LAKE MANITOBA
LAKE ST. MARTIN

OUTLET CHANNELS PROJECT

MANITOBA TRANSPORTATION AND INFRASTRUCTURE

Sediment Management 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 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, 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 Sediment Management Plan (SMP) 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 Project 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 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 rights-holders and stakeholders on its structure and purpose.

Manitoba Transportation and Infrastructure remains committed to consultation and ongoing engagement with 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, *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.

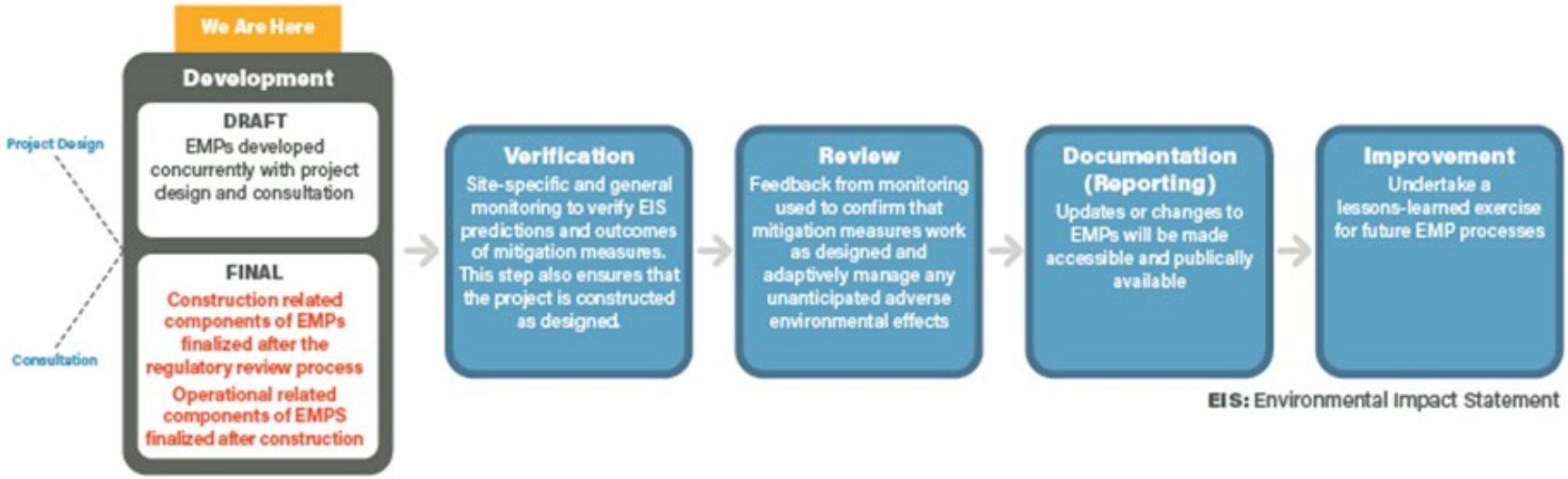


Figure A: EMP Process

LIST OF ACRONYMS AND GLOSSARY OF TERMS

Acronyms

AEMP	Aquatic Effects Monitoring Plan
CCME	Canadian Council of Ministers of the Environment
CEMP	Construction Environmental Management Program
DFO	Department of Fisheries and Oceans Canada
EIS	Environmental Impact Statement
EMP	Environmental Management Program
ft	feet
LAA	Local Assessment Area
LMOC	Lake Manitoba Outlet Channel
LSMOC	Lake St. Martin Outlet Channel
m	metre
mg/L	milligrams per litre
MWQSOG	Manitoba Water Quality Standards, Objectives and Guidelines
OEMP	Operation Environmental Management Program
O&M	Operations and Maintenance
PER	Project Environmental Requirements
PR	Provincial Road
PTH	Provincial Trunk Highway
the Project	Lake Manitoba and Lake St. Martin Permanent Outlet Channels Project
RM	Rural Municipality
ROW	right-of-way
RVMP	Revegetation Management Plan
SMP	Sediment Management Plan
SWMP	Surface Water Management Plan
TSS	Total Suspended Solids
WCS	Water Control Structure

Glossary of Terms

Aquatic life: Organisms temporarily or permanently living or found in water.

Aquatic vegetation: Submerged, floating-leaved and floating plants that only grow on or beneath the water surface. Submerged plants may be rooted in soils or free-floating.

Aquifer: A body of rock or sediment that is sufficiently porous and permeable to store, transmit, and yield significant or economic quantities of groundwater to wells and springs.

Aquitard: A confining bed and/or formation composed of rock or sediment that retards but does not prevent the flow of water to or from an adjacent aquifer. It does not readily yield water to wells or springs, but stores groundwater.

Artesian: A body of rock or sediment containing groundwater that is under greater than hydrostatic pressure: that is a confined aquifer. When an artesian aquifer is penetrated by a well, the water level will rise above the top of the aquifer; a flowing artesian well is when the water level will rise above ground surface.

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

Bedrock: The solid rock that lies beneath the soil and other loose material on the Earth's surface.

Cofferdam: An enclosure, usually only partially obstructing a river, from which water is pumped to expose the bottom to permit construction.

Confined aquifer: An aquifer that is bounded above and below by formations of distinctly lower permeability than that of the aquifer itself. An aquifer containing confined ground water. See artesian.

Contract Administrator: refers to the individuals, entities or groups delegated by Manitoba Transportation and Infrastructure to provide professional Engineering and Consulting Services for the Permanent Outlet Channels Project. This includes oversight of construction and maintenance contracts and operations; review of Contractor submittals, plans and proposals for compliance with Project commitments and restrictions and making recommendation for acceptance or rejection of such plans by the Owner; and monitoring, inspecting, documenting and enforcing compliance with contractual and regulatory requirements.

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.

Depressurization: Action of decreasing hydrostatic pressure. Active depressurization involves the use of pumps. Passive depressurization does not involve the use of pump, but rather uses a relation between hydrostatic pressure elevation and topographic elevation.

Dewatering: Removal or draining groundwater or surface water from a riverbed, construction site, caisson, or mine shaft, by pumping or evaporation.

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

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.

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

Hydraulic profile: The graphical representation of the water level through the channel based on the water level of the receiving water, control points, and the head loss.

Inspector: refers to the individuals or designated representatives delegated by Manitoba Transportation and Infrastructure to monitor, inspect, document, and enforce compliance with contractual and regulatory requirements associated with the construction and/or maintenance activities and associated works for the Project.

Invert (channel): The stream bed or floor within a structure or channel.

Piezometric pressure: A measurement at a discrete location expressing the potentiometric surface which is an imaginary surface representing the pressure of groundwater in an aquifer that is defined by the level to which water will rise in a well.

Rights-holders: include First Nations, Metis Communities and other Indigenous communities who hold Aboriginal or Treaty rights that are protected under Section 35 of *The Constitution Act* 1982. Commonly, these include hunting, trapping, fishing or gathering rights.

Riprap: A lightweight stone covering used to protect soil or surface bedrock from erosion by water or the elements.

Runoff: Surface water that flows overland and into streams, wetlands or waterbodies, or into drainage systems.

Suspended sediment: Particulate matter that is held in the water column due to movement of the water.

The Owner: refers to Manitoba Transportation and Infrastructure or a designated representative delegated by Manitoba Transportation and Infrastructure with overall responsibility for, and oversight of, Project design, construction and operation.

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.

Waterbody: Standing and flowing surface waters (such as a creeks, rivers, lakes, and wetlands with open water), including seasonally and ephemerally occurring surface waters.

Part 1: Introduction

1.0 PURPOSE AND SCOPE

The Sediment Management Plan (SMP) is a component of the overall Environmental Management Program (EMP) for the Lake Manitoba and Lake St. Martin Permanent Outlet Channel Project (the Project). The Project will involve the construction and operation of the Lake Manitoba Outlet Channel (LMOC), the Lake St. Martin Outlet Channel (LSMOC) and associated components such as bridges, control structures with power connections, a new realignment of Provincial Road (PR) 239, and other ancillary infrastructure, as described in the EMP Framework. The construction methodology for the LMOC and LSMOC is described in the Construction Environmental Management Program (CEMP). The purpose of the SMP is to describe measures to minimize or mitigate impacts of erosion and sedimentation in or near water from construction and operation activities of the Lake Manitoba Outlet Channel (LMOC) and the Lake St. Martin Outlet Channel (LSMOC).

The SMP supports the requirements described in Sections 2.3 and 2.5 of the Project Environmental Requirements (PERs) regarding Erosion and Sediment Control and Working Near Water, respectively. Section 2.3 defines erosion and sediment control measures as including the long-term, temporary, or emergency stabilization of any and all soil types to prevent undesirable soil movement or soil releases and discharges to a waterbody, as well as efforts to minimize substrate disturbance and sediment uplift or suspension during in-water work. Section 2.5 defines work near water as any and all activities occurring within the ordinary high-water mark of a waterbody, and that apply to work in or near fish-bearing and non-fish bearing waterbodies, dewatering, temporary diversions, temporary crossings and access pads, stream crossings (bridges and culverts), blasting near a waterbody, debris and sedimentation removal, and water quality monitoring.

In consideration of the PERs, measures described in the SMP include temporary construction management practices, as well as permanent mitigation measures built into the channel design, to minimize the potential for erosion and to minimize and mitigate the transport and deposition of sediment beyond construction areas or into off-site receiving water bodies. The SMP is closely coordinated with the Surface Water Management Plan (SWMP), which describes the monitoring requirements that support the implementation of SMP measures.

The SMP is intended to be a living document that will be refined over the life of the Project and will be updated as detailed design advances and various aspects are implemented, incorporating lessons learned and applicable engagement feedback provided via regulators, stakeholders and/or rights-holders. In particular, additional information will be added to the SMP during detailed design that will include general arrangement layout drawings for the PDA and the locations where the sediment management measures will be implemented.

Different sediment management strategies are required for the LMOC and the LSMOC as these distinct components of the Project are located in substantially different environmental settings with different hydraulic profiles. The LMOC, for example, is located in a well-developed agricultural area with less available area for vegetated buffers and other more naturalized mitigation measures, whereas the LSMOC is located in an undeveloped wetland and forested area. Furthermore, the strategies for handling local surface water drainage during construction differ between the two channels, as their specific designs impact on how surface water can be managed, which in turn impact the sediment management practices planned. Given these overarching site-specific differences, the SMP is organized into three parts:

- Part 1 contains general information that is common to both the LMOC and LSMOC.
- Part 2 contains information that is specific to the LMOC.
- Part 3 contains information that is specific to the LSMOC.

A number of other environmental management and monitoring plans are being developed for the Project that interrelate with sediment management, including an Aquatic Effects Monitoring Plan (AEMP), a SWMP and a Revegetation Management Plan (RVMP).

Monitoring to confirm effectiveness of sediment management measures and the identification of when adaptive management may be required is summarized in this document, with the details presented in the AEMP and SWMP. Regional and operational monitoring is included in the AEMP.

2.0 OBJECTIVES

The SMP has been developed to address the following objectives:

- Define guidelines and procedures for construction to minimize the potential for erosion and sedimentation.
- Identify erosion and sediment control measures to minimize adverse, sediment related, effects to receiving waterbodies.
- Identify emergency response practices to mitigate extreme design conditions, respond to unforeseen events and accidents, and minimize potential environmental impacts.

3.0 MANAGEMENT CRITERIA

3.1 General Considerations

Erosion and sedimentation are natural processes that occur during precipitation events and in waterbodies, particularly during spring or flood events. However, Project-related erosion and sedimentation that could increase conditions beyond these natural events must be managed. The erosion and sediment control measures described in this plan and other related plans are designed to mitigate the potential environmental effects during construction and operation activities for the proposed LMOC and LSMOC. Erosion and sediment control measures will be developed in consideration of these guidelines, environmental needs, and Project cost. The range of baseline total suspended solids (TSS) concentrations in potential receiving waters will also be considered. Sediment transport to downstream receiving bodies is viewed as detrimental to the potential habitats in the receiving bodies. Suspended sediment can cover fish spawning, feeding and rearing areas, as well as transport other pollutants into the receiving environment, and therefore must be mitigated.

A number of physical and hydrologic (weather) related items are considered in the development of erosion and sediment control measures, including:

- The range of potential rainstorm events that could occur during construction of the LMOC and LSMOC.
- The background sediment concentrations in downstream receiving bodies.
- The rate at which revegetation will occur due to various weather influences occurring during construction.
- The potential for erosion relative to the time of year in which construction will take place.
- The potential for runoff into the construction sites and the control of water during construction.
- The integration of the temporary and permanent vegetation.
- Issues related to site dewatering and acceptable dewatering practices.
- The use of temporary diversion ditches and treatments.
- The responsibility expectations for construction site management.
- The regular inspection criteria and frequency of these inspections.

3.2 Water Quality Criteria

The SWMP describes the surface water quality parameters that will be monitored, and the thresholds upon which decisions to implement or modify mitigation measures will be made, including those described in the SMP. The SWMP should therefore be used in conjunction with the SMP to effectively manage erosion and sedimentation issues.

Water quality management controls during Project construction will be designed by the Contractor, following guidance from the SWMP, in accordance with contract requirements and as approved by Manitoba Transportation and Infrastructure, to allow discharge into waterbodies using various methods of containment, treatment and discharge. The actions will be guided by a combination of the results of visual

inspections and testing, where appropriate as determined by the Inspector, and meeting appropriate Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG) objectives and Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life in waterbodies. In addition to observable changes in potential erosion sources and surface water quality issues (e.g., exposed soil areas, sediment plumes), these guidelines form the basis of the adaptive management and follow-up measures described in Section 7.0 and 12.0, as well as the relevant adaptive management sections of the other EMPs.

3.3 Design Criteria

The storm event to be used for the design of sediment control measures during construction will be selected with consideration of the final design of temporary surface water management features, as discussed in the SWMP. This will be completed at detailed design once the duration and size of contracts are finalized. A storm event will be selected to manage and mitigate environmental risks that is commensurate with overall Project costs. For the operation phase, the LMOC and LSMOC and associated outside drains are being designed according to criteria adopted for the Project to minimize the potential for bed erosion, including the channel armouring designs to address uncertainties.

Part 2: Lake Manitoba Outlet Channel

4.0 CONSTRUCTION PHASE (TEMPORARY MEASURES)

The following general construction management practices are key components of the temporary erosion and sediment control measures for the LMOC.

- Coordinating construction staging and sequencing to maximize excavation in each work area while minimizing the time of exposure for newly excavated slopes. This will be accomplished by restricting excavation to within manageable units.
- Implementation of erosion and sediment control measures such as silt fences, slope roughening techniques, slope terracing, runoff management, and straw mulching. These will be specified on construction drawings and will be implemented in accordance with Project Environmental Requirements (PERs) for Erosion and Sediment Control and Working Within or Near Water.
- Maintaining a natural vegetated buffer zone on the east side of the right of way (ROW), where possible, to reduce erosion and sediment transport between the construction site and existing receiving water bodies and streams.
- Revegetating exposed areas directly after finished grade is established. Planting will, if practicable, commence immediately upon completion of a section of LMOC to maximize the potential for growth and establishment of a vegetative cover. The revegetation is considered to be part of the permanent erosion and sediment control measures discussed in Section 5.0.
- Minimizing disturbance to adjacent vegetated areas to accommodate buffering of suspended sediment.

It should be noted that channel design features such as armouring and shallow side slopes will help minimize the erosion and sediment generated during construction.

The sections that follow provide further detail on erosion and sediment control measures that will be completed at detailed design once the duration and size of contracts are finalized and applied during the construction of the various components of the LMOC. As identified in Section 6.0, monitoring will be undertaken to assess the effectiveness of proposed erosion and sedimentation control measures. A preliminary monitoring and response protocol related to LMOC in-lake construction is provided in Appendix 2A.

4.1 Main Channel Excavation

The temporary erosion and sediment control measures for excavation of the main channel are based on accepted construction industry practice to minimize erosion and sediment transport to receiving water bodies. These measures are broken down into perimeter measures, intermediate measures, and potential adaptive management and contingency measures, as defined below:

- Perimeter erosion and sediment control measures are implemented at the onset of each construction contract to enclose the designated construction area.
- Intermediate erosion and sediment control measures are the measures implemented within each construction area.
- Adaptive management measures are the erosion and sediment control measures that would be implemented in the event that one or more of the intermediate measures do not to achieve the desired performance. These are described in Section 7.2.
- Contingency measures would be implemented in the event of an emergency condition that would overwhelm the "base" erosion and sediment control measures, for example, due to a storm event that exceeds the selected design event. These are described in Section 7.3.

Specifications and drawings for LMOC construction will be prepared during detailed design and customized for each individual contract as required. Section 4.1.1 describes the base measures that will be implemented as a minimum for the LMOC.

4.1.1 Intermediate Controls

Intermediate controls will be developed as the channel excavation proceeds with a full set of controls in-place upon completion of excavation and before revegetation begins. As the excavation progresses downward to the final grade, slope roughening techniques on exposed side slopes will be implemented.

Re-establishing the vegetation cover in the LMOC is fundamental to minimizing the erosion potential during both the construction and operation phases of the LMOC. Within the planting season, and after final grade is established within a reasonably sized work area of a channel segment, the grade will be prepared and revegetated according to the appropriate revegetation prescription(s) as outlined in the RVMP. A component of the main revegetation prescription includes a cover species that will establish quickly to protect the bare soil from erosion as the remainder of the species germinates.

If stockpiles are to be left in place for more than one growing season, temporary topsoil stockpiles will be contoured and seeded during construction to reduce erosion and control weed establishment. If sandy soils are encountered during excavation to the degree and extent which sandy soils are the dominant soil texture in a soil stockpile in a given area, due to higher risk of wind erosion losses in these exposed soils, the surfaces of temporary stockpiles should be contoured and seeded, and stabilized using straw mulch treatments (mechanically anchored/crimped or treated with tackifier) or topical spray on mulches, as soon as practically feasible.

Additional intermediate controls will also be considered in the completed excavation area, or in locations with a higher risk of erosion (e.g., if sandy soils are encountered) and will be developed during detailed design based on an assessment of potential sediment that could be generated and the final construction contracting strategy. These intermediate controls may include:

- Slope interrupters constructed at regular intervals (10 m) cross-slope on the channel and spoil embankment slopes. These can be effectively constructed with a grader or dozer with an adjustable blade to create a deep furrow into the side slope. Slope interrupters are not intended to trap or filter sediment, but they will serve to minimize further slope erosion protecting against deep rills or gullies by interrupting flow of runoff down the slope.
- Straw mulch treatment outside of the channel after the surface has been seeded with vegetation. The straw mulch would be anchored/crimped into the surface of the soil. The straw mulch helps protect the slope against erosion, but also provides an enhanced environment to promote quick growth of the grass seed. Other environmentally friendly types of topical spray on mulches may also be considered, where appropriate.

The temporary erosion and sediment control measures discussed above will be left in place until the permanent vegetation is re-established. Other erosion and sediment control methods will be considered as alternatives for use as adaptive management and/or contingency measures if the base approach measures do not perform as expected. Further discussion of these adaptive management and contingency measures is provided in Section 7.0.

4.2 Other Project Components

Temporary erosion and sediment control measures will be required for the other Project components that are part of the LMOC, which include:

- Outside Drain
- Water Control Structure and Bridges
- Inlet and Outlet works

An overview description of the temporary erosion and sediment control measures for each component listed above is provided in the following subsections. Monitoring of the Project area will be conducted to assess the effectiveness of proposed erosion and sedimentation control measures as outlined in Section 6.0. Adaptive management and/or contingency and emergency response measures for these components will include similar measures described in Section 7.0.

4.2.1 Outside Drain

As part of the site preparation Project works, an outside drain will be constructed on the west side of the LMOC to collect surface water runoff. The design discharge for the outside drain will be based on the 1 in 10-year runoff event from the contributing area west of the channel alignment, which is in line with current provincial drainage standards typically applied in rural settings. To reduce the potential for erosion in this

drain, maximum average velocities will be kept below 1.0 m/s during the design event. Permeable in-stream geosynthetic sediment barriers (check dams) may be placed, as required, to control the flow velocity and help to intercept and settle out any sediment that is mobilized.

Should a runoff event or series of runoff events that is greater than the design condition be experienced prior to the re-establishment of permanent vegetation, then contingency and emergency response measures will be implemented to mitigate the risk of excess erosion as described in Section 7.3.

A vegetated buffer will be maintained between the outside drain and the channel excavation spoil pile, where practical. Silt fences will be used where vegetated buffer zones cannot be maintained effectively. Combined, these measures are expected to substantially reduce the potential for sediment transport along the drain.

Flows intercepted by the outside drain will be discharged into Lake Manitoba and Lake St. Martin.

4.2.2 Water Control Structure and Bridges

Construction work areas for the bridges and water control structures (WCS) will be isolated from channel construction activities to prevent surface water runoff from entering and to reduce the amount of groundwater depressurization pumping required.

Surface water within these work areas that must be discharged offsite will be monitored and controlled, as required, to comply with the water quality criteria outlined in Section 3.2. It is likely that the Contractor will manage surface runoff within excavation areas by directing it to low areas of the excavation to allow sediment to settle prior to being pumped to offsite receiving areas. Pump discharge points will be lined with clean rock or other acceptable flow dissipating applications, as required, to prevent erosion and the release of suspended sediments. Settling ponds will be constructed adjacent to the work areas, as deemed necessary, prior to discharge into the outside drain and/or the waterbodies east of the LMOC, or at alternate locations that may be approved by Manitoba Transportation and Infrastructure during construction. Additional discussion on surface water management is provided in the SWMP.

4.2.3 Inlet and Outlet Works

The inlet works will consist of excavating the lake bottom within an approximately 140 m long by 215 m wide area of Lake Manitoba (Watchorn Bay). This excavation is expected to take place in the wet with the construction area isolated by a double turbidity curtain (i.e., two separate turbidity curtains) to prevent or minimize the migration of disturbed sediments into the lake during construction. Turbidity monitoring will be used to confirm the effectiveness of the measures and allow for adaptive management to be implemented if required. A preliminary monitoring and response protocol related to this is provided in Appendix 2A. A fish salvage program will be required within the isolated area which will be developed and conducted in accordance with the PERs. Methods are described in the AEMP.

Installation and removal of the double turbidity curtain, as well as the excavation work itself, will comply with the Department of Fisheries and Oceans Canada (DFO) Restricted Activity Timing Windows (DFO, 2013), and will be completed in accordance with the conditions outlined in the DFO authorization. Removal of the

curtain would occur once monitored water quality parameters on both sides of the curtain are similar and meet the criteria outlined in Section 3.2.

Specific methods of construction within the area will be determined by the Contractor, in accordance with contract requirements and as approved by Manitoba Transportation and Infrastructure. Alternate construction methods may be proposed, such as isolating the area with a cofferdam that would be constructed behind a turbidity curtain. The outlet works will consist of excavating the lake bottom within an approximately 140 m long by 115 m wide area of Lake St. Martin (Birch Bay). Construction activities and measures to manage surface water during construction will be similar to the inlet works and will comply with regulatory conditions.

4.3 Commissioning

The till base and lower sides slopes of the LMOC will be covered with an armour layer comprised of small stones to guard against its potential erosion by hydraulic forces when the channel is in operation. The armouring will be crushed limestone rock, which will be overlain on geotextile that will isolate the channel from the underlying till substrates. On the channel base and lower side slopes, the median stone size will be 35 to 40 mm diameter and the overall gradation will range in size from 25 to 100 mm. The thickness of the armouring in these areas will be 225 mm thick. On portions of the side slopes that could interact with the ice cover in the channel, the same rock sizes will be used but the thickness will be increased to 400 mm. While the size of the stones that comprise the armour layer will be designed to resist the hydraulic forces, it is also expected that some fine material will remain both on the surface and within the armour layer at the end of construction, which is anticipated to be mobilized and transported out of the LMOC when it is first operated during commissioning. Other sources of fine material may also be mobilized during commission (i.e., loose material remaining within the channel from earth plug removal, erosion of fine sands in the vicinity of the outlet, resuspended sediment near the inlet, etc.). Mobilization and transport of these materials is expected to result in a short-term temporary increase in the concentration of suspended sediment at the outlet in Birch Bay.

To limit the potential increase in suspended sediment concentrations, a controlled gate opening procedure and response protocol is being developed and will be implemented which will be informed with TSS monitoring data that will be collected during the commissioning operation from real-time turbidity loggers to be installed in Watchorn Bay and Birch Bay. Commissioning will be planned to be undertaken between July 1 and September 14, so as to comply with the DFO Restricted Activity Timing Windows (DFO, 2013). A preliminary monitoring and response protocol for this aspect of the work is provided in Appendix 2A, which will be further developed and finalized prior to commissioning taking place.

The mitigation and response measures used during commissioning, along with any adjustments made and lessons learned, will be reviewed and used to inform an updated procedure that can be followed during the initiation of future operation events, should it be found to be required.

5.0 OPERATION PHASE (PERMANENT MEASURES)

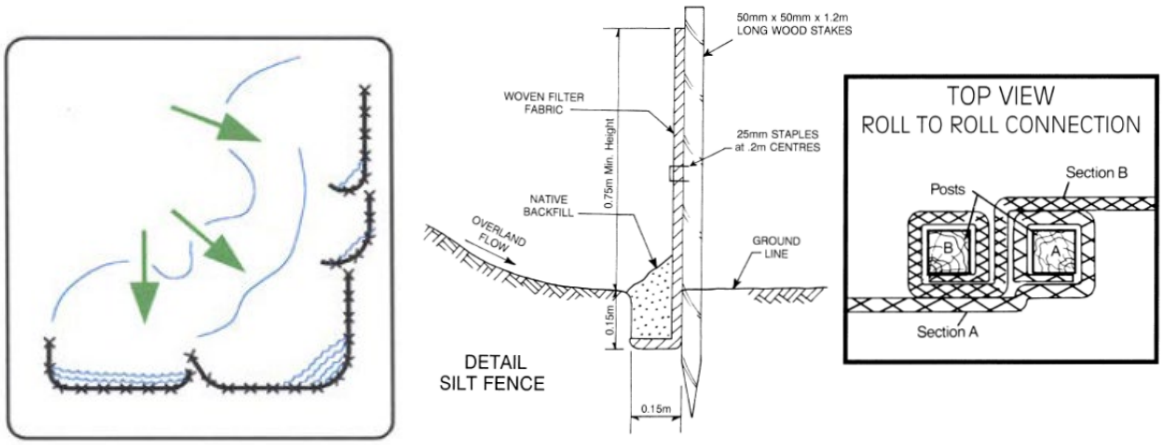
The permanent erosion and sediment control measures are those that are implemented for long-term, post construction erosion control. Permanent erosion and sediment control will consist primarily of the establishment of a permanent vegetative cover, as described in the RVMP, as well as armouring of the base and lower side slopes of the channel with stone. The channel inlet and outlet, WCS and bridges will have additional methods of permanent erosion protection as described in Section 5.2.

The temporary erosion and sediment control measures described in Section 4.0 will be maintained post construction until vegetation has fully established. As discussed in Section 6.0, monitoring will be undertaken over a 2 year post-commissioning period to confirm the effectiveness of the permanent erosion and sedimentation control measures and to identify if any supplementary measures are required as part of adaptive management. Some temporary measures may need to be re-implemented post construction following an extended operation period with the WCS gates open, or other conditions, that may result in the permanent vegetation not providing effective permanent erosion and sediment protection.

5.1 Perimeter Controls

The best method for establishing and maintaining a perimeter around exposed areas, such as staging areas and material stockpiles, is with a vegetated buffer zone. However, as vegetated buffer zones will be limited for the LMOC, it is likely that silt fencing will also be installed along the full length of the LMOC, in areas of active construction and until adequate vegetation cover becomes established. Location and placement of the silt fences will be selected to prevent additional erosion due to undercutting or end-cutting of the fence. Installation of the silt fences would adhere to typical industry specifications, with a typical detail as shown on Figure 1.

Silt fences will be of particular importance to control sediment movement in areas where staged excavation and spoil placement takes place prior to final grades being established, which are required to allow revegetation to proceed. For example, as discussed in Section 3.1.2 of the CEMP, excavation of the upper portion of the channel within a channel segment could be performed in the winter months (when no depressurization pumping is required to address the risk of basal heave), with the remaining lower portion excavation then completed in the summer months so as to limit the duration of depressurization pumping required and avoid the complications of having to pump and manage water in sub-freezing temperatures.



Note: Details may vary.

Figure 1: Typical Silt Fencing Detail

In addition to silt fences, surface water from within the construction area that must be discharged offsite will be monitored and controlled, as required, to comply with the water quality criteria outlined in Section 3.2. details are provided in the SWMP. It is likely that the Contractor will manage surface runoff within excavation areas by directing it to low areas of the excavation to allow sediment to settle prior to being pumped to offsite receiving areas. Pump discharge points will be lined with clean rock or other acceptable flow dissipating applications, as required, to prevent erosion and the release of suspended sediments. If required, any water that must be pumped outside of the work area will be discharged into dense vegetation or settling ponds. Settling ponds will be constructed adjacent to work areas, as deemed necessary, prior to discharge into the outside drain and/or the waterbodies east of the LMOC, or at alternate locations that may be approved by Manitoba Transportation and Infrastructure during construction.

Turbidity curtains will be used to prevent or minimize the migration of disturbed sediments during removal of earth plugs that separate one channel excavation segment from another, if flooding of those segments is required.

5.2 Constructed Channel

The LMOC is being designed to minimize the potential for bed erosion during operation at the design discharge. It is designed to pass, at a minimum, the flows that would occur during the passage of the 1:300 year flood event through the Lake Manitoba/Lake St. Martin system, without exceeding the erosion thresholds. This event reflects a repeat of the 2011 Flood of Record. As indicated, the portion of the channel bed permanently under water will be covered with a stone armour layer. Remaining disturbed areas throughout the entire length of the LMOC will be revegetated, except for roads and structures.

Establishing and maintaining a vegetation cover is a key component to minimizing the long-term erosion potential. The revegetation will be designed to provide a competent initial cover that will establish quickly to protect the bare soil from erosion as the remainder of the permanent non-invasive perennial vegetation cover establishes, as described in the RVMP. It is based on the following:

- A seed mix consisting of permanent perennial native species and a quicker growing cover crop species (cereal crop) suited for the growing conditions.
- Seeding would occur in the spring months for optimal growth. Seeding would continue in the summer months with an adjusted seed mix to improve seed propagation. Seeding would not occur in the late summer/early fall as it would not likely yield enough growth to provide soil protection during fall, winter and early spring.
- Seeding with a fall prescription mix would take place after frost conditions are established and before snow hinders placement to allow early germination in the spring.
- Re-seeding would be required to compensate for the lack of vegetation cover success, if necessary.

Where possible, the Contractor's construction activities will be staged to keep the amount of un-vegetated surfaces during the excavation process to a manageable size.

The mode of operation of the LMOC is such that some revegetated portions of the channel side slopes will experience alternating periods of submergence (wet) and exposure (dry). This could lead to zones where vegetation may not survive or grow well, thus making these portions of the slopes potentially susceptible to erosion. Where submergence for extended periods of time causes substantial die off of planted vegetation, it is reasonable to expect that residual root systems that have been established will offer an interim temporary mode of erosion control while volunteer seedlings (or surviving plants) establish or recover and provide ground cover.

Plant species used in areas that will be inundated during channel operation will be selected based on their inherent capability to withstand flooding as well as seasonal drought. The channel and outside drain need erosion control in both dry and wet conditions using dry and wet condition tolerant plants and seed mixes with appropriate successional rates and processes. Measures such as monitoring and adjustment of seed mixes if required, as discussed in the RVMP, will be implemented to address the risk of poor vegetation growth on portions of the channel side slopes above the channel armouring in areas that will experience alternating periods of submergence and exposure as a result of long-term operation of the LMOC.

Over time, areas along the channel that are regularly flooded may favour the growth of annual weedy species and potentially the establishment of taller woody species including willow that may be able to access oxygen during periods of prolonged flooding. Routine inspection and maintenance of vegetation (mowing/cutting) will be undertaken so that the channel maintains hydraulic capacity in the long-term as discussed in the RVMP.

5.3 Other Project Components

The permanent erosion and sediment control measures required for the other Project components that are part of the LMOC will also generally consist of revegetation consistent with that identified in Section 5.1. If there are specific areas in which vegetation is not appropriate or adequate for permanent erosion and sediment protection, other measures such as the placement of riprap, turf reinforcement mats, etc. may be utilized. Specific areas in which vegetation will not provide the required level of protection, and therefore require other methods for permanent erosion and sediment control, include:

- Channel Base and Lower Side Slopes – The portion of the channel cross-section below the top of the normal operating range of Lake Manitoba and Lake St. Martin will be covered with an armour layer comprised of small stones to mitigate the potential risk of erosion by hydraulic forces when the channel is in operation.
- Gradient Control Structures – Gradient control structures may be necessary with the outside drain in areas where high erosive forces may be present to prevent erosion in the drain. The gradient control structures will be constructed of rockfill.
- Channel Inlet – Riprap protection will be provided along channel banks and shoreline near the channel inlet where the Project is vulnerable to wave action.
- Channel Outlet – Riprap protection will be provided along the channel banks and shoreline near the channel outlet where the Project is vulnerable to wave action.
- Outside Drain Inlets – Riprap protection will be provided at the locations where existing drainage ways will discharge into the outside drain to prevent erosion.
- Water Control Structure – The channel bottom and side slopes upstream and downstream of the WCS will have permanent riprap erosion protection installed to address the higher velocities that will be present. The WCS also includes a concrete stilling basin to dissipate energy downstream of the structure.
- Bridges – The channel bottom and side slopes in the vicinity of each bridge will have permanent riprap erosion protection installed to address the higher velocities that will be present.

6.0 MONITORING

6.1 Construction Phase

Surface water quality monitoring during construction of the LMOC is described in Section 6.2 of the SWMP. This monitoring will be undertaken to identify any changes that may result from construction activities and to assess the effectiveness of proposed erosion and sedimentation control measures. Sediment monitoring will include visual observations of signs of erosion and/or sedimentation during routine construction inspection activities (i.e., erosion of exposed slopes, presence of sediment plumes, etc.) and measurements made using sampling devices. If the water quality criteria identified in Section 3.2 are exceeded and attributed to the Project, or signs of erosion and/or sedimentation are observed, then additional mitigation measures would be considered as described in Section 7.0. A preliminary monitoring plan to identify potential sediment effects during in-lake excavation work is provided in Appendix 2A, which will be further developed and finalized during detailed design.

During the initial channel commissioning, a short-term temporary increase in suspended sediment concentration in the outlet area may occur due to the mobilization of several sources of material (i.e., fine material remaining within the armour layer, loose material remaining within the channel from earth plug removal, erosion of fine sands in Lake St. Martin downstream of the outlet, re-suspended sediment near the inlet, etc.). As discussed in Section 4.3, a controlled gate opening procedure and response protocol will be implemented to manage the potential increase in suspended sediment concentrations entering Birch Bay. Real-time turbidity monitoring in Watchorn Bay and Birch Bay will be conducted during this period which will be used to inform the gate opening procedure and make adjustments as needed. An overview of this monitoring plan is provided in Appendix 2A, which will be further developed and finalized prior to commissioning taking place.

6.2 Operation Phase

Surface water quality monitoring within the local waterways outside of the LMOC will initially be carried out during the first two years post-commissioning, as discussed in the SWMP, the intent of which is to confirm the effectiveness of construction mitigations and site restoration measures.

Longer-term regional water quality monitoring, which will include monitoring in the LMOC, will be conducted as part of an operational monitoring program that is discussed in the AEMP. In addition, visual observations of signs of erosion and/or sedimentation will also be undertaken as part of routine operation and maintenance inspection activities.

7.0 ADAPTIVE MANAGEMENT AND FOLLOW-UP

7.1 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 Canadian Environmental Assessment Act 2012* 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."

As discussed in Section 12.4.1.2 of the Project EIS, construction activities and the changes in flows and water levels caused by the Project may have minor effects on fluvial geomorphology, sediment and debris transport, in the surface water Local Assessment Area (LAA), but primarily during and immediately after construction. Suspended sediment levels may temporarily increase at work sites during construction activities, and at outlet areas during initial operation (gates open) of the outlet channels after a period of non-operation (gates closed). As such, the purpose and objectives of follow-up activities will be to monitor and further understand the residual effects due to the Project.

Although the methods and recommendations outlined in the SMP were developed based on site-specific expectations and conditions, it is accepted that these conditions are subject to change. For example, weather conditions and climate change will inevitably drive some of the design decisions during Project construction and long-term operation. Results from ongoing data collection and monitoring programs will inform and facilitate any necessary adjustments to this plan, to the extent feasible. By employing adaptive management strategies, assumptions used in the initial design will be evaluated and management practices modified in response to the outcomes during the Project construction period and subsequent operation phase based on baseline investigations, follow-up monitoring and reporting.

Adaptive management uses the Project designs while learning from field performance to manage risk and allow the incorporation of new knowledge into subsequent steps. The foundation of this process relies on data input and implementation of sound monitoring programs. Based on the monitoring results and feedback

during construction, temporary mitigation measures described in this SMP, as well as those included in the SWMP and RVMP, should be revisited and updated, as required. For example, if the establishment of vegetation following excavation work is more difficult than expected, alternate vegetating methods may be considered, or additional temporary erosion control measures may be warranted. Adaptive management will play an important role in acknowledging and working through management challenges in the presence of uncertainty.

7.2 Follow Up Response

As described in the SWMP, monitoring will include visual inspections and water quality monitoring. The data and analyses generated by monitoring will be used to provide information on the effectiveness of mitigation measures, aid in the validation of predicted residual effects, and provide data and results required for environmental regulatory approvals requirements. If conditions recorded appear to be exceeding criteria or management thresholds, relative to baseline conditions, then follow-up responses will be implemented as described in the sub-sections below, as well as those identified in the CEMP, PERs, SMP, RVMP and any other applicable plans under the EMP.

7.2.1 Construction

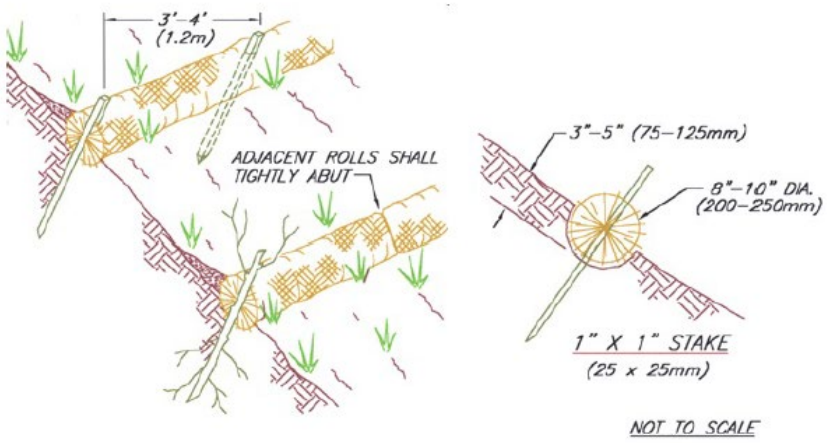
The requirements for erosion and sediment control are discussed in Section 2.3 of the PERs. As noted in Section 6.0 of this SMP, monitoring during construction will include visual inspections and water quality monitoring. Section 7.2 of the SWMP describes the protocols to identify sediment issues and trigger management responses.

In general, for any issue of potential non-compliance, an Environmental Monitor or Inspector will report the issue immediately so that Manitoba Transportation and Infrastructure or the Contract Administrator can direct the Contractor to stop work and/or implement mitigation activities if/as required. Management responses to address non-compliance related to erosion and sediment control could include (but not be limited to): temporary suspension of work activity; modifying the rate of water discharges and/or location; installing additional erosion and sediment control measures.

Some measures/activities that could be implemented in the context of erosion control and sediment management during construction include:

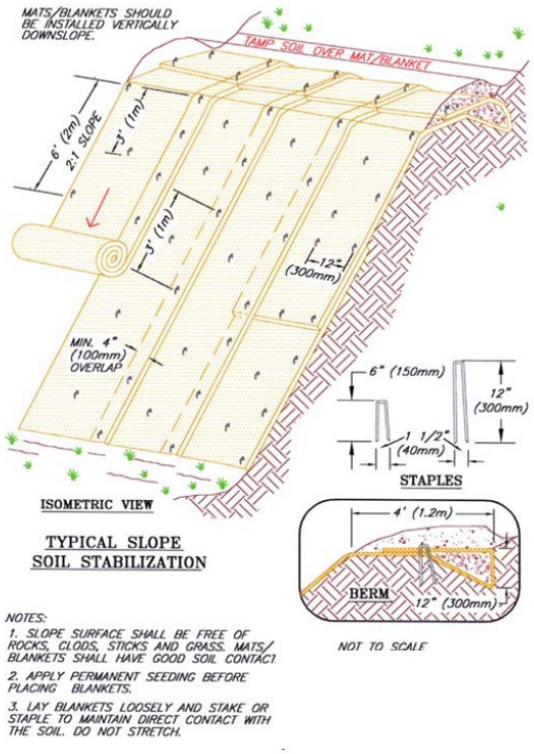
- Straw rolls/wattles could be considered as alternate measure or in addition to slope interrupters. Typical details are shown in Figure 2.
- Erosion control blankets could be used in critical areas where erosion potential is concentrated. Lining exposed areas with erosion control blankets was not considered for widespread application, as it would be very costly given the amount of area to cover. Typical details are shown in Figure 3.
- Spray mulches and bonded matrix could be substituted for straw mulch areas that require special treatment or where access for straw mulch is limited. Concerns associated with the high cost and poor success rates when the products are applied during periods of the year when temperatures are near or below freezing would need to be overcome.

- Turbidity curtains or filter systems could be installed in locations where there is water with flow velocities slow enough to facilitate effective filtration of suspended sediment.
- Rapid stabilization techniques that could include the placement of riprap and tackifiers (i.e., soil bonding agents).
- Dewatering techniques and/or pumping to decanting areas.
- Additional slope interrupters if the specified number does not meet requirements to control runoff.
- Additional sediment controls such as silt fencing or filter/check dams.
- Supplementary seeding or additional agronomic measures, such as irrigation, to promote the temporary and permanent re-vegetation on finished sections of the completed channel.
- Modification of the excavation schedule to adapt to weather conditions or limit overall exposed excavation areas.
- Implement dredging in accordance with the DFO Interim Code of Practice for Routine Maintenance Dredging (https://www.dfo-mpo.gc.ca/pnw-ppe/codes/dredge-drageur-eng.html) to remove material that may deposit in the inlet or outlet from natural shoreline morphology processes, or upstream of drop structures, to reduce sediment that could be mobilized at start of channel operation, in the unlikely event that it is needed .
- Monitoring and management measures to address potential sediment effects during in-lake excavation work are described in Appendix 2B of this SMP.



Note: Details may vary.

Figure 2: Typical Straw Roll Detail



Note: Details may vary.

Figure 3: Typical Erosion Control Blanket Details

7.2.2 Commissioning

As indicated previously, Appendix 2A, establishes monitoring and management measures to address potential sediment effects during commissioning of the LMOC. This will involve implementation of a real-time sediment monitoring plan to monitor the magnitude, spatial, and temporal changes in TSS during these activities. The plan is based on an upstream and downstream approach to capture effects in the initial mixing zone, as well as the effects downstream in the fully mixed area. Turbidity will be monitored in the field, and measurements will be converted to TSS levels for comparison against the criteria, as described in Appendix 2A, through deployment of *in situ* turbidity loggers at multiple transect locations.

During commissioning, a controlled gate opening procedure will be implemented to manage the potential increase in suspended sediment concentrations entering Birch Bay. Input from the monitoring network during this period will be used to inform the gate opening procedure, and to make adjustments as needed to manage the TSS levels.

7.2.3 Operation

Several of the erosion and sediment control measures identified in Section 7.2.1 of this SMP can be implemented during the operation phase, depending on the specific situation that must be addressed in the event that operation phase monitoring identifies issues of potential non-compliance.

The procedures to be followed to initially open the WCS at the start of future operating events will be a part of the Operation & Maintenance Manual. Short-term increases in suspended sediment concentration entering Birch Bay that exceed the water quality criteria identified in Section 3.2 are not anticipated. Monitoring will be carried out during the first two operations to confirm this prediction, as described in Section 6.2. Should such increases be found to occur, then a controlled gate opening procedure that is similar to the mitigation and response measures used during commissioning would be implemented to manage the suspended sediment concentrations, as required.

Dredging to remove material that may be deposited in the inlet or outlet from natural shoreline morphology processes could be undertaken to reduce sediment that could be mobilized at start of channel operation, in the unlikely event that any such deposits are found to be problematic. Any such dredging would be implemented in accordance with the DFO Interim Code of Practice for Routine Maintenance Dredging (https://www.dfo-mpo.gc.ca/pnw-ppe/codes/dredge-drageur-eng.html).

7.3 Contingency Measures and Emergency Response

Adaptive management and follow-up plans discussed above are implemented based on initial monitoring of the effectiveness of the "base" erosion and sediment control measures with adjustments made as needed. The "base" erosion and sediment control measures will be designed and maintained in good working order to manage conditions arising from the design event, as described in Section 3.3.

Contingency measures and emergency response plans will be developed for use in the event that the "base" erosion and sediment control measures are overwhelmed during a severe runoff event. Contingency planning will also be incorporated for unexpected events such as, but not limited to, an uncontrolled breach of a settling pond or failure of a turbidity curtain. Many of the contingency measures will be similar to those identified as part of follow up response in Section 7.2. These will be developed by the Contractor in accordance with Section 1.3 of the PERs and submitted to Manitoba Transportation and Infrastructure for approval prior to start of construction.

In the event of an emergency during construction, the Contractor, Manitoba Transportation and Infrastructure, and the Contract Administrator will determine which contingency and emergency control measures will be implemented. These measures would be carried out within a predetermined time period depending on the site conditions and nature of the emergency. It should be noted that in the event of an excessive precipitation event during construction, runoff would generally be contained to the area within the excavation.

During the operation phase, the channel will be resistant to large precipitation events through vegetation and armoring. Nevertheless, contingency and emergency control measures will be implemented by Manitoba Transportation and Infrastructure, depending on the site conditions and nature of the emergency, with consideration given to the Operations & Maintenance (O&M) manual that will be developed for the Project prior to the operation phase.

8.0 REFERENCES

Department of Fisheries and Oceans (DFO). December 27, 2013. Manitoba Activity Timing Windows for the Protection of Fish and Fish Habitat [online]. Available from https://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/mb-eng.html [accessed October 29, 2020].

Part 3: Lake St. Martin Outlet Channel

9.0 CONSTRUCTION PHASE (TEMPORARY MEASURES)

The following general construction management practices are key components of the temporary erosion and sediment control measures for the LSMOC.

- Construction staging and sequencing will be coordinated to maximize excavation in each work area, while minimizing the time of exposure for newly excavated slopes. This will be accomplished by restricting excavation to within manageable units.
- Implementation of erosion and sediment control measures such as silt fences, slope roughening techniques, slope terracing, runoff management, and straw mulching. These will be specified on construction drawings and will be implemented in accordance with PERs for Erosion and Sediment Control and Working Within or Near Water.
- A vegetated buffer zone will be maintained, where possible, to reduce erosion and sediment transport between the construction site and existing receiving waterbodies. Along the LSMOC, existing vegetation on either side of the ROW will act as a natural vegetated buffer zone between the construction site and existing receiving water bodies and streams, such as Lake St. Martin and Lake Winnipeg, or any tributary of Buffalo Creek.
- Exposed areas will be revegetated directly after the finished grade is established. Planting will, if practicable, commence immediately upon completion of a section of LSMOC to maximize the potential for growth and establishment of a vegetative cover. The revegetation is considered to be part of the permanent erosion and sediment control measures, discussed in Section 10.0.
- Disturbance to adjacent vegetated areas will be minimized to accommodate buffering of suspended sediment.

It should be noted that the channel design features, such as shallow side slopes, will help minimize the erosion and sediment generated during construction.

The sections which follow, provide further detail on erosion and sediment control measures that will be applied during the construction of the various components of the LSMOC. As discussed in Section 11.0, monitoring will be undertaken to assess the effectiveness of proposed erosion and sedimentation control measures. A preliminary monitoring and response protocol related to in-water construction is provided in Appendix 2B.

9.1 Main Channel Excavation

The temporary erosion and sediment control measures are based on accepted construction industry practice to minimize erosion and sediment transport to receiving water bodies. The temporary erosion and sediment control measures are broken down into perimeter measures, intermediate measures, and potential adaptive management and contingency measures. A definition of each of these terms is given below:

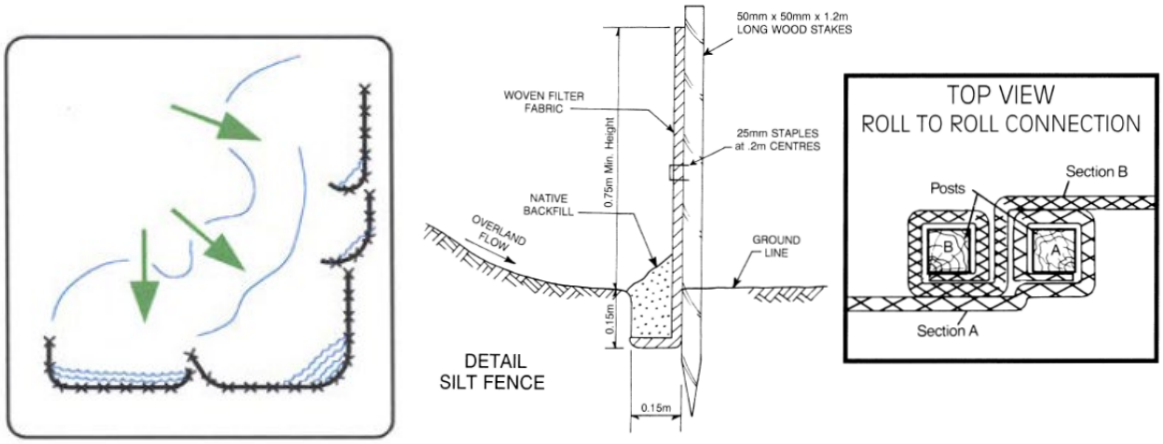
- Perimeter erosion and sediment control measures are implemented at the onset of each construction contract to enclose the designated construction area.
- Intermediate erosion and sediment control measures are implemented within each construction area.
- Adaptive management measures are the erosion and sediment control measures that would be implemented in the event that one or more of the intermediate measures do not achieve the desired performance. These are described in Section 12.0.
- Contingency measures would be implemented in the event of an emergency condition that would overwhelm the "base" erosion and sediment control measures, for example, due to a storm event that exceeds the selected design event. These are described in Section 12.3.

Specifications and drawings for LSMOC construction will be prepared during detailed design and customized for each individual contract as required. Sections 9.1.1 and 9.1.2, describe the base measures that will be implemented as a minimum for the LSMOC.

9.1.1 Perimeter Controls

The best method for establishing and maintaining a perimeter around exposed areas, such as staging areas and material stockpiles, is with a vegetated buffer zone. For the LSMOC, where vegetated buffer zones or intermediate controls are implemented, described in Section 9.1.2 cannot be maintained effectively, installation of silt fencing will likely be considered. Location and placement of the silt fences will be selected to prevent additional erosion due to undercutting or end-cutting of the fence. Installation of the silt fences would adhere to typical industry specifications, with a typical detail as shown on Figure 4.

Silt fences will be of particular importance to control sediment movement in areas where staged excavation and spoil placement takes place prior to final grades being established, which are required to allow revegetation to proceed. For example, as discussed in Section 3.1.2 of the CEMP, excavation of the upper portion of the channel within a channel segment could be performed in the winter months (when no depressurization pumping is required to address the risk of basal heave), with the remaining lower portion excavation then completed in the summer months so as to limit the duration of depressurization pumping required and avoid the complications of having to pump and manage water in sub-freezing temperatures.



Note: Details may vary.

Figure 4: Typical Silt Fencing Detail

In addition to silt fences, surface water quality from within the construction area that must be discharged offsite will be monitored and controlled, as required, to comply with the water quality criteria outlined in Section 3.2. details are provided in the SWMP. It is likely that the Contractor will manage surface runoff within excavation areas by will be directing it ed to low areas of the excavation to allow any sediment to settle prior to being pumped to offsite receiving areas. Pump discharge points will be lined with clean rock or other acceptable flow dissipating applications, as required, to prevent erosion and the release of suspended sediments. If required, any water that must be pumped outside of the work area will be discharged into dense vegetation or settling ponds. Settling ponds will be constructed adjacent to work areas, as deemed necessary, prior to discharge into the outside drain and/or the waterbodies east of the LMOC, or at alternate locations that may be approved by Manitoba Transportation and Infrastructure during construction.

Turbidity curtains will be used to prevent or minimize the migration of disturbed sediments during removal of earth plugs that separate one channel excavation segment from another, if flooding of those segments is required.

9.1.2 Intermediate Controls

Intermediate controls will be developed as the channel excavation proceeds with a full set of controls in-place upon completion of excavation and before revegetation begins. As the excavation progresses downward to the final grade, slope roughening techniques on exposed side slopes will be implemented.

Re-establishing the vegetation cover in the LSMOC is fundamental to minimizing the erosion potential during both the construction and operation phases of the LSMOC. Within the planting season, and after final grade is established within a reasonably sized work area of a channel segment, the grade will be prepared and revegetated according to the appropriate revegetation prescription(s) as outlined in the RVMP. A component

of the main revegetation prescription includes a temporary cover species that will establish quickly to protect the bare soil from erosion as the remainder of the species germinates.

Due to the presence of areas of sandy soils in the LMOC, some additional measures will be considered. If, after August 15th, sandy soils are encountered during excavation to the degree and extent which sandy soils are the dominant soil texture in a soil stockpile, within a given area due to higher risk of wind erosion losses in these exposed soils, final grade will be prepared and revegetated, and stabilized using straw mulch treatments (mechanically anchored/crimped or treated with tackifier) or topical spray on mulches, as soon as practically feasible. August 15 is the fall seeding deadline for fall establishment of forage crops (alfalfa, grasses, etc.) provided by the Manitoba Agricultural Services Corporation, and therefore provides a reasonable guideline as to timing after which forage type crops may not establish well.

Additional intermediate controls will also be considered in the completed excavation area or in locations with a higher risk of erosion (e.g., if sandy soils are encountered) and will be developed during detailed design based on an assessment of potential sediment that could be generated and the final construction contracting strategy. These intermediate controls may include:

- Slope interrupters constructed at regular intervals (10 m) cross-slope on the channel and spoil embankment slopes. These can be effectively constructed with a grader or dozer with an adjustable blade to create a deep furrow into the side slope. Slope interrupters are not intended to trap or filter sediment, but they will serve to minimize further slope erosion protecting against deep rills or gullies by interrupting flow of runoff down the slope.
- Straw mulch treatment outside of the channel after the surface has been seeded with vegetation. The straw mulch would be anchored/crimped into the surface of the soil. The straw mulch helps protect the slope against erosion, but also provides an enhanced environment to promote quick growth of the grass seed. Other environmentally friendly types of topical spray on mulches may also be considered, where appropriate.

The temporary erosion and sediment control measures discussed above will be left in place until the temporary cover species vegetation and the permanent vegetation are re-established. Other erosion and sediment control methods will be considered as alternatives for use as adaptive management and/or contingency measures if the base approach measures do not perform as expected. Further discussion of these adaptive management and contingency measures is provided in Section 12.0.

9.2 Other Project Components

Temporary erosion and sediment control measures will be required for the other Project components that are part of the LSMOC, which include:

- Outside Drain
- Various types of structures
- Inlet and Outlet works

An overview description of the temporary erosion and sediment control measures for each component listed above is provided in the following subsections. Monitoring of the Project area will be conducted to assess the effectiveness of proposed erosion and sedimentation control measures as outlined in Section 11.0. Adaptive management and/or contingency and emergency response measures for these components are described in Section 12.0.

9.2.1 Outside Drain

As part of the site preparation Project works, an outside drain will be constructed on the east side of the LSMOC to collect surface water runoff. The design discharge for the outside drain will be based on the 1 in 10-year runoff event from the contributing area east of the channel alignment, which is in line with current provincial drainage standards typically applied in rural settings. To reduce the potential for erosion in this drain, allowable shear stress will not exceed the threshold value of 6 Pascals for clay and clay till, as described in the SWMP. Numerous gradient control structures will be constructed along the outside drain to reduce the velocities and shear stress in the channel, to meet this criteria. Rockfill check dams will also be installed, as required, to control the flow velocity and promote deposition of sediments that may be transported along the drain. After the outside drain has been excavated, it will also be revegetated in accordance with the RVMP.

Should a runoff event or series of runoff events, that are greater than the design condition has experienced prior to the re-establishment of permanent vegetation, then contingency and emergency response measures will be implemented to mitigate the risk of excess erosion as described in Section 12.3.

A vegetated buffer will be maintained between the outside drain and the channel excavation spoil pile, where practicable. In addition, silt fences will be used where vegetated buffer zones cannot be maintained effectively. Combined, these measures are expected to substantially reduce the potential for sediment transport along the drain.

The drain outlet will temporarily discharge into Lake Winnipeg. riprap will be placed as required to prevent erosion of the shoreline from water flowing from the drain. The temporary drain outlet will be constructed during winter with portions extending into Lake Winnipeg, completed where the lake typically freezes to bottom. This will help improve constructability and mitigate the potential for erosion and sedimentation. Construction activities and measures to manage surface water, erosion and sedimentation during construction will comply with regulatory requirements.

9.2.2 Structures

Various types of structures will be constructed as part of the Project, including a WCS, multiple drop structures, and an outlet structure for the outside drain. Construction of structures will be isolated from channel construction activities to prevent surface water runoff from entering the work area, and therefore, reduce the potential for erosion and sedimentation. For all structures, dewatering activities will be required during construction to collect surface water runoff within the work area. At the WCS, dewatering is also

required to address groundwater depressurization requirements, as described in the Groundwater Management Plan.

Surface water quality within the work areas will be monitored and controlled, as required, to comply with the criteria outlined in Section 3.2. Any water that must be pumped outside of the work area will be discharged into dense vegetation or settling ponds and managed as per the SWMP. Settling ponds will be constructed adjacent to the work area, as deemed necessary, prior to discharge at locations to be approved by Manitoba Transportation and Infrastructure during construction. Pump discharge points will be lined with clean rock or other acceptable flow dissipating applications, as required, to prevent erosion and the release of suspended sediments.

9.2.3 Inlet and Outlet Works

Inlet works will consist of excavating the lake bottom within an approximately 1,200 m long by 600 m wide area of Lake St. Martin. The construction area will be surrounded with a temporary rock plug or cofferdam to allow work activities to be isolated from the lake, preventing the release of any deleterious substances. Riprap protection will be incorporated into the design to protect the plug/cofferdam against wave action. A turbidity curtain will be temporarily installed in Lake St. Martin, outside of the rock plug/cofferdam, as required, to prevent or minimize the migration of disturbed sediments into the lake during installation/removal of the rock plug/cofferdam. A fish salvage program will be required within the isolated area, which will be developed and conducted in accordance with the PERs. Once construction of the LSMOC is complete, the rock plug/cofferdam will be removed in part or in whole, as required and in accordance with environmental requirements.

Installation and removal of the turbidity curtain, as well as the construction and removal of the cofferdam, will comply with the DFO Restricted Activity Timing Windows (DFO, 2013), and will be completed in accordance with the conditions outlined in the DFO authorization. Once the construction area has been isolated by a cofferdam, construction works within it, may proceed year-round. Removal of the curtain would occur once monitored water quality parameters on both sides of the curtain are similar and meet the criteria outlined in Section 3.2.

Installation of a double turbidity curtain, in lieu of a rock plug/cofferdam, will also be considered depending on the preferred construction methods to be determined during detailed design. Winter construction may also be considered in areas where the lake typically freezes to bottom to help improve constructability. With winter construction, the potential for erosion and sedimentation is significantly reduced.

Outlet works will consist of excavating the lake bottom within an approximately 200 m long by 200 m wide area of Lake Winnipeg (Sturgeon Bay). Construction activities and measures to manage surface water, erosion and sedimentation during construction will be similar to the inlet works and will comply with regulatory conditions. In addition to the excavation, groins extending into Lake Winnipeg will be constructed to control the longer-term migration of sediment. Similar erosion control methods will be used to manage sediment during the construction of these structures.

Turbidity monitoring will be used at both the inlet and outlet locations to confirm the effectiveness of the measures and allow for adaptive management to be implemented if required. A preliminary monitoring and response protocol related to this is provided in Appendix 2B.

9.3 Commissioning

The till base and lower sides slopes of the LSMOC will be covered with an armour layer comprised of small stones, to guard against the potential erosion by hydraulic forces, when the channel is in operation. The armouring will be crushed limestone rock, which will be overlain on geotextile that will isolate the channel from the underlying till substrates. On the channel base and lower side slopes, the median stone size will be 35 to 40 mm diameter and the overall gradation will range in size from 25 to 100 mm. The thickness of the armouring in these areas will be 225 mm thick. On portions of the side slopes that could interact with the ice cover in the channel, the same rock sizes will be used but the thickness will be increased to 400 mm. While the size of the stones that comprise the armour layer will be designed to resist the hydraulic forces, it is also expected that some fine material will remain both on the surface and within the armour layer at the end of construction, which is anticipated to be mobilized and transported out of the LSMOC when it is first operated during commissioning. Other sources of fine material may also be mobilized during commission (i.e., loose material remaining within the channel from cofferdam removal, erosion of fine sands in the vicinity of the outlet, resuspended sediment near the inlet, etc.). Mobilization and transport of these materials is expected to result in a short-term temporary increase in the concentration of suspended sediment at the outlet in Sturgeon Bay.

To limit the potential increase in suspended sediment concentrations, a controlled gate opening procedure and response protocol is being developed and will be implemented, which will be informed with TSS monitoring data that will be collected during the operation from real-time turbidity loggers to be installed in the North Basin of Lake St. Martin and in Lake Winnipeg (Sturgeon Bay). The commission will be planned to be undertaken between July 1 and September 14, to comply with the DFO Restricted Activity Timing Windows (DFO, 2013).

A preliminary monitoring and response protocol for this aspect of the work is provided in Appendix 2A, which will be further developed and finalized prior to commissioning taking place.

The mitigation and response measures used during commissioning, along with any adjustments made and lessons learned, will be reviewed, and used to inform an updated procedure that can be followed during the initiation of future operation events, should it be found to be required.

10.0 OPERATION PHASE (PERMANENT MEASURES)

The permanent erosion and sediment control measures are those that are implemented for long-term post construction erosion control. Permanent erosion and sediment control will consist primarily of the establishment of a permanent vegetative cover, as described in the RVMP, as well as armouring of the base and lower side slopes of the channel with stone. The channel inlet and outlet, WCS and drainage control structure inlets and outlets will have additional methods of permanent erosion protection as described in Section 10.2.

The temporary erosion and sediment control measures, described in Section 9.0, will be maintained post construction, until vegetation has fully established. As discussed in Section 11.0, monitoring will be undertaken over a 2-year post-commissioning period to confirm the effectiveness of the permanent erosion and sedimentation control measures, and to identify if any supplementary measures are required as part of adaptive management. Some temporary measures may need to be implemented post construction, following an extended operation period with the WCS gates open, or other conditions that may result in the permanent vegetation not providing effective permanent erosion and sediment protection.

10.1 Constructed Channel

The LSMOC is being designed to minimize the potential for bed erosion during operation at the design discharge. It is designed to pass, at a minimum, the flows that would occur during the passage of the 1:300 year flood event through the Lake Manitoba/Lake St. Martin system, without exceeding the erosion thresholds. This event reflects a repeat of the 2011 Flood of Record. The portion of the channel bed permanently under water will be covered with a stone armour layer. Remaining disturbed areas throughout the entire length of the LSMOC will be revegetated, except for roads and structures.

Establishing and maintaining a vegetation cover is a key component to minimizing the long-term erosion potential. The revegetation will be designed to provide a competent initial coverage that will establish quickly to protect the bare soil from erosion, as the remainder of the permanent non-invasive perennial vegetation coverage establishes, as described in the RVMP. It is based on the following:

- A seed mix consisting of permanent perennial native species and a quicker growing cover crop species (cereal crop), suited for the growing conditions.
- The planting season would be in the spring months for optimal growth of the native species and continue in the summer months to late August, with an adjusted seed mix to improve propagation of the cover crops. Seeding would not occur in the late summer/early fall as it would not likely yield enough growth to provide soil protection during fall, winter, and early spring.

- Areas that are excavated following the end of the typical growing season in a year will be seeded with a fall prescription mix after October 15th of that year, during the dormant seeding window until frost or snow inhibits seed placement. This will facilitate early germination and vegetation growth in the spring even in the event that conditions are not suitable to allow for seeding during the spring period.
- Re-seeding would be required to compensate for the lack of vegetation cover success, if necessary.

Where possible, the Contractor's construction activities will be staged in such a manner that manageable areas of un-vegetated surface may be specified and maintained during the excavation process.

The revegetation plan for the LSMOC consists of two zones, an upper berm and lower berm zones, to reflect the different environmental conditions that will be present during the operation phase. The zones are defined largely by an anticipated gradient in moisture availability from the uplands to the side slopes, as follows:

- The upper berm zone includes sites that will regularly be subjected to drought conditions during dry summer months, however, in extreme wet conditions, these sites may also experience flooding for short periods (three to four days). Species planted in this zone will include drought tolerant native grasses well-suited to upland sites and local climatic conditions. Several species in this mix will also have a degree of flood tolerance to account for flooding potential.
- The lower berm zone includes channel and drain side-slopes that will be periodically flooded during heavy rainfall periods and channel operation. In times of water deficit, this zone may also be subjected to extended periods of drought. To account for these moisture variations, the seed mix will be designed using species capable of tolerating inundation as well as those adapted to drought conditions.

The final RVMP will include plant species suited to the anticipated site conditions with some overlap in species selected for each zone to accommodate seasonal moisture variations.

Disturbed areas including those areas along the side slopes, ditch bottoms, and back slopes throughout the entire length of the Project will be revegetated. To make the most efficient use of seeding opportunities and to minimize exposure of prepared sites to further erosion, seeding will commence immediately upon completion of final grading operations. Areas to be seeded will be prepared by de-compacting the subsoil, placement of stockpiled organics, and integration of the organics into the subsoil by harrowing. Following preparation, the permanent native grasses and/or cover crop will be seeded in accordance with the planting windows. Seed bed preparation and seeding operations will be carried out parallel to the centerline of the channel to discourage erosion. Further details are provided in the RVMP.

The mode of operation of the LSMOC is such that some portions of the channel side slopes will experience alternating periods of submergence (wet) and exposure (dry). This could lead to zones where vegetation may not survive or grow well, thus making these portions of the slopes potentially susceptible to erosion. Where flooding due to opening of the WCS gates causes substantial die-off of planted vegetation, it is reasonable to expect that residual root systems that have been established will offer an interim temporary mode of erosion control while volunteer seedlings (or surviving plants) establish or recover and provide ground cover.

Plant species used in areas that will be inundated during channel operation will be selected based on their inherent capability to withstand flooding as well as seasonal drought. The channel and outside drain need erosion control in both dry and wet conditions, using dry and wet condition tolerant plants and seed mixes

with appropriate successional rates and processes. Mitigation measures such as monitoring and adjustment of seed mixes, as discussed in the RVMP, may be required to address the risk of poor vegetation growth on the portions of the channel side slopes that will experience alternating periods of submergence and exposure as a result of long-term operation of the Project.

Over time, areas along the channel that are regularly flooded may favour the growth of annual weedy species and potentially the establishment of taller woody species including willow, that may be able to access oxygen during prolonged flooding. Routine inspection and maintenance of vegetation (mowing/cutting) will be undertaken in such a manner that the channel maintains hydraulic capacity in the long-term as discussed in the RVMP.

10.2 Other Project Components

The permanent erosion and sediment control measures required for the other Project components that are part of the LSMOC will also generally consist of revegetation consistent with that discussed in Section 10.1. If there are specific areas in which vegetation is not appropriate or adequate for permanent erosion and sediment protection, other measures such as the placement of riprap, turf reinforcement mats, etc. may be utilized. Some specific areas in which vegetation will not provide the required level of protection and therefore will require other methods for permanent erosion and sediment control include:

- Channel Base and Lower Side Slopes – The portion of the channel cross-section below the top of the non-operating water level in the channel will be covered with an armour layer comprised of small stones to mitigate the potential risk of erosion by hydraulic forces when the channel is in operation.
- Rock Fill Drop Structures – The LSMOC will require eight drop structures to minimize channel flow velocity and erosion in areas of steep sloping terrain. The drop structures will be constructed of rockfill, with a sheet pile cutoff at the upstream crest.
- Gradient Control Structures – multiple gradient control structures will be constructed along the outside drain to minimize flow velocities and erosion in areas of steep sloping terrain. The gradient control structures will be constructed of rockfill.
- Channel Inlet – Riprap protection will be constructed along channel banks and shoreline near the channel inlet where the Project is vulnerable to wave action.
- Channel Outlet – Rock jetties and riprap protection will be constructed along the channel banks and shoreline near the channel outlet where the Project is vulnerable to wave action. The jetties will also limit sedimentation from natural shoreline morphology processes within the deepest portion of the outlet.
- Outside Drain Outlet Structure – Specific areas near the inlet and outlet of this structure will require the placement of riprap protection.
- Water Control Structure – The channel bottom and side slopes upstream and downstream of the WCS will include riprap to provide permanent erosion protection. The WCS also includes a concrete stilling basin to dissipate energy downstream of the structure.

11.0 MONITORING

11.1 Construction Phase

Surface water quality monitoring during construction of the LSMOC is described in Section 11.2 of the SWMP. This monitoring will be undertaken to identify any changes that may result from construction activities and to assess the effectiveness of proposed erosion and sedimentation control measures. Sediment monitoring will include visual observations of signs of erosion and/or sedimentation during routine construction inspection activities (i.e., erosion of exposed slopes, presence of sediment plumes, etc.) and measurements made using sampling devices. If the water quality criteria identified in Section 3.2 are exceeded and attributed to the Project, or signs of erosion and/or sedimentation are observed, then additional mitigation measures would be considered as described in Section 12.0. A preliminary monitoring plan to identify potential sediment effects during in-lake excavation work is provided in Appendix 2B, which will be further developed and finalized during detailed design.

During the initial channel commissioning, a short-term temporary increase in suspended sediment concentration in the outlet area may occur due to the mobilization of several sources of material (e.g., fine material remaining within the armour layer, loose material remaining within the channel after construction, erosion of fine sands in Lake Winnipeg downstream of the outlet, etc.). As discussed in Section 9.3, a controlled gate opening procedure and response protocol will be implemented to manage the potential increase in suspended sediment concentrations entering Lake Winnipeg. Real-time turbidity monitoring in the North Basin of Lake St. Martin and in Lake Winnipeg (Sturgeon Bay) will be conducted during this period, which will be used to inform the gate opening procedure and to make adjustments as needed. An overview of this monitoring plan is provided in Appendix 2B, which will be further developed and finalized prior to commissioning taking place.

11.2 Operation Phase

Surface water quality monitoring within the local waterways outside of the LSMOC will initially be carried out during the first two years post-commissioning, as discussed in the SWMP, the intent of which is to confirm the effectiveness of construction mitigations and site restoration measures. Longer-term regional water quality monitoring, which will include monitoring in the LSMOC, will be conducted as part of an operational monitoring program that is discussed in the AEMP. In addition, visual observations of signs of erosion and/or sedimentation will also be undertaken as part of routine operation and maintenance inspection activities.

12.0 ADAPTIVE MANAGEMENT AND FOLLOW-UP

12.1 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 Canadian Environmental Assessment Act 2012* 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.

As discussed in Section 12.4.1.2 of the Project EIS, construction activities and the changes in flows and water levels caused by the Project may have minor effects on fluvial geomorphology, sediment and debris transport, in the surface water LAA, but primarily during and immediately after construction. Suspended sediment levels may temporarily increase at work sites during construction activities, and at outlet areas during initial operation (gates open) of the outlet channels after a period of non-operation (gates closed). As such, the purpose and objectives of follow-up activities will be to monitor and further understand the residual effects due to the Project.

Although the methods and recommendations outlined in the SMP were developed based on site-specific expectations and conditions, it is accepted that these conditions are subject to change. For example, weather conditions and climate change will inevitably drive some of the design decisions during implementation and long-term operation. Results from ongoing data collection and monitoring programs will inform and facilitate and necessary adjustments to this plan, to the extent feasible. By employing adaptive management strategies, assumptions used in the initial design will be evaluated and management practices modified in response to the outcomes during the Project construction period and subsequent operation phase based on baseline investigations, follow-up monitoring and reporting.

Adaptive management uses the initial designs while learning from field performance to manage risk and allow the incorporation of new knowledge into subsequent steps. The foundation of this process relies on data input and implementation of sound monitoring programs. Based on the monitoring results and feedback

during construction, temporary mitigation measures described in this SMP, as well as those included in the SWMP and RVMP, should be revisited and updated, as required. For example, if the establishment of vegetation following excavation work is more difficult than expected, alternate vegetating methods may be considered, or additional temporary erosion control measures may be warranted. Adaptive management will play an important role in acknowledging and working through management challenges in the presence of uncertainty.

12.2 Follow Up Response

As described in the SWMP, monitoring will include visual inspections and water quality monitoring. The data and analyses generated by monitoring will be used to provide information on the effectiveness of mitigation measures, aid in the validation of predicted residual effects, and provide data and results required for environmental regulatory approvals requirements. If conditions recorded appear to be exceeding criteria or management thresholds, relative to baseline conditions, then follow-up responses will be implemented as described in the sub-sections below, as well as those identified in the CEMP, PERs, SMP, RVMP and any other applicable plans under the EMP.

12.2.1 Construction

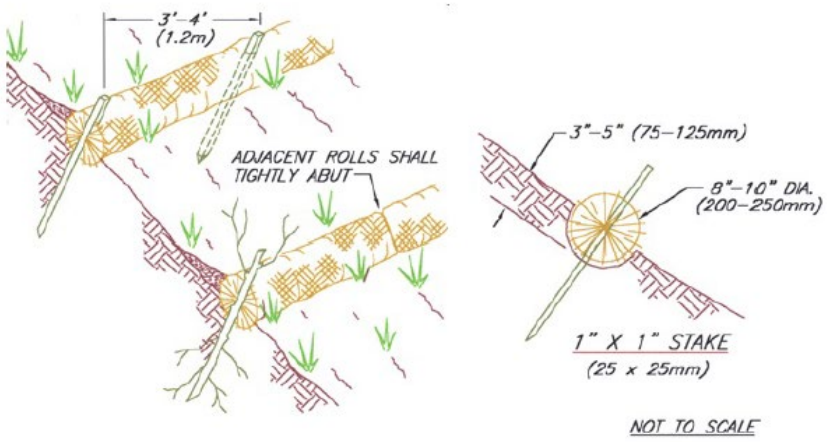
The requirements for erosion and sediment control are discussed in Section 2.3 of the PERs. As described in Section 11.0 of this SMP, monitoring will include visual inspections and water quality monitoring as part of the SWMP and AEMP. Section 12.2 of the SWMP describes the protocols to identify sediment issues and trigger management responses.

In general, for any issue of potential non-compliance, the Environmental Monitor or Inspector will report the issue immediately so that Manitoba Transportation and Infrastructure or the Contract Administrator can direct the Contractor to stop work and/or implement mitigation activities if/as required. Management responses to address non-compliance related to erosion and sediment control could include temporary suspension of work activity, modifying the rate of water discharges, and/or installing additional erosion and sediment control measures.

Some measures/activities that could be implemented in the context of erosion control and sediment management during construction include:

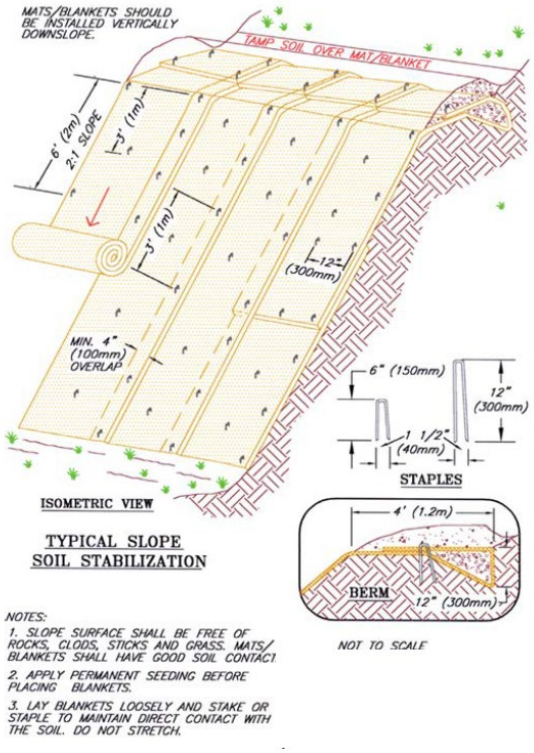
- Straw rolls/wattles could be considered as alternate measure or in addition to the slope interrupters. Typical details are shown in Figure 5.
- Erosion control blankets could be used in critical areas where erosion potential is concentrated. Lining exposed areas with erosion control blankets was not considered for widespread application, as it would be very costly given the amount of area to cover. Typical details are shown in Figure 6.
- Spray mulches and bonded matrix could be substituted for straw mulch areas that require special treatment or access for straw mulch is limited. Concerns associated with the high cost and poor success rates when the products are applied during periods of the year when temperatures are near or below freezing would need to be overcome.

- Turbidity curtains or in-channel filter systems could be installed in locations where there is water with flow velocities slow enough to facilitate effective filtration of suspended sediment.
- Rapid stabilization techniques that could include the placement of rip rap and tackifiers (i.e., soil bonding agents).
- Dewatering techniques and/or pumping to decanting areas.
- Additional slope interrupters if the specified number does not meet requirements to control runoff.
- Additional sediment controls such as silt fencing or filter/check dams.
- Supplementary seeding or additional agronomic measures, such as irrigation, to promote the temporary and permanent revegetation on finished sections of the completed channel.
- Modification of the excavation schedule to adapt to weather conditions or limit overall exposed excavation areas.
- Implement dredging in accordance with the DFO Interim Code of Practice for Routine Maintenance Dredging (https://www.dfo-mpo.gc.ca/pnw-ppe/codes/dredge-drageur-eng.html) to remove material that may deposit in the inlet or outlet from natural shoreline morphology processes, or upstream of drop structures, to reduce sediment that could be mobilized at start of channel operation, in the unlikely event that it is needed.
- Monitoring and management measures to address potential sediment effects during in-lake excavation work are described in Appendix 2B of this SMP.



Note: Details may vary.

Figure 5: Typical Straw Roll Detail



Note: Details may vary.

Figure 6: Typical Erosion Control Blanket Details

12.2.2 Commissioning

As indicated previously, Appendix 2B establishes monitoring and management measures to address potential sediment effects during commissioning of the LSMOC. This will involve implementation of a real-time sediment monitoring plan to monitor the magnitude of spatial and temporal changes in TSS during these activities. The plan is based on an upstream and downstream approach to capture effects in the initial mixing zone, as well as the effects downstream in the fully mixed area. Turbidity will be monitored in the field and measurements converted to TSS levels for comparison against the criteria, as described in Appendix 2A, through deployment of in *situ* turbidity loggers at multiple transect locations. During commissioning, a controlled gate opening procedure will be implemented to manage the potential increase in suspended sediment concentrations entering Sturgeon Bay. Input from the monitoring network during this period, will be used to inform the gate opening procedure and to make adjustments as needed to manage the TSS levels.

12.2.3 Operation

Several of the erosion and sediment control measures identified in Section 12.2.1 of this SMP can be implemented during the operation phase, depending on the specific situation that must be addressed in the event that operation phase monitoring identifies issues of potential non-compliance.

The procedures to be followed to initially open the WCS at the start of future operating events will be a part of the Operation & Maintenance Manual. Short-term increases in suspended sediment concentration entering Sturgeon Bay that exceed the water quality criteria identified in Section 3.2 are not anticipated. Monitoring will be carried out during the first two operations to confirm this prediction, as described in Section 11.2. Should such increases be found to occur, then a controlled gate opening procedure that is similar to the mitigation and response measures used during commissioning would be implemented to manage the suspended sediment concentrations, as required.

12.3 Contingency Measures and Emergency Response

Adaptive management plans discussed in the previous section are implemented based on initial monitoring of the effectiveness of the "base" erosion and sediment control measures with adjustments made as needed. The "base" erosion and sediment control measures will be designed and maintained in good working order to manage conditions arising from the design event, as described in Section 3.3.

These will be developed by the Contractor in accordance with Section 1.3 of the PERs and submitted to Manitoba Transportation and Infrastructure for approval prior to start of construction.

In the event of an emergency during construction, the Contractor, Manitoba Transportation and Infrastructure, and the Contract Administrator will determine which of the contingency and emergency control measures will be implemented. Emergencies which need to be reported to regulators will be reported as soon as possible. These measures would be carried out within a predetermined time period depending on the site conditions and nature of the emergency.

During the operation phase, the channel will be resistant to large precipitation events through vegetation and armoring. Nevertheless, contingency and emergency control measures will be implemented by Manitoba Transportation and Infrastructure, depending on the site conditions and nature of the emergency, with consideration given to the O&M manual that will be developed for the Project prior to the operation phase.

13.0 REFERENCES

Department of Fisheries and Oceans (DFO). December 27, 2013. Manitoba Activity Timing Windows for the Protection of Fish and Fish Habitat [online]. Available from https://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/mb-eng.html [accessed October 29, 2020].

APPENDIX 2A

Preliminary Sediment Monitoring Plan and Response Protocol for LMOC In-Lake Excavation and Commissioning Activities

Preliminary Sediment Monitoring Plan and Response Protocol for LMOC In-Lake Excavation and Commissioning Activities

1.0 REAL-TIME SEDIMENT MONITORING PLAN

A detailed in-lake real-time total suspended sediment (TSS) monitoring program will be implemented during the course of construction to monitor the magnitude and spatial and temporal changes in TSS within the proximity of the Project during in-lake construction and commissioning activities. The monitoring program design is based on the expected construction effects on the sedimentation regime in Watchorn Bay and Birch Bay, and recent experience on other construction projects in the Province of Manitoba. Overall, the design is based on an upstream and downstream approach to capture effects in the initial mixing zone as well as the effects downstream in the fully mixed area. Changes to this plan, if required, will be shared with Indigenous communities, stakeholders and IAAC will be informed of prior to implementation of changes.

1.1 OBJECTIVES

The sediment monitoring program is intended to document the spatial and temporal variations of TSS concentrations and the magnitude of any increases in Watchorn Bay and in Birch Bay during in-lake construction activities, as well as any increases in Birch Bay during the commissioning stage. The program has been designed to facilitate responses to pre-determined action levels described in Section 2.0.

1.2 MONITORING PARAMETERS

The main parameter being monitored is TSS; however, TSS cannot be measured in real time but must be determined in a laboratory using a water sample. Turbidity (Tu) will be measured as a surrogate using automated in-situ Tu loggers that can measure and report Tu on a real time basis. This is an industry standard approach and has been used in several projects in the Province of Manitoba, including Manitoba Hydro's Wuskwatim and Keeyask Generating Station projects and the Pointe du Bois Spillway Replacement project. The Coordinated Aquatic Monitoring Program (CAMP) also adopted a similar approach in Manitoba. Typically, the relationship would be expressed in the form of:

$$TSS(\mathrm{mg/L}) = X * Tu(\mathrm{NTU}) + Y,$$

where *X* and *Y* would be calculated using regression analysis.

Relationships between Tu and TSS will be developed prior to construction in order to facilitate the use of Tu as a surrogate of TSS. Typically, development of the relationships will be based on TSS and Tu data that have been collected in Lake Manitoba and Lake St. Martin in the past, as well as any additional data that will be collected prior to the in-lake construction activities. The development of relationships will consider ranges of TSS and Tu that typically occur in the existing environment, their natural variabilities, and correlation between the two parameters. In addition, laboratory analysis will be carried out to develop relationships between TSS and Tu using sediment particles that are predominant in the till mix. The relationships will be used to determine if in-lake construction and commissioning activities are causing TSS increases that exceed specific action thresholds so that the corrective actions discussed in Section 2.0 can be implemented in a timely manner. During in-lake work, samples of water at the monitoring stations will be periodically collected and analyzed for TSS to confirm or adjust the Tu-TSS relationship, as required.

The assessment of potential effects on the TSS concentration in the water will be based on an upstream and downstream approach to capture changes in the downstream area. Given that the monitoring locations are located in two different lakes, a relationship will be developed between TSS concentrations in Watchorn Bay and Birch Bay using existing environment data.

1.3 MONITORING LOCATIONS

TSS and turbidity will be monitored through deployment of in-situ turbidity loggers at multiple transect locations approximately as shown in Figure 1 and Figure 2. Multiple loggers will be installed at each transect to monitor average conditions across the initial mixing zone as well as in the fully mixed area. The logger locations and purpose will vary depending on whether in-lake excavation work or commissioning activities are underway, as described below. There will be common logger locations (sediment monitoring point [SMP]-1 and SMP-5) for both the in-lake excavation and commissioning stages to measure background TSS in the lakes. For the purpose of the in-lake excavation stage, there will be loggers at SMP-2 and at SMP-3 immediately outside of turbidity curtains to make sure that additional TSS that may be generated from the excavation work can be tracked and measured. The commissioning stage will include a logger location at SMP-4 that will be within the mixing zone of additional TSS that could result from the initial gate operation. The logger locations may be modified during the program as more data becomes available to improve and optimize the monitoring plan and response protocol.

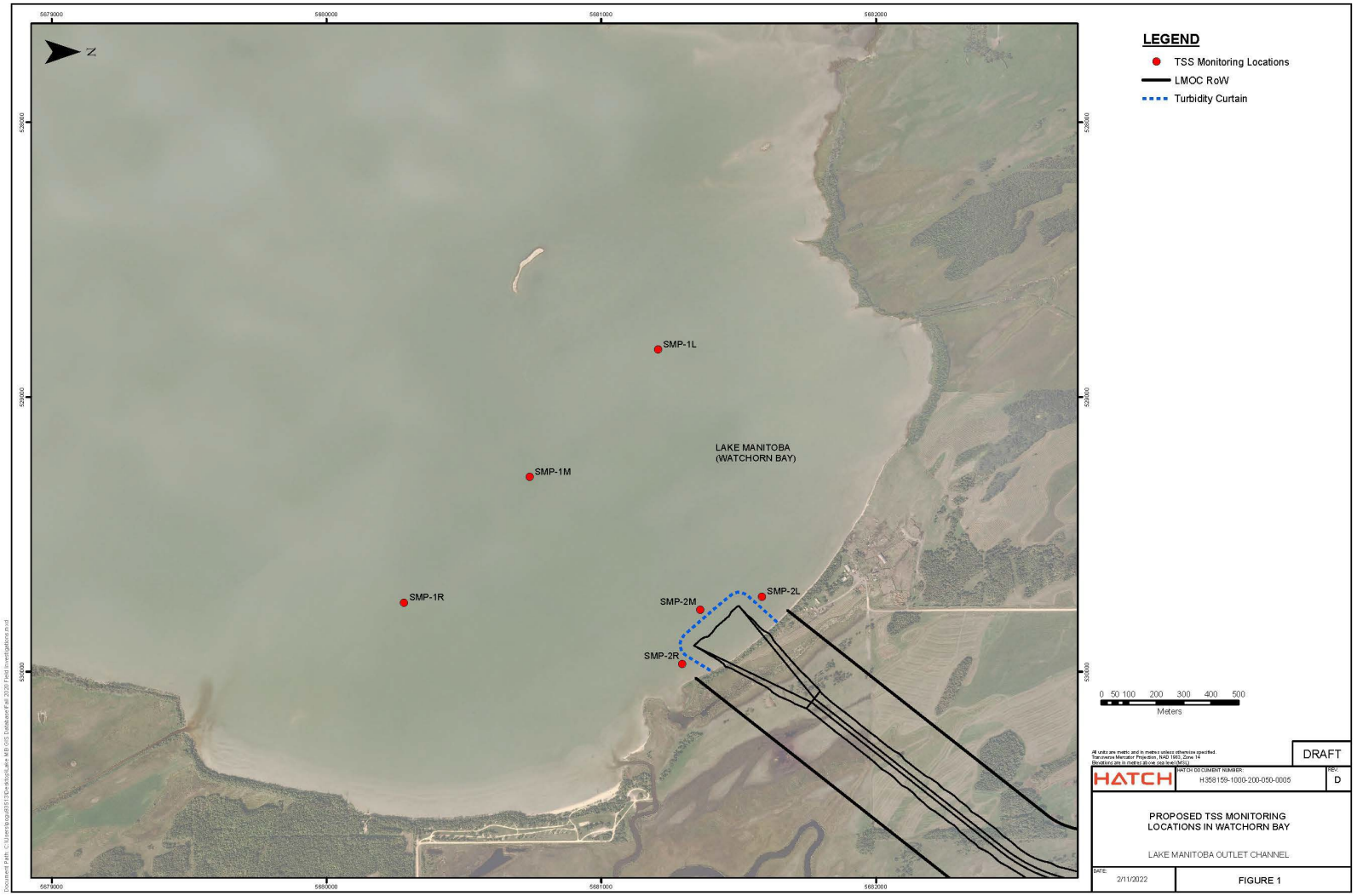


Figure 1: Proposed TSS Monitoring Locations in Watchorn Bay

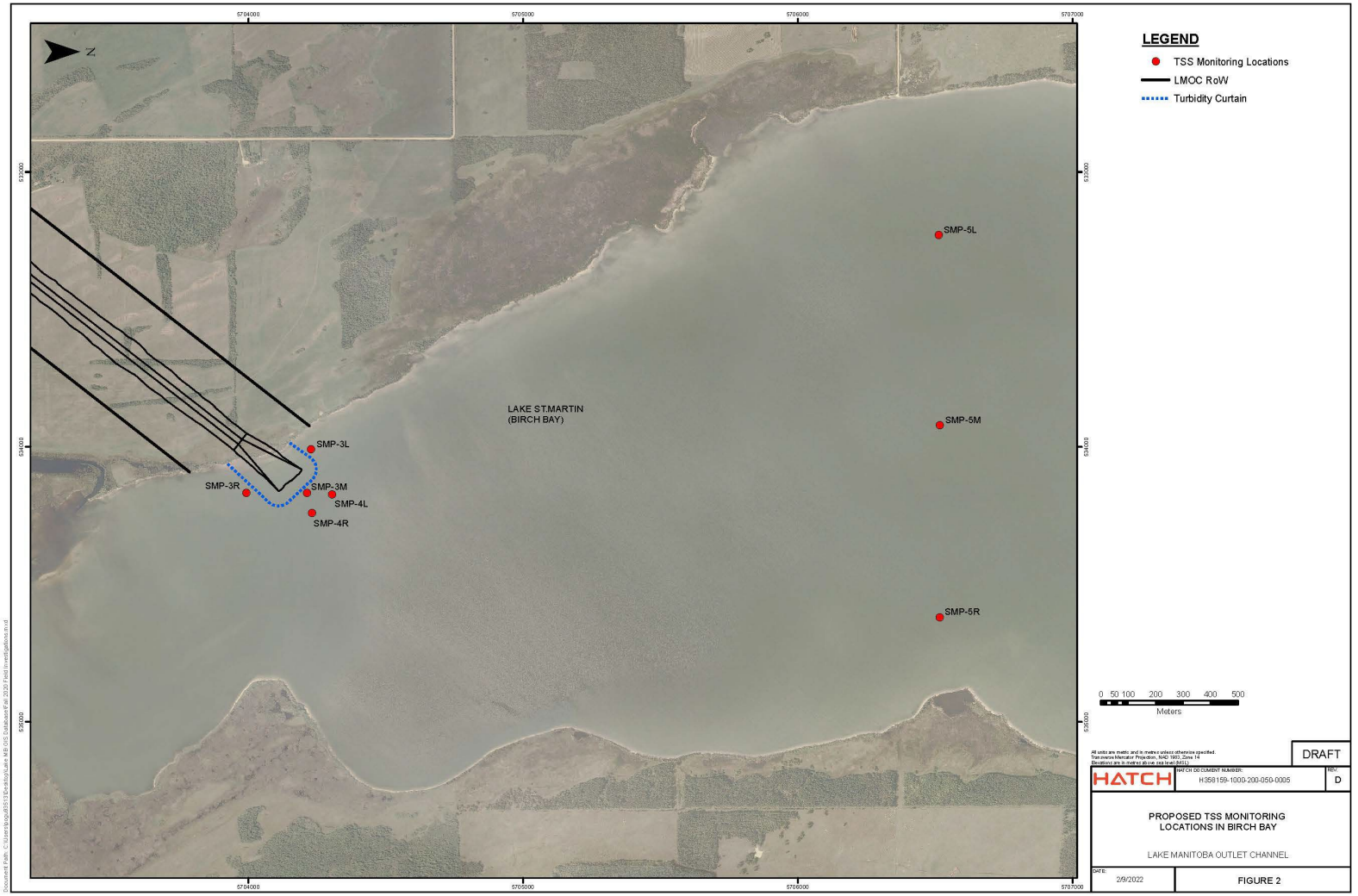


Figure 2: Proposed TSS Monitoring Locations in Birch Bay

1.3.1 In-Lake Excavation

- SMP-1 will be located in Watchorn Bay approximately 1 kilometre (km) upstream of the shoreline at the entrance to the Lake Manitoba Outlet Channel (LMOC) to monitor ongoing background conditions. Loggers will be installed at three sites (SMP-1L, SMP-1M and SMP-1R) located across the width of the bay.
- SMP-2 will be located just outside of the inlet excavation double turbidity curtain, approximately 200 metre (m) from the shoreline. Loggers will be installed at three sites (SMP-2L, SMP-2M and SMP-2R) located across the length of the curtain (transect). In addition, multiple measurements along the length of the turbidity curtain will frequently be made using handheld loggers to augment the permanent loggers and detect if any transport of sediment through the curtain is occurring. The frequency and locations of monitoring will be further developed with input from the Contractor based on the construction sequence and methodology. Given the close proximity of the transect to the construction area, handheld logger measurements that will be made at least once a day will provide flexibility to track potential sediment plumes that may not be otherwise detected at the permanent loggers.
- SMP-3 will be located just outside of the outlet excavation double turbidity curtain, approximately 150 m from the shoreline. Loggers will be installed at three sites (SMP-3L, SMP-3M and SMP-3R) located across the length of the curtain (transect). In addition, multiple measurements along the length of the turbidity curtain will frequently be made using handheld loggers to augment the permanent loggers and detect if any potential transport of sediment through the curtain is occurring. The frequency and locations of monitoring will be further developed with input from the Contractor based on the construction sequence and methodology. Given the close proximity of the transect to the construction area, handheld logger measurements that will be made at least once a day will provide flexibility to track potential sediment plumes that may not be otherwise detected at the permanent loggers.
- SMP-5 will be located approximately 2.5 km downstream of the shoreline at the LMOC outlet into Birch Bay to monitor ongoing background conditions. Loggers will be installed at three sites (SMP-5L, SMP-5M and SMP-5R) located across the width of the bay.

Aerial image capture with drones may be considered to augment the permanent turbidity monitoring locations and allow identification of potential sediment plumes during construction that could then inform the deployment of a monitoring crew to a specific area of concern to obtain handheld logger readings.

1.3.2 Commissioning

- SMP-1 will be located in Watchorn Bay approximately 1 km upstream of the shoreline at the entrance to the LMOC to monitor ongoing background conditions. Loggers will be installed at three sites (SMP-1L, SMP-1M and SMP-1R) located across the width of the bay. These will be the same locations selected for monitoring of background conditions during in-lake construction activities at the inlet.

- SMP-4 will be located approximately 250 to 300 m downstream of the shoreline at the LMOC outlet into Birch Bay outside the excavation area and beyond the area of in-lake activities during construction. This is a near-field location within the mixing zone prior to fully mixed conditions. Loggers will be installed at two sites (SMP-4L and SMP-4R) located across the channel width to monitor for sediment plumes.
- SMP-5 will be located approximately 2.5 km downstream of the shoreline at the LMOC outlet into Birch Bay in the fully mixed zone of the flow. Loggers will be installed at three sites (SMP-5L, SMP-5M and SMP-5R) located across the width of the bay. The locations of the loggers at the three sites were selected based on the expected sediment plume's shape and extent, as estimated through sediment transport modeling for selected commissioning scenarios. These will be the same locations selected for monitoring of background conditions during in-lake construction activities at the outlet.

Aerial image capture with drones may be considered to augment the permanent turbidity monitoring locations.

1.4 Monitoring Methodology

Both permanent and handheld loggers will be used to collect Tu at the sites described in Section 1.3. The purpose of the permanent loggers would be to monitor Tu on a longer-term basis at pre-determined locations to monitor average conditions across the transect. This will help identify changes in sediment concentrations that may occur during in-lake construction and commissioning activities. The purpose of the handheld loggers would be to track and measure sediment plumes, as well as help identify potential sediment sources and thus assist in formulating mitigation measures. Periodically, Tu measurement will also be conducted using handheld loggers at the permanent logger sites for quality control purposes.

Real-time Tu data from the permanent loggers installed at monitoring sites will be remotely transmitted to a central computer at the construction site at a pre-determined interval (every 15 minutes anticipated) so monitoring results can be evaluated as soon as possible.

The permanent Tu loggers will be equipped with self-cleaning optical sensors with integrated wipers to remove deposits from the sensor's glass and maintain high data accuracy. They will be visited every two weeks to maintain and clean the monitoring system (and free them of any potential algae and vegetation debris) to avoid erratic spikes in data. In addition to planned routine maintenance, the permanent Tu logger will also be inspected and maintained as soon as practicable if the real-time readings indicate a potential problem with the logger (i.e., a logger stops working; erratic readings are obtained; etc.). The details of logger maintenance will be developed depending on the selection of loggers, the supplier's specification and maintenance requirements.

During each maintenance visit, Tu will be measured using handheld loggers, and water samples will be collected for laboratory analysis of TSS to confirm or improve the Tu-TSS relationship. Manual sampling will be performed at near surface, mid-depth, and near-bottom depths to collect data across the entire water column at each site.

2.0 ADAPTIVE RESPONSE PROTOCOLS

2.1 In-Lake Construction

2.1.1 Target Levels

Management of TSS levels during in-lake construction at the inlet will incorporate the following action levels:

1. An average TSS reading of all permanent loggers deployed at the SMP-2 location, based on four consecutive 15-minute averaged measurements, that is equal to or greater than 25 milligram per litre (mg/L) above background TSS at monitoring site SMP-1.
2. An average TSS reading of all permanent loggers deployed at the SMP-2 location, based on a 15-minute averaged measurement, that is equal to or greater than 200 mg/L above background TSS at monitoring site SMP-1. The increase will also be compared against TSS measurements at SMP-1 collected during the pre-construction period.
3. A background TSS reading at monitoring site SMP-1 that is equal to or greater than 25 mg/L above the computed 24-hour rolling average at this location.

Background TSS at monitoring site SMP-1 during construction will be determined by computing the average TSS reading of all permanent loggers deployed at the SMP-1 location, based on four consecutive 15-minute averaged measurements.

Management of TSS levels during in-lake construction at the outlet will incorporate the following action levels:

1. An average TSS reading of all permanent loggers deployed at the SMP-3 location, based on four consecutive 15-minute averaged measurements, that is equal to or greater than 25 mg/L above background TSS at monitoring site SMP-5.
2. An average TSS reading of all permanent loggers deployed at the SMP-3 location, based on a 15-minute averaged measurement, that is equal to or greater than 200 mg/L above background TSS at monitoring site SMP-5. The increase will also be compared against the TSS measurements at SMP-5 collected during the pre-construction period.
3. A background TSS reading at monitoring site SMP-5 that is equal to or greater than 25 mg/L above the computed 24-hour rolling average at this location.

Background TSS at monitoring site SMP-5 during construction will be determined by computing the average TSS reading of all permanent loggers deployed at the SMP-5 location, based on four consecutive 15-minute averaged measurements.

Both proposed action levels (i.e., 25 mg/L and 200 mg/L above background) identified above are below acutely lethal thresholds of suspended sediment for freshwater fish, which range from the hundreds to hundreds of thousands mg/L (DFO, 2000). Exceedance of these action levels will initiate an action plan to identify the source of the TSS and secondary mitigation strategies for unanticipated events as discussed in Section 2.1.2 and/or a modification to the construction procedures. The action levels will be reviewed periodically throughout the construction period and updated if required to optimize the monitoring plan and response protocol.

2.1.2 Adaptive Action Plan for Unanticipated Events

The Adaptive Action Plan for responding to TSS levels will be implemented as soon as possible in response to these results as follows:

When the average displayed TSS output at SMP-2 or SMP-3 is less than 25 mg/L above background at SMP-1 and SMP-5, respectively, results will continue to be monitored and no action will be taken.

When the average TSS reading of all permanent loggers at SMP-2 or SMP-3 associated with four consecutive 15-minute averaged measurements is equal to or greater than 25 mg/L above background at SMP-1 and SMP-5, respectively, but less than 200 mg/L, the following tasks will be carried out:

a) Confirm the results are accurate (i.e., rule out logger malfunction);

b) If possible, take a handheld turbidity reading to confirm the result;

c) Discuss the exceedance with the Manitoba Transportation and Infrastructure;

d) Take action, which includes investigating to try to identify if a project activity is resulting in the recorded TSS increase and if it is still underway, implement effective mitigation. Mitigation may include directing the Contractor to modify work activities, such as (but not limited to):

   - Temporary suspension of work activity
   - Modifying the rate of material placement or removal
   - Modifying the sequence of material placement or removal
   - Installing additional erosion and sediment control measures
   - Verifying the quality of the material being used is appropriate
   - Temporarily moving to a new work area

e) Record the event in the daily report.

When the average TSS reading of all permanent loggers at SMP-2 or SMP-3 associated with a 15-minute average measurement is equal to or greater than 200 mg/L above background at SMP-1 and SMP-5, respectively, the following steps will be taken:

a) Confirm the results are accurate (i.e., rule out logger malfunction);

b) If possible, take a handheld turbidity reading to confirm the result;

c) Discuss the exceedance with the Manitoba Transportation and Infrastructure;

d) Take action, which in this case should be carried out by the Manitoba Transportation and Infrastructure after they evaluate whether the construction activity that resulted in high TSS is still underway. If so, the following measures may be required of the Contractor:

   - Temporary work stoppage
   - Installation of sediment containment
   - Other modifications to construction practices

e) Notify Fisheries and Oceans Canada (DFO); and

f) Record the event in the daily report.

When the average TSS reading of all permanent loggers at SMP-1 or SMP-5 associated with four consecutive 15-minute averaged measurements is equal to or greater than 25 mg/L above the computed 24-hour rolling average at these respective locations, the following steps will be taken:

a) Confirm the results are accurate (i.e., rule out logger malfunction)

b) Discuss the exceedance with the Manitoba Transportation and Infrastructure;

c) Take action, which includes investigating to try to identify if a project activity is resulting in the recorded TSS increase and if it is still underway, mitigation may need to be implemented. This may include advising the Contractor of the need to modify work activities, such as (but not limited to):

   - Temporary suspension of work activity
   - Modifying the rate of material placement or removal
   - Modifying the sequence of material placement or removal
   - Installing additional erosion and sediment control measures (i.e., turbidity curtains)
   - Verifying the quality of the material being used is appropriate
   - Temporarily moving to a new work area

d) Record the event in the daily report.

e) If the exceedance continues for 3 consecutive days, notify DFO and take further action, which in this case should be carried out by the Manitoba Transportation and Infrastructure. The following measures may be required of the Contractor:

   - Temporary work stoppage
   - Installation of sediment containment

2.2 Commissioning

2.2.1 Target Levels

Management of TSS levels during commissioning will incorporate the following action levels measured in the mixing zone at SMP-4 and the fully mixed zone at SMP-5:

1. An average TSS reading of all loggers deployed at the SMP-4 location, based on four consecutive 15-minute averaged measurements, that is equal to or greater than 25 mg/L above the background TSS at monitoring site SMP-1. Given that SMP-4 is located in Birch Bay and the background monitoring reference site SMP-1 is in Watchorn Bay, the SMP-1 measurements will be factored using a relationship that will be developed between the existing environment TSS of the two lakes. Development of potential TSS relationships between the two lakes will consider assessments of natural ranges of TSS that typically occur in the existing environment, natural variabilities in TSS, influences from wind events, and correlation between the TSS concentrations in the two lakes.
2. An average TSS reading of all loggers deployed at the SMP-4 location, based on a 15-minute averaged measurement, that is equal to or greater than 200 mg/L above the background TSS at monitoring site SMP-1. Given that SMP-4 is located in Birch Bay and the background monitoring reference site SMP-1 is in Watchorn Bay, the SMP-1 measurements will be factored using a relationship that will be developed between the existing environment TSS of the two lakes.
3. A computed 24-hour rolling average TSS reading of all loggers deployed at the SMP-5 location that is equal to or greater than 25 mg/l above the 24-hour rolling average TSS reading of all loggers deployed at the SMP-1 location. Given that SMP-5 is located in Birch Bay and SMP-1 is in Watchorn Bay, the SMP-1 measurements will be factored using a relationship that will be developed between the existing environment TSS of the two lakes. The increase at SMP-5 will also be compared against the TSS measurements at SMP-5 collected during the pre-commissioning period

Background TSS at monitoring site SMP-1 during commissioning will be determined by computing the average TSS reading of all loggers deployed at the SMP-1 location, based on four consecutive 15-minute averaged measurements.

Both proposed action levels (i.e., 25 mg/L and 200 mg/L above background) are below acutely lethal thresholds of suspended sediment for freshwater fish, which range from the hundreds to hundreds of thousands mg/L (DFO, 2000). Exceedance of these action levels will initiate an action plan to identify the source of the TSS and secondary mitigation strategies as discussed in in Section 2.2.2 for unanticipated events and/or a modification to the channel commissioning procedures. The action levels will be reviewed periodically throughout the commissioning period and updated if required, to optimize the monitoring plan and response protocol.

2.2.2 Adaptive Action Plan for During Commissioning

The Adaptive Action Plan for responding to TSS levels will be implemented during commissioning (initial gate operation) as soon as possible in response to these results as follows:

When the average displayed TSS output at SMP-4 and SMP-5 is less than 25 mg/L above the factored background SMP-1, results will continue to be monitored and no action will be taken.

When the average TSS reading of all loggers at SMP-4 associated with four consecutive 15-minute averaged measurements is equal to or greater than 25 mg/L above the factored background at SMP-1, but less than 200 mg/L, the following tasks will be carried out:

a) Confirm the results are accurate (i.e., rule out logger malfunction);

b) If possible, take a handheld turbidity reading to confirm the result;

c) Lowering the gates in a controlled manner to reduce TSS concentration flowing downstream until measurements return below the action levels ; and

d) Record the event in the daily report.

When the average TSS reading of all loggers at SMP-4 associated with a 15-minute average measurement is equal to or greater than 200 mg/L above the factored background at SMP-1, the following steps will be taken:

a) Confirm the results are accurate (i.e., rule out logger malfunction);

b) If possible, take a handheld turbidity reading to confirm the result;

c) Discuss the exceedance with the Manitoba Transportation and Infrastructure;

d) Take action, which may include:

- Further lowering of the gates in a controlled manner to reduce outflows and TSS concentrations
- Review and adjustment of controlled gate opening sequence
- Temporary stoppage of commissioning activities

e) Notify DFO; and

f) Record the event in the daily report.

When the computed 24-hour rolling average of all loggers at SMP-5 is equal to or greater than 25 mg/L above the computed 24-hour rolling average factored TSS of all loggers at SMP-1, the following steps will be taken:

a) Confirm the results are accurate (i.e., rule out logger malfunction);

b) Take action, which includes:

- Lowering the gates in a controlled manner to reduce TSS concentration flowing downstream
- Evaluating whether the commissioning activity that resulted in high TSS is still underway. If so, the controlled gate opening sequence should be reviewed and further adjusted.

c) Record the event in the daily report.

d) If the exceedance continues for 3 consecutive days, the following steps will be taken:

- Temporarily stop commissioning activities; and
- Notify DFO.

3.0 REFERENCES

Department of Fisheries and Oceans (DFO) Canada. January 2000. Effects of Sediment on Fish and Their Habitat. DFO Pacific Region Habitat Status Report 2000/01.

APPENDIX 2B

Preliminary Sediment Monitoring Plan and Response Protocol for LSMOC In-Lake Excavation and Commissioning Activities

Preliminary Sediment Monitoring Plan and Response Protocol for LSMOC In-Lake Excavation and Commissioning Activities

1.0 REAL-TIME SEDIMENT MONITORING PLAN

A detailed in-lake real-time total suspended sediment (TSS) monitoring program will be implemented during the course of construction to monitor the magnitude and spatial and temporal changes in TSS within the project area during in-lake construction and commissioning activities. The monitoring program design is based on the expected construction effects on the sedimentation regime in the North Basin of Lake St. Martin and Sturgeon Bay (Lake Winnipeg), and recent experience on other construction projects in the Province of Manitoba. Overall, the design is based on an upstream and downstream approach to capture effects in the initial mixing zone as well as the effects downstream in the fully mixed area. Changes to this plan, if required, will be shared with Indigenous communities, stakeholders and Impact Assessment Agency of Canada (IAAC) will be informed of prior to implementation of changes.

1.1 OBJECTIVES

The sediment monitoring program is intended to document the spatial and temporal variations of TSS concentrations and the magnitude of any increases in the North Basin of Lake St. Martin and in Sturgeon Bay during in-lake construction activities, as well as any increases in Sturgeon Bay during the commissioning stage. The program has been designed to facilitate responses to pre-determined action levels described in Section 2.0.

1.2 MONITORING PARAMETERS

The main parameter being monitored is TSS; however, TSS cannot be measured in real time but must be determined in a laboratory using a water sample. Turbidity (Tu) will be measured as a surrogate using automated in-situ Tu loggers that can measure and report Tu on a real time basis. This is an industry standard approach and has been used in several projects in the Province of Manitoba, including Manitoba Hydro's Wuskwatim and Keeyask Generating Station projects and the Pointe du Bois Spillway Replacement project, as well as the Province of Manitoba Red River Floodway Expansion Project and the Lake St. Martin Emergency Outlet Channel Project. The Coordinated Aquatic Monitoring Program (CAMP) also adopted a similar approach in Manitoba. Typically, the relationship would be expressed in the form of:

$$TSS(\text{mg/L}) = X * Tu(\text{NTU}) + Y,$$

where *X* and *Y* would be calculated using regression analysis.

Relationships between Tu and TSS will be developed prior to construction to facilitate the use of Tu as a surrogate of TSS. Typically, development of the relationships will be based on TSS and Tu data that have been collected in Lake St. Martin and Lake Winnipeg in the past, as well as any additional data that will be collected prior to the in-lake construction activities. The development of relationships will consider ranges of TSS and Tu that typically occur in the existing environment, their natural variabilities, and correlation between the two parameters. In addition, laboratory analysis will be carried out to develop relationships between TSS and Tu using sediment particles that are predominant in the soils located within the project area that may be suspended during construction or commissioning. The relationships will be used to determine if in-lake construction and commissioning activities are causing TSS increases that exceed specific action thresholds so that the corrective actions discussed in Section 2.0 can be implemented in a timely manner. During in-lake work, samples of water at the monitoring stations will be periodically collected and analyzed for TSS to confirm or adjust the Tu-TSS relationship, as required.

The assessment of potential effects on the TSS concentration in the water will be based on an upstream and downstream approach to capture changes in the downstream area.

1.3 MONITORING LOCATIONS

TSS and turbidity will be monitored through deployment of in-situ turbidity loggers at multiple transect locations approximately as shown in Figure 1, Figure 2 and Figure 3. Multiple loggers will be installed at each transect to monitor average conditions across the initial mixing zone as well as in the fully mixed area. The logger locations and purpose will vary depending on whether in-lake excavation work or commissioning activities are underway, as described below. There will be common logger locations (sediment sampling point [SMP]-1, SMP-5, and SMP-6) for both the in-lake excavation and commissioning stages to measure background TSS in the lakes. For the purpose of the in-lake excavation stage, there will be loggers at SMP-2 and at SMP-3 immediately outside of turbidity curtains to make sure that additional TSS that may be generated from the excavation work can be tracked and measured. The commissioning stage will include a logger location at SMP-4 that will be within the mixing zone of additional TSS that could result from the initial gate operation. The logger locations may be modified during the program as more data becomes available to improve and optimize the monitoring plan and response protocol.

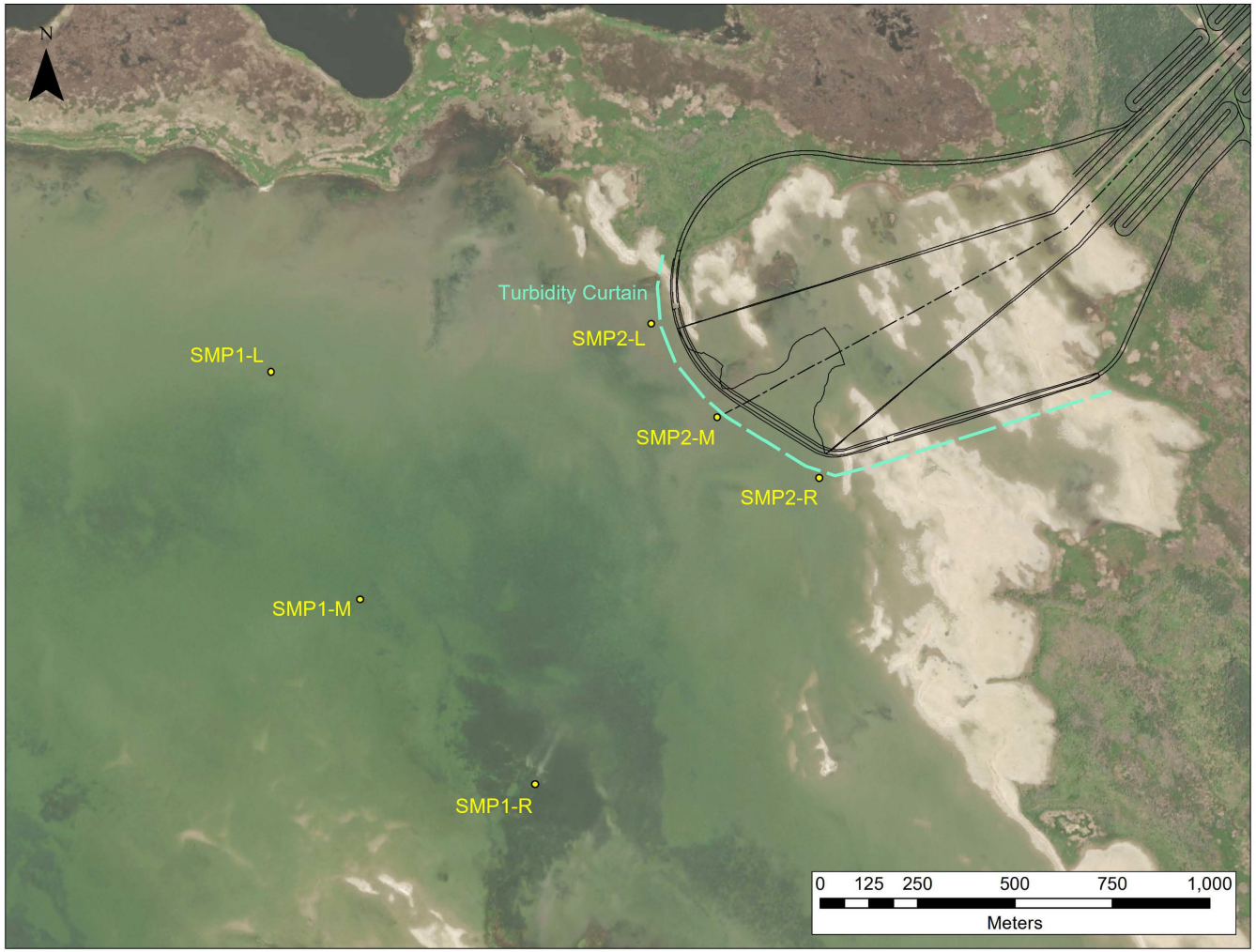


Figure 1: Proposed TSS Monitoring Locations in the North Basin of Lake St. Martin during Inlet Construction

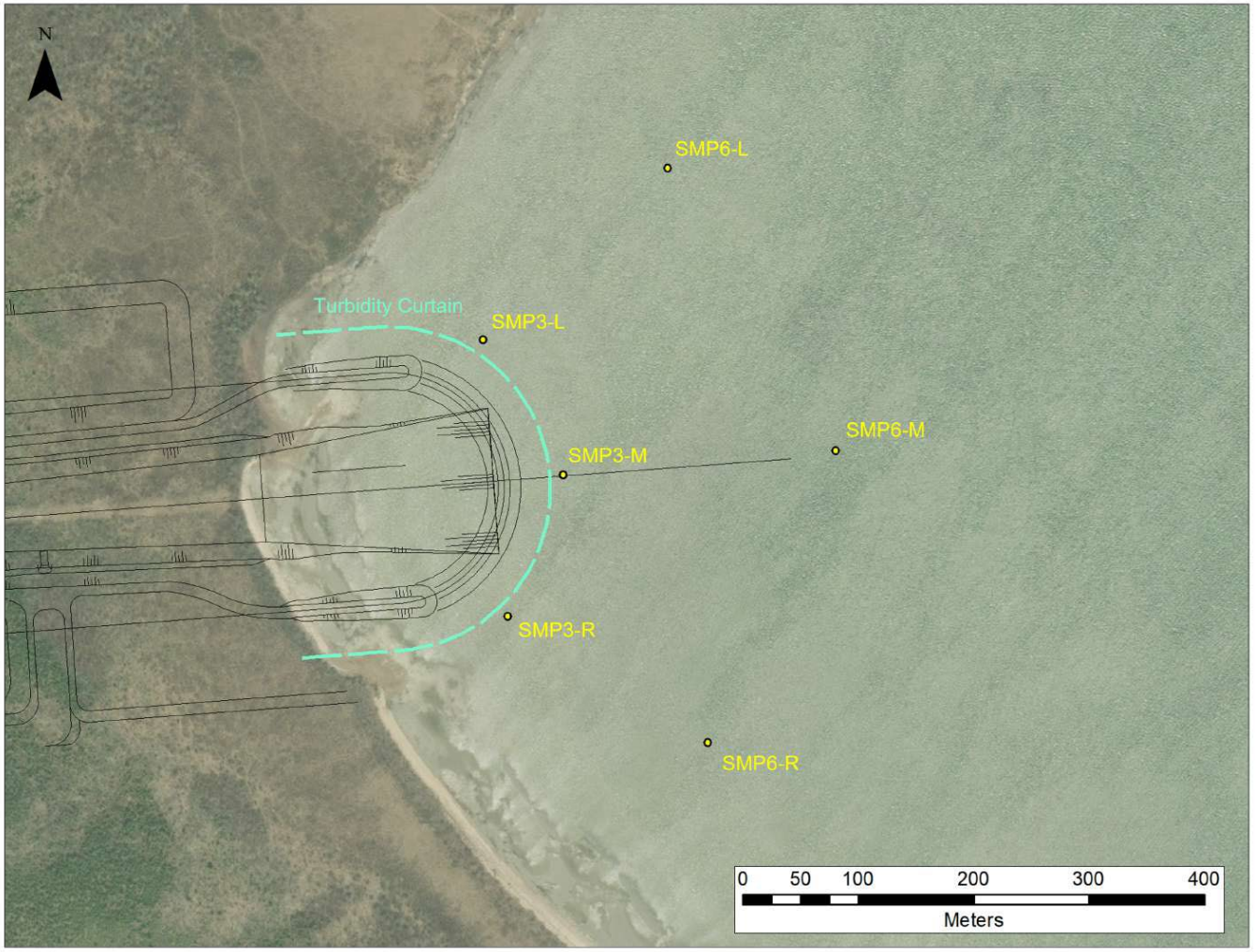


Figure 2: Proposed TSS Monitoring Locations in Sturgeon Bay during Outlet Construction

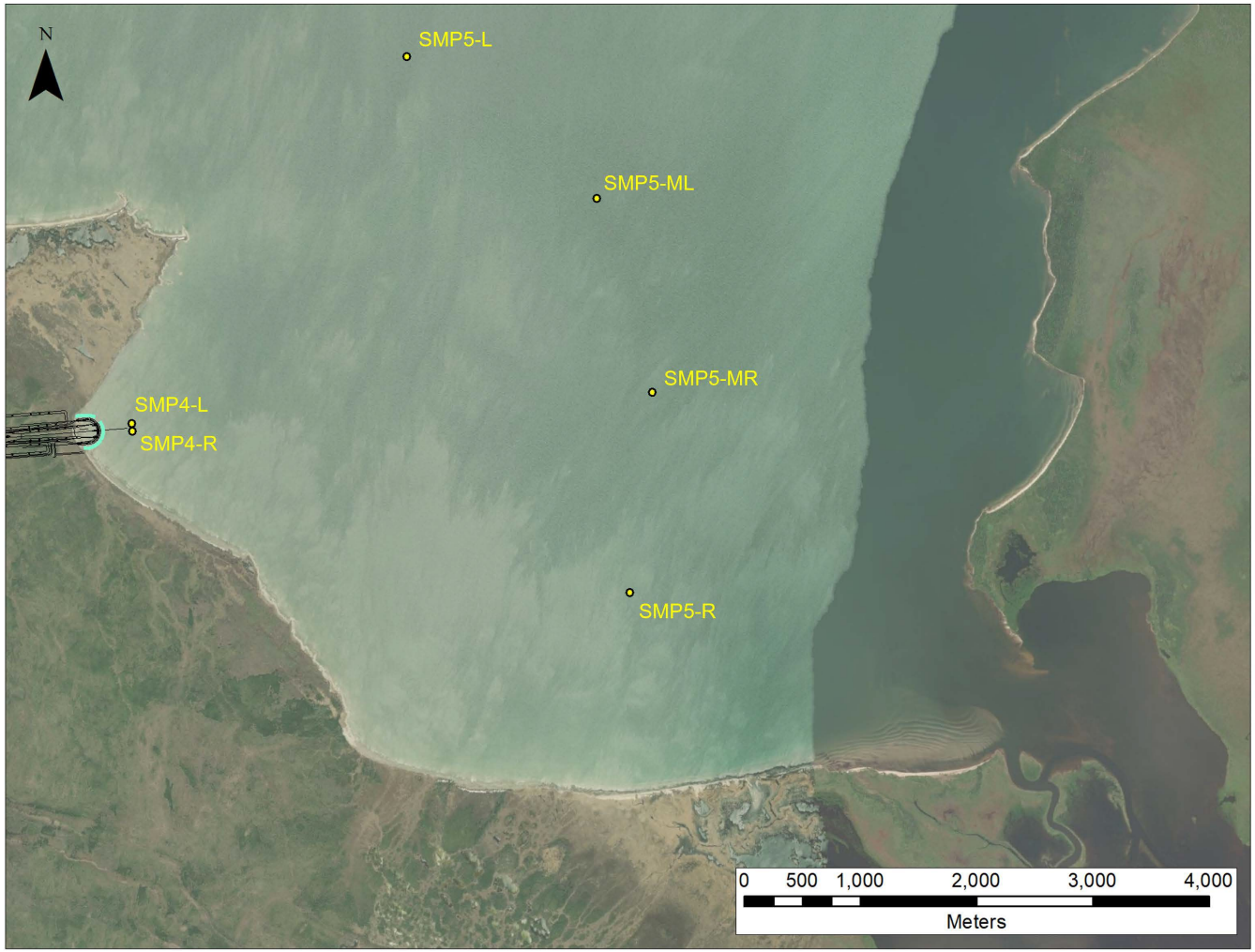


Figure 3: Proposed TSS Monitoring Locations in Sturgeon Bay during Outlet Commissioning

1.3.1 In-Lake Excavation

- SMP-1 will be located in The North Basin of Lake St. Martin approximately 2 kilometre (km) upstream of the shoreline at the entrance to the LSMOC to monitor ongoing background conditions. Loggers will be installed at three sites (SMP-1L, SMP-1M and SMP-1R) located across the width of the bay.
- SMP-2 will be located just outside of the inlet cofferdam double turbidity curtains. Loggers will be installed at three sites (SMP-2L, SMP-2M and SMP-2R) located across the length of the curtain (transect). In addition, multiple measurements along the length of the turbidity curtain will frequently be made using handheld loggers to augment the permanent loggers and detect if any transport of sediment through the curtain is occurring. The frequency and locations of monitoring will be further developed with input from the Contractor based on the construction sequence and methodology. Given the close proximity of the transect to the construction area, handheld logger measurements that will be made at least once a day will provide flexibility to track potential sediment plumes that may not be otherwise detected at the permanent loggers.
- SMP-3 will be located just outside of the cofferdam double turbidity curtain, approximately 200 metres (m) from the shoreline. Loggers will be installed at three sites (SMP-3L, SMP-3M and SMP-3R) located across the length of the curtain (transect). In addition, multiple measurements along the length of the turbidity curtain will frequently be made using handheld loggers to augment the permanent loggers and detect if any potential transport of sediment through the curtain is occurring. The frequency and locations of monitoring will be further developed with input from the Contractor based on the construction sequence and methodology. Given the close proximity of the transect to the construction area, handheld logger measurements that will be made at least once a day will provide flexibility to track potential sediment plumes that may not be otherwise detected at the permanent loggers.
- SMP-6 will be located approximately 500 m downstream of the shoreline at the LSMOC outlet into Sturgeon Bay to monitor ongoing background conditions. Loggers will be installed at three sites (SMP-6L, SMP-6M and SMP-6R) located across the width of the bay.

Aerial image capture with drones may be considered to augment the permanent turbidity monitoring locations and allow identification of potential sediment plumes during construction that could then inform the deployment of a monitoring crew to a specific area of concern to obtain handheld logger readings.

1.3.2 Commissioning

- SMP-1 will be located in The North Basin of Lake St. Martin approximately 2 km upstream of the shoreline at the entrance to the LSMOC to monitor ongoing background conditions. Loggers will be installed at three sites (SMP-1L, SMP-1M and SMP-1R) located across the width of the bay. These will be the same locations selected for monitoring of background conditions during in-lake construction activities at the inlet.

- SMP-4 will be located approximately 500 m downstream of the shoreline at the LSMOC outlet into Sturgeon Bay outside the excavation area and beyond the area of in-lake activities during construction. This is a near-field location within the mixing zone prior to fully mixed conditions. Loggers will be installed at two sites (SMP-4L and SMP-4R) located across the channel width to monitor for sediment plumes.
- SMP-5 will be located approximately 5 km downstream of the shoreline at the LSMOC outlet into Sturgeon Bay in the fully mixed zone of the flow. Loggers will be installed at four sites (SMP-5L, SMP-5ML, SMP-5MR and SMP-5R) located across the width of the bay. The locations of the loggers at the four sites were selected based on the expected sediment plume's shape and extent, as estimated through sediment transport modeling for selected commissioning scenarios.

Aerial image capture with drones may be considered to augment the permanent turbidity monitoring locations.

1.4 Monitoring Methodology

Both permanent and handheld loggers will be used to collect Tu at the sites described in Section 1.3. The purpose of the permanent loggers would be to monitor Tu on a longer-term basis at pre-determined locations to monitor average conditions across the transect. This will help identify changes in sediment concentrations that may occur during in-lake construction and commissioning activities. The purpose of the handheld loggers would be to track and measure sediment plumes, as well as help identify potential sediment sources and thus assist in formulating mitigation measures. Periodically, Tu measurement will also be conducted using handheld loggers at the permanent logger sites for quality control purposes.

Real-time Tu data from the permanent loggers installed at monitoring sites will be remotely transmitted to a central computer at the construction site at a pre-determined interval (every 15 minutes anticipated) so monitoring results can be evaluated as soon as possible.

The permanent Tu loggers will be equipped with self-cleaning optical sensors with integrated wipers to remove deposits from the sensor's glass and maintain high data accuracy. They will be visited every two weeks to maintain and clean the monitoring system (and free them of any potential algae and vegetation debris) to avoid erratic spikes in data. In addition to planned routine maintenance, the permanent Tu logger will also be inspected and maintained as soon as practicable if the real-time readings indicate a potential problem with the logger (i.e., a logger stops working; erratic readings are obtained; etc.). The details of logger maintenance will be developed depending on the selection of loggers, the supplier's specification and maintenance requirements.

During each maintenance visit, Tu will be measured using handheld loggers, and water samples will be collected for laboratory analysis of TSS to confirm or improve the Tu-TSS relationship. Manual sampling will be performed at near surface, mid-depth, and near-bottom depths to collect data across the entire water column at each site.

2.0 ADAPTIVE RESPONSE PROTOCOLS

2.1 In-Lake Construction

2.1.1 TARGET LEVELS

Management of TSS levels during in-lake construction at the inlet will incorporate the following action levels:

1. An average TSS reading of all permanent loggers deployed at the SMP-2 location, based on four consecutive 15-minute averaged measurements, that is equal to or greater than 25 milligram per litre (mg/L) above background TSS at monitoring site SMP-1.
2. An average TSS reading of all permanent loggers deployed at the SMP-2 location, based on a 15-minute averaged measurement, that is equal to or greater than 200 mg/L above background TSS at monitoring site SMP-1. The increase will also be compared against TSS measurements at SMP-1 collected during the pre-construction period.
3. A background TSS reading at monitoring site SMP-1 that is equal to or greater than 25 mg/L above the computed 24-hour rolling average at this location.

Background TSS at monitoring site SMP-1 during construction will be determined by computing the average TSS reading of all permanent loggers deployed at the SMP-1 location, based on four consecutive 15-minute averaged measurements.

Management of TSS levels during in-lake construction at the outlet will incorporate the following action levels:

1. An average TSS reading of all permanent loggers deployed at the SMP-3 location, based on four consecutive 15-minute averaged measurements, that is equal to or greater than 25 mg/L above background TSS at monitoring site SMP-6.
2. An average TSS reading of all permanent loggers deployed at the SMP-3 location, based on a 15-minute averaged measurement, that is equal to or greater than 200 mg/L above background TSS at monitoring site SMP-6. The increase will also be compared against the TSS measurements at SMP-6 collected during the pre-construction period.
3. A background TSS reading at monitoring site SMP-6 that is equal to or greater than 25 mg/L above the computed 24-hour rolling average at this location.

Background TSS at monitoring site SMP-6 during construction will be determined by computing the average TSS reading of all permanent loggers deployed at the SMP-6 location, based on four consecutive 15-minute averaged measurements.

Both proposed action levels (i.e., 25 mg/L and 200 mg/L above background) identified above are below acutely lethal thresholds of suspended sediment for freshwater fish, which range from the hundreds to hundreds of thousands mg/L (DFO, 2000). Exceedance of these action levels will initiate an action plan to identify the source of the TSS and secondary mitigation strategies for unanticipated events as discussed in

Section 2.1.2 and/or a modification to the construction procedures. The action levels will be reviewed periodically throughout the construction period and updated if required to optimize the monitoring plan and response protocol.

2.1.2 ADAPTIVE ACTION PLAN FOR UNANTICIPATED EVENTS

The Adaptive Action Plan for responding to TSS levels will be implemented as soon as possible in response to these results as follows:

When the average displayed TSS output at SMP-2 or SMP-3 is less than 25 mg/L above background at SMP-1 and SMP-6, respectively, results will continue to be monitored and no action will be taken.

When the average TSS reading of all permanent loggers at SMP-2 or SMP-3 associated with four consecutive 15-minute averaged measurements is equal to or greater than 25 mg/L above background at SMP-1 and SMP-6, respectively, but less than 200 mg/L, the following tasks will be carried out:

a) Confirm the results are accurate (i.e. rule out logger malfunction);

b) If possible, take a handheld turbidity reading to confirm the result;

c) Discuss the exceedance with the Owner, Manitoba Transportation and Infrastructure ;

d) Take action, which includes investigating to try to identify if a project activity is resulting in the recorded TSS increase and if it is still underway, implement effective mitigation. Mitigation may include directing the Contractor to modify work activities, such as (but not limited to):

   - Temporary suspension of work activity
   - Modifying the rate of material placement or removal
   - Modifying the sequence of material placement or removal
   - Installing additional erosion and sediment control measures
   - Verifying the quality of the material being used is appropriate
   - Temporarily moving to a new work area

e) Record the event in the daily report.

When the average TSS reading of all permanent loggers at SMP-2 or SMP-3 associated with a 15-minute average measurement is equal to or greater than 200 mg/L above background at SMP-1 and SMP-6, respectively, the following steps will be taken:

a) Confirm the results are accurate (i.e. rule out logger malfunction);

b) If possible, take a handheld turbidity reading to confirm the result;

c) Discuss the exceedance with the Manitoba Transportation and Infrastructure ;

d) Take action, which in this case should be carried out by the Manitoba Transportation and Infrastructure after they evaluate whether the construction activity that resulted in high TSS is still underway. If so, the following measures may be required of the Contractor:

   - Temporary work stoppage

- Installation of sediment containment
- Other modifications to construction practices

e) Notify Fisheries and Oceans Canada (DFO); and

f) Record the event in the daily report.

When the average TSS reading of all permanent loggers at SMP-1 or SMP-6 associated with four consecutive 15-minute averaged measurements is equal to or greater than 25 mg/L above the computed 24-hour rolling average at these respective locations, the following steps will be taken:

a) Confirm the results are accurate (i.e. rule out logger malfunction)

b) Discuss the exceedance with the Manitoba Transportation and Infrastructure ;

c) Take action, which includes investigating to try to identify if a project activity is resulting in the recorded TSS increase and if it is still underway, mitigation may need to be implemented. This may include advising the Contractor of the need to modify work activities, such as (but not limited to):

- Temporary suspension of work activity
- Modifying the rate of material placement or removal
- Modifying the sequence of material placement or removal
- Installing additional erosion and sediment control measures (i.e., turbidity curtains)
- Verifying the quality of the material being used is appropriate
- Temporarily moving to a new work area

d) Record the event in the daily report.

e) If the exceedance continues for 3 consecutive days, notify DFO and take further action, which in this case should be carried out by the Manitoba Transportation and Infrastructure. The following measures may be required of the Contractor:

- Temporary work stoppage
- Installation of sediment containment

2.2 Commissioning

2.2.1 TARGET LEVELS

Management of TSS levels during commissioning will incorporate the following action levels measured in the mixing zone at SMP-4 and the fully mixed zone at SMP-5:

1. An average TSS reading of all loggers deployed at the SMP-4 location, based on four consecutive 15-minute averaged measurements, that is equal to or greater than 25 mg/L above the background TSS at monitoring site SMP-5. The increase at SMP-4 will also be compared against the background TSS measurements at SMP-1.

2. An average TSS reading of all loggers deployed at the SMP-4 location, based on a 15-minute averaged measurement, that is equal to or greater than 200 mg/L above the background TSS at monitoring site SMP-5. The increase at SMP-4 will also be compared against the background TSS measurements at SMP-1.
3. A background TSS reading at monitoring site SMP-5 that is equal to or greater than 25 mg/L above the computed 24-hour rolling average at this location. The increase at SMP-5 will also be compared against the TSS measurements at SMP-5 collected during the pre-commissioning period

Background TSS at monitoring sites SMP-1 and SMP-5 during commissioning will be determined by computing the average TSS reading of all loggers deployed at these locations, based on four consecutive 15-minute averaged measurements.

Both proposed action levels (i.e., 25 mg/L and 200 mg/L above background) are below acutely lethal thresholds of suspended sediment for freshwater fish, which range from the hundreds to hundreds of thousands mg/L (DFO, 2000). Exceedance of these action levels will initiate an action plan to identify the source of the TSS and secondary mitigation strategies as discussed in in Section 2.2.2 for unanticipated events and/or a modification to the channel commissioning procedures. The action levels will be reviewed periodically throughout the commissioning period and updated if required, to optimize the monitoring plan and response protocol.

2.2.2 ADAPTIVE ACTION PLAN FOR DURING COMMISSIONING

The Adaptive Action Plan for responding to TSS levels will be implemented during commissioning (initial gate operation) as soon as possible in response to these results as follows:

When the average displayed TSS output at SMP-4 is less than 25 mg/L above the background at SMP-5, results will continue to be monitored and no action will be taken.

When the average TSS reading of all loggers at SMP-4 associated with four consecutive 15-minute averaged measurements is equal to or greater than 25 mg/L above the background at SMP-5, but less than 200 mg/L, the following tasks will be carried out:

a) Confirm the results are accurate (i.e. rule out logger malfunction) and occurring from commissioning activity;
b) If possible, take a handheld turbidity reading to confirm the result;
c) Lowering the gates in a controlled manner to reduce TSS concentration flowing downstream until measurements return below the action levels ; and
d) Record the event in the daily report.

When the average TSS reading of all loggers at SMP-4 associated with a 15-minute average measurement is equal to or greater than 200 mg/L above the background at SMP-5, the following steps will be taken:

a) Confirm the results are accurate (i.e. rule out logger malfunction) and occurring from commissioning activity;

b) If possible, take a handheld turbidity reading to confirm the result;

c) Discuss the exceedance with the Manitoba Transportation and Infrastructure ;

d) Take action, which may include:

    - Further lowering of the gates in a controlled manner to reduce outflows and TSS concentrations
    - Review and adjustment of controlled gate opening sequence
    - Temporary stoppage of commissioning activities

e) Notify DFO; and

f) Record the event in the daily report.

When the average TSS reading of all loggers at SMP-5 associated with four consecutive 15-minute averaged measurements is equal to or greater than 25 mg/L above the computed 24-hour rolling average at this location, the following steps will be taken:

a) Confirm the results are accurate (i.e. rule out logger malfunction) and occurring from commissioning activity;

b) Take action, which includes:

    - Lowering the gates in a controlled manner to reduce TSS concentration flowing downstream
    - Evaluating whether the commissioning activity that resulted in high TSS is still underway. If so, the controlled gate opening sequence should be reviewed and further adjusted.

c) Record the event in the daily report.

d) If the exceedance continues for 3 consecutive days, the following steps will be taken:

    - Temporarily stop commissioning activities; and
    - Notify DFO.

3.0 REFERENCES

Department of Fisheries and Oceans (DFO) Canada. January 2000. Effects of Sediment on Fish and Their Habitat. DFO Pacific Region Habitat Status Report 2000/01.