LAKE MANITOBA
LAKE ST. MARTIN

OUTLET CHANNELS PROJECT

MANITOBA INFRASTRUCTURE

Ice Management Plan

November 16, 2020

Manitoba

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DISCLAIMER

This document was developed to support the Lake Manitoba and Lake St. Martin Outlet Channel Environmental Management and Monitoring Program. This document has been prepared by Manitoba Infrastructure as a way to share information and have discussion with Indigenous Communities and Groups and the public. This document has been prepared using existing environmental and preliminary engineering information, 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 and will not be considered complete until further engagement and consultation is complete. The plans may be further revised based on information and direction received from provincial and federal environmental regulators. This draft report be read as a whole, and sections or parts should not be read out of context.

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 PR 239, and other ancillary infrastructure.

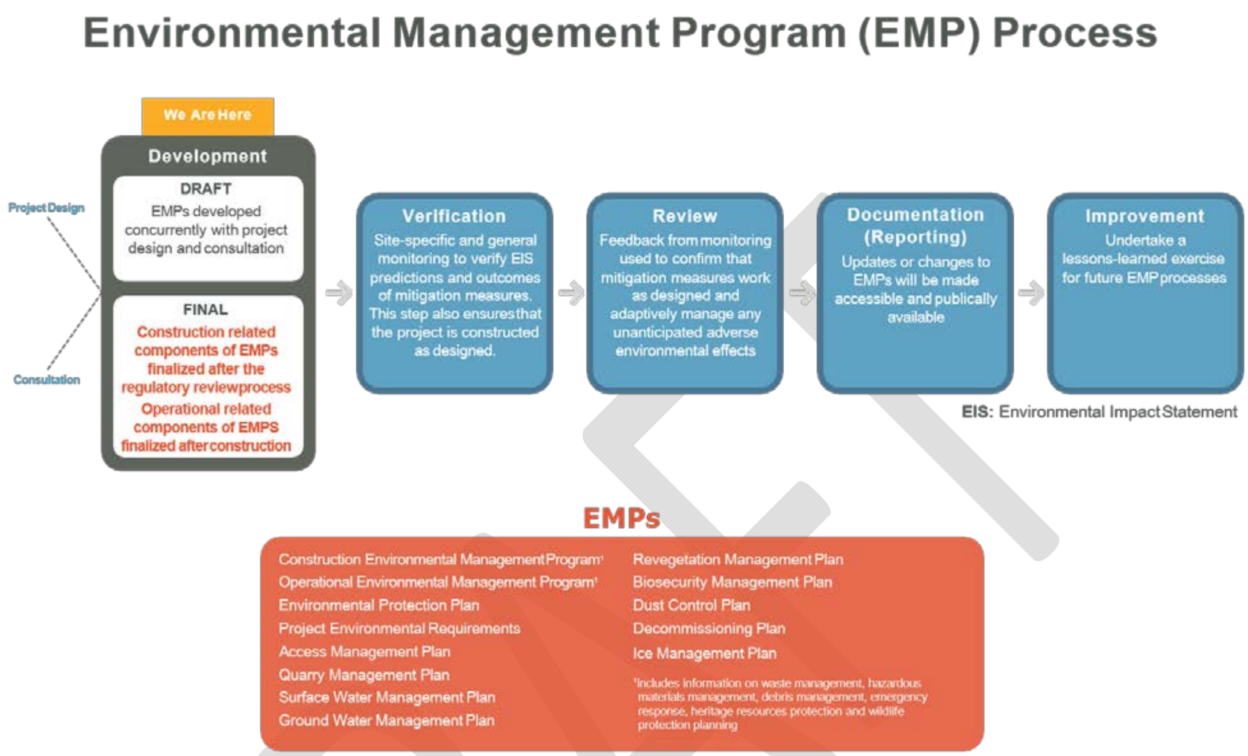
Manitoba Infrastructure (MI) is the proponent for the proposed Project. After receipt of the required regulatory approvals, MI will develop, manage and operate the Project. This Ice Management Plan is one component of the overall Environmental Management Program (EMP) framework which describes the environmental management processes that will be followed during the construction and operation phases of the Project. The goal of the EMP is to ensure that the environmental protection measures committed to in the Environmental Impact Statement (EIS) and the conditions of the Environment Act Licence and Federal Decision Statement Conditions are undertaken in a timely and effective manner. This includes the verification that environmental commitments are executed, monitored, evaluated for effectiveness, and that information is reported back in a timely manner to the Project management team for adjustment if required.

Manitoba Infrastructure remains committed to ongoing engagement and consultation with Indigenous groups and other stakeholders that are potentially impacted by the Project. Detailed EMP review discussions have been incorporated into community-specific consultation work plans and additional engagement opportunities will be provided prior to EMP finalization. Engagement opportunities include virtual open house events and EMP-specific questionnaires. EMP-specific questionnaires will be provided to Indigenous groups and stakeholders to obtain feedback and views on the draft plans, in addition to exploring opportunities for Indigenous participation in follow-up monitoring. Feedback and recommendations will be used to inform the completion of the plans.

The EMP provides the overarching framework for the Construction Environmental Management Program (CEMP) and an Operation Environmental Management Program (OEMP), which will be finalized as separate documents prior to Project construction and ideally operation, respectively. Their finalization will consider applicable conditions of the Environmental Act Licence and associated approvals, any other pertinent findings through the design and regulatory review processes and key relevant outcomes of the ongoing Indigenous and public engagement and Consultation processes.

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 (e.g. surface water, groundwater, sediment, etc.), as shown in the Figure below, that will guide MI's development of the Project's contract documents and subsequently, the Contractor(s) activities, in constructing the Project in an environmentally responsible manner. The OEMP will likely include 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.

Environmental Management Program Process and Associated Environmental Management Plans



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GLOSSARY OF TERMS AND ACRONYMS

Acronyms

AMP	Access Management Plan
CEMP	Construction Environmental Management Program
EIS	Environmental Impact Statement
EMP	Environmental Management Program
EPP	Environmental Protection Plans
GWMP	Groundwater Management Plan
HRPP	Heritage Resources Protection Plan
LMOC	Lake Manitoba Outlet Channel
LSMOC	Lake St. Martin Outlet Channel
MI	Manitoba Infrastructure
OEMP	Operation Environmental Management Program
PERs	Project Environmental Requirements
Project	The Lake Manitoba and Lake St. Martin Permanent Outlet Channels Project
SAR	Species at Risk
SMP	Sediment Management Plan
SWMP	Surface Water Management Plan
VMP	Vegetation Monitoring Plan
WMP	Wildlife Monitoring Plan

Glossary of Terms

Frazil Ice: Small discs of ice ranging in size from less than 0.1 mm to a few mm, formed in turbulent water.

Hanging Ice Dam: Ice accumulation created by the deposition of entrained ice on the underside of an ice cover.

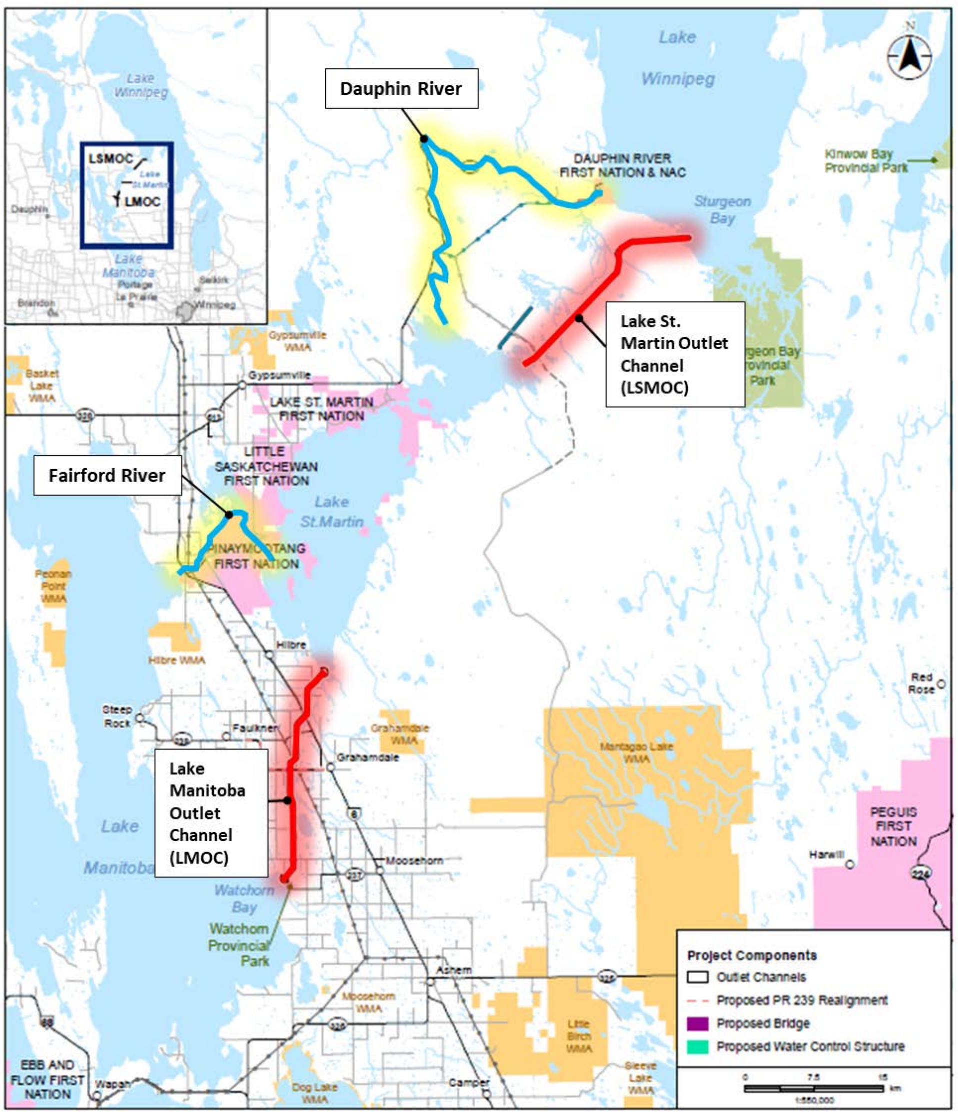
Ice Jam: Generic term referring to the accumulation of ice fragments in a watercourse that restricts flow and causes staging of water levels upstream.

1.0 INTRODUCTION

1.1 Background

The Lake Manitoba Outlet Channel (LMOC) and Lake St. Martin Outlet Channel (LSMOC), collectively referred to as the “Project” herein, will provide additional outlets to release water from Lake Manitoba and Lake St. Martin. Operation of the outlet channels will result in changes to the regional flow system, including changes to lake water levels and changes to flows in the connecting rivers. The location of the proposed outlet channels in relation to the regional flow system is shown in Figure 1.

Figure 1: Map of Project Area



Although the outlet channels will be used primarily during the spring and summer to reduce damages of open water flooding, the channels are designed to permit operation in the winter months as well. Winter operation of the outlet channels may be considered to reduce water levels in the lakes following a large flood the previous spring/summer, or to preemptively lower lake levels to prepare for a large flood in the subsequent spring. Based on a simulation of historic conditions from 1915-2017, it is estimated that the LMOC and LSMOC would be operated in approximately 25-30% of winters. Management of ice processes, both in the channels and in the connected flow system, will be considered during winter operation of the outlet channels.

1.2 Objective

The objective of the Ice Management Plan is to manage hazards related to ice during operation of the outlet channels in consideration of public and worker safety and environmental impacts. Potential ice hazards include river ice jams (within the outlet channels and in Project-affected rivers) and variations in lake ice thicknesses. The Ice Management Plan is a component of the Operation Environmental Management Program (OEMP).

1.3 Reference Documents

Documents referenced in this Ice Management Plan are listed below:

- Manitoba Infrastructure. Development of Operating Rules for Lake Manitoba and Lake St. Martin Outlet Channels with Recommended Revisions. February 4, 2019.
- Manitoba Infrastructure. Lake Manitoba and Lake St. Martin Outlet Channels Project EIS. Volume 2: Physical Environment Effects Assessment. March 2020.
- Manitoba Infrastructure Dam Site Signage Manual.

2.0 ICE MANAGEMENT WITHIN OUTLET CHANNELS

2.1 Operation of Outlet Channels Following Winter Non-Operation

In years when the LMOC and LSMOC are not operated in the winter, thermal ice covers will form in the channels. Depending on winter air temperatures, the ice thickness may range from approximately 0.6-1.2 m. In accordance with the operating guidelines developed for the Project, the Water Control Structure (WCS) gates will not typically be initially opened during the period where there is a solid ice cover in the channels (approximately December 1 to April 30).

Prior to normal spring operation, an observational survey of the outlet channels will be conducted to assess ice conditions. The observations may be performed from land via the access paths that run alongside the outlet channels or by air via helicopter or drone. Once the channels are observed to be free of ice (or significant deterioration of the ice cover has occurred), spring operation of the outlet channels will commence.

In extreme cases where there is a risk of severe flooding the following spring, operation (opening) of the WCS gates may be considered even if a solid ice cover still exists within the outlet channels. Such operations will require careful adjustments of the gates and continuous monitoring; flow in the outlet channels would be gradually increased and ice conditions in the channels would be monitored concurrently for signs of undesirable changes in ice conditions. If the ice cover is observed to be breaking up uncontrollably and/or if ice jams form in the channel, the WCS gates would be lowered to reduce flow into the channels and prevent potential overtopping of the channel dikes or banks from the flow constriction caused by the ice jam. The broken-up ice pieces could also cause damage to bridge piers or drop structures as they are transported downstream.

2.2 Winter Operation of Outlet Channels

In years with significant spring/summer floods, the outlet channels may continue to be operated through the winter to continue reducing water levels in Lake Manitoba and Lake St. Martin. As mentioned previously, it is estimated that the LMOC and LSMOC would be operated in approximately 25-30% of winters. During operation of the channels, communication processes will be managed by the Province according to existing protocols for other flood control infrastructure (e.g. FRWCS, Shellmouth Dam, Portage Diversion, and Red River Floodway). This involves a combination of press releases, forecasts and reports by the Hydrologic Forecasting Center, and real time operation/monitoring data on MI’s website.

In general, lake inflows and water levels are lower during the winter season and thus potential maximum flows in the outlet channels are less than during an open water flood. In addition to lake level considerations in controlling the flows in each of the outlet channels, ice processes within the channels must be considered. The Water Control Structures will have heated vertical gates that can be operate throughout the winter.

2.2.1 Ice Conditions in LMOC

The WCS of the LMOC is located near the downstream end of the channel, approximately 3 km upstream of the outlet to Lake St. Martin. Should winter operation be required, the LMOC will be operated to mitigate potential negative impacts of ice formation in the channel. At the onset of freeze-up, the WCS gates will be operated to temporarily reduce or stop flow in the LMOC. The reduction in water velocity afforded by this will promote the rapid formation of an ice cover in the channel. Once formed, the ice cover will insulate the water surface, and reduce the volume of frazil ice produced (frazil ice refers to small discs of ice ranging in size from less than 0.1 mm to a few mm, formed in turbulent water). This will limit the severity of ice accumulations in the channel and avoid the formation of a hanging ice dam at the outlet in Lake St. Martin. Depending on the hydraulic and meteorological conditions, the stable ice cover may form thermally or through the accumulation of ice pans at the surface. Once a stable ice cover has formed, the WCS gates would be fully opened to allow the channel to operate at maximum capacity in accordance with the operating guidelines. The flow will be increased gradually, and in steps to limit the risk of mechanical breakup of the ice cover. Ice conditions in the LMOC will be monitored to minimize the chance of ice cover instabilities.

In the event of unforeseen ice conditions in the LMOC during winter operation (e.g. development of an ice jam), the WCS gates will be lowered to reduce the flow in the channel. If required, equipment such as tracked excavators with extended reach will be mobilized to help remove ice jam blockages if forecasted flood conditions necessitate the continued operation of the LMOC.

2.2.2 Ice Conditions in LSMOC

The WCS of the LSMOC is located at the upstream end, near the inlet in Lake St. Martin. Similar to the LMOC, the LSMOC WCS will be operated to limit winter flows to promote the formation of a stable ice cover in the channel, thereby reducing the volume of frazil ice produced. These operational constraints have been discussed with MI and are deemed acceptable. This will limit the severity of ice accumulations on the drop structures and will inhibit the formation of a hanging dam at the outlet in Lake Winnipeg.

Provision of a riparian flow in the LSMOC with a small riparian conduit at the WCS is anticipated to maintain adequate dissolved oxygen (DO) concentrations in the channel during winter to minimize potential aquatic impacts. The details of the riparian flow required to maintain adequate DO levels will be determined during Detailed Design

During operation, depending on the hydraulic and meteorological conditions, the stable ice cover may form thermally or through the accumulation of ice pans at the surface. Observational monitoring of ice conditions and dike freeboard will be conducted regularly during winter operation of the LSMOC. If unforeseen ice conditions develop in the outlet channel (i.e. ice jams or excessive accumulation of ice on the drop structure crests), the WCS gates will be lowered to reduce flow in the LSMOC and maintain safe freeboard. Equipment such as long-reach excavators will be used, if necessary, to assist in clearing ice jams if forecasted flood conditions necessitate the continued operation of the LSMOC at higher flows.

2.2.3 Ice Conditions at Channel Inlets

Operation of the outlet channels during the winter will alter the local flow patterns in the lakes near the inlets. Higher water velocities through the inlets will result in sustained open water and/or thinner ice covers compared to when the channels are not operated.

Two-dimensional (2D) hydraulic modeling of Lake Manitoba and Lake St. Martin will help assess the area of influence of channel operation on lake flow patterns and delineate potential areas where open water or thinner lake ice may occur. It is expected that operation of the outlet channels may alter lake ice thicknesses within a few hundred metres of the excavated inlets. Signage indicating potential areas of thin ice will be displayed at the LMOC and LSMOC inlet areas in accordance with Transport Canada requirements.

2.2.4 Ice Conditions at Channel Outlets

Winter operation of the outlet channels will alter local flow patterns at the channel outlets in Lake St. Martin and Lake Winnipeg. Similar to the inlets, higher water velocities during channel operation will result in open water areas and/or thinner lake ice covers near the outlets. 2D hydraulic modeling will help identify the areas of influence of channel operation on lake flow patterns and highlight potential areas of thinner ice cover.

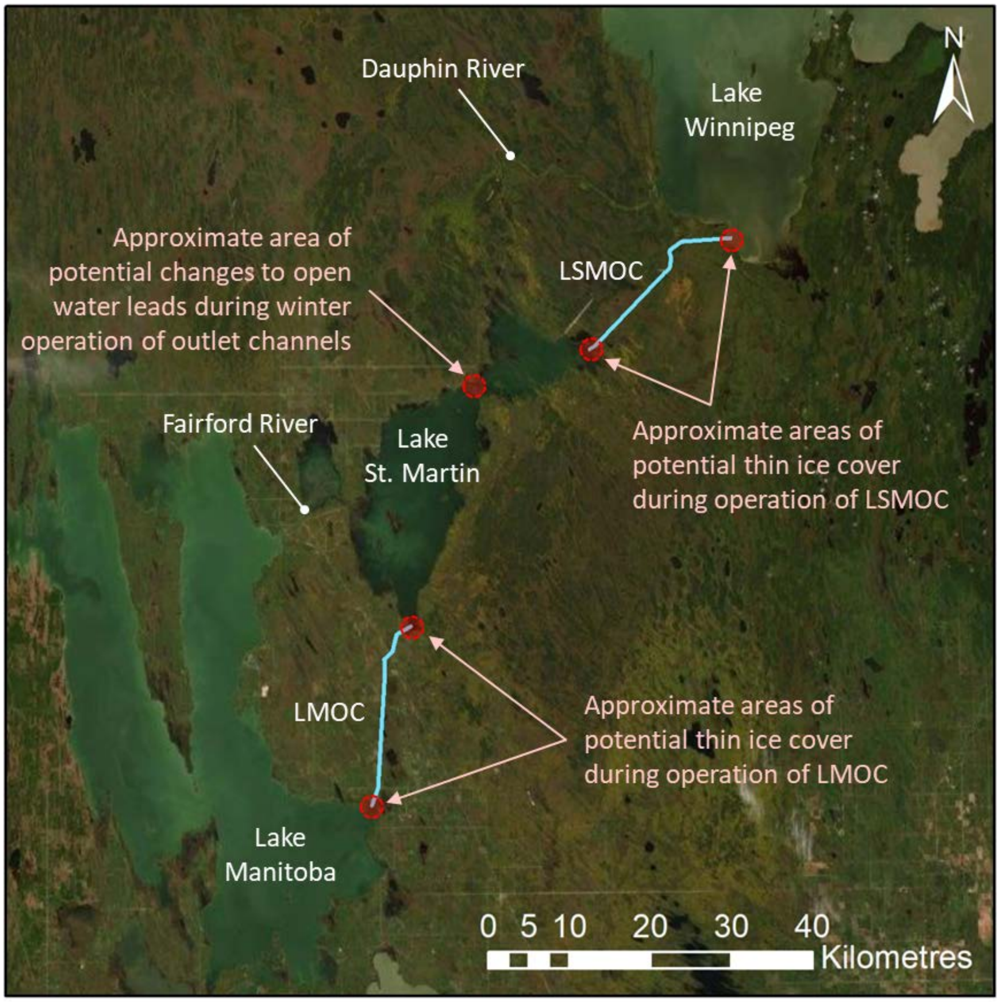
As described in Section 2.2.1, when winter operation is required, the LMOC WCS will be operated to promote the development of a stable ice cover over its full length, which will limit the volume of frazil ice produced and transported into Lake St. Martin. The channel immediately downstream of the WCS will remain open for a short distance due to local high velocities and turbulence leaving the WCS. The remainder of the downstream channel is expected to develop a stable ice cover that will transition to a lake ice cover near the channel outlet in Lake St. Martin. The lake ice cover in the vicinity of the outlet will be thinner due to the local changes to water velocities resulting from operation of the LMOC.

When operated at higher flows, the LSMOC may not form a stable ice cover over its entire length (some reaches between drop structures may have a stable ice cover while others may not). Frazil ice will continue to be produced in the open water areas, and the ice will be transported downstream to Lake Winnipeg. The entrained frazil slush and ice pans will deposit under the thermal lake ice cover on Lake Winnipeg, creating a hanging dam. This type of ice formation occurs naturally each year at the outlet of the Dauphin River to Lake Winnipeg. As the hanging dam grows, the water level in the outlet and in the channel immediately upstream will rise. Water levels upstream of the final drop structure will not be directly affected by the hanging dam. Monitoring of ice processes in the LSMOC during winter operation will therefore also include observations of the hanging dam formation at the outlet. In the event that the hanging dam conditions become severe and the channel dikes are at risk of overtopping, flow in the LSMOC may be reduced to form a stable ice cover in the LSMOC and cut off the supply of ice to the hanging dam. The flow would not be reduced below the riparian flow required to maintain adequate DO concentrations for aquatic organisms (as discussed in Section 2.2.2). If a hanging dam does not form, the lake ice cover in the vicinity of the outlet will be thinner due to the local changes to water velocities resulting from operation of the LSMOC.

Signage indicating potential areas of thin ice will be displayed at the LMOC and LSMOC outlet areas in accordance with Transport Canada requirements. Figure 2 shows the approximate extents of the areas of thinner lake ice covers resulting from outlet channel operation. Figure 2 also indicates an area in the Lake St.

Martin narrows that could experience changes in freeze-up patterns (discussed later in Section 3.2). These areas will be refined with 2D modeling of the lakes.

Figure 2: Locations of Potential Thin Lake Ice



3.0 ICE MANAGEMENT IN PROJECT-AFFECTED FLOW SYSTEM

Outflows from Lake Manitoba and Lake St. Martin are currently conveyed solely by the Fairford River and Dauphin River, respectively. Operation of the outlet channels will alter the flow regimes of these rivers; assessments are ongoing to quantify the project impacts on the flow system, including winter ice processes. Descriptions of the existing river ice conditions and anticipated effects of the project are provided in the following sections.

3.1 Existing River Ice Processes

3.1.1 Fairford River

The Fairford River runs from the northeast edge of Lake Manitoba, through Lake Pineimuta, to Lake St. Martin. The primary flow path is approximately 17 km long, but the river branches into multiple smaller reaches in the delta region through Lake Pineimuta. The Fairford River Water Control Structure (FRWCS) regulates outflow from Lake Manitoba. The outflows from the FRWCS are normally limited in magnitude in the winter to promote the formation of a stable ice cover in the Fairford River and reduce the severity of frazil ice formation in the Dauphin River downstream. Under these conditions of low flow, ice formations on the river both upstream and downstream of the FRWCS do not substantially influence the outflow capacity from the lake.

The majority of Lake Pineimuta typically freezes over with a thermally grown ice cover early in the winter. The two channels of the Fairford River take longer to develop an ice cover and may remain open through the majority of the winter in some years. Border ice may bridge across the river at certain locations, initiating ice covers at various points along the river. An ice front also progresses upstream from the thermal ice cover on Lake St. Martin. Throughout the winter, the ice coverage can change quite drastically as the various ice covers advance and retreat in response to flow conditions and air temperatures. The area upstream of the FRWCS in Lake Manitoba takes longer to freeze over due to the higher water velocities, and often does not completely freeze over throughout the entire winter.

3.1.2 Dauphin River

The Dauphin River is approximately 52 km long, running from the north basin of Lake St. Martin to Lake Winnipeg. Flow in the Dauphin River is not directly regulated, but is influenced by operation of the FRWCS.

The ice processes in the Dauphin River are notably different in the upper, low gradient reach compared to the lower, high gradient reach. During winter, water flowing out of Lake St. Martin and into the Dauphin River cools and forms frazil ice. The shallow depth of Lake St. Martin reduces the residual heat capacity of the lake water, allowing ice to begin to form in the river within a few hundred metres of the lake. The frazil ice volume increases in the downstream direction, and the frazil slush forms competent ice pans which are transported downstream with the flow. Border ice forms in the lower velocity regions near the banks and in the side channels of the upper reach.

Approximately 11 km from Lake Winnipeg, the river gradient increases abruptly. The fast-moving water in this reach limits the extent of border ice growth and frazil pans are transported downstream with the flow to Lake Winnipeg. A thermal ice cover grows in Lake Winnipeg early in the winter. Incoming frazil pans and slush can be swept under the lake ice cover or may juxtapose against the lake ice cover depending on the hydraulic conditions at the outlet. Typically, during higher flows, the frazil pans are swept under the lake ice cover and are transported further into the lake where they are eventually deposited. This forms a hanging dam, and causes the upstream water levels to gradually increase. Eventually, the staging of water allows incoming frazil pans to juxtapose against the lake ice cover, and the leading edge of the cover begins to progress upstream.

Due to the high gradient of the lower reach, the ice cover typically experiences several consolidation events as it advances upstream; this refers to the collapse and mechanical thickening of the ice cover in response to the external forces of gravity and water shear which grow as the cover lengthens. The thickness and roughness of the consolidated cover can raise water levels by several metres (as much as 3-5 m in some areas).

When the ice front progresses to the upper reach, it generally advances much faster via juxtaposition and surface packing of the ice pans. Some mechanical thickening of the cover in the upstream reach can occur, but not nearly to the same extent as in the lower reach. Provincial Road 513 has been flooded in the past due to ice-affected staging in the upper reach. If the flow is sufficiently low, border ice may completely bridge across sections of the upper reach early in the winter, which cuts off the ice supply to downstream and also insulates the water flowing in the river. Consequently, the ice cover in the lower reach takes longer to form.

Once an ice cover forms, open water leads typically develop as the flowing water erodes the ice along preferential flow paths. As air temperatures rise in the spring, additional open water leads form and grow in size as the ice cover decays and melts.

3.2 Potential Project Effects

As documented in Section 6.4.7 of the EIS, changes to regional flow patterns in the post-Project environment were quantified using a water balance model. The general effect of the Project is a reduction in the frequency of high winter flows on the Fairford and Dauphin Rivers. The Project has a negligible effect on the frequency of low flow events.

The Lake St. Martin narrows typically does not freeze over completely in the winter in the existing environment; open water leads remain in the constriction where water velocities are highest. Winter operation of the outlet channels would increase flow through the system and could cause some increase in the size of the open water leads that remain through the Lake St. Martin narrows over the winter (see Figure 2).

In general, the magnitude of the potential changes to ice processes in regional waterways is predicted to be low to negligible. Therefore, no special ice management practices are anticipated to be required outside of the LMOC and LSMOC. During winter operation of the outlet channels, ice conditions in the connected flow system will be monitored, particularly at key locations that are identified by stakeholder communities in the public consultation process (e.g. at the mouth of the Dauphin River where the community constructs an ice road each winter). As noted in Section 2.2, operation of the outlet channels could be communicated to nearby communities via press releases, forecasts and reports by the Hydrologic Forecasting Center, and or real time operation/monitoring data on MI's website.

4.0 ADAPTIVE MANAGEMENT AND MONITORING

4.1 General

A follow up process is a form of adaptive management to improve practices by learning about their effects and then making changes in those practices as new information is available. The federal Impact Assessment Act defines a follow up program as “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) indicated that “a follow-up program is used to:

- verify predictions of environmental effects identified in the environmental assessment
- determine the effectiveness of mitigation measures in order to modify or implement new measures where required
- support the implementation of adaptive management measures to address previously unanticipated adverse environmental effects
- provide information on environmental effects and mitigation that can be used to improve and/or support future environmental assessments including cumulative environmental effects assessments, and
- support environmental management systems used to manage the environmental effects of projects.”

In summary, operation of the LMOC and LSMOC in the winter will be performed in a manner to reduce the severity of ice formations in the outlet channels. Warning signage indicating potential areas of thin lake ice will be displayed at the channel inlets and outlets in accordance with Transport Canada requirements. Conditions in the channels will be monitored during winter operation, which may include water levels, ice processes, ice thicknesses, and water temperature. Monitoring techniques may include deployment of water level and temperature sensors, conducting reconnaissance surveys, or use of time-lapse cameras. Although operation of the outlet channels is not anticipated to have any negative impacts on ice processes in the Project-affected flow system, ice monitoring may also be conducted at key locations identified by stakeholders during winter operation of the LSMOC and LMOC.

4.2 Follow up Response

In the event of adverse ice conditions in the channels or connected flow system, mitigation measures may include operational adjustments (e.g. flow reductions) in the outlet channels, or deployment of equipment such as long-reach excavators to help clear ice jams. The latter is not expected to be a regular occurrence as operational measures are intended to prevent the formation of ice jams in the outlet channels and connected waterways. Adaptive management options to be considered, if required, include additional operational guidelines for the outlet channels and consideration of additional ice management works such as ice booms.