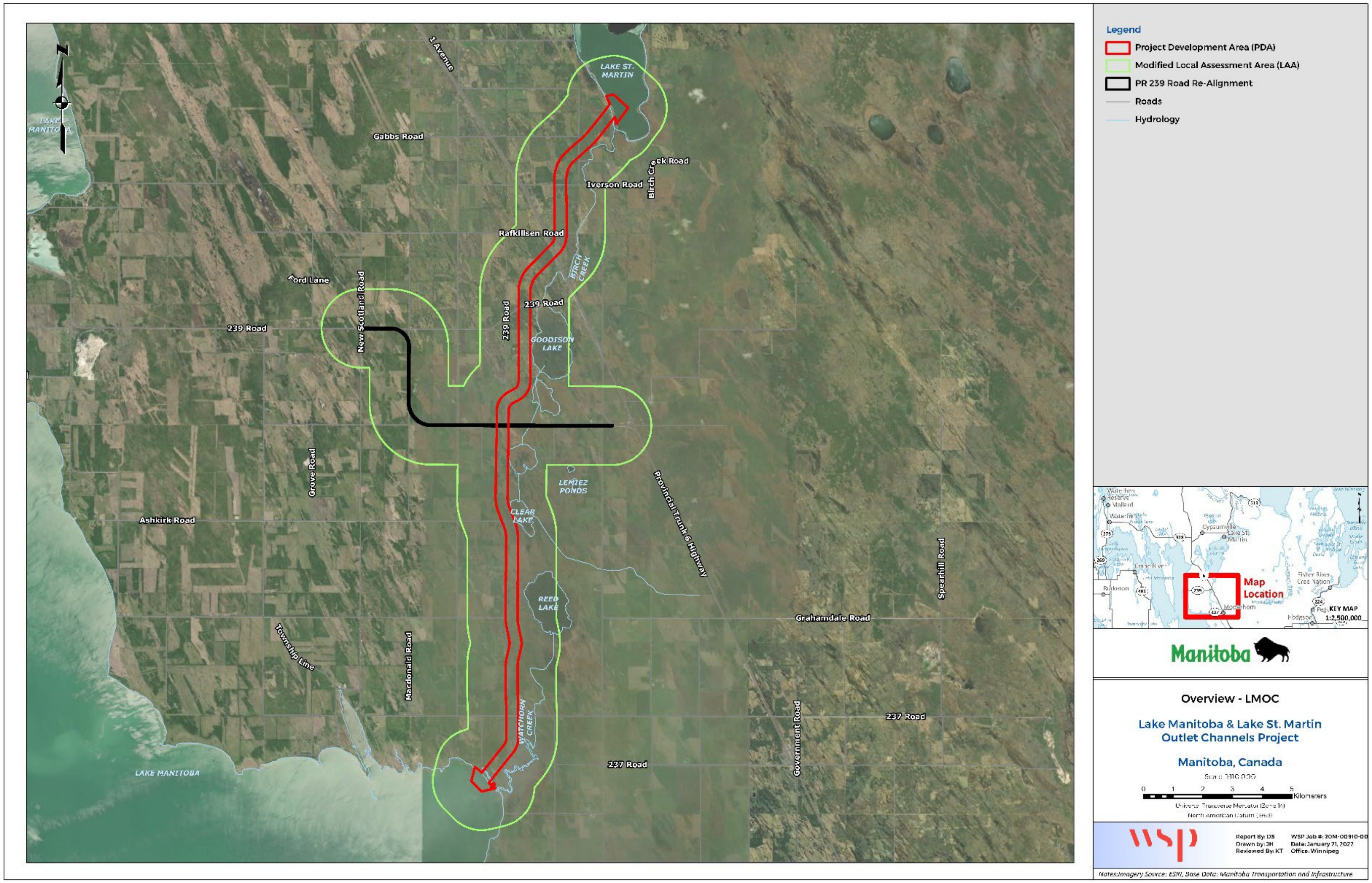


Figure 1: Overview of the LMOC Study Areas

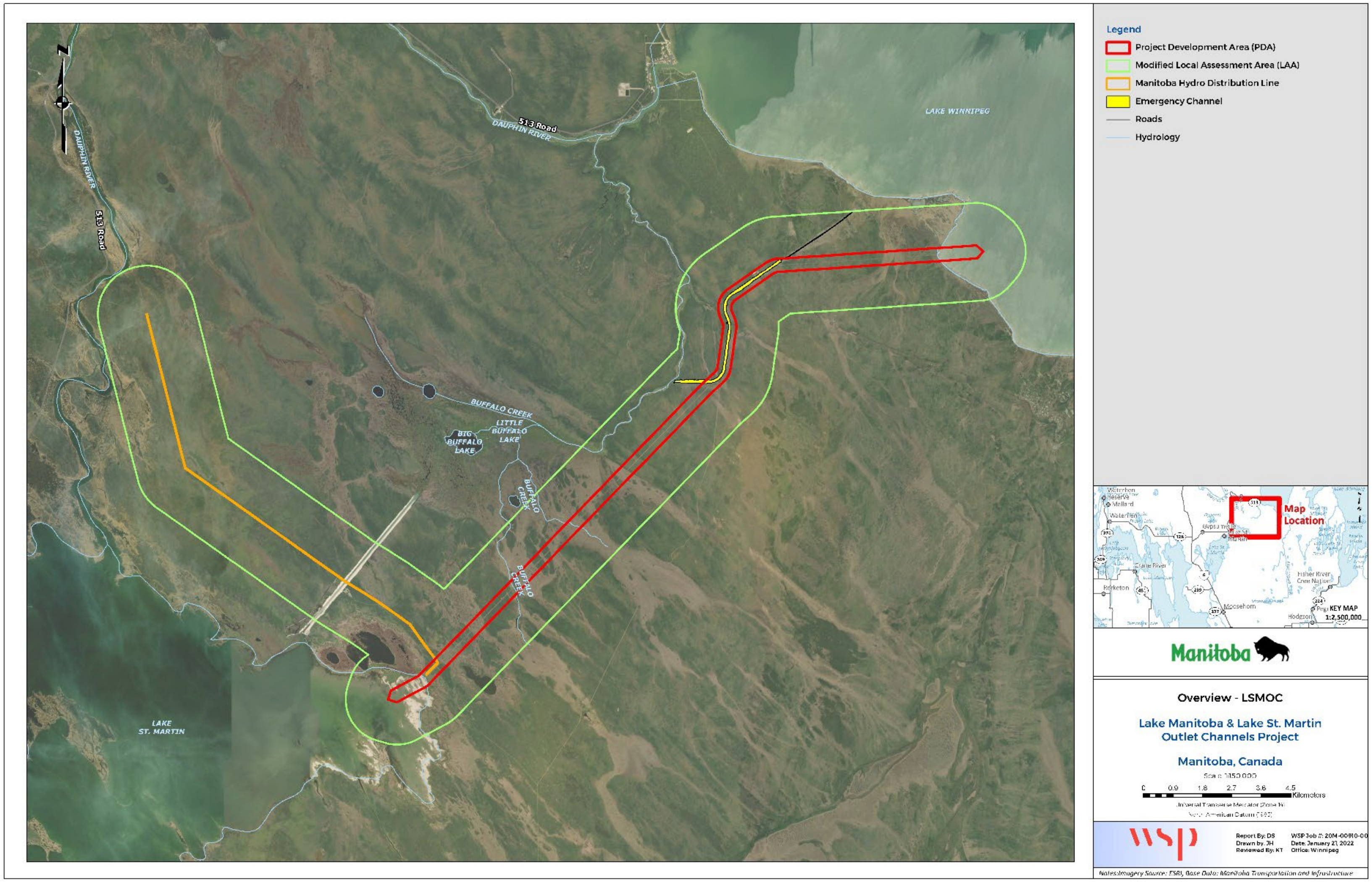


Figure 2: Overview of the LSMOC Study Areas

1.3.1 Previous Monitoring/Survey Locations

In support of the Project, baseline data was collected by Manitoba Transportation and Infrastructure's consultants including, surface water quality, groundwater conditions, vegetation ecosystem classification and cover, wetland classification and extent, wildlife species at risk (SAR) and vegetation plant species of conservation concern (SOCC) presences/absence. Monitoring/survey locations for these previous assessments are provided in Figures 1A, 1B, 2A, 2B, 3A, 3B, 4A and 4B in Appendix 1 and included the following sites:

- Twelve surface water quality monitoring sites were established between 2017 and 2019 within the LMOC Project EIS LAA and included monitoring at locations such as Watchorn Creek, Birch Creek, Reed Lake, Clear Lake, Water Lake, Goodison Lake, Lake St. Martin, and Lake Manitoba (Stantec Consulting Ltd. [Stantec], 2021a). Within the LSMOC seven surface water sampling locations were established between 2019 and 2020 in the PDA or Project EIS LAA.
    - Two of the LSMOC surface water sites are located within the PDA and, therefore, will be lost as potential monitoring sites once the channel is constructed. As such, they are not likely to provide long-term comparative baseline monitoring information for future wetland monitoring activities.
- Eighty-five monitoring wells have been installed in the PDA and six wells outside of the PDA of the outlet channels between 2017 and 2019. In 2019, groundwater quality and quantity monitoring in conjunction with geotechnical testing was conducted within the LMOC PDA and at bridge structure locations, at four existing wells and 12 new well locations (including pump, observation, and test hole wells). Twelve instrumental test holes were established in 2015 in the LSMOC PDA, with survey and monitoring completed in 2019 (MTI 2022b).
    - Construction of the LMOC and LSMOC will remove all these groundwater monitoring wells. As such, use of these sites for baseline comparison for future monitoring activities of groundwater parameter in wetlands will not be feasible.
- The updated wetland mapping completed in 2020 (WSP, 2020) identified wetland classes and aerial extent within the Modified LAA and the PDA for both the LMOC and LSMOC. Field verification of a subset of the wetlands within the PDA provided additional details on general site characteristics and vegetation cover/species present.
    - Many of these wetland verification sites will remain intact or can shift to remnant wetland areas adjacent to the PDA (within Modified LAA) to provide baseline monitoring for future comparisons.
- Wildlife surveys were completed in 2017 as part of the baseline studies for the Project and included surveys for breeding birds, SAR (e.g., rail yellow) and amphibians. The 2020 preconstruction survey included breeding songbird and yellow rail surveys. Survey locations that detected bird and amphibian SAR were mapped for the channel study areas and included sites with the Modified LAA as well as within the Project EIS regional assessment area (RAA).
    - Two amphibian and two bird survey locations detected SAR within the Project EIS LAA for the LMOC and LSMOC, respectively and as such, have the potential to provide a limited baseline comparison.

1.4 Monitoring Plan Objectives

Monitoring is part of the provincial and federal environmental assessment process, as part of the follow-up on impacts and mitigation with uncertain outcomes. Monitoring of indirect impacts on wetlands within the Modified LAA will consider the Federal Policy on Wetland Conservation (1991), which recommends an assessment of wetland loss in terms of both form (i.e., wetland class) and ecological function. In practice, such impacts are challenging to predict, particularly where surface and groundwater drainage patterns may be disrupted. As such, a Before-After-Control-Impact (BACI) design (Underwood, 1992) is proposed for this monitoring plan, which will maximize the use of baseline data collected during the project to detect long-term (before-after) effects, as well as more immediate changes using paired control-subject sites. BACI designs are an effective method to assess human-induced distance of environmental variables when random selection of treatment or subject sites is not possible (Conner, Saunders, Bouwes and Jordan, 2016). This approach will allow Manitoba Transportation and Infrastructure to track changes of KMPs (e.g., specific plant assemblages) over time and separate seasonal from Project effects. It will also allow for early detection of impacts, triggering an adaptive management approach to assess the scale of change and develop mitigation measures.

The Project EIS described potential changes to hydrology and hydrogeological conditions adjacent to the outlet channels, which included the diversion of surface flows in some watersheds (e.g., Buffalo Creek in the LSMOC) and in groundwater inputs to surface waterbodies (e.g., Reed Lake). The outlet channels will be constructed with a ditch on the upgradient side (“outside drain” in the Project EIS), which will capture and redirect surface flows, and possibly shallow groundwater away from downgradient wetlands. Wetlands associated with these areas of predicted change as well as those of concern to Federal departments, Indigenous rights-holders and other stakeholders that overlap with an area of potential and measurable change, provide a focus for the WetMP. Given the uncertainty regarding predicted impacts in these areas, an adaptive management approach will be adopted (refer to Section 1.4.2).

1.4.1 Objectives

The objective of the WetMP is to outline a framework for multi-disciplinary studies that will enable Manitoba Transportation and Infrastructure to determine and evaluate potential indirect effects on wetlands in the Modified LAA, and provide guidance for appropriate action required in the event that indirect effects exceed standards or benchmarks (process of active management). The overarching monitoring program will consist of an integrated sampling and assessment structure, including field, remote and laboratory components. By following a BACI structure, a comparison of conditions in potentially affected (subject) wetlands adjacent to the PDA (within 100 - 200 metres [m]) will be made against those in pre-disturbance and control locations to allow for the determination and quantification of potential effects. This will be accomplished by monitoring KMPs that influence the form and function of wetlands in the Modified LAA. The WetMP will assess changes to wetland form in terms of classification, and wetland function in terms of surface water flow/quality, groundwater interchange/hydraulics, vegetative cover (function), wildlife habitat for species biodiversity and SAR, and use by Indigenous rights-holders. This approach is consistent with similar monitoring programs conducted for linear development in the Athabasca Oil Sands region of Alberta (refer to Section 3.1).

Specific components of the WetMP objective are as follows:

- Evaluate effects on wetland function for those wetlands that do not receive compensation under the WCP, but that may be indirectly affected by the Project. The WetMP provides a process to evaluate changes to wetland form and function in terms of:
    - surface water flow/quality
    - groundwater parameters
    - wetland class
    - vegetative cover, including wildlife habitat (biodiversity and SOCC/SAR)
    - use by Indigenous rights-holders
    - Meet federal Wetland Policy guidance to assess change to wetland form and function (hydrological, ecological), including changes in wetland class (e.g., drying or increased hydroperiod effects).
- Maximize monitoring efforts by coordinating program design with other previous baseline studies and construction/operation monitoring plans (including the Groundwater Management Plan [GWMP], Revegetation Management Plan, Surface Water Management Plan [SWMP] and the Wildlife Monitoring Plan [WMP]) to capture all relevant Project data indicative of functional wetland impacts.
- Identify benchmarks or thresholds for when Project related activities may be deleterious to wetlands and vegetation and wildlife species.

1.4.2 Adaptive Management Approach

The *Impact Assessment Act* process includes an adaptive management process to address impacts with uncertainty or public concern. Specifically, the Act requires a follow-up program: “a program for verifying the accuracy of the impact assessment of a designated project and determining the effectiveness of any mitigation measures.” An associated Operational Policy Statement (https://www.canada.ca/content/dam/iaac-acei/documents/ops/ops-follow-up-programs-2011.pdf) further explains that a follow-up program is used to:

- verify predicted environmental effects
- determine the effectiveness of mitigation measures, and inform modifications or new measures where required
- support implementation of adaptive management measures to address unanticipated adverse environmental effects
- provide information on environmental effects and mitigation to improve future environmental assessments and cumulative environmental effects assessments
- support environmental management systems used to manage the environmental effects of projects

The WetMP will assess changes to wetland size and class, key indicator functional forms and drainage patterns by focusing on sites of concern to Federal departments, Indigenous rights-holders and other stakeholders where changes to groundwater and surface water flow and quality are anticipated, which in turn could affect vegetation community composition, wildlife habitat, presence of SOCC/SAR, and use by Indigenous rights-holders. An adaptive approach will be employed in the WetMP to allow for the flexibility to monitor changes to wetlands adjacent to the PDA (within 100 - 200 m), thereby identifying the potential need to assess effects on wetlands within the Modified LAA and to determine the need for mitigation strategies or further offsetting such as through restoration or enhancement activities or additional rehabilitation measures.

The spatial extent of the Modified LAA is anticipated to be sufficient to document Project-related indirect effects. If effects are of greater magnitude than anticipated, the spatial extent of monitoring could be modified to document unanticipated changes if there is a risk that effects extend beyond the LAA.

2.0 REGIONAL SETTING

2.1 Ecological Context

The Project lies within the Boreal Plains Ecozone, a region where the terrain is generally flat, with a distinct north to south trending ridged and swale (drumlinoid) topography formed from subglacial deposition, with slopes of 1 to 3 percent (%). Ridges are generally well-drained and support upland forest vegetation, while the swales are poorly drained and support wetland communities. These characteristic physiographic features are evident in aerial imagery of the channel areas: southeast to northwest-trending, shallow drumlin ridges are very evident in the LMOC area, and complex patterns of bog, fens, and small streams dominate the LSMOC area. Jack pine (*Pinus banksiana*), white spruce (*Picea glauca*), trembling aspen (*Populus tremuloides*), and white birch (*Betula papyrifera*) are the dominant upland trees present in the Boreal Plains Ecozone, with balsam poplar (*Populus balsamifera*) occupying transitional and wetland ecosystems. The occurrence of black spruce (*Picea mariana*) and tamarack (*Larix laricina*) increases moving north as peatland habitats increase in frequency and scale in the landscape (Smith et al., 1998). The Project components traverse two Ecoregions of the Boreal Plains Ecozone: the Interlake Plain and Mid-Boreal Lowland.

The LMOC lies within the Interlake Plain Ecoregion. The regional landform is underlain by low relief Paleozoic limestone bedrock, with a general surface form of a level to ridged lake terrace complex. Surficial deposits range from loamy glacial till, varying from deep (>30 m) to very shallow (<20 m) deposits to water-worked areas with veneers to blankets of glaciolacustrine sand, gravel and boulder deposits (Smith et al., 1998). Flooding issues are linked to the low relief: at times of high seasonal precipitation, surface flows in the south will collect in low-lying swales between drumlins and ridges or in the lowland floodplains adjacent to larger lakes. The resulting landscape includes complexes of large graminoid marsh and shrubby swamp wetlands of temporary to seasonal water duration, with smaller to moderately large kettle ponds supporting permanent to semi-permanent marshes and shallow open water. Trembling aspen is the dominant forest cover, with balsam poplar and white spruce mixedwood stands occurring less frequently (Smith et al., 1998). Depressional lowland areas support sedges (*Carex* spp.), meadow grasses (*Poaceae*) and willows (*Salix* spp.), and reed and cattail (*Typha latifolia*) emergent species in deeper marshes with reed and cattail (*Typha latifolia*) emergent species in deeper marshes. Mineral wetlands (marshes, swamps) are typically surface water fed but can also have some groundwater supply. Reed Lake was identified to have some groundwater influence in the Project EIS (MI, 2020).

The LSMOC lies within the southern part of the Mid-Boreal Lowland Ecoregion. Climatic factors combined with the smoothing action of clay, silt and sand glacial deposits from Lake Agassiz have supported the development of complex patterns of bog, fens, small streams and large to very large lakes (Smith et al., 1998), such as Lake Winnipeg. In the Mid-Boreal Lowland Ecoregion, predominant tree species in upland communities consist of trembling aspen, Jack pine, white spruce, and occasionally balsam fir (*Abies balsamea*), with black spruce and balsam poplar present on transitional sites (Smith et al., 1998). Peatland vegetation consists of black spruce, ericaceous shrubs (*Ericaceae*), and moss (e.g., Sphagnum) in bog habitats, with tamarack, swamp birch (*Betula pumila*), sedges and brown moss dominating fens (Smith et al., 1998). Bogs are primarily surface water fed, while fens typically have a mixture of ground and surface water inputs.

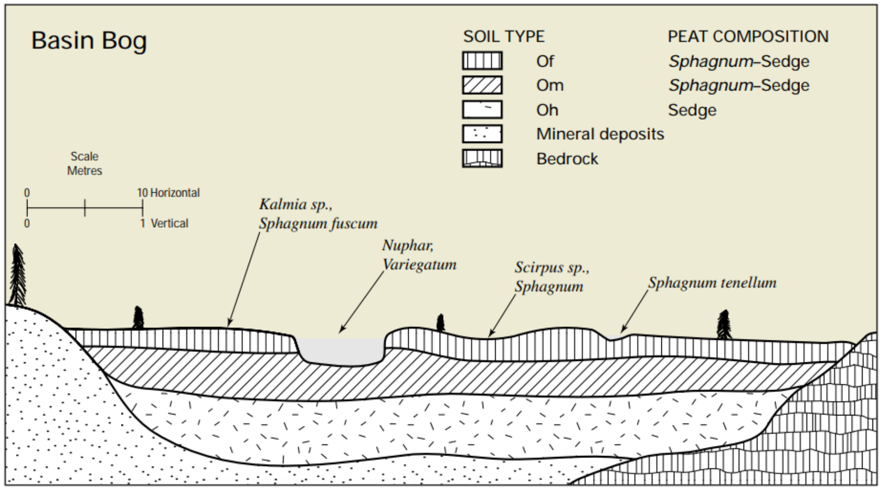
2.2 Existing Wetlands and Predicted Impacts

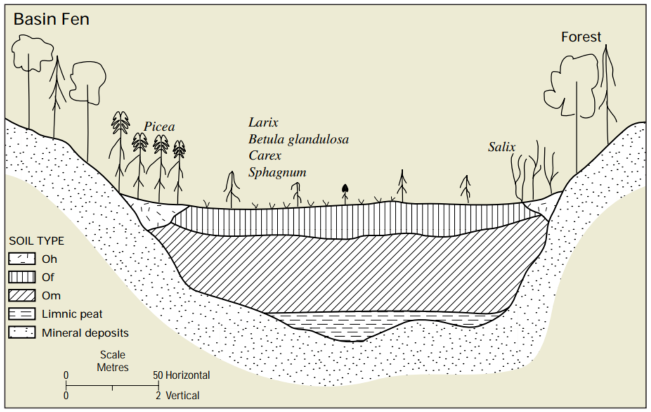
2.2.1 Existing Wetland Class and Abundance

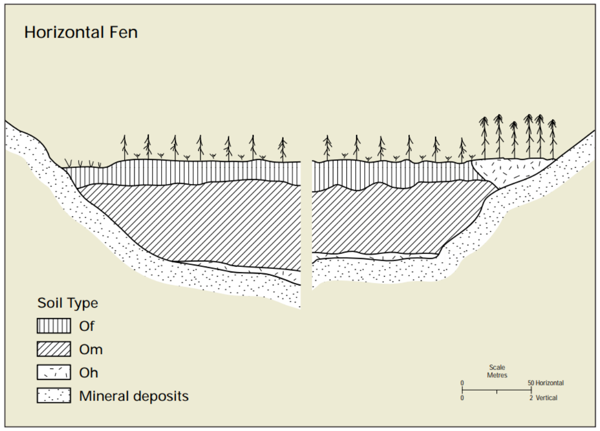
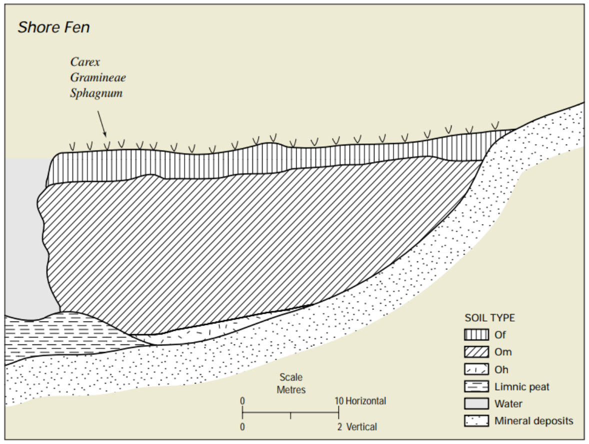
In 2020, wetland mapping was refined to better delineate the diverse types of wetlands and uplands in the northern (LSMOC and Manitoba Hydro distribution line) and southern (LMOC and Provincial Road 239 realignment) Project areas to support planning and the WCP. For wetlands, both the Stewart and Kantrud (1971) system and the Canadian Wetland Classification System (National Wetlands Working Group, 1997) were used (Table 1). The combination allowed identification of the marshes in the southern Project areas and the organic and swamp wetland types in the northern Project areas. Further, the Steward and Kantrud system is used in Manitoba's wetland compensation process. Waterbodies and all anthropogenic land cover types followed the EOSD Land Cover classification for the Manitoba area (Wulder and Nelson, 2003).

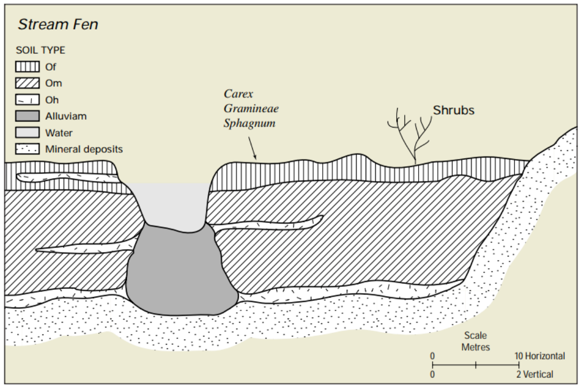
The Stewart and Kantrud classification differentiate wetlands based on the duration of wetted conditions in the deepest part of the wetland. Wetlands range from permanent waterbodies to those that have open water for only part of the year. The system includes two wetlands that support water only briefly during the year (Class I and II wetlands, see wetland classes in Table 1). Of these, only Class II wetlands could be accurately identified in the updating exercise. Class I wetlands could not be mapped accurately using the GIS mapping approach since, by definition, such areas are wet only briefly in early spring or during rain events. Neither Class I nor Class II wetlands require compensation under Manitoba's *Water Rights Act* or its Regulations.

Table 1: Wetland Classifications

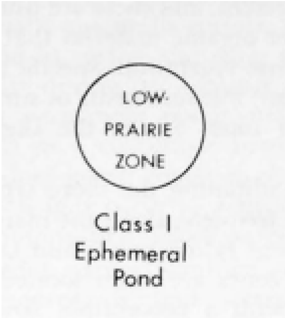
Classification System	Description	Image Example
Canadian Wetland Classification System[1]		
Bog – Bogs are peat wetlands that have a raised or level surface and are unaffected by runoff waters or groundwaters from surrounding mineral soils. In general, the water table is at or slightly below the surface of the bog. Precipitation and snowmelt are the primary water sources of bogs, and as such, bogs are ombrogenous (rely on rainwater for dissolved minerals and are therefore nutrient poor). The water is bogs is therefore low in dissolved minerals and are acidic. (pH between 4.0-4.8). They may be treed or treeless and are typically covered with Sphagnum spp, and ericaceous shrubs (tolerate acidic conditions) and have an acceptation of peat[1].		
Basin Bog	Topographically confined peatland with poor nutrients and level surface; water input limited to snowmelt, rain and local surface run-off. Located in basins with a flat surface across the entire peatland; there are no surface streams that feed into the wetland. The thickest peat depth is found in the centre of the bog basin[1].	 Image 1. Basin Bog (Image from Canadian Wetland Classification System[1])

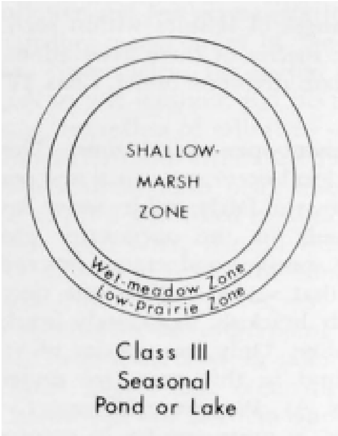
Classification System	Description	Image Example
Fen – Fens are peat wetlands that have fluctuating water levels and are minerotrophic (waters in fens are rich in dissolved minerals). Movement of groundwater and surface water is characteristic of fens. Fens are composed of variable thickness of moderately decomposed sedge and brown moss peats. Wetter fens contain graminoid vegetation and some bryophytes, whereas fens with lower water tables contain shrubs, and the driest fens may contain trees (typically black spruce)[1].		
Basin Fen	Topographically confined peatland in basins; water inputs consisting of snowmelt, rain, surface runoff, and groundwater. Basin fens may be entirely isolated to both surface water streams inflow and outflow or may lack inflowing streams but will have surface stream outflow. Bain fens may be flat or slightly concave, and thickness of peat is variable but often exceeds 2 m in depth[1]	 Image 2. Basin Fen (Image from Canadian Wetland Classification System[1])

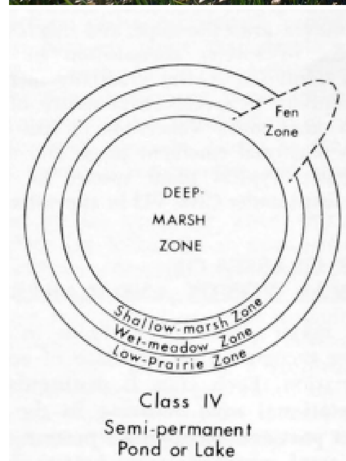
Classification System	Description	Image Example
Horizontal Fen	Uniformly vegetated peatland on broad depressions or plains; water inputs consisting of snowmelt, rain, surface runoff, and groundwater. Horizontal fens are typically uniformly vegetated by graminoid, shrub or tree species. Driver treed islands may be present. Peta thickness varies from 2 to 3 m in depth[1].	 Image 3. Horizontal Fen (Image from Canadian Wetland Classification System[1]). Center portion of wetland omitted from image to emphasize margins.
Shore Fen	Peatland situated adjacent to lakes or ponds with firmly anchored surface peat; water inputs consist of snowmelt, rain, surface runoff, groundwater and surface flow. Peat depth typically exceeds 2 m[1].	 Image 4. Shore Fen (Image from Canadian Wetland Classification System[1])

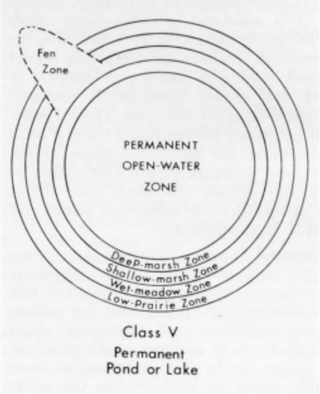
Classification System	Description	Image Example
Stream Fen	Peatland located in main channel or along banks of permanent or semi-permanent streams; water inputs consist of snowmelt, rain, surface runoff, groundwater and surface flow. The low gradient and slow water flow associated with the stream allow for the formation of peat along the stream edges. Peat depth is variable and often exceeds 3 m in depth. Water table depth is affected by steam levels under normal and flood conditions[1].	 Image 5. Stream Fen (Image from Canadian Wetland Classification System[1])
Swamp – Swamps are wetlands that are dominated by treed or tall shrubs and are influenced by minerotrophic groundwater, either on mineral or organic soils[1].		
Basin Swamp	Topographically confined shrubby or treed wetland with less than 40 centimetres (cm) of organic soil. Water is derived by surface water runoff, groundwater or precipitation and occasionally by small inflowing streams[1].	No image in Canadian Wetland Classification System[1]
Lacustrine Swamp	Shrubby or treed wetland with less than 40 cm of organic soil occurring along the shores of permanent ponds or lakes; water level affected by lake during high water periods[1].	No image in Canadian Wetland Classification System[1]

Classification System	Description	Image Example
Lagg Swamp	Sloping shrubby or treed wetland with less than 40 cm of organic soil occurring between upland mineral terrain and peatlands[1].	No image in Canadian Wetland Classification System[1]
Riverine Swamp	Shrubby or treed wetland with less than 40 cm of organic soil occurring along banks of rivers and permanent and intermittent streams; subject to flooding when stream or river waters are high. Water table is maintained by the water level in the adjacent river or stream[1].	No image in Canadian Wetland Classification System[1]
Unconfined Flat Swamp	Broad shrubby or treed wetland that lack defined edges; with less than 40 cm of organic soil. Occur among other kinds of wetlands with poorly defined edges[1].	No image in Canadian Wetland Classification System[1]
Prairie Pothole Wetland Classification System, Stewart and Kantrud (1971)[2]		
Marsh – Marshes are wetlands characterized by periodic or persistent standing water or slow-moving surface water. Water levels in marshes may fluctuate seasonally or annually due to flooding, groundwater recharge, seepage losses or evapotranspiration. Marshes receive water through surface runoff, steam inflow, precipitation, and groundwater discharge. Marshes are generally nutrient rich and may be alkaline. Vegetation species include graminoids, shrubs, forbs and emergent plants[1].		

Classification System	Description	Image Example
Class I	Temporary wetland with standing water present after snowmelt or rainfall events; standing water lasting only a few weeks after snowmelt and a few days after rainfall[3].	 Image 6. Class I Wetland[2]
Class II	Temporary graminoid/forb mineral wetland with wet meadow plant community; surface water is present for a short period of time after snowmelt or heavy rainfall.	  Image 7. Class II Wetland (image from WSP, 2020). Image 8. Class II Wetland[2]

Classification System	Description	Image Example
Class III	Seasonal graminoid/forb mineral wetland with shallow wetland plant community; surface water is present throughout the majority of the growing season but is typically dry by the end of summer. Water sources for Class III wetlands in the Project area may include precipitation (annual rainfall and snowfall), runoff from surrounding areas as well as shallow groundwater recharge*.	  Image 9. Class III Wetland (image from WSP, 2020). Image 10. Class III Wetland[2]

Classification System	Description	Image Example
Class IV	Semi-permanent graminoid/forb mineral wetland with deep wetland community; surface water is present for most or all of the year, except in periods of drought. Water sources for Class IV wetlands in the Project area may include precipitation (annual rainfall and snowfall), runoff from surrounding areas as well as shallow groundwater recharge*.	  Image 11. Class IV Wetland (image from WSP, 2020). Image 12. Class IV Wetland[2]

Classification System	Description	Image Example
Class V	Permanent graminoid/forb mineral wetland with open water community; surface water is present throughout the year. Water sources for Class V wetlands in the Project area may include precipitation (annual rainfall and snowfall), runoff from surrounding areas as well as shallow groundwater recharge*.	  Image 13. Class V Wetland (image from WSP). Image 14. Class I Wetland[2]

Classification System	Description	Image Example
Other		
Water Bodies		
Water Bodies	Consists of all open water, including lakes, rivers, streams, ponds and lagoons.	 Image 15. Class V Wetland (image from WSP).

Notes:

[1] Warner, B.G. and Rubec, C.D.A. (eds.) 1997. The Canadian Wetland Classification System, 2nd Edition. Wetlands Research Centre, University of Waterloo, Waterloo, ON, Canada. 68 pp.

[2] Stewart, R.E. and H.A. Kantrud. 1971 Classification of Natural Ponds and Lakes in the Glaciated Prairie Region. Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Washington, D.C., USA. Resource Publication 92. 57 pp.

[3] Manitoba Conservation and Climate and Manitoba Agriculture and Resource Development (n.d.). Wetland Classification Key.

[4] *Refer to Section 2.6.2 for additional details on groundwater recharge to wetlands in the Project area.

Table 2 provides a summary of wetland classes and areas mapped in the LMOC PDA and Modified LAA, and links to compensation requirements.

Table 2: Wetland Classification within the Modified LAA and LMOC PDA

Broad Land Cover Category	Land Cover Class	Area in LMOC Modified LAA (ha)	Area in LMOC PDA (ha)	Estimated Impacted Area In the PDA (ha)	Compensation Area (ha)[1]
Other Water/Bare	Water Bodies	480.85	64.18	64.18	N/A
Wetlands					
Marsh	Class II	325.22	68.01	68.01	N/A
	Class III	1,120.53	197.91	197.91	197.91
	Class IV	638.87	38.38	38.38	N/A
	Class V	297.29	0.83	0.83	N/A
Swamp	Basin Swamp	102.85	47.76	47.76	N/A
	Lacustrine Swamp	1.75	0.74	0.74	N/A
Total Wetlands		**2,486.52**	**353.63**	**353.63**	**197.91**

Notes:

The *Water Rights Act* sets out requirements for restoration, enhancement, and/or compensation of prescribed wetlands that are lost or altered by the construction, operation and maintenance of a Project. The prescribed wetlands considered for compensation under the W*ater Rights Act* for the Lake Manitoba and Lake St. Martin Outlet Channels Project include Class III, IV and V wetlands.

Table 3 provides a summary of the overall wetland cover found within the LSMOC PDA and the Modified LAA. This outlet channel passes through extensive peatlands, including a range of bogs and fens, many of which are contiguous. Fens were the most abundant wetland type in the PDA and Modified LAA, and horizontal fens comprised the main type of fen. Fen wetlands occupy flat terrain, are fed by both groundwater and surface water flows, and can have slow velocity surface flow. The outlet channel, where it bisects such wetlands, will have both direct and indirect effects that extend beyond the PDA. Swamps were also relatively abundant in the LSMOC PDA and were often found adjacent to fens and bogs where terrain sloped up slightly, such that soils were not inundated year-round. Neither swamps nor peatlands are addressed in Manitoba's Wetland Compensation Policy, and only the small area of Class III marsh impact (0.11 hectares [ha]) requires compensation under The Water Rights Regulation.

Table 3: Wetland Classification within the Modified LAA and LSMOC PDA

Broad Land Cover Category	Land Cover Class	Area in LSMOC Modified LAA (ha)	Total Impacted Area in the LSMOC PDA (ha)	Estimated Impacted Area in the PDA (ha)	Compensation Area Requirements (ha)[1]
Other Water/ Bare	Water Bodies	573.61	1.39	30.47	N/A
Wetlands					
Marsh	Class I	0	0	0	N/A
	Class II	0	0	0	N/A
	Class III	15.05	0.11	0.11	0.11
	Class IV	42.40	N/A	N/A	N/A
Peatland	Basin Bog	722.66	114.10	114.10	N/A
	Basin Fen	196.54	40.94	40.94	N/A
	Horizontal Fen	3,335.27	333.26	333.26	N/A
	Shore Fen	126.18	4.84	4.84	N/A
	Stream Fen	1,728.69	232.53	232.53	N/A
Swamp	Basin Swamp	7.22	3.78	3.78	N/A
	Lacustrine Swamp	71.59	10.66	10.66	N/A
	Lagg Swamp	158.29	11.46	11.46	N/A
	Riverine Swamp	12.81			
	Unconfined Flat Swamp	80.17	18.06	18.06	N/A

Broad Land Cover Category	Land Cover Class	Area in LSMOC Modified LAA (ha)	Total Impacted Area in the LSMOC PDA (ha)	Estimated Impacted Area in the PDA (ha)	Compensation Area Requirements (ha)[1]
Wetland Total		6,496.87	769.74	769.74	0.11

Notes:

The *Water Rights Act* sets out requirements for restoration, enhancement, and/or compensation of prescribed wetlands that are lost or altered by the construction, operation and maintenance of a project. The prescribed wetlands considered for compensation under the *Water Rights Act* for the Lake Manitoba and Lake St. Martin Outlet Channels Project include Class III, IV and V wetlands.

2.2.2 Predicted Impacts to Wetlands

Construction of the LMOC and LSMOC will result in direct loss to wetland habitat intersected by the Project footprint. Wetlands adjacent to Lake St. Martin and Lake Manitoba have the potential to be indirectly affected by Project operations due to changes in surface and groundwater flows during non-flood conditions (MTI 2022c). For the LMOC, upgradient surface drainage structures (outside drain) are anticipated to limit the extent of effects on surface water drainage and shallow subsurface flow to the PDA; however, downgradient (i.e., on the east side) of the PDA, residual effects are anticipated to potentially extend up to 1,000 m into the Modified LAA (MI, 2020; KGS Group [KGS] 2021a). Changes to water balance east of the LMOC PDA may change water levels in wetlands which could reduce areas of open water, change vegetation composition toward those species adapted to lower water levels/less frequent flooding and ultimately reduce wetland extent or change wetland class (MTI 2022d).

Residual effects to surface drainage and shallow subsurface flow along the LSMOC are anticipated to also extend beyond the PDA into the Modified LAA (MI, 2020). Surface water drainage structures (outside drain) constructed on the upgradient side of the LSMOC (i.e., the east side of the channel) will limit the increased wetness of land outside of the PDA resulting from the impoundment of water against the LSMOC. There is the potential for surface and shallow subsurface flow to be affected along the entire length of the LSMOC. Effects are not anticipated to extend beyond 600 m downgradient and potentially up to 1,000 m upgradient (during 1 in 100-year flood conditions) and perpendicular to the channel (MI, 2020; KGS 2021a). Implementation of the outside drains along the LSMOC will minimize the wetting up on the east side of the LSMOC channel which in turn is anticipated to minimize impacts to the vegetation communities associated with the wetlands outside the PDA (MTI 2022d).

Changes to water levels, vegetation composition and coverage, may cause changes to wetland habitat quantity and quantity resulting in effects on wildlife species, including migratory birds, waterbirds, and SAR. Wetland-dependent wildlife species, including SAR such as yellow rail, least bittern and northern leopard frog, rely on particular wetland types/habitat to complete their life cycles (e.g., nesting, breeding, staging and over-wintering).

2.3 Hydrogeological Context and Predicted Impacts

Information about the areas of potential impact on groundwater flow to wetlands within the Modified LAA is critical to monitoring indirect effects on wetlands. Similarly, baseline data from past monitoring activities can be used to compare data collected at control and impact sites before and after construction to detect changes over longer timeframes.

The Project lies within the Interlake area of the Manitoba lowland physiographic region. Bedrock is present along the alignment and dips gently to the southwest. The bedrock is a carbonate rock with minor clastic and argillaceous units. Tills, proglacial lacustrine sediments, and younger organic deposits overlay the bedrock within the sites in the Project EIS LAA. The LMOC study area is predominantly dominated by a large silty to silt clay till layer, with areas of exposed bedrock where the till is thinner, while the LSMOC is dominated by a thick clay to silty clay layer below a thin peat and organic layer. A deeper silt to silt till is superimposed over the limestone bedrock (KGS, 2021b).

Topography is relatively flat at the site, and regional topography slopes gently towards Lake Winnipeg, Lake St. Martin, and Lake Manitoba. Figure 3 illustrates regional topography at the site.

Groundwater within the PDA has been monitored since 2017 via monitoring wells that have been constructed as part of previous geotechnical investigations. There were 85 monitoring wells installed in the PDA and seven wells outside of the PDA. The geotechnical investigation, which included the drilling program along the site, had been primarily completed by KGS. Groundwater wells were installed from 2015 through 2019 by KGS, apart from 2017, when wells were installed by Manitoba Transportation and Infrastructure along the LSMOC. Ranges in depths along the LSMOC are from 1.22 metres below ground surface (mbgs) to 30.78 mbgs (212.261 metres above sea level [masl] and 220.207, respectively) (KGS, 2019). At the time of this report, the well construction details along the LMOC, such as date of construction, well depths, screen intervals, etc. are unknown.

Groundwater levels within the PDA ranged from 247.84 m to 248.70 masl at the LMOC and 243.5 masl to 257.5 masl at the LSMOC. The highest recorded groundwater level was after a significant precipitation event on July 13, 2014, at G05LM002A, which is screened in the limestone bedrock (KGS, 2021a). As outlined in the GWMP, all of these wells within the PDA will be destroyed during construction). No monitoring wells exist within the Project EIS LAA with the exception of six wells TH19-KGS-19, TH15-03(A), TH15_02(A), TH19-KGS-20, TH15-01, TH-GD-08 and TH-GD-02 (refer to Figures 1A 1B, 2A and 2B Appendix 1).

Groundwater flow was observed during the baseline monitoring program, generally moving towards the future proposed LSMOC and LMOC alignments as well as Lake Winnipeg, Lake St. Martin, and Lake Manitoba. Figure 3 below illustrates the groundwater flow at the site (MI 2020).

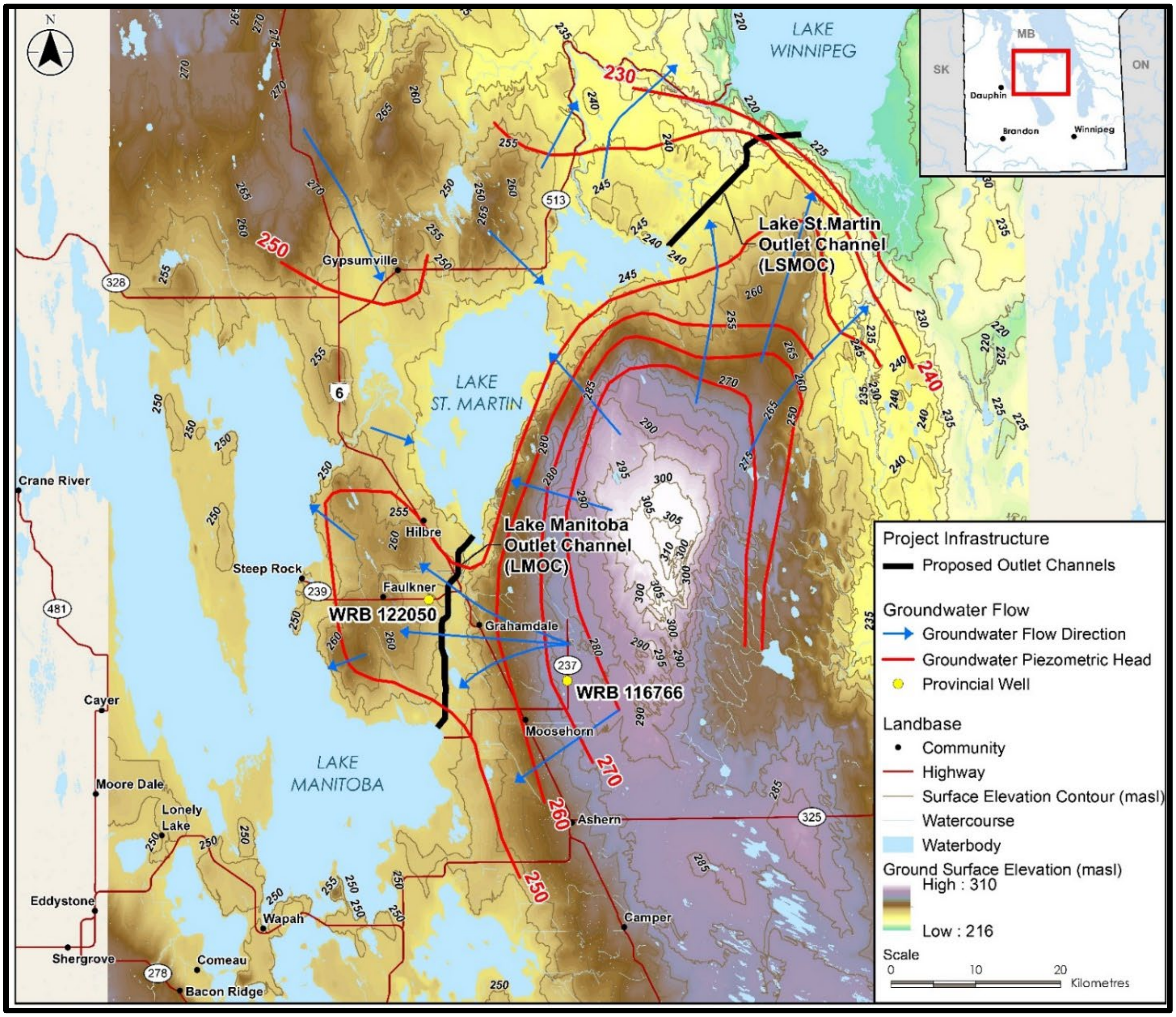


Figure 3: Regional Groundwater Flow (MI, 2020)

Groundwater flow within the northern region of the LMOC flows towards the west, and near the outlet channel, groundwater flows southerly into Lake Manitoba. While the LSMOC is observed to be flowing north towards Lake Winnipeg. Figures 5A and 5B, Appendix 1 illustrate site specific groundwater flow at the LMOC and LSMOC, respectively.

Groundwater quality sample analysis has been completed during previous monitoring events conducted in 2016, 2017, 2018, 2019, and 2020 (MTI 2022b). Groundwater parameters were tested against the Canadian Water Quality Guidelines for Protection of Aquatic Life (CWQG-Fal) (short-and-long-term), Manitoba Standards, Objectives, and Guidelines for the Protection of Freshwater Aquatic Life (MSOF-FAL) (chronic and acute), and Guidelines for Canadian Drinking Water Quality (CDWQ) (MTI 2022b).

As outlined in the GWMP, groundwater quality results from samples collected at LSMOC in March, June and October 2019 and again in June and October 2020 are provided in Table 4 below. This quality sampling was conducted during the preliminary design phase of the Project for the purpose of obtaining baseline parameters to support environmental assessments for the Project. These samples were obtained from 31 standpipes, three pump wells, and one sentinel well and were sampled and analyzed for water chemistry. The other two sentinel wells were sampled when they were installed in September 2019.

Table 4: LSMOC Baseline Groundwater Quality Measurement Ranges from field measurements (MI, 2020)

Field Parameter	Range of 2019 Monitoring Results		Range of 2020 Monitoring Results	
	Minimum	Maximum	Minimum	Maximum
pH	6.51	8.76	6.00	8.50
Electric Conductivity (µS/cm)	436	1,888	522.6	1,163
Dissolved Oxygen (DO) (mg/L)	0.36	13.72	0.19	8.07
Oxygen Reduction Potential (mV)	-93.2	490	-29.0	82.2

As outlined in the KGS report (KGS, 2021b), there were samples collected from the overlying till and samples also from the bedrock aquifer for LSMOC. The till groundwater geochemistry is unique from the bedrock aquifer groundwater geochemistry, and surface water geochemistry, and shows generally higher dissolved solids and more frequent elevated percentages of sulphate and chloride than in the bedrock groundwater or surface water system. One well at the proposed location of the Water Control Structure (WCS) is typically high in dissolved solids and sulphate. The low permeability of the till limits any water influx into the till, either from discharge from fresher groundwater below or recharge from fresher surface water and wetland sources perched above the till. The integrity and functioning of the till aquitard are demonstrated by its thickness and low permeability characteristics, combined with its unique groundwater geochemistry, and with the observation of upward gradients (to flowing artesian conditions) and because it demonstrates a confining condition for the underlying bedrock aquifer throughout the region of the LSMOC. Bedrock groundwater chemistry along the channel alignment is generally similar and consistent with a few wells showing more mineralized conditions with higher dissolved solids and sulphate. It should be noted that one well near the end of the channel near Lake Winnipeg that shows significant flux in water type seasonality which could indicate a connection with surface water sources or changes in groundwater flow paths (KGS, 2021c).

LMOC groundwater quality monitoring was conducted from thirteen sites, including pump wells, observation wells, and test hole wells (within the channel right of way and at future bridge structure locations) established by the Hatch team, were monitored for groundwater quality during field campaigns in June, August, and October of 2019 (Appendix 1, Figure 1A and 1B). Sampling frequency at groundwater sites was dependent on the timing of well installation following geotechnical work; therefore, some sites were not sampled on every 2019 campaign. Groundwater sample collection was also limited at some sites by lack of landowner permission for personnel access and site conditions.

Table 5 below (refer to Figures 1A and 1B, Appendix 1) is a summary of the exceedances for DO, Turbidity, Fluoride, Total Phosphorus, Total Dissolved Solids (TDS), E-Coli., Total Coliforms, Toluene, Dissolved Manganese, Dissolved Zinc, Total Aluminium, Total Copper, Total Iron and Total Manganese. Figures 1A and 1B Appendix 1 provide locations of groundwater sampling locations).

Table 5: LMOC Groundwater Exceedances, 2019 Sampling Event (MTI 2022c)

Parameter	Guidelines		Sites Where Exceedances are Present	No. of Exceedances	Percent Exceedances	Max. Value	Site of Max. Value	Date of Max Value
Dissolved Oxygen	CWQG-FAL	>5.5/6/6.5/ 9.5[VAR-B]	BH19-12, BH19-29, CH19-08, CH19-37, OW19-05, OW19-16, OW19-18, OW19-23, OW19-40, OW19-17, PW19-06, PW19-22	17	68%	0.98[+]	Ow19_18[+]	7-Oct-19[+]
Turbidity Field (NTU)	CDWQ	≤0.3/1.0/0.1[G]	BH19-12, BH19-29, CH19-08, CH19-37, OW19-05, OW19-16, OW19-18, OW19-23, OW19-40, PW19-17, CH19-11, PW19-06, PW19-22	20	80%	166.67	CH19-08	7-Oct-19
Fluoride	CWQG-FAL	0.12[B]	BH19-12, BH19-29, CH19-08, CH19-37, OW19-05, OW19-16, OW19-18, OW19-23, OW19-40, PW19-17, CH19-11, PW19-06, PW19-22	23	92%	0.855	BH19-29	20-Aug-19
Total Phosphorus	MSOF-FAL	0.025[C]	CH19-08, OW19-05, PW19-06	5	25%	0.191	CH19-08	7-Oct-19
Total Dissolved Solids	CDWQ	≤500[E]	CH19-08	3	12%	561	CH19-08	7-Oct-19

Parameter	Guidelines		Sites Where Exceedances are Present	No. of Exceedances	Percent Exceedances	Max. Value	Site of Max. Value	Date of Max Value
E-Coli (mpn/100 mL)	CDWQ	0[G]	CH19-23	1	5%	2	OW19-23	8-Oct-19
Total Coliforms (mpn/100 mL)	CDWQ	0[G]	BH19-12, BH19-29, CH19-08, CH19-37, OW19-05, OW19-16, OW19-18, OW19-23, OW19-40	12	60%	196	OW19-16	19-Aug-19
Toluene	CWQG-FAL	0.002[B]	OW19-05	1	5%	0.0098	OW19-05	19-Aug-19
Dissolved manganese	CDWQ	≤0.05[E]	OW19-05	1	5%	0.0546	OW19-05	19-Aug-19
Dissolved Zinc	CWQG-FAL	Varies with hardness	CH19-37, OW19-18, OW19-23, PW19-17, PW19-06, PW19-22	6	30%	0.128	OW19-18	7-Oct-19
Total Aluminum	CWQG-FAL MSOG-FAL CDWQ	Varies with pH	CH19-08, OW19-05, PW19-06, PW19-22	7	35%	2.15	CH19-08	19-Aug-19
Total Copper	CWQG-FAL CDWQ	Varies with hardness	BH19-29, CH19-08, CH19-37, OW19-40	5	25%	0.0310	CH19-37	8-Oct-19

Parameter	Guidelines		Sites Where Exceedances are Present	No. of Exceedances	Percent Exceedances	Max. Value	Site of Max. Value	Date of Max Value
Total Iron	CWQG-FAL MSOG-FAL CDWQ	0.3[B/D/E]	CH19-08, OW19-05	5	25%	3.11	CH19-08	19-Aug-19
Total Manganese	CWQG-FAL CDWQ	≤0.05[E]	CH19-08, OW19-05	3	15%	0.125	CH19-08	7-Oct-19

Notes:
Results are in mg/L unless otherwise specified in the parameter column.
Percent Exceedances: percent of total collected samples with guideline exceedances.

+ DO values listed are the minimum value since it is the value farthest from the acceptable guidelines.
  VAR Lowest acceptable DO concentration: for warm mater biota: early life stages = 6 mg/L; for warm water biota: other life stages = 5.5 mg/L; for cold water biota: early life stages = 9.5 mg/L; for cold water biota: other life stages = 6.5 mg/L

A Canadian Water Quality Guideline (CWQG)-FAL Freshwater Aquatics Short Term
B CWQG-FAL Freshwater Aquatics Long Term
C Manitoba standard, objectives and guidelines (MSOG)-FAL Tier I – Water Quality Guidelines – Freshwater Aquatic Life
D MSOG-FAL Tier III – Water Quality Guidelines – Freshwater Aquatic Life
E CDWQ Aesthetic Objectives/Operational Guidelines
F CDWQ Maximum Acceptable Concentration
G CDWQ Microbial Parameters

2.4 Hydrological Context and Predicted Impacts

Surface water flows are a critical aspect of wetland form and function since water flood duration and depth will determine the vegetation that can establish and be sustained, as well as the wildlife that may use it. Areas of predicted impact and current hydrological context informed candidate site selection, while past water monitoring sites offer baseline data useful for future comparison to control and impact monitoring sites.

2.4.1 LMOC

The LMOC is located within the Birch Creek and Watchorn Creek drainage systems. As shown in Figure 4, the LMOC will cross Birch Creek and Watchorn Creek drainage areas, intercepting part of the surface runoffs currently draining into these creeks. The Birch Creek current watershed area is estimated at 286 square kilometres (km^2) and drains toward Lake St. Martin. Birch Creek generally flows parallel and east of the LMOC alignment, outside of the PDA, and feeds numerous wetlands and lakes along that alignment, such as Reed Lake, Clear Lake, Water Lake and Goodison Lake. Roughly 27% of its total drainage area, or 78.5 km^2, is located to the west of the LMOC. This section of the watershed is expected to be “affected” by the LMOC, meaning that the Birch Creek effective drainage area is expected to be reduced by about 27%, as LMOC would intercept any runoff coming from the western sub-watersheds (MI, 2020). A preliminary hydrologic assessment of Birch Creek estimated the mean annual flow to be 15 cubic metres per second (m^3/s) at its outlet in Lake St. Martin (MTI 2022c). The impact of this drainage area reduction on Birch Creek water balance remains unclear, as no water balance or hydrological modelling has been completed so far.

Watchorn Creek has a total drainage area of 93 km^2 and drains into Watchorn Bay, near the inlet of the LMOC. About 89 km^2 of its watershed is located on the east side of the LMOC, and only about 3.7 km^2 of the watershed, or 4%, is located on the west side of the LMOC and is expected to be impacted by the Project.

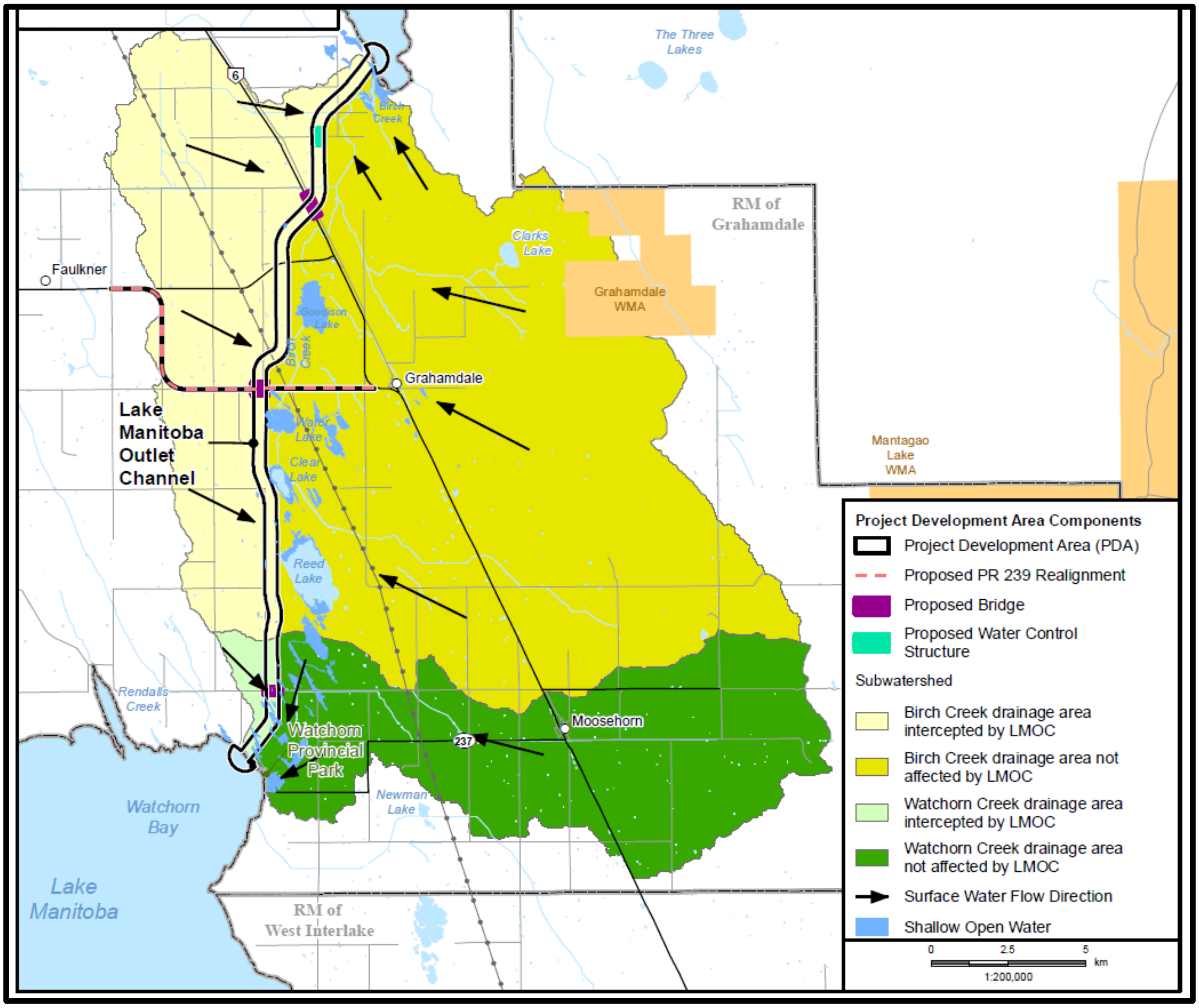


Figure 4: Watersheds within the LMOC Study Area (MTI 2022c)

The LMOC watersheds were monitored between 2017 and 2019 at ten monitoring sites. The characteristics of these monitoring stations are summarized in Table 6 and are shown on Figures 1A, 1B, 2A and 2B, Appendix 1. Monitoring at these sites generally consisted of punctual surface water sampling and water depth measurements. In 2019, water sampling and water depth measurements were conducted in June, August, and October.

Twelve surface water quality monitoring sites, identified on Figure 2 in the Aquatic Effects Monitoring Plan (AEMP) (MTI 2022a)completed for the Project; monitoring sites were established between 2017 and 2019 within the LMOC Project EIS LAA and included monitoring at locations such as Watchorn Creek, Birch Creek, Reed Lake, Clear Lake, Water Lake, Goodison Lake, Lake St. Martin and Lake Manitoba (MTI 2022c). Other water sampling sites are also identified in the AEMP (MTI 2022a) and the Project SWMP (MTI 2022c).

Table 6: LMOC Surface Water Monitoring Sites

Watershed	Sites ID	Data
Lake Manitoba	D1	Water quality and water depth
Watchorn Creek	D2	Water quality and water depth
Birch Creek	2017-2019: D3, D4, D6, D8 2019: D10, D11, D12,	Water quality and water depth
Lake St. Martin	D9	Water quality and water depth

2.4.2 LSMOC

The LSMOC is located within the Buffalo Creek drainage system (Figure 5 and Figure 6). The Buffalo Creek watershed comprises Big Buffalo Lake, Little Buffalo Lake, and several small unnamed lakes, ponds, and creeks. It discharges into the Dauphin River downstream of the Big Rapids, about 4 km from the outlet of Dauphin River into Sturgeon Bay. Its drainage area is estimated to about 31.5 km^2 at that location, of which 16.2 km^2, or 52% of its total drainage area, is projected to be intercepted by the LSMOC. To mitigate the diversion of flows from the east side of the watershed, various mitigation options are currently being explored. One of these options consists of constructing a ditch on the west side of the channel from a gated control structure in the LSMOC WCS. The ditch would carry flows from Lake St. Martin and be released at one or more points to distribute flow to the area of wetlands downgradient of the outlet channel (MTI 2022c). The preferred mitigation option has not been selected yet. Moreover, the full hydrological impact of this reduction in drainage area is currently under study but no results have been published yet. The effectiveness of the potential mitigation options on downgradient wetlands remains uncertain.

Buffalo Creek was monitored between 2011 and 2015 to support aquatic monitoring of the Lake St. Martin Emergency Outlet Channel (EOC). Measured base flow during that period ranged from approximately 1 m^3/s and 10 m^3/s and peak flows of up to about 25 m^3/s were observed following significant storm events (MTI 2022c). The anticipated impact upgradient of the LSMOC on surface drainage consists of increased impoundment due to poor drainage and water accumulation. Inversely, drying down is expected downgradient of the LSMOC due to surface water being intercepted by the channel. The Project EIS reports that LSMOC impact on surface and shallow subsurface drainage is not expected to occur beyond 500 m upgradient or downgradient. No hydraulic analysis supporting this assumption is mentioned in the Project EIS. To test this assumption, monitoring stations will have to be implemented within and outside a 500 m buffer from the channels. The location selection of the monitoring stations is discussed in Section 3.1.

Within the LSMOC, seven surface water sampling locations were established between 2019 and 2020 in the PDA or Project EIS LAA. Two of the LSMOC surface water sites are located within the PDA and, therefore, will be lost as potential monitoring sites once the channel is constructed. As such, while they will provide baseline information, they cannot be used for baseline comparison to future monitoring activities for surface water parameters.

Vegetation analysis using remote sensing methods (NDVI, vegetation health index) on the existing EOC suggested that soil drainage/moisture impacts extended up to 1,600 m upgradient and 600 m downgradient and perpendicular to the outlet channel (MTI 2022c). Generally, though, effects were most noticeable within 300 m of the channel, and the 1,600 m effect was linked to backwater effects from impounded flows. The EOC had no provisions for drainage from the upstream side of the channel, as proposed for the LSMOC, and thus lessened effect on wetlands adjacent to the channel is predicted. The proposed drainage channel is predicted to limit upgradient effects to about 500 m, an impact assessed conservatively along both sides of the entire channel alignment in the Project EIS and supplemental updates as outlined in the environmental assessment (EA) information responses.

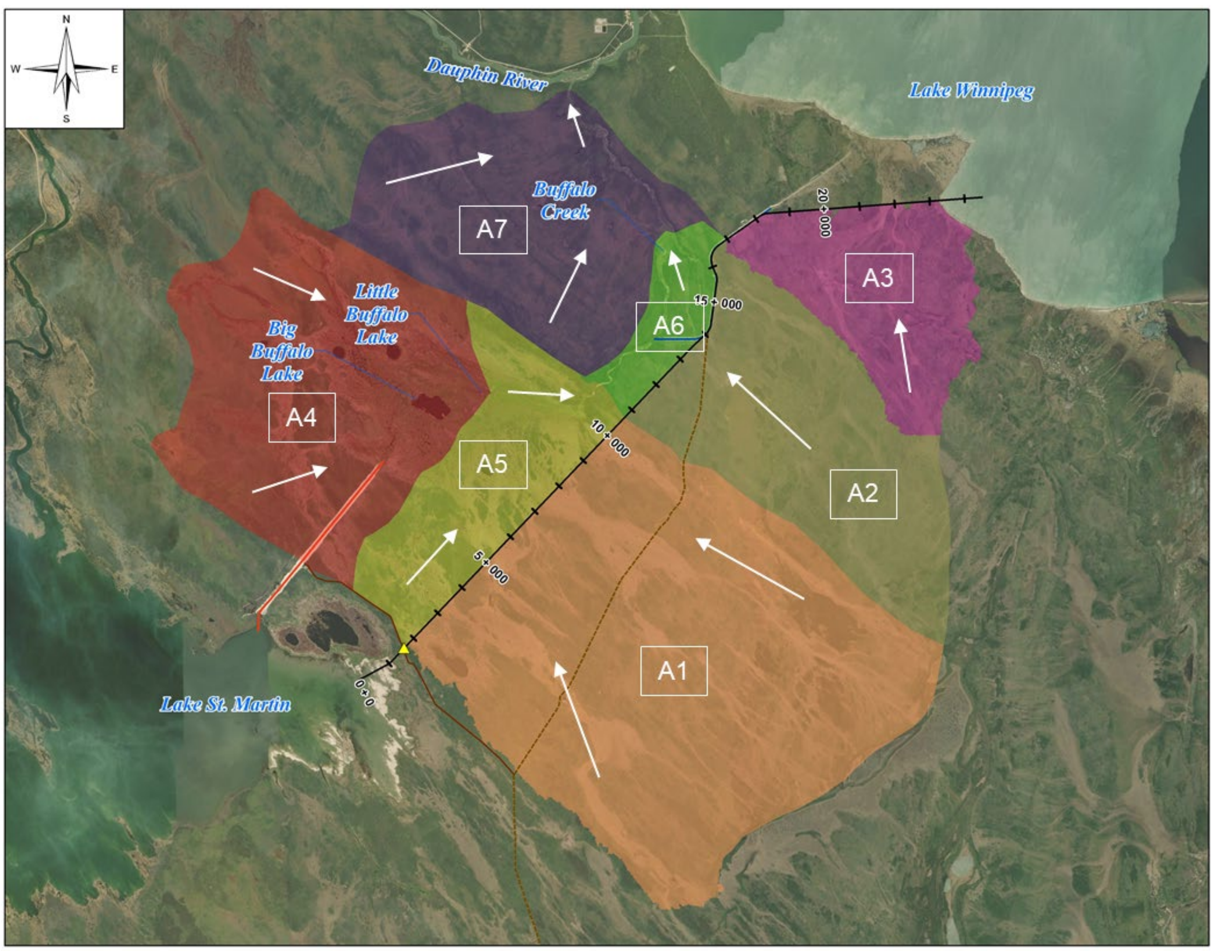
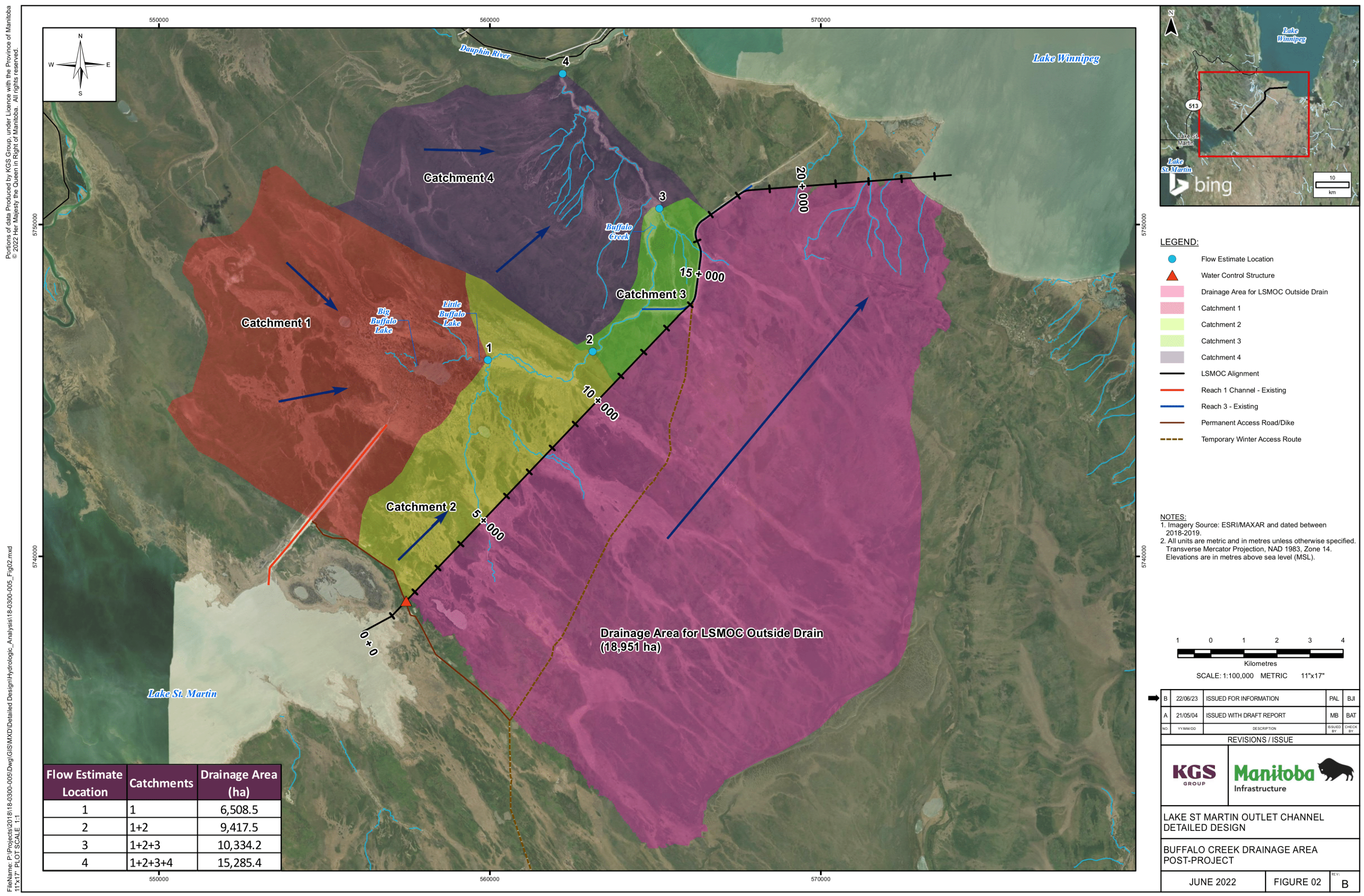


Figure 5: Surface Water Catchment Areas Intercepted by the LSMOC (MTI 2022c)



Flow Estimate Location	Catchments	Drainage Area (ha)
1	1	6,508.5
2	1+2	9,417.5
3	1+2+3	10,334.2
4	1+2+3+4	15,285.4

Figure 6: Buffalo Creek Watershed and Surface Flows, LSMOC Study Area, Post-construction (MTI 2022c)

2.5 Vegetation Species at Risk

Plant SOCC were identified in the PDA during vegetation and wetland pre-construction surveys (refer to Figures 3A, 3B, 4A and 4B, Appendix 1). Two plant SOCCs were observed in wetland areas, including narrow-leaved water plantain (*Alisma gramineum*) and yellow sedge (*Carex flava*). One plant SOCC was observed in wetland areas prior to 2020 surveys, dragon's mouth orchid (*Arethusa bulbosa*). The conservation status rank of these species is provided in Table 7. Habitat preferences and status information for these species are briefly described below.

Table 7: Vegetation SOCC Conservation Status Ranks

Species	MBCDC[1]		Schedule 1 of SARA
Narrow-leaved Water Plantain	S1	Critically imperilled - At very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.	Not listed
Yellow Sedge	S2	Imperilled - At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.	Not listed
Dragon's Mouth Orchid	S2	Imperilled - At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.	Not listed

Notes:

1 Information obtained from: MB CDC (Manitoba Agriculture and Resource Development, 2021a) and Nature Serve (Nature Serve Explorer, 2022).

Narrow-leaved Water Plantain

Narrow-leaved water-plantain was found on the upstream, flooded southeast side of the existing Lake St. Martin EOC in the northeastern portion of LSMOC. As narrow-leaved water plantain was observed in a marsh created by water impoundment against the existing EOC, there is potential for a population increase as additional impounded areas are created on the upstream side of the LSMOC. However, drying effects on the downstream side will limit suitable habitat for this species to establish and spread. Monitoring will focus on any populations that may be present in the Modified LAA or that establish during or after construction, and any changes in population size or plant vigour.

Yellow Sedge

Yellow sedge was observed in 2020 in an overgrown cutline intersecting in a rich swamp within Manitoba Hydro's distribution line PDA. Drying effects on the downstream side may result in a change of moisture regime in swamp habitats, resulting in habitats that are no longer wet enough to support this species. Monitoring within wetland sites in the LSMOC Modified LAA will seek to identify any existing and new populations, and any changes in population size or plant vigour.

Dragon's Mouth Orchid

One species was found during SOCC surveys prior to 2020, the dragon's mouth orchid (Arethusa bulbosa). It was observed in an open tamarack-dominated horizontal fen, southeast of the existing EOC. Increased flooding at the location where this individual was found may result in conditions outside the window of tolerance for this species, negatively affecting this specific population. Drying of fens on the downstream side of the channel may have the same effect, resulting in a reduction in the local population of dragon's mouth orchids. Monitoring sites will seek to identify occurrences of this species in the Modified LAA, and track change over time.

2.6 Wildlife Species at Risk

The Project EIS and the supporting WMP developed for the Project identified the yellow rail (*Coturnicops noveboracensis*), least bittern (*Ixobrychus exilis*), and northern leopard frog (*Lithobates pipiens*) as the SAR most likely to be affected by altered wetland function within the Project EIS LAA, based on the species' habitat preference and wetland classes present (MTI 2022e). Indirect effects of the Project on wetlands adjacent to the outlet channels due to altered drainage patterns (e.g., increased water retention in wetlands on the west side of the LMOC and decreased water flow on the east side) have the potential to alter habitat characteristics for wetland-dependent migratory birds and SAR that require specific habitat conditions and is why surveys for wetland dependent SAR have been included as part of the WetMP. The conservation status ranks of these species is provided in Table 8.

Of the wetlands identified during the pre-construction vegetation-wetland mapping program, the following types are considered suitable for each of the wildlife SAR:

- Least bittern – Class IV and V marsh
- Yellow rail – stream fen, shore fen, Class II and III marsh
- Northern leopard frog – Class II, III, IV and V marsh

This determination was made based on the habitat descriptions below in Section 2.6.1.

Table 8: Wildlife SAR Conservation Status Ranks

Species	Scientific Name	MBCDC[1]		Schedule 1 of SARA
Least Bittern	*Ixobrychus exilis*	S2S3B	Imperilled to Vulnerable - At a high to very high risk of extirpation in its breeding range in the province.	Threatened
Yellow Rail	*Coturnicops noveboracensis*	S3B	Vulnerable - At a high risk of extirpation in its breeding range in the province.	Special Concern
Northern Leopard Frog	*Lithobates pipiens*	S4	Widespread, abundant, and apparently secure throughout its range or in the province.	Special Concern

Notes:

[1] Information obtained from: MB CDC(Manitoba Agriculture and Resource Development, 2021b) and Nature Serve (Nature Serve Explorer, 2022).

2.6.1 Habitat Descriptions for Wetland-Dependent Wildlife SAR

2.6.1.1 Least Bittern

The least bittern's breeding habitat includes marsh environments dominated by emergent vegetation that are surrounded by areas of open water. Dense vegetation stands are a critical part of their breeding habitat as they construct their nests on platforms of stiff vegetation. Open water areas within 10 m of nesting sites are also critical for foraging (Government of Canada, 2018a).

Although no observations for the least bittern were recorded during the 2016 baseline studies nor the 2020 pre-construction breeding bird survey, breeding records do list this species as existing in the Project EIS LAA along the LMOC near Goodison Lake as well as near the LMOC inlet (MI, 2020).

2.6.1.2 Yellow Rail

The yellow rail is a nocturnal waterbird that inhabits wetland/marsh areas where there is little to no standing water (less than 12 cm of water) and where the ground stays wet for most of the summer, including wet meadows, hay fields, grassy marshes, floodplains, and bogs (Environment Canada, 2013a).

According to the Project EIS, the yellow rail has the potential to occur along the LMOC channel area and west of Lake St. Martin. Breeding records exist four km east of the LMOC, near Birch Bay, west of Lake St. Martin. This species was not detected during 2016 baseline surveys (MI, 2020), but was detected at several sites during pre-construction breeding bird surveys in 2020. The yellow rail was detected at edge-dominated fen sites adjacent to the LSMOC Modified LAA and within/outside of the Manitoba Hydro distribution line Modified LAA. This species commonly occurs in similar habitats to LeConte's sparrow (*Ammospiza leconteii*), Nelson's sparrow (*Ammospiza nelson*) and the sedge wren (*Cistothorus stellaris*). The LeConte's sparrow was detected south of Lake St. Martin.

2.6.1.3 Northern Leopard Frog

During their life cycle, northern leopard frogs utilize three distinct habitat types: they overwinter in deeper, permanent water bodies that are cold (<4 °C), well oxygenated (7-10 parts per million) and that do not freeze solid (Environment Canada, 2013b; breeding and larval development occurs in ponds, marshes, and lakes and sometimes creeks and streams; and during the summer they forage in moist upland meadows and native prairie grasslands. (Government of Canada, 2018b).

According to the Project EIS, a habitat for the northern leopard frog exists throughout the Project EIS LAA, with species observations in wetland habitats along both outlet channel rights-of-way (ROW) during the 2016 baseline survey (MI, 2020). This species was detected incidentally during 2016 baseline surveys south of Lake St. Martin (MI, 2020). There were no detections of this species during the pre-construction surveys, likely because surveys occurred after the breeding season had finished in 2020.

2.7 Data Gaps

2.7.1 Existing Wetlands

While updated mapping provides a good indication of the distribution of potential wetland habitat, the specific hydrological and hydrogeological water regimes contributing to potential candidate sites are not yet known. Collection of baseline data prior to construction from the representative candidate sites would be helpful to understand the relative contributions and specific water balance in monitoring sites and to confirm the degree of impact anticipated at proposed monitoring sites.

2.7.2 Groundwater

There are currently three sentinel wells located approximately 6 km north of the LSMOC at Dauphin River First Nation Community. There are also seven current monitoring wells located outside of the PDA (TH19-KGS-19, TH15-03(A), TH15_02(A), TH-GD-08 and TH-GD-02m) and two of the seven are outside the LAA (TH19-KGS-20, TH15-01). The majority of the current groundwater monitoring wells within the PDA will be decommissioned as construction progresses. The Project GWMP (MTI 2022b) generally outlines a groundwater monitoring plan indicating that where construction works interfere with existing monitoring wells, the wells either be decommissioned or relocated, as required, to enable continued collection of groundwater quality and quantity data during construction and operation phases. The GWMP could also support the WetMP and its associated surface water and ecological programs.

The location of the proposed groundwater monitoring wells for the WetMP is based on wetland type and classification. The wetlands of interest are those that are potentially groundwater dependent. Table 9 below summarizes the wetland types and classifications and recharge dependency.

Table 9: Surface and Groundwater Influence on Project Wetland Classes

Wetlands and Water	
Bog[2]	
Basin Bog	Topographically confined peatland with poor nutrients and level surface; **water input limited to snowmelt, rain, and local surface run-off.**
Fen[2]	
Basin Fen	Topographically confined peatland; **water inputs consist of snowmelt, rain, surface runoff, and groundwater.**
Horizontal Fen	Uniformly vegetated peatland on broad depressions or plains; **water inputs consist of snowmelt, rain, surface runoff, and groundwater.**
Shore Fen	Peatland is situated adjacent to lakes or ponds with firmly anchored surface peat; **water inputs consist of snowmelt, rain, surface runoff, groundwater, and surface flow.**
Stream Fen	Peatland is located in main channel or along banks of permanent or semi-permanent streams; **water inputs consist of snowmelt, rain, surface runoff, groundwater, and surface flow.**
Marsh[3]	
Class II	Temporary graminoid/forb mineral wetland with wet meadow plant community; **surface water is present for a short period of time (flooded 1 – 4 weeks[5]) after snowmelt or a heavy rainfall.**
Class III	Seasonal graminoid/forb mineral wetland with shallow wetland plant community; **surface water is present throughout most of the growing season but is typically dry by the end of summer (flooded 5-17 weeks).**
Class IV	Semi-permanent graminoid/forb mineral wetland with deep wetland community; **surface water is present for most or all of the year, except in periods of drought flooded (8-40 weeks).**
Class V	Permanent graminoid/forb mineral wetland with open water community; **surface water is present throughout the year (flooded 52 weeks).**

Wetlands and Water	
Swamp[2]	
Basin Swamp	Topographically confined shrubby or treed wetland with less than 40 cm of organic soil.
Lacustrine Swamp	Shrubby or treed wetland with less than 40 cm of organic soil occurring along the shores of permanent ponds or lakes; **water level affected by a lake during high water periods.**
Lagg Swamp	Sloping shrubby or treed wetland with less than 40 cm of organic soil occurring between upland mineral terrain and peatlands; **water level affected by shallow groundwater and surface infiltration from peatland**.
Riverine Swamp	Shrubby or treed wetland with less than 40 cm of organic soil occurring along banks of rivers and permanent and intermittent streams; **subject to flooding when a stream or river waters are high.**
Unconfined Flat Swamp	Broad shrubby or treed wetland with less than 40 cm of organic soil among other kinds of wetlands with poorly defined edges; **water level affected by shallow groundwater and surface infiltration from peatland**.
Water Bodies[4]	
Water Bodies	Consists of all open water, including lakes, rivers, streams, ponds, and lagoons **water level affected by surface runoff and/or shallow groundwater**

Notes:

1 Forest ecosystem classification for Manitoba (Zoladeski, et al., 1995)

2 Canadian Wetland Classification System (National Wetlands Working Group, 1997)

3 Prairie Pothole Wetland Classification System, Stewart and Kantrud (1971)

4 Manitoba Land Cover Classification (LCC) is based on the EOSD Land Cover Classification system (Wulder and Nelson, 2003)

5 Water flood durations based on Cowardin et al. (1979)

Table 9 above identifies wetlands that may have a groundwater dependency, including fens (Basin, Horizontal, Shore and Stream Fens), swamps (Lagg Swam and Unconfined Flat Swamp), and marshes (Class III, Class IV, and Class V wetlands). Collecting baseline groundwater quantity and quality information at these wetlands will provide critical pre-construction information that can help to interpret any changes identified during post-construction and operations phases of the Project. Currently there are no groundwater monitoring wells dedicated to wetland monitoring as part of the Project. As such, groundwater monitoring of those wetland systems that have groundwater recharge potential (Basin Fen, Horizontal Fen, Class III-V wetlands) is required to assess indirect impacts to wetlands.

2.7.3 Surface Water

Continuous flow and water level monitoring has not been conducted within Watchorn Creek, Buffalo Creek and Birch Creek watersheds. Therefore, no flow regime baselines can be established for any of these creeks. Although significant flow reduction is expected at Birch Creek and Buffalo Creek, it will not be quantifiable as hydrological baselines are unavailable. Collecting baseline flow information within these watersheds, downgradient of the LMOC and LSMOC channels, can help to interpret any changes identified during post-construction and operations phases of the Project. Continuous flow monitoring, pre- and post-construction is also recommended at the existing surface water monitoring sites to develop monthly flow regime statistics. Continuous monitoring will allow for a more robust baseline definition and for abnormal hydrotechnical trends during construction and operation of the LMOC and LSMOC. The SWMP (MTI 2022c) mentions that a hydrological analysis of Buffalo Creek was ongoing at the time to determine the potential impact of the LSMOC and Buffalo Creek and adjacent wetlands water inputs. The results of this study are currently not available but should be reviewed once they are released to ensure that the wetland areas that are expected to be impacted the most are covered by the WetMP.

3.0 MONITORING PROGRAM DESIGN

The proposed WetMP design incorporated concerns raised by the Federal regulatory agencies, Indigenous rights-holders and stakeholders as well as existing baseline data and monitoring information to identify sites and a monitoring approach consistent with a BACI strategy. The proposed sites, methodologies, analysis, and schedule for sampling described below provide a proposed framework that would be adapted to field conditions and construction plans.

3.1 Overall Design Considerations

The proposed design of the WetMP follows a BACI strategy, which builds on pre-construction baseline information to detect both short and long-term change. Paired control wetland (indirect effects not anticipated) and subject wetland (potential for indirect effects) monitoring sites within the same wetland class/types allow detection of short-term change resulting from Project activities. Where possible, subject sites are located in close proximity to or within the same wetland as previously conducted baseline survey sites, which also allows detection of change from undisturbed to constructed and operational states. This approach does not recreate the baseline inventory but instead aims to detect change due to the Project and differentiate it from seasonal / annual differences.

A robust design for wetland monitoring also considers co-variates that can influence observed changes in water levels, water quality and vegetation development. Co-variates can include contextual factors, drivers, stressors, and indicators of ecologically-relevant change. These factors will influence both site selection and monitoring approach. Co-variates can be managed in the design of a wetland monitoring program by considering the following factors:

- Contextual aspects include annual and seasonal climatic variation, beaver presence, fish, other land uses (agriculture, forestry, and transportation), and watershed order (Cobbaert, 2017; Eaton and Charrette, 2017).
- An approach that uses sentinel control and impact sites that are measured repeatedly over a long time period will better detect change in wetlands, given the effects of annual and seasonal climatic influences (Eaton and Charette, 2017).
- Use of available baseline data helps to establish typical pre-disturbance patterns in the various wetland types of interest, which will help identify unusual differences (e.g., in water levels or chemistry, Eaton and Charette, 2017).
- Semi-annual monitoring (April/May, after spring thaw and August/September, late summer) will capture the typical wetland water cycle of spring freshet and fall drawdown periods (Eaton and Charette, 2017).
- Selecting anticipatory parameters to monitor is preferred for adaptive management but can be challenging to identify (Eaton and Charette, 2017). Some flexibility should be included in the design to adjust parameters as monitoring continues. Inclusion of a full suite of parameters or sites that may later be deleted or adjusted ensures enough data to support adjustments.

- Clearly stated thresholds/benchmarks reflecting potential impacts of concerns should be identified in advance, as triggers for management response (Eaton and Charette, 2017).
- Use of rapid assessment techniques will reduce monitoring costs, but limit statistical analysis (Comer et al., 2017). The level of effort in data collection should match the statistical rigour needed to detect change.

The Athabasca Oil Sands region of Alberta has faced regulatory and stakeholder concerns related to landscape-scale wetland impacts that are similar to those raised for this Project. Various regulatory and research agencies in Alberta have developed wetland monitoring tools and approaches to assist in monitoring impacts related to water diversion and disturbances to mineral and peatland wetlands. In addition to the points raised above, Alberta Biodiversity Monitoring Institute [ABMI], 2016) recommended a suite of standard parameters to monitor disturbance impacts that have been incorporated in the methodology section below.

3.2 Monitoring Sites

Selection for candidate wetland monitoring sites focused on locations where wetland function could be measurably affected, where potential Project-related effects may occur on groundwater and surface water, in consideration of other Project monitoring objectives/plans/locations (e.g., , GWMP) to help inform detailed design, proximity to locations of previous baseline monitoring sites, and areas of concern to Federal, Indigenous, and other stakeholders.

3.2.1 Monitoring Site Criteria

The selection of monitoring locations drew on best management approaches for study design and available information collected during the Project EIS and pre-construction surveys, including wetland mapping and field confirmation, surface and groundwater monitoring, vegetation, wildlife and SOCC/SAR observations. Site selection also recognized that surface and groundwater impacts may not affect different wetland types similarly (e.g., seasonal marshes may be more sensitive to altered water regimes). Further, surface water and groundwater impacts do not necessarily overlap. Surface water diversion effects will apply throughout the Project, but groundwater effects will be localized and additive.

Accordingly, site selection criteria included the following considerations:

- Potential wetland drying impacts are predicted to arise from construction of the channel, with berms on either side and the outside drain on the upgradient side of the channel, which will divert water flows and change local drainage patterns. Some ponding is predicted on the upgradient side of the channel in certain locations. Both flooding and drying impacts could result in the wetlands within the Modified LAA, and both effects should be addressed in the WetMP.
- Upgradient ponding is predicted to extend up to 500 (LMOC) – 1,000 m (LSMOC) from the channels. As such, control wetland monitoring sites will require placement outside of the “zone” of potential indirect effects but be of similar wetland type/class to demonstrate comparable conditions to that downgradient of the channel but must also avoid potential flooding effects.

- Upgradient areas with the potential for flooding should be monitored separately to capture flooding / impoundment effects on wetlands within the Modified LAA.
- Wetlands of the same class will be used for paired control/subject sites. Large waterbodies (Class 4 and 5 wetlands, shallow lakes) that have existing surface water monitoring sites (and past baseline monitoring) can be used to monitor change without paired controls, since baseline data can provide 'before' data for comparisons to 'after,' post-construction monitoring. Suitable separate waterbodies for controls would be challenging to find.
- A variety of wetland types will be representative of a diversity of wetland vegetation community types and habitat for wildlife and wetland dependent SAR present within the Lake Manitoba and Lake St. Martin areas.
- Stratify wetland sampling to focus on dominant wetland classes within each study area.
- Wetland classes differ between the LSMOC and LMOC Modified LAAs, with peatlands dominating in the LSMOC, and marsh and swamps in the LMOC. The overall monitoring plan can include sites representative of the diversity of wetlands but for analytical purposes, will focus on dominant wetland classes in the LSMOC and LMOC, respectively. In general, wetlands representing <5% of the Modified LAA area were not selected for monitoring.
- Baseline monitoring sites for surface and groundwater, wetland vegetation wildlife species and SAR are available, and will provide useful pre-construction context. Previous baseline data was primarily collected within the PDA. The scope of the WetMP focuses on conditions outside the PDA. As such, the establishment of monitoring sites during a pre-construction year should be completed to provide baseline data in order to fulfill the before/after component of the design and have a repetitive number of sites in each wetland type for statistical analysis. New groundwater wells will be required at all wetland monitoring sites that may have groundwater influence (fens, swamps, Class III-V wetlands), due to construction impacts to existing monitoring wells. As stated above, wetlands representing <5% of the Modified LAA area were not selected for monitoring.
- A construction access road will be constructed on the upgradient side, of the channel, but immediately downgradient o the outside drain (i.e. between the drain and the channel), permanently removing wetland habitat but providing access to potential monitoring sites. However, the existing ROW may not necessarily provide access to monitoring sites adjacent to the channels. Where possible, sites should be located on Crown lands to ensure long-term access.
- The Manitoba Hydro distribution line construction will require limited site disturbance (clearing and foundation construction for towers) and should not exacerbate channel impacts. Additional monitoring sites where the distribution line and channel meet could be helpful to confirm interacting impacts, or lack of effect.
- Site selection will include selection of contingency sites and will need to be "field-fitted" and adaptive; if during monitoring site establishment, a site is deemed to be unsuitable (e.g., unforeseen disturbance to the stie from non-Project related activities), a contingency site will be utilized.
- Locate potential monitoring sites with adequate setbacks to avoid backflooding, constructed infrastructure and other land use effects (e.g., intensive grazing).
- Monitoring sites assume some improved access along the channels post-construction. However, baseline data and monitoring data collection would require helicopter access.

3.2.2 Monitoring Site Locations/Distribution

Using this set of selection criteria, preliminary paired control and subject sites have been identified on a stratified set of the dominant wetlands on the LSMOC and LMOC (refer to Figures 7A, 7B, 8A and 8B, Appendix 1). Using this approach, marsh, swamp, bog, and fen habitats will be monitored in areas with surface water, combined surface and groundwater impoundments or flood zones (refer to Tables 10 and 11 for a list of preliminary proposed wetland monitoring sites). Some baseline monitoring sites on two large, shallow lakes in the LMOC study area will serve as pre-construction (control) and post-construction (impact) monitoring sites (i.e., single, not paired sites), and baseline monitoring will help to track potential change.

Monitoring sites were distributed spatially along the LMOC and LSMOC according to wetland type and anticipated impacts on water regimes. In the LMOC, this resulted in a relatively even distribution of monitoring sites along the length of the proposed channel. In the LSMOC, there is a gap in monitoring sites near the outlet into Lake Winnipeg. This area is dominated by horizontal fen and may experience both groundwater and surface water impacts. It is also the location of the existing EOC, which has experienced previous flooding and drying impacts, such that water regimes for wetlands in this area will have already been changed over a wide zone (500 m – over 1 km, based on NDVI analysis in the Project EIS, (MI 2020). The EOC will be incorporated into the new LSMOC, and existing connections to surface water bodies will be blocked, and that, with the proposed water management mitigation to sustain some surface water flow across the channel, is predicted to impact wetlands within 500 m of the channel (MTI 2022c). Differentiating impacts of the new channel, the old channel and annual variation could be quite challenging in this area, given the anticipated combination of surface and groundwater impact and water management mitigation. The WetMP will compliment information collected in other monitoring programs for the Project. For example, the GWMP will be focusing on potential impacts on deep groundwater (aquifer) resources with monitoring of the aquifer conditions being conducted at the PDA and at locations up to 5 km from the PDA. The focus of the WetMP is on more localized indirect effects on wetlands, with the groundwater monitoring aspect for the WetMP focusing on potential impacts to wetlands from changes to shallow groundwater within 200 – 500 m of the PDA.

Monitoring aspects at each site will also be dependent on the characteristics of the wetland (refer to Table 10 and 11). For example, not all of the wetland types being monitored are recharged via shallow groundwater; thus, at such sites, groundwater monitoring would not occur. Similarity, for Class II wetlands, a continuous surface water probe would not be installed as these wetlands are ephemeral and typically are dry by mid-summer; water samples for laboratory analysis during the spring freshet would be collected at these wetlands instead.

Table 10: Proposed Preliminary Wetland Monitoring Sites – LMOC

Site Type	ID	Wetland Class	Easting	Northing
Control	1C	Class IV Wetland	533273.9761	5704599.33
Subject	1S	Class IV Wetland	534140.4883	5703369.545
Control	2C	Class II Wetland	531338.6175	5700418.94
Subject	2S	Class II Wetland	532543.5324	5700818.197
Control	3C	Class III Wetland	529983.6994	5696764.914
Subject	3S	Class III Wetland	531353.7147	5696815.185
Control	4C	Class III Wetland	529641.5264	5694200.766
Subject	4S	Class III Wetland	530647.6065	5693654.4
Control	5C	Class IV Wetland	529814.4469	5688400.42
Subject	5S	Class IV Wetland	530999.9149	5687296.047
Control	6C	Class III Wetland	529652.996	5686679.718
Subject	6S	Class III Wetland	531023.1436	5686829.367
Control	7C	Class II Wetland	529799.4538	5685217.3
Subject	7S	Class II Wetland	531022.2281	5684974.148
Control	8C	Class III Wetland	530000.8091	5683368.857
Subject	8S	Class III Wetland	531045.9154	5684213.805
Control	9C	Class IV Wetland	529024.6093	5682373.748
Subject	9S	Class IV Wetland	530829.3095	5682299.453
Ongoing Baseline Comparison	D10	Class V Wetland	531272.7971	5692229.408
Ongoing Baseline Comparison	D4	Water Bodies	531215	5689935
Total number of proposed monitoring sites: 20				

Table 11: Proposed Wetland Monitoring Sites - LSMOC

Type	ID	Wetland Class	Easting	Northing
Control	1C	Horizontal Fen	573108.1832	5752165.648
Subject	1S	Horizontal Fen	572789.492	5751139.195
Control	2C	Basin Bog	566197.5275	5746709.519
Subject	2SA	Basin Bog	565367.4019	5747332.218
Subject	2SB	Basin Bog	565761.1027	5746896.449
Control	3C	Horizontal Fen	564023.5742	5744331.836
Subject	3SA	Horizontal Fen	563028.8978	5744915.427
Subject	3SB	Horizontal Fen	563560.7115	5744600.573
Control	4C	Horizontal Fen	562647.7381	5742915.916
Subject	4SA	Horizontal Fen	561675.6838	5743597.535
Subject	4SB	Horizontal Fen	562300.7631	5743352.795
Control	5C	Stream Fen	560780.3052	5740696.189
Subject	5SA	Stream Fen	560231.0558	5741962.804
Subject	5SB	Stream Fen	560643.2775	5741545.158
Control	6C	Horizontal Fen	558943.2152	5738845.461
Subject	6SA	Horizontal Fen	558058.9547	5739756.836
Subject	6SB	Horizontal Fen	558528.3264	5739292.491
Control	7C	Stream Fen	558833.413	5738704.57
Subject	7SA	Stream Fen	557908.1418	5739216.291
Subject	7SB	Stream Fen	558269.2988	5738982.134

Type	ID	Wetland Class	Easting	Northing
Control	8C	Lacustrine Swamp	557831.6985	5737681.688
Subject	8SA	Lacustrine Swamp	557083.9631	5738671.248
Subject	8SB	Lacustrine Swamp	557517.8806	5738263.789
Total Number of Proposed Monitored Sites: 23				

Notes:

[1] Backflooding and drying impact monitoring site were identified for the LSMOC channel to accommodated predicted impact zones.

4.0 MONITORING PROGRAM STUDIES

Wetland function can be described in terms of the factors that influence habitat conditions (e.g., water supply and water quality) and the wetland form and plant and wildlife species that become established within a given site. Specific methods for measuring change in these disciplines have been developed by others and offer a framework for overall program requirements. That overall set of program requirements, and specific considerations and methodologies for wetlands, surface and groundwater, wetland vegetation, wildlife habitat, wetland dependant SAR and resources with Indigenous cultural significance are also described below.

Specific monitoring studies that form the basis of the program include:

- Surface water (quality and flow)
- Groundwater (quality and quantity)
- Wetland form (class and extent)
- Vegetation Community Composition (indicator species [richness, abundance, vigour], ingress of non-native invasive species and weeds, presence of plant SOCC, traditional/cultural use)
- Wildlife Biodiversity, Habitat and Wetland Dependent Wildlife SAR (indicator species [including indirectly through SAR presence], habitat quality indirectly through measurement of community composition studies, traditional/cultural use)

4.1 Overall Program Requirements

To assess indirect impacts on wetland form and function, a comprehensive set of monitoring parameters helps to ensure an integrated approach to assessing change in water inputs and potentially resulting impacts on vegetation and wildlife use of the available habitat. Other considerations include consistency in data management, including consistency in measurement methods. Establishing an overall framework for monitoring helps address these considerations and identify appropriate coordination and data management processes.

Key considerations utilized to develop the monitoring parameters included:

- can be measured and compared over time
- provides meaningful information to understanding indirect effects on wetlands
- can be repeated each year (i.e., same or similar methodology can be utilized to achieve results)
- utilize scientific standards or known methodologies
- can aid in informing other Project monitoring programs and activities
- can be adaptive (i.e., work with an adaptive management approach)

4.1.1 Monitoring Parameters

ABMI (2016) developed a set of parameters/indicators for wetland monitoring programs for assessing landscape-level impacts associated with development in Alberta's Athabasca Oil Sands region. Those indicators were adapted to provide a set of key indicators with measurable parameters related to predicted drying and flooding impacts associated with channel construction and operation of the LMOC and LSMOC.

Table 12 below summarizes the parameters, survey timing, and types of data, which can also help in planning for field / desktop analysis steps and data storage and management. Baseline characterization at each monitoring site will be required, ideally at least one year prior to construction. Subsequent monitoring will be done using continuous monitoring probes (surface and groundwater) and field monitoring in spring (April/May) and fall (August/September) to capture typical seasonal fluctuation due to freshet and fall drawdown. Monitoring would be expected to continue annually for up to five years post-construction, to allow sufficient time for vegetation and wildlife adaptations to changing water conditions to be evident. Following the adaptive management approach, annual reporting should be evaluated on an on-going basis to detect and track changes, inform development of additional mitigation or compensation (if required), and adjust monitoring scheduling and approach.

Since monitoring will continue over several years, compiling the resulting data within one centralized database and for the specific monitoring sites identified here that allow analysis of all factors that could affect wetland function will be essential. Manitoba Transportation and Infrastructurewill establish a digital data collection format that will allow integration and sharing of monitoring data collected by separate contractors (e.g., from groundwater, surface water, and wildlife monitoring teams).

Table 12: Summary of LMOC and LSMOC Wetland Monitoring Indicators (adapted from ABMI, 2016)

Functional Aspect	Measurable Parameter	Timing	Indicator Purpose	Type Of Data
Wetland Form	**Wetland Class and Extent**			
	Wetland Classification	Spring	Flood/drying impacts	Field
	Total Area (annual change from spring freshet and fall drawdown)	Spring & fall	Flood/drying impacts	Satellite imagery Spectral Signature (Remote Sensing)[1]
	Area of vegetative zone (including open water)	Fall	Flood/drying impacts	Satellite imagery Spectral Signature (Remote Sensing)[1]
	Wetted soils – whole study area	Fall	Flood/drying impacts	Satellite imagery Spectral Signature (Remote Sensing)[1]
Wetland Function	**Vegetation Community Composition**			
	Plant SOCC occurrence and abundance	Spring & fall	Tracking change in SOCC	Field
	Tree vigour	Spring	Tracking change in community composition	Field
	Ingress of non-native invasive species and weeds	Spring & fall	Tracking change in community composition	Field

Functional Aspect	Measurable Parameter	Timing	Indicator Purpose	Type Of Data
Wetland Function (cont'd)	Proportion of indicator species functional groups, species richness and diversity	Spring & fall	Tracking change in community composition	Field
	Indigenous culture use plants	Spring & fall	Tracking change in cultural land use	Field
	Wildlife Biodiversity and Habitat			
	Wetland species diversity	Spring breeding season	Tracking change in diversity	Field
	Habitat Suitability	Spring & Summer	Tracking change in community composition	Field
	Indigenous harvested wildlife	Spring & fall	Tracking change in cultural land use through the engagement of Indigenous monitoring	Field
Water	**Water Quality**			
	Temperature	Spring, late summer, late fall	Surface/groundwater change	Field
	pH and alkalinity	Spring, late summer, late fall	Surface/ground water change	Field & Laboratory
	Salinity	Spring, late summer, late fall	Surface/ground water change	Laboratory
	Conductivity	Spring, late summer, late fall	Surface/ground water change	Laboratory
	DO concentration	Spring, late summer, late fall	Surface/groundwater change	Laboratory
	Redox potential	Spring, late summer, late fall	Surface/groundwater change	Laboratory

Functional Aspect	Measurable Parameter	Timing	Indicator Purpose	Type Of Data
Water (cont'd)	Water transparency (TSS)	Spring, late summer, late fall	Surface/groundwater change	Laboratory
	Total dissolved solids (TDS)	Spring, late summer, late fall	Surface/groundwater change	Laboratory
	Hardness	Spring, late summer, late fall	Surface/groundwater change	Laboratory
	Chlorophyll a	Spring, late summer, late fall	Surface water change	Laboratory
	Mercury	Spring, late summer, late fall	Surface water change	Laboratory
	Pesticides	Spring, late summer, late fall	Surface water change	Laboratory
	Hydrocarbons	Spring, late summer, late fall	Surface water change	Laboratory
	Nutrients			
	Total nitrogen	Spring & fall sampling	Surface/groundwater change	Field
	Total phosphorus	Spring & fall sampling	Surface/groundwater change	Field
	Ions			
	Na^{+}, K^{+}, Ca^{2+}, Mg^{2+}	Spring & fall sampling	Surface/groundwater change	Field
	SO_4^{2-}, Cl^{-}, CO_3^{2-}, HCO_3	Spring & fall sampling	Surface/groundwater change	Field

Functional Aspect	Measurable Parameter	Timing	Indicator Purpose	Type Of Data
Water (cont'd)	**Metals**			
	Total, Iron (Fe), Aluminium (Al)	Spring & fall sampling	Surface/groundwater change	Field
	Water Quantity			
	Depth to groundwater table and amplitude of seasonal change	Continuous (probe)	Flood/drying impact (GW)	Field
	Surface water depth and amplitude of seasonal change	Continuous (probe)	Flood/drying impact (SW)	Field
	Soil moisture	Spring & fall sampling	Flood/drying impact	Field
Baseline Site Conditions	**Soil Quality**			
	Moisture	Spring & fall sampling	Baseline drainage characterization	Field
	Texture	First visit sampling	Baseline drainage characterization	Field
	Type	First visit sampling	Baseline drainage characterization	Field
	Depth (mineral /peat horizons)	First visit sampling	Baseline drainage characterization	Field
	Metals			
	Total, Fe, Al	First visit	Baseline drainage characterization	Field

Functional Aspect	Measurable Parameter	Timing	Indicator Purpose	Type Of Data
Baseline Site Conditions (cont'd)	**Nutrients**			
	Total Nitrogen	First visit	Baseline drainage characterization	Field
	Total Phosphorous	First visit	Baseline drainage characterization	Field
Land Use	% Disturbed land	Establishment & post-construction	Contextual factors	Satellite imagery Spectral Signature (Remote Sensing)[1]
	Linear density	Establishment & post-construction	Contextual factors	Satellite imagery Spectral Signature (Remote Sensing)[1]

Notes:

[1] Many vegetation and soils indices used to discriminate classes, e.g., Normalized Differeence Vegetation Index (NDVI)

4.1.2 Adaptive Management

Standards (established scientific limits/regulatory standards e.g., CCME Water Quality Standards for aquatic life), or benchmarks (degree of change from baseline conditions) will be used to detect meaningful change relative to the monitoring parameters listed above. An adaptive management approach will be applied to determine whether monitoring study results indicate the need for a change in monitoring activities or mitigation measures.

Manitoba Transportation and Infrastructure will retain an environmental consultant experienced in conducting monitoring studies described in this WetMP as well as in the analysis and interpretation of biological data, with emphasis on wetlands, groundwater, surface water, vegetation, and wildlife. While benchmarks and responses differ between aspects and variables, in general the following procedures will be observed.

A three-staged approach is being used for adaptive management based on the development of three benchmarks: a change notification indicating change is taking place; an early warning trigger; and a management threshold, the level of an indicator when the magnitude of an adverse effect attributed to the

Project is sufficient that it may result in long term adverse effects wetlands. The change notification is intended to highlight that a change has occurred, though not necessarily as a result of the Project, and additional or expanded monitoring or investigation may be required. The early warning trigger indicates a detection of a change that may require modifications to the monitoring program to acquire additional information, and/or subsequent evaluation of potential causes of the change to determine whether it is related to the Project. Management thresholds indicate that additional mitigation or management actions may need to be undertaken. Benchmarks are described for specific environmental components in Table 13 below. In most instances, collection and analysis of supplemental data is required before the numerical value of the benchmark can be calculated but the data that will be used to calculate benchmarks are described.

Results of monitoring will be reviewed after each field program to determine the answers to relevant key questions as described in this AEMP. Key questions will be addressed in consideration of:

- Is there a statistically significant difference from pre-Project conditions, i.e., has a change notification occurred or an early warning trigger been passed?
- Is the nature of the pre/post-Project difference sufficient to exceed a management threshold, i.e., should an adaptive measure be undertaken?
- What is the monitoring result in comparison to anticipated effects based on the environmental assessment?

Where it is determined that further assessment is required, the following questions will be considered:

- Are further investigations required to determine if the effect is related to the Project? Are modifications to the monitoring plan required?
- What are the potential implications to wetlands in the Modified LAA?
- Has a management threshold been reached and is additional mitigation required?
- If additional mitigation is required, what are potential methods and how could they be applied?
- What monitoring is required to determine whether the new mitigation measures are functioning as intended?

In the event analysis by the environmental consultant indicates that a benchmark or standard has been exceeded, then the experimental design calls for Manitoba Transportation and Infrastructure and their consultants to undertake a review to examine the potential for linkages to the Project and the need for changes to mitigation measures. It is anticipated that results of this review will be conducted in consultation with regulators. Manitoba Transportation and Infrastructure will also discuss results with directly affected First Nations communities and user input on observed changes shared by resource users and other First Nation members to inform the review and decision making. The Environmental Advisory Committee (EAC) - a committee comprised of local Indigenous rights-holders and representatives for the RM of Grahamdale - will be in contact with stakeholders regarding any issues or concerns, and may facilitate further adjustments on how and where monitoring occurs during construction and opertational periods. Modification of mitigation measures will be implemented if and as required and subsequent monitoring will indicate whether the modified mitigation successfully addressed the environmental issue or whether further changes are required.

In the event that changes are observed that are not attributable to the Project, these will be highlighted in reporting of monitoring results to provincial and federal environmental regulators.

Benchmarks for wetland ecological function are by their nature contextual and linked to subjective management goals. A conservative degree of change was set for benchmarked parameters to prompt further investigation and possible intervention or adjustment to operations if required. These benchmarks could be adjusted through consultation with other affected stakeholders (e.g., local farmers and ranchers, Indigenous rights-holders) to ensure meaningful ranges of change are identified relative to land use.

Table 13: Standards and Benchmarks for Monitoring Parameters

Functional Aspect	Variable	Standard / Benchmark	Exceedance Response
Wetland	**Wetland Class and Extent**		
	Wetland Classification	Change in flood duration (per Cowardin et al. 1979 and Stewart and Kantrud 1971 classes).	Follow-up, investigate climate variables / external factors, Review water flow mitigation / access options.
	Total Area (annual change from spring and fall drawdown)	Change notification: less than 10% (assumption of annual variation).	Follow-up, investigate climate variables / external factors.
		Early warning trigger: 10-20% annual change unless similar change in control site.	Follow-up, investigate climate variables / external factors. Review water flow mitigation.
		Management threshold: Greater than 20% annual change unless similar change in control site.	If impacts to wetland are observed or are expected, review / implement changes to local water management (per proposed mitigation plan).
	Area of vegetative zone (including open water)	Change notification: less than 10% (assumption of annual variation).	Follow-up, investigate climate variables / external factors.
		Early warning trigger: 10-20% annual change unless similar change in control site.	Follow-up, investigate climate variables / external factor. Review water flow mitigation.
		Management threshold: Greater than 20% annual change unless similar change in control site.	If impacts (i.e., drying down of wetlands, increased soil wetness, changes in vegetation community composition) to wetland are observed or are expected, review / implement changes to local water management (per proposed mitigation plan).

Functional Aspect	Variable	Standard / Benchmark	Exceedance Response
Wetland (cont'd)	Wetted soils (NDVI analysis) – whole study area	Change notification: NDVI reduced compared to baseline less than 500 m beyond channel (LSMOC). Less than 10% annual change from baseline (LMOC)	Follow-up, investigate climate variables / external factors.
		Early warning trigger: NDVI reduced compared to baseline between 500 m – 750 m beyond channel (LSMOC). 10 - 20% annual change from baseline (LMOC).	Follow-up, investigate climate variables / external factors. Review water flow mitigation.
		Management threshold: NDVI reduced compared baseline greater than 750 m beyond channel (LSMOC). Greater than 20% annual change (LMOC).	If impacts (i.e., drying down of wetlands, increased soil wetness, changes in vegetation community composition) to wetland are observed or are expected, review / implement changes to local water management (per proposed mitigation plan).
Wetland Species	**Vascular and Non-vascularly Plants**		
	Community Composition (richness/diversity)	Change notification: Less than 10% change in proportion of indicator species functional groups compared to control sites.	Expand survey effort, confirm natural / operational causes.
		Early warning trigger: 10 - 20% change in proportion of indicator species functional groups compared to control sites.	Follow-up, investigate climate variables / external factor. Review water flow mitigation.
		Management threshold: Greater than 20% change in proportion of indicator species functional groups compared to control sites.	If impacts (i.e., drying down of wetlands, increased soil wetness) to wetland are observed or are expected, review / implement changes to local water management (per proposed mitigation plan).

Functional Aspect	Variable	Standard / Benchmark	Exceedance Response
Wetland Species (cont'd)	Vegetation Health	Change notification: Decrease of vigour class by less than 10% for 30% or more of population at subject sites compared to control sites.	Expand survey effort, confirm natural / operational causes.
		Early warning trigger: Decrease of vigour class by 10 - 20% for 30% or more of population at subject sites compared to control sites.	Follow-up, investigate climate variables / external factor. Review water flow mitigation.
		Management threshold: Decrease of vigour class by greater than 20% for 30% or more of population at subject sites compared to control sites.	If impacts (i.e., drying down of wetlands, increased soil wetness) to wetland are observed or are expected, review / implement changes to local water management (per proposed mitigation plan).
	Abundance of Non-native Invasive Species and Weeds	Change notification: % cover of non-native invasive species and weeds exceeds normal range compared to control sites by less than 10% (assumption of annual variation).	Expand survey effort, confirm natural / operational causes.
		Early warning trigger: % cover of non-native invasive species and weeds exceeds normal range compared to control sites by 10 - 20%.	Follow-up, investigate climate variables / external factors. Review water flow mitigation.
		Management threshold: % cover of non-native invasive species and weeds exceeds normal range compared to control sites by greater than 20%.	If impacts (i.e., drying down of wetlands, increased soil wetness) to wetland are observed or are expected, review / implement changes to local water management (per proposed mitigation plan).

Functional Aspect	Variable	Standard / Benchmark	Exceedance Response
Wetland Species (cont'd)	Abundance of Plant SOCC	Change notification: Decrease in single species plant SOCC abundance by less than 10% at subject or control site (assumption of annual variation.	Expand survey effort, confirm natural / operational causes.
		Early warning trigger: Decrease in single species plant SOCC abundance by 10-20% at subject or control site.	Compare with vegetation community community and health results for larger changes. Follow-up, investigate climate variables / external factor. Review water flow mitigation.
		Management threshold: Decrease in single species plant SOCC abundance by greater than 20% at subject of control site.	If impacts (i.e., drying down of wetlands, increased soil wetness, change to vegetation community) to wetland are observed or are expected, review / implement changes to local water management (per proposed mitigation plan).
	Wildlife Species		
	Wildlife Biodiversity	Change notification: Less than 10% change in proportion of species diversity (including SAR) compared to control sites.	Expand survey effort, confirm natural / operational causes.
		Early warning trigger: 10 - 20% change in proportion of species diversity (including SAR) compared to control sites.	Compare with vegetation community community and health results as indicator of habitat changes. Follow-up, investigate climate variables / external factor. Review water flow mitigation.
		Management threshold: Greater than 20% change in proportion of species diversity (including SAR) compared to control sites.	If impacts (i.e., drying down of wetlands, increased soil wetness, changes to vegetation community) to wetland are observed or are expected, review / implement changes to local water management (per proposed mitigation plan).

Functional Aspect	Variable	Standard / Benchmark	Exceedance Response
Water	**Water Quality**		
	Water quality objectives set out in: Canadian Water Quality Guidelines for Protection of Aquatic Life (short-and-long-term), Manitoba Standards, Objectives, and Guidelines for the protection of Freshwater Aquatic Life (chronic and acute)	Change notification: Water quality data exceeds historical baseline.	Increase monitoring frequency as deemed adequate.
		Early warning trigger: Water quality data exceeds water quality objectives.	Increase monitoring frequency as deemed adequate, investigate variable and root-cause.
		Management threshold: Water quality data and duration of exposure exceeds water quality objectives.	If impacts (i.e., drying down of wetlands, increased soil wetness, changes to vegetation community) to wetland are observed or are expected, implement changes to local water management (per proposed mitigation plan).
	Water Quantity		
	Depth to groundwater table	Change notification: Less than 10% change at subject sites compared to control sites (assumption of annual variation).	Follow-up, investigate climate variables / external factors.
		Early warning trigger: 10 - 20% annual change at subject sites compared to control sites.	Review water flow mitigation and cross-reference with wetland form variables to confirm impact.
		Management threshold: Greater than 20% annual change at subject sites compared to control sites.	If impacts (i.e., drying down of wetlands, increased soil wetness, changes to vegetation community) to wetland are observed or are expected, implement changes to local water management (per proposed mitigation plan).

Functional Aspect	Variable	Standard / Benchmark	Exceedance Response
Water (cont'd)	Surface water depth and amplitude of seasonal change	Change notification: Less than 10% change at subject sites compared to control sites (assumption of annual variation).	Follow-up, investigate climate variables / external factors.
		Early warning trigger: 10 - 20% annual change at subject sites compared to control sites.	Review water flow mitigation and cross-reference with wetland form variables to confirm impact.
		Management threshold: Greater than 20% annual change at subject sites compared to control sites.	If impacts (i.e., drying down of wetlands, increased soil wetness, changes to vegetation community) to wetland are observed or expected, implement changes to local water management (per proposed mitigation plan).
	Soil moisture	Change notification: Less than 10% annual change (one moisture regime class[1]) at subject sites compared to control sites (assumption of annual variation).	Follow-up, investigate climate variables / external factors.
		Early warning trigger: 10 - 20% annual change (one to two moisture regime classes[1]) at subject sites compared to control sites.	Review water flow mitigation.
		Management threshold: Greater than 20% annual change (one to two moisture regime classes[1]) at subject sites compared to control sites.	Implement changes to local water management (per proposed mitigation plan).
Indigenous Cultural	Resource availability (e.g., medicinal plants, harvested wildlife species)	Change notification: Less than 10% change at subject sites compared to control sites (assumption of annual variation).	Follow-up, investigate climate variables / external factors.
		Early warning trigger: 10 - 20% annual change at subject sites compared to control sites	Review water flow mitigation.
		Management threshold: Greater than 20% annual change at subject sites compared to control sites.	Implement changes to local water management (per proposed mitigation plan).

Notes:

Moisture regime classification to follow Forest Ecosystem Classification for Manitoba (Zoladeski et. al, 1995)

4.2 Wetland Form Monitoring

Potential indirect effects of the Project on wetland form will be monitored yearly through a combination of in-field verification and remote sensing techniques (e.g., NDVI). Comparisons of changes in wetland form at subject sites will be made with control sites as well as at a regional level to assess for indications of flooding or drying impacts on wetlands.

4.2.1 Measurable Parameters

Proposed monitoring aspects for wetland form include checking for a change in wetland form in terms of the following parameters:

- wetland classification (using Canadian and/or Stewart and Kantrud (1971) classification as appropriate),
- total wetland area (using standard delineation techniques and air photo interpretation such as Alberta Wetland Policy directives),
- total vegetated zone area (using standard delineation techniques and air photo interpretation such as Alberta Wetland Policy directives [Government of Alberta, 2022]), and
- wetted soil extent (landscape soil moisture levels from remote sensing, NDVI techniques).

4.2.2 Benchmark

Change would be detected based on seasonal (typical spring to fall) differences relative to pre-construction conditions (Table 3-4). Larger shifts in water drainage patterns observed at monitored wetlands using these parameters may signal need for additional investigation and adaptive management. Landscape level changes in wetted soils, measured using remote sensing techniques could indicate larger scale changes to water drainage patterns than originally predicted, and need for more extensive change to operational management. Changes beyond the predicted zone to be impacted may indicate unanticipated effects that would require further investigation.

4.3 Groundwater Monitoring

Groundwater water quantity and quality will be monitored through a combination of in-field techniques (i.e., continuous probe readings) and water sample collection and analysis at a qualified laboratory (spring and fall sampling) in conjunction with the surface water monitoring to develop an understanding of the interface between these water sources in applicable wetlands. Comparisons of changes in groundwater quality and quantity at subject sites will be made with control sites to assess for indications of changes in groundwater flow and quality in wetlands in relation to flooding or drying impacts on wetland form and function.

4.3.1 Measurable Parameters

Proposed monitoring parameters for surface water include:

- amplitude of seasonal change in piezometric levels
- water quality (in-field measures and laboratory analysis as per Tables 12 and 13.

4.3.2 Methods

It is assumed that all the new groundwater monitoring wells outlined above will be installed one year prior to construction activities. Wells will only be installed in applicable wetland types where groundwater contributes to wetland characteristics/function (i.e., fens, swamps, Class III-V wetlands). The proposed groundwater monitoring plan for an initial duration of five years is as follows:

- Groundwater levels will be obtained from data loggers which will be installed in all monitoring wells. These loggers are to be downloaded three times a year for a duration of one year after installation. This will provide as baseline water level data against which future impacts on groundwater can be compared. For the remaining four years these loggers will continue to be downloaded about three times a year.
- Groundwater quality will be collected twice a year in all monitoring wells for a duration of one year after installation. This will provide a baseline groundwater quality data against which future impacts on groundwater can be compared. The groundwater quality parameters to be collected are as follows:
    - Field analysis of pH, EC, DO, and temperature.
    - Laboratory analysis of TSS, TDS, fluoride, nitrogen, phosphorous, sulfide, sulphate, sodium, chloride, iron, and general metals.

These wetlands have a predominantly groundwater recharge potential. It is understood that nested wells (i.e., one shallow and one deep well at the same location) are not required for the wetland monitoring.

It should be noted that turbidity can influence analytical results therefore low flow pumping techniques may be required.

Following the first year of monitoring a report summarizing these baseline water levels, and groundwater quality will be generated. At that time, the frequency of water level monitoring and groundwater quality sampling will be reassessed and refined, if required. In addition, the groundwater analytical suite will also be reviewed and refined, where necessary.

4.3.3 Standard

The standards for groundwater monitoring will be through comparison between subject and control sites, compared to the data collected regionally during previous groundwater monitoring studies and comparison to water quality objectives set out in the Canadian Water Quality Guidelines for Protection of Aquatic Life (short-and-long-term), and the Manitoba Standards, Objectives, and Guidelines for the protection of Freshwater Aquatic Life (chronic and acute) as outlined in Table 13.

4.4 Surface Water Monitoring

Surface water quantity and quality will be monitored through a combination of in-field techniques (i.e., continuous probe readings) and water sample collection and analysis at a qualified laboratory (spring and fall sampling). Comparisons of changes in surface water quality and quantity at subject sites will be made with control sites to assess for indications of changes in surface water flow and quality in wetlands in relation to flooding or drying impacts on wetland form and function.

4.4.1 Measurable Parameters

Proposed monitoring parameters for surface water include:

- amplitude of seasonal change in water levels
- water quality (in-field measures and laboratory analysis as per Tables 12 and 13).

4.4.2 Methods

Continuous sampling loggers would be installed at wetland locations in spring and data collected in fall during field surface water quality sampling visits. Typical parameters that can be monitored with probes include water level, pH, temperature, alkalinity, salinity, conductivity, and DO. Data can be downloaded on site at the end of the season or transmitted remotely with telemetry systems via satellite/cell connection. Continuous monitoring should be implemented prior to construction to gather site-specific baseline data and complement the surveyed data being completed as part of the Project AEMP.

Field water chemistry and soil moisture samples summarized in Table 14 would be collected in spring and fall field visits and submitted for laboratory analysis. Baseline water chemistry would be collected prior to construction at all wetland monitoring sites, in spring and fall, at least one year prior to construction. Baseline data collected within the RAA during the Project EIS assessed larger waterbodies; none of the monitoring wetlands were previously assessed for water quality (Figures 1A and 1B, Appendix 1). Where applicable, water quality monitoring parameters proposed in the Project AEMP to be tracked as part of water quality monitoring (Table 15) were incorporated into this WetMP to allow comparison to the surrounding waterbodies which may provide information on the function of wetlands in terms of biofiltration and importance to other ecological aspects such as fisheries.

The amplitude of seasonal change is best estimated using continuous water levels measurements from spring (April/May), immediately after snow melt, until fall (August/September), after late summer draw down. Most mineral wetlands (i.e., marsh and swamp) in Canadian prairie climates will exhibit some change in water level over the summer season due to climatic change (dry/wet cycles). Snow melt and summer precipitation will maintain water levels early in the summer, but evaporative losses in August and September will lower water levels, exposing shorelines. Peatlands (bogs and fens) will show similar changes in water levels within the peat, which can be detected from soil pits or perforated pipes created within the wetted area of a peatland. Significant change from those seasonal amplitudes could indicate flooding or drying impacts arising from the LMOC and LSMOC construction and operation.

Table 14: Summary of Surface Water Quality Parameters for Regional and Local Waterways in the Project EIS RAA1 (MI, 2020)

Parameter	Fairford River	Watchorn Bay	WatchornCreek	Birch Bay	Birch Creek	Lake St. Martin	Buffalo Creek	DauphinRiver	Sturgeon Bay
Water temperature(°C)	0 to 23.5	0.5 to 26.1	4.5 to 21.5	5.5 to 21.8	5.4 to 20.5	0 to 26	0 to 25	0 to 26	0 to 23.5
Laboratory pH	7.59 to 8.67	8.35 to 8.62	7.56 to 8.22	8.24 to 8.61	8.06 to 8.49	8.03 to 8.68	8.12 to 8.19	7.48 to 9.15	7.8 to8.60
Laboratory conductivity (µmho/cm)	898 to 2.000	604 to 886	561 to 841	813 to 917	667 to 857	857 to 1,310	217 to 237	767 to 3,630	410 to 1,100
DO (mg/L)	4.4 to 15.1	5.2 to 12.7	1.60 to 8.31	5.4 to 10.6	3.11 to 10.04	6.1 to 14.4	6.4 to12.2	1.1 to 7.1	7.2 to 16.7
TSS (mg/L)	< 2.0 to 44	1 to 51	< 2.0 to 4	3.6 to 10.4	< 2.0 to 6.4	< 2.0 to 47	< 2.0 to 6.0	< 2.0 to 69	< 2.0 to 28
TDS (mg/L)	508 to 1.480	373 to 532	358 to 511	488 to 532	436 to 549	488 to 772	164 to 177	240 to 1,470	230 to 756
Hardness(CaCO3) (mg/L)	203 to 348	229 to 322	316 to 476	196 to 270	419 to 526	224 to 350	155 to 166	178 to 358	149 to 324
Total nitrogen(mg/L)	0.64 to 2.96	0.87 to 2.6	1.22 to 2.12	0.82 to 2.18	1.36 to 2.55	0.40 to 2.33	0.76 to 1.15	0.34 to 2.51	0.35 to 1.38
Total phosphorus(mg/L)	0.002 to 0.045	0.008 to 0.089	0.032 to 0.082	0.014 to 0.027	0.016 to 0.073	0.010 to 0.054	< 0.010 to 0.026	0.002 to 0.070	0.012 to 0.108
Chlorophyll a (µg/L)	<0.50 to 19.5	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	<0.50 to 9.16	0.37 to 0.52	0.47 to 9.0	0.13 to 14.7
E. coli (CFU/100 mL)	1 to 461	<1 to 114	20 to <100	1 to 613	11 to 249	Not Detected	Not Analyzed	1 to 100	Not Detected
Petroleum hydrocarbons	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Detected	Not Detected	Not Detected	Not Analyzed

Note:

Including Data Provided by Manitoba Environment, Climate and Parks.

Table 15: Project EIS Proposed Water Quality Monitoring Parameters

Category	Water Quality Parameters
Field Parameters	DO; E.C.; Oxidation Reduction Potential; pH; Temperature; Turbidity
General Chemistry	Alkalinity, Bicarbonate (as $CaCO_3$); Alkalinity, Carbonate (as $CaCO_3$); Alkalinity, Hydroxide (as $CaCO_3$); Alkalinity, Total; Hardness (as $CaCO_3$), Total Dissolved Solids; Chloride; Fluoride
Sediment	Total Suspended Solids
Microbiological Parameters	E.coli; Fecal Coliforms
Nutrients/Carbon	Ammonia (as N); Nitrate (as N); Nitrite (as N); Total Kieldahl Nitrogen; Nitrogen (total); Phosphorus; Total Phosphorus; Total (Dissolved) Phosphorus; Phosphorus, Total (Particulate); Phosphorus (PO_4), (dissolved and reactive); Dissolved Organic Carbon: Dissolved Inorganic Carbon; Total Organic Carbon; Total Inorganic Carbon
Petroleum Hydrocarbons	BTEX; Hydrocarbons
Metals	Standard Total/Dissolved Meals Scan (including Mercury)
Pesticides	Glyphosate; Organochlorinated

4.4.3 Standard

The standards for surface water monitoring will be through comparison between subject and control sites, compared to the data collected regionally during previous studies as outlined in Table 14 and comparison to water quality objectives set out in the Canadian Water Quality Guidelines for Protection of Aquatic Life (short-and-long-term), and the Manitoba Standards, Objectives, and Guidelines for the protection of Freshwater Aquatic Life (chronic and acute) as outlined in Table 13.

4.5 Vegetation Community Composition (Vascular and Non-vascular) and Wetland Vegetation SOCC Monitoring

Vegetation community composition for vascular and non-vascular plants and the presence of plant SOCC will be monitored in-field via spring and fall surveys. Comparisons of changes in vegetation composition, vigor, non-native invasive species and weeds and presence of plant SOCC at subject sites will be made with control sites to assess for indications of changes in vegetation cover in wetlands in relation to changes in surface and / or groundwater that may be associated with flooding or drying impacts on wetland form and function.

4.5.1 Measurable Parameters

To gain a broader understanding of potential effects on wetland vegetation communities, it is proposed that indicator species functional groups be utilized to aid in tracking changes to vegetation species richness, diversity and health. It should also be noted that SOCC species are often difficult to detect and abundance can fluctuate yearly as many species required specific habitat requirements. Proposed monitoring parameters include:

- proportion of indicator species functional groups (as a measurement of species richness and diversity)
- tree vigour (as a measurement of vegetation health)
- ingress of non-native invasive species and weeds (as a measurement of vegetation health)
- presses/abundance of plant SOCC overtime (if detected) (as a measurement of furcation of species richness and diversity)

4.5.2 Methods

4.5.2.1 Indicator Species and Non-native Invasive Species and Weeds Species

Species composition will be recorded through the use of a nested plot design, recording species name, strata, vigour on a 5 point scale, and % cover. Data collected will be analyzed to determine the percent cover of non-native invasive species and weeds. Species richness and diversity will be assessed statistically using the plant lists assembled. Finally, impacts on wetland vegetation community composition as a result of decrease or increase in moisture or nutrients will be assessed using indicator species functional groups. For example, in fen type wetlands, three functional groups could be used: wet forb, wet-rich bryophyte and dry bryophyte. Species in each functional group will be driven by observations during baseline monitoring data collection, but may include some or all of the species listed below.

1. Vascular plants are assigned to the wet forb group if a strong preference for wet habitats is indicated in the literature, and if they are categorized as "obligate wetland" species (i.e., hydrophytes that almost always occur in wetlands) in the PLANTS database (USDA NRCS 2018), which may include but not be limited tog: marsh-marigold (*Caltha palustris*), marsh cinquefoil (*Comarum palustris*), marsh willowherb (*Epilobium palustre*), swamp horsetail (*Equisetum fluvatile*), tufted loosestrife (*Lysimachia thyrsiflora*), buck-bean (*Menyanthes trifoliata*), dock species (*Rumex* sp.), scheuchzeria (*Scheuchzeria palustris*), seaside arrow-grass (*Triglochin maritima*), flat-leaved bladderwort (*Utricularia intermedia*) and small bladderwort (*Utricularia minor*).

2. Bryophytes are assigned to the dry bryophyte group if their distribution is limited to hummock microhabitats (Vitt and Lüth, 2017) and may include but not be limited to: *Aulacomnium palustre, Calypogeia sp., Calypogeia sphagnicola, Cephalozia connivens, Cephalozia lunulifolia, Cephalozia pleniceps, Cephalozia sp., Dicranum polysetum, Dicranum undulatum, Hylocomnium splendens, Pleurozium schreberi, Polytrichum strictum, Ptilium crista-castrensis, Sanonia uncinata, Sphagnum capillifolium, Sphagnum fuscum, Sphagnum girgensohnii, Tomentypnum falcifolium, Tomentypnum nitens.*
3. Bryophytes are assigned to the wet-rich bryophyte group if their distribution is limited to lawn, carpet and pool microhabitats in moderate-rich and extreme rich fens (Vitt and Lüth 2017) and may include but not be limited to: *Aneura pinguis, Calliergon cordifolium, Calliergon giganteum, Calliergon richardsonii, Calliergon trifarium, Calliergon sp., Drepanocladus aduncus, Drepanocladus sp., Hamatocaulis vernicosus, Limprichtia cossonii, Limprichtia revolvens, Lophozia rutheana, Meesia triquetra, Meesia uliginosa, Paludella squarrosa, Plagiomnium ellipticum, Sarmentypnum tundrae, Sphagnum contortum.*

Due to the difficult nature of field identification of bryophytes, field assessors should be encouraged to carry and be familiar with reputable guides during assessments. Crews should also be equipped for the potential to collect voucher specimens outside plots for species confirmation by bryophyte specialists following fieldwork.

4.5.2.2 Tree Vigor

Tree vigour assessments will incorporate the examination of 10 trees for up to two dominant species in treed wetlands. These trees will be marked and their GPS location recorded. Trees will be assigned a qualitative or quantitative ranking of vigour on a five-point scale and photographed for comparison across monitoring years.

4.5.2.3 Plant SOCC

Three wetland-dependant plant SOCC were observed in the LMOC and/or LSMOC PDA during previous surveys and were predicted to be affected by changes to the water regime in wetlands adjacent to the channels (e.g., flooding or drying of upland or wetland habitat). These species may also be present in the Modified LAA.

Baseline Monitoring

Rare plant occurrence at monitoring sites within the Modified LAA will be surveyed during the initial baseline monitoring visits (spring and fall). Subsequent monitoring can be adjusted based on the presence (or non-detection) of these or other plant SOCC. Rare plant surveys would follow standardized methodologies such as those outlined by the Alberta Native Plant Council (2012). Any plant SOCC observed would be identified visually, photographed, location recorded by GPS, and flagged / marked to allow repeated visits to the same location.

Monitoring During Construction and Post-Construction

For any monitoring sites at which plant SOCC are identified during the initial baseline monitoring, populations will be checked to confirm they are maintained during construction and operational phases of the Project. While populations may vary in size from year to year, changes in vigour and population size may indicate unanticipated ecological changes. Protocols such as those outlined by Elzinga, Salzer and Willoughby (1998) would be utilized to assess rare plant vigour and condition.

4.5.3 Benchmark

The benchmark for vegetation community monitoring will be through comparison between subject and control sites of similar wetland types, through a review of changes over time and to data collected during previous studies (e.g. 2020 Plant SOCC survey), as outlined in Table 13 and other planned monitoring programs for the Project.

4.6 Wildlife Biodiversity, Habitat and Wetland Dependent Wildlife SAR Monitoring

Monitoring for wildlife biodiversity (i.e., amphibians, migratory songbirds, and marsh birds) and for wetland-dependent wildlife SAR including species such as the yellow rail, least bitten and northern leopard frog will be completed at all the proposed control and subject wetland monitoring sites as identified in Table 12 and 13. Given the low density of rare species, monitoring will help confirm presence, and sustained use post-construction. Given the anticipated rarity of wildlife SAR within the modified LAA, biodiversity has been included as a monitoring parameter.

Section 2.2.2 identifies the anticipated impacts on the wetlands within the LMOC and LSMOC study areas. To gain a broader understanding of potential effects on wetland wildlife biodiversity and habitat it is proposed that key indicator species functional groups be utilized to aid in tracking changes to species riches and diversity. Species within a key indicator species functional group that are not a SAR and can be recorded with an autonomous recording units (ARU) will be considered if detections of SAR are minimal. The key indicator species functional groups will be identified that represent similar habitats to the three wildlife SAR species and will be included in the ARU analysis. Wildlife SAR species are often difficult to detect due to their rarity, mobility and requirements of specific habitat requirements. As such, the proposed monitoring parameters include:

- proportion of indicator species functional groups (measurement of songbirds and marsh birds as indictors of species richness and diversity). Note, if detected, wildlife SAR presence data would inform diversity measure
- vegetation community monitoring data combined with general habitat assessment (measurement for wildlife habitat suitability)

4.6.1 Methods

4.6.1.1 Wildlife Biodiversity and SAR Inventories at Impact and Subject Sites

Bird diversity (including songbirds and some waterbirds) and SAR occurrence will be determined through the use of ARU (e.g., Wildlife Acoustics Song Meters SM3 and SM4 [Wildlife Acoustics, 2020]). ARUs can be effective in detecting secretive marsh bird species and species rare across the landscape, particularly when attempting to optimize spatial and temporal coverage (Sidie-Slettedahl et al., 2015). ARUs will be deployed in the monitored wetlands during the peak breeding periods, and ARUs will be pre-programmed to collect daily recordings during peak calling periods for the respective SAR. Habitat descriptions at each site will be recorded and supplemented by data collected as part of the vegetation monitoring component of the WetMP, in order to record and track changes to vegetation communities which are indicative of potential changes to wildlife habitat, in particular for SAR. Specifically, during ARU establishment, habitat types around the unit will be described to confirm the habitats from which the multidirectional ARU microphone is recording.

Upon retrieval of the ARUs, the data files will be processed through a review of segments of the data to by a qualified biologist to assess biodiversity through the use of commercial software (e.g., Kaleidoscope Pro [Wildlife Acoustics, 2020]). A basic cluster analysis will be used to focus on the three wildlife SAR using sound files for the species of interest using a reference library. A qualified biologist will review and validate a sample of the results for false-negative and false-positive results.

Surveys will occur at the proposed control and subject wetland monitoring sites over the initial timeline, as described for other parameters in this WetMP (i.e., including groundwater and surface water parameters, vegetation, and wetland class) with an initial baseline year followed by five years of monitoring. Many marsh water birds have low detection rates, requiring several repeat visits to many survey sites to obtain sufficient data for statistical modelling (Tozer et al., 2006, 2016; Steidl et al., 2013). The initial sampling design can be reviewed after each year of sampling, to assess the need for adjustments, particularly if no SAR are detected at sites over several years. Survey periods, timing and frequency for SAR will follow those outlined in the Project Wildlife Management Plan (MTI 2022e) for continuity as summarized in Table 16.

Table 16: Wetland Species at Risk Survey Criteria (MTI 2022e)

Target Species	Survey Period	Survey Timing	Frequency
Least Bittern	Mid-May to early July	Sunrise to 4.5 h after sunrise	Daily
Yellow Rail	Mid- to late-May until mid-July	23:00 – 0300 h	Daily
Northern Leopard Frog	Early April until late-May	22:00 to 0300 h	Daily

4.6.1.2 Wildlife Habitat Suitability

Wildlife habit suitability will be monitored through information collected from the vegetation community composition monitoring combined with general habitat site characterization collected during ARU setup for diversity surveys, indirectly through the presence and continued use of sites by wetland-dependent wildlife SAR and information collected through other monitoring programs (e.g. Project WMP). The anticipated potential for detecting SAR is low; therefore, the BACI design will not be applicable to address potential effects on SAR. Any changes in form and function of the wetland will be considered as an assessment of habitat changes for SAR. Further opportunities to study habitat changes along the gradient using remote sensing techniques may be explored in the future. The purpose of the wildlife SAR component along with the other assessments included in the WetMP is to provide integrated monitoring with respect to indirect effects, in this case, habitat, and to measure the effectiveness of mitigation measures and follow-up.

4.6.2 Benchmark

The benchmark for wildlife diversity and habitat suitability will be through comparison between subject and control sites of similar wetland types, through review of changes over time and to data collected during previous studies (e.g. 2020 Bird SAR survey), as outlined in Table 13 and other planned monitoring programs for the Project.

4.7 Baseline Site Conditions

Baseline soil conditions (moisture, texture, type, and horizon depths) and chemistry (metals, nutrients) would be collected at initial monitoring site set-up, to characterize contextual factors that could influence soil drainage, or water chemistry. Other contextual factors, including land use (% disturbed area, linear density) would be determined from existing mapping information, within 500 m of each wetland site.

4.8 Indigenous Monitoring Involvement

Concerns about potential impacts on resources harvested for Indigenous cultural purposes have been discussed during Indigenous consultation conducted by Manitoba Transportation and Infrastructure. For example, Section 8.2.4.5 of the Project EIS identified that Indigenous rights-holders (Fisher River Cree Nation, Lake St. Martin First Nation, Black River First Nation) have indicated concerns over potential effects on the Buffalo Lake bog and creeks intersected by the LMOC and LSMOC from changes in drainage patterns in local wetlands. Specific resources have not yet been identified and in some cases, may be culturally sensitive or confidential, such that collection of information on the resources of concern cannot be easily integrated into this WetMP. However, by partnering with Indigenous monitoring personnel from interested Nations, there is an opportunity to build shared understanding of any observed changes to the monitored wetlands. That shared understanding, in turn, can help identify meaningful thresholds and benchmarks for change, particularly for those resources with seasonal variation and limited baseline information (e.g., groundwater and surface water levels, SAR, rare plants and culturally important plants or wildlife). The EAC will also be involved in the by facilitating discussions between Indigenous rights-holders and Manitoba Transportation and Infrastructure.

Indigenous cultural uses can be included in this program by recruiting traditional land use monitors from interested groups to assist in site monitoring activities. Working with Environmental Monitors would facilitate sharing of information, and discussion that can lead to mitigations based on findings from the Western scientific and Indigenous monitoring programs.

4.9 Analysis

Data analysis will include both quantitative / statistical analysis and comparison against identified criteria. Where possible, quantitative parameters were included in the study design, to facilitate statistical comparison (1) over time (before and after construction) and (2) within a given year (control and impact sites). This approach will help to differentiate seasonal or annual changes from Project impacts and help explore linkage to other quantitative influencing factors (e.g., annual precipitation and temperature patterns can influence evaporative loss from wetlands).

Quantitative thresholds included legislated standards (e.g., for water quality) and more subjective criteria for an acceptable degree of change (e.g., proportional changes from baselines and/or controls for water levels). In the case of subjective criteria, selection of appropriate cut-off points was somewhat arbitrary, and linked to perceived management objectives. Ideally, change would be compared to a long-term baseline that would identify the degree of annual or seasonal fluctuation. In this case, baseline data may be limited (e.g., for surface and groundwater levels and quality), and comparison to long term, pre-construction patterns will not be possible. Inclusion of control and impact sites is intended to compensate for this data gap, facilitating checks for effects of higher or lower precipitation or temperatures in a given year. The cut-off points do not necessarily reflect natural variation, and may require adjustment to reflect observed changes, including indirect effects on other ecological functions (e.g., vegetated wetland area, rare or cultural plant abundance).

Overall, the annual analysis over the early years of post-construction is structured to inform changes to criteria and cut-off points, and adjustments will be made, informed by observations and analysis. Analysis will aim to facilitate adaptive management, and observations will build on information collected over the initial five-year period of post-construction operation. As the effectiveness of mitigation measures to reduce indirect effects on wetlands becomes clearer, sampling parameters and frequency as well as associated thresholds and benchmarks may be periodically adjusted. An annual review of the WetMP results with stakeholder advisory committees, including an EAC, would be helpful in adjusting subjective benchmarks that are indicative of meaningful change, and to develop collaborative mitigation approaches, if adjustments are necessary.

For statistical analyses, quantitative data will be assessed between years (before and after construction) and within years (control and impact), using t-test comparisons for each sampling event. Specifically, analysis would compare the following data sets:

- **Between year comparisons:** Baseline replicate years (pre-construction) against post construction replicate years.
- **Within year comparisons:** Impact and control sites would be compared for the respective year of monitoring.

Any changes between years will be evaluated against potential environmental influences (e.g., annual precipitation, temperature) to determine if the observed change can be explained by the Project, or other confounding, natural factors. Observed changes will also be explored to identify other indirect effects caused by interaction amongst parameters (e.g., surface water level and vegetated area within the monitored wetland).

4.9.1 Adaptive Management

As previously mentioned, an adaptive management approach will be implemented as part of the WetMP. Under this approach the monitoring program will:

1. define the area of potential and measurable indirect effects;
2. design a sampling program within that zone to assess effects;
3. if there is a measurable and significant effect that is determined to be caused by the Project (as per Table 3-4), then take the following steps:
    a. assess measurable parameters and revise/refine if required;
    b. consider expanding the monitoring to further define the effect (e.g., establishment of additional monitoring sites further afield in a selected wetland complex);
    c. refine existing mitigation or develop new measures;
    d. if mitigation measures are ineffective with respect to reducing effects to or below a defined threshold/benchmark, then consideration may be given to other approaches (e.g., restoration or enhancement activities or additional rehabilitation measures)

[1] Note that for the few sites in larger waterbodies, only the between year comparisons will be possible, as there is no paired impact and control site available for these waterbodies.

4.10 Schedule

Although monitoring sites were selected near areas where surface water, groundwater, wetland vegetation and wildlife surveys have previously been completed for the Project, to facilitate their use as baseline comparators, wetland monitoring sites will be effectively established as new survey locations. In the case of groundwater monitoring wells, most of the previous sites will be removed during construction and new monitoring wells will be developed within the Modified LAA. Ideally, at least one year of pre-construction data should be collected from the newly established wetland monitoring sites allowing collection of one complete year of spring and fall data, prior to construction.

Tree clearing for the Project is proposed to begin in fall 2022, assuming all Project approvals are secured in summer 2022. Channel construction would then commence, with sequencing of LMOC and LSMOC infrastructure yet to be determined (assuming two years construction). Accordingly, additional baseline data could be collected from areas not yet constructed in 2023, while monitoring can also track change during construction, facilitating adaptations during the construction phase. Post-construction monitoring may thus start in different years for the LMOC and LMOC Projects. As noted above, five years of during/post-construction monitoring would be conducted, with an option for additional years, based on program findings.

The proposed monitoring schedule thus would ideally be as follows:

- Baseline monitoring and monitoring site establishment: Pre-construction (spring/fall)
- Year 1 (baseline/during-construction): April/May (spring) and August/September (fall)
- Year 2 (baseline/during construction): April/May (spring) and August/September (fall)
- Year 3 (post-construction): April/May (spring) and August/September (fall)
- Year 4 (post-construction): April/May (spring) and August/September (fall)
- Year 5 (post-construction): April/May (spring) and August/September (fall)

4.11 Reporting

Annual workplans will be developed prior to each monitoring season. If benchmarks were exceeded in the preceding monitoring year and the need for adaptive management (including modifications to the monitoring program, and development and implementation of additional mitigation) was identified, then monitoring activities and workplans would be adjusted accordingly. This iterative approach of advising Manitoba Transportation and Infrastructure in the development of adaptive management measures will apply to the construction phase in particular, and possibly during the operations phase.

The report that documents the methods, results, discussion and further recommendations (adaptive management requirements) will be produced by the consultant and reviewed by Manitoba Transportation and Infrastructure within one year of completion of the field studies conducted in that particular year. If the subsequent year involves field studies, the reports will be completed and reviewed at least two months prior to the field season to allow for informative planning of activities to be implement for that year. Reports will provide the following information:

- the objective of the particular study
- methods, including a description of any departure from the methods set out in the WetMP or additional details
- results of the study and comparison to pre-Project conditions, where applicable
- comparison to previous monitoring results, where relevant
- comparison to benchmarks set out in the WetMP
- a discussion of results in comparison to anticipated effects identified during the environmental assessment, indicating whether unanticipated changes may be occurring
- recommendations for modifications to the monitoring program, if any

A synthesis report describing wetland monitoring results will be prepared by the consultant for Manitoba Transportation and Infrastructure’s review after two cycles of monitoring related to channel construction and/or operation have been completed. The synthesis will include:

- a summary of monitoring studies and results completed to date, including in relation to the magnitude of flood events
- comparison of monitored parameters pre and post-Project, and in reference to anticipated environmental effects
- a comparison to management thresholds, where relevant

- a discussion of the overall changes observed as a result of the Project
- a description of recommended and/or implemented changes to mitigation measures
- recommendations for future monitoring

Final annual and synthesis reporting will be shared with the EAC on an annual basis. Manitoba Transportation and Infrastructure will meet regularly with the EAC to provide updates on the WetMP.

5.0 IMPLEMENTATION CONSIDERATIONS

Implementation of this plan was based on certain assumptions regarding data management and construction scheduling. Considerations included:

- Need for at least one year of baseline (pre-construction) monitoring at all monitoring sites. Groundwater well establishment and site characterization should begin in spring in the year prior to construction, to collect one complete spring to summer season of baseline data.
- Access to monitoring sites will improve post-construction, as travel will be possible along the channel berms and Project access roads. Any baseline or early construction monitoring would require remote access (e.g., helicopter). Specific monitoring sites would be accessed through natural vegetation in most cases.
- To facilitate data storage, Manitoba Transportation and Infrastructurewill develop a database that will serve as a data warehouse for compiling and managing data over the full monitoring period. Manitoba Transportation and Infrastructure control over this data will ensure consistency in data collection, data entry and data analysis, which will be key for multi-year comparisons.
- The WetMP has assumed a list of parameters that would be measured with standardized field samples (e.g., for water quality), including field and/or trip blanks for quality control. While some flexibility is planned within the scope of assessment, to adjust sites and parameters to best detect and track changes associated with the LMOC and LSMOC Project, the methods of analysis, and data collection should remain consistent, if possible, to facilitate comparisons between years. Remote monitoring probes, the analytical laboratory, and general timing of collection can introduce other sources of variability, and thus should not change without incorporating comparison samples.
- This plan recommends a minimum five years of consistent monitoring, with the potential to extend monitoring longer, should impacts be detected. Conversely, specific parameters could be deleted from the program if, over time, change is not detected. Such adjustments should be considered on a case-by-case basis, as part of annual reporting and review as per an adaptive management approach.

Next steps in planning will include logistical arrangements, including selection of a contractor for baseline data collection and initial monitoring site set-up, development of a centralized database for data management, and procedures for data input and maintenance, including quality checks.

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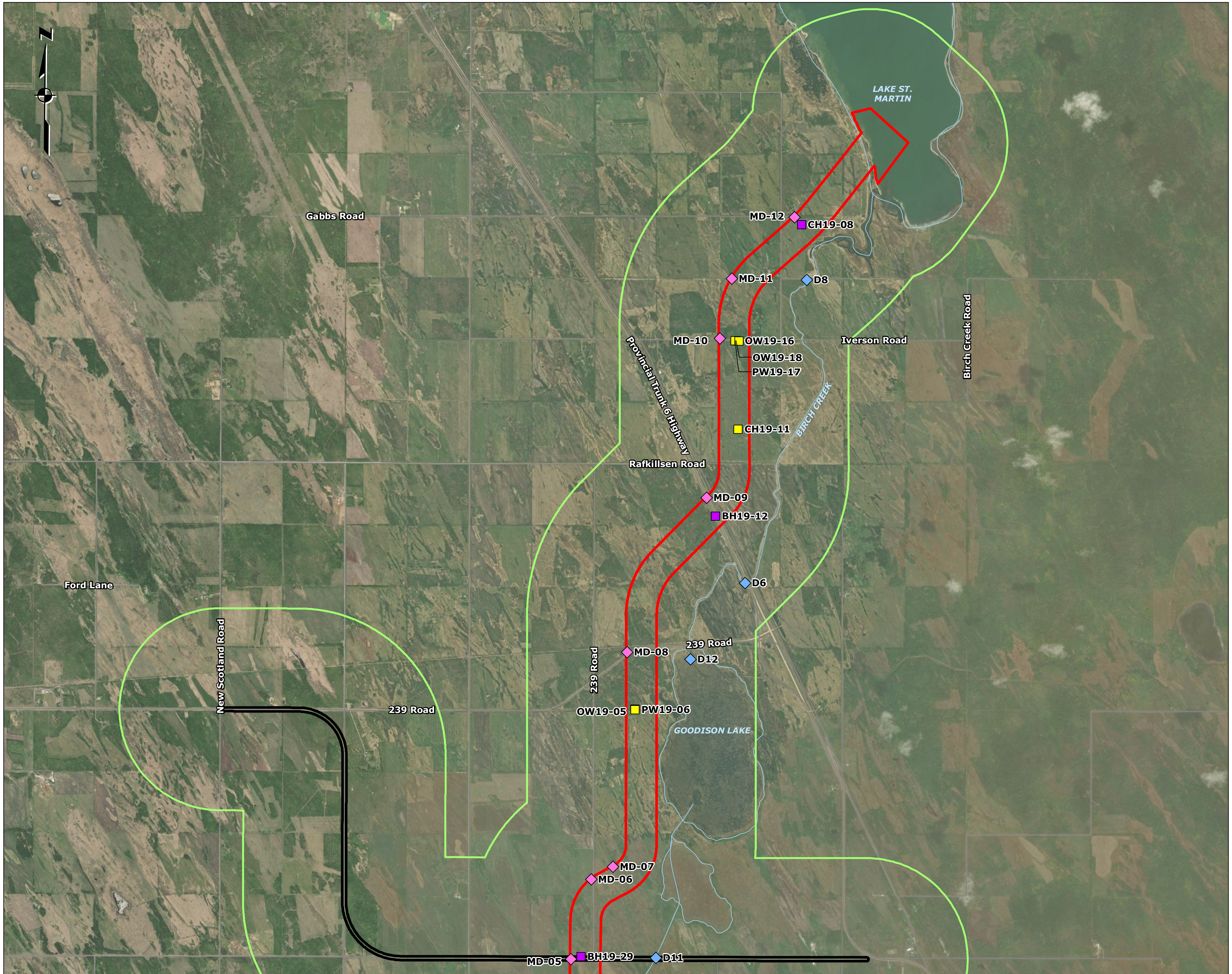
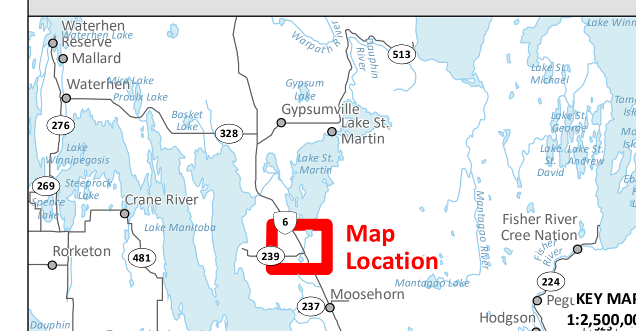
APPENDIX 1

Map Figures



Legend

- Groundwater Quality Sites (2019)
- Groundwater Quality Sites (2019, 2020, 2021)
- Suface Water Quality Sites (2019, 2020, 2021)
- Suface Water Quality Sites (2021)
- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- PR 239 Road Re-Alignment
- Roads
- Hydrology



Manitoba

Figure 1A: Past Water Monitoring Sites - LMOC

Lake Manitoba & Lake St. Martin
Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

0 1 2 3 Kilometers

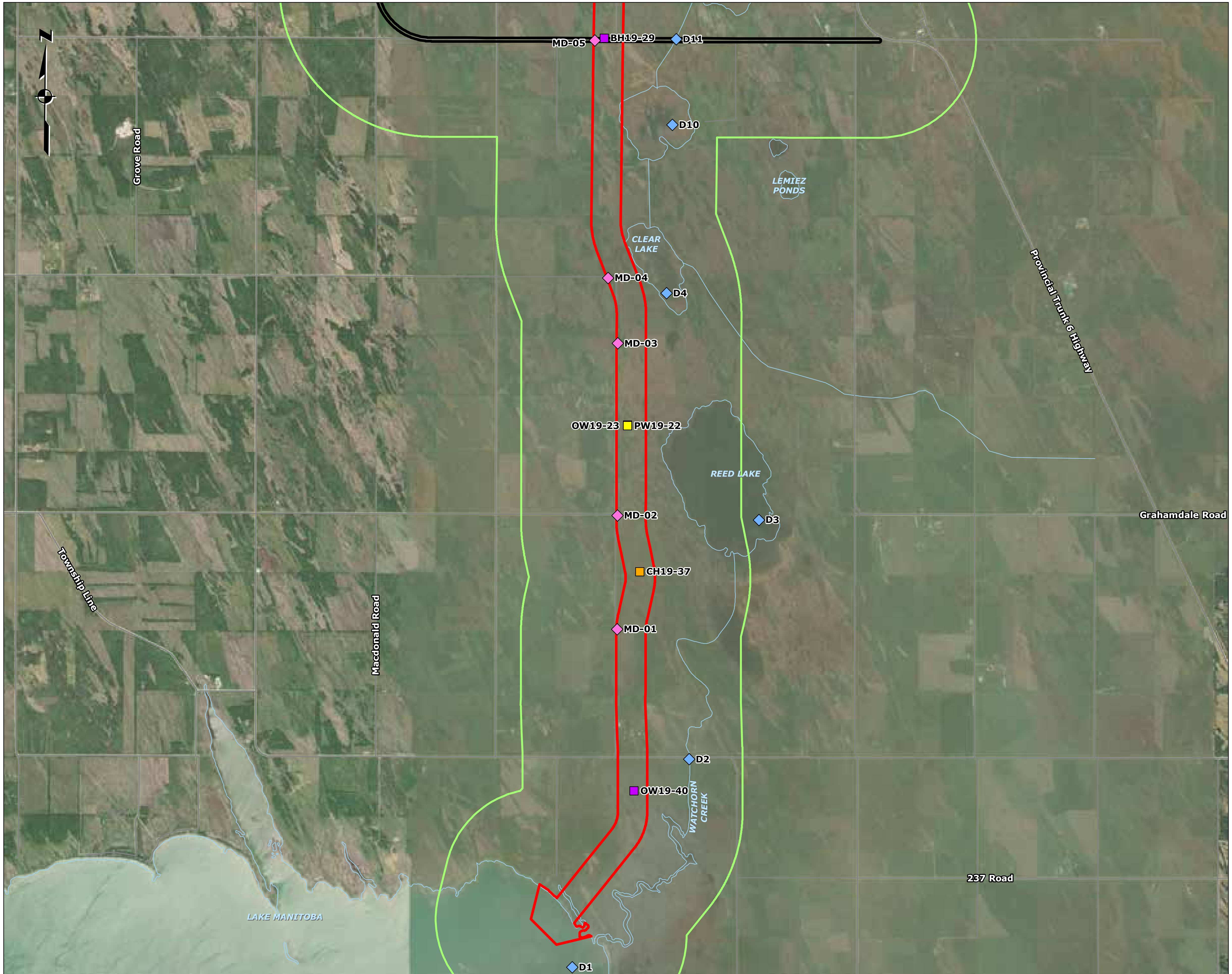
Universal Transverse Mercator (Zone 14)
North American Datum (1983)

WSP

Report By: DS
Drawn by: JH
Reviewed By: KT

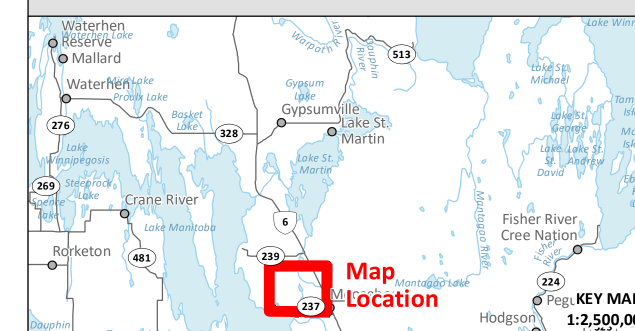
WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes:Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure



Legend

- Groundwater Quality Sites (2019)
- Groundwater Quality Sites (2019, 2020)
- Groundwater Quality Sites (2019, 2020, 2021)
- Suface Water Quality Sites (2019, 2020, 2021)
- Suface Water Quality Sites (2021)
- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- PR 239 Road Re-Alignment
- Roads
- Hydrology



Manitoba

Figure 1B: Past Water Monitoring Sites - LMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

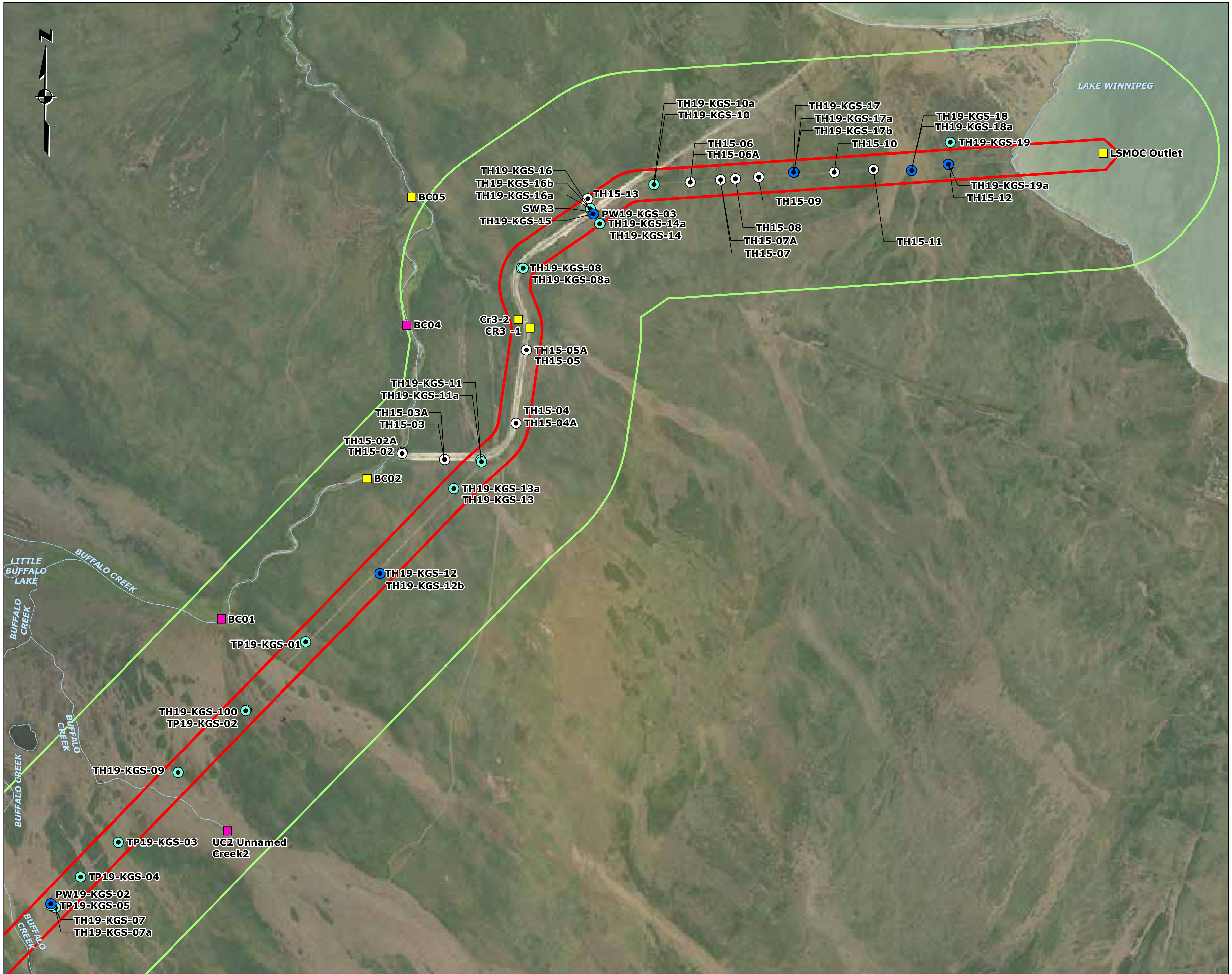
0 1 2 3 Kilometers

Universal Transverse Mercator (Zone 14)
North American Datum (1983)

Report By: DS
Drawn by: JH
Reviewed By: KT

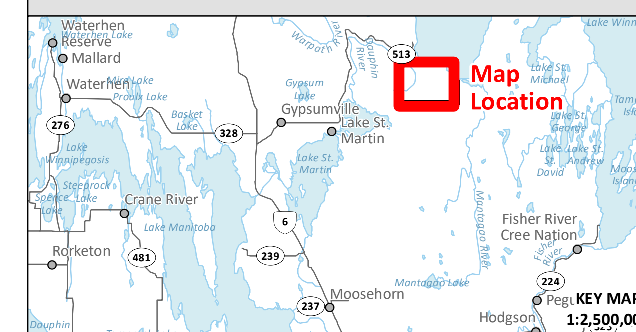
WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes:Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure



Legend

- Monitoring Well Instrumented
- Monitoring Well_Instrumented Groundwater Sample
- Monitoring Well Not Instrumented
- Surface Water Quality Station Design
- Surface Water Quality Station EIS
- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- Hydrology



Manitoba

Figure 2A: Past Water Monitoring Sites - LSMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

0 1 2 3 Kilometers

Universal Transverse Mercator (Zone 14)
North American Datum (1983)

WSP

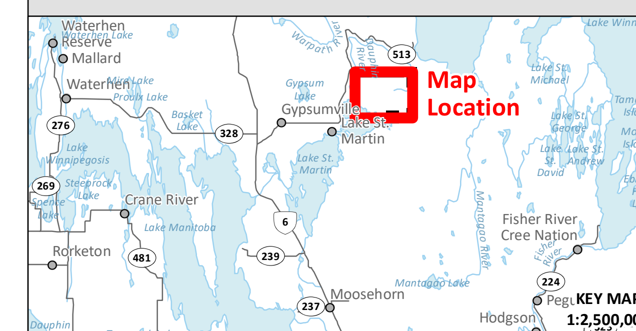
Report By: DS
Drawn by: JH
Reviewed By: KT

WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes:Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure

Legend

- Monitoring Well Instrumented
- Monitoring Well_Instrumented Groundwater Sample
- Monitoring Well Not Instrumented
- Surface Water Quality Station Design
- Surface Water Quality Station EIS
- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- Manitoba Hydro's Distribution Line
- Roads
- Hydrology



Manitoba

Figure 2B: Past Water Monitoring Sites - LSMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

0 1 2 3 Kilometers

Universal Transverse Mercator (Zone 14)
North American Datum (1983)

WSP

Report By: DS
Drawn by: JH
Reviewed By: KT

WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes:Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure

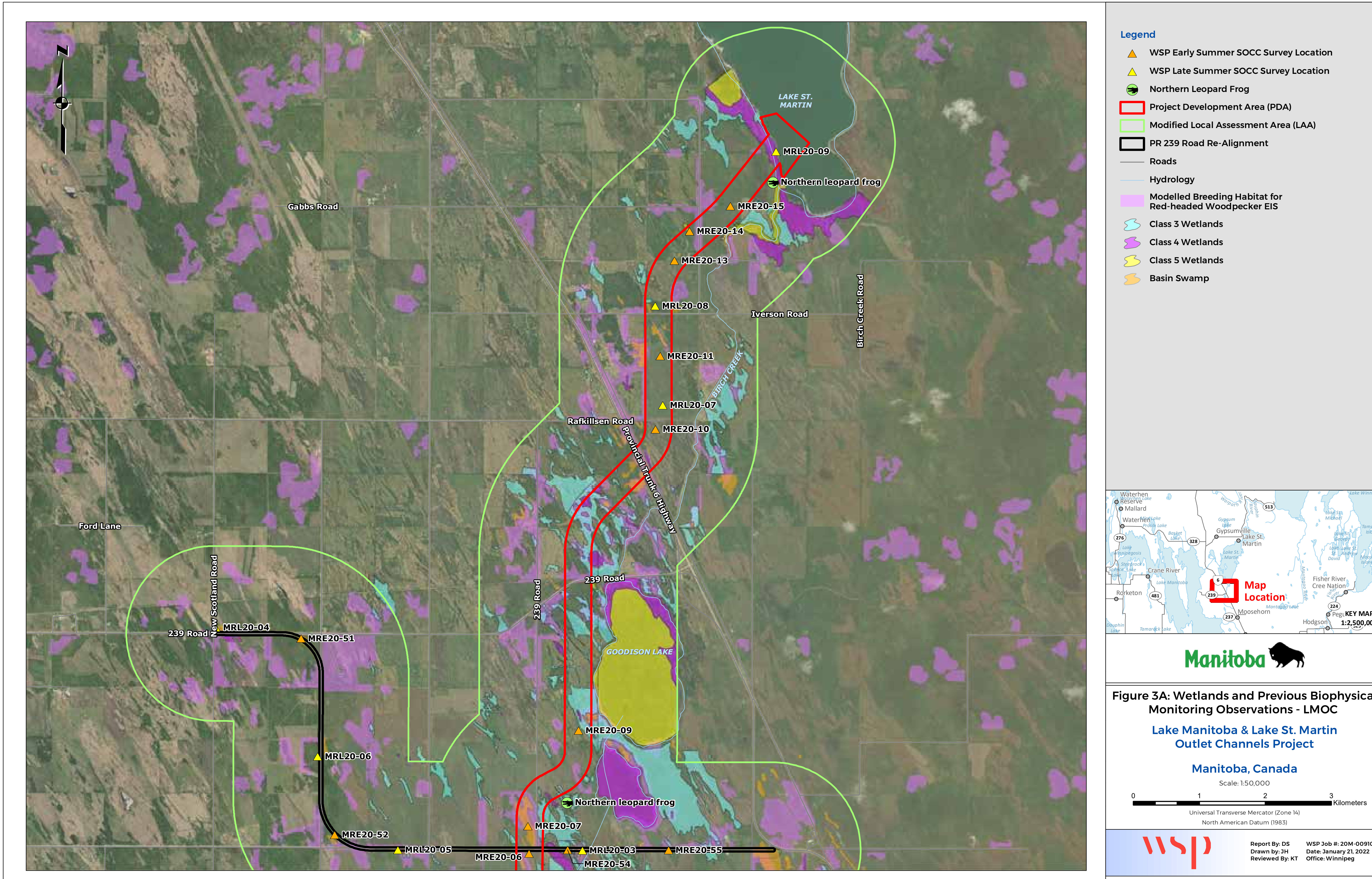
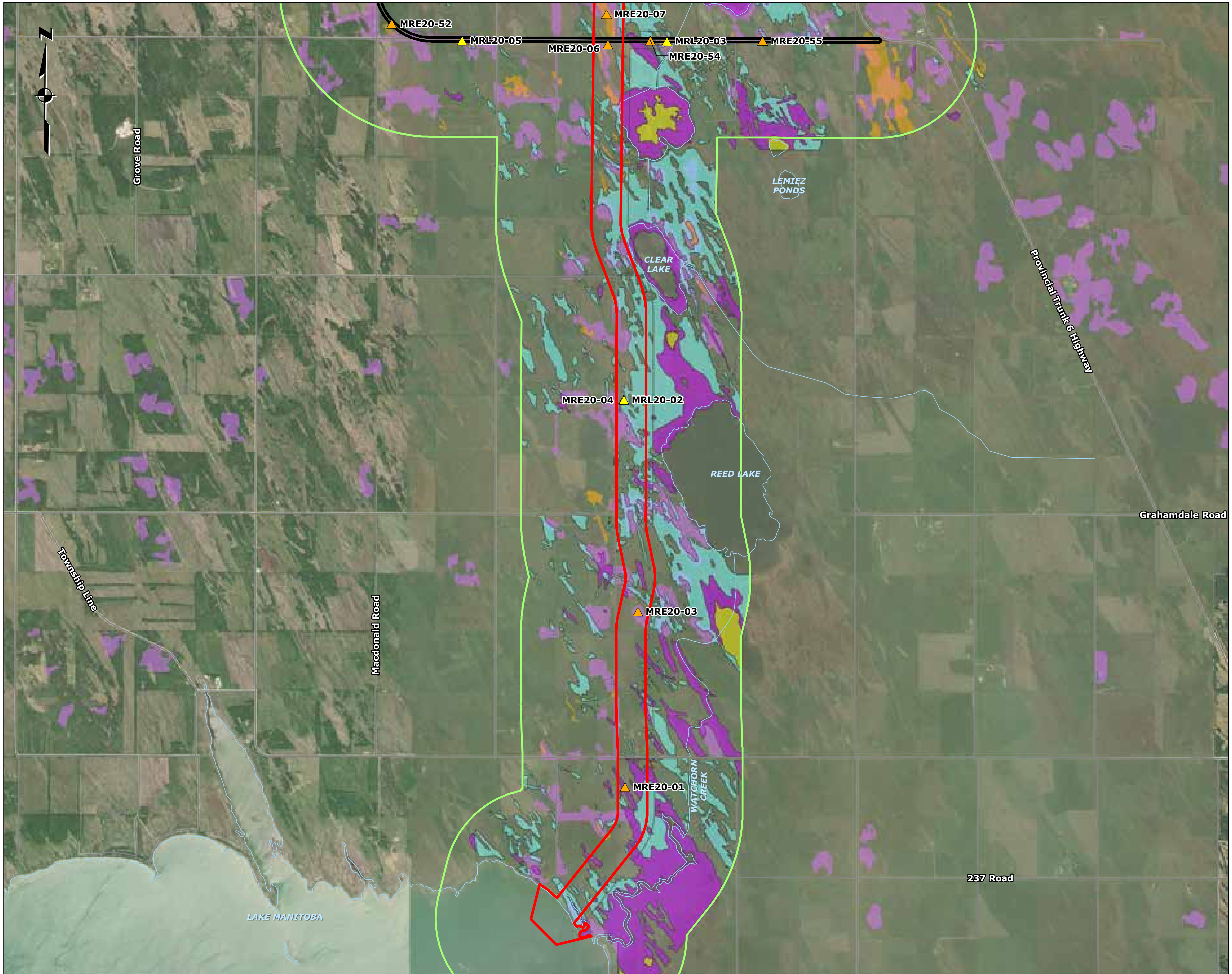


Figure 3A: Wetlands and Previous Biophysical Monitoring Observations - LMOC

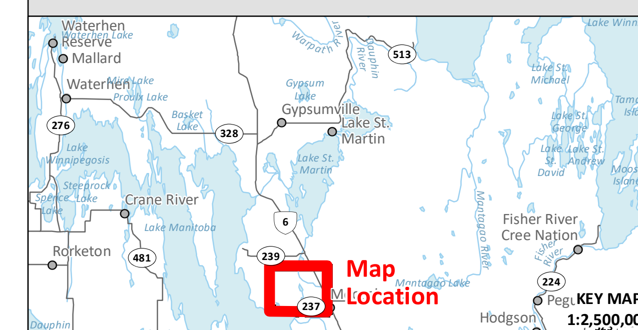
Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada



Legend

- WSP Early Summer SOCC Survey Location
- WSP Late Summer SOCC Survey Location
- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- PR 239 Road Re-Alignment
- Roads
- Hydrology
- Modelled Breeding Habitat for Red-headed Woodpecker EIS
- Class 3 Wetlands
- Class 4 Wetlands
- Class 5 Wetlands
- Basin Swamp
- Lacustrine Swamp



Manitoba

Figure 3B: Wetlands and Previous Biophysical Monitoring Observations - LMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

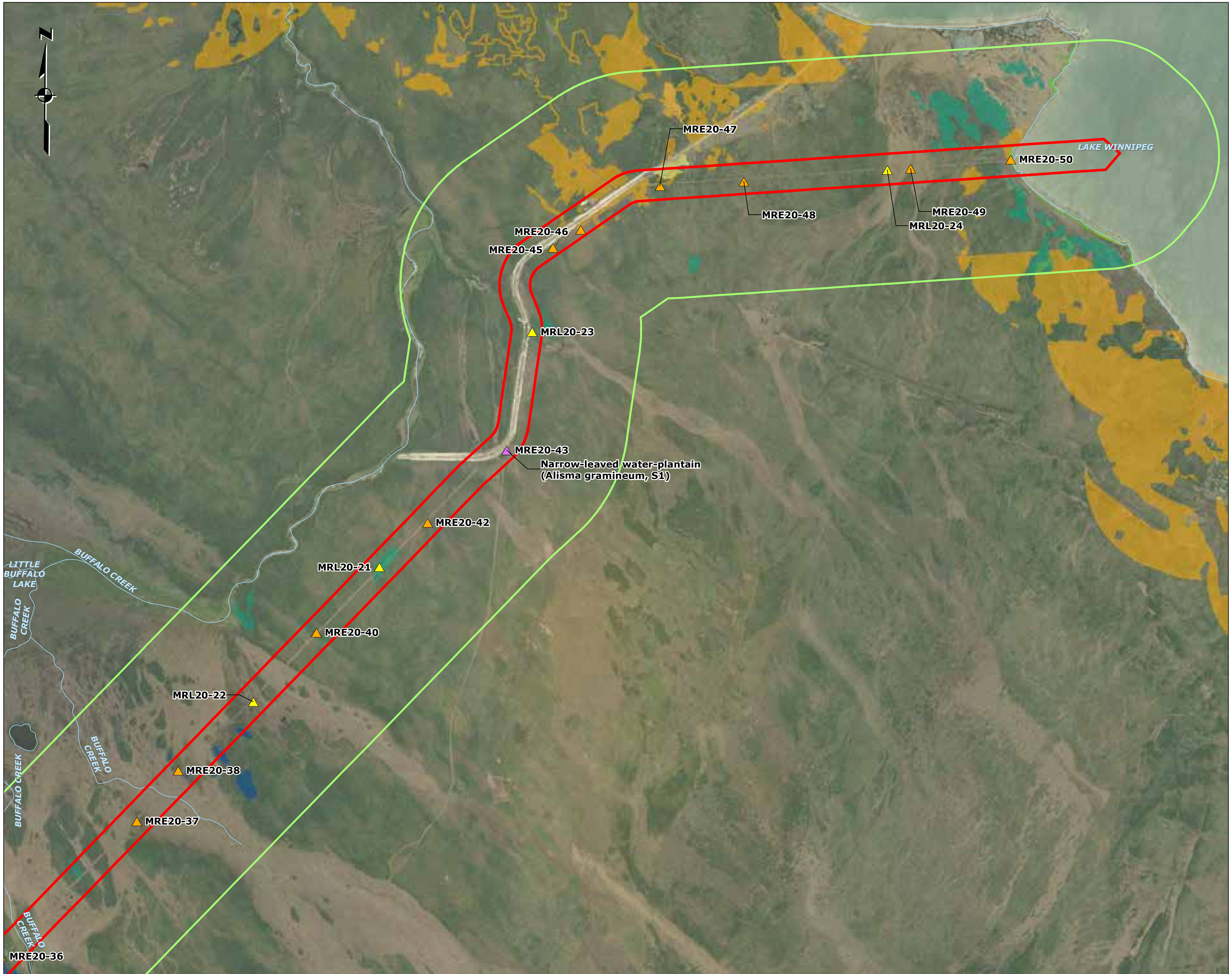
0 1 2 3 Kilometers

Universal Transverse Mercator (Zone 14)
North American Datum (1983)

Report By: DS
Drawn by: JH
Reviewed By: KT

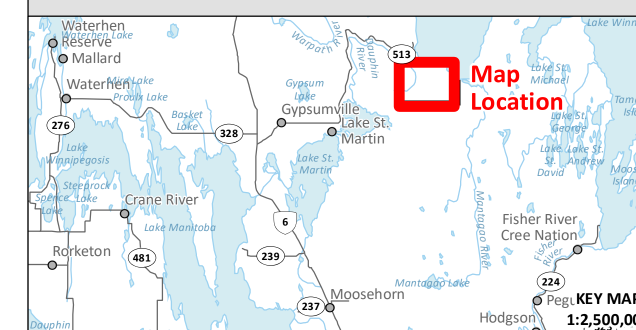
WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes:Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure



Legend

- WSP Early Summer SOCC Survey Location
- WSP Late Summer SOCC Survey Location
- WSP SOCC Observation
- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- Hydrology
- Modelled Breeding Habitat for Eastern Whip-poor-will EIS
- Basin Swamp
- Lacustrine Swamp
- Lagg Swamp
- Unconfined Flat Swamp



Manitoba

Figure 4A: Wetlands and Previous Biophysical Monitoring Observations - LSMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

0 1 2 3 Kilometers

Universal Transverse Mercator (Zone 14)
North American Datum (1983)

WSP

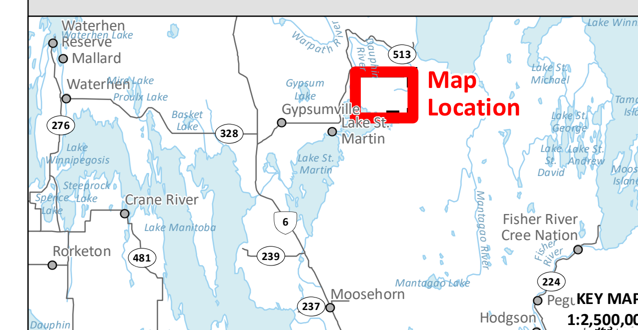
Report By: DS
Drawn by: JH
Reviewed By: KT

WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes: Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure

Legend

- WSP Early Summer SOCC Survey Location
- WSP Late Summer SOCC Survey Location
- WSP SOCC Observation
- Yellow Rail Location
- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- Manitoba Hydro's Distribution Line
- Roads
- Hydrology
- Modelled Breeding Habitat for Eastern Whip-poor-will EIS
- Modelled Breeding Habitat for Red-headed Woodpecker EIS
- Class 3 Wetlands
- Class 4 Wetlands
- Lacustrine Swamp
- Lagg Swamp
- Riverine Swamp
- Unconfined Flat Swamp



Manitoba

Figure 4B: Wetlands and Previous Biophysical Monitoring Observations - LSMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

0 1 2 3 Kilometers

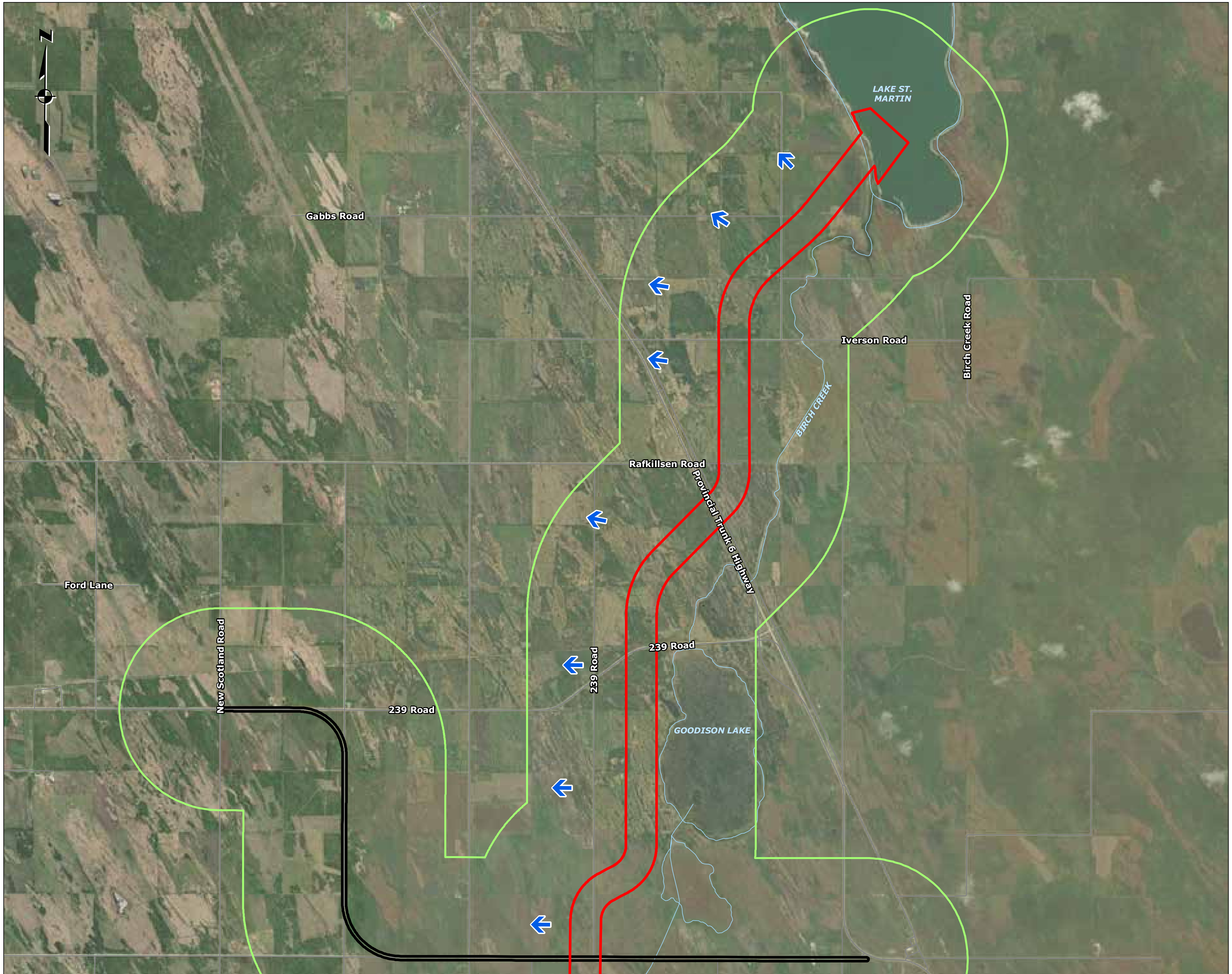
Universal Transverse Mercator (Zone 14)
North American Datum (1983)

wsp

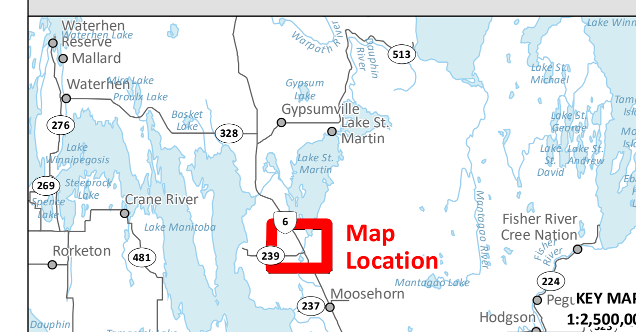
Report By: DS
Drawn by: JH
Reviewed By: KT

WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes: Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure



Legend
- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- PR 239 Road Re-Alignment
- Roads
- Hydrology
- Groundwater Flow



Manitoba

Figure 5A: Groundwater Flow - LMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

0 1 2 3 Kilometers

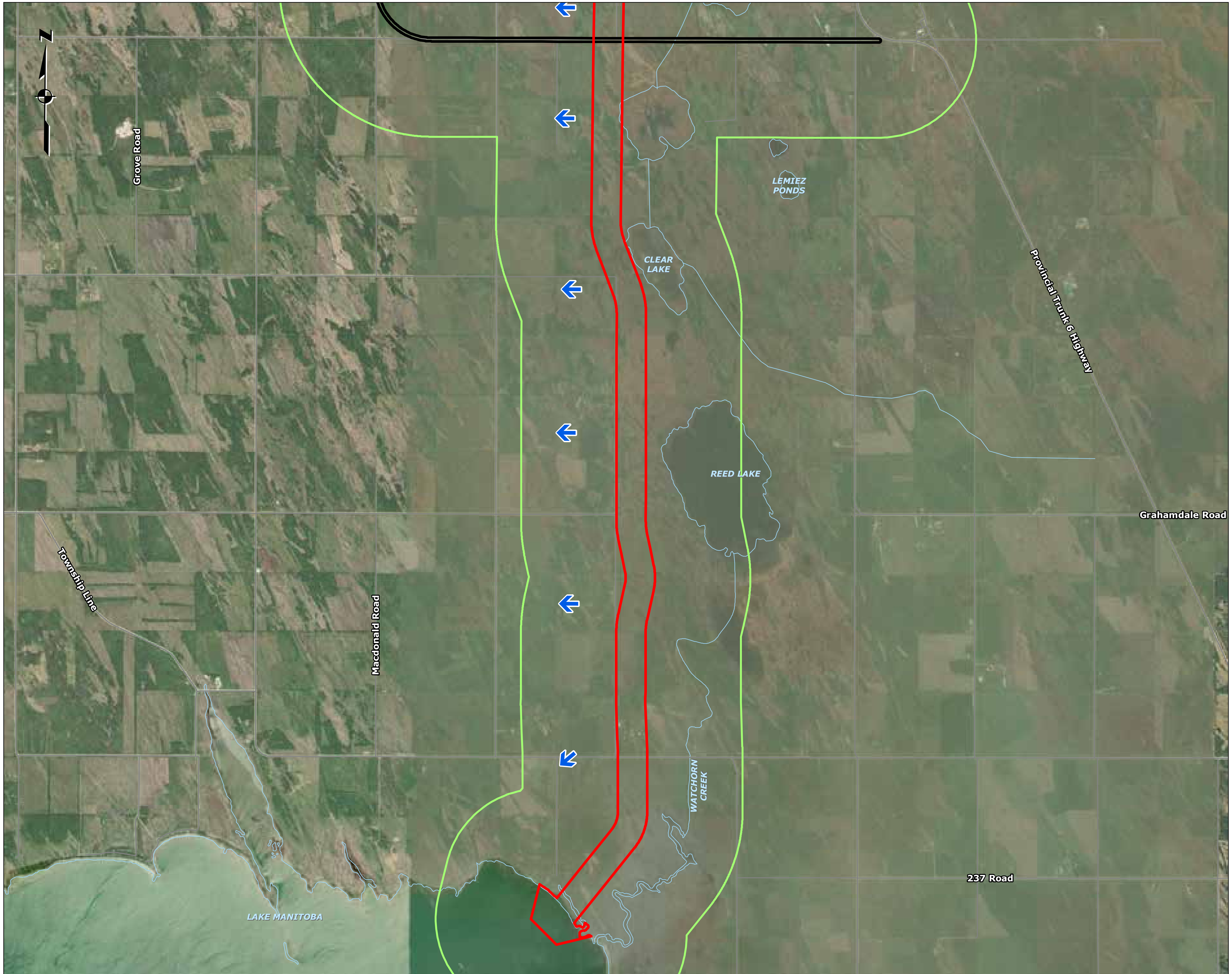
Universal Transverse Mercator (Zone 14)
North American Datum (1983)

WSP

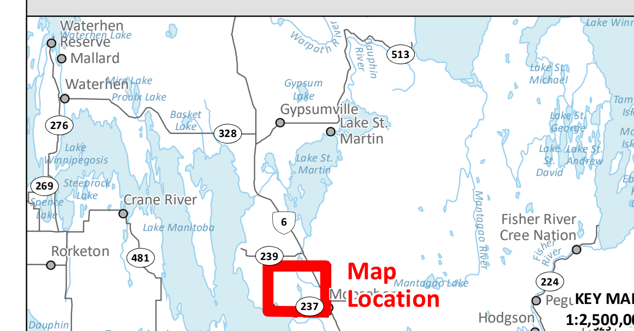
Report By: DS
Drawn by: JH
Reviewed By: KT

WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes: Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure



Legend
- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- PR 239 Road Re-Alignment
- Roads
- Hydrology
- Groundwater Flow



Manitoba

Figure 5B: Groundwater Flow - LMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

0 1 2 3 Kilometers

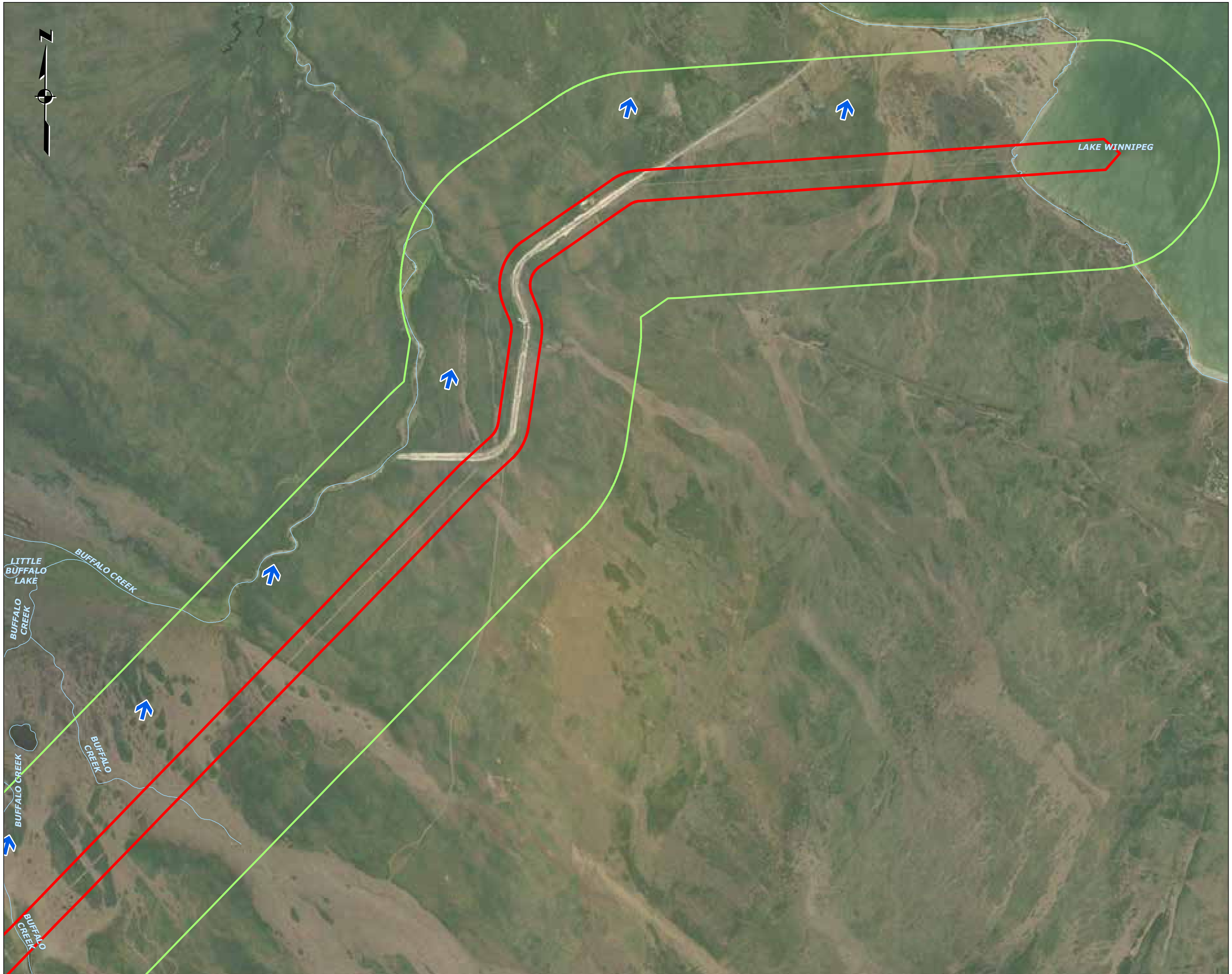
Universal Transverse Mercator (Zone 14)
North American Datum (1983)

WSP

Report By: DS
Drawn by: JH
Reviewed By: KT

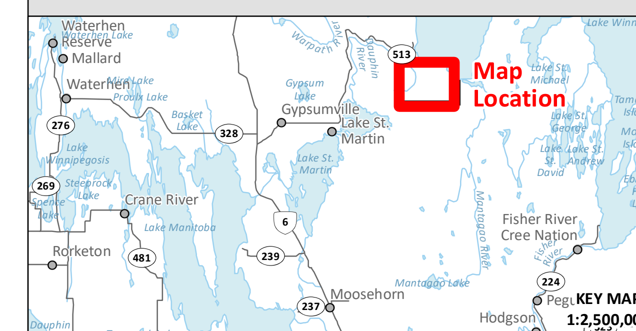
WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes:Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure



Legend

- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- Hydrology
- Groundwater Flow



Manitoba

Figure 6A: Groundwater Flow - LSMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

0 1 2 3 Kilometers

Universal Transverse Mercator (Zone 14)
North American Datum (1983)

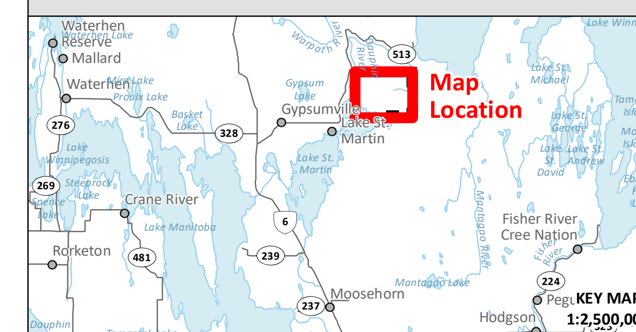
Report By: DS
Drawn by: JH
Reviewed By: KT

WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes:Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure

Legend

- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- Manitoba Hydro's Distribution Line
- Roads
- Hydrology
- Groundwater Flow



Manitoba

Figure 6B: Groundwater Flow - LSMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

0 1 2 3 Kilometers

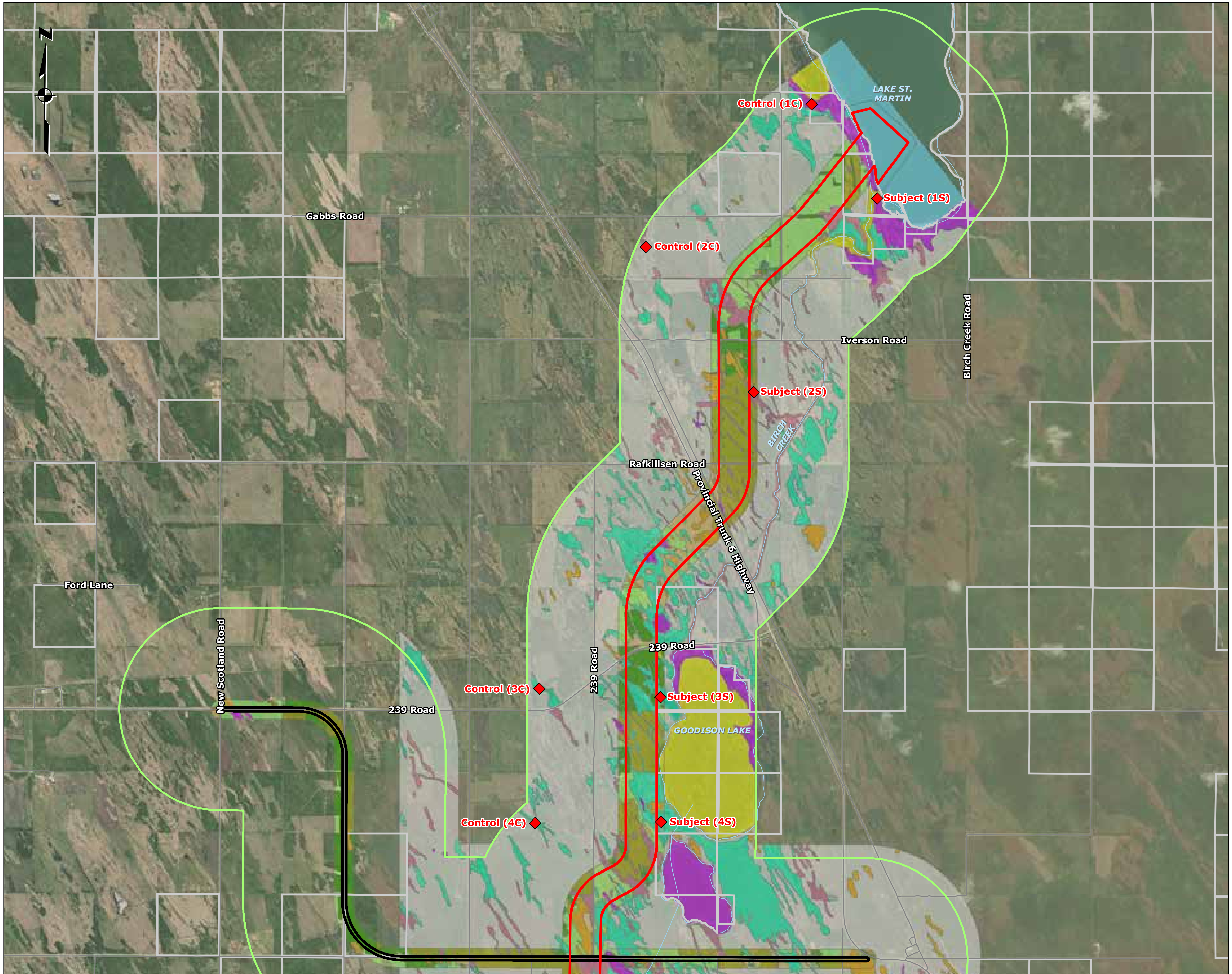
Universal Transverse Mercator (Zone 14)
North American Datum (1983)

WSP

Report By: DS
Drawn by: JH
Reviewed By: KT

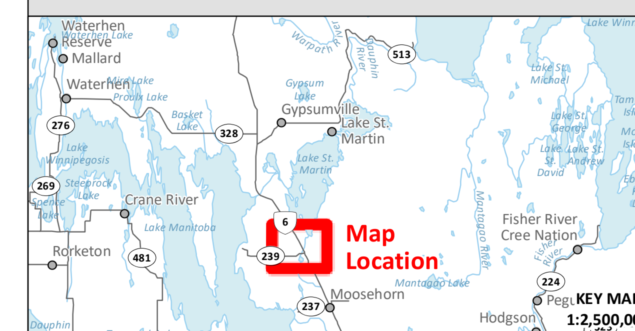
WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes: Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure



Legend

- Recommended Monitoring Sites
- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- PR 239 Road Re-Alignment
- Crown Land
- Roads
- Hydrology
- Agricultural Cropland
- Basin Swamp
- Class II Wetland
- Class III Wetland
- Class IV Wetland
- Class V Wetland
- Cultural Features
- Forage Crops
- Roads and Trails
- V1 = Balsam Poplar Hardwood and Mixedwood
- V5 = Aspen Hardwood
- Undefined upland
- Water Bodies



Manitoba

Figure 7A: Proposed Wetland Monitoring Sites - LMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

0 1 2 3 Kilometers

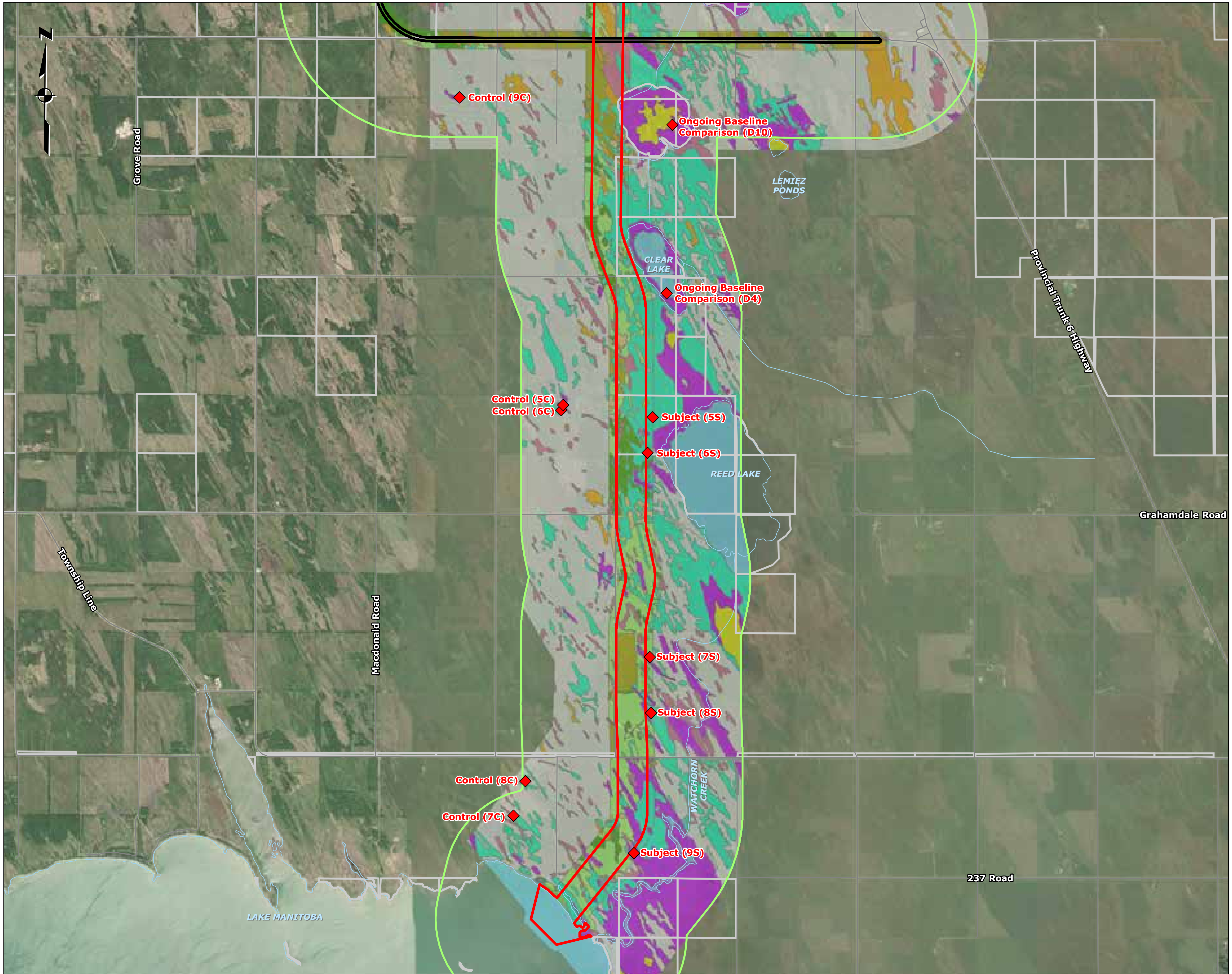
Universal Transverse Mercator (Zone 14)
North American Datum (1983)

WSP

Report By: DS
Drawn by: JH
Reviewed By: KT

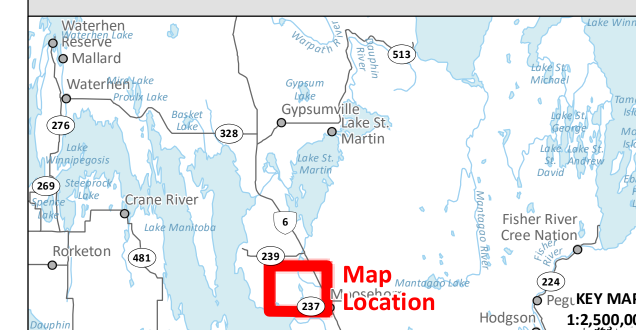
WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes: Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure



Legend

- Recommended Monitoring Sites
- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- PR 239 Road Re-Alignment
- Crown Land
- Roads
- Hydrology
- Agricultural Cropland
- Bare Rock, Gravel and Sand
- Basin Swamp
- Class II Wetland
- Class III Wetland
- Class IV Wetland
- Class V Wetland
- Cultural Features
- Forage Crops
- Lacustrine Swamp
- Roads and Trails
- V1 = Balsam Poplar Hardwood and Mixedwood
- V5 = Aspen Hardwood
- Undefined upland
- Water Bodies



Manitoba

Figure 7B: Proposed Wetland Monitoring Sites - LMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

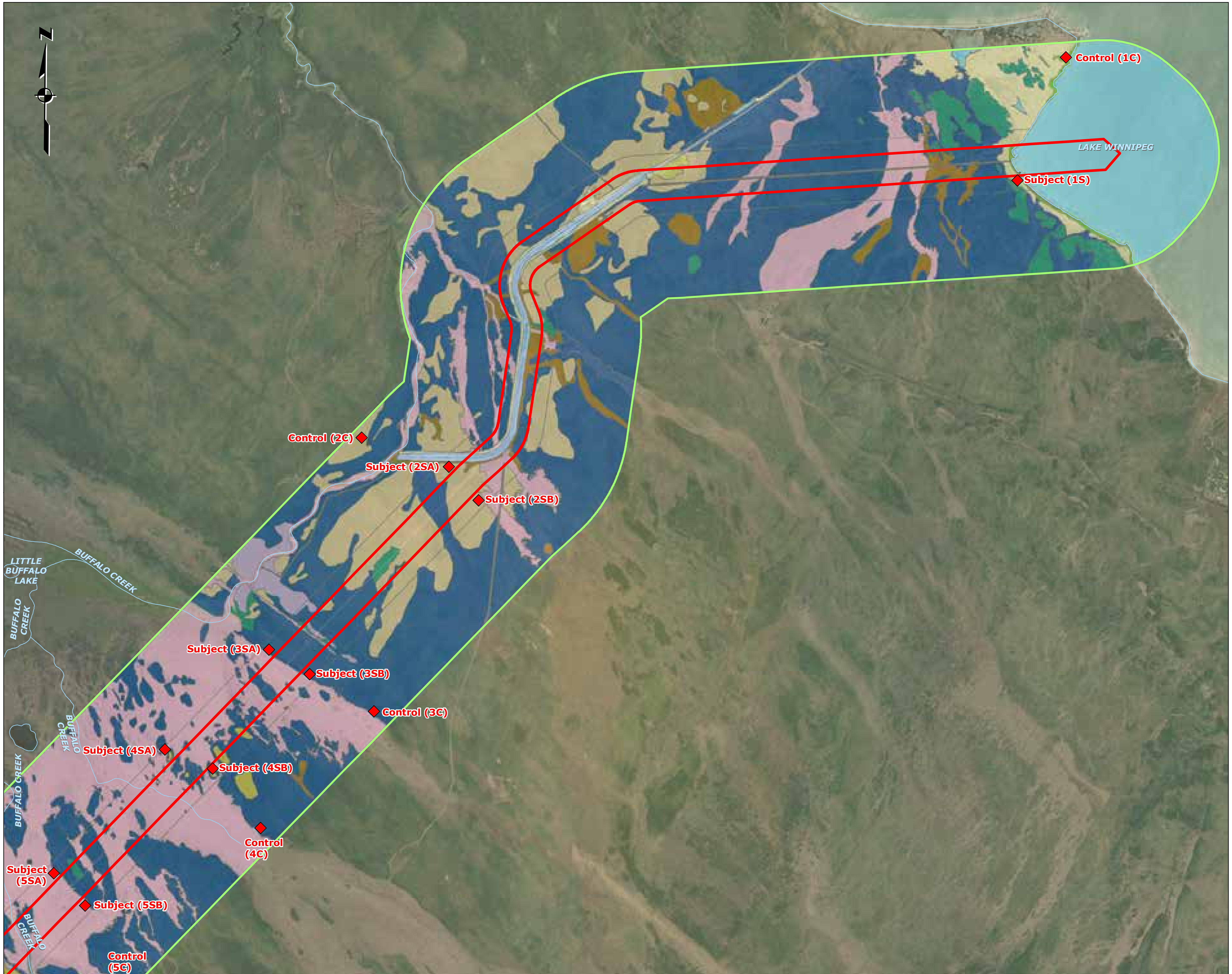
0 1 2 3 Kilometers

Universal Transverse Mercator (Zone 14)
North American Datum (1983)

Report By: DS
Drawn by: JH
Reviewed By: KT

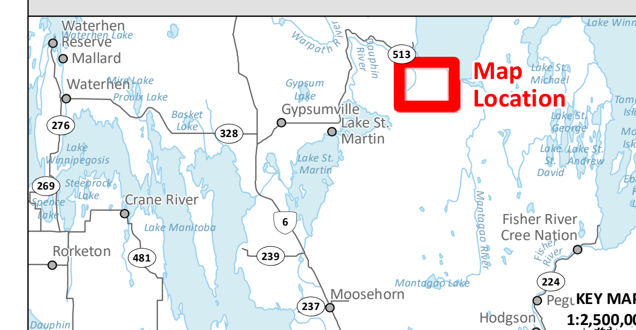
WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes:Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure



Legend

- Recommended Monitoring Sites
- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- Hydrology
- Bare Rock, Gravel and Sand
- Basin Bog
- Basin Fen
- Basin Swamp
- Channel
- Forest Cutovers
- Horizontal Fen
- Lacustrine Swamp
- Lagg Swamp
- Roads and Trails
- Shore Fen
- Stream Fen
- Unconfined Flat Swamp
- V1 = Balsam Poplar Hardwood and Mixedwood
- Water Bodies



Manitoba

Figure 8A: Proposed Wetland Monitoring Sites - LSMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

0 1 2 3 Kilometers

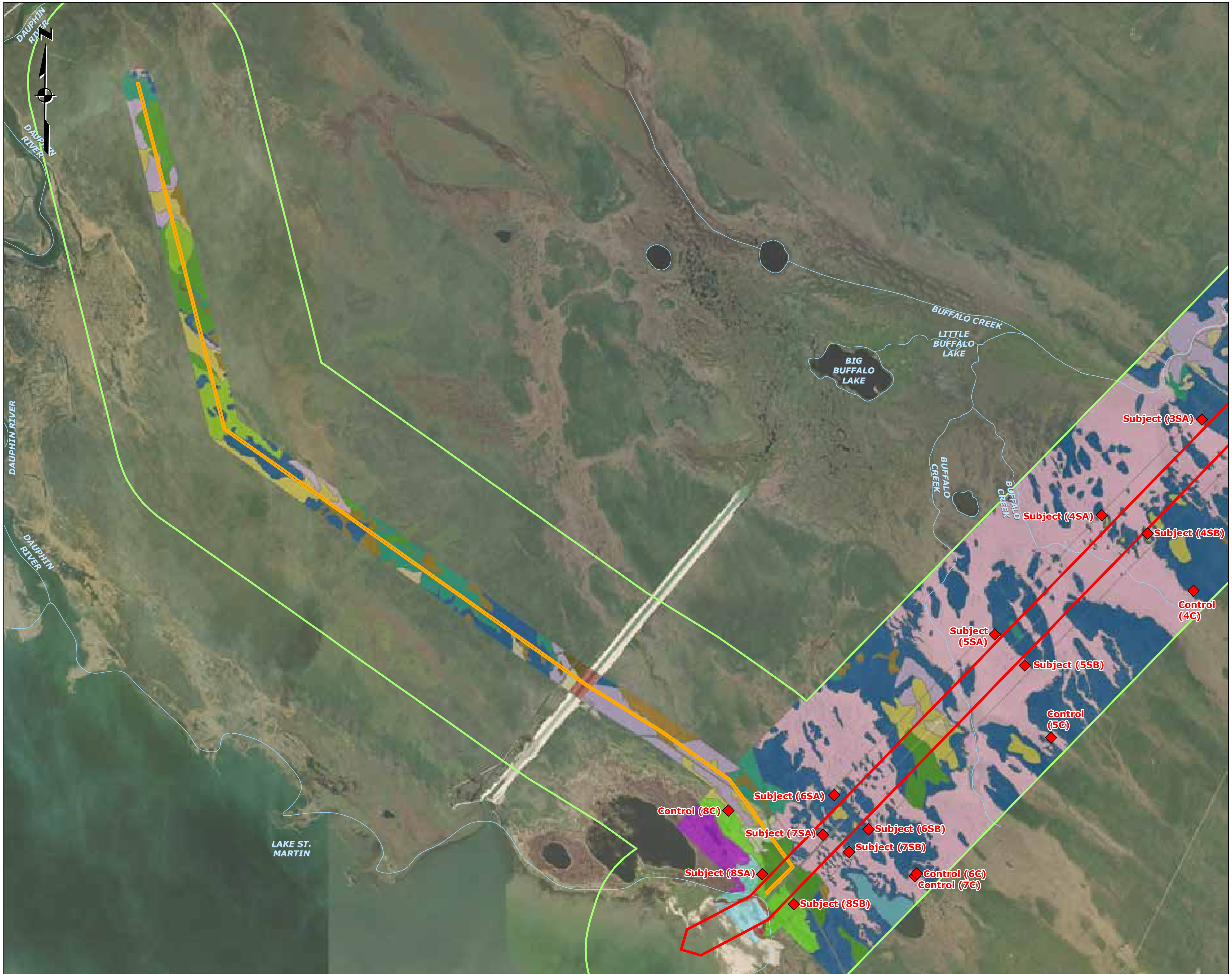
Universal Transverse Mercator (Zone 14)
North American Datum (1983)

wsp

Report By: DS
Drawn by: JH
Reviewed By: KT

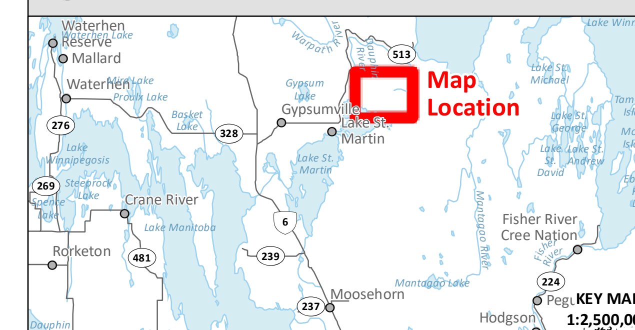
WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes: Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure



Legend

- Recommended Monitoring Sites
- Project Development Area (PDA)
- Modified Local Assessment Area (LAA)
- Manitoba Hydro's Distribution Line
- Roads
- Hydrology
- Bare Rock, Gravel and Sand
- Basin Bog
- Basin Fen
- Class III_Wetland
- Class IV Wetland
- Forest Cutovers
- Horizontal Fen
- Lacustrine Swamp
- Lagg Swamp
- Riverine Swamp
- Roads and Trails
- Stream Fen
- Unconfined Flat Swamp
- V1 = Balsam Poplar Hardwood and Mixedwood
- V4 = White Birch Hardwood and Mixedwood
- V5 = Aspen Hardwood
- V24 = Jack Pine Conifer
- V28 = Jack Pine-Black Spruce/Feather Moss
- Water Bodies



Manitoba

Figure 8B: Proposed Wetland Monitoring Sites - LSMOC

Lake Manitoba & Lake St. Martin Outlet Channels Project

Manitoba, Canada

Scale: 1:50,000

0 1 2 3 Kilometers

Universal Transverse Mercator (Zone 14)
North American Datum (1983)

WSP

Report By: DS
Drawn by: JH
Reviewed By: KT

WSP Job #: 20M-00910-00
Date: January 21, 2022
Office: Winnipeg

Notes:Imagery Source: ESRI, Base Data: Manitoba Transportation and Infrastructure