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Abbreviations and Acronyms

EIS	environmental impact statement
LMOC	Lake Manitoba outlet channel
LSMOC	Lake St. Martin outlet channel
VC	valued component

QUESTION IAAC-59

EIS Guideline Reference: 7.6.1. Effects of potential accidents or malfunctions; 7.6.2 Effects of the environment on the project

EIS Reference: 14 Accidents and Malfunctions; 14.2 Outlet Channel Breach/Control Structure Failure; 15 Effect of the Environment on the Project; 15.5 Effect of Long-Term Climate Change on the Project

Context and Rationale

The EIS Guidelines require the proponent to analyze the risks of accidents and malfunctions, their effects, and preliminary emergency response measures, and state that the EIS must take into account how local conditions and natural hazards could adversely affect the project and how this in turn could result in effects to the environment.

The EIS indicates that if a breach were to occur, effects to VCs would be similar to during a flood event in the absence of the project. It also indicates that if damage to Project infrastructure occurs at the same time as a flood event, the potential residual effects of a channel breach would extend beyond the PDA, depending on the location of the breach, and lessen the effectiveness of the Project acting as a flood mitigation measure. The EIS does not describe Project effects to the environment from such a scenario, other than to say the effects on the environment would likely be less than those expected without the Project.

Given that the project involves large infrastructure and will channel and move water within the landscape, further information is needed to understand effects that might not otherwise occur during a flood due to interactions between the project and flood waters.

Information Requests

a) In the case of a channel breach or infrastructure failure, discuss any effects to the environment that could occur due to the interaction of the project, the event and environment, e.g., interaction of infrastructure and flooding, location of effects due to project routing of water.

Response IAAC-59

a) The purpose of the Lake Manitoba and Lake St. Martin Outlet Channel Project (the Project) is to develop permanent flood mitigation for Lake Manitoba and Lake St. Martin to alleviate flooding effects around those lakes. As stated in the environmental impact statement (EIS) Volume 1, Section 1.1, the intended outcome "...is to reduce or completely avoid overland inundation during high water events such as the 2011 flood". Flooding has long been a major naturally caused historical influence on the environment in the region. That history and its outcomes are described in the existing conditions sections for each valued component (VC) (Volumes 2-4, Sections 6-10). The effects of the Project on these VCs are also discussed in each of those VC sections.

Question IAAC-59

Adverse effects that might occur for a channel breach or infrastructure failure are summarized in Volume 5, Chapter 14, Section 14.2.3. Prevention of such incidents is discussed in Volume 5, Section 14.2.2; incident response and mitigation is discussed in Volume 5, Section 14.2.4 and in the response to IAAC-62. The likelihood of uncontrolled channel breaches or infrastructure failure is low, based on Manitoba Infrastructure's several decades of experience in the construction and operation of such structures across the province, which includes following industry standard good practices for accident prevention and implementation of mitigation measures.

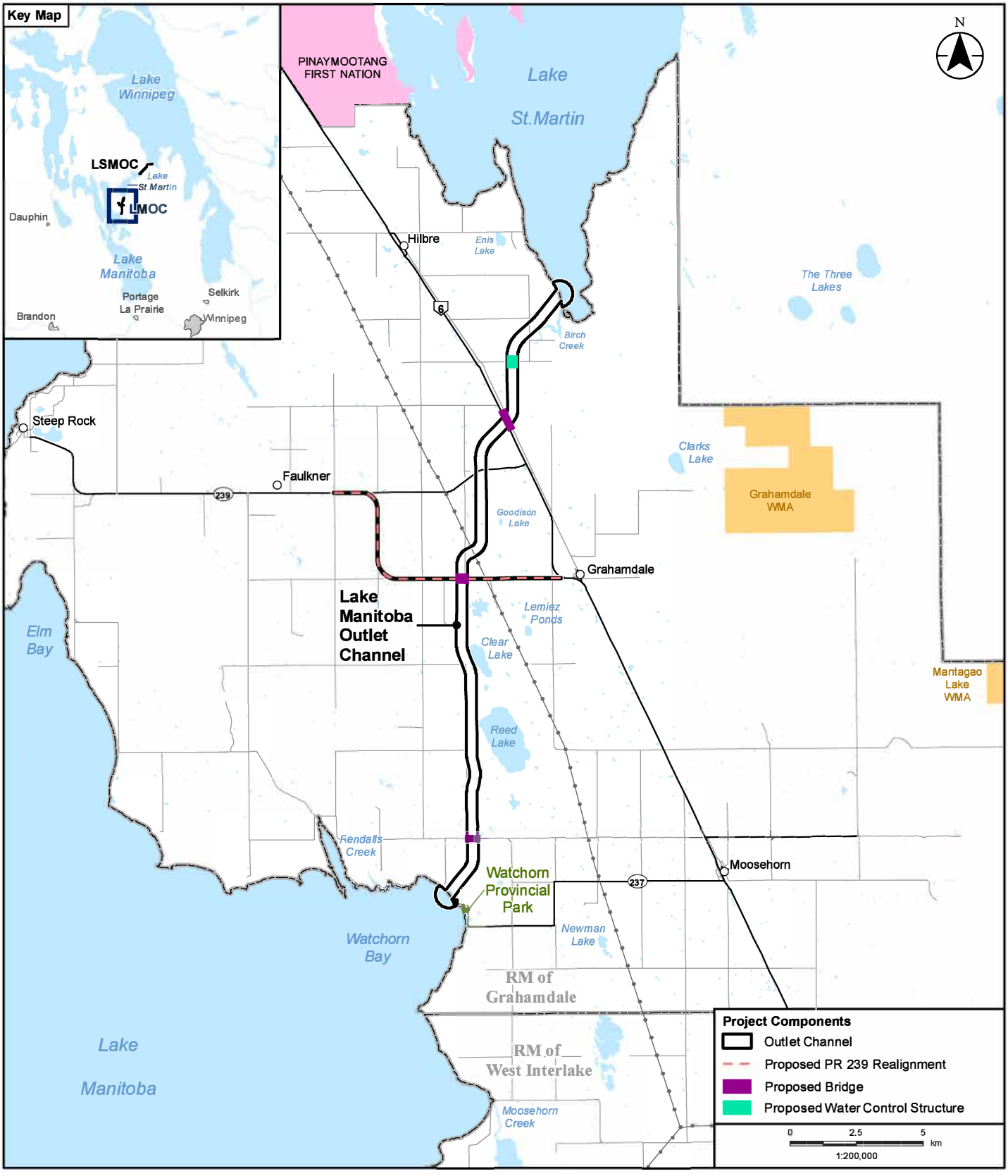
Accidents and malfunctions of Project infrastructure are considered during Project design which meet Canadian Dam Safety Guidelines (Canadian Dam Association 2007). These guidelines present principles on dam safety management; operation, maintenance and surveillance; emergency preparedness (including emergency response); dam safety review; and analysis and assessment (including safety risk analysis).

A breach could potentially occur if the dikes protecting the channel are broken through and water escapes the channel. Overtopping occurs when the volume of water in the channel exceeds its capacity and water flows into the surrounding area. Failure of infrastructure could include a water control structure failure or a drop structure failure. A water control structure failure would limit control of the volume of water moved. A drop structure failure could result in increased flow velocities over sharper topographic drops and create additional erosion/scour within the channel.

Appendices IAAC-59-1 and IAAC-59-2 describe potential design failures for the Lake Manitoba Outlet Channel (LMOC) (Figure IAAC-59-1) and the Lake St. Martin Outlet Channel (LSMOC) (Figure IAAC-59-2).

References

Canadian Dam Association. 2007. Dam Safety Guidelines.



Legend

- Existing Transmission Line
- Provincial Highway (PTH/PR)
- Municipal Road
- First Nation
- Wildlife Management Area
- Provincial Park
- Rural Municipality

Manitoba

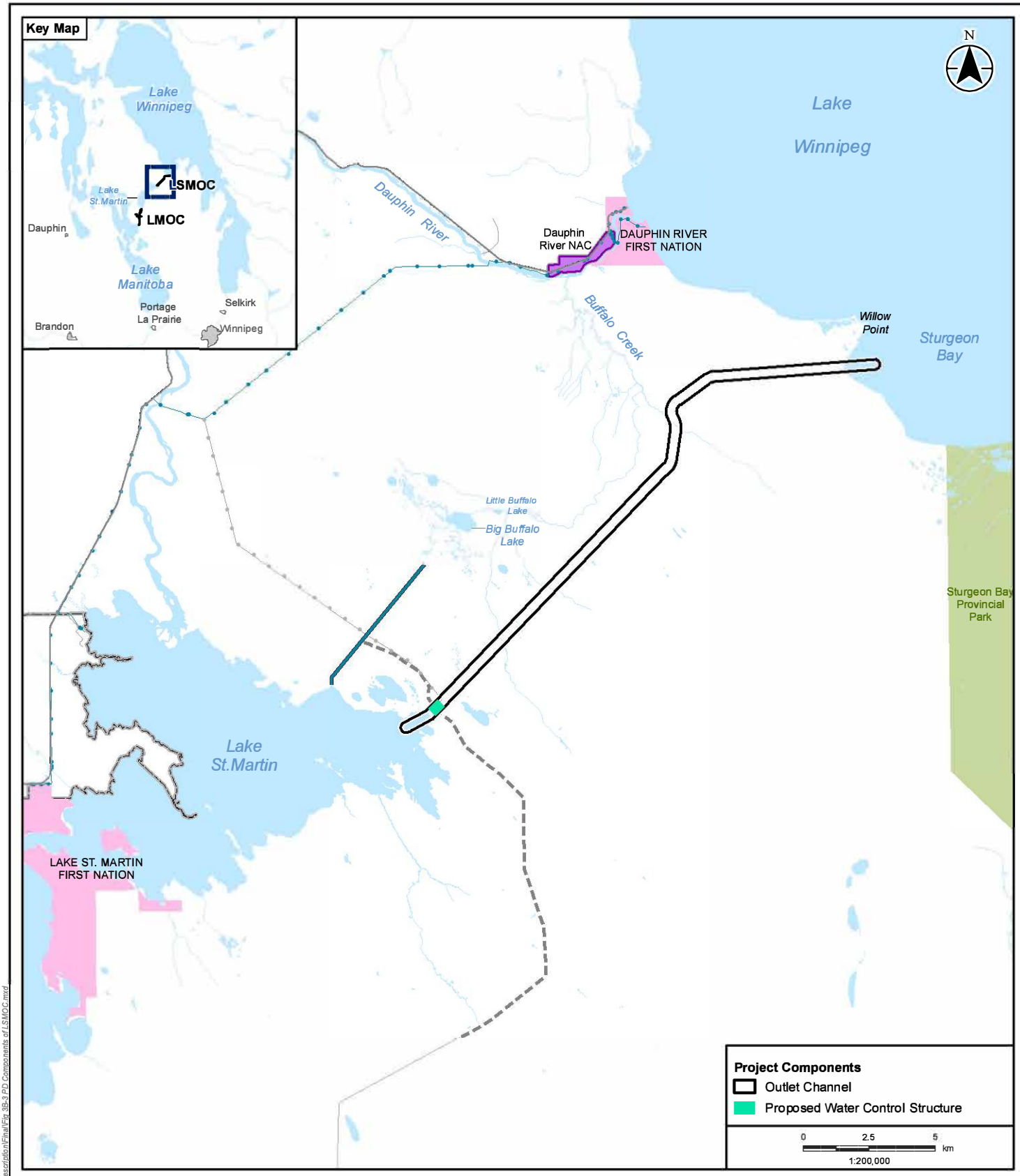
MANITOBA INFRASTRUCTURE
Lake Manitoba & Lake St.Martin Outlet Channels Project
Environmental Impact Statement

Components of LMOC

Figure IAAC-59-1

Notes
1. Coordinate System: WGS 1984 UTM Zone 14N
2. Data Sources: Governments of Manitoba and Canada, Manitoba Infrastructure
3. Last Update: 8/13/2019 9:06:11 AM

G:\ GIS_Proj\ _Folder\1114751206\arcmap\Ch3 Project Description\Final\Fig 3B-2 PD Components of LMOC.mxd



Legend

- Lake St.Martin Emergency Outlet Channel (Reach 1)
- Lake St.Martin Access Road
- Existing Distribution Line
- Planned Distribution Line
- Provincial Highway (PTH/PR)
- Municipal Road
- Rural Municipality
- Northern Affairs Community (NAC)
- First Nation
- Provincial Park

Manitoba

MANITOBA INFRASTRUCTURE
Lake Manitoba & Lake St.Martin Outlet Channels Project
Environmental Impact Statement

Components of LSMOC

Notes

1. Coordinate System: WGS 1984 UTM Zone 14N
2. Data Sources: Governments of Manitoba and Canada, Manitoba Infrastructure
3. Last Update: 8/13/2019 9:09:56 AM

Figure IAAC-59-2

G:\ GIS_Project_Folder\11147512\06\figures\Ch3_Project_Description\Final\Fig 3B-3 PD Components of LSMOC.mxd

Appendix IAAC-59-1 MEMORANDUM: PRELIMINARY SUMMARY OF CONSEQUENCES ASSOCIATED WITH FAILURE OF VARIOUS COMPONENTS OF THE LAKE MANITOBA OUTLET CHANNEL, DRAFT, HATCH

Project Memo

H358519

June 12, 2020

To: Jaime Smith (Manitoba Infrastructure)

From: Andrew Baryla, P.Eng

cc: Scott Johnstone (Manitoba Infrastructure)
Jared Baldwin, P.Eng. (Manitoba Infrastructure)

Manitoba Infrastructure
Lake Manitoba Outlet Channel

Preliminary Summary of Consequences Associated with Failure of Various Components of the Lake Manitoba Outlet Channel

1. Introduction

The intent of this document is to provide a brief preliminary summary of anticipated consequences associated with failure of various components of the Lake Manitoba Outlet Channel (LMOC) during operation. It is based on work currently in progress that has not been finalized.

2. Existing Conditions

During an extreme flood without the LMOC in place, water will naturally inundate low-lying inland areas near the periphery of both Lake Manitoba and Lake St. Martin. The amount of inundation and its extents will be dependent on the levels to which these lakes ultimately rise. In particular (unless measures are taken to intervene), once the level of Lake Manitoba reaches an elevation of approximately 248.75 m to 248.9 m (816.1 to 816.6 ft), it is anticipated that lake water will have naturally flooded the wetland areas located just to the east of the proposed LMOC sufficiently to establish a hydraulic connection between Lake Manitoba and Lake St. Martin. This connection would result in an additional flow conveyance route between the two lakes.

While the potential for overland flooding will not be eliminated with the construction of the LMOC, the frequency of its occurrence with be reduced due to the ability of the Channel to increase outflows from Lake Manitoba and thus reduce peak water levels experienced on that lake.

3. Post-Project Conditions

The design of the LMOC is such that the channel is excavated below existing grade with depths varying between approximately 6 m and 12 m. It includes the excavation of an Inlet and Outlet to connect the Channel proper to Lake Manitoba and Lake St. Martin, respectively, as well as the construction of a gated concrete water control structure, and three separate

road bridges to provide access across the Channel. The LMOC will result in the channelization and movement of water within an area of the landscape where none exists at present.

Along portions of the Channel route, the existing ground elevation is such that some low height dikes will need to be constructed to contain the water within the Channel under non-operating conditions, as well as during extreme flood events when the level of Lake Manitoba is greater than 248.11 m (814 ft) and the Channel is passing flows greater than the 212 m^3/s (7,500 cfs) design conveyance capacity. A minimum elevation of 249.05 m has been selected for these dikes upstream of the Water Control Structure. In addition, almost continuous spoil berms (i.e., excavated material placement areas) will be constructed with nominal equipment compaction parallel to the Channel within the available Right-of-Way (ROW). These spoil berms will vary in height but will be at least 3 m above the minimum dike level. There will be a few short gaps in these spoil berms at the location of the road crossings, the Manitoba Hydro transmission line ROW, and outside drain overflow locations on the west side of the Channel. The elevation at these gaps will be either the minimum dike elevation (249.05 m) or the existing prairie level, whichever is greater.

Below is a brief summary of anticipated consequences associated with failure of various components of the LMOC.

3.1 Failure of Water Control Structure

Sudden failure of the Water Control Structure (WCS) during operation would cause the Channel to flow in an uncontrolled manner. However, it is important to note that maximum flows in the LMOC are governed by the size of the Channel, rather than the size of the WCS. Accordingly, even if the WCS were to be fully lost, the maximum flow released will be limited and governed by the Channel hydraulics and the prevailing water levels on Lake Manitoba and Lake St. Martin. The increased flows may result in some erosion within the Channel.

In the event that the Water Control Structure gates malfunction and are unable to be opened, then the water level in the Channel upstream and downstream of the Water Control Structure will remain equal to the level of Lake Manitoba and Lake St. Martin, respectively. Overtopping of the Channel banks/dikes would not be a concern under this condition as significant freeboard will be available. However, any flood mitigation benefits provide by the Channel on Lake Manitoba would be negated and conditions would revert to those that would be experienced without the LMOC in place, until such time as the gates can be opened.

3.2 Breach of Channel Dikes

Some Channel diking is required along the LMOC to meet Canadian Dam Association (CDA) Dam Safety Guidelines. Breach of the Channel dikes would result in the loss of water to the surrounding landscape and could occur either due to piping (i.e., internal erosion) through the dikes or overtopping of the dikes during extreme high water events.

3.2.1 Piping Failure

Failure of a portion of the dikes by piping could lead to water exiting the Channel and inundating a portion of the surrounding lands. The magnitude of the resulting inundation would be dependent on the location where the breach occurs and the water level on Lake Manitoba.

- Dikes potentially susceptible to piping during normal non-operating conditions are limited to a location on the east side of the Channel between PTH 6 and Iverson Road. A breach in this location would result in the inundation of land on the east side of the Channel as the released water makes its way into Birch Creek, and from there into Lake St. Martin.
- Portions of the east and west dikes located closer to the Inlet are potentially susceptible to piping during Channel operation under extreme flood conditions. However, the consequences of a breach on the east or west side would be limited as the released water will effectively be returned to Lake Manitoba as the surrounding landscape would already be naturally flooded by high Lake Manitoba levels.

3.2.2 Dike Overtopping Failure – Extreme Floods

Overtopping of the dikes upstream of the Water Control Structure could occur during extreme flood events. However, because the minimum elevation of these dikes are to be set to 249.05 m, it is expected that the low-lying receiving areas located to the east of the Channel would already be naturally flooded by high Lake Manitoba water levels and already conveying water into Lake St. Martin prior to any dike overtopping occurring. As a result, negligible incremental flooding damages are anticipated to be associated with overtopping of these Channel dikes. On the west side, the higher natural ground topography should contain water that may leave the Channel to the area alongside the LMOC.

Once the level of Lake Manitoba reaches elevation 249.05 m (817.1 ft) – estimated by MI to be approximately a 1:850 year flood post-construction – water from the inland areas adjacent to the Channel that are naturally inundated by high Lake Manitoba water levels would begin to spill over the dikes and back into the Channel at the various gaps in the spoil berms, starting with the ones at Township Line Road. This will further increase the flow in the Channel, causing the Channel water level downstream of each of mobilized gap to rise. More flow will be admitted into the Channel should Lake Manitoba rise even further. Once the level of Lake Manitoba reaches an elevation of approximately 249.3 m (817.9 ft), it is anticipated that Channel water levels will have risen to an elevation that begins to submerge the underside of the Township Line Road bridge girders, and possibly the road leading to it, at which point the bridge may need to be closed for safety reasons. Passage of flows associated with such extreme floods may result in erosion within the Channel.

Downstream of the Water Control Structure the flows will be contained within the existing topography, with only a very short section of dike required where the Channel is close to the mouth of Birch Creek. However, the presence of continuous spoil berms should preclude overtopping in this area.

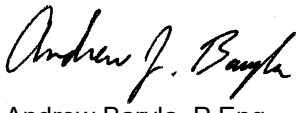
3.3 Inlet/Outlet Failure

It is anticipated that a failure at the Inlet would not result in any detrimental flood inundation effects, but could potentially (although highly unlikely) limit the amount of discharge that can be conveyed into the Channel. In this case, the flood mitigation benefits provide by the Channel on Lake Manitoba could be partially negated and conditions would revert towards those that would be experienced without the LMOC in place.

A failure at the Outlet would result in only local effects, as the water is already at its endpoint in Lake St. Martin.

3.4 Bridge Failure

It anticipated that a failure of one of the bridges would not result in any detrimental flood inundation effects, but could potentially limit the amount of discharge that can be conveyed by the Channel. In this case, the flood mitigation benefits provide by the Channel on Lake Manitoba would be partially negated and conditions would revert towards those that would be experienced without the LMOC in place.



Andrew Baryla, P.Eng.

AJB:ajb

Appendix IAAC-59-2 MEMORANDUM, LSMOC BREACH SCENARIOS – DRAFT, KGS GROUP

Memorandum

To:	Dave MacMillan, P.Eng.	**Date:**	June 12, 2020
		Project No.:	18-0300-005
From:	Lucas Wazney, E.I.T.	**Cc:**	Colin Siepman, P.Eng.
Re:	LSMOC Breach Scenarios - Draft		

Background

The Lake St. Martin Outlet Channel (LSMOC) connects Lake St. Martin to Lake Winnipeg and provides an additional outlet to mitigate flooding on Lake St. Martin. Without the LSMOC in place, in the event of an extreme flood, water would naturally spill over the northeast edge of Lake St. Martin and flow through the Big Buffalo Lake bog complex, through Buffalo Creek, and into the Dauphin River. This overland flooding would be eliminated by the LSMOC, which provides a channelized path for water to flow from Lake St. Martin to Lake Winnipeg.

When the water level in Lake St. Martin reaches flood stage and the LSMOC Water Control Structure (WCS) gates are opened, water is conveyed through the channel to Lake Winnipeg. The design discharge of the LSMOC is 326 m^3/s. Water flowing within the LSMOC is contained by dikes that run along both sides of the channel. The access road that runs along the northeast edge of Lake St. Martin prevents water from spilling overland, exterior to the LSMOC.

To define the Dam Classification of the LSMOC and select the Inflow Design Flood (IDF), the incremental consequences of various failure scenarios were considered (described below). The incremental consequences refer to damages caused by the breach over and above what would occur without the breach, but with the project in place. As a result of this analysis, the IDF was selected as the flood corresponding to 1/3 between the 1:1,000 year flood event and the Probable Maximum Flood (PMF). This roughly corresponds to a flood with a return period of 6,500 years.

Potential Breach Scenarios

Failure of WCS Gates and Pier

The sudden failure of the WCS gates and pier during non-operation of the channel would cause a sudden increase in discharge through the LSMOC. The flow through the channel in this event may exceed the design discharge (estimated to reach approximately 400 m^3/s), but would not result in overtopping of the channel dikes or failure of the drop structures. Thus, all flow out of Lake St. Martin would be contained within the

channel and discharged directly to Lake Winnipeg. The increased flows may result in some limited erosion within the channel.

Breach of Access Road

In the event of an extreme flood, if the water level in Lake St. Martin exceeds the elevation of the access road, an overtopping breach could occur. This would cause water to spill overland, exterior to the LSMOC.

If the breach were to occur on the northwest side of the WCS, water would flow through the Big Buffalo Lake bog and into Buffalo Creek, eventually discharging into the Dauphin River. If the breach were to occur on the southeast side of the WCS, water would flow in the northeast direction toward Lake Winnipeg. Due to the natural ground topography (which slopes to the northwest), the flow would be contained alongside the alignment of the LSMOC.

Consequences associated with this breach scenario include temporary inundation of land, potential damages to fish and wildlife habitat, and erosion of sediment along the overland flow paths. Potential breach outflows are anticipated to be of the same order of magnitude as flows experienced during operation of Reach 1 of the Lake St. Martin Emergency Outlet Channel in 2011/12. However, the duration of flow release would be much shorter and as such, damages are expected to be less than what was experienced during operation of Reach 1. In the case of a summer flood breach on the west of the WCS, the additional flow to Dauphin River (from Buffalo Creek) would not cause any inundation of buildings in the community of Dauphin River.

The minimum design elevation of the access road in the vicinity of the WCS is 246.5 m. Based on a frequency analysis of peak Lake St. Martin water levels in the south basin, it is estimated that at the 1:100,000 year lake level (used as an approximator of the PMF), the water level in the north basin would still leave over 1 m of freeboard on the access road.

Failure of Channel Dikes

A breach of the channel dikes downstream of the WCS would cause water to spill overland, exterior to the LSMOC.

A breach on the east side of the channel would result in water flowing overland to Lake Winnipeg. Due to the natural ground topography, the flow would be relatively contained in the area alongside the alignment of the LSMOC. A breach on the west side of the channel occurring within 16 km from Lake St. Martin would cause water to flow overland, into the Buffalo Creek bog, and into the Dauphin River. Breaches occurring downstream of this location (i.e. further than 16 km from Lake St. Martin), would cause water to flow overland to Lake Winnipeg without entering Buffalo Creek.

In the case of a piping failure of the channel dike during normal channel operation, the maximum outflows are on the same order of magnitude as what was released during operation of Reach 1 in 2011/12. Consequences would include inundated land, damages to fish and wildlife habitat, and erosion. The ability to operate the WCS to cut off flow into the channel would limit the damages of the breach and allow repair of the dike. It is expected that restoration of lost or damaged habitat would be highly possible.

Overtopping breaches of the channel dikes will be prevented by designing the dikes to maintain adequate freeboard during passage of the IDF, and if required, by operating the WCS to restrict flow into the channel at more extreme flood events. As such, the water level in the channel would not overtop the dikes to cause a breach.

The flow through the LSMOC in the winter will be limited to promote the formation of a stable ice cover. Ice conditions in the channel will be monitored during winter operation to assess freeboard on the channel dikes. In the case of unforeseen severe ice conditions, the heated WCS gates could be operated to reduce flow into the channel and eliminate the possibility of a winter overtopping breach.

Failures at the Inlet and Outlet

Water released from a failure at the inlet would still be contained by the access road. Thus, this would not result in any flow exterior to the LSMOC (unless the access road subsequently breached). A failure at the outlet would result in only limited local effects, as the water is already at its endpoint in Lake Winnipeg.

Drop Structure Failure

The drop structures are designed to prevent substantial movement of the rockfill during passage of the IDF. As mentioned above, in the event of extreme floods that exceed the IDF, the WCS gates will be operated such that the maximum flow allowed to enter the LSMOC is the IDF flow. Because of this, failure of the drop structures is unlikely to occur.

In the unlikely event of a failure of one of the drop structures, the surge of water sent downstream could cause temporary overtopping of the channel dikes (the increase in flow would be temporary as the volume of water that was previously contained by the drop structure is released downstream).

The loss of hydraulic control at the drop structure would result in higher velocities and shear stresses in the section of the LSMOC where the drop structure had failed, resulting in increased potential for erosion.

Prepared By:

Lucas Wazney, EIT
Water Resources Engineering-in-Training

Approved By:

Dave MacMillan, P.Eng.
Project Manager / Principal

LEW/as

cc: Colin Siepman, P.Eng.

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