Churchill River Diversion

Final Report: Lower Churchill River Ecohydraulics Study

Study undertaken pursuant to conditions outlined in the Churchill River Diversion Water Power Act Final Licence Cover Letter

Prepared by: Manitoba Hydro
August 24, 2026

Prepared for: Environmental Approvals Branch - Environment & Climate Change, Government of Manitoba

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Land Acknowledgement

Manitoba Hydro has a presence right across Manitoba – on Treaty 1, Treaty 2, Treaty 3, Treaty 4 and Treaty 5 lands – the original territories of the Anishinaabe, Anishininew, Cree, Dakota, and Dene peoples and the National Homeland of the Red River Métis.

We also acknowledge the ancestral lands of the Inuit in northern Manitoba. We acknowledge these lands and pay our respects to the ancestors of these territories.

The legacy of the past remains a strong influence on Manitoba Hydro's relationships with Indigenous communities today, and we remain committed to establishing and maintaining strong, mutually beneficial relationships with Indigenous communities.

Executive Summary

This study was completed by Manitoba Hydro (MH) in collaboration with Manitoba (MB) Fisheries to address a requirement identified in the cover letter accompanying the Churchill River Diversion (CRD) Water Power Act Final Licence issued by the Province of Manitoba. The study has improved understanding of how current CRD operations influence fish habitat downstream of the Missi Falls Control Structure (CS) through hydrologic analysis, physical environment monitoring, hydraulic modelling (including extensive topo-bathymetric data collection), desktop fish habitat assessments, and engagement with Indigenous communities.

MH acknowledges that the CRD has permanently changed flow conditions in the lower Churchill River and that these changes have reduced wetted area, altered hydraulic conditions, and affected habitat availability and connectivity. Hydraulic modelling demonstrates that habitat availability remains strongly influenced by flow, with some species and life stages experiencing substantial habitat limitations under portions of the modelled flow range.

For this study, Walleye, Lake Whitefish, and Lake Sturgeon were selected as target species based on known distributions, provincial Fisheries Management Objectives, cultural importance and from a resource use perspective. Habitat criteria were developed using published literature, regional monitoring data, available fisheries data, and professional judgement.

Modelling showed that habitat was available for target species and life stages across most of the modelled flow range; however, spawning/larval habitats were substantially limited under portions of the modelled flow range. Lake Sturgeon and Lake Whitefish spawning habitat was limited under low flow conditions, with no suitable Lake Sturgeon spawning habitat identified under the lowest flow scenario modeled at the Little Churchill River confluence. Lake Sturgeon and Lake Whitefish spawning habitat increased with flow, while Walleye spawning habitat declined substantially under high flows. These results indicate that suitable spawning habitat is constrained by species-specific hydraulic thresholds and is not continuously available across the modelled flow range. This finding is important for future considerations because actions that benefit one species may not provide equivalent benefits for others.

Monitoring data collected through the Coordinated Aquatic Monitoring Program (CAMP) indicates that Walleye, Lake Whitefish, Northern Pike, and White Sucker dominate the fish community of the lower Churchill River, while Lake Sturgeon are concentrated near the confluence of the lower Churchill and Little Churchill rivers. Monitoring undertaken by MH and Tataskweyak Cree Nation (TCN) has shown there to be a stable and self-sustaining population of Lake Sturgeon at the confluence, but that this population is limited in distribution, and represents the sole remaining sturgeon population present in the lower Churchill River (Dolce-Blanchard and Barth 2015; Ambrose and McDougall 2016; 2018; Ambrose et. al. 2017; AAE Tech Services 2025 a,b). Aging data collected by the CAMP demonstrates ongoing (if variable) recruitment of Walleye and Lake Whitefish over recent decades, indicating that fish populations remain self-sustaining despite the substantial changes to the aquatic environment that occurred following CRD implementation.

Results from the physical environment monitoring program indicate that water quality conditions within the monitored reaches generally support fish habitat functions. Dissolved oxygen concentrations remained above applicable guideline thresholds for most of the monitoring period, and turbidity levels were generally low throughout the study area. Together, these findings do not indicate widespread water quality limitations within the monitored reaches. However, the available monitoring record is limited both spatially and temporally, and additional monitoring would improve understanding of water quality variability throughout the lower Churchill River.

Collectively, the study provides an assessment of current fish habitat conditions downstream of the Missi Falls CS and establishes an important technical foundation for future monitoring and research. The results of this study demonstrate that flow remains a key factor influencing the availability and distribution of suitable fish habitat within the study area. As a whole, the study improves the understanding of the relationship between flow, hydraulics, and fish habitat on the lower Churchill River and identifies opportunities to strengthen long-term environmental monitoring through both the CAMP and monitoring that may be undertaken by the Churchill–Burntwood Regional Monitoring Committee.

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List of Acronyms

2D	Two-Dimensional
AFP	Augmented Flow Program
BL	Billard Lake
CRD	Churchill River Diversion
CS	Control Structure
DEMs	Digital Elevation Models
DO	Dissolved Oxygen
FL	Fidler Lake
FNU	Formazin Nephelometric Units
HIS	Habitat Suitability Index
LSSEP	Lake Sturgeon Stewardship and Enhancement Program
MB	Manitoba
MH	Manitoba Hydro
MWQSOG	Manitoba Water Quality Standards, Objectives and Guidelines
NCN	Nisichawayasihk Cree Nation
NFA	Northern Flood Agreement
NIL	Northern Indian Lake
OPCN	O-Pipon-Na-Piwin Cree Nation
PBL	Partridge Breast Lake
PEMP	Physical Environment Monitoring Program
RCEA	Regional Cumulative Effects Assessment
RMC	Regional Monitoring Committee
TCN	Tataskweyak Cree Nation
TU	Turbidity
WPA	Water Power Act
WSC	Water Survey of Canada
WT	Water Temperature
YOY	Young-of-Year

1.0 Introduction

This report has been prepared to fulfill a requirement identified in the cover letter accompanying the Churchill River Diversion (CRD) Water Power Act (WPA) Final Licence issued by the Province of Manitoba.

As part of preparations for CRD licence renewal, Manitoba Hydro (MH) was requested to work with Manitoba to undertake studies that may be employed to improve the environment for fish downstream of the Missi Falls Control Structure (CS).

MH operates the CRD in accordance with the Final Licence for the diversion of water from the lower Churchill River to the Nelson River, and the impoundment of water on the Rat River and Southern Indian Lake. This Final Licence was issued in accordance with the provisions of The Water Power Act on May 12, 2021, and is in effect until September 1, 2026.

In the Final Licence cover letter, Manitoba included:

> *"Manitoba acknowledges the traditional importance of the fishery to Indigenous resource users, has heard their concerns about the ongoing impacts of the project, and recognizes the activities and Agreements that MH has undertaken to address these impacts. In preparation for renewal of the Final Licence and participation in large area planning, it is expected that MH will work with Manitoba to undertake studies that may be employed to improve the environment for fish downstream of Missi control structure. These may include habitat studies, investigating flow regime scenarios, and any associated analysis."*

This report documents the ecohydraulic study and engagement activities undertaken by MH in collaboration with Manitoba Fisheries Branch to address this WPA licence cover letter requirement. The results provide improved information on, and understanding about, the physical habitat conditions, hydraulic conditions, and habitat availability downstream of the Missi Falls CS.

1.1 Study Approach & Objectives

The purpose of the study was to characterize hydraulic conditions and assess their implications on fish habitat availability and movement downstream of Missi Falls CS under the current CRD operating regime.

The study combined hydrotechnical analysis, hydraulic modeling, physical environment and bathymetric data collection and processing, and desktop assessment of fish habitat to characterize current ecohydraulic conditions downstream of the Missi Falls CS.

Bathymetric data were collected along approximately 380 km of the lower Churchill River from the inlet of Northern Indian Lake (NIL) to Hudson Bay. Physical environment monitoring was undertaken within a primary study area extending approximately 300 km along the lower Churchill River from Partridge Breast Lake (PBL) to Red Head Rapids. Hydraulic modelling and habitat assessments were focused on two model reaches: NIL to Billard Lake (BL) and the Little Churchill River confluence area (Figure 1-1; Map 1 in Appendix D).

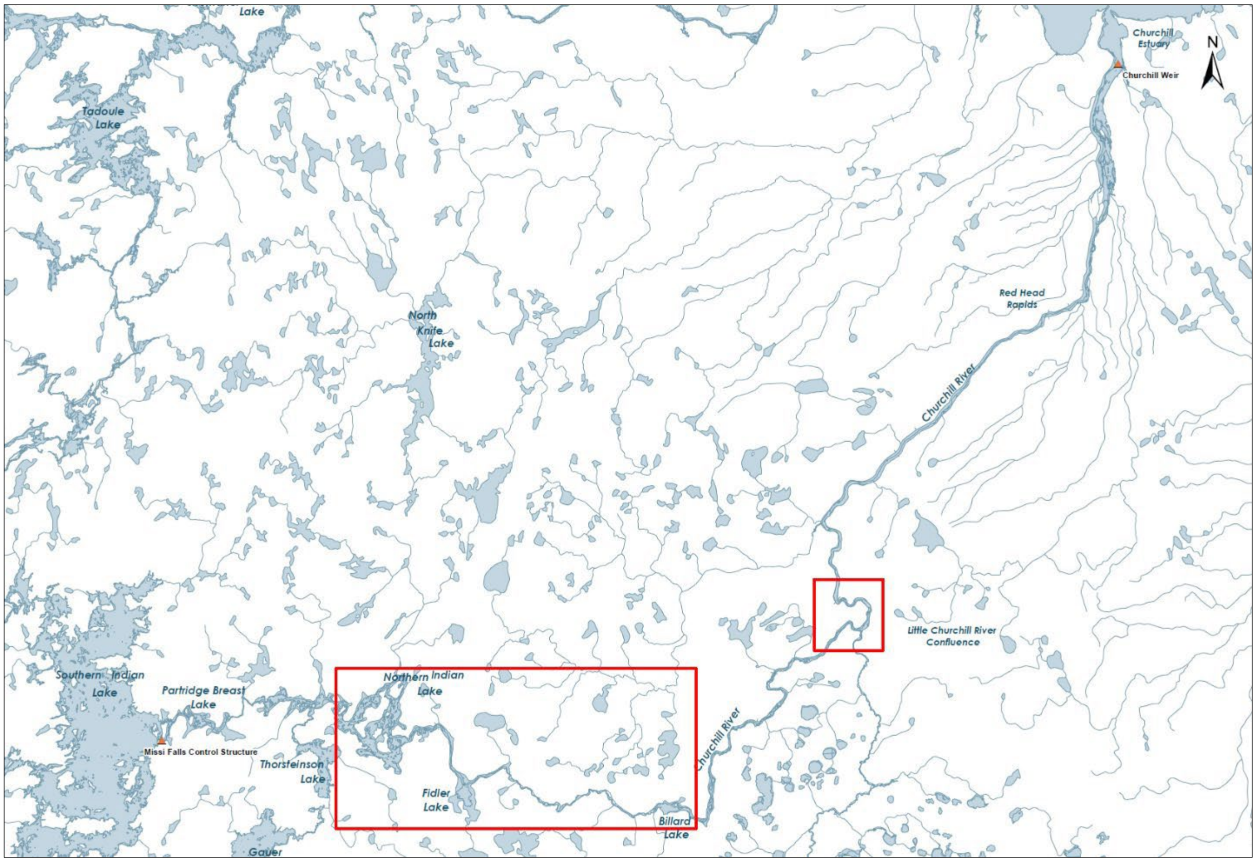

Figure 1-1: Lower Churchill River model domains

The analysis undertaken for the model reaches integrated existing monitoring data, newly developed digital elevation models (DEMs), and two-dimensional (2D) hydraulic models developed for key reaches of the lower Churchill River. The key outputs of the analysis include quantification of wetted area, water depths, and water velocities as they relate to fish habitat and barriers to movement under representative CRD flow conditions.

Fish habitat assessments were completed using species- and life stage-specific habitat criteria developed in collaboration with Manitoba Fisheries Branch. Where appropriate, the study also considered the Manitoba Fisheries Branch Management Objectives (Appendix B) for the Churchill River issued by Manitoba Fisheries Branch in September 2024. The resulting analyses provide information on the quantity of habitat available and potential barriers to fish movement under a range of flow conditions.

The study also included opportunities for engagement with Indigenous communities known to have an interest in the study area.

1.2 Collaboration with Manitoba Fisheries Branch

MH worked with staff from Manitoba Fisheries Branch to plan and implement this study. MH and Manitoba Fisheries Branch staff collaborated on multiple aspects of the study, including:

- Development of the study approach
- Planning for and participating in engagement with Indigenous communities
- Collection of field data
- Selection of target species
- Establishment of species and life stage specific habitat criteria
- Reviewing and interpreting modeling outputs

This collaboration occurred through emails, phone calls and scheduled meetings. In total, 16 meetings with the Manitoba Fisheries Branch were held between 2024 and 2026 to support study development and implementation.

Separately, MH met with and shared the study scope and objectives with Manitoba Environmental Approvals Branch (EAB) before finalizing the study approach. MH began submitting bi-monthly progress reports to EAB on August 30, 2024 for this study outlining the background, approach, progress achieved, next steps and schedule. MH recently submitted “Bi-Monthly Report #12 on the CAMP Expansion and Lower Churchill River Study” on June 26, 2026. All the Bi-Monthly reports are publicly available at:

https://manitoba.ca/sd/about/articles-and-publications/index.html?wg=camp

1.3 Report Structure

This report is organized as follows:

- Section 2.0 summarizes community engagement and information-sharing activities undertaken throughout the study, including engagement with Indigenous communities and the Churchill-Burntwood Regional Monitoring Committee (RMC).
- Section 3.0 describes the CRD, the evolution of CRD operating parameters and the extensive hydrometric data monitoring and collection program that provide water level and flow data essential for the development of the hydraulic models required to perform the ecohydraulic studies.

- Section 4.0 describes the study region, including the physical setting, study area boundaries, and available environmental information used to support the assessment.
- Section 5.0 presents the ecohydraulic studies completed as part of this assessment, including data collection and processing, hydrotechnical analyses, hydraulic model development, habitat assessment methods, and evaluation of habitat conditions and barriers to fish movement under representative post-CRD flow conditions.
- Section 6.0 presents concluding comments and notes future opportunities for monitoring and community-led studies through the CAMP and the Churchill-Burntwood Regional Monitoring Committee.

2.0 Community Engagement

While this report focuses on the engagement process undertaken for specifically for this study (sometimes referred to as the 'Missi Falls Study'), it is important to note that this process occurred within the context of longstanding relationships between MH and the Indigenous Nations and communities in the region. For many years, MH has worked with communities, resource user groups, and associations through settlement agreement processes, mitigation and monitoring programs, and ongoing communications to address the impacts of the CRD and strengthen working relationships. These efforts have included the Northern Flood Agreement (NFA) and related claims process, Comprehensive NFA Implementation Agreements, and other settlement agreements. The implementation of these agreements often requires ongoing collaboration among the parties.

In some cases, formal forums have been established to support agreement implementation and discuss matters of mutual interest. For communities involved in this study, these forums include the Tataskweyak Cree Nation Executive Implementation Committee, Environmental Monitoring and Investigation meetings with Nisichawayasihk Cree Nation, the South Indian Lake Environmental Steering Committee, and the Churchill Executive Implementation Committee.

MH also works with the communities engaged as part of this study to implement a range of monitoring, mitigation and other engagement initiatives. Information about these activities is provided in MH's annual reports to Manitoba Environment and Climate Change regarding engagement with Indigenous communities on the continued operation of the CRD. These reports can be found on the Manitoba Government's website at:

https://www.gov.mb.ca/sd/water/water-power/churchill/index.html

Although these forums and initiatives are not exclusively focused on the CRD, they provide ongoing opportunities to share information, discuss operational matters, and better understand community perspectives and concerns, including those related to Missi Falls operations. This report does not provide a comprehensive account of discussions that have occurred through agreement forums or during the implementation of various programs, initiatives, and mitigation measures. Rather, it focuses specifically on the engagement process undertaken for this study in recent years.

2.1 The Engagement Process

At the onset of this study, MH, in partnership with the Manitoba Fisheries Branch, designed the study approach to provide opportunities for engagement with communities with an interest in the study area. MH has sought community participation and shared information about the study as it progressed.

Community engagement was designed as a phased process that would allow for community feedback throughout the duration of the study (ending September 2026). MH initially proposed four phases of engagement for the study:

> **Phase 1 - Initial Invitation and Community Leadership Meetings**: Meetings with community leadership to discuss the study approach, anticipated timelines, engagement process, and invitation to participate.
>
> **Phase 2 - Meetings with Resource Users and Knowledge Keepers**: Meetings with resource users and knowledge keepers to hear their understandings of the river system and gather insights and local knowledge of the river, fish populations, fish habitat, and field work priorities and locations.
>
> **Phase 3 - Sharing Modeling and Field Work Plans**: Sharing modeling and field work plans along with summaries of data collected, and developing data sharing agreements where needed.
>
> **Phase 4 - Sharing Initial Study Results**: Sharing initial study findings with communities as well as information on “what we heard” through engagement and how it was included in the analysis and reporting. Share the final report.

Communities identified for engagement and as having interest in the study area included Nisichawayasihk Cree Nation (NCN), O-Pipon-Na-Piwin Cree Nation (OPCN), Tataskweyak Cree Nation (TCN) and the Town of Churchill (Churchill).

2.2 Engagement Outcomes

In the fall of 2024, MH initiated Phase 1 of planned engagement activities by sending a letter along with background information to communities with an interest in the study area and inviting leadership to meet and discuss the proposed study. In person meetings between MH, Manitoba Fisheries Branch, and communities took place in November and December 2024.

This first round of engagement aimed to:

- share information on the study, including the proposed study approach, anticipated timelines, and a process of engaging and sharing information throughout the study;
- hear community leadership's thoughts on the planned activities;
- determine if and how communities would like to participate, including sharing Indigenous Knowledge that could be incorporated to strengthen the study;
- understand community perspectives on how field studies should occur; and
- explore opportunities to work with resource users and knowledge keepers from communities to hear their understandings of fish populations and habitat on the lower Churchill River.

Initial meetings occurred with NCN on November 21, 2024, OPCN on November 22, 2024, and TCN on December 20, 2024. Efforts were made to meet with the Town of Churchill, but an initial meeting did not occur.

In these initial meetings, both TCN and OPCN indicated they were not prepared to commit to future participation in the study. Concerns were expressed regarding the scope and timeline for the study, and the potential for participation to be perceived or documented as support for the CRD and its WPA relicensing. TCN expressed a desire to speak to the Manitoba EAB independent of MH before further engaging with MH on this study. OPCN expressed concern that the scope of analysis did not include modeling the Churchill River without the Augmented Flow Program (AFP; see section 3.2 for a description of the AFP). They also expressed concern that the planned study area was limited to downstream of the Missi Falls CS and did not include Southern Indian Lake.

NCN indicated interest in the study but also communicated the importance of participation by other communities. Follow-up efforts were made to hold meetings with resource users from NCN that use the river downstream of Missi or that have historical knowledge of the area. For a variety of reasons, meetings with NCN resource users did not occur.

Following the initial meetings with community leaders, MH shared meetings summaries and sent follow-up information regarding any questions that could not be answered immediately in the meetings.

Based on the feedback received regarding participation, the study and engagement plans were modified. MH continued to share study information and progress via email, field work notices, and existing forums where possible (e.g. at separate annual MH-led spring communication meetings with community leadership).

At the same time, MH continued to proceed with hydrotechnical data collection in the winter of 2024 and summer of 2025 and ensured that communities were informed of study field work and activities.

MH was able to share preliminary study findings with NCN, OPCN and Churchill at a meeting on June 18, 2026 in Thompson. Presentation materials were shared with attendees following the meeting. TCN was unable to attend the June 18th meeting; however, a copy of the presentation materials was provided to the community along with an offer to meet separately to review the materials with community leadership. TCN expressed interest in a separate meeting, which was subsequently held on July 22, 2026.

In both the June 18 and July 22 meetings, community participants expressed interest in the information and took part in an engaging discussion regarding the material. Questions and comments were raised regarding the study specifically, and also about broader operational and environmental issues, including:

- The impact of wildfires on water quality;
- The relationship between dissolved oxygen and algae;
- Whether communities had shared the results of their own data collection and analysis regarding sturgeon in the region;
- Methodological queries related to specific aspects of the hydrotechnical model;
- Whether the hydrotechnical model would be extended to the entire length of the Churchill River;
- The accuracy of bathymetry data;
- The possibility for additional ice condition monitoring in future years; and
- Whether flow data would be shared with the Wuskwatim partners.

During the July 22 meeting, TCN requested an additional meeting to review and discuss the data collected and prepared as part of this study in more detail. It is anticipated that this meeting will occur in the near future. It is also anticipated that conversations started in these meetings will continue into the future via the Churchill and Burntwood Rivers Regional Monitoring Committee.

3.0 The Churchill River Diversion

3.1 Description of the CRD

The Churchill River Diversion (CRD) was approved in 1973 by the Province of Manitoba with the granting of a Water Power Act Licence. The objective was to improve downstream hydropower generation by transferring water from the Churchill River to the Nelson River via the Rat River and the Burntwood River. The Churchill River Diversion was constructed between 1973 and 1977. The CRD has three main operating components: the Missi Falls CS, the South Bay Diversion Channel and the Notigi CS. Two mitigatory structures were built at Manasan Falls upstream of the City of Thompson and near the Town of Churchill. Extent and components of the CRD are shown below in Figure 3-1.

- The Missi Falls CS, built between 1973 and 1976, is located at the outlet of Southern Indian Lake into the Churchill River, 170 km north of Thompson. This structure regulates the amount of water allowed to pass down the Churchill River at the natural outlet from Southern Indian Lake. Missi Falls CS consists of six spillway bays as well as earth dams and dikes. The CS is capable of discharging 3,200 m^3/s at a forebay level of 258.32 m. Major components include the spillway control structure, south channel dam, north channel dam, main dam, and south dike.
- The South Bay Diversion Channel created a new outlet to allow Churchill River water to flow into the Rat River-Burntwood River-Nelson River system, diverting water from the South Bay of Southern Indian Lake to Issett Lake. The channel is approximately 61 m wide at its base and 9.3 km long.
- Notigi CS, a control dam on the Rat River, regulates the amount of water released through the diversion route into the Nelson River. It creates an impoundment on Rat Lake.
- Subsequently, two mitigation components were added: the Manasan CS in 1976 and the Churchill Weir in 1999. The Manasan CS on the Burntwood River, which includes a weir, reduces the risk of ice jam flooding in Thompson. The Churchill Weir increases upstream water levels on the Churchill River to enhance access, improve and maintain fish habitat, and ensure a potable water source for the Town of Churchill.

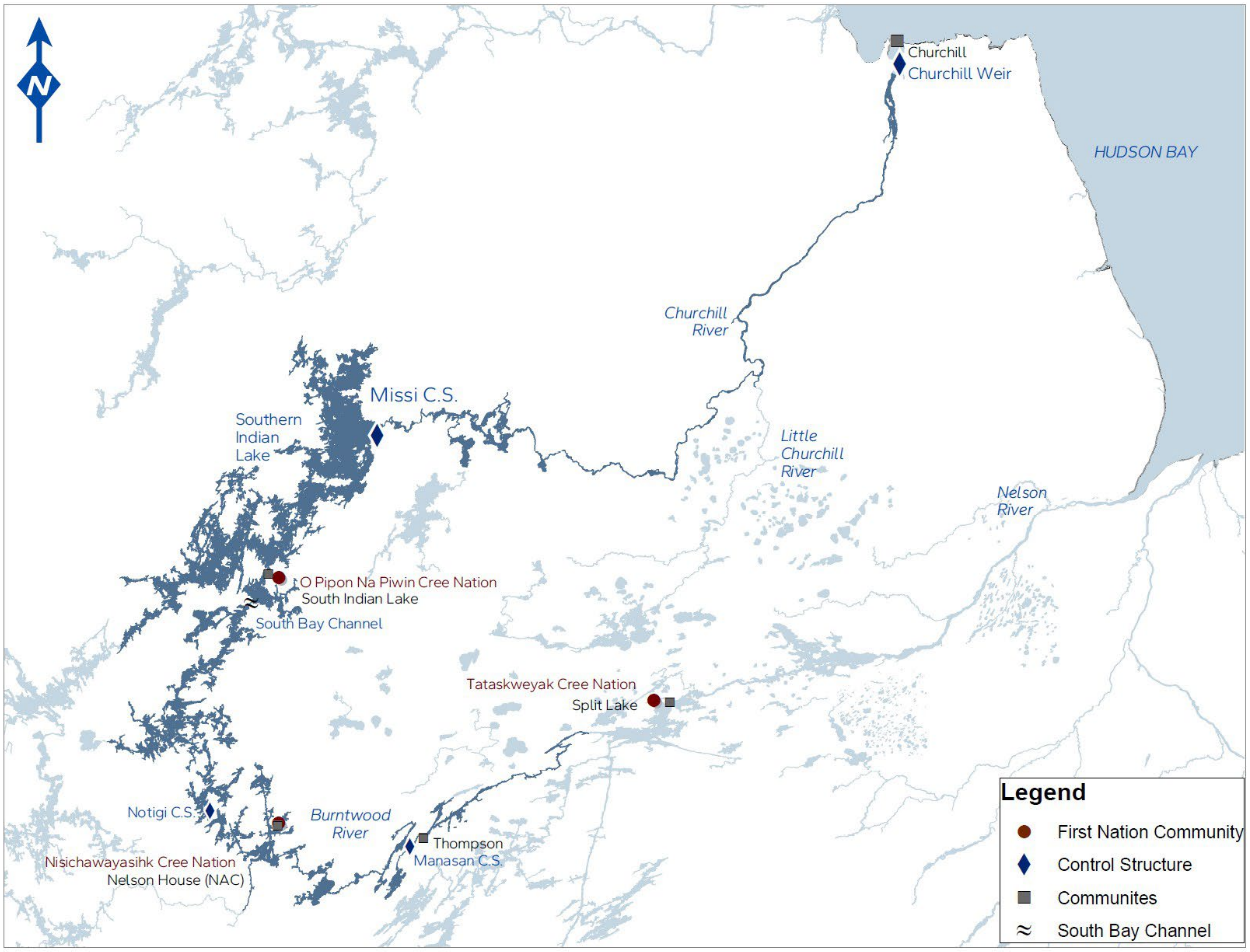

Figure 3-1: Map of Churchill River Diversion

With the CRD in place, water is impounded in Southern Indian Lake and approximately 80% of the Churchill River flow is diverted through the South Bay Diversion Channel down the Rat and Burntwood rivers to Split Lake using the Notigi CS to control the releases.

The remaining flow is released by the Missi Falls CS into the lower Churchill River. Natural tributary inflows from contributing watersheds such as the Little Churchill River, Gauer River, and numerous smaller tributaries also flow into the lower Churchill River. Consequently, flows within the lower Churchill River vary as a function of both CRD operations and natural hydrologic inputs. Moving downstream from Missi Falls, the influence of local tributary inflows becomes increasingly important, particularly during freshet and high runoff periods. (Manitoba Hydro and Manitoba Government, 2015, Section 4.2)

3.2 Evolution of CRD Operating Parameters

Full CRD operations began in 1977, pursuant to an Interim Water Power Act Licence. Operating parameters outlined in the Interim Licence were set based on the anticipated impacts of operations on winter ice. After initial operations revealed fewer impacts from winter ice than initially anticipated, MH requested approval to test higher diversion flows over a wider range of Southern Indian Lake water levels. This request was approved in 1979 and was followed by a series of "Test Programs" conducted from 1979 to 1985 that examined the physical capabilities of the diversion channel and impacts to the lower Churchill River.

From 1986 to 2021, following this testing phase, MH sought and received identical annual approvals for what became known as the Augmented Flow Program (AFP). The AFP allowed MH to deviate from the Interim Licence by diverting more water on average from the Churchill River into the Nelson River. This was accomplished with an increase in allowable discharges at the Notigi CS and a wider range of levels on Southern Indian Lake. By increasing the available storage volume within Southern Indian Lake, MH gained greater flexibility to retain water during periods of surplus inflow and release or divert water during periods of high system demand. The CRD has operated in this way since 1986.

The Final Water Power Act Licence for the CRD was issued in 2021 and embedded the AFP within the licence operating parameters. (Manitoba Conservation and Climate, 2021). As such, the AFP is no longer a separately approved program under the Water Power Act. All current MH forecasts and operating decisions are based on the parameters outlined in the Final CRD Water Power Act Licence.

4.0 Overview of the Study Region

4.1 Study Area

The study region encompasses the lower Churchill River downstream of the Missi Falls CS to the river outlet at Hudson Bay. This approximately 400 km river system comprises a diverse range of aquatic environments, including large lake basins, river reaches, rapids, tributary confluences, and the estuarine transition zone near Churchill. Major waterbodies within the study area include PBL, NIL, Fidler Lake (FL), and BL. Key tributaries include the Little Churchill River and Gauer River, which contribute an increasing proportion of total flow moving downstream from Missi Falls CS due to the reduced mainstem discharge resulting from the CRD.

Within the broader study region, a more focused Regional Study Area was identified. Within this Regional Study Area, detailed hydraulic modelling focused on two representative reaches where hydraulic conditions were considered particularly relevant to fish habitat and connectivity, and high-quality bathymetric and topographic data were available: These focus reaches are:

- Reach 1: NIL to BL, encompassing the river-lake system extending through NIL, FL and BL; and
- Reach 2: The Fours to Swallow Rapids, including the confluence of the lower Churchill and Little Churchill rivers, and the downstream reach to Swallow Rapids.

These representative reaches include hydraulic conditions across a range of habitat types and geomorphic settings present within the lower Churchill River, including lake outlets, rapids, shallow dewatered margins, and major tributary confluences. Together, they provide representative examples of the hydraulic processes that influence fish habitat availability and barriers to movement in the study area. Reaches 1 and 2 are identified on Figure 1-1 *(*Map 1 in Appendix D).

4.2 Environmental Overview of the Lower Churchill River

The operation of the CRD and Missi Falls CS has a substantial impact on water levels, flows, and aquatic habitat both upstream on Southern Indian Lake and downstream along the Churchill River. While the CRD met the environmental regulatory requirements in effect at the time it was developed, there were limited studies undertaken to quantify and understand the impacts associated with the CRD. All available studies (pre- and post-CRD) up to 2014 were included in the Manitoba/MH Regional Cumulative Effects Assessment (RCEA).

4.2.1 Lake Winnipeg, Churchill and Nelson Rivers Study Board

The primary study that examined the potential environmental effects of the CRD prior to its implementation was the Lake Winnipeg, Churchill and Nelson Rivers study. This study started in 1971 and was undertaken to determine the effects of the Churchill River Diversion and Lake Winnipeg Regulation on social, economic and environmental conditions, make recommendations on the design and operation of the projects and recommend remedial measures to lessen undesirable effects. The study took over three years to complete and involved experts from federal and provincial agencies, universities and consulting firms.

The study board report predicted that the CRD would substantially reduce water levels, flows and fish habitat in the lower Churchill River, resulting in declines in fish productivity, impaired spawning success and the eventual loss of commercial fishery viability in PBL, NIL, FL, and BL.

In anticipation of these impacts, salvage fisheries were undertaken in 1975 on PBL, NIL, FL, and BL to allow fishers to harvest fish before the CRD went into service. The program supported fishers in harvesting fish before water levels declined and fish habitat was reduced as a result of the CRD. The salvage fisheries were substantial, particularly on NIL, and resulted in the harvest of more than 320,000 kg of fish from the four lakes.

Post-project monitoring and assessment confirmed the predicted reductions in fish habitat and fishery productivity. Subsequent settlement agreements with impacted communities and resource users were established to address the impacts of these changes, as well as other adverse effects associated with the CRD.

4.2.2 Summary of Lower Churchill River Environment from RCEA

The effects of CRD on the lower Churchill River were detailed in the RCEA, a retrospective study conducted to evaluate environmental and socio-economic changes over time resulting from past hydroelectric developments in northern Manitoba. The study focused on a "Region of Interest" encompassing the Churchill, Burntwood, and Nelson River systems. It was jointly undertaken by MH and the Province of Manitoba as a response to a non-licensing recommendation (Recommendation 13.2) from the Clean Environment Commission's (CEC) 2013 Bipole III Hearing Report.

As detailed in the RCEA, the primary driver of effects to fish and fish habitat downstream of Missi Falls CS is the diversion of the majority of the river's flow into the Nelson River system to enhance power production, which substantially reduces the total volume of water passing at Missi. (RCEA Phase 1 Part IV, section 4.2 Water Regime). Key effects include, but are not limited to:

- Flow Reduction: The diversion typically redirects approximately 79% to 80% of the river's average pre-CRD flow at Missi Falls into the Nelson River basin. Median monthly flows at the outlet of FL have been reduced by 83% to 93%. At Red Head Rapids, median monthly flows were reduced by 63-91%.
- Water Level Declines: Average water levels in downstream lakes have dropped substantially: 4.1 m in PBL, 2.3 m in NIL, 4.6 m in FL, and 2.8 m in BL.
- Dewatering: Reductions in flow and, subsequently, water level has resulted in a decrease in the amount of wetted river channel and associated aquatic habitat. Amounts of dewatered area are a function of flow but have been estimated to be in the order of 200 km^2 between Missi Falls and Mosquito Point (near the Town of Churchill) (Manitoba Hydro and Manitoba Government, 2015, Section 4.3.3.3).
- Timing Shifts: The timing of peak flows has also shifted from July and August (pre-CRD) to June (post-CRD), primarily due to the increased relative influence of local tributaries like the Gauer and Little Churchill rivers.
- Sedimentation: While suspended sediment concentrations remain relatively similar to pre-CRD levels, the substantially lower flows mean the total

annual sediment load transported down the river has been reduced. Additionally, alluvial fans have formed at the mouths of tributaries due to the lower mainstem water levels (Manitoba Hydro and Manitoba Government, 2015, Section 5.3.8.4).

- Habitat Fragmentation: The Missi Falls CS acts as a permanent barrier to upstream fish movement between the lower Churchill River and Southern Indian Lake. In addition, reductions in flow and water level have raised concerns regarding connectivity to tributary and shallow-water habitats elsewhere in the system (Manitoba Hydro and Manitoba Government, 2015, Section 4.2).

The full RCEA document is publicly available on MH's website at:

https://www.hydro.mb.ca/corporate/regulatory-affairs/regional-cumulative-effects-assessment/

4.2.3 Summary of Existing Monitoring from CAMP & Other Studies

The current understanding of the ecosystem along the lower Churchill River is primarily informed by monitoring completed through the CAMP. The CAMP is a long-term aquatic monitoring program to study and monitor waterbodies (rivers and lakes) affected by MH's generating system. It was established in 2006 with a Memorandum of Understanding between the Province of Manitoba and MH and monitors a series of on-system sites, as well as representative off-system locations.

Along the lower Churchill River, the CAMP monitors flows, water levels, water quality and fish community at on-system sites. Monitoring takes place annually at NIL and the confluence of the Churchill River with the Little Churchill River (although many components have not been monitored at the latter location since 2018, at Tataskweyak Cree Nation's request) and rotationally (every three years) at PBL, FL, BL, and Red Head Rapids. Monitoring is intended to provide a general overview of current conditions in the ecosystem and would identify if current conditions are changing over time.

The following is a summary of monitoring results on the lower Churchill River from 2008 - 2020 (Water Quality; CAMP 2024) and 2008 - 2024 (Fish Community; CAMP 2024 and additional data available at www.campmb.ca), as well as additional studies undertaken by both MH and Tataskweyak Cree Nation.

4.2.3.1 *Water Quality*

All waterbodies on the lower Churchill River monitored by the CAMP were well-oxygenated year-round and dissolved oxygen (DO) concentrations throughout the water column consistently met Manitoba Water Quality Standards, Objectives, and Guidelines instantaneous minimum objectives for cool- and cold-water aquatic life (MWS 2011). Lakes along the lower Churchill River were typically well mixed (isothermal) and DO was similar throughout the water column. Occasionally, NIL was thermally stratified in spring or summer, although it remained well-oxygenated throughout the water column.

Water clarity along the lower Churchill River was high as indicated by mean Secchi disk depths of greater than a meter, and low turbidity and total suspended solids. Water clarity was similar along the lower Churchill River from Partridge Breast Lake to the Churchill Weir and was similar to that observed upstream of Missi Falls. Water clarity was slightly higher in Gauer Lake, the off-system waterbody monitored in this region. Throughout the region, total suspended solids tended to be lower in winter under the ice than during the open-water season; however, no seasonal differences were observed for turbidity.

The trophic status of lakes and reservoirs along the lower Churchill River were similar to those upstream of Missi Falls; mesotrophic based on total phosphorus (TP) and chlorophyll *a*, and with one exception, oligotrophic based on total nitrogen (TN). The exception was FL, which was mesotrophic based on TN. The off-system Gauer Lake was mesotrophic based on TP, TN and chlorophyll *a.*

The lower Churchill River at the Little Churchill River was mesotrophic based on TP and oligotrophic based on TN and chlorophyll *a*. Conditions were similar to the Hayes River - the off-system riverine site monitored as part of the lower Nelson River Region - which was also mesotrophic based on TP and oligotrophic based on TN and chlorophyll *a*. Phytoplankton biomass (as indicated by chlorophyll *a*) tended to be lower in winter under the ice than during the open-water season.

4.2.3.2 *Fish Community*

An overview of existing technical monitoring data (CAMP 2024), focusing on fish populations in the study area, is provided in Appendix A. This data was used to guide identification of target species and life stages for the study. Additional information can be found at *www.campmb.ca*.

Based on data collected through the CAMP on the lower Churchill River, a total of 12 large-bodied species and 13 forage fish species have been caught since 2008. Apart from the Churchill River at the Little Churchill River, where Lake Sturgeon are abundant, Walleye, Lake Whitefish, White Sucker, and Northern Pike were the dominant large-bodied species in the Churchill River. All together the four species accounted for 88% of all large-bodied fish caught in the lower Churchill River since 2008. Similarly, the forage fish community is dominated by four species, Spottail Shiner, Troutperch, Emerald Shiner and Yellow Perch accounting for 96% of the total catch.

Ageing data from the region indicates that recruitment of key species such as Walleye and Lake Whitefish has occurred fairly consistently over the last 20-30 years but with large variations in year class success. The 2017 year class for both Walleye and Lake Whitefish appears strong in several locations along the Churchill River including PBL, NIL, and FL. The 2017 year classes of both Walleye and Lake Whitefish correspond to a period where the lower Churchill River was experiencing some of the highest water levels on record. Other strong year classes were present in the catches but were variable with no clear pattern.

4.2.3.3 *Additional Studies*

Additional information related to the abundance and habitat use of Lake Sturgeon in and around the confluence of the Churchill and Little Churchill rivers has resulted from studies by MH’s Lake Sturgeon Stewardship and Enhancement Program (LSSEP, Dolce-Blanchard and Barth 2015; Ambrose and McDougall 2016; 2018; Ambrose et. al. 2017) and studies undertaken by the Tataskweyak Cree Nation (TCN) from 2018 to 2024 (with funding provided in large part by MH; AAE Tech Services 2025 a,b). Collectively, this work has found there to be a stable and self-sustaining population of Lake Sturgeon at the confluence, but that this population is limited in distribution, and represents the sole sturgeon population present in the lower Churchill River.

4.2.3.4 *Hydrometric Data Collection*

To confirm operation of the CRD and other components of the hydro-electric system remain compliant with the operating terms outlined in Water Power Act licences, and to support ongoing system operating decisions, MH employs an extensive program to collect hydrometric data on water levels and flows.

MH's Hydrometric Monitoring Program was initially established in 1973 to support the Lake Winnipeg Regulation and CRD projects.

The program consists of the collection and storage of water level and flow data from locations province-wide. The majority of MH's monitoring sites are considered remote, requiring solar panels for power. Sensors called pressure transducers are used to record water levels and data loggers with transmitters are used to store and send this information via satellite to ground-based receivers. Water Survey of Canada (WSC) uses recorded water levels and rating curves (that correlate water level to flow measurements) to generate the flow data.

On the lower Churchill River and its tributaries, MH operates nine water level stations, and WSC operates six stations (level and flow). For MH operated stations, site visits occur every two months for sensor calibration measurements, any required sensor adjustments or replacements and site maintenance.

The continuous stations in the lower Churchill River basin are listed in Table 4-1 below:

Table 4-1: Continuous gauging stations for water level and flow

Station Number	Station Name	Latitude	Longitude	Operating Agency	Data Type	Period of Record, Continuous Data
06FA001	GAUER RIVER ABOVE THORSTEINSON LAKE	57.30206	-97.52494	WSC	Level & Flow	2001-2026
06FB001	CHURCHILL RIVER BELOW FIDLER LAKE	57.23888	-96.83245	WSC	Level & Flow	1968-2026
06FB002	LITTLE BEAVER RIVER NEAR MOUTH	57.65328	-95.66386	WSC	Level & Flow	1973-2026
06FC001	LITTLE CHURCHILL RIVER ABOVE RECLUSE LAKE	56.95292	-95.73925	WSC	Level & Flow	1973-2026
06FD001	CHURCHILL RIVER ABOVE RED HEAD RAPIDS	58.11862	-94.62245	WSC	Level & Flow	1973-2026
06FD002	DEER RIVER NORTH OF BELCHER	58.01353	-94.19806	WSC	Level & Flow	1977-2026

Station Number	Station Name	Latitude	Longitude	Operating Agency	Data Type	Period of Record, Continuous Data
06FA701	NORTHERN INDIAN LAKE	57.27750	-97.27111	MH	Level	1997-2026
06FA703	PARTRIDGE BREAST LAKE	57.33122	-97.83004	MH	Level	2009-2026
06FB701	CHURCHILL RIVER ABOVE FIDLER LAKE	57.24583	-96.98775	MH	Level	1997-2026
06FB702	BILLARD LAKE NEAR CHURCHILL RIVER INLET	57.15083	-96.18694	MH	Level	1997-2026
06FC701	LITTLE CHURCHILL RIVER ABOVE CHURCHILL RIVER	57.45728	-95.37464	MH	Level	1997-2026
06FD702	CHURCHILL RIVER ABOVE SWALLOW RAPIDS	57.56944	-95.43944	MH	Level	1997-2026
06FD704	GOOSE CREEK ABOVE CHURCHILL WEIR	58.67528	-94.16669	MH	Level	1999-2026
06FD706	CHURCHILL RIVER AT CR30	58.62611	-94.22917	MH	Level	1999-2026
06FD726	GOOSE CREEK BELOW CHURCHILL WEIR	58.67556	-94.16651	MH	Level	1999-2022

Initially, WSC was engaged to monitor water levels; however, the program has expanded to include approximately 75 MH-operated continuous real time water level monitoring stations and 20 flow stations throughout the north. In the 1980s, MH partnered with WSC through the National Hydrometric Program. This partnership facilitates the cooperative collection and publication of water levels and flows to national standards system wide.

Benefits include:

- Shared standards in the operation of remote water level and flow stations
- Standardized site equipment and data telemetry systems.
- Application of standard quality assurance and quality control processes.
- Standardized data work up and publication of water levels and flows.
- Formal station repair agreement to maximize data completeness.
- Participation in station audits to ensure data compliance to documented standards.

The Hydrometric Monitoring Program provides water level data that is credible and comparable between gauging sites regardless of the operator. The program provides standardized and quality-controlled data that is foundational for hydrologic operations and analysis, hydraulic design, and hydraulic modeling. For the purposes of the current study, the hydrometric data was essential for the development of credible hydraulic models required to perform the ecohydraulic studies.

Links for real time water levels or flows websites are:

Water Survey of Canada:
https://wateroffice.ec.gc.ca/map/index_e.html

Manitoba Hydro Hydrological Data:
https://www.hydro.mb.ca/hydrologicalData/static/

5.0 Lower Churchill River Ecohydraulics Study

To address the CRD Water Power Act licence requirement, MH completed an ecohydraulic assessment of representative reaches of the lower Churchill River downstream of the Missi Falls CS.

Specific objectives of the study were to:

- Complete bathymetry surveys of the lower Churchill River in order to support this and future work with respect to fish habitat in the region;
- Characterize hydraulic conditions within representative reaches of the lower Churchill River;
- Quantify habitat availability for target fish species and life stages under representative post-CRD flow conditions; and
- Evaluate potential barriers to fish movement under representative CRD flow conditions.

The study integrated physical environment monitoring, bathymetric data collection, hydrologic analysis, hydraulic modelling, and fish habitat assessment.

The work was completed in collaboration with Manitoba Fisheries Branch and supported through field investigations conducted between 2024 and 2026.

The study findings are organized into four sections: Section 5.1 presents the physical environment monitoring program and results, Section 5.2 presents the hydraulic model development and results, Section 5.3 presents the fish habitat assessment, and Section 5.4 presents the key findings of the Study.

5.1 Physical Environment Monitoring

Physical environment monitoring was conducted between June 2024 and May 2026 at locations extending from Partridge Breast Lake to Red Head Rapids. Monitoring included dissolved oxygen, water temperature, turbidity, water depth, and ice thickness measurements. The program was designed to improve understanding of the physical environmental conditions on the lower Churchill River and to supplement existing long-term monitoring information available through the CAMP.

5.1.1 Methodology

5.1.1.1 *Water Temperature, Dissolved Oxygen and Turbidity*

In summer 2024, eight continuous water temperature (WT) and dissolved oxygen (DO) sites were monitored. This included seven sites located along the lower Churchill River, from downstream of the Missi Falls CS to Red Head Rapids, as well as one site on the Little Churchill River. Additionally, three of these sites monitored continuous turbidity (TU) (Table 5-1; Map 3 in Appendix D). Three continuous WT and DO sites were monitored from October 2024 to March 2026 (Table 5-1; Map 3 in Appendix D).

DO and WT monitoring were performed using Hobo brand (U26 and MX800 series) electronic sensors that measure and record both parameters. At sites where TU was monitored, YSI multi-parameter sondes (EXO series) were used to measure and record TU, DO, and WT. The monitoring stations were comprised of stand-alone buoy systems that required manual data downloads and the deployment of appropriate sensors. At all sites, sensors were positioned one metre above the bottom.

Discrete measurements were obtained throughout the water column to assess vertical variability and at up to seven points (denoted as *a* to *g*) across the river width to evaluate lateral variability. Particular attention was given to DO levels, focusing on whether concentrations were low, a potential concern for aquatic organisms, near the bottom. The discrete DO readings were used to verify the continuous data, as were the TU measurements where continuous TU data was available.

The discrete and continuous datasets were reviewed for data quality to filter out erroneous and inconsistent data. Factors contributing to poor data, such as algae or vegetation on probes, dead batteries, and equipment malfunctions, were identified and addressed. For the continuous data sets, the review tended to err on the side of leaving data in rather than remove potentially suspect data.

There are some gaps in the data due to sensor malfunctions. The sensor at FL (06FB706) stopped recording at the beginning of June 2025, resulting in a data gap from June through September 2025. It stopped recording data again in October 2025 and could not be repaired resulting in a data gap for the rest of the winter season (October 2025 to May 2026). The sensor at BL (06FB707) stopped recording data in December 2025 but was repaired during the next site visit in January 2026. The sensor at Swallow Rapids (06FD705) stopped recording data in November 2025, resulting in a data gap for the rest of the winter season (November 2025 through March 2026).

5.1.1.2 *Ice Thickness*

Discrete ice thickness and water depth measurements were added in late winter 2025 in response to concerns raised by Tataskweyak Cree Nation.

Ice thickness and water depth were initially monitored at three locations in 2025, at the same sites as the continuous winter DO and WT loggers at FL (PE_CR-4), BL (PE_BL-1), and Swallow Rapids (PE_CR-1). In winter 2026, five additional monitoring locations were established, increasing the total number of sites to eight (Table 5-1; Map 3 in Appendix D). These included four sites along the lower Churchill River between FL and BL (PE_CR-10 to PE_CR-7) and one site upstream of the confluence with the Little Churchill River (PE_CR-2).

Discrete measurements of ice thickness and water depth were collected at up to three points across the river width (designated *a* to *g*) to assess lateral variability.

Table 5-1: Physical environment monitoring locations

Location	Parameter	Continuous Data		Discrete Data	
		Site ID	Period of Record	Site ID	Period of Record
Partridge Breast Lake	DO, WT	06FA701	Jul 24/24 – Oct 10/24	PE_PBL-1	-
Northern Indian Lake	DO, WT	06FA702	Jul 24/24 – Oct 10/24	PE_NIL-1	2025: Sep
Churchill River 500 m upstream of Fidler Lake	DO, WT, Ice	06FB706	Jul 24/24 – Oct 10/24, Oct 29/24 – Jun 5/25, Sep 4/25 – Oct 17/26	PE_CR-4-a	2025: Mar, Apr, Sep 2026: Jan, Feb, Mar, May
Churchill River below Fidler Lake	Ice	-	-	PE_CR-10-a to c	2026: Jan, Feb, Mar, May
Churchill River 58 km upstream of Billard Lake	Ice	-	-	PE_CR-9-a to b	2026: Mar, May
Churchill River 46 km upstream of Billard Lake	Ice	-	-	PE_CR-8-a to c	2026: Jan, Feb, Mar, May
Churchill River 28.5 km upstream of Billard Lake	Ice	-	-	PE_CR-7- a to c	2026: Feb, Mar, May
Billard Lake	DO, WT, Ice	06FB707	Jul 24/24 – Oct 7/24, Oct 29/24 – Sep 3/25, Sep 3/25 – Mar 24/26	PE_BL-1	2025: Mar, Apr, Sep 2026: Jan, Feb, Mar, May

Location	Parameter	Continuous Data		Discrete Data	
		Site ID	Period of Record	Site ID	Period of Record
Churchill River upstream of confluence with Little Churchill River	DO, WT, TU, Ice	06FB703	Jul 23/24 – Oct 9/24	PE_CR-2-a to e	2024: Jun, Jul, Aug, Oct 2025: Feb, Mar, May
Little Churchill River 6 km upstream of confluence with Churchill River	DO, WT, TU	06FC702	Jun 18/24 – Oct 9/24	PE_LCR-1-a to c	2024: Jun, Jul, Aug, Oct
Churchill River upstream of Swallow Rapids	DO, WT, TU*, Ice	06FD705	Jun 18/24 – Oct 9/24, Oct 29/24 – Sep 3/25, Sep 3/25 – Mar 25/26	PE_CR-1-a to g	2024: Jun, Jul, Aug, Oct 2025: Mar, Apr, Sep 2026: Feb, Mar, May
Churchill River above Red Head Rapids	DO, WT	06FD708	Jul 24/24 – Oct 7/24	PE_CR-3	-

Notes:
* TU only monitored during the 2024 open water period

5.1.1.3 *Hydrologic Conditions*

Flow influences water quality conditions through its effects on water depth, velocity, mixing, residence time, and ice processes. To provide hydrologic context for the water quality monitoring program, daily flows recorded at the Churchill River Below Fidler Lake (06FB001) WSC hydrometric station were reviewed for the monitoring period (Figure 5-1).

During 2024, daily flow ranged from approximately 68 m^3/s to 387 m^3/s, with a mean annual flow of 128 m^3/s (below the P50 flow scenario). The lowest daily flow occurred on April 2, while the highest daily flow occurred on June 21.

Daily flow data for 2025 were available but remained provisional at the time of reporting and therefore are not included in the long-term hydrograph. However, the 2025 provisional record indicated a mean flow of 85 m^3/s (below the P25 flow scenario), a minimum daily flow of 40 m^3/s on August 14, and a maximum daily flow of 182 m^3/s on May 18.

Flow conditions during the monitoring period provide important context for interpreting the water temperature (WT), dissolved oxygen (DO), turbidity (TU) and ice thickness. Both 2024 and 2025 were relatively low flow years compared to the modelled flow range.

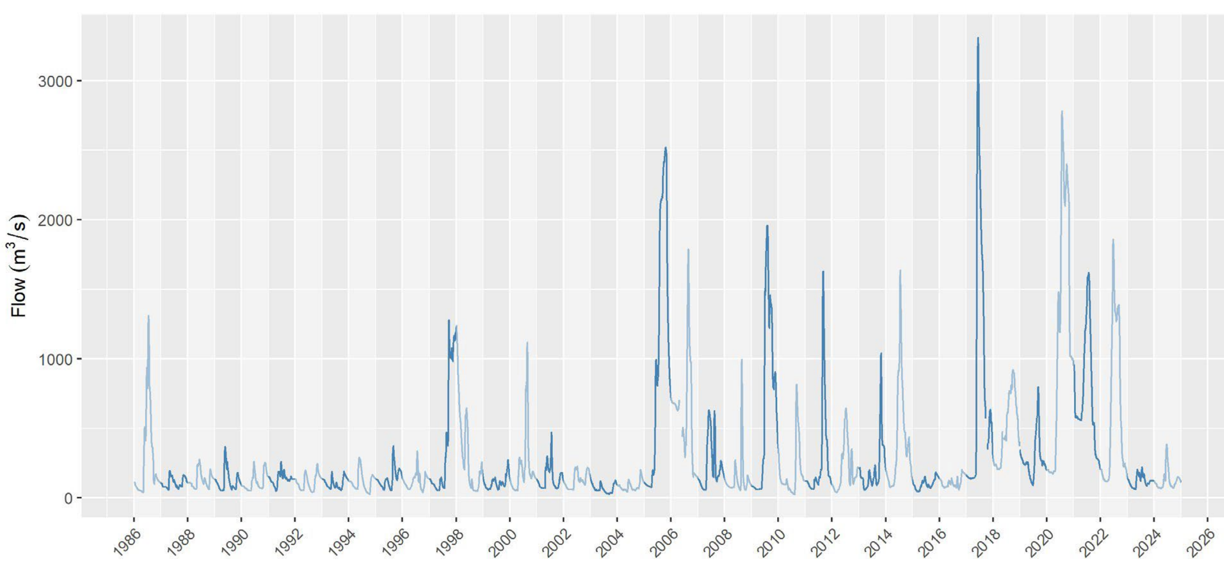

Figure 5-1 - Daily flow recorded at Lower Churchill River below Fidler Lake (WSC 06FB001), 1986 to 2024

5.1.2 Data Analysis

5.1.2.1 *Turbidity – Continuous Data*

Continuous TU data is only available for the 2024 open water period (Figure 5-2). The lower Churchill River and Little Churchill River sites exhibited relatively low continuous TU values with little variation, apart from occasional spikes. The highest peaks were observed in late August (83 Formazin Nephelometric Units (FNU) at the lower Churchill River upstream of the confluence with the Little Churchill River (06FB703)), followed by a secondary peak in late September (35 FNU at 06FB703). Given that Missi Falls CS releases were maintained near minimum discharge during this period, these elevated turbidity events were most likely associated with local rainfall and runoff. On average, TU values were highest at the lower Churchill River upstream of the confluence with the Little Churchill River (6 FNU), with the lower Churchill River upstream of Swallow Rapids and Little Churchill River averaging 4 and 5 FNU, respectively.

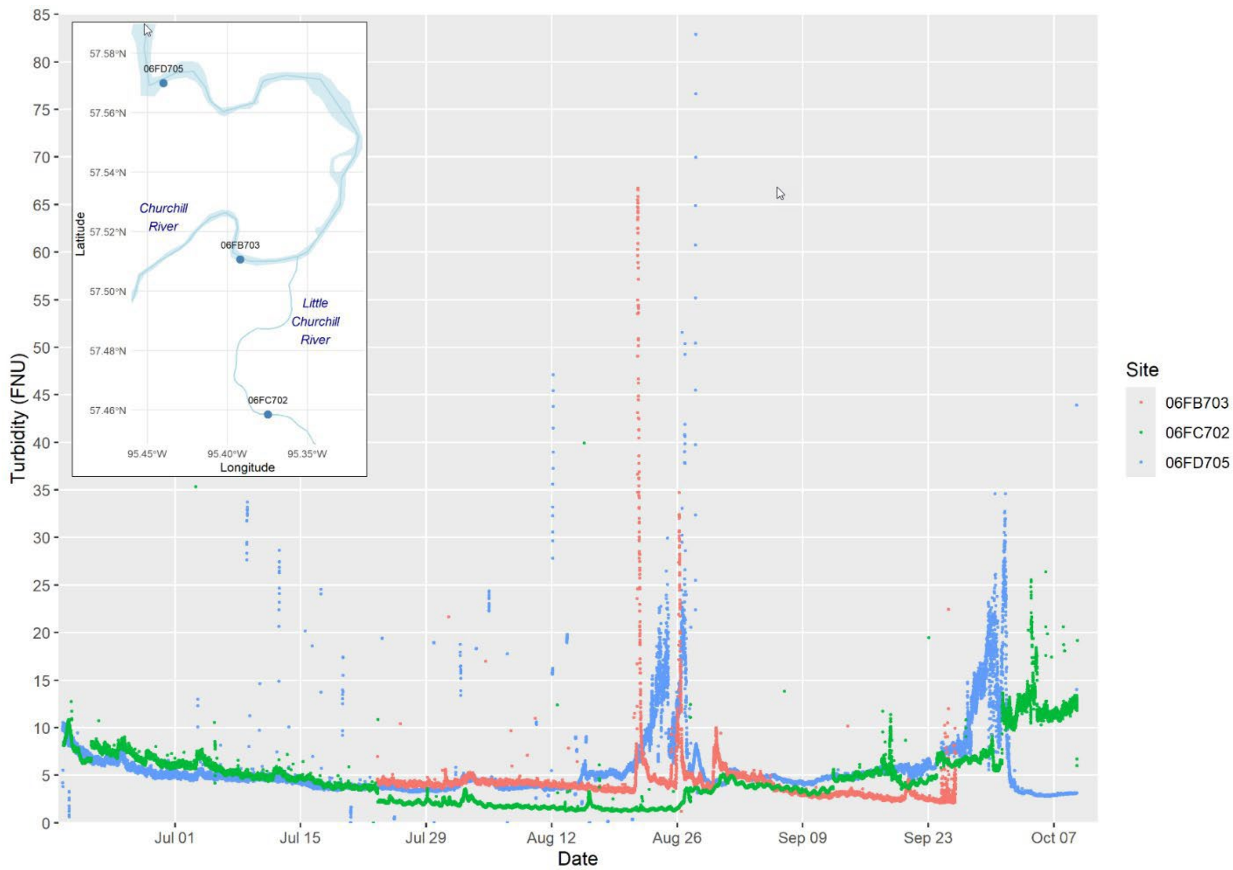

Figure 5-2: 2024 continuous turbidity

5.1.2.2 *Turbidity – Discrete Data*

Temporal comparison of discrete TU values was constrained because monthly sampling could not be completed at all sites due to wildfire-related travel restrictions in 2025. Accordingly, turbidity values during open-water and winter periods were not directly compared.

Due to the limited number of measurements collected during the monitoring period, daily average TU values were calculated across the river width and depth profile for each site.

Average daily TU across all sites and the entire monitoring period was 4 FNU. The highest mean value occurred in January 2026 at the lower Churchill River upstream of the confluence (20 FNU at PE_CR-2), and the lowest occurred in May 2026 at the lower Churchill River 500 m above FL (1.5 FNU at PE_CR-10) (Figure 5-3).

An outlier measurement of 255 FNU was recorded at the lower Churchill River upstream of the confluence (PE_CR-2) in August 2024. This value was removed from the dataset because it was most likely caused by the sensor contacting the river bottom during sampling.

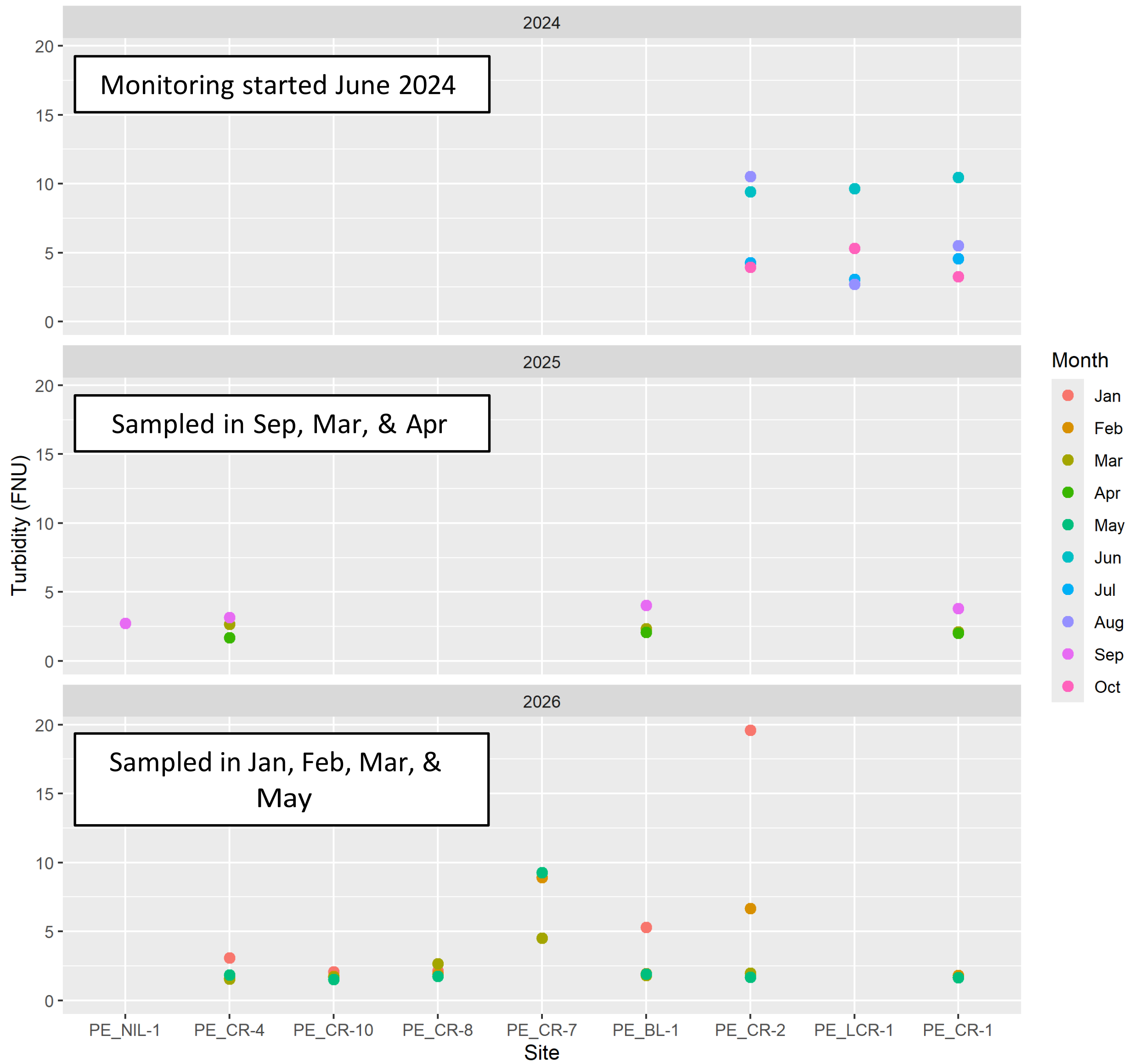

Figure 5-3: Mean daily turbidity values from 2024 to 2026, Lower Churchill River

5.1.2.3 *Dissolved Oxygen – Continuous & Discrete Data*

DO conditions were assessed using both continuous monitoring and discrete measurements. In all monitoring periods, discrete measurements were consistent with the continuous monitoring results and confirmed the temporal and spatial patterns described below (Figure 5-4 to Figure 5-7).

DO concentrations were evaluated against the Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOG) for the protection of cool- and cold-water fish species during early and mature life stages.

The applicable instantaneous minimum DO concentrations are:

- For water temperatures >5°C:
  - Cool-water fish species, early life stages: 5 mg/L
  - Cold-water fish species, mature life stages: 4 mg/L
- For water temperatures <5°C:
  - Cool-water fish species, mature life stages: 3 mg/L
  - Cold-water fish species, early life stages: 8 mg/L

Continuous DO monitoring results during the 2024 open water period (Figure 5-4*)* showed generally high oxygen concentrations, with a mean concentration of 9.6 mg/L. Variability at these sites was low (typically <1 mg/L) and followed a regular diel cycle, with lowest DO levels in early morning, increasing through the day, and peaking in late afternoon to evening.

Lower DO concentrations and more frequent declines were observed at PBL (06FA701), NIL (06FA702), FL (06FB706), and BL (06FB707). Although these monitoring locations are referred to as lake sites, the FL station is located approximately 4 km upstream of the lower Churchill River inlet to FL and therefore provides a better representation of riverine conditions than the lentic environment of the lake itself. The NIL and BL stations are located within the lakes along the main thalweg, whereas the PBL station is situated off the main channel.

During the open-water period, water temperatures exceeded 5°C and the applicable MWQSOG instantaneous minimums were 5 mg/L for cool-water fish species in early life stages and 4 mg/L for cold-water fish species in mature life stages. DO concentrations fell below the 5 mg/L for two days in August and September at PBL (06FA701) and for three days in August at FL (06FB706). DO concentrations also fell below the 4 mg/L for one day in August at PBL (06FA701) during the same low DO event. Across all sites, temporal trends were evident, with minimum DO values occurring in August 2024 and maximum values in October 2024, consistent with seasonal temperature patterns. The lowest mean DO recorded during the 2024 open water period was 8.4 mg/L at NIL (06FA702).

During the 2024–25 winter monitoring period (Figure 5-5), DO concentrations gradually declined throughout the winter until late March but remained generally high, with a mean concentration of 13.3 mg/L. Variability was minimal, typically less than 1 mg/L. The diel cycle was less pronounced than in summer, likely due to reduced light penetration and limited photosynthetic activity; it was only observed at the FL site. DO concentrations began to rise in April 2025 as ice breakup began but declined in May as ice fully cleared and air temperatures increased. DO concentrations remained above all applicable MWQSOG instantaneous minimum thresholds throughout the winter monitoring period, including the 8 mg/L criterion for cold-water fish species in early life stages.

Continuous DO monitoring results during the 2025 open water period (Figure 5-6) showed generally high oxygen concentrations, with a mean concentration of 9.8 mg/L. DO concentrations were generally stable across sites, with the exception of a two-week period in July 2025 when concentrations at Swallow Rapids (06FD705) declined below 8 mg/L. During this isolated event, DO concentrations fell below the MWQSOG instantaneous minimum of 5 mg/L for cool-water fish species in early life stages for one day. A clear diel cycle was observed throughout the monitoring period.

During the 2025-26 winter monitoring period (Figure 5-7), DO concentrations gradually declined throughout the winter until late March, with a mean concentration of 11.8 mg/L. Due to equipment malfunctions during this monitoring period, the only continuous dataset was collected at the Swallow Rapids station; however, discrete measurements collected at the other sites indicated similar conditions. As in the previous winter monitoring period, DO concentrations remained above applicable MWQSOG instantaneous minimum thresholds throughout the monitoring period.

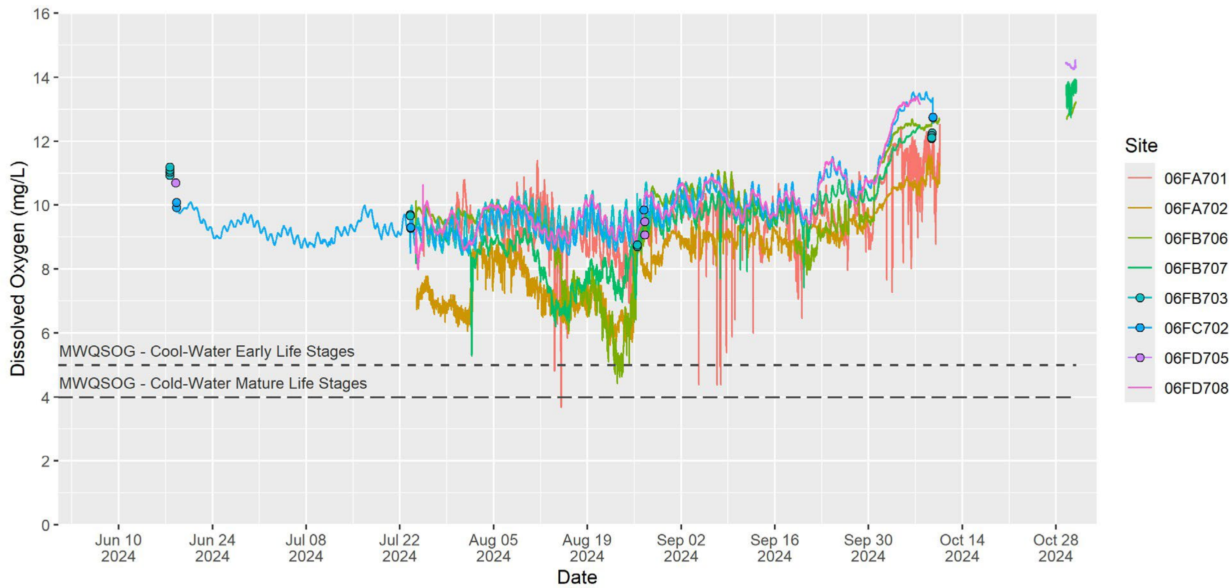

Figure 5-4: Continuous and discrete dissolved oxygen concentrations measured during the 2024 open-water season, with Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG) thresholds for cool-water early life stages (5 mg/L) and cold-water mature life stages (4 mg/L) shown as horizontal reference lines

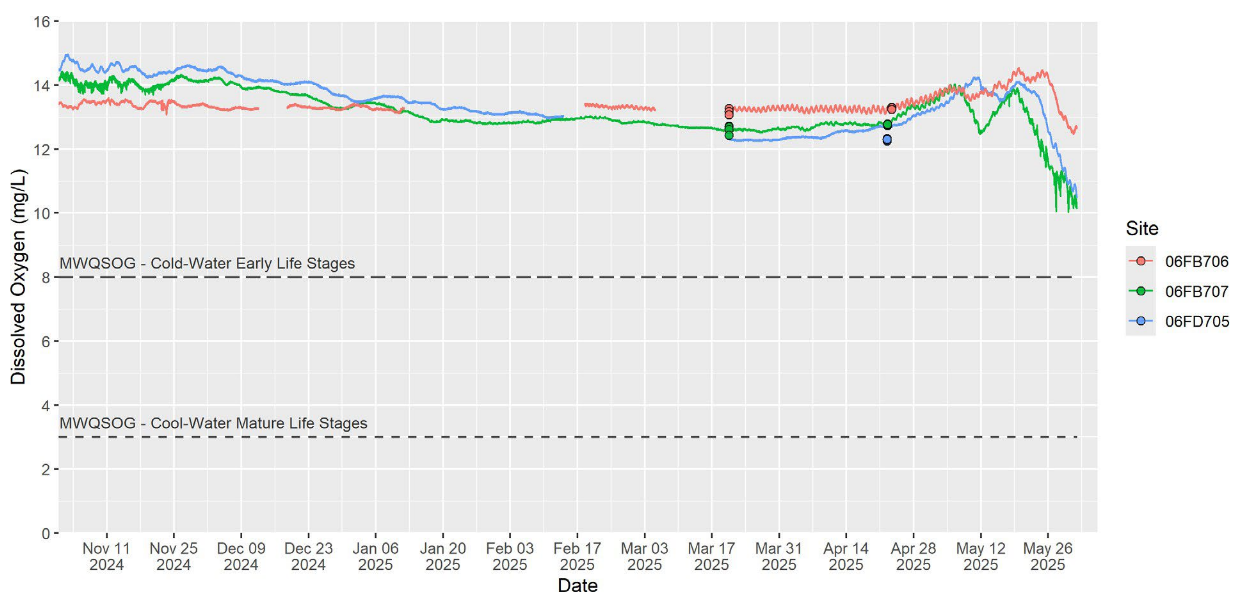

Figure 5-5: Continuous and discrete dissolved oxygen concentrations measured during the 2024-25 winter season, with Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG) thresholds for cold-water mature life stages (8 mg/L) and cool-water early life stages (3 mg/L) shown as horizontal reference lines

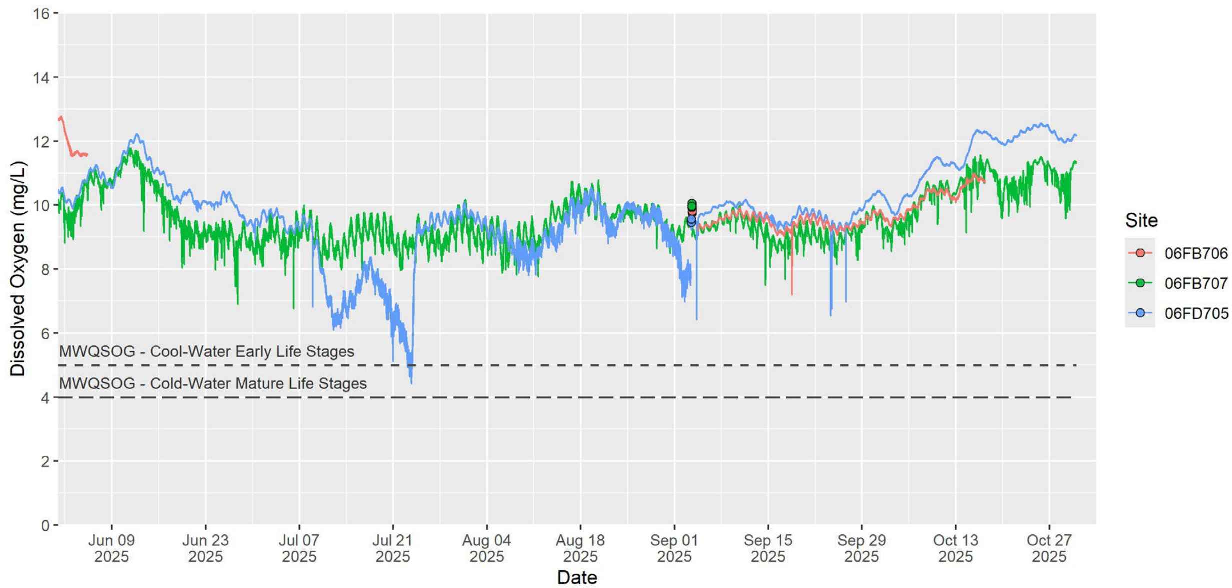

Figure 5-6: Continuous and discrete dissolved oxygen concentrations measured during the 2025 open-water season, with Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG) thresholds for cool-water early life stages (5 mg/L) and cold-water mature life stages (4 mg/L) shown as horizontal reference lines

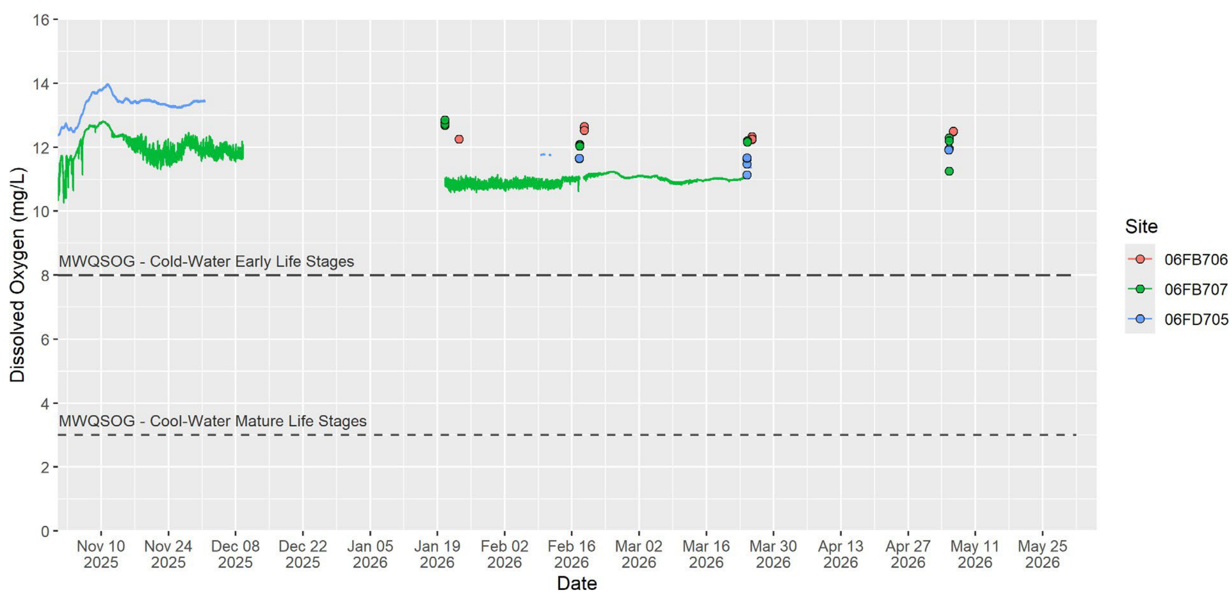

Figure 5-7: Continuous and discrete dissolved oxygen concentrations measured during the 2025-26 winter season, with Manitoba Water Quality Standards, Objectives and Guidelines (MWQSOG) thresholds for cold-water mature life stages (8 mg/L) and cool-water early life stages (3 mg/L) shown as horizontal reference lines

5.1.2.4 *Dissolved Oxygen – Discrete Data*

Discrete monitoring along the lower Churchill and Little Churchill rivers showed no vertical DO differentiation, with all values exceeding 6 mg/L (Figure 5-8). The lack of vertical variability was generally expected due to the location of the sampling sites, which were primarily in river reaches and lake areas near inlets and outlets where flow promotes mixing of the water column. Vertical differentiation was noted at NIL, specifically around 10 m below the water surface. DO was 9.3 mg/L at the surface and 7.3 mg/L near the lake bottom.

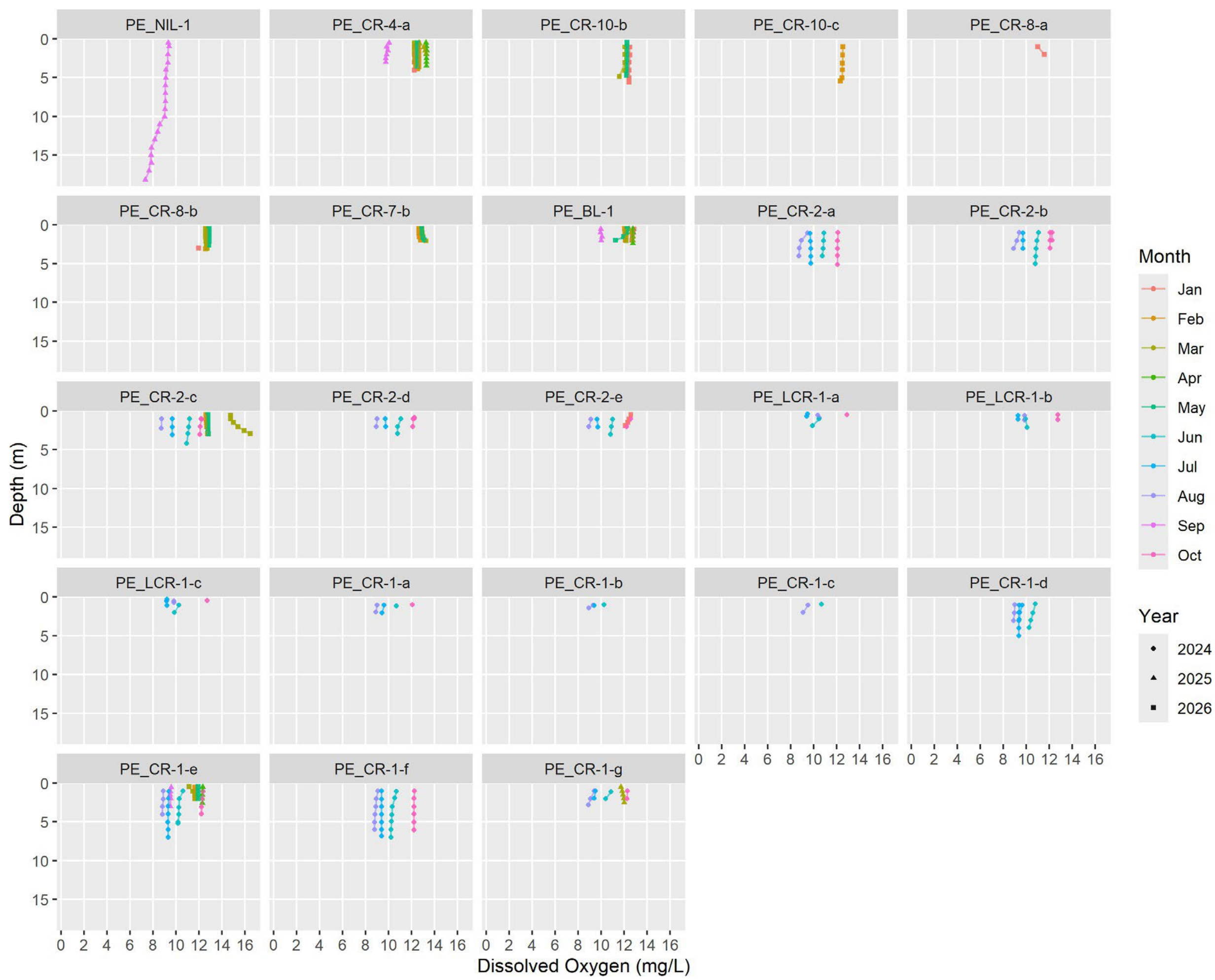

Figure 5-8: Dissolved oxygen depth profiles by site

5.1.2.5 *Ice Thickness*

Across all monitoring locations, the mean ice thickness was 0.75 m (Figure 5-9). The minimum water depth observed during the monitoring period was 1.9 m at the site upstream of the confluence with the Little Churchill River (PE_CR-2) in March 2026.

Given the limited temporal record, particularly at the newer monitoring locations, additional measurements collected during subsequent winters are required to assess the significance and persistence of observed ice conditions and processes. Of the monitored locations, FL has the longest and most consistent monitoring record, and observations indicate relatively stable ice conditions over the monitoring period. However, ice development is highly site- and flow-specific, and the relatively stable conditions observed at FL may not be representative of ice conditions elsewhere along the river.

For example, although only two months of ice thickness data were collected at PE_CR-9, located downstream of FL, several notable ice processes were observed (Figure 5-10). Ice along both riverbanks appeared fractured as water levels declined, and frazil slush was present beneath the ice cover. Ice thickness measurements could not be collected at the mid-channel location because open water was visible, and ice conditions were considered unsafe.

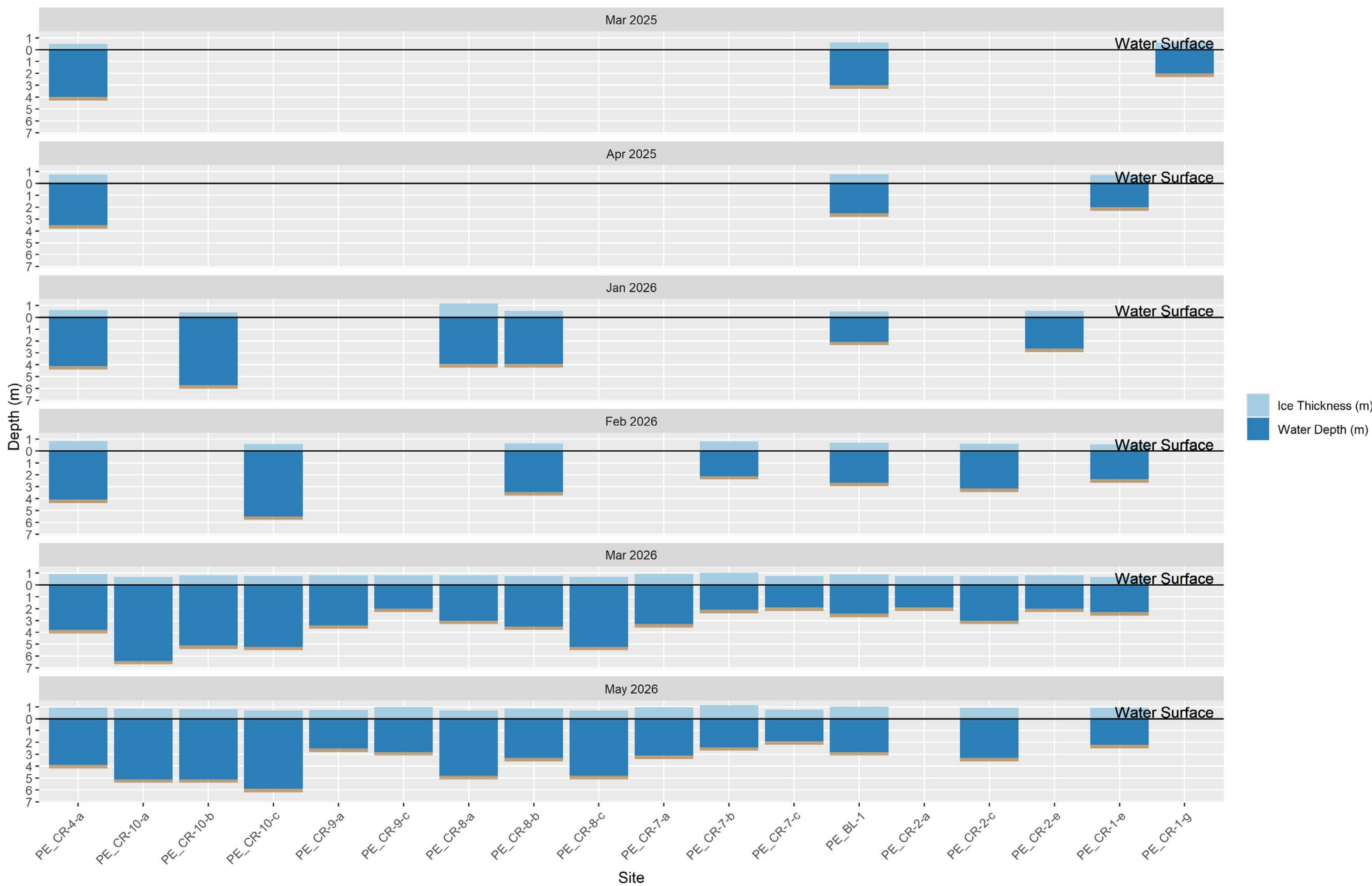

Figure 5-9: 2025-26 ice thickness and water depth measurements. Water depth is referenced to the water surface (0 m), and the brown line at the base of each column indicates the riverbed.

Figure 5-10: Looking downstream at site PE_CR-9 on the Lower Churchill River between Fidler and Billard lakes, March 25, 2026

5.1.3 Summary of Physical Environment Monitoring Results

Results from the physical environment monitoring program indicate that water quality conditions within the lower Churchill River were generally suitable for fish species assessed as part of this study. Dissolved oxygen concentrations remained above applicable guideline thresholds for most of the monitoring period, and turbidity levels were generally low throughout the study area.

Winter monitoring indicated that ice conditions vary throughout the study area and are influenced by local hydraulic conditions, channel morphology, and water level fluctuations.

Collectively, these findings do not indicate widespread water quality or winter habitat constraints within the monitored reaches. However, the available monitoring record is limited both spatially and temporally, and additional monitoring would improve understanding of water quality and winter habitat conditions throughout the lower Churchill River.

5.2 Hydraulic Model Development & Results

Two-dimensional hydraulic models were developed for two reaches of the lower Churchill River where high-quality bathymetric and topographic information was available and where fish habitat and hydraulic connectivity were considered particularly important. The first model extended from NIL to Billard Lake, while the second model focused on the Little Churchill River confluence area from The Fours to Swallow Rapids.

The models were used to simulate water levels, flow velocities, wetted area, and hydraulic connectivity across a range of representative open water flow conditions.

This section describes model development, calibration and validation, and presents the results of the associated hydraulic simulations.

5.2.1 Digital Elevation Model Development

The hydraulic models developed for the ecohydraulics study required topographic and bathymetric elevation data. Topographic data were needed to define the upland banks and shoreline areas that may be wetted or exposed under varying flow conditions, while bathymetric data were required to define river and lake bottoms. However, little to no elevation data were available for most of the study area. Consequently, a data collection program was undertaken to obtain accurate topographic and bathymetric data required for model development.

Traditional LiDAR (light detection and ranging) was identified as the preferred method for collecting topographic elevation data because it provides accurate and efficient coverage over large areas. Bathymetric data are typically collected using boat-based sonar; however, this approach was not preferred due to the large extent of the study area and its limited ability to survey rapids and shallow nearshore environments. Instead, the study team identified an innovative topo-bathymetric LiDAR technology being used by the Nova Scotia Community College Applied Geomatics Research Group. Unlike traditional LiDAR, this technology can penetrate the water surface and collect bathymetric elevations in shallow aquatic environments.

Topo-bathymetric LiDAR surveys were completed from 2024 and 2025 by the Nova Scotia Community College Applied Geomatics Research Group from the inlet of NIL to Hudson Bay (Figure 5-11). The surveys proved particularly valuable for rapidly collecting accurate data in areas that would have been difficult to survey using conventional boat-based methods.

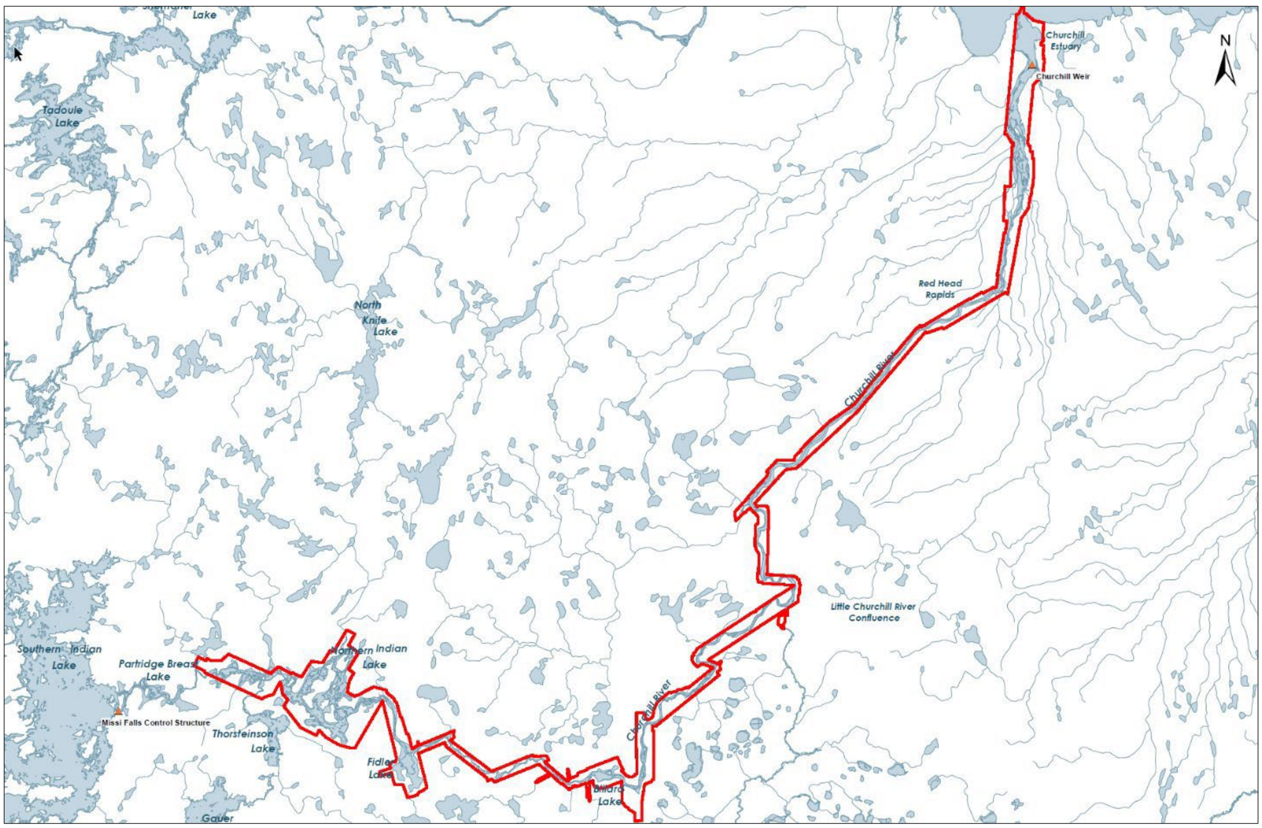

Figure 5-11: Bathymetric data collected in the Lower Churchill River by the Nova Scotia Community College Applied Geomatics Research Group, 2024–2025

For Model 1 (NIL to BL), deep-water areas not captured by topo-bathymetric LiDAR were supplemented with MH bathymetric surveys undertaken in the summer of 2024. Additional bathymetry collected during the CAMP program at NIL (Manitoba Hydro and Manitoba Government, 2010a) and BL (Manitoba Hydro and Manitoba Government, 2010b) was incorporated to fill remaining gaps during the DEM development.

For the Little Churchill River confluence area model, bathymetric survey data collected by MH Engineering Survey Services in September 2011 as part of the

Little Churchill River confluence area Low Flow Connectivity Analysis (Hunt and Slota, 2016) were combined with the 2024 topo-bathymetric LiDAR dataset to develop a continuous DEM. The 2011 survey program included collection of river bathymetry throughout the lower Churchill River reach from The Fours to Swallow Rapids and within the Little Churchill River near the confluence.

The topo-bathymetric LiDAR surveys completed between 2024 and 2025 provided a continuous, high-resolution representation of both terrestrial and shallow aquatic environments across much of the study area. The integrated acquisition of topographic and bathymetric data substantially increased spatial coverage compared to traditional survey methods and facilitated the development of seamless DEMs for hydraulic modelling. Historical datasets from 2010 and 2011 were incorporated where LiDAR coverage was limited, resulting in complete DEMs for model development.

5.2.2 Hydraulic Modelling Approach

The hydraulic analyses completed for this study were undertaken using MIKE 21, a 2D, depth-averaged hydrodynamic modelling system developed by DHI (2023). The software simulates water levels, flow velocities, and flow distribution across complex river and lake environments using the depth-averaged shallow-water equations.

A 2D modelling approach was selected because flow conditions within the study area are spatially complex and influenced by braided channels, rapids, lake-river transitions, islands, and tributary confluences. Compared with one-dimensional modelling approaches, the 2D framework provides improved resolution and representation of flow patterns, velocity distributions, wetted area, and hydraulic connectivity across the floodplain and river channel.

The MIKE 21 modelling system utilizes an unstructured computational mesh consisting of triangular elements. This approach allows model resolution to be refined in hydraulically complex areas such as rapids, constrictions, and confluences, while employing coarser resolution in areas of relatively uniform flow.

Historical CRD operations and lower Churchill River hydrology were reviewed to develop representative flow scenarios. Model simulations were completed under steady-state flow conditions corresponding to the 5th, 25th, 50th, 75th, and 95th percentile open-water CRD flow conditions on the lower Churchill River.

Each of the models were calibrated based on actual water level data available from a range of sites throughout the region. This included a combination of continuous long-term flow and water-level records collected through Manitoba MH's Hydrometric Monitoring Program, as well as spot measurements at various locations. The model for reach 1 reproduced observed water levels within ±0.3 m and for reach 2 within ±0.2 m under the calibration flow conditions at the locations with available calibration data.

Flow scenarios were then developed for the two study areas based on the 5th, 25th, 50th, 75th, and 95th percentile open-water flows (P5, P25, P50, P75, and P95, respectively). Percentiles were calculated using simulated flows for the open-water period (June 1 to October 31) over the historical period extending from 1986 to 2024, using recorded releases from the Missi Falls CS.

For the purposes of the hydraulic modelling study, flow scenarios based on monthly average values were selected as the preferred metric, as this time step is representative of the scale of the travel time of the lower Churchill River and consistent with the steady-state modelling approach being adopted. Simulated flow duration curves at a monthly time step also show a good level of agreement with the flow duration curve calculated at a monthly time step from the observed flow data at FL.

Inflows and the associated water levels at the downstream model boundary for each flow scenario and each model reach are outlined in Table 5-2 and Table 5-3 below. The flows were used as the upstream boundary condition and the levels were used as the downstream boundary condition for each associated model run.

Table 5-2: Flow scenarios and downstream boundary water levels used for Model 1 hydraulic simulations

Flow Scenario	Flow (m^3/s)	Billard Lake Water Surface Elevation (mASL)
P5	54	187.3
P25	100	187.5
P50	164	187.8
P75	519	189.0
P95	1782	191.8

Table 5-3: Flow scenarios and downstream boundary water levels used for Model 2 hydraulic simulations

Flow Scenario	Lower Churchill River flow at The Fours (m^3/s)	Inflow from Little Churchill River (m^3/s)	Lower Churchill River flow at Swallow Rapids (m^3/s)	Water Surface Elevation at Swallow Rapids (mASL)
P5	64	31	95	132.6
P25	118	55	173	132.8
P50	199	104	302	133.1
P75	512	99	610	133.5
P95	1783	167	1950	134.7

5.2.3 Hydraulic Model Results

The calibrated hydraulic models were used to simulate five representative open-water flow scenarios corresponding to the P5, P25, P50, P75, and P95 flow conditions. For each scenario the model outputs of water depth and depth-averaged velocity were generated. These hydraulic indicators were subsequently used to evaluate wetted area and connectivity (presented within this section) as well as habitat availability throughout the study reaches (presented in Section 5.3.2). Maps illustrating modelled hydraulic conditions for each flow scenario are provided in Appendix D.

Supporting maps, hydraulic modelling outputs, and fish habitat mapping are provided in Appendix D. To facilitate navigation of the large number of map products generated as part of this study, a standardized map key system was adopted for the hydraulic modelling and fish habitat map series in place of sequential figure numbering. Each map is assigned a unique identification code that conveys the model domain, result type, flow scenario, and geographic extent represented by the map. A complete list of map codes is provided in Appendix D.

The map identification format is:

[Model]-[Result Type]-[Flow Scenario]-[Extent]

For example:

M1-WD-P50-NILFL

where:

- **M1** = Model 1;
- **WD** = Water Depth;
- **P50** = 50th percentile flow scenario; and
- **NILFL** = Northern Indian Lake to Fidler Lake.

This system enables rapid identification and cross-referencing of map products throughout the report and appendices.

5.2.3.1 *Water Depth, Flow Velocity, and Barriers to Movement*

Model 1 – Northern Indian Lake to Billard Lake

Water depth increased throughout the modelled reach as flow increased from the P5 to P95 scenarios (Appendix D, maps starting with M1-WD). The greatest depths were consistently associated with lake environments, particularly within NIL. Shallow areas were concentrated along shorelines and exposed bars and riffle sections.

At lower flows (P5 and P25), several sections of the channel exhibited extensive shallow-water areas, exposed shorelines, and dewatered channel features. As flows increased, these areas became progressively inundated, increasing the continuity of aquatic habitat.

Key water depth observations include:

- The south channel of NIL contains areas of substantial depth exceeding 40 m, even under the P5 flow scenario, and depths of this magnitude are unique within the study reach.
- Large portions of the reach are dewatered at or below P50, particularly along the shorelines of NIL and FL.

Water velocities and the extent of rapids generally increased as flows increased from the P5 to P95 scenarios (Appendix D, maps starting with M1-V). Areas of elevated water velocity were concentrated within rapids, lake outlets, and channel constrictions.

The Model 1 reach predominantly maintains hydraulic connectivity (water depth > 20 cm) under even the P5 flow scenario. A notable exception occurs at the Lower Fidler Rapids, approximately halfway between FL and BL, where low water depths during the P5 flow scenario may present a barrier to fish movement. Water depths at this location are sufficient to maintain hydraulic connectivity under all other flow scenarios.

The Lower Fidler Rapids are immediately followed by a wide boulder and cobble field with a poorly defined thalweg, resulting in wide, shallow flow conditions. Fish passage at this location may be more challenging than indicated by the modelled results because the hydraulic model cannot represent interstitial flow within the river substrate (i.e., flow through the spaces between rocks) and assumes all flow passes over the riverbed surface. Consequently, the model may overestimate the depth of surface flow available for fish passage, particularly under low flow conditions. Fish stranding has been observed at sites with similar hydraulic characteristics elsewhere in the system under low flow conditions (Hunt and Slota, 2016).

While water depth is not a limiting factor at higher flows, the Lower Fidler Rapids may also present a barrier to fish movement under the P75 to P95 flow conditions due to elevated water velocities. Under the P75 scenario, water velocities are elevated across the entire channel, making upstream passage challenging for most fish species and life stages. Note that a detailed investigation of fish passage conditions at this site would require development of a finer scale hydraulic model, potentially utilizing 3D modelling software and evaluating a greater range of flow scenarios or undertaking on-site fish movement monitoring.

Model 2 – Little Churchill River confluence area

Water depth increased throughout the modelled reach as flow increased from the P5 to P95 scenarios (Appendix D, maps starting with M2-WD). Areas of greatest depth were consistently observed in the lower Churchill River between the Little Churchill River confluence and Swallow Rapids. Increased depths within this reach are associated with channel morphology and the addition of flow from the Little Churchill River. Under higher flows (P75–P95), water depths in this area can exceed 10 m.

Water velocities and the extent of rapids increased throughout the modelled reach as flow increased from the P5 to P95 scenarios (Appendix D, maps starting with M2-V). Elevated velocities were concentrated within the steeper sections of the model domain between The Fours and the Little Churchill River confluence, as well as the lower reach of the Little Churchill River just upstream of the confluence. The deeper downstream reach between the confluence and Swallow Rapids maintained comparatively lower velocities.

Connectivity at the confluence is limited under the P5 and P25 flow scenarios, with extensive shallow areas of the Little Churchill River having water depths of less than 20 cm as flow spreads across the wide alluvial fan at the river mouth. As determined in previous studies, at this site, connectivity between the lower Churchill River and the Little Churchill River is primarily driven by flow in the Little Churchill River (Hunt and Slota, 2016).

5.2.3.2 *Wetted Area*

Wetted area for each flow scenario and model reach was calculated by extracting the surface area of each water depth map using the ArcGISPro software package.

Model 1 – Northern Indian Lake to Billard Lake

The calculated wetted area in Reach 1 increased from approximately 141 km^2 under the P5 flow scenario to 229 km^2 under the P95 flow scenario, representing a 62% (88 km^2) increase across the simulated flow range (Figure 5-12). Wetted area increased linearly with flow. However, the flow duration distribution is skewed toward lower flows, with 50% of flows occurring below 164 m^3/s (P50). As a result, the greatest increases in wetted area were associated primarily with the less frequent high flow events (P75–P95).

The largest changes in wetted area occurred along shallow shoreline environments, lake margins, islands, and within broad channel areas. These areas are particularly sensitive to changes in water level because of the low-gradient terrain, where relatively small increases in water level can inundate large areas. In contrast, channelized sections of the reach with steep shorelines remain largely wetted across the full range of modelled flows.

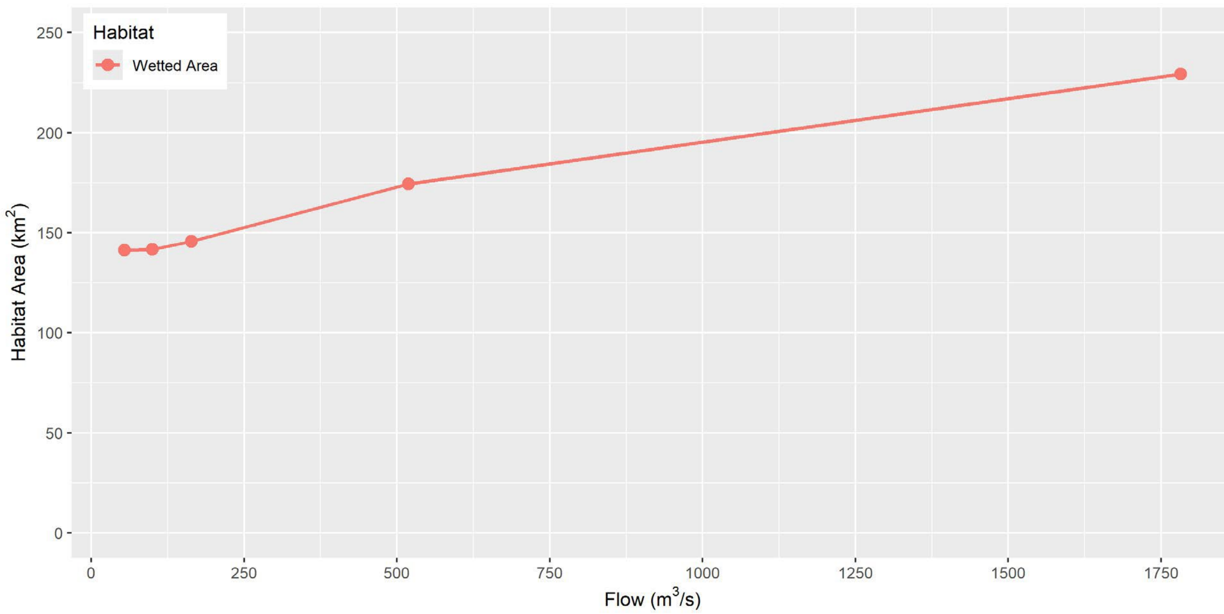

Figure 5-12: Northern Indian Lake to Billard Lake wetted area as a function of flow

Model 2 – Little Churchill River confluence area

Wetted area for Reach 2 increased from approximately 12.9 km^2 under the P5 flow scenario to 15.1 km^2 under the P95 scenario, representing an 18% (2.3 km^2) increase across the modelled flow range (Figure 5-13). The largest changes in wetted area were concentrated near the alluvial fan at the mouth of the Little Churchill River and along shallow channel margins adjacent to the thalweg.

The relatively small increase in wetted area reflects the channel morphology of this reach, where additional flow is accommodated primarily through increases in water depth and velocity rather than extensive lateral expansion of the wetted channel. Most of the increase in wetted area occurred between the P25 and P75 flow scenarios, indicating that low-lying areas at the confluence become inundated at intermediate flows. At higher flows, additional increases in flow are accommodated primarily through increases in water depth and velocity rather than further expansion of the wetted area.

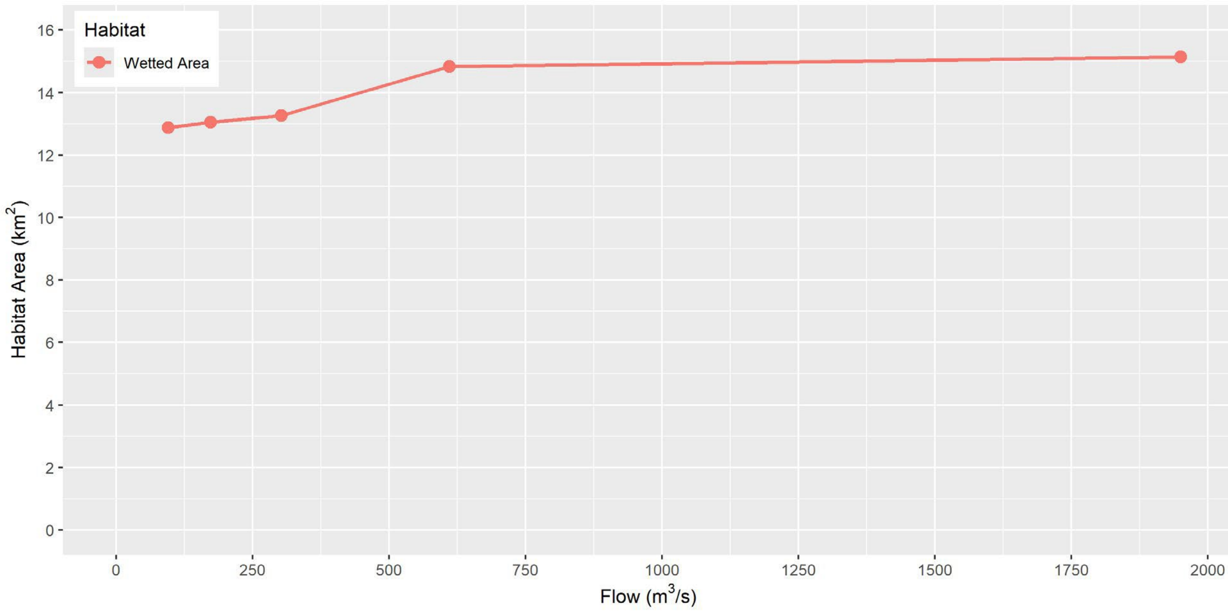

Figure 5-13: Little Churchill River confluence area wetted area as a function of flow

5.3 Fish Habitat Assessment

5.3.1 Approach

Desktop habitat assessments were completed for Lake Sturgeon, Walleye, and Lake Whitefish. These species were selected based on known species distributions, provincial Fisheries Management Objectives (Manitoba Fisheries Branch, 2024) (Appendix B), and species known to be important culturally and from a resource use perspective.

Habitat criteria were developed using published literature, regional monitoring data and information from the Keeyask Generating Project Environmental Impact Statement (2012) (Table 5-4). Where appropriate, these criteria were adapted to known local conditions by assessing local monitoring results and by consulting fisheries biologists from Manitoba Fisheries Branch.

Fish habitat was assessed using a criteria-based spatial analysis rather than a traditional Habitat Suitability Index approach. Individual habitat criteria, including water depth and velocity, were evaluated independently for each species and life stage. For each species-life stage combination, spatial layers representing the individual depth and velocity criteria were overlaid to identify areas where all habitat criteria were simultaneously met. Unlike a traditional habitat suitability analysis, this approach does not assign suitability scores, weighting factors, or combined habitat indices. Instead, the approach provides a transparent assessment of habitat distribution by identifying and mapping locations where species- and life stage-specific habitat criteria are met.

For Lake Sturgeon spawning and larval habitat, suitable areas were defined as locations with water depths greater than 1.0 m and velocities characteristic of swift water or rapids, ranging from approximately 1.0 to 2.1 m/s (Table 5-4). These criteria were based on the habitat features and attributes required to support essential life stage functions for Lake Sturgeon (Lacho et al., 2021) and were subsequently refined through consultation with fisheries biologists from Manitoba Fisheries Branch. Juvenile and young-of-year (YOY) Lake Sturgeon were not assigned specific depth or velocity criteria, as published studies and monitoring results from multiple river systems demonstrate considerable plasticity in habitat use during these life stages (Cleator et al., 2010; Barth et al., 2009; Lacho et al., 2021; Manitoba Economic Development, Investment, Trade and Natural Resources, 2024).

For Walleye spawning habitat, suitable conditions were defined as water depths less than 2.0 m and velocities between 0.3 and 1.0 m/s (Table 5-4). These criteria were based on the Department of Fisheries and Oceans research conducted by Hartman (2009) and the Department of Fisheries and Oceans Canadian Science Advisory Secretariat (2011), and were refined through consultation with fisheries biologists from Manitoba Fisheries Branch. These velocity conditions were selected to ensure adequate egg oxygenation and waste removal during incubation.

For Lake Whitefish spawning habitat, suitable habitat was defined as areas with water depths between 2.0 and 9.0 m, thereby reducing the risk of egg dewatering or freezing (Table 5-4). Velocities between 0.3 and 1.0 m/s were considered suitable for supporting healthy dissolved oxygen concentrations. These criteria were based on *Freshwater Fishes of Canada* (Scott and Crossman, 1973) and refined through consultation with fisheries biologists from Manitoba Fisheries Branch. The same depth and velocity criteria were applied to the egg incubation period to ensure eggs remained submerged and adequately oxygenated throughout development.

Adult and overwintering habitat for all study species was identified as areas with water depths greater than 2.5 m, as these areas are expected to provide sufficient depth, habitat area, and flow to maintain suitable temperatures and dissolved oxygen concentrations. This criterion was based on Lake Sturgeon habitat research presented by Lacho et al. (2021).

Egg incubation habitat criteria were not assessed for Lake Sturgeon and Walleye, as it was assumed spawning and larval habitats would also support that life stage. Similarly, YOY and juvenile habitat criteria for Walleye and Lake Whitefish were not assessed separately as they were assumed to be similar to the criteria for larval and adult life stages.

Potential fish movement barriers were assessed using a minimum depth threshold of 0.2 m (Manitoba Natural Resources and Fisheries and Oceans Canada, 1996).

Table 5-4: Fish habitat assessment criteria by species and life stage

-	**Lake Sturgeon**	**Walleye**	**Lake Whitefish**
Spawning/larval	Depth: > 1.0 m Velocity: 1.0 - 2.1 m/s	Depth: < 2 m Velocity: 0.3 – 1.0 m/s	Depth: 2.0 – 9.0 m Velocity: 0.3 – 1.0 m/s
Egg Incubation			Depth: 2.0 – 9.0 m Velocity: 0.3 – 1.0 m/s
Young-of-Year/Juvenile	Depth: > 2.5 m		
Adult	Depth: > 2.5 m		
Overwintering	Depth: > 2.5 m		
Movement Barriers	Depth: > 0.2 m		

5.3.2 Habitat Analysis

The following sub-sections provide an overview of theoretical habitat availability within the two model domains for four habitat types: Lake Sturgeon spawning/larval, Walleye spawning/larval, Lake Whitefish spawning/larval and egg incubation, and general habitat. General habitat includes Lake Sturgeon YOY and juvenile habitat, adult habitat for all target species, and overwintering habitat for all species and life stages other than Lake Whitefish eggs. Results for each habitat type are presented in Appendix D following the map key presented in Section 5.2.3.

Table 5-5 and Table 5-6 summarize the estimated habitat area available within the NIL to BL and Little Churchill River confluence area model domains under each modelled flow scenario. Detailed results for each habitat type are discussed in the following sections.

Table 5-5: Summary of habitat availability within the Northern Indian Lake to Billard Lake model domain

Flow Scenario	**Flow (m^3/s)**	**Habitat Quantification (km^2)**			
		Lake Sturgeon Spawning/ larval	**Walleye** Spawning/ larval	**Lake Whitefish** Spawning/ larval & egg incubation	**General**
P5	54	0.01	3.53	0.13	55.33
P25	100	0.10	5.07	0.81	60.28
P50	164	0.42	5.48	2.89	66.62
P75	519	2.54	3.17	13.87	101.32
P95	1782	9.70	1.04	18.93	184.11

Note: General habitat includes Lake Sturgeon young-of-year and juvenile habitat, adult habitat for all target species, and overwintering habitat for all species and life stages, excluding Lake Whitefish egg incubation habitat.

Table 5-6: Summary of habitat availability within the Little Churchill River confluence area model domain

Flow Scenario	Flow (m^3/s)	Habitat Quantification (km^2)			
		Lake Sturgeon Spawning/ larval	**Walleye** Spawning/ larval	**Lake Whitefish** Spawning/ larval & egg incubation	**General**
P5	95	0	2.15	0.04	2.97
P25	173	0.01	2.83	0.39	3.31
P50	302	0.16	3.05	1.97	3.80
P75	610	4.66	1.01	5.86	10.67
P95	1950	5.05	0.68	6.08	11.70

Note: General habitat includes Lake Sturgeon young-of-year and juvenile habitat, adult habitat for all target species, and overwintering habitat for all species and life stages, excluding Lake Whitefish egg incubation habitat.

5.3.2.1 *Spawning/Larval and Egg Incubation Habitat*

Model 1 – Northern Indian Lake to Billard Lake

The availability of spawning and larval habitat within the NIL to BL model domain varied substantially among species and flow scenarios (Table 5-5 and Figure 5-14; Appendix D, maps starting with M1-LKST, M1-LKWF, and M1-WALL). Habitat availability for Lake Sturgeon and Lake Whitefish increased with flow, whereas Walleye habitat peaked under intermediate flow conditions and declined under high flow scenarios. These contrasting responses reflect differences in species-specific depth and velocity requirements.

Interpretation of the Walleye and Lake Whitefish results requires consideration of an important model limitation. Potential spawning and larval habitat for Walleye and Lake Whitefish may be underestimated because the hydraulic model does not account for wind and wave action, which are important factors in the formation and maintenance of windswept shoreline and reef spawning habitats. Consequently, the decline in Walleye habitat under higher-flow scenarios, and Lake Whitefish spawning habitat under low flow scenarios, may be less pronounced than indicated by the model results.

Suitable Lake Sturgeon spawning habitat increased from 0.01 km^2 under the P5 flow scenario to 9.70 km^2 under the P95 flow scenario (Figure 5-14). Habitat was generally associated with rapids, lake outlets, channel constrictions, and other areas characterized by relatively high velocities. As flow increased, both the extent and connectivity of these habitats increased, resulting in substantially greater spawning habitat availability throughout the model domain.

Suitable Walleye spawning habitat increased from 3.53 km^2 under the P5 flow scenario to a maximum of 5.48 km^2 under the P50 flow scenario before declining to 1.04 km^2 under the P95 flow scenario (Figure 5-14). This pattern reflects the preference of Walleye for relatively shallow habitats with moderate velocities. At lower flows (P5–P25), suitable habitat was concentrated within the deeper, central portions of riverine reaches. By intermediate flows (P50), suitable habitat expanded toward shorelines. At higher flows (P75–P95), the deeper, mid-channel portions of riverine reaches either exceeded preferred velocity ranges or became too deep, resulting in a reduction in suitable habitat area. Under all flow conditions, suitable habitat was not present within lake environments except near inlet and outlet areas. However, as noted above potential spawning habitat within lake environments may be underestimated, as windswept shoreline and reef habitats known to support Walleye spawning were not represented in the assessment. Subject to this limitation, the results suggest that intermediate flow conditions provide the greatest extent of potential Walleye spawning habitat within the NIL to BL reach.

Lake Whitefish spawning/larval and egg incubation habitat increased progressively across the flow range, from 0.13 km^2 under the P5 flow scenario to 18.93 km^2 under the P95 flow scenario (Figure 5-14). Suitable habitat was concentrated in deeper, mid-channel portions of riverine reaches, generally near the thalweg. As water levels increased, the extent of suitable habitat expanded, resulting in a substantial increase in habitat availability. Suitable habitat was not present within lake environments except near inlet and outlet areas. Similarly to Walleye, potential spawning habitat within lake environments may be underestimated, as windswept shoreline and reef habitats known to support Lake Whitefish spawning were not represented in the assessment.

An important consideration for Lake Whitefish is that spawning occurs in the fall and suitable habitat must remain wetted (and below the ice cover) throughout the winter for successful egg incubation. The habitat assessment presented here reflects hydraulic conditions under individual open water flow scenarios and does not evaluate subsequent changes in water level during the incubation period. If water levels decline following spawning, as may occur under typical CRD operations, portions of the initially suitable habitat may become dewatered or subject to ice-related disturbance, reducing egg survival.

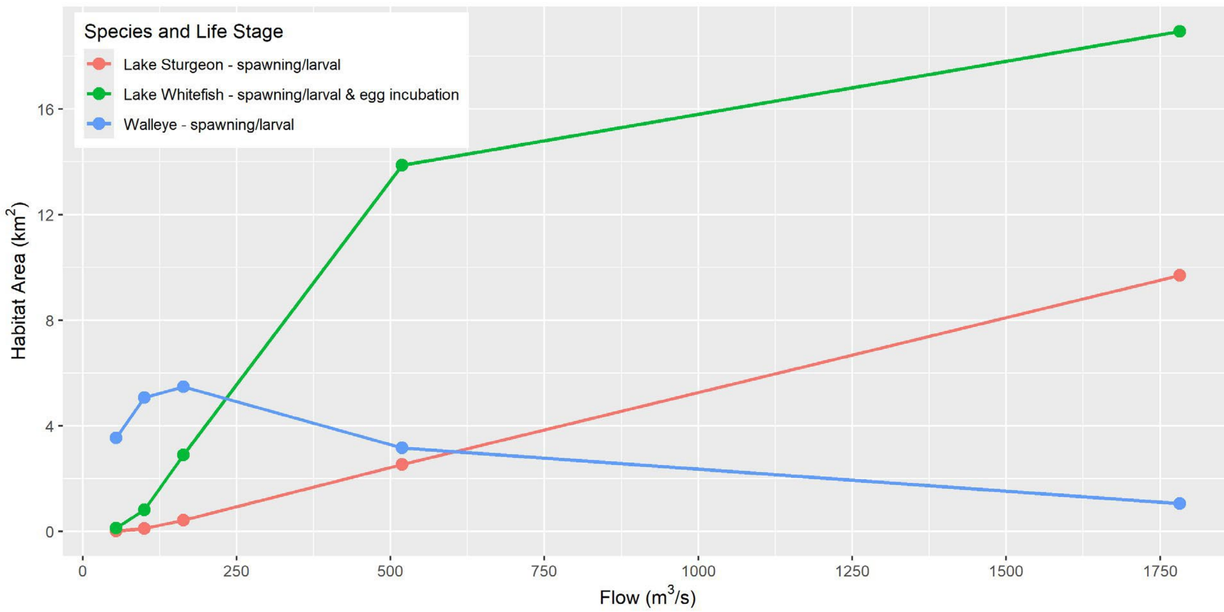

Figure 5-14: Northern Indian Lake to Billard Lake early life stage habitats

Model 2 – Little Churchill River confluence area

The availability of spawning and larval habitat within the Little Churchill River confluence area varied substantially among species and flow scenarios (Table 5-6 and Figure 5-15; Appendix D, maps starting with M2-LKST, M2-LKWF, and M2-WALL). As observed in the NIL to BL model domain, Lake Sturgeon and Lake Whitefish habitat generally increased with flow, whereas Walleye habitat was greatest under intermediate flow conditions. The magnitude and pattern of habitat change, however, differed because of the hydraulically confined nature of the reach and the influence of the Little Churchill River alluvial fan.

Suitable Lake Sturgeon habitat was not identified under the P5 flow scenario, and was only present in small amounts in the P25 and P50 scenarios, before increasing to 5.05 km^2 under the P95 flow scenario (Figure 5-15). Suitable habitat was primarily associated with rapids and channel constrictions upstream of the confluence, where increased flow produced the high velocity conditions required to satisfy the Lake Sturgeon habitat criteria. The largest increase in habitat occurred between the P50 and P75 flow scenarios, increasing from 0.16 km^2 to 4.66 km^2. This increase coincided with improved hydraulic connectivity through portions of the confluence area, resulting in more extensive areas that satisfied the Lake Sturgeon habitat criteria. In contrast, habitat increased by only 0.39 km^2 between the P75 and P95 flow scenarios. These results indicate that Lake Sturgeon spawning and larval habitat within this reach is highly flow-dependent and largely absent under low flow conditions (P5–P25). Habitat availability increases substantially between the P25 and P75 flow scenarios as hydraulic connectivity improves and suitable velocity conditions become more widespread. However, flows greater than the P75 scenario provide relatively little additional habitat.

Walleye spawning and larval habitat increased from 2.15 km^2 under the P5 flow scenario to 3.05 km^2 under the P50 flow scenario, before declining to 0.68 km^2 under the P95 flow scenario (Figure 5-15*)*. Similar to the NIL to BL model domain, intermediate flows provided the greatest extent of suitable habitat. The one exception may be windswept spawning areas, which were not quantified in this hydraulic model. At higher flows, increasing water depths and velocities reduced the amount of habitat that met the selected criteria.

Lake Whitefish spawning/larval and egg incubation habitat increased with flow, from 0.04 km^2 under the P5 flow scenario to 6.08 km^2 under the P95 flow scenario (Figure 5-15). Habitat increased most substantially between the P50 and P75 flow scenarios, from 1.97 km^2 to 5.86 km^2, with little additional increase at higher flows. Similar to Lake Sturgeon, this increase coincided with improved hydraulic connectivity through portions of the confluence area. Habitat increased by only 0.22 km^2 between the P75 and P95 flow scenarios. These results indicate that Lake Whitefish habitat within this reach is highly flow-dependent and largely absent under low flow conditions (P5); however, flows greater than the P75 scenario provide relatively little additional habitat. Habitat was generally concentrated within deeper portions of the lower Churchill River, where moderate velocities and suitable depths occurred, with comparatively minimal habitat in the Little Churchill River.

Compared to the NIL to BL model domain, habitat responses within the Little Churchill River confluence area were more strongly influenced by channel hydraulics than changes in wetted area. As discussed in Section 5.2.3.2, total wetted area changes within this reach were relatively small across the modelled flow range. Consequently, changes in spawning habitat were primarily driven by shifts in water depth, velocity, and hydraulic connectivity rather than large-scale inundation of new habitat. In particular, the results demonstrate the importance of flow in maintaining connectivity between the Little Churchill River and the lower Churchill River. Under the P5 and P25 flow scenarios, extensive shallow areas (<20 cm depth) developed across the Little Churchill River alluvial fan, limiting hydraulic connectivity between the two rivers and potentially restricting fish access to upstream spawning habitats. As a result, low flow conditions reduced both access to habitat and the availability of suitable spawning conditions within portions of the confluence area. The extent of these effects varied among species. Under low flow conditions (P5-P25), suitable Lake Sturgeon spawning habitat was absent or extremely limited throughout the confluence area. Similarly, suitable Walleye spawning habitat was generally absent within the lower Churchill River at and downstream of the confluence. In contrast, Lake Whitefish spawning habitat remained available in localized pockets of the lower Churchill River, although suitable habitat was not identified within the Little Churchill River.

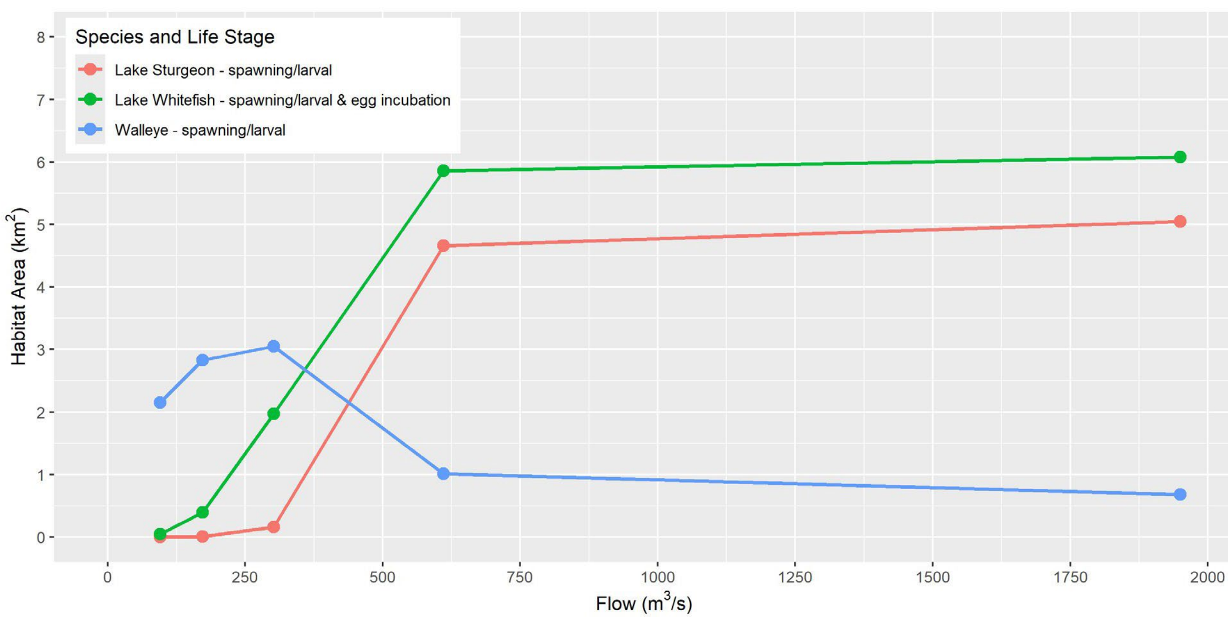

Figure 5-15: Little Churchill River confluence area early life stage habitats

5.3.2.2 *General Habitat*

Model 1 – Northern Indian Lake to Billard Lake

General habitat in the NIL to BL model domain increased linearly with flow, from 55.33 km^2 under the P5 flow scenario to 184.11 km^2 under the P95 flow scenario, representing more than a three-fold increase across the modelled flow range (Table 5-5 and Figure 5-16; Appendix D, maps starting with M1-G). The increase in general habitat was primarily driven by the inundation of shallow shoreline habitats along lake margins and islands at NIL, FL, and BL, as well as around riverine islands and broad channel features.

Despite the substantial differences in total habitat area, deep-water habitats remained available throughout the modelled reach under all flow scenarios. These habitats were concentrated within the deeper portions of the lake basins and the main river thalweg. As a result, suitable adult and overwintering habitat was present throughout the study reach even under low flow conditions, although the quantity and spatial extent of available habitat were reduced.

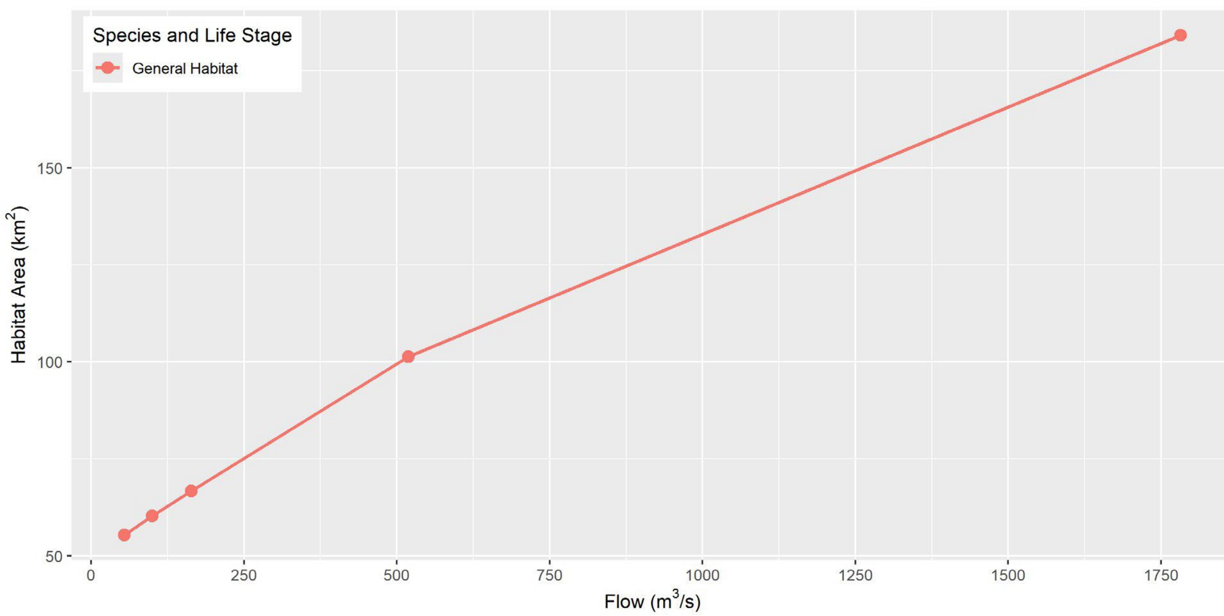

Figure 5-16: Northern Indian Lake to Billard Lake general habitat

Model 2 – Little Churchill River confluence area

General habitat in the Little Churchill River confluence area increased substantially with flow, from 2.97 km^2 under the P5 flow scenario to 11.70 km^2 under the P95 flow scenario, representing nearly a four-fold increase across the modelled flow range (Table 5-6 and Figure 5-17; Appendix D, maps starting with M2-G).

Unlike the NIL to BL model domain, where habitat increased linearly with flow and large increases in habitat were associated with inundated shallow environments, the Little Churchill River confluence area is geomorphologically confined. Consequently, increases in general habitat were driven primarily by deepening of existing aquatic habitats rather than the creation of large areas of newly inundated habitat.

Under low flow conditions, areas meeting the general habitat criterion were largely restricted to the deeper portions of the lower Churchill River downstream of the confluence and within localized deep pools throughout the reach. As flows increased, the extent and connectivity of these habitats increased, particularly within the confluence area and lower Little Churchill River where shallow-water conditions were prevalent under the P5 and P25 flow scenarios. The largest increase in habitat occurred between the P50 and P75 flow scenarios, increasing from 3.80 km^2 to 11.70 km^2. This increase coincided with improved hydraulic connectivity through portions of the confluence area, resulting in more extensive areas that satisfied the general habitat criteria. In contrast, habitat increased by only 1.03 km^2 between the P75 and P95 flow scenarios, indicating that most suitable habitat became available once hydraulic connectivity was established and that further increases in flow provided relatively little additional habitat.

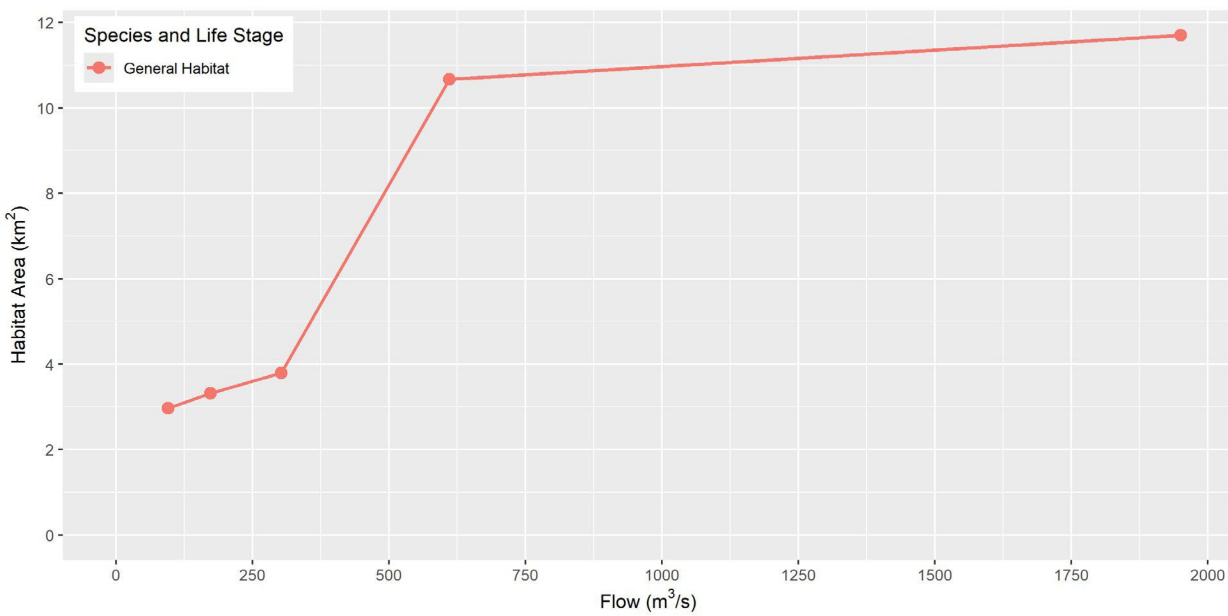

Figure 5-17: Little Churchill River confluence area general habitat

5.4 Summary of Key Findings of the Ecohydraulics Study

The following summarizes the key findings of this work.

Note that the results should be interpreted within the context of the study methodology and associated uncertainties. Habitat assessments were based on hydraulic criteria and represent potential habitat availability under a range of representative flow conditions rather than direct measurements of habitat use. In addition, the assessment did not evaluate temporal changes in habitat availability or the connectivity of habitats required among life stages. A detailed description of Study Limitations and Uncertainty is provided in Appendix C.

Despite these limitations, the study provides a robust assessment of the hydraulic factors influencing habitat availability and barriers to movement under current CRD operating conditions and establishes a solid baseline for future evaluations of fish habitat within the lower Churchill River.

5.4.1 Ecohydraulic Conditions

The ecohydraulic assessment demonstrated that flow is the primary factor controlling habitat availability and hydraulic connectivity within the lower Churchill River with the CRD in place. However, habitat responses varied substantially among species, life stages, and geomorphic settings, indicating that no single flow condition maximizes all habitat functions simultaneously.

Habitat availability remained strongly influenced by flow throughout both modelled reaches. Habitat was available for many target species and life stages across most of the modelled flow range; however, spawning/larval habitats were substantially limited under portions of the modelled flow range.

Lake Sturgeon spawning and larval habitat and Lake Whitefish spawning, larval, and egg incubation habitat were absent or highly limited under portions of the low-flow range. Within the NIL to BL model domain, only 0.01 km^2 of suitable habitat was identified under the P5 flow scenario. Within the Little Churchill River confluence area, no suitable habitat was identified under the P5 flow scenario and only 0.01 km^2 was identified under the P25 flow scenario. Similarly, Lake Whitefish spawning, larval, and egg incubation habitat was limited under low flow conditions, with habitat availability ranging from less than 0.05 km^2 in the Little Churchill River confluence area to 0.1 km^2 in the NIL to BL model reach under the P5 flow scenario. Habitat availability for both species generally increased with increasing flow. In contrast, Walleye spawning and larval habitat was most limited under high flow conditions, declining to approximately 1 km^2 or less within both model domains under the P95 flow scenario. These results indicate that suitable spawning habitat is constrained by species-specific hydraulic requirements and is not continuously available across the range of flow conditions evaluated.

Habitat availability did not increase uniformly with flow in both modelled reaches. Within the NIL to BL model reach, increases in habitat availability were driven primarily by inundation of shallow shoreline, nearshore, and channel-margin habitats as water levels increased. In contrast, habitat responses within the Little Churchill River confluence area were controlled primarily by changes in water depth, velocity, and hydraulic connectivity. In this reach, substantial increases in habitat availability occurred only after threshold hydraulic conditions were achieved, after which habitat expanded rapidly and additional increases in flow provided relatively little benefit.

The assessment also identified an important ecological trade-off among species. While increasing flows generally benefited Lake Sturgeon and Lake Whitefish habitat availability, as well as adult/overwintering habitat for all species, Walleye spawning and larval habitat peaked under intermediate flow conditions. Consequently, flow conditions that maximize habitat availability for one species or life stage may not maximize habitat availability for others.

Two locations were identified where hydraulic conditions may constrain fish movement and access to habitat. At the Lower Fidler Rapids, under the P5 flow scenario, portions of the rapids approached or fell below the minimum depth criteria used to assess fish passage. Increasing flows generally improved depth-related connectivity through this reach. However, under higher P75 and P95 flow conditions, elevated velocities created a barrier to upstream fish movement for some species and life stages. At the Little Churchill River confluence, connectivity was reduced under low flow scenarios due to shallow conditions across portions of the alluvial fan at the river mouth. These findings suggest that habitat accessibility, in addition to extent, is an important consideration when evaluating ecohydraulic conditions within the lower Churchill River. While the present assessment identifies locations where hydraulic conditions may influence fish movement, a comprehensive evaluation of fish passage would require site-specific studies incorporating additional flow scenarios, fish swimming performance information, and potentially higher-resolution hydraulic modelling.

Habitat responses also reflected the geomorphic characteristics of each reach, with habitat gains in the NIL to BL model domain being driven primarily by inundation of shallow shoreline and channel-margin habitats, whereas habitat responses within the Little Churchill River confluence area were driven largely by changes in water depth and hydraulic connectivity. These findings demonstrate that habitat availability is influenced not only by flow magnitude, but also by the geomorphic and hydraulic characteristics of individual reaches. Consequently, no single flow condition is likely to optimize habitat availability throughout the lower Churchill River. Any future habitat assessments would need to consider multiple habitat objectives, as well as the hydraulic and geomorphic characteristics of individual reaches.

5.4.2 Water Quality and Winter Habitat Considerations

Results from the physical environment monitoring program, which was conducted during a period of predominantly low flow conditions, indicate that water quality conditions within the monitored reaches generally support fish habitat functions. Dissolved oxygen concentrations remained above applicable guideline thresholds with only a few exceptions, and turbidity levels were generally low throughout the study area. Collectively, these findings do not indicate widespread water quality limitations within the monitored reaches. However, the available monitoring record is limited both spatially and temporally, and additional monitoring under a broad range of flow conditions would improve understanding of water quality variability throughout the lower Churchill River.

Ice processes represent a greater source of uncertainty for the habitat assessment. Although ice monitoring was completed within the study area, the monitoring occurred during years characterized by relatively low flow conditions. Consequently, the available information may not fully represent the range of winter habitat conditions that could occur under higher flow scenarios. Successful Lake Whitefish egg incubation depends not only on suitable spawning conditions during the fall, but also on the persistence of suitable habitat throughout the winter. The habitat assessment presented here reflects hydraulic conditions under individual open water flow scenarios and does not evaluate subsequent changes in water level, ice formation, or ice-related habitat disturbance during the incubation period. Future ice monitoring and winter hydraulics modelling would improve understanding of potential effects on egg incubation habitat and provide a more comprehensive assessment of Lake Whitefish reproductive habitat within the lower Churchill River.

6.0 Concluding Comments

This study provides information to better understand the relationships among flow, hydraulics, and fish habitat in the lower Churchill River. It contributes to other historical studies, including those done at the time of development, and more current work downstream of Missi Falls and on the lower Churchill River. This includes monitoring and studies being undertaken through the CAMP, community-led studies (e.g., Tataskweyak Cree Nation) and other studies that may be implemented by the Churchill-Burntwood Regional Monitoring Committee.

Known opportunities where future work may be valuable include conducting habitat use and recruitment assessments to validate mapped and modelled habitat, and undertaking analyses that link habitat availability to fish population abundance, distribution, and productivity. These opportunities will be reviewed and assessed, in collaboration with Manitoba Fisheries Branch and the Churchill-Burntwood Regional Monitoring Committee for potential future implementation.

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APPENDICES

Appendix A: Summary of Fish Community Monitoring Data in the Study Area

Summary of Fish Community Monitoring Data in the Study Area

An overview of existing technical monitoring data (from the Coordinated Aquatic Monitoring Program, CAMP), focusing on fish populations in the study area, is provided below. This data was used to guide identification of target species and life stages for the study. Additional information can be found at *www.campmb.ca*.

The information and analyses contained in this summary are based on unpublished CAMP data and are considered preliminary.

Missi Falls CS to Partridge Breast Lake

Relatively little is known about the fish community from Missi Falls CS to Partridge Breast Lake. Prior to CRD, there was no background information collected.

Partridge Breast Lake

Results from CAMP sampling conducted on a three-year rotation from 2008-2024 indicate that the large-bodied fish community in Partridge Breast consists largely of Walleye, White Sucker, Northern Pike, and Lake Whitefish. The relative abundance of species fluctuates from year to year, but the same four species dominate the catch. Other large-bodied species such as Cisco, Longnose Sucker, Sauger and Burbot are also present but at much lower abundances. The forage fish community includes Spottail Shiner, Emerald Shiner, Yellow Perch, Troutperch, Lake Chub, and Slimy Sculpin. Catches of forage fish in Partridge Breast have also varied in each of the six sampling years ranging from 66 fish in 2021 to 341 fish in 2015.

Ageing data available for Walleye, Northern Pike and Lake Whitefish indicate successful recruitment of all three species in each of the last 28 years (1995-2023) (Table A-1). During the most recent sampling conducted in 2024, Lake Whitefish ranged in age from 1 to 23 with the majority of the catch between the ages of 2 and 9 (2015-2022) and strong cohort years from both 2017 and 2018. Walleye, on the other hand, tended to be older with the majority of the catch in 2024 ranging from 10 to 15 years old (2009-2014 cohorts).

Northern Indian Lake

In Northern Indian Lake (NIL), sampling has been conducted on a yearly basis since 2008 with a total of 17 different species represented in the catch. Similar to Partridge Breast, the large-bodied fish community in NIL is dominated by Walleye and White Sucker with Lake Whitefish, Northern Pike, and Cisco also present but at lower abundances. The remaining species account for a small fraction of the catch and include Longnose Sucker, Burbot and Sauger. The forage fish community in NIL was slightly more diverse than Partridge Breast with a total of nine species represented, however, the catch was dominated by the same four species (Spottail Shiner, Emerald Shiner, Yellow Perch and Troutperch) accounting for almost the entire catch.

Ageing data available for Walleye, Northern Pike and Lake Whitefish indicate successful yearly recruitment of all three species from 1993 to 2022 (30 years) (Table A-1). Yearly variations in spawning success can be observed for all three species over the 16-year sampling period. In 2024, Lake Whitefish aged from NIL ranged in age from 2 to 22 years old (2002-2022 cohorts) with the majority of the fish from the 2014-2022 cohorts (ages 2-10). Similar to Partridge Breast, the 2017 and 2018 cohorts were the most abundant age classes in the 2024 study year. Year classes from Walleye aged in 2024 were variable and ranged from 1-27 years old with four strong cohorts (2012, 2017, 2020, and 2023) accounting for over 50% of all aged fish.

Fidler Lake

Relative abundances of large-bodied species in Fidler Lake were consistent with other lower Churchill River sample locations and were dominated by the four main species. However (unlike in Partridge Breast and NIL where Lake Whitefish were caught in moderate abundances) Lake Whitefish were the most abundant species caught during Fidler Lake sampling in 2011, 2014, 2017, and 2020. The forage fish community is dominated by Trout Perch and Spottail Shiner with the remaining catch composed of Emerald Shiner, Yellow Perch and Lake Chub.

Ageing data available for Walleye, Northern Pike and Lake Whitefish indicate successful recruitment of all three species over a period of 25 years (1997-2021) (Table A-1). For Walleye, recent year classes (2015-2023) have been relatively low in the catch (ranging from 1-7 total fish) with the exception of a strong 2017 cohort (60 fish). Year class strengths for Lake Whitefish have been variable with the period from 2001-2013 having fairly stable recruitment followed by several years of noticeably higher recruitment (2014 and 2017). Recently, Lake Whitefish from the 2019, 2020, 2021 and 2022 year classes have not been particularly abundant. No young of the year or 1-yr old Walleye, Northern Pike or Lake Whitefish were caught in 2023, representing the 2023 and 2022 year classes respectively.

Billard Lake

The same four species that dominated the catches in Partridge Breast, NIL, and Fidler were also abundant in Billard Lake in each of the five monitoring years since 2010. Yearly fluctuations in species abundance were observed for all species with Lake Whitefish and Walleye the most abundant. Northern Pike and White Sucker were also regularly caught but at lower numbers. The remaining catch was composed of Cisco, Longnose Sucker, Burbot and Lake Sturgeon. Unlike waterbodies further upstream, one Lake Sturgeon was caught in Billard Lake during CAMP sampling in 2010 but no Lake Sturgeon have been caught since. The forage fish community in Billard Lake, as with other lower Churchill River sampling locations, was dominated by Troutperch, Spottail Shiner, and Emerald Shiner. Catches of forage fish have been lower in each of the last two study years (2019 and 2022) when compared to the first three (2010, 2013, and 2016).

Ageing data from fish community sampling in Billard Lake demonstrates a clear period of consistent recruitment for all three species from 1997-2018 with variable recruitment from 2019-2022 (Table A-1). Walleye ages determined over the five sampling years show that individuals from the 1986-2018 year classes have been present in the catch with the 2010 year class appearing the strongest with more than double the number of individuals caught compared to the next closest year class. In the most recent round of sampling conducted in 2022, no Walleye from the previous four year classes (2019-2022) were present in the catch. Lake Whitefish recruitment has been fairly consistent with individuals from the 2001-2021 cohorts present in the catch during sampling in 2022. In 2022, several strong year classes were present including the 2014 and 2015 cohorts.

Churchill River and the Little Churchill River

Sampling at the confluence of the Little Churchill River started in 2008 but unfortunately was stopped in 2018 due to community concerns around Lake Sturgeon and fish mortality. Despite the absence of recent fish community data, there are still a total of 11 study years of fish community data available for review. The fish community at the confluence of the Little Churchill River is unique to the lower Churchill River system in that it's the only reach where Lake Sturgeon are consistently captured during sampling. In the 11 years of sampling, Lake Sturgeon were the second most abundance species in the catch behind Walleye. Lake Whitefish, Northern Pike, White Sucker, Cisco, Longnose Sucker, Burbot, and Arctic Grayling accounted for the remaining catch. The forage fish community was slightly more diverse than Fidler and Billard lakes over the 11 sampling seasons but the same key species (Trout Perch, Spottail Shiner, and Emerald Shiner) accounted for the majority of the catch at the confluence with the Little Churchill River.

Although not technically a target species of CAMP sampling, ageing structures were taken from some Lake Sturgeon captured during sampling at the confluence of the Little Churchill River between 2008 and 2015. Ages ranged from 1-22 and covered the 1989-2013 year classes. Ageing structures were not taken from Lake Sturgeon captured between 2016-2018 other than from mortalities. Similar to other waterbodies, Walleye recruitment was variable but consistent recruitment occurred from 1981-2013 (Table A-1). For Walleye, the most recent strong year class appears to be the 2010 cohort. During the final few years of sampling (2014-2018), only two individuals were caught from those year classes, both being from the 2015 year class. Lake Whitefish have also had fairly consistent recruitment between 1987-2015 and like Walleye the relative strength of each year class varies with 2010 being the strongest in the catch. No Lake Whitefish from the 2016, 2017, and 2018 year classes were caught in the area before sampling was stopped at the end of 2018 (Table A-1).

Churchill River at the Churchill Weir

While not included in the model domain of the current study, CAMP monitoring also takes place rotationally (every three years) at the Churchill Weir (2014 – 2023). The large-bodied fish community in the vicinity of the Churchill Weir is slightly different than that of the other Churchill River waterbodies. While the four main species are still dominant, White Sucker and Walleye are far less abundant in the catch compared to Lake Whitefish and Northern Pike. Several species not caught elsewhere on the Churchill River such as Round Whitefish and Arctic Char also appear in the catch but infrequently. The forage fish community remained similar to other waterbodies sampled on the Churchill River with Troutperch, Spottail Shiner and Lake Chub accounting for almost the entire catch. Longnose Dace and Slimy Sculpin were also caught but infrequently.

Ageing structures were only taken from a small proportion of Walleye caught in the vicinity of the Churchill Weir and therefore an accurate assessment of the populations age structure is not possible. Lake Whitefish recruitment has occurred consistently since 2009 with the 2020 cohort the most captured year class.

Summary

Based on data collected through the CAMP on the lower Churchill River, a total of 12 large-bodied species and 13 forage fish species have been caught since 2008. Apart from the Churchill River at the Little Churchill River, where Lake Sturgeon are abundant, Walleye, Lake Whitefish, White Sucker, and Northern Pike were the dominant large-bodied species in the Churchill River. Collectively, the four species accounted for greater than 85% of all large-bodied fish caught in the lower Churchill River since 2008. Similarly, the forage fish community is dominated by four species, Spottail Shiner, Troutperch, Emerald Shiner and Yellow Perch accounting for the vast majority of the total catch.

Ageing data from the region indicates that recruitment of key species such as Walleye and Lake Whitefish has occurred fairly consistently over the last 20-30 years but with large variations in year class success. The 2017 year class for both Walleye and Lake Whitefish appears strong in several locations along the Churchill River including Partridge Breast, and Fidler. Other strong year classes were present in the catches but were variable with no clear pattern.

Additional Studies

Additional information related to the abundance and habitat use of Lake Sturgeon in and around the confluence of the Churchill and Little Churchill rivers has resulted from studies by MH’s Lake Sturgeon Stewardship and Enhancement Program (LSSEP, Dolce-Blanchard and Barth 2015; Ambrose and McDougall 2016; 2018; Ambrose et. al. 2017) and studies undertaken by the Tataskweyak Cree Nation (TCN) from 2018 to 2024 (with funding provided in large part by MH, AAE Tech Services 2025 a,b). Collectively, this work has found there to be a stable and self-sustaining population of Lake Sturgeon at the confluence, but that this population is limited in distribution, and the sole sturgeon population present in the lower Churchill River.

Table A-1: Recruitment summary for target species (Walleye and Lake Whitefish) in Lower Churchill River waterbodies over the period of record. Y (green highlight) indicates capture of fish spawned in that year, N (red highlight) indicates no capture of fish spawned in that year, black cells represent years and locations with no sampling.

Cohort *(Year Spawned)*	**Partridge Breast Lake**		**Northern Indian Lake**		**Fidler Lake**		**Billard Lake**		**Confluence**	
	Lake Whitefish	Walleye	Lake Whitefish	Walleye	Lake Whitefish	Walleye	Lake Whitefish	Walleye	Lake Whitefish	Walleye
2023	Y	Y	N	Y						
2022	Y	Y	Y	Y	N	N				
2021	Y	Y	Y	Y	Y	Y	Y	N		
2020	Y	Y	Y	Y	Y	Y	Y	N		
2019	Y	Y	Y	Y	Y	Y	Y	N		
2018	Y	Y	Y	Y	Y	Y	Y	N		
2017	Y	Y	Y	Y	Y	Y	Y	Y	N	N
2016	Y	Y	Y	Y	Y	Y	Y	Y	N	N
2015	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2014	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
2013	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2012	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2011	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2010	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2009	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2008	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2007	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2006	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2005	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2004	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2003	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2002	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2001	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2000	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1999	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1998	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Cohort *(Year Spawned)*	Partridge Breast Lake		Northern Indian Lake		Fidler Lake		Billard Lake		Confluence	
	Lake Whitefish	Walleye	Lake Whitefish	Walleye	Lake Whitefish	Walleye	Lake Whitefish	Walleye	Lake Whitefish	Walleye
1997	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1996	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
1995	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
1994	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
1993	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
1992	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
1991	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
1990	N	N	Y	Y	N	Y	Y	Y	N	Y
1989	N	Y	Y	Y	N	Y	Y	Y	N	Y
1988	N		Y	Y	N		N	Y	Y	Y
1987	Y		Y	Y	Y		Y	Y	Y	Y
1986			Y	Y				N		Y
1985			Y	Y				Y		Y
1984			Y	Y						Y
1983			N	Y						Y
1982			Y	Y						Y
1981										Y

Appendix B: Province of Manitoba - Fisheries Management Objectives for the Lower Churchill River

FISHERIES MANAGEMENT OBJECTIVES FOR THE LOWER CHURCHILL RIVER

(issued by Manitoba Fisheries Branch in September 2024)

Context

In 1976, the Churchill River Diversion Project (CRD) began to divert a portion of the Churchill River flow into the Lower Nelson River to enhance hydro generation capacity of the generating stations built on that system. The Lower Churchill River is defined as the portion of the river downstream of the Missi control structure located at the Northeast margin of Southern Indian Lake.

Some of the larger lakes on the lower Churchill River include Partridge Breast, Northern Indian, Fidler, and Billard. An important tributary to the Lower Churchill River is the Little Churchill River, and areas that supports a significant Lake Sturgeon population. After CRD began operations, average flows were significantly reduced in the Lower Churchill River with some of the most dramatic changes in habitat occurring in the portion of the river between the Missi control structure and the Little Churchill River. As part of the 2021 final Water Power Act licencing process, the Minister responsible for Water Power Act licensing instructed Manitoba Hydro to work with the Province of Manitoba to undertake studies to improve fish habitat downstream of the Missi control structure:

> "*In preparation for renewal of the Final Licence and participation in large* area planning, it is expected that Manitoba Hydro will work with Manitoba to undertake studies that may be employed to improve the environment for fish downstream of Missi control structure. These may include habitat studies, investigating flow regime scenarios, and any associated analysis."

Provincial fisheries management objectives are neither an endorsement nor a criticism of any project or development but are a solicited response to proponents who seek to mitigate the effects of their work on fish stocks and habitats and contribute to Fisheries Branch management of those stocks.

It should be noted that Fisheries Management Objectives are based on assumptions about local use and may be subject to change if additional information is obtained regarding local use and priorities. In this case, the area in question lies within the Tataskweyak Cree Nation (TCN) Resource Management Area and the proposed O-Pipon-Na-Piwin Cree Nation (OPCN) Resource Management Area. There is considerable interest to improve fish habitat in the areas at and upstream of the confluence with the Little Churchill River. The objectives presented are therefore based on the Branch's best understanding of both recent and potential resource use in this area, but not on any formal consultation with resource users. As noted above, it is important to understand that Fisheries Management Objectives are based on government policy and Branch strategic documents that also consider the broader public good, including the values that Manitobans have for resources in general, even resources that they do not utilize directly.

Objectives

Fisheries Management Objective:

- Manage stocks and fishing activity for a self-sustaining Lake Sturgeon population capable of contributing to the subsistence harvest needs of local First Nations (TCN and OPCN). The contribution of spawning at the confluence of the Lower Churchill River and Little Churchill River on populations is not currently known; however, it is presumed to be significant, and that functionality must be maintained.
- Maintain conditions that support the development of a viable and self-sustaining population of Lake Sturgeon in the Lower Churchill River and its tributaries.
- Maintain habitat characteristics that would support the year-round occupation of fish species reflective of a typical fish community in the area.
- Maintain self-sustaining stocks (including forage and other non-target fish species) in a natural form that would contribute to a fishery.

Mechanisms that Support FMOs

- Collaborate with Manitoba Hydro, OPCN, TCN and other interested and invested groups and communities to better understand habitat requirements to support the fishery objectives.
- Monitor the existing fish community and assess impacts to fish stocks if significant habitat changes occur.
- Maintain a flow regime to sustain river functions that support fisheries.

- Gain a better understanding of the naturalized flow record.
- Collaborate with the Split Lake Resource Management Board to develop a Lake Sturgeon management plan for the Lower Churchill River that includes monitoring of Lake Sturgeon stocks to ensure that harvest is sustainable.
- Mitigating impacts and habitat enhancement are the preferred mechanisms for ensuring that self-sustaining stocks exist.

Appendix C: Study Limitations and Uncertainty

Study Limitations and Uncertainty

The results presented in this study provide a quantitative assessment of present-day ecohydraulic conditions within representative reaches of the lower Churchill River; however, several limitations should be considered when interpreting the findings.

The hydraulic modelling was completed using steady-state flow scenarios representing a range of percentile open-water flows. This approach was selected to evaluate habitat conditions under representative hydraulic conditions; however, it does not explicitly simulate temporal changes in flow, water level, or habitat availability associated with seasonal hydrographs, short-term operational fluctuations, spring freshet, or ice-affected conditions. As a result, the study characterizes potential habitat availability and barriers to movement under a range of flow conditions but does not evaluate the duration, frequency, timing, or spatial continuity of suitable habitat conditions.

The fish habitat assessment was based on a criteria-based approach using published literature, regional monitoring information, and professional judgement. While this approach provides a transparent and defensible screening-level assessment, the selected criteria do not represent direct measurements of habitat use within the lower Churchill River. Consequently, mapped habitats should be interpreted as potential habitat rather than confirmed habitat use or habitat suitability, and due to modelling limitations, may overestimate or underestimate available habitat at any given flow. The assessment did not include fish population monitoring, habitat use investigations, recruitment assessments, or analyses linking habitat availability to fish population abundance, distribution, or productivity. Similarly, the assessment does not account for biological factors such as spawning site fidelity, habitat-use plasticity, competition, predation, food availability, or species interactions.

Long-term fish community monitoring data is available within the study area through the CAMP and indicates generally consistent recruitment of Walleye and Lake Whitefish throughout the period of record (mid-1990s onward) in PBL, NIL, FL, and BL, with few missing year classes (*Manitoba Hydro and Manitoba Government, 2024*). Sampling at the Little Churchill River confluence was also conducted annually from 2008 to 2018, after which it was suspended at the request of Tataskweyak Cree Nation. Data during this 10-year period indicate consistent recruitment of Lake Whitefish and Walleye, although recruitment appeared to decline during the final years of monitoring. Aging structures for Lake Sturgeon have not been collected consistently through the CAMP; therefore, information on cohort strength is not available. While these data provide important context for interpreting the habitat assessment, no formal evaluation of relationships between modelled habitat availability and fish population responses was undertaken as part of this study.

Additionally, species-specific habitats were evaluated and mapped independently by life stage. While this approach identifies areas that satisfy the selected habitat criteria, it does not assess the spatial relationship or connectivity among habitats required throughout a species' life cycle. Successful spawning and recruitment depend not only on the availability of suitable spawning, rearing, juvenile, and adult habitats, but also on the ability of individuals to move between these habitats. Consequently, the presence of suitable habitat for multiple life stages under a given flow scenario does not necessarily indicate that those habitats are functionally connected or capable of supporting successful recruitment. Further, because habitat availability and distribution vary with flow, the location, extent, and connectivity of suitable habitats are not static through time. Habitat patches that are connected under one flow condition may become isolated under another, potentially affecting movement between habitats required at different life stages. The influence of habitat connectivity among life stages was not assessed in this study and should be considered when interpreting the modelling results.
Hydraulic modelling was limited to two representative reaches of the lower Churchill River and Little Churchill River where suitable topographic and bathymetric datasets were available. Although these reaches encompass a range of habitat types and hydraulic conditions representative of the broader system, results should not be interpreted as a direct estimate of habitat availability throughout the entire lower Churchill and Little Churchill rivers.

The hydraulic models evaluate open-water conditions only and do not explicitly simulate river ice processes, winter hydraulics, or ice-related habitat conditions. Similarly, the assessment was not designed to evaluate fish passage directly. Connectivity analyses were based primarily on depth criteria and hydraulic interpretation. A comprehensive assessment of fish passage would require additional investigation including species-specific swimming performance information, behavioural considerations, and higher-resolution hydraulic modelling at potential movement constraints.

Potential spawning habitat for Walleye and Lake Whitefish may also be underestimated. The hydraulic models do not account for wind- and wave-generated processes that are known to influence spawning habitat selection in lake environments, particularly along exposed shorelines where wave action can affect substrate conditions, oxygen exchange, and egg incubation success.

Finally, the physical environment monitoring program represents a relatively short period of record compared to the long-term variability that exists within the lower Churchill River system. Although the monitoring results provide valuable information regarding current water quality and ice conditions, additional years of monitoring would improve the understanding of interannual variability and support continued refinement of ecohydraulic assessments.

Despite these limitations, the study provides a robust assessment of the hydraulic factors influencing habitat availability and barrier to movement under current CRD operating conditions and establishes a solid baseline for future evaluations of fish habitat within the lower Churchill River.

Appendix D: Supporting Mapping Products

A map folio will accompany the report separately.
Below is a complete list of map codes used in the key map system.

Model Codes

- M1 = Model 1
- M2 = Model 2

Result Type Codes

- WD = Water Depth
- V = Velocity
- LKST = Lake Sturgeon Spawning Habitat
- WALL = Walleye Spawning Habitat
- LKWF = Lake Whitefish Spawning and Egg Habitat
- G = General Habitat

Flow Scenario Codes

- P5 = 5th Percentile Flow
- P25 = 25th Percentile Flow
- P50 = 50th Percentile Flow
- P75 = 75th Percentile Flow
- P95 = 95th Percentile Flow

Extent Codes

Model 1

- ALL = Entire Reach (Northern Indian Lake to Billard Lake)
- NIL = Northern Indian Lake
- NILFL = Northern Indian Lake to Fidler Lake
- FL = Fidler Lake
- FLBL = Fidler Lake to Billard Lake
- BL = Billard Lake

Model 2

- ALL = Entire Reach (The Fours to Swallow Rapids)
- FOURS = Churchill River at The Fours
- LCRC = Little Churchill River Confluence
- SR = Churchill River at Swallow Rapids