Keeyask Generation Project
Environmental Review – Change of Timing of Water-up and Impoundment

The Keeyask Generation Project Environmental Impact Statement (EIS) assessed effects of reservoir impoundment between August and October 2019. Water-up and impoundment of the Keeyask reservoir to elevation 159 m is proposed to commence in February 2020. An environmental review was undertaken to understand the potential environmental effects of water-up and impoundment (and associated work) under ice conditions rather than open water. The EIS provides the overall project effects; the review focusses on any incremental effects of water-up and impoundment commencing in February 2020.

1. Background

The Keeyask Generation Project (the Project) is a hydroelectric development that includes a powerhouse with seven turbine generators, a spillway that stretches across the south side of Gull Rapids, dams across Gull Rapids, and dykes on the north and south sides of the future reservoir. It is being built in the Split Lake Resource Management Area, and within the ancestral homeland of the four Partner First Nations: Tataskweyak Cree Nation, War Lake First Nation, York Factory First Nation, and Fox Lake Cree Nation. It will be a reliable source of renewable energy providing 695 megawatts of generation capability.

The Keeyask reservoir will extend upstream approximately 42 km from the Generating Station to about 3 km downstream of the outlet of Clark Lake. The flooded area of reservoir is approximately 45 km^2. Refer to Figure 1 for the water surface profiles and flooded area. The full supply level (FSL) near the principal structures will be 159 m and the minimum operating level (MOL) will be 158 m.

In the EIS, impoundment was identified to occur in August to October 2019 and this was thoroughly assessed as part of the EIS submission. After the 2016 construction season, it was identified that the Project was delayed (i.e. schedule changed) by approximately 11 months. The construction schedule at the end of 2018 had advanced to the point where water-up and impoundment had the potential to occur during the summer of 2020. It was known that there are a number of environmentally sensitive timing periods that occur in the summer months and a decision was made to explore other alternatives that posed less environmental and construction risk. Three alternatives for the timing of water-up and impoundment were considered - fall (EIS timing), winter (current plan), and summer. In each alternative, project costs, risks and environmental and social effects were examined. This included detailed consideration of potential effects on public safety, mammals, fish, and birds. Based on a review of these three options, water-up and impoundment commencing in February 2020 was determined to be the only other viable alternative to a fall 2020 impoundment. Appendix 1 is the summary of alternatives for impoundment that was sent to the Keeyask Hydropower Limited Partnership (KHLP) board.

A proposal is being made to start water-up on February 1, with impoundment to begin after March 21. This ensures that the water elevations required for turbine commissioning and operation will be in place by April 24 to achieve the objective of lowest cost and schedule for the Project. As well, with this schedule, impoundment avoids sensitive breeding periods for birds and fish.

2. Description of Work

2.1. Powerhouse Tailrace Cofferdam

The Powerhouse Tailrace Cofferdam (TRCD) was constructed so that work within the tailrace channel could occur in the dry. The Keeyask construction area is shown in Figure 2. Prior to removing the cofferdam, water levels will be equalized on both sides of the cofferdam by pumping water into the area bounded by the TRCD utilizing sumps installed in the turnouts. Watering-up of the TRCD will take approximately 12-14 days.

The TRCD has an inner and outer rock groin, and between the groins is a central core of semi-pervious and impervious material. Removal of the TRCD will start by first removing the central core material as much as possible. This will be followed by removal of the inner rock groin and then the outer rock groin. The rock groins may be removed at the same time as the core, but there would be a lag between the groins and core. This removal process reduces direct exposure of the finer core materials to the river flow, reducing the potential for entrainment of suspended sediment.

Partial removal of the TRCD is required to allow for commissioning of one or more turbine units in the Powerhouse. Removal will likely begin near the south-east corner of the TRCD and progress north along the north-south leg of the TRCD towards the north shoreline. It is expected that at least 100 m would be removed before mid-May, although it is likely that the entire north-south leg would be removed before commissioning.

Water-up and initial stages of removal of the TRCD will occur between January 16 and May 15; however, in-stream work associated with the removal of the TRCD will not commence until after February 1. The remainder of the cofferdam will be removed after July 15 and may extend until October 31, 2020.

2.2. Water-up and Impoundment

Water-up and impoundment are two milestones that need to happen before the first of the generators commence commissioning. Water-up is the process of transferring water into work areas contained by the permanent and temporary structures up to the prevailing water level (current water level) outside of the cofferdam. Impoundment is the formation of the reservoir upstream of the Keeyask Generating Station. The following are the steps associated with water-up and impoundment (refer to Table 1 for a tentative schedule). Figures 3 and 4 show the water levels during the various stages of water-up and impoundment.

- Water-up of the dewatered area between the Powerhouse and the North Channel and Stage I & II Island cofferdams will involve gradually flooding the dewatered work area at a rate of 1 m/day up to the prevailing water level in the river. To do this, a channel will be cut north of the Stage I

Island Cofferdam near the North Channel Cofferdam so water can be diverted directly from the river into the work area.
- The North Channel and Stage I & II Island cofferdams will be lowered.
- Once the cofferdams are lowered, water levels at the principal structures will then be raised from approximately 153 m to 155 m using the Spillway gates, keeping water level increases below 1 m/day.
- With levels at 155 m, the North Channel Rock Groin (NCRG) will be lowered.
- Once the NCRG is lowered, water levels will be raised using the Spillway gates to the full supply level (FSL), at an elevation of 159 m.

Table 1. Currently Anticipated Keeyask Water-up and Impoundment Schedule

Activity	Approx. Duration (days)	Earliest		Planned		Latest	
		Start	End	Start	End	Start	End
Water elevation to 133 m - approx. 1 m/ hour	1	Jan 16	Jan 17	Feb 01	Feb 02	Feb 28	Feb 29
Water elevation 133 to prevailing water level (~153 m) - approx. 1 m / day	22	Jan 17	Feb 08	Feb 02	Feb 24	Feb 29	Mar 22
Remove / lower North Channel and Stage II Island Cofferdams	11	Feb 08	Feb 19	Feb 24	Mar 06	Mar 22	Apr 02
Water elevation prevailing (~153m) to 155 m - 1 m / day - no more than 10% of river flow	3	Feb 19	Feb 22	Mar 06	Mar 09	Apr 02	Apr 05
Remove/lower North Channel Rock Groin	11	Feb 22	Mar 04	Mar 09	Mar 20	Apr 05	Apr 16
Water elevation 155 to 156 m - 1 m / day - no more than 10% of river flow	1	Mar 04	Mar 05	Mar 20	Mar 21	Apr 16	Apr 17
Water elevation 156 m to 159 m - 0.5 m / day - no more than 10% of river flow	8	Mar 21	Mar 29	Mar 21	Mar 29	Apr 17	Apr 25
Commissioning of first unit	60	Apr 01	May 31	Apr 01	May 31	Apr 25	Jun 24
Commissioning of second unit	60	May 31	Jul 30	May 31	Jul 30	Jun 24	Aug 23

3. Environmental Review Process

During the planning and assessment phase of the Project, leading up to the submission of the EIS in June of 2012, the construction schedule had impoundment of the reservoir in the fall of 2019. The assessment of potential effects was based on this timeframe. After the 2016 construction season, it was identified that the Project was delayed by approximately 11 months. With this schedule, impoundment would commence in July 2020. Impounding during the summer season would result in effects to the environment that were greater than those identified in the initial assessment as it would occur during the sensitive breeding period of birds, mammals and fish. The Project team looked into alternatives to avoid impoundment in the summer. Various water-up, impoundment and commissioning alternatives were developed based on potential progress during the 2019 construction season. Based on construction progress in 2019, it was determined in late fall that a summer impoundment could be avoided and advancement of the schedule was possible.

The advancement of impoundment to the winter period precipitated a technical science review of the potential physical, aquatic and terrestrial environment effects of this change, as well as discussions between Manitoba Hydro and the partner First Nations.

Manitoba Hydro made best efforts to share information and understandings on impoundment options with the partner First Nations. Initially, in April 2019, information focused on different scenarios under consideration, and the factors that could influence these. As more refined schedules were available, more detailed technical information and understandings were shared. Discussions occurred at the Keeyask Hydropower Limited Partnership Board, Keeyask Partnership Monitoring Advisory Committee (MAC), Construction Advisory Committee (CAC), and the Keeyask Caribou Coordination Committee (KCCC). In September 2019, MAC members participated in a boat tour of the future reservoir to see Gull Lake in its current open-water condition for the last time prior to impoundment. In addition to the committee discussions, discussions occurred through meetings with resource users and open houses in the communities. There were also bilateral meetings between Manitoba Hydro and each of the partner First Nations. Some of the partner First Nations have expressed that the level of engagement on the issue has not been satisfactory and there is a desire by the partner First Nations for more frequent MAC meetings before and during impoundment. Manitoba Hydro intends to work with the communities to have additional engagement prior to and during the water-up and impoundment period; including ongoing dialogue and collaboration through monitoring.

In these discussions, the partner First Nations raised a number of concerns regarding the change from a fall impoundment to impoundment under ice conditions. Some of the questions and concerns raised are based on a fundamentally different world view and cannot always be addressed through technical science. The original environmental assessment work documented in the EIS also found this same difference in perspectives on potential effects. These concerns will require ongoing dialogue and monitoring throughout the process to be fully addressed.

The key concerns and mitigation to address the concerns are listed below.

- **WATER LEVELS ON SPLIT LAKE:** There is considerable concern surrounding the potential for effects to water levels on Clark Lake and Split Lake during impoundment and what this could mean for the ice road to York Landing and safe ice travel on both lakes. The ice road typically operates from the end of January to the third week in March. Although water levels are not predicted to change on Clark Lake or Split Lake, mitigation measures have been identified to address this fundamental difference in perspective.

  - Mitigation – A commitment has been made that the impoundment process will not begin until after March 21, when the ice road season is typically over.
  - Mitigation – safe ice trails are being installed on Split Lake through existing programing and additional land-based trails are being developed further back from the shoreline in Clark Lake to Gull Lake region to provide for safe travel in this area before and during the impoundment period. A number of longer term safe travel measures are identified in the EIS and the Joint Keeyask Development Agreement and will begin to be implemented this summer following forebay impoundment.
  - Mitigation - Water elevations and flows will be monitored during the impoundment process. If technical water level monitoring indicates that changes are occurring on Clark Lake because of impoundment, the impoundment process will be paused.
- **CARIBOU:** There are concerns regarding the safety of caribou during impoundment.
  - Mitigation - The migratory caribou herd will be monitored with participation from partner First Nations through the ATK monitoring programs and the Province. If monitoring indicates that the migratory caribou are not a safe distance from the future reservoir, impoundment will not continue.

The results of discussions between Manitoba Hydro and the partner First Nations are integrated throughout this report and are primarily discussed in the environmental effects section of this report.

4. Existing Environment Summary

The information presented in this section is a summary of information from the EIS, what was heard during meetings with the partner First Nations and the following technical memos (forming Appendixes 2-5):

- Keeyask Generation Project, Review of Potential Physical Effects: Reservoir Impoundment; Removal of Upstream Earth Structures and Tailrace Cofferdam, and; Powerhouse Commissioning, December 2019
- Effects of Winter Impoundment on Fish, December 2019
- Impoundment Timing Effects on Terrestrial Habitat, Ecosystems and Plants, October 2019
- Review of Impoundment Timing Effects on Mammals in the Keeyask Reservoir, January 2020

4.1. Physical Environment

In the pre-Project environment, a complete ice cover formed most years (approximately 2 out of 3 years) on Gull Lake and the Nelson River up to Birthday Rapids, although the timing and extent varied with flow and climate conditions. Since the 2015/16 winter, with the ice boom in place, an early ice cover has formed on Gull Lake in November each winter. The ice front then moves upstream from Gull Lake and the leading ice front has reached about 4 to 6 km upstream of Birthday Rapids at its maximum extent. Both in the pre-construction and during construction environment an open water lead through Clark Lake is present due to higher water velocities. Ice break-up on Gull Lake has occurred between May 4 and May 24 over the last five winters.

As of August 2018, the entire flow of the Nelson River is passing through the constructed Spillway. In December 2019, water levels on Gull Lake upstream of the ice boom were around elevation 156.2 m and at the Spillway around 153 m; similar water levels are expected in February 2020. In November 2019, a stable ice cover developed upstream of the ice booms and it is expected that a full ice cover will be in place upstream of the ice boom to at least Birthday Rapids by the proposed time of reservoir impoundment.

4.2. Aquatic Environment

Four species of fish; Lake Sturgeon, Walleye, Northern Pike, and Lake Whitefish; found in the Nelson River near Keeyask were studied in the EIS, in part due to their cultural importance to the partner First Nations. Spawning sites and effects to spawning for these fish species was an important part of what was considered in the EIS and has been reviewed during the construction period. While exact locations of Lake Sturgeon spawning downstream of the Keeyask site are not known, there is potential that it is occurring along the south-east portion of the Tailrace Cofferdam (TRCD), based on water velocities. Spawning is temperature dependent (10˚C to low teens) and generally occurs at the end of May or early June in the Nelson River. Walleye and Northern Pike both spawn near Gull Rapids earlier in spring and further from the construction site compared to Lake Sturgeon. Upstream, Lake Sturgeon and Walleye primarily use Birthday Rapids for spawning and Northern Pike use various locations. Lake Whitefish spawn in fall with eggs remaining on the substrate until the following spring. Lake Whitefish from Stephens Lake spawn in or downstream of Gull Rapids. As with the other fish species, the precise location is not known. There is potential that some spawning has occurred along the TRCD.

4.3. Terrestrial Environment

Keeyask is being constructed in a region that is boreal forest with extensive peatland areas, 90% of which is black spruce bog. There are 178 species of birds that breed or migrate through the Keeyask region. Generally migratory birds start arriving in April, with migration peaking in June. Mammals are important to the ecology of the Keeyask region, contributing to the culture and economy of the area. The main groups of mammals include big game, furbearers and small mammals. About 30 different mammal species have been documented through the environmental assessment field studies.

Caribou can be found in or near the Keeyask region throughout the year. The Pen Islands coastal caribou herd generally arrives between December and February and is usually found on the south side of the Nelson River. Its movements vary annually, and large numbers do not always reach the Keeyask site. The herd typically begins its northward migration to their calving grounds in Ontario in the spring and is gone from the Keeyask area by early April. The Cape Churchill coastal caribou herd is usually found on the north side of the Nelson River and rarely moves as far south as the Keeyask region. While the Nelson River generally serves as a physical boundary for both Pen Islands and Cape Churchill caribou in the Keeyask region, river crossing locations have been observed on the Nelson River and on Gull and Stephens lakes (for more detail, see Appendix 5).

Barren-ground caribou from the Qamanirjuaq herd, which calve in large groups on the tundra in Nunavut, migrate southward in fall and early winter. Very infrequently, the herd moves far enough south into Manitoba that they enter the Keeyask region. The last time Qamanirjuaq caribou were observed in the Keeyask region was 2004. Like coastal caribou, Qamanirjuaq Barren-ground caribou depart for their calving grounds in spring.

There are also between 20 and 50 caribou that remain in the Keeyask region to calve on islands in Stephens and Gull lakes, as well as in peatland complexes in mainland areas. These caribou were referred to as "summer resident caribou" in the EIS. Summer residents can be found in or near the Keeyask Region year-round, but some move outside the area for part of the year. The summer resident caribou that calve on islands in Gull and Stephens lakes move to calving areas in mid-April to late May.

Moose occupy the Keeyask Region year-round; it is unknown if their movements typically include crossing Gull Lake in winter. Moose tend to inhabit forested areas in winter but occasionally move to shorelines to feed on willow and other shrubs.

4.4. Socio-Economic

The Keeyask Project is located within the Split Lake Resource Management Area immediately upstream of Stephens Lake. Six communities are located in the vicinity of the Project: Split Lake, home to Tataskweyak Cree Nation; Ilford, home to War Lake First Nation; York Landing, home to York Factory First Nation; Fox Lake/Bird, home to Fox Lake Cree Nation; Gillam, Manitoba Hydro's key operations and service center and home to Fox Lake Cree Nation Members and their urban reserve; and Thompson. Resource use, including hunting, fishing, trapping, and gathering for both domestic/subsistence and commercial purposes, continues to be important to the Indigenous people who live in this region and recreational users.

5. Environment Effects, Monitoring, and Mitigation

The following section provides an overview of the potential incremental, environmental effects of water-up and impoundment commencing in February 2020. For the purposes of outlining potential environmental effects, concerns raised by the partner First Nations are described first in each section below, followed by the technical assessment information. A summary of the additional mitigation measures and monitoring that will occur prior to and during water-up and impoundment as a result of the change in timing is provided in Table 2.

5.1. Physical Environment

Through the various meetings, open houses and update communications, concerns from partner First Nations related to the physical environment were generally centered on ice conditions, water levels, erosion, debris and sedimentation and their associated effects on safety, travel, wildlife and the aquatic environment.

Concern regarding the potential for slush ice to develop due to increasing water levels was raised by all communities. The concerns related to the safety of the winter road to York Landing, traveling on the ice, and caribou crossing in the affected area. Substantial concern has also been raised about the possibility of a backwater effect increasing water levels on Split Lake and Clark Lake resulting from the ice processes downstream of Clark Lake during impoundment.

Concerns were also heard about how winter impoundment may affect erosion processes, suspended sediment sources and concentrations and debris primarily related to effects due to impounding under ice conditions. Concerns expressed were related to ice scouring of banks and substrate potentially causing increased erosion and generating additional suspended sediment. There was some concern that there could be an increase in debris due to ice dragging debris into the water.

Many of the concerns raised by the partner First Nations were considered when the original environmental assessment was undertaken (e.g., water level concerns) and are key environmental considerations associated with impoundment, regardless of timing. These concerns are incorporated into this current assessment and contributed substantially to the mitigation and monitoring measures to be implemented during impoundment.

The technical, scientific assessment considered the incremental effects of a late winter impoundment when compared to a fall impoundment. In most cases, this assessment found that the anticipated effects did not substantively change from what was presented in the original EIS. The following is a summary of the incremental Physical Environment changes along with planned monitoring and mitigation in response to changing the timing of water-up and impoundment. A detailed technical memo is also included in Appendix 2.

5.1.1. Water Levels and Ice Conditions

It is assumed the prevailing water level prior to water-up will be approximately 153 m at the Spillway. To water-up the work area, flow through the Spillway will be reduced to raise upstream levels above the bottom of the water-up diversion channel. While levels will be raised above 153 m by varying amounts depending on how fast the water levels in the work area may be increased, it is likely that the maximum level above the Spillway would not exceed 154 m during this process. Raising levels to 154 m between the Spillway and NCRG would produce a small water level increase of about 0.2 m upstream of both the NCRG and Ice Booms, resulting in an incremental increase in wetted area. Over the one-month water-up period this area is expected to freeze. As noted in the memo by DeWit (2019), the water level changes associated with water-up and NCRG removal are within the range of changes that are typically seen in this area. As well, water level changes similar to those expected from water-up and NCRG removal activities (i.e., 0.2 m) can be expected to occur during the coming winter due to non-project effects as has happened in the past.

After water-up, the North Channel and Stage I & II Island cofferdams are lowered / removed. Water levels upstream of the Spillway would then be raised up to 155 m and held there during NCRG removal. Raising levels to 155 m between the Spillway and NCRG would produce a small water level increase of about 0.2 m upstream of the NCRG above the levels that occur with a water level of 154 m at the Spillway during water-up. As result, the water is approximately 156.4 m between the NCRG and Ice Booms and 156.6 m upstream of the Ice Booms.

As the NCRG is removed the conveyance capacity through the North Channel will increase, which could cause upstream levels to drop by almost a metre. However, upstream levels will be held relatively steady by managing the Spillway gates to gradually increase levels between the Spillway and NCRG as the NCRG is removed. This operation will result in levels at the Spillway that would more closely match the level upstream of the NCRG once removal is complete, likely in the range of 156-156.5 m.

The major rise in water levels will occur during the final impoundment phase, currently scheduled at the end of March. This will raise the water levels by about three metres and will bring the reservoir to a full supply level of 159 m. Upstream of the Ice Booms on Gull Lake the ice cover will lift from shore and is expected to remain floating in place. As levels increase, open water and slush from wetted snow will form around the shoreline, progressively expanding in size. Newly wetted areas may freeze but the new ice generally would be considered thin and weak. As water levels are not predicted to change on Clark Lake and Split Lake due to impoundment, no changes to ice conditions different from what currently occurs (as described in the EIS) is expected.

Border ice downstream of the Ice Booms will detach from shore and some may pass downstream through the Spillway, but a thin ice cover may develop as velocities decrease. Later in spring, the ice cover would be expected to melt in place as expected in the post-impoundment environment.

5.1.2. Suspended Sediment

During meetings with partner First Nations concerns were raised about increases in suspended sediment and its potential effect on water quality during the impoundment process.

The TRCD is comprised of inner and outer rock groins between which a central core of semi-pervious and impervious material was placed. These materials are partly comprised of fine grained material that may be suspended and transported downstream. Based on the process employed for the Spillway Cofferdam removal in 2018, the TRCD work is expected to involve first removing the central core material as much as possible. The inner rock groin would be removed after that, followed by the outer rock groin. The rock groins may be removed while the core material is also being removed but would lag behind the work on the core material. This removal process reduces direct exposure of the finer core materials to the river flow, reducing the potential for entrainment of suspended sediment. The model results indicate that Total Suspended Sediment (TSS) increases of 5 mg/L or more above background are confined to a relatively small area along the east face of the TRCD.

The North Channel Cofferdam, Stage I & II Island Cofferdams and NCRG will be partially removed as part of the impoundment process. The effects of removing the upstream cofferdams and rock groin are expected to produce locally elevated TSS near where the work is occurring. The sediment will mix rapidly when it reaches the main flow and as it passes through the Spillway, resulting in no discernable effects downstream.

Similar to conditions considered in the EIS, final reservoir impoundment will occur within a short period. Any erosion during this time is expected to be negligible, particularly since flooding will occur over frozen ground and water velocities are expected to be relatively low, while the presence of an ice cover will prevent erosion from wave action. The original erosion analysis covered in detail in the Response to EIS Guidelines assumed final impoundment would occur relatively quickly and largely considering frozen ground conditions, which is similar to conditions expected with the revised impoundment schedule.

With an ice cover there is the potential that shifting ice could temporarily cause some short term, localized increases in erosion. There is no practical means to reasonably estimate specific erosion and TSS effects during final impoundment. As noted in the EIS, to the extent that any erosion does occur during final impoundment, it is assumed the potential impacts would be captured in the overall EIS predictions for Year 1 of operation and this is not expected to change with the proposed change in timing of impoundment.

Ice effects will occur in areas cleared under the Reservoir Clearing Plan and ice could potentially attach to and lift up woody debris that may have been left after clearing. These effects impact woody debris that would be affected by impoundment under open water or winter conditions and does not represent new debris. The overall impact of impounding in winter would not substantively alter the effects presented in the Keeyask EIS with respect to woody debris.

Commissioning of Unit 1 is predicted to generate a sharp rise in TSS at the start of Unit 1 commissioning. At the center of the plume approximately 350 m downstream of the TRCD, there is a peak of approximately 210 mg/L above background in the center of the plume. This drops to approximately 25 mg/L above background after three hours and to less than 5 mg/L above background after eight hours. At the center of the plume approximately 1.3 km downstream at SMP-2L on the left side of the river, the peak TSS increase is approximately 44 mg/L above background about 2 hours after Unit 1 flow starts. The TSS increases are more than 25 mg/L above background over a period of about 75-95 minutes, drops to less than 5 mg/L above background after 6 hours, and the 24-hour average increase is less than 5 mg/L. At SMP-2R on the right side of the river the peak TSS increase is 18 mg/L and drops below 5 mg/L after about 3 hours. Subsequent flow increases through Unit 1 would produce diminishing effects and commissioning of Unit 2 would result in a peak increase of only about 6 mg/L, with a 24-hour average increase of less than 1 mg/l. TSS effects of commissioning additional units may not be detectable.

5.1.3. Monitoring and Mitigation

Monitoring of the physical environment parameters will occur in winter of 2020, with particular attention to water levels and ice conditions. Regular visits to water level gauges will occur and during the final phase of impoundment daily trips to maintain water level gauges and to record ice conditions are planned.

While extensive studies show that there are no predicted backwater effects into Clark Lake during the proposed impoundment period, it is understood that there remain significant concerns that Clark Lake and Split Lake water elevations will be raised due to the impoundment process. A commitment has been made to monitor flows and water elevations collaboratively with the partner First Nations and to pause the impoundment process if technical water level monitoring indicates that changes are occurring on Clark Lake because of impoundment. A commitment has also been made to delay the start of the final impoundment process until after March 21, when the ice road season on Split Lake is typically over. Winter monitoring as outlined in the Sediment Management Plan is typically planned to occur from approximately mid-January to mid-April. Background turbidity measurements upstream of the project will be taken at Clark Lake and Gull Lake and downstream measurements will be taken at two locations on Stephens Lake, in the Long Spruce forebay and at the Limestone Generating Station. For safety reasons, the turbidity loggers will typically be removed in approximately mid-April. This winter, Manitoba Hydro is planning on leaving monitoring equipment in place beyond mid-April to monitor turbidity as long as possible through the ice breakup period in an attempt to monitor through the start of the powerhouse commissioning process when increases in turbidity are expected. There is uncertainty whether this monitoring will be successful due to changing ice conditions at this time and not being able to safely maintain the equipment during ice break-up period.

Manitoba Hydro and the partner First Nations will be working together on physical environment monitoring during impoundment. Efforts will be made to include community ATK staff in field monitoring activities, including visits to water level gauges and to record ice conditions. Plans are also being developed for Manitoba Hydro and the partner First Nations to conduct an aerial survey of the region before, during and after impoundment to observe conditions and changes. Refer to Appendix 6 for the monitoring plan.

5.2. Aquatic Environment

Manitoba Hydro has heard concerns from the partner First Nations regarding the effects on the aquatic environment. Tataskweyak Cree Nation, in particular, has expressed concern that impounding under ice conditions will increase pressure in the water and that this pressure will harm sturgeon and other fish. The loss of Lake Whitefish eggs laid and fertilized in fall 2019 was also flagged as an issue. Concerns have also been raised regarding scouring of aquatic habitat by ice; impacts to spawning from increased TSS in the reservoir; effects to fish movements due to movements in the ice; and impacts on benthic invertebrates and other organisms lower in the food chain.

The technical science review of the change in impoundment timing predicts no change to the effects to fish or other aquatic species from what was presented in the EIS. The review of potential incremental effects only focused on fish because based on the scale of effects that result from impoundment, a change in timing of the event is not expected to have a material effect to lower trophic levels, food chains, and aquatic ecosystems. The rise in water levels in the upstream environment occurs prior to ice off and the start of fish spawning in the spring. This creates the same condition as would have occurred with a fall impoundment. As such, the removal of the tailrace cofferdam (TRCD) and commissioning the first unit were the primary considerations for the aquatic review.

Removal of the TRCD would disrupt any Lake Whitefish eggs that may have been deposited there. However, the EIS predicted that spawning in Gull Rapids would be disrupted during the construction period, with a decrease in year class strength of Lake Whitefish. The TRCD will be removed prior to mid-May; in the case it is not completed it will be suspended on May 14 and resume on July 16, after the spawning period is over. Therefore, its removal would not disrupt spawning by Northern Pike, Walleye, or Lake Sturgeon.

Commissioning of Unit 1 is associated with the release of a sediment plume that extends from within the tailrace downstream, initially in an easterly and then a north-easterly direction. This plume does not overlap with locations where Lake Sturgeon are thought to spawn during the construction period (i.e., along the east-west leg of the TRCD and at the base of the spillway channel (i.e., former Gull Rapids). If Lake Sturgeon are attracted into the tailrace by flows during commissioning, the sediment plume would have dissipated prior to the onset of spawning activity. The sediment plume may overlap with spawning habitat of other species such as Walleye and Northern Pike; however, the plume will remain above 5 mg/L above background for only 7 hours after initial operation. This short term increase in suspended sediments is not expected to adversely affect eggs that may be present. Increases in TSS during the commissioning of Unit 2 are expected to generally remain below 5 mg/L.

5.2.1. Monitoring and Mitigation

Under the Aquatic Effects Monitoring Plan for the Project there will be comprehensive, long term monitoring of Lake Sturgeon and other fish. There will be population and fish movement studies for Lake Sturgeon in Gull and Stephens lakes. There will be fish community monitoring and movement studies for other key species. These existing monitoring plans will capture changes as a result of impoundment regardless of the proposed change of timing. No additional monitoring is required due to the proposed change in timing of impoundment. As well, the mitigation measures outlined in the EIS will continue to be implemented.

5.3. Terrestrial Environment

The potential effect of the change in impoundment schedule on caribou was raised by partner First Nations community members in several forums. Community members expressed substantial concern regarding the potential for caribou migration during impoundment, and the possibility of related drowning and hypothermia risks to the animals.

The potential effects to caribou were also considered carefully with technical science knowledge. The migration of caribou varies annually and there is no way to predict if they will come into the Keeyask region in 2020. The water level increase during water-up is predicted to be approximately 0.2 m upstream of the ice booms; this change in water levels is within the normal range of changes seen in this stretch of the river during the construction period.

The water level increase during the final stage of impoundment is currently scheduled to occur after March 21. By this time, it is likely that the Pen Islands herd, if they move into the area this winter, will have begun their migration back towards their calving grounds at the coast. In the event caribou from the Pen Island herd are still present and are not a safe distance from the future reservoir, impoundment will not continue. This will avoid potential effects to the migratory herd, which include injury, hypothermia, and possible drowning. Some of the summer resident caribou also stay in the Keeyask region year-round and may be present at the time of impoundment. Movements of a few (i.e., one to three) summer resident caribou onto calving islands in Gull Lake or across the Nelson River to calving areas between mid-April and late May are unlikely to be affected by impoundment.

There are relatively few individuals in the regional moose population that are expected to travel to calving areas in Gull Lake after impoundment. Based on this the effects to moose are predicted to be the same as stated in the EIS.

Winter impoundment does not change the predicted effects to terrestrial plants, habitat, and ecosystems from what was presented in the EIS. It was assumed that the ground would be frozen when impoundment occurred and that has not changed. As the impoundment occurs outside of the migratory bird breeding period there are no incremental effects to birds due to the timing change. Beaver and muskrat have been trapped out of the reservoir area in the winters of 2017, 2018, and 2019. A trapping program is in place to start in December 2019 and continue into early 2020 to trap out the remaining two active beaver lodges. The trapping program will be complete prior to impoundment. Potential effects on moose, aquatic furbearers, and small mammals are not expected to change from the EIS predictions.

5.3.1. Monitoring and Mitigation

Manitoba Hydro and the partner First Nations will be working together on caribou monitoring leading up to and during impoundment. To gain an understanding of the presence of caribou, partner First Nation community members and Manitoba Hydro’s wildlife consultant (Wildlife Resources Consulting Services) will monitor caribou movements starting in December and continuing through water-up and impoundment - using both traditional knowledge and technical science approaches. There will be regular communication of caribou observations between Manitoba Hydro and the partner First Nations, and aerial surveys by helicopter will occur weekly starting in mid-January through to March. Participation in the aerial surveys and any on-the-ground surveys by ATK monitoring staff and the Province is planned. All information will be compiled by Manitoba Hydro and shared with Provincial wildlife managers regularly. Refer to Appendix 7 for the monitoring plan.

The KCCC will meet in Thompson at the end of January, prior to the beginning of water-up and impoundment, to allow the Partnership to review winter observations of caribou in the Keeyask region up to that point, including information gathered through the KCCC caribou monitoring network, ATK monitoring activities, technical science monitoring activities, and the Province’s wildlife staff. The Province’s Wildlife Branch will also be invited to attend this meeting.

Another KCCC meeting will occur in mid-March, prior to the final stage of impoundment occurring, so the Partnership can again review and discuss the most recent status of caribou in the Keeyask region. Based on the caribou distribution within the Keeyask region at this time, a decision will be made on whether the final stage of impoundment can proceed as planned, or whether it needs to be delayed to avoid a potential impact to caribou. Representation from the Project's Senior Leadership Team at this meeting will allow a decision to be made on how impoundment is to proceed. The Province's Wildlife Branch will also be invited to attend this meeting.

5.4. Socio-Economic

With the exception of travel, access and safety, winter impoundment does not change the predicted effects to the socio-economic environment presented in the EIS. It is recommended that during impoundment, travel on ice and shorelines along the Nelson River is avoided between the outlet of Clark Lake and Keeyask.

Local trails function as access routes to resource areas and allow people to remain connected to their traditional way of life. The effects of the Keeyask Project on water and ice travel and access are addressed through a comprehensive program of mitigation measures contained in the Waterways Management Program that was developed with the KCNs (Schedule 11-2 of the JKDA). This includes provisions for a safe ice trail program in the Keeyask area. With impoundment now planned to take place in winter, and to mitigate the resulting effects on ice travel, Manitoba Hydro is working with a local KCN contractor to provide safe access in the Keeyask area through the installation of a land-based access trail.

As noted above in the Physical Environment section, to address partner First Nation concerns regarding conditions on Split Lake during impoundment, a commitment has been made to start the final impoundment process on or after March 21,when the winter road season is typically over and to review the current safe ice trails program to confirm it provides for safe travel during the impoundment period.

A communication plan is being developed so that community members are kept up to date on the start of impoundment activities, as well as changing water levels and potential hazards during the process. This plan will be developed in collaboration with each of the communities and will include a range of communication tools such as Facebook posts and radio announcements.

Impoundment will raise fish mercury levels in Gull Lake and to a lesser extent, Stephens Lake, which are expected to peak within 3-7 years and then gradually decrease over time (approximately 20-30 years). Community members raised questions about mercury and the impact of impoundment at community meetings, including effects on the aquatic ecosystem and food chains on which fish depend. A winter impoundment does not change the EIS predictions regarding the methylation process and fish mercury levels. Monitoring and mitigation measures, developed by the KHLP through the Mercury and Human Health Implementation Group considered the uncertainties in the potential time for fish levels to peak; they were designed to be responsive to these uncertainties in timing and peak fish mercury levels to be protective of human health. A Mercury and Human Health Risk Management Plan outlines key monitoring and mitigation efforts, including monitoring of fish, plants and wildlife, periodic human health risk assessments and voluntary hair sampling and food surveys, as well as information events and communication of fish consumption recommendations and food replacement programming. These measures mitigate the risk of exposure and potential negative health effects on partner community members as a result of elevated methylmercury concentrations in fish. The measures noted above have occurred prior to impoundment and will continue into operational period.

Table 2. Summary of Additional Mitigation Measures and Monitoring to Occur Prior to and During Water-up and Impoundment.

Concern / Incremental Effect	Monitoring	Mitigation
Concern - Understanding change in the landscape as a result of impoundment.	- Manitoba Hydro (MH) and Aboriginal Traditional Knowledge (ATK) staff will undertake an aerial survey of the Keeyask area before, during and after impoundment.	
Concern - Water levels on Split Lake increase as a result of impoundment (not a predicted effect based on technical science).	- Water elevations and flows will be monitored during the impoundment process by MH and ATK staff.	- If technical water level monitoring indicates that changes are occurring on Clark Lake or upstream because of impoundment, the impoundment process will be paused.
Incremental effect - Travel concerns as a result of slush ice.		- It is recommended that during impoundment, travel on ice and shorelines along the Nelson River is avoided between the outlet of Clark Lake and Keeyask. - Safe ice trails are being installed on Split Lake through existing programing and additional land-based trails are being developed further back from the shoreline in Clark Lake to Gull Lake region to provide for safe travel in this area before and during the impoundment period.
Concern - Impacts to the ice road to York Landing as a result of impoundment (not a predicted effect based on technical science).		- A commitment has been made that the impoundment process will not begin until after March 21, when the ice road season is typically over.
Concern - changes in total suspended sediments.	- Background turbidity measurements will be taken. - For safety reasons, the turbidity loggers are typically removed in mid-April. The monitoring equipment will remain in place to monitor turbidity as long as	

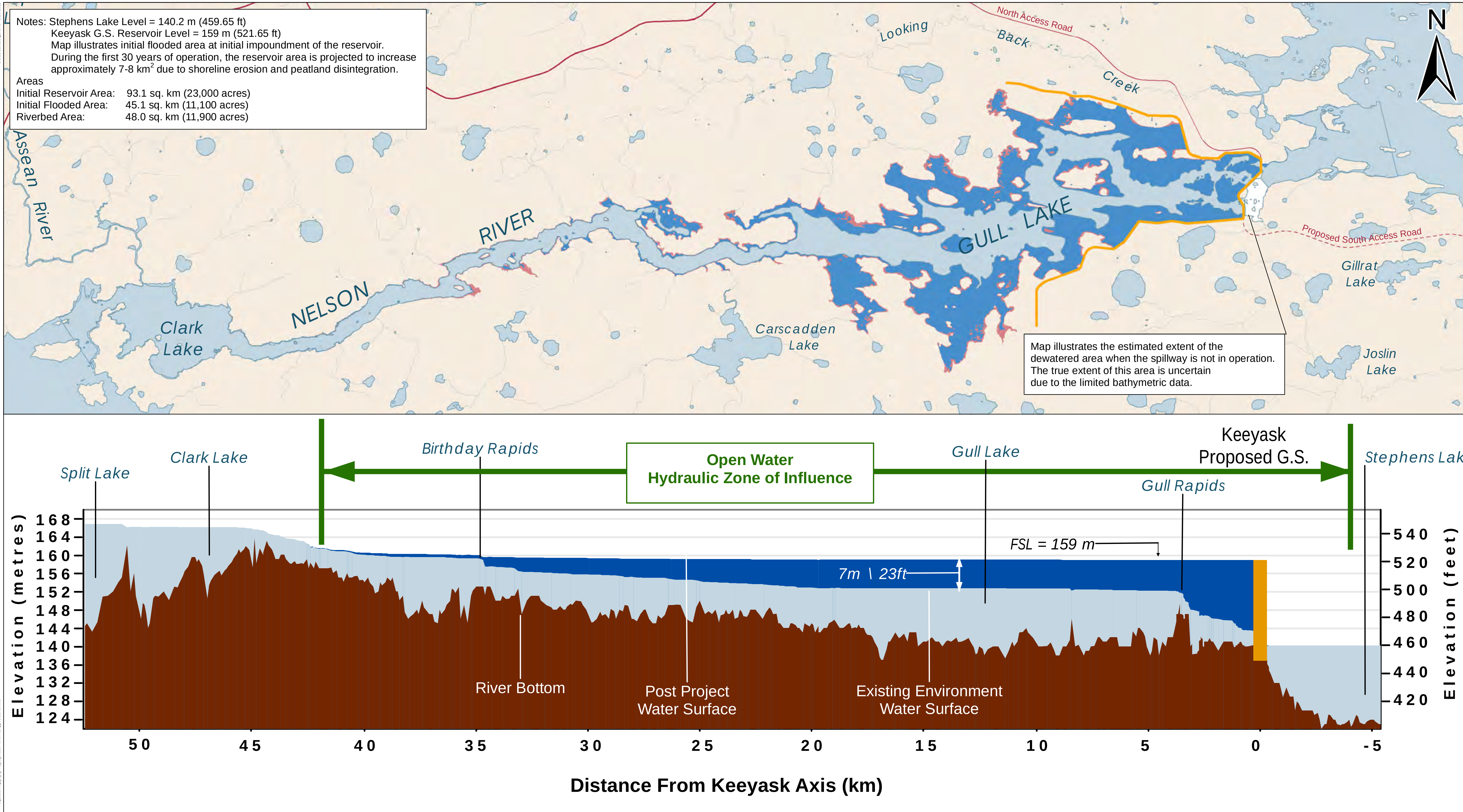
Concern / Incremental Effect	Monitoring	Mitigation
	possible through the ice breakup period in an attempt to monitor through the start of the powerhouse commissioning process when increases in turbidity are expected. There is uncertainty whether this monitoring will be successful due to changing ice conditions and not being able to safely maintain the equipment during the ice break-up period.	
Incremental Effect - Safety of caribou during impoundment.	- The migratory caribou herd will be monitored with participation from partner First Nations through the ATK monitoring programs and the Province.	- If monitoring indicates that the migratory caribou are not a safe distance from the future reservoir, impoundment will not continue.

6. Summary

As a result of the change in timing to water-up and impoundment, an environmental review was undertaken to assess the potential incremental environmental effects of water-up and impoundment (and associated work) commencing in February 2020 under ice conditions rather than open water. The key changes and mitigation are:

- The change to the water levels will occur under ice conditions. It is recommended that during impoundment, travel on ice and shorelines along the Nelson River is avoided between the outlet of Clark Lake and Keeyask. Mitigation measures will be in place during this time to provide safe access in the Keeyask area through the installation of a land-based access trail.
- If migratory caribou are in the Keeyask area this winter, they could be affected if the final stage of impoundment occurs prior to them leaving the area. To avoid having an effect, if monitoring indicates that the migratory caribou are not a safe distance from the future reservoir, impoundment will not continue. There are no predicted backwater effects into Clark Lake; however, there remain significant concerns from the First Nations that Clark Lake and Split Lake water elevations will be raised due to impoundment and there are related safety issues. The impoundment process will not begin until after March 21, when the ice road season is typically over. As well, water elevations and flows will be monitored during the impoundment process. If technical water level monitoring indicates that changes are occurring on Clark Lake because of impoundment, the impoundment process will be paused.

Taking into account the additional proposed mitigation, it is not anticipated that there will be significant environmental effects differing from those originally assessed for the EIS.



DATA SOURCE:
Government of Canada; Government of Manitoba; Manitoba Hydro: gull-ee-50perc-3032cms-rev3; Shore Year 30 Polygon pp-50perc-3032-159-shore-rev3; pp-DS-50perc-3030-140p2-shore-rev1

CREATED BY:
Manitoba Hydro - Water Resources Engineering Department

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-JAN-10	29-MAY-12
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 2.0	QA/QC: JJM/WJD/ZZZ

KEEYASK Hydropower Limited Partnership

Legend

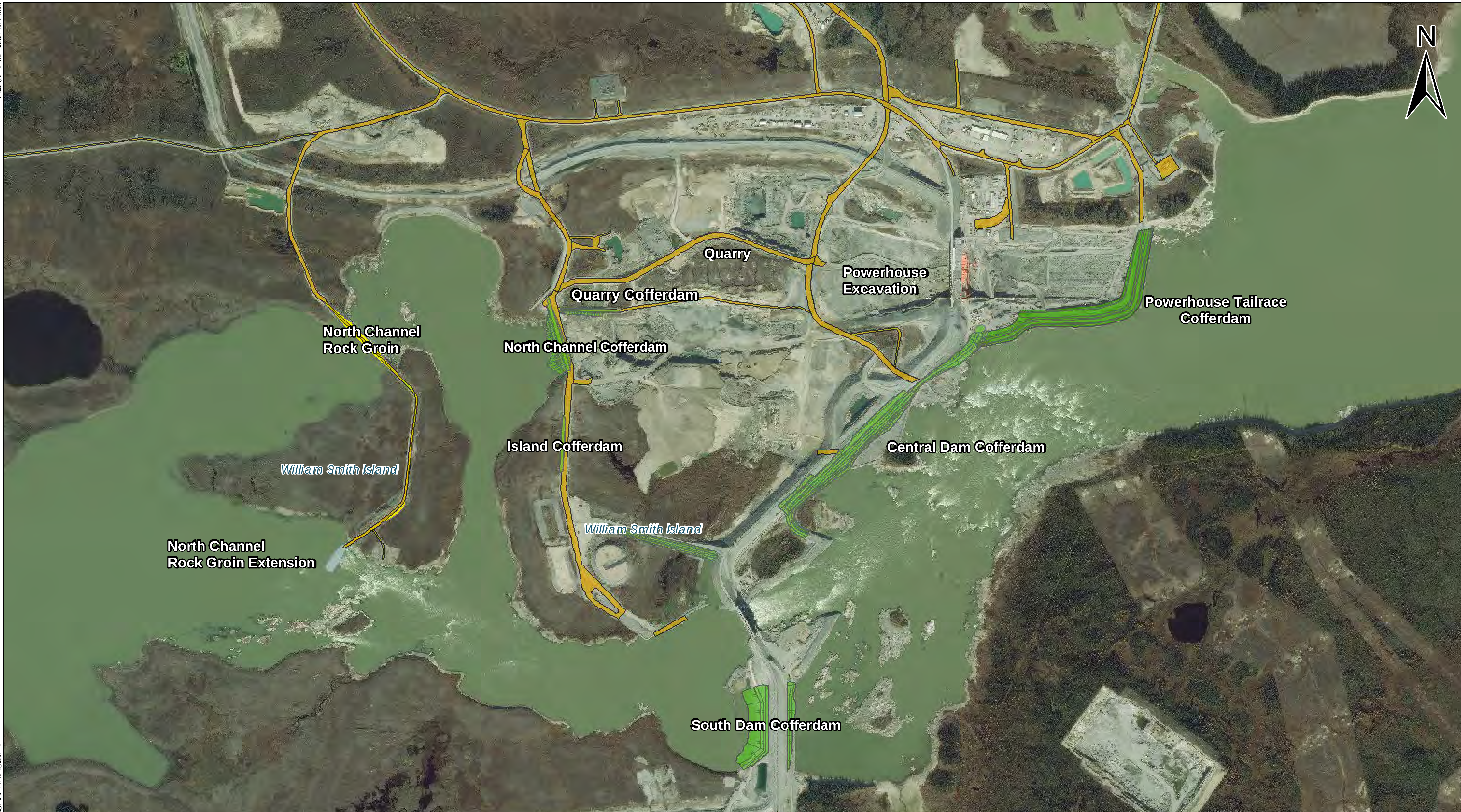
- Existing Water Surface Area
- Initial Flooded Area (159 m)
- Reservoir Expansion During First 30 Years
- Keeyask Principle Structures

Note:
50th Percentile, Open Water Flow Existing Environment and Post-Project Environment

The 30-year shoreline expansion upstream, of Birthday Rapids is not a Project effect as it is predicted to occur without the Project.

Water Surface Profiles and Flooded Area

Figure 1



KEEYASK

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada;
Image Source: ESA Sentinel 2 Satellite; October 2, 2019

CREATED BY:
Manitoba Hydro - GIS Studies

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	06-DEC-19	
0 0.15 0.3 Kilometres / 0 0.1 0.2 Miles	VERSION NO: 1.0	QA/QC:

Legend

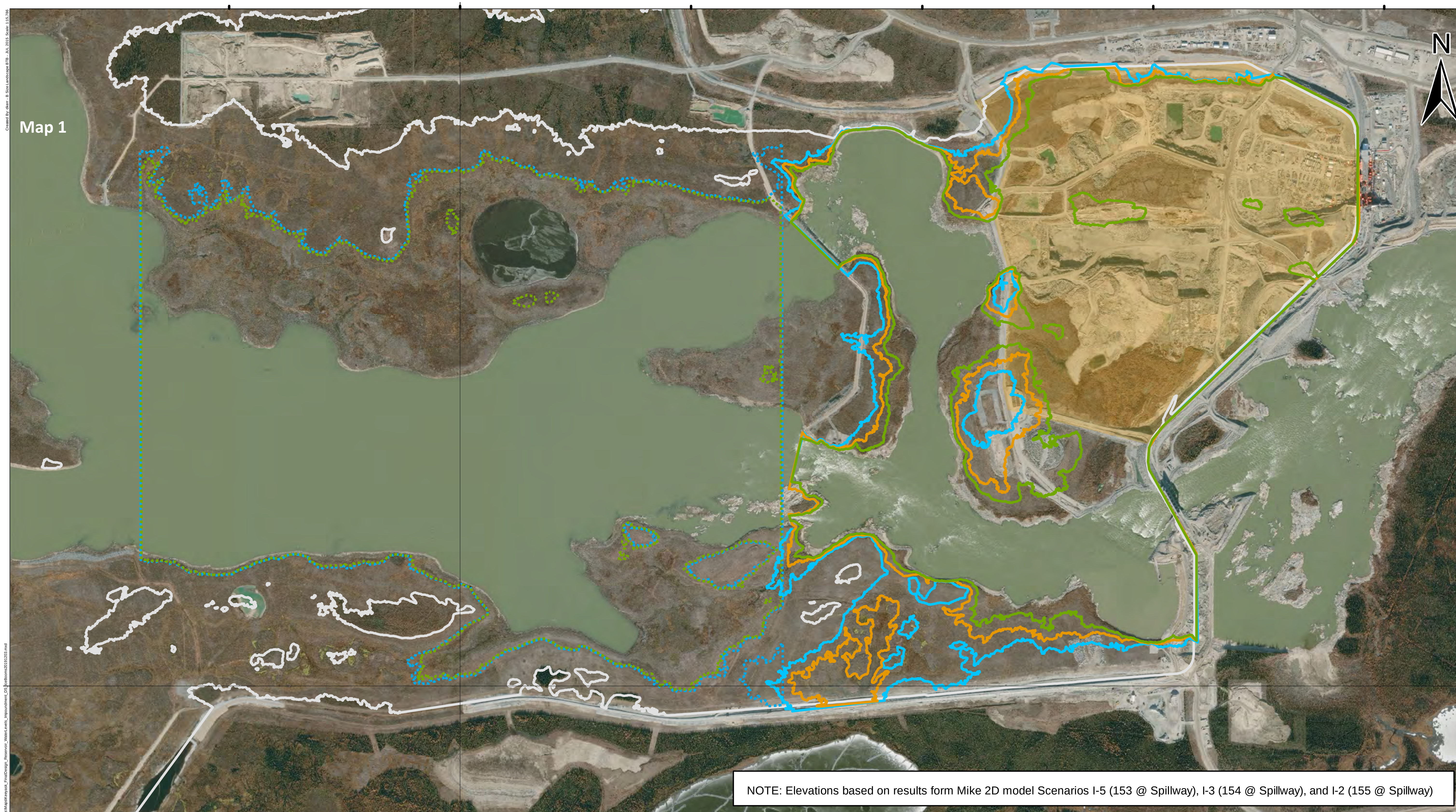
Active Construction Areas

- Cofferdam
- Haul & Site Road
- North Channel Rock Groin
- North Channel Rock Groin Extension (in water)

October 2019

Figure 2

Satellite Imagery - October, 2019



KEEYASK

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada

CREATED BY:
Manitoba Hydro - WRE

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	13-MAY-19	11-DEC-19
0 0.2 0.4 Kilometres / 0 0.15 0.3 Miles	VERSION NO: 1.0	QA/QC:

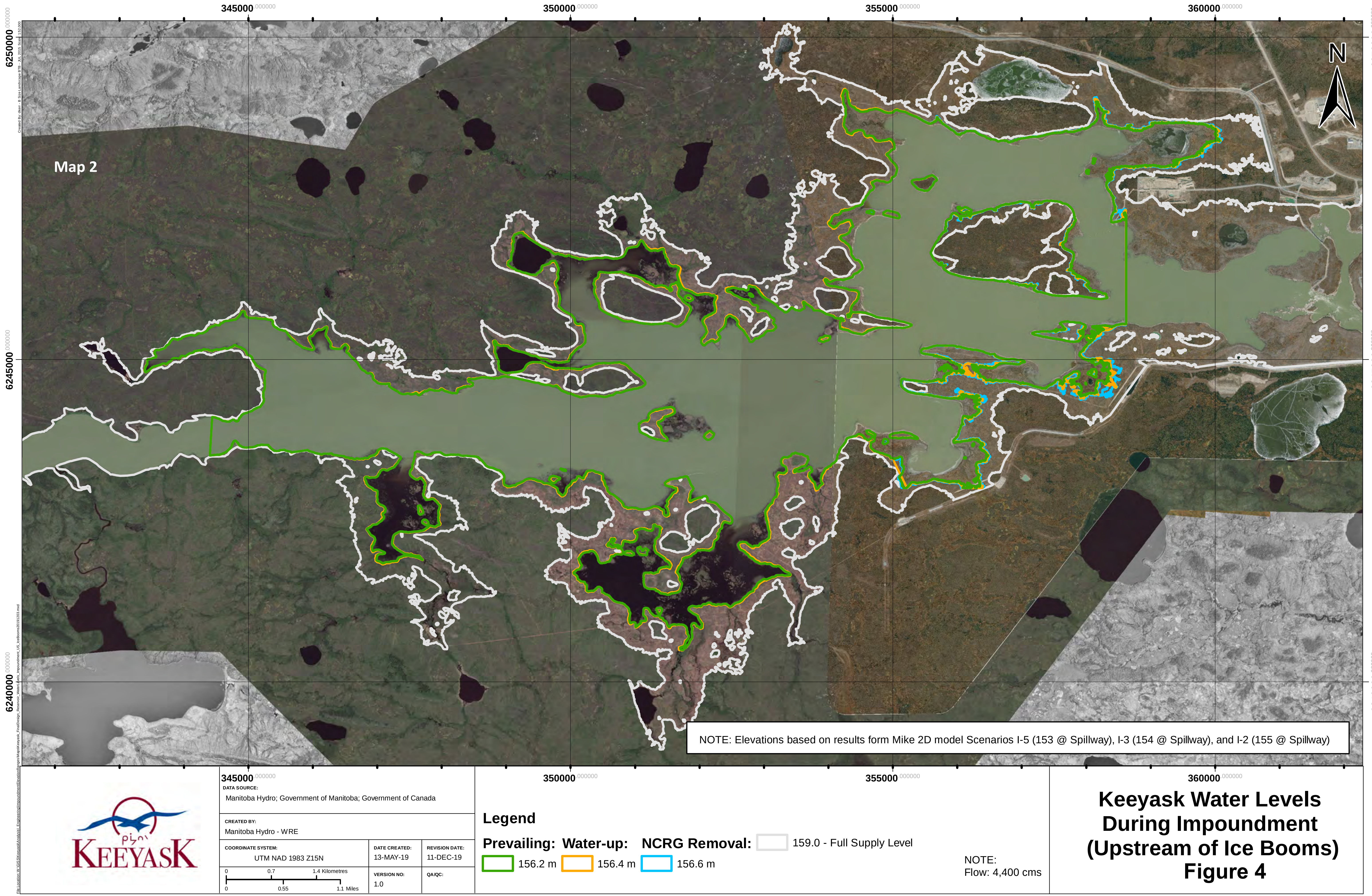
Legend

Prevailing:	Water-up:	NCRG Removal:	
			159.0 - Full Supply Level
153.0 m	154.0 m	155.0 m	Water-Up Area
156.2 m	156.2 m	156.4 m	

NOTE:
Flow: 4,400 cms

Keeyask Water Levels During Impoundment (Downstream of Ice Booms) Figure 3

Satellite Imagery - October, 2018



Satellite Imagery - October, 2018

Appendix 1

E1910E

MANITOBA HYDRO

MEMORANDUM

FROM Dave Bowen
Keeyask Project Director
Keeyask Project
Generation & Wholesale

TO KHLP Board Members

DATE 2019 12 20

SUBJECT **SUMMARY OF ALTERNATIVES FOR IMPOUNDMENT**

At the recent Board meeting we discussed the important project decision related to the start of water-up and impoundment for our Keeyask Project. There was a request that a summary of alternatives considered be provided related to the timing of water-up and impoundment. The purpose of this memo is to provide a high-level summary of the alternatives and the factors considered in deciding that a winter impoundment was best for the project.

There are two steps to complete impoundment:

1. **Water-up:** The first step is to add water to the current dry work areas and bring the water level at the work site to the prevailing elevation on Gull Lake (currently just under 156 metres above sea level). It involves watering up the area behind the cofferdams and north channel rock groin and then removing these temporary structures. This process of water-up takes approximately 50 days to complete. Water level changes are within the range of those that are typically seen and are almost all within the current Keeyask construction site (an area of 1-2 km from the station upstream) (Figure 1).
2. **Impoundment:** The second step is impoundment in which water level changes are raised to the full supply level at elevation 159m. This step takes place after water-up over a period of about 10 days. The impoundment period is when flooding will occur upstream of the station. Water level changes associated with impoundment are expected to extend from the Keeyask site to just downstream of the outlet of Clark Lake. No changes will occur on Clark Lake or Split Lake; however, it is understood that this prediction is not viewed as accurate by many community members.

BACKGROUND

In the EIS, water-up and impoundment were identified to occur between the months of August to October 2019. After the 2016 construction season, the Project was delayed (i.e. schedule changed) and the capital cost increased. The project team worked diligently to reduce the impacts to capital costs and schedule in accordance with the Construction Agreement in the JKDA. The construction schedule at the end of 2018 indicated that water-up and impoundment may land in the summer months. It was known that there are a number of environmental timing windows that occur in the summer months and that other alternatives should be explored. Three alternatives timeframes for water-up and impoundment were considered - fall (EIS timing), winter (current plan), and summer. In each alternative, project costs, risks and environmental and social effects were examined. This included detailed consideration of potential effects on public safety, mammals, caribou, fish, and birds.

COMMON TO ALL Alternatives

For all alternatives, adequate water levels are required to commission and run the units. At forebay water elevation 156.5m, a unit can be partially commissioned and operate without any potential warranty issues. At elevation 159m, the unit can be fully commissioned and operated. In addition, during the water-up/impoundment process there is always a risk that a repair to the earth and/or concrete structures may be discovered. There is a low likelihood that this would occur. If this occurs, the forebay would need to be drawn down 2m below the repair elevation, until such time as the necessary repair is completed, which typically requires non-freezing conditions.

ALTERNATIVES

There are three alternatives that were considered; the base alternative of fall water-up and impoundment; a summer water-up and impoundment; and a winter water up and impoundment. Water-up and impoundment during the fall period was thoroughly assessed as part of the EIS submission; therefore, only **incremental** effects were evaluated against the fall water-up and impoundment alternative. There have been 20 years of environmental studies and ongoing monitoring in this region and there was confidence that this incremental assessment could be undertaken using this existing information.

Based on a review of these three options, winter water-up and impoundment was determined to be the only other viable alternative to a fall 2020 impoundment. Key considerations examined include the incremental effects to fish, birds, mammals, caribou, public safety, and the overall impact to project cost and schedule. Appendix 1 provides a summary.

Alternative 1 – Base Alternative – Fall 2020 Water-up & Impoundment

The EIS considered water-up and impoundment between August and October. The effects of this timing are documented in the EIS. This option has incremental cost and significant risk impacts.

Alternative 2 - Summer 2020 Water-up & Impoundment

Water-up and impoundment cannot occur from April 24 to August 25. There are no viable technical solutions that can be implemented during these months that do not contravene the *Migratory Birds Convention Act*. This Act is stringent and there are no applicable regulatory exceptions. Water-up and impoundment need to take place either before or after this environmental timing window.

Alternative 3 – Winter 2020 Water-up & Impoundment

A winter water-up and impoundment avoids the summer environmental exclusion windows and allows the current scheduled advancements to be maintained. The incremental effects when compared to fall impoundment were identified and are considered to be manageable with appropriate mitigation measures in place. This includes measures to address key community concerns, as summarized below.

ADDRESSING KEY CONCERNS

During the recent open houses and our Board meeting, key concerns have been raised regarding a winter impoundment.

Split Lake Water Levels & The Ice Road to York Landing

There is considerable concern surrounding the potential impacts to water levels on Split Lake during impoundment and what this could mean for the ice road to York Landing and safe ice travel on the lake.

The ice road typically operates from the end of January to the 3rd week in March. ***The project team can provide certainty that the impoundment process will not begin until after March 21, when the ice road season is typically over.***

Manitoba Hydro has committed to monitoring water levels during the impoundment process. Our extensive studies show that there are no predicted backwater effects into Clark Lake; however, we understand that there remain significant concerns that Clark Lake and Split Lake water elevations will be raised due to impoundment. ***We are committed to monitoring flows and water elevations together with your communities and will pause the impoundment process if technical water level monitoring indicates that changes are occurring on Clark Lake because of impoundment.***

Caribou

Manitoba Hydro has committed to monitoring the migratory caribou herd with the participation of representatives from your communities. Commitments have also been made to additional community-led monitoring of caribou through your ATK monitoring programs.

If monitoring indicates that the migratory caribou are not a safe distance from the future reservoir, impoundment will not continue. This will avoid potential effects to the herd.

A process to monitor and make the decision to proceed or pause impoundment to mitigate risks to caribou is being developed and we will require each community to identify an individual(s) who can be part of this decision-making process.

NEXT STEPS

The project team continues to pursue starting water-up on February 1, with impoundment to begin after March 21. This ensures that the water elevations required for turbine commissioning and operation will be in place by April 24 to achieve the objective of lowest cost and schedule for our project. A formal submission to the Regulators has now been pushed back to January 10, 2020 to provide additional time to address concerns.

If water-up and impoundment are not accomplished early in the new year, commissioning will not commence until after August 25 and project costs will increase substantively. As well, any disruption to the work at site that has the potential to alter this schedule will result in contractor claims from BBE, Voith and all other contractors. This will limit their liability and will result in increased costs to these contractors and the project.

COMMUNICATION DURING WATER-UP & IMPOUNDMENT

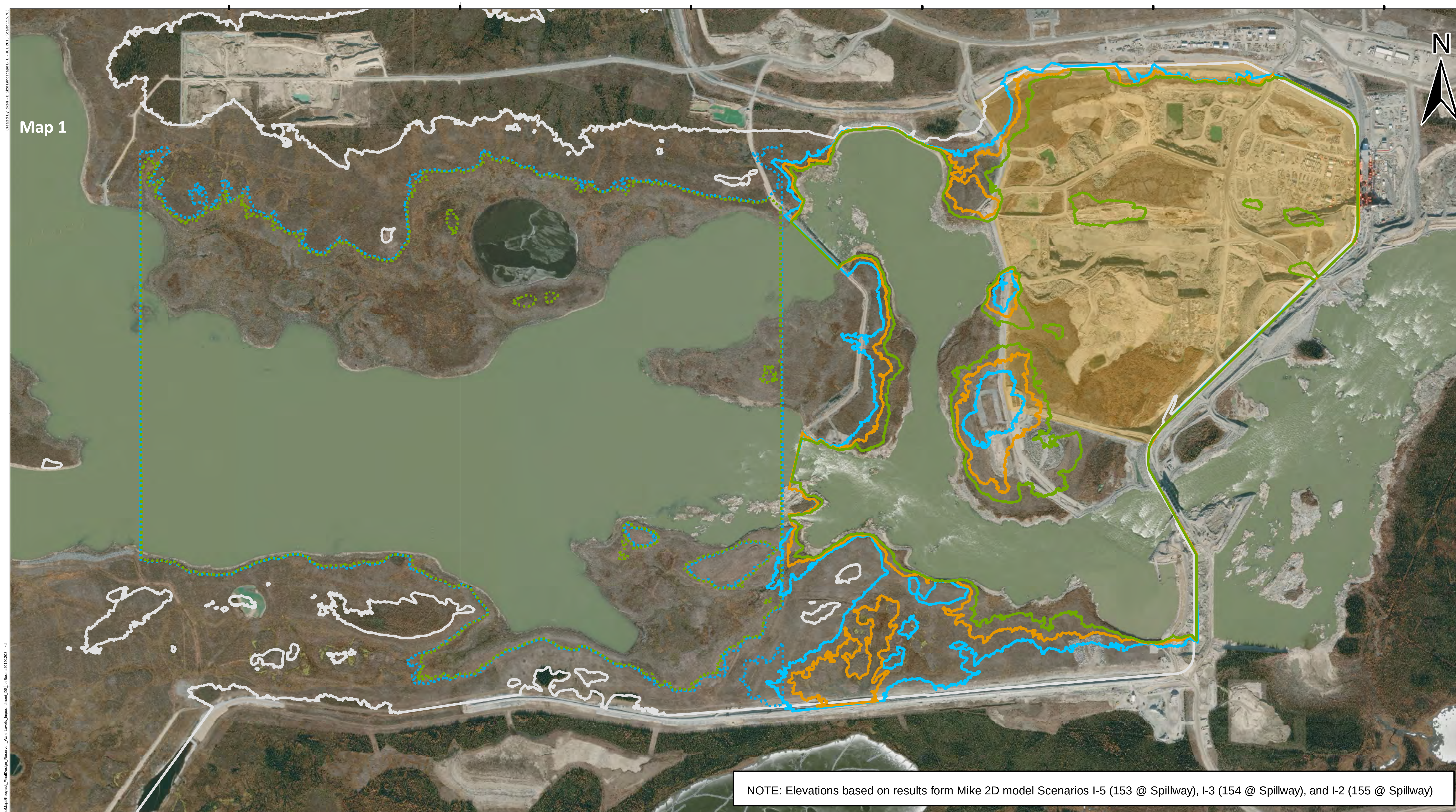
Throughout Keeyask water up and impoundment, weekly communications are being planned. These will be provided by email to partner First Nations representatives and will include information about:

- recent and/or planned water-up and impoundment activities;
- water level and flow conditions from Keeyask to Split Lake;
- the partnership's monitoring and observations including caribou;
- options for safe snowmobile travel from Clark Lake to Keeyask; and
- who to contact if recipients have additional questions.

Manitoba Hydro will be seeking input from the partner First Nations regarding the content of these outlooks and the information you would find most useful.

Please advise if you have any questions.

Figure 1 – Extent of Water-Up
Appendix 1 – Table of Alternatives



KEEYASK

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada

CREATED BY:
Manitoba Hydro - WRE

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	13-MAY-19	11-DEC-19
0 0.2 0.4 Kilometres / 0 0.15 0.3 Miles	VERSION NO: 1.0	QA/QC:

Legend

Prevailing:	Water-up:	NCRG Removal:	
153.0 m	154.0 m	155.0 m	159.0 - Full Supply Level
156.2 m	156.2 m	156.4 m	Water-Up Area

NOTE:
Flow: 4,400 cms

Keeyask Water Levels Water-up/ Impoundment (Downstream of Ice Booms) Figure 1

Satellite Imagery - October, 2018

Appendix 1. Keeyask Impoundment Alternatives.

Alternative	Project Effects	Incremental Environmental Effects (in comparison to a fall impoundment)				
		Public Safety	**Water Levels and Shoreline Erosion**	**Mammals**	**Birds**	**Fish**
Alternative 1 – Fall Water-up / Impoundment as defined in EIS (August start)	- Potential increase to costs is substantive due to increased construction costs and lost revenue.	- Baseline, Incremental effects from alternatives 2 and 3 are compared to this option below.	- Baseline, Incremental effects from alternatives 2 and 3 are compared to this option below.	- Baseline, Incremental effects from alternatives 2 and 3 are compared to this option below.	- Baseline, Incremental effects from alternatives 2 and 3 are compared to this option below.	- Baseline, Incremental effects from alternatives 2 and 3 are compared to this option below.
Alternative 2 – Summer Water-up / Impoundment (July start)	- Schedule will need to be advanced or delayed due to non-compliance with Migratory Birds Convention Act.	- No additional anticipated effects	- No additional anticipated effects	- Sensitive breeding period.	- Sensitive breeding period. - Non-compliance with Migratory Birds Convention Act so water-up and impoundment not allowed.	- Sensitive spawning period, instream work associated with removing of TRCD.
Alternative 3 – Winter Water up / Impoundment (February start)	- Achieves lowest cost and earliest possible ISD for project schedule. - Revenues start to be earned from commissioned units beginning in June 2020.	- Thin and slush ice on shorelines between the outlet of Clark Lake and Keeyask - travel on ice and shorelines should be avoided once impoundment starts. Safe land-based trails being installed from Clark Lake to the Keeyask area; safe ice trails being installed on Split Lake. - Impoundment to start at the end of the winter road season.	- No additional anticipated effects. - Impoundment will not continue if monitoring detects changes to water levels on Clark Lake.	- Mitigation will be implemented, no additional impacts anticipated. - If migratory caribou are present and not a safe distance from the future reservoir, impoundment will not continue. - Resident caribou typically travel to islands to calve later in May after the impoundment period. - Monitoring plan is being developed with Partners and Province, as well as a decision process for adaptive mgmt.	- No additional anticipated effects.	- No additional anticipated effects.

Impoundment Alternatives and Environmental Sensitivities

	January	February	March	April	May	June	July	August	September	October	November	December
Birds				Nesting								
Lake Sturgeon					Sensitive spawning							
Caribou	Migration influx and ice crossing				Sensitive calving & calf-rearing							Migration…
Moose					Sensitive calving & calf-rearing							
Small Mammals					Sensitive birthing & young-rearing							
Alternative 1 - Same timing as EIS								Impoundment				
Alternative 2 - Summer water-up / Impoundment							Water-up, lowering of temp. structures, impoundment					
Alternative 3 - Winter water-up / Impoundment		Water-up, lowering of temp. structures	Impoundment									

Appendix 2

E1910E

MANITOBA HYDRO
INTEROFFICE MEMORANDUM

FROM Wil DeWit, M.Sc., P.Eng
Sediment & Erosion Studies Engineer
Ice & Environmental Engineering
Water Resources Engineering
Generation & Wholesale

TO Carolyne Northover
Senior Environmental Specialist
Major Projects & Protection Programs
Environmental Licensing & Protection
Generation & Wholesale

DATE 2019 12 20

FILE 243980-0500 Environmental Protection & Regulatory

SUBJECT **Keeyask Generation Project, Review of Potential Physical Effects: Reservoir Impoundment; Removal of Upstream Earth Structures and Tailrace Cofferdam, and; Powerhouse Commissioning (Rev 5)**

1. BACKGROUND & SCHEDULE

Construction on the Keeyask Generation Project began in July 2014 and has progressed to the stage where plans are being made to impound the reservoir to the Full Supply Level (FSL) of 159 m sometime between mid-February and the end of April 2020. Subsequent to filling the reservoir, commissioning of powerhouse turbine units will be initiated starting with Unit 1 at the north end of the Powerhouse. The other six units will be commissioned on roughly a two month interval. Before the reservoir can be fully impounded, it will be necessary to lower or remove some earth structures upstream of the Keeyask dam and, prior to Powerhouse commissioning, the downstream Tailrace Cofferdam (TRCD) will need to be at least partially removed.

The current schedule is different from what was considered in the Keeyask EIS[1], which had impoundment occurring in the fall. Because the planned timing of these activities has changed, a review of potential environmental effects is being performed to consider if the difference in timing might change effects considered in the EIS.

Reservoir impoundment will be accomplished in several sequential steps. The time required to complete each step has been estimated and the likely earliest and latest periods in which the steps may be completed have been estimated (Table 1). Ultimately, the specific timing will depend on the actual progress of work that needs to be completed.

[1] *Keeyask Hydropower Limited Partnership, 2012. Keeyask Generation Project: Physical Environment Supporting Volume. June 2012. Winnipeg, Manitoba*

Table 1: Estimated timing for stages of impoundment, structure removal and initial powerhouse commissioning

		Earliest		Latest	
Activity	Approx. Duration (days)	Start	End	Start	End
Water elevation to 133 m - approx 1 m/ hour	1	16-Jan-2020	17-Jan-2020	28-Feb-2020	29-Feb-2020
Water elevation 133 to prevailing water level (~153 m) - approx 1 m / day	22	17-Jan-2020	8-Feb-2020	29-Feb-2020	22-Mar-2020
Remove / lower North Channel and Stage II Island Cofferdams	11	8-Feb-2020	19-Feb-2020	22-Mar-2020	2-Apr-2020
Water elevation prevailing (~153m) to 155 m - 1 m / day - no more than 10% of flow	3	19-Feb-2020	22-Feb-2020	2-Apr-2020	5-Apr-2020
Remove North Channel Rock Groin	11	22-Feb-2020	4-Mar-2020	5-Apr-2020	16-Apr-2020
Water elevation 155 to 156 m - 1 m / day - no more than 10% of flow	1	4-Mar-2020	5-Mar-2020	16-Apr-2020	17-Apr-2020
Water elevation 156 m to 159 m - 0.5 m / day - no more than 10% of flow	8	5-Mar-2020	13-Mar-2020	17-Apr-2020	25-Apr-2020
Unit 1 Commissioning	60	13-Mar-2020	12-May-2020	25-Apr-2020	24-Jun-2020
Unit 2 Commissioning	60	12-May-2020	11-Jul-2020	24-Jun-2020	23-Aug-2020

2. RESERVOIR IMPOUNDMENT EFFECTS

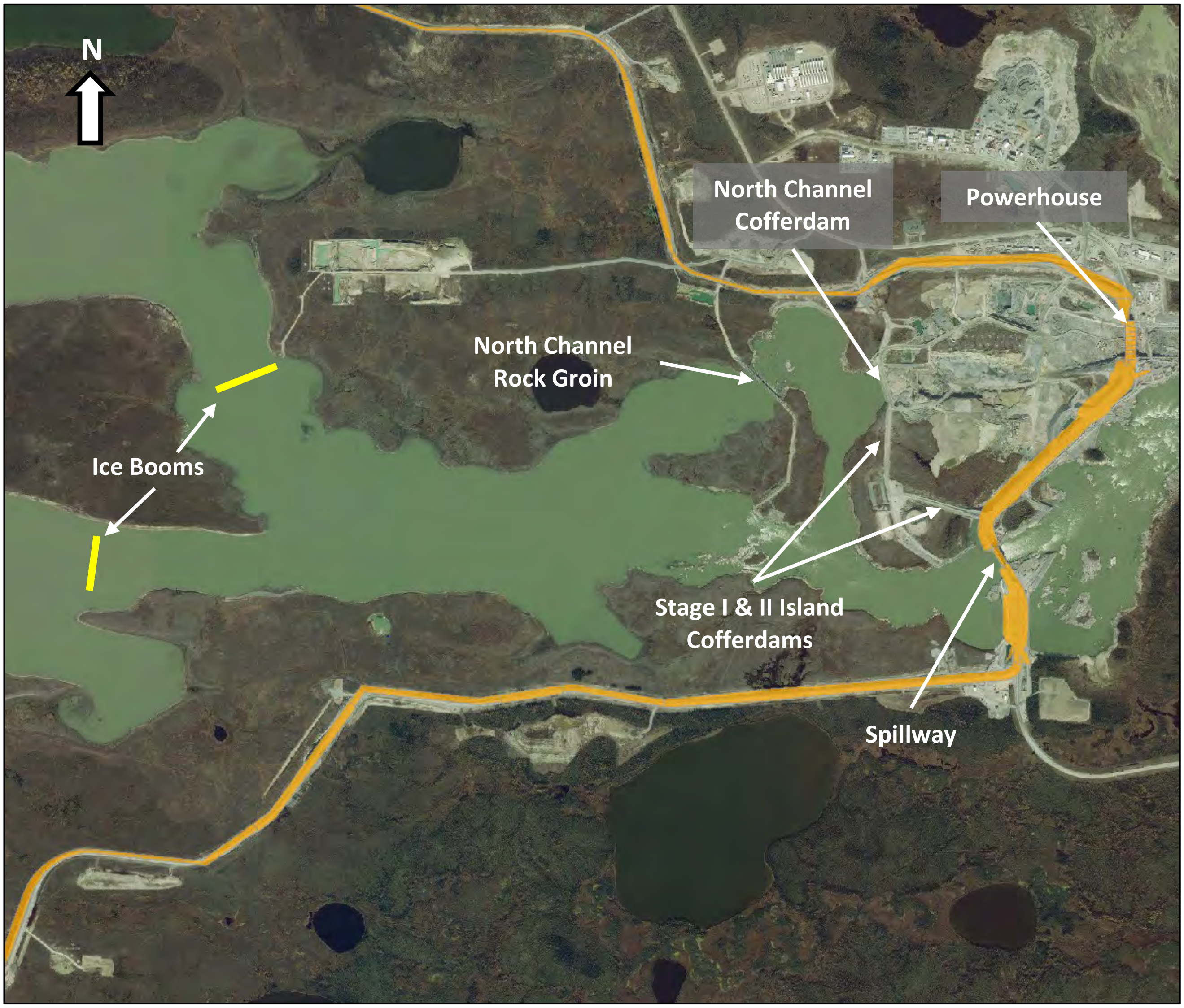
2.1. Timing and Extent of Water Level Changes

The general steps for impoundment noted in Table 1 are:

- Water-up of the dewatered area between the Powerhouse and the North Channel and Stage I & II Island cofferdams upstream (Figure 1) will involve gradually flooding the dewatered work area at a rate of 1 m/day up to the prevailing water level in the river. The prevailing level will depend on actual flow conditions but it is assumed it will be about 153 m. Water-up will occur over about 23 days within the period from January 16 to March 22 (earliest start date to latest end date).
- After water-up is completed, the North Channel and Stage I & II Island cofferdams will be lowered over about 11 days in the period from February 8 to April 2. Water levels will likely be maintained at about 153 m while this work proceeds.
- Once the cofferdams are removed, levels will then be raised from 153 m to 155 m over a period of about 3 days, keeping water level increases below 1 m/day. This will occur in the period from February 19 to April 5.

- With levels at 155 m, the North Channel Rock Groin (NCRG) will be lowered over about 11 days in the period from February 22 to April 16.
- Once the rock groin is removed, the reservoir will be raise to FSL at 159 m over about 9 days after the third week of March.

Figure 1: Site layout



Hydrodynamic modeling was performed for open-water conditions to identify the changes in water levels at different impoundment stages and the approximate extents of areas that would be affected. The upstream boundary for the models was set just upstream of Gull Lake to manage model run times. The model was run for a high flow of 4,400 m^3/s (approx. 95th percentile flow) to estimate the maximum extent of potential effects. Flows in the project area are currently high at around 4,000 cms and are expected to remain relatively high through the winter. For water-up and impoundment the upstream water levels will be raised by controlling the Spillway gates to reduce outflows so that water backs up behind the dam. While the model assumed steady state flow conditions (i.e., flows do not change in the simulation), actual flows can be expected to vary over the extended water-up and impoundment period. Because flows will vary during the impoundment process, Spillway gates may need to be adjusted to keep water levels near those required for water-up and NCRG removal, which may cause small upstream water level variations.

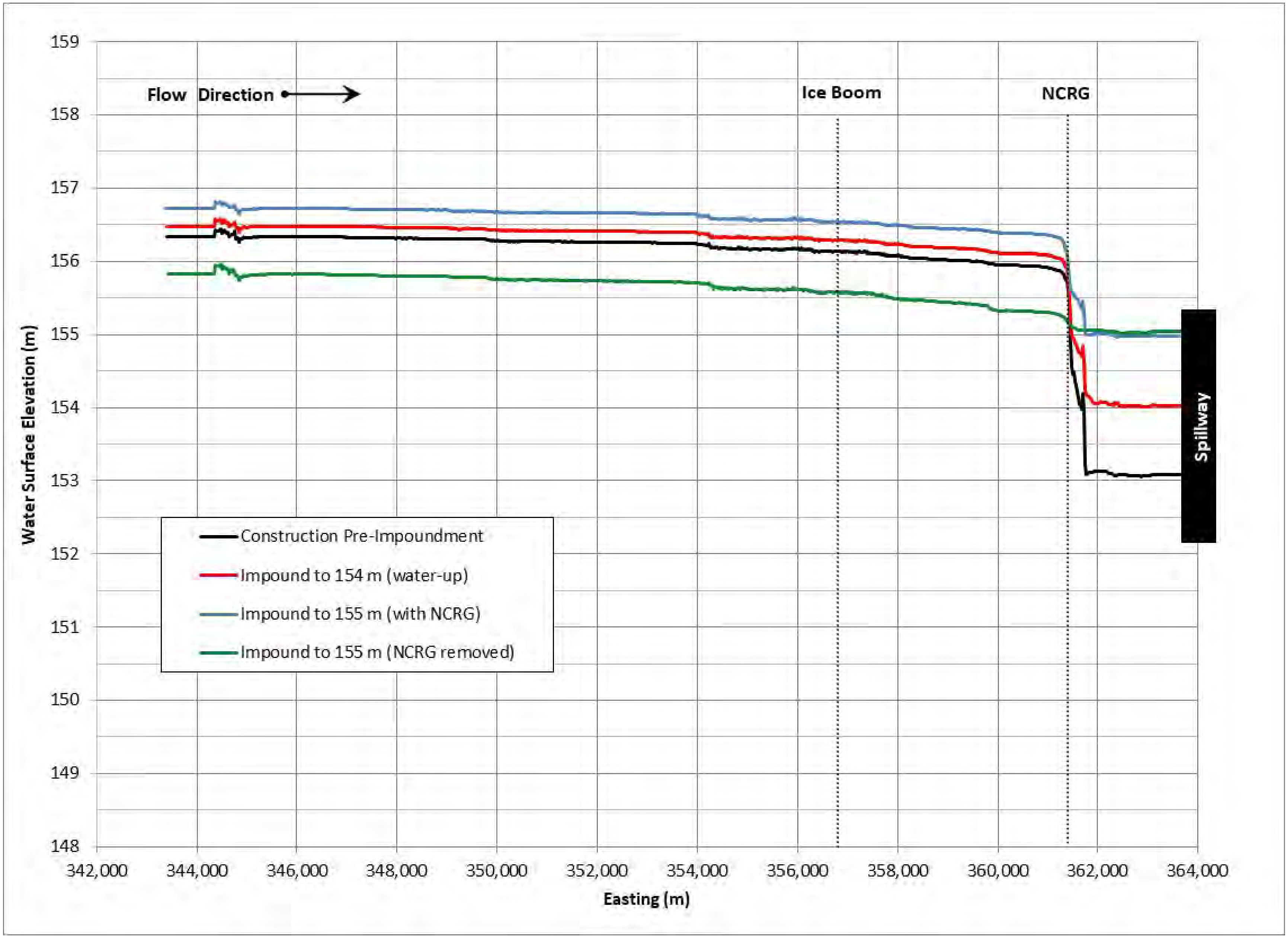
Since the Nelson River area being modeled is generally aligned in an east-west direction, the model area was divided into a series of north-south sections every 25 m and the average water level was calculated for each section to produce water surface profiles between the Spillway and the upstream end of the model for the different model scenarios (Figure 2). This provides a reasonable estimate of water levels along the length of the reservoir. Although this results in minor anomalies because of different water levels occurring within some sections, these anomalies do not affect the consideration of overall effects.

As noted above, it is assumed the prevailing water level prior to water-up will be about 153 m at the Spillway based on expected high flow conditions. This level would generally prevail up to the North Channel Rock Groin. With this level at the Spillway the average prevailing level between the NCRG and Ice Booms is about 156.0 m with ice effects (Figure 2). Note that the average level in this reach is calculated from the levels at the Ice Booms and at the head of Gull Rapids about 400 m upstream of the NCRG near the west end of William Smith Island, which the NCRG is connected to. Averaging between the booms and the NCRG would result in a lower average water level. Upstream of the Ice Booms the average prevailing level is about 156.2 m. The elevation contours corresponding to the average water levels in these three zones (Spillway to NCRG, NCRG to Ice Booms, and upstream of Ice Booms) have been mapped and represent the approximate prevailing shoreline prior to raising levels for water-up, NCRG removal and impoundment (Map 1 & 2).

In order to water-up the de-watered work area, a channel will be cut north of the Stage I Island Cofferdam near the North Channel Cofferdam so water can be diverted from the river into the work area. The base of this water-up channel will be at an elevation of about 152 m with a weir at elevation 153 m. To flood the work area, flow through the Spillway will be reduced to raise upstream levels above the weir in the water-up channel. While levels will be raised above 153 m by varying amounts depending on how fast the water levels in the work area may be increased, it is likely that the maximum level above the Spillway would not exceed 154 m during this process. Raising levels to 154 m between in the Spillway and NCRG would produce a small water level increase of about 0.2 m (about 0.15-0.25 m) upstream of the NCRG, up to approximately 156.2 m between the NCRG and Ice Booms and 156.4 m upstream of the Ice Booms (Figure 2).

Contours for the levels upstream of the NCRG show that the lateral extents of areas potentially affected by the small water level increase are generally limited (Map 1 & 2). Along the main channel the shorelines are generally steeper and potential effects are largely within about two meters of the prevailing level, and in most areas the potential effects are within about 5 m of the prevailing level. In areas with lower slopes like wetlands that are typically off the main channel, the effects may extend farther, with maximum potential changes from the prevailing

Figure 2: Water levels upstream of Keeyask



level extending 20-30 m from the prevailing level contours. Although this occurs in various locations upstream of the NCRG, areas with these larger potential changes from the prevailing level are generally limited and do not appear over any large contiguous regions. In the modeled reach from the dam to just upstream of Gull Lake, the incremental area potentially affected by raising levels from 153 m to 154 m is approximately 1.4 km^2.

After the North Channel and Stage I & II Island cofferdams are lowered, water levels upstream of the Spillway would be raised up to 155 m and held there during NCRG removal. Raising levels to 155 m between in the Spillway and NCRG would produce a small water level increase of about 0.2 m (about 0.15-0.25 m) above the levels that occur with a water level of 154 m at the Spillway during water-up. As result, the water is approximately 156.4 m between the NCRG and Ice Booms and 156.6 m upstream of the Ice Booms (Figure 2). With the increase from 154 m to 155 m at the Spillway producing water level changes similar to the increase from 153 m to 154 m, the extents of potential effects are also correspondingly limited (Map 1 & 2). In most areas the water level contours during NCRG removal (155 m at Spillway) are within a few meters of the contours during water-up (154 m at Spillway). Maximum potential effects may extend to about 20-30 m, but again these areas are generally limited and do not cover large contiguous areas. In the modeled reach from the dam to just upstream of Gull Lake, the incremental area potentially affected by raising levels from 154 m to 155 m is approximately 1.0 km^2.

As the NCRG is removed the conveyance capacity through the North Channel will increase, which could cause upstream levels to drop by almost a meter (Figure 1). However, upstream levels could be held relatively steady by managing the Spillway gates to gradually increase levels between the Spillway and NCRG as the NCRG is removed. This operation would result in levels at the Spillway that would more closely match the level upstream of the NCRG once removal is complete, likely in the range of 156-156.5 m.

It is noted that the small water level changes that may occur during water-up and NCRG removal are at about the level of precision for the model. In addition, the contour elevations may have an accuracy of 0.5 m. As a result, areas of effects may be somewhat larger or smaller than modeled: however, despite these potential sources of uncertainty, the results suggest that the extents of effects during water-up and impoundment would be generally limited.

To put the potential water level changes during water-up and NCRG removal into perspective, water levels at the monitoring station near the Ice Booms were investigated to determine how frequently increases of 0.15 m or more have occurred in the winter (December – March) during construction. These changes would primarily result from flow changes, although shifting ice conditions may also affect levels. This represents 5 winter periods when construction activity (e.g., spillway operation) have not raised levels upstream of the NCRG. Although the potential changes in level discussed above may occur within a day, similar increases over several days would likely have similar effects. Results of the analysis found that over periods of 1 to 4 days water level increases exceeding 0.15 m occurred about 40 times, while increases of 0.2 m and 0.25 m or more occurred 28 times and 20 times respectively. One four day increase reached 0.55 m. These results suggest that the water level changes associated with water-up and NCRG removal are within the range of changes that have occurred with some regularity independent of construction effects. Water level changes similar to those expected from water-up and NCRG removal activities (i.e., 0.2 m) can be expected to occur during the coming winter due to non-project effects as has happened in the past.

After NCRG removal is finished, water levels upstream of the Spillway will be raised over a period of about 9 days up to FSL at 159 m, which will result in the creation of the new initial shoreline for the Keeyask reservoir (Map 1 & 2). During final impoundment, the water level may be raised up to 1 m per day for levels between up to 156 m, and up to 0.5 m per day for levels between 156-159 m. During final impoundment the reservoir will expand as levels are raised the final 3-4 meters, with the expansion extending up to a several hundred meters from the levels achieved during NCRG removal (Maps 1 & 2). The larger areas of expansion will be in the flatter, lower lying wetlands on either side of Gull Lake. In the modeled reach from the dam to just upstream of Gull Lake, the incremental area potentially affected by raising levels from 155 m to 159 m is approximately 24.2 km^2. Impoundment effects upstream of Gull Lake are limited, with approximately 2.4 km^2 of land being flooded between the pre-construction and initial FSL shorelines (at 95^{th} percentile flows) presented in the Keeyask EIS.

2.2. Ice Conditions:

With the ice boom in place during construction an ice cover has typically started forming upstream of the boom by early to mid-November (Table 2). On the date of this memo an ice cover had developed to the upstream end of Gull Lake. Except for winter 2014/15 when the ice boom broke, the ice cover has typically developed up to about 4-6 km upstream of Birthday Rapids at its furthest extent. Ice conditions and resulting water levels are dependent on flow, air and water temperatures, and amounts of precipitation (snow, rain), which causes uncertainty in predicting ice condition. Modeling of winter ice and water level conditions is not available. Based on past conditions, it is expected a full ice cover will be in place upstream of the ice boom up to at least Birthday Rapids by the time reservoir impoundment begins.

Raising water levels in winter would primarily impact ice conditions upstream of the Ice Booms as there is typically little ice present downstream of the booms except for border-ice along shorelines. Border ice between the dam and NCRG will likely detach and become mobile as levels are raised up to 154 m during water-up and may partially reform as levels vary and seasonal weather conditions permit. As noted above, increasing water levels to as high as elevation 154 m above the Spillway will periodically raise levels upstream of the NCRG by about 0.2 m. The main channel ice cover will rise with the water and most likely hinge up rather than lift off the shore, which may result in hinge cracking parallel to some shorelines. Open water and slush ice up to 0.2 m depth may develop along the shoreline over frozen ground and on the existing ice along hinge cracks. These effects will be limited given the limited extent of areas affected by this water level increase noted above. Considering the approximate 1-month duration for water-up and cofferdam removals, and normal cold temperatures during this period, areas affected will likely freeze partially or completely through the 0.2 m depth of effects.

Table 2: Ice Conditions During Construction

Year	Initial Freeze-up on Gull Lake	Furthest Ice Cover Advancement	Gull Lake Ice Break-up
2014/15	Jan 23, 2015 Nov 9, 2014*	Foot of Birthday Rapids	May 13-15, 2015
2015/16	Nov 20, 2015	About 4km upstream of Birthday Rapids	May 4-9, 2016
2016/17	Nov 19, 2016	About 6km upstream of Birthday Rapids	May 22-24, 2017
2017/18	Nov 4, 2017	About 6km upstream of Birthday Rapids	May 19-20, 2018
2018/19	Nov 4-6, 2018	About 6km upstream of Birthday Rapids	May 13-15, 2019

*Shortly after initial freeze-up began in Nov 2014 the ice-boom failed causing the ice cover to break up and it did not re-form until late January 2015.

Following cofferdam removal, levels at the Spillway would be raised to and held at 155 m as the NCRG is removed over about 11 days. This would raise levels upstream of the NCRG about 0.4 m above the prevailing level prior to the start of water-up (i.e., assumed prevailing level of 153 m at Spillway), or about 0.2 m above the level affected during water-up. The upstream ice cover will rise with the changing water level, either rising free of the ground or hinging with hinge cracking parallel to the shore. The increase in level will result in additional effects, creating areas of open water and slush over frozen ground or on the existing ice cover to a depth of about 0.2 m, assuming areas affected during water-up are frozen. Depending on snow cover and weather conditions, this water and slush may partially freeze as the NCRG is removed, but any ice cover development would generally be considered thin and weak.

With the water level held at 155 m at the Spillway, removal of the NCRG would progressively cause levels to drop about 0.9 m upstream of the NCRG due to increased flow capacity through the North Channel. Resulting levels would be about 0.5 m lower than the prevailing level prior to beginning water-up (Figure 2). In this case the ice would drop and rest on the ground until final impoundment begins. The drop in water level could be prevented by progressively raising water levels at the Spillway as the NCRG is removed in order to maintain steady levels upstream of the NCRG. In this case, water levels at the Spillway could end up in the range of 156-156.5 m or more when NCRG removal is complete.

Final impoundment of the reservoir would begin once the NCRG is removed and would involve raising water levels about 4 m or less up to the 159 m Full Supply Level at the Spillway, depending on water level management activities during NCRG removal. Upstream of the Ice Booms, the levels would rise about 2-3 m to full supply level, again depending on how levels are managed during NCRG removal. Assuming final impoundment starts from 155 m at the Spillway, it will take about 9 days to reach FSL, with levels rising up to 1 m/day up to 156 m and up to 0.5 m/day from 156-159 m (Table 1). Upstream of the Ice Booms the water level changes would be between 0.5-1 m/d.

Final impoundment will result in open water and slush along shorelines, progressively expanding in area and depth as levels are raised. These flooded areas may be several meters deep, commensurate with the water level increases that will occur during final impoundment. With final impoundment occurring in late March, the flooded margins will likely progressively freeze to due to expected cold temperatures, although slush may persist where it remains covered by an insulating snow layer. The ice cover developed over these flooded margins will likely remain relatively thin and weak as final impoundment is occurring late in the winter season when days are getting longer and warmer. After reaching FSL, the water level would remain steady and the surface would continue to freeze, both along the flooded margins and in the area between the Ice Booms and the dam. The thickness to which the areas may freeze will depend on how early FSL is achieved, weather conditions, and the amount of snow cover that may accumulate. An ice thickness of least several centimeters (e.g., 5 cm / 2 in) is likely to develop, while a thicker cover may be possible with under favourable conditions (cold, little or no snow). In general, the ability for people or larger animals to safely traverse newly formed ice is uncertain.

As noted above, water level modeling only considered the reach up to the upstream end of Gull Lake. In the river reach upstream of Gull Lake, ice effects during construction prior to impoundment have caused levels to rise each winter by as much as 3-5 m or possibly more above corresponding open water conditions. This occurs because flow at the entrance to Gull Lake and within the river channel is constrained by a thick buildup of ice as ice sheets are pushed and shoved by the flow. The small water level increases above prevailing level during water-up and NCRG removal would not be expected to create any notable change in conditions upstream of Gull Lake. It is likely that similar small, rapid changes in level occur in this area as the thick ice cover develops with ice periodically building up and releasing.

During final impoundment it is not clear that increasing levels about 2-3 m on Gull Lake would correspondingly raise levels the same amount upstream of the lake. As the water level rises on Gull Lake the thick ice cover at the lake's entrance will also be raised, which will increase flow conveyance capacity of the channel into Gull Lake. The improvement in conveyance may at least partially offset the effect of raising levels on the lake, resulting in smaller water level changes upstream. In addition, backwater effects would naturally diminish in the upstream direction. Overall, the upstream ice cover would be expected to largely rise in place with some shifting and reforming of the cover, similar to processes that occur during the winter under changing flow conditions. In winter periods during construction the upstream levels have typically begun to decline in March, dropping up to a few meters from winter peak levels depending on location. With upstream water levels likely declining leading up to final impoundment at the end of March and diminishing backwater effects upstream of Gull Lake, water levels upstream are not expected to exceed peak winter levels that have previously occurred in that reach of the river. New, large ice jams and associated large upstream water level increases would not be expected to occur.

When the spring breakup occurs, it is expected that the ice cover upstream of the ice booms would largely melt in place, as occurs on Stephens Lake and as is expected during Keeyask operation. Thinner ice that may have formed around the reservoir margins during and after final impoundment would likely melt before the thicker lake ice that will have formed over the course of the winter prior starting water-up. The thinner, weaker ice downstream of the ice booms may melt in place or pieces may break off and pass through the Spillway. Similarly, if ice sheets break off from upstream of the booms and manage to get past the booms, they may remain upstream of the dam and melt in place or pass through the Spillway similar to current conditions.

2.3. Erosion & Sediment:

Although the proposed timing for impoundment is different than considered in the Keeyask EIS, the overall effects of the Project with respect to erosion, peat breakdown and resurfacing, and sedimentation would not be substantively altered from what was presented in the EIS. The erosion analysis assumed final impoundment would occur relatively quickly with frozen ground conditions, which is similar to conditions expected with the revised impoundment schedule. Any erosion during this time is expected to be negligible, particularly since flooding will occur over frozen ground and water velocities are expected to be relatively low, while the presence of an ice cover will prevent erosion from wave action. With an ice cover there is the potential that shifting ice could temporarily cause some short term, localized increases in erosion. There is no practical means to reasonably estimate specific erosion and TSS effects during final impoundment. As noted in the EIS, to the extent that any erosion does occur during short period for final impoundment, it is assumed the potential impacts would be captured in the overall EIS predictions for Year 1 of operation.

Woody debris present along shorelines and in cleared areas will float up as impoundment progresses but is likely to remain near where it originates as ice will largely prevent it from being transported downstream. Ice effects will occur in areas cleared under the Reservoir Clearing Plan and ice could potentially attach to and lift up woody debris that may have been left after clearing. These effects impact woody debris that would be affected by impoundment under open water or winter conditions and does not represent new debris. The overall impact of impounding in winter would not substantively alter the effects presented in the Keeyask EIS with respect to woody debris.

3. SUSPENDED SEDIMENT EFFECTS FROM REMOVAL OF TAILRACE COFFERDAM AND UPSTREAM EARTH STRUCTURES

3.1. Tailrace Cofferdam

At some time in the period from the beginning of January 2020 and the middle of May, the dewatered work area inside the Tailrace Cofferdam (TRCD) will be flooded and then a portion of the cofferdam will be removed. The schedule does not anticipate any removal during the sturgeon spawning period (May 15 – July 15). At the very least, partial removal of the TRCD is required to allow for commissioning of one or more turbine units in the Powerhouse. Removal will likely begin near the Southeast corner of the TRCD and progress north along the north-south leg of the TRCD towards the north shoreline. It is expected that at least 100 m would be removed before mid-May, although it is likely that the entire the north-south leg would be removed before commissioning.

The TRCD is comprised of inner and outer rock groins between which a central core of semi-pervious and impervious material was placed. These materials are partly comprised of fine grained material that may be suspended and transported downstream. Based on the process employed for the Spillway Cofferdam removal in 2018, the TRCD work is expected to involve first removing the central core material as much as possible. The inner rock groin would be removed after that, followed by the outer rock groin. The rock groins may be removed while the core material is also being removed but would lag behind the work on the core material. This removal process reduces direct exposure of the finer core materials to the river flow, reducing the potential for entrainment of suspended sediment.

The potential effects of TRCD removal on total suspended sediment (TSS) in the river was analyzed using the MIKE21, two-dimensional hydrodynamic model. To define the sediment load to add to the river, the potential rate of material loss during removal must be estimated in terms of mass lost per unit time (kg/s). Assuming the same removal and material loss rates used in the analysis of the Spillway Cofferdam removal, the potential rate of material loss to the river is estimated to be approximately 1.19 kg/s. To simulate the addition of this sediment into the river, the load needs to be added as if it were an inflow with a specified level of TSS. As in the previous Spillway analysis, the TRCD removal model assumes the sediment loading enters the river like a pumping discharge with a flow rate of 5,250 l/s (5.25 m^3/s) and a TSS concentration of 228 mg/l, which gives a mass loading rate of 1.2 kg/s. This loading is injected into the river along the north-south leg of the TRCD, about 100 m from the north shore of the river (Map 3).

The model results indicate that TSS increases of 5 mg/l or more above background are confined to a relatively small area along the east face of the TRCD (Map 3). The affected area extends about 100 m from the face of the TRCD at its widest point. The largest increases occur at the point where the sediment is injected, but the area in which the TSS exceeds 200 mg/l is very small. The concentration drops off rapidly as the TSS mixes in the flow. The main river flow and higher velocities are south of the TRCD, while the area where the TRCD is being removed is affected by a back-eddy with low flow velocities of less than 0.2 m/s. This flow pattern causes the sediment to generally move to the southeast corner of the TRCD where it mixes into the main flow at which point the TSS increase above background rapidly drops to less than 5 mg/l within a short distance downstream of the TRCD. Sensitivity analyses performed for the Spillway Cofferdam removals found that assuming the sediment is injected as a lower flow with higher TSS (i.e., 2,625 l/s at 556 mg/l – half the flow at twice the concentration) did not substantively change the results. The overall area affected and pattern of effects remains largely the same except at the immediate point of discharge where a higher TSS occurs due to the greater TSS of the discharge being injected.

The modeled area of TSS increases greater than 5 mg/l represents an equilibrium condition that is achieved assuming a steady loading of sediment while work is occurring. This equilibrium condition is reached within a few hours after the sediment loading is initiated and would remain in place while excavation of the cofferdam is actively taking place. The plume would be expected to dissipate and largely disappear within several hours after work ceases, which would occur each day if removal work does not take place 24 hours per day.

3.2. Upstream Earth Structures

As discussed above, the North Channel Cofferdam, Stage I & II Island Cofferdams and NCRG will be partially removed as part of the impoundment process. Some of this work will occur in the water, particularly for the North Channel Cofferdam and the NCRG. The North Channel and Stage I & II Island cofferdams were constructed using the same types of earth materials as for the Spillway cofferdam and the TRCD (i.e., granular filter and finer impervious). Sediment plume modeling has not been performed for the removal of the upstream cofferdams and NCRG. However, based on modeling results for the Spillway Cofferdam and TRCD removals, the effects of removing the upstream cofferdams and rock groin would be expected to produce locally elevated TSS near where the work is occurring. For the North Channel and Stage I & II Island cofferdam removals, the plume would extend some distance downstream along the shore in the channel between the cofferdams and the NCRG (Figure 1A). The sediment would mix rapidly when it reaches the main flow and as it passes through the Spillway, resulting in no discernable effects downstream.

The NCRG was constructed of rock material with limited fine content, and any fine material that was present is likely to have been suspended and transported downstream when the NCRG was constructed. Fine material that may have been filtered out by the rock groin as flow has passed through it during the past 5.5 years of construction may become suspended, but the quantity of fine material present is likely limited. Any larger increases in TSS during NCRG removal are expected to be localized near the work area with rapid mixing to low levels as it flows downstream to the Spillway and no discernable effects would result further downstream of the Spillway.

4. SUSPENDED SEDIMENT EFFECTS FROM UNIT 1 INITIAL COMMISSIONING AND UNIT 2 COMMISSIONING

4.1. Suspended Sediment Model Setup

The Mike 21, two dimensional hydrodynamic model was run to simulate effects on TSS due to first flow through the Powerhouse during commissioning of Unit 1. The analysis considered mobilization of remnant sediment from within the Tailrace Channel. It does not consider sediment that may originate from remnant material in the Intake Channel upstream of the Powerhouse. However, the potential quantity of sediment available for entrainment in the Tailrace Channel is greater than in the Intake Channel because all remnant material in the Tailrace will likely be mobilized due to high velocities. Because velocities in the Intake Channel are lower, the relatively coarse remnant material is expected to rapidly self-armour because larger material cannot be mobilized, which limits the amount of material that may be entrained. Additionally, sediment may be entrained upstream due to impoundment of the reservoir, which will flood an area of approximately 45 km^2.

Within the Tailrace Channel, the potential sediment source extends about 350 m between the Powerhouse and the west edge of the Tailrace Spawning Shoal constructed in the downstream portion of the Tailrace Channel. The spawning shoal is excluded as a sediment source because the material used to construct the shoal must be large enough to resist displacement even when the Powerhouse is at maximum discharge of about 4,000 m^3/s with all 7 units running. The amount of sediment that may be available for entrainment was estimated based on test cleaning of a 750 m^2 area of the channel and previous results of test cleaning in the Spillway Discharge Channel. Based on these test cleaning results, it was estimated that about 11 mm of suspendable material (i.e., ≤ 0.25 mm) may be left on the channel bed after it has been cleaned. For the model, a remnant depth of 15 mm, about 1/3rd greater than indicated from test cleaning, was assumed over a Tailrace Channel area of about 7 ha. Thus, the total amount of sediment available for displacement from the Tailrace Channel in the model is about 1,050 m^3 or about 1,700 tonnes. Although not included in the model, it was estimated that about 0.5-1 mm of remnant sediment might be available to be entrained in the flow from the Intake Channel before self-armouring prevents further entrainment. It is assumed that potential effects from the Intake Channel would be captured by considering a greater remnant depth in the Tailrace Channel than indicated from the test cleaning.

As noted above, it is expected that at least 100 m of the north-south leg of the TRCD would be removed prior to commissioning although it is possible that the entire north-south leg may be removed. The sediment model was run for both the 100 m and full removal conditions to consider if there is much difference in downstream effects between the two conditions.

Actual commissioning of the first turbine, Unit 1, will involve incrementally increasing flows in stages up to full capacity over several weeks as various tests are performed on the generating equipment. The initial operation will involve running the unit at the minimum speed-no-load condition where the turbine is allowed to spin freely without generating electricity. In this condition, Unit 1 will pass a flow of about 250 m^3/s, which is the Powerhouse discharge assumed for the sediment model. The model was run at a total river flow of 3,420 m^3/s (average river flow is about 3,300 m^3/s), which means 2,820 m^3/s would be passing through the Spillway.

Unit 1 will likely run for several hours at speed-no-load to allow things like bearing temperatures to stabilize. Although flows will eventually be increased up to the unit's maximum discharge of about 580 m^3/s (model assumes 600 m^3/s) over a period of weeks, with intermittent periods of no flow through the unit, the largest effects on downstream TSS are expected to occur with the initial speed-no-load operation (based on preliminary model runs). It is anticipated that subsequent flow increases would occur after the effects of the initial operation have largely dissipated so that there would be no significant overlapping of effects. A preliminary model run that brought Unit 1 to full discharge in half a day and commissioning of Unit 2 a day later showed that the largest effects on TSS occurred due to the first flow and that subsequent flow increases produced smaller and diminishing effects.

Based on the current estimated schedule (Table 1), Unit 1 commissioning up to its full capacity and any resulting effects on suspended sediment may be completed before the sturgeon spawning period from May 15 – July 15. Commissioning of Unit 2 would be expected to occur about 2 months after Unit 1 commissioning was started (with additional units being commissioned every 2 months). As a result, Unit 2 commissioning may be initiated during the sturgeon spawning period. A sediment model was run to consider potential effects of Unit 2 commissioning. When Unit 2 is commissioned, Unit 1 will be running at full flow capacity, which will displace sediment before Unit 2 begins operation. To account for this, Unit 1 was brought up to full flow in 4 hours (rather than several weeks) and then there was a 44 hour delay until Unit 2 flow was initiated. This delay allows Unit 1 TSS effects to dissipate before starting flow through Unit 2. It is noted that longer model run times to match longer gaps between unit operations are not considered because each simulated hour of operation requires about an hour of computation: the 88 hour period simulated for Unit 2 operation required about 4 days of computer run time. Because TSS effects from Unit 2 commissioning were expected to be much smaller than for Unit 1, it was brought up to full flow capacity in three steps: 250 m^3/s initial flow for 3 hours, increased to 450 m^3/s for 3 hours and then increased to 600 m^3/s. During Unit 2 commissioning Unit 1 continues to run at 600 m^3/s so that after Unit 2 is at capacity there is 1,200 m^3/s of flow through the Powerhouse or a little more than 1/3rd of the total river flow.

4.2. Unit 1 Initial Commissioning Model Results

Model results were extracted at 6 locations (Figure 3). The first four are in the vicinity of the SMP-2 open-water monitoring location about 1.3-1.5 km downstream of the TRCD while the last three are only 350 m downstream of the TRCD where larger effects would be anticipated due to the close proximity of these sites to the sediment source. Discussion of the results focusses on the condition with the entire north-south leg of the TRCD removed as this produces a larger effect on downstream TSS versus the case with a 100 m opening in the TRCD.

The model estimates TSS increases above background conditions. TSS monitoring results reported in the 2018/19 annual report[2] for the Physical Environment Monitoring Plan indicated that during construction with the ice-booms in place, average downstream TSS concentrations have been about 4-5 mg/l during ice covered conditions. This is much lower than winter TSS levels of about 25-30 mg/l observed prior to construction. The winter TSS reduction likely results from reduced ice damming immediately below Gull Rapids due to the ice boom. In open-water, summer conditions the average TSS during construction has been about 15 mg/l, generally varying between about 10-30 mg/l. Based on the observed conditions, background TSS during Powerhouse commissioning may be about 4-5 mg/l under winter conditions, or about 15 mg/l for open-water conditions, recognizing that background TSS can vary and may be affected by impoundment of the reservoir.

Time series results of TSS concentration changes for SMP-2L, SMP-2R, and K-PHCOMM-2 respectively show peak TSS increases of about 44 mg/l, 50 mg/l and 18 mg/l above background about 2 hours after Unit 1 flow starts (Figure 4). SMP-2L and K-PHCOMM-2 are located near the centerline of the sediment plume, while SMP-2R is nearer the right edge of the plume. At location K-PHCOMM-1, the response is quite different because it is located where there is a large back eddy: the peak increase at K-PHCOMM-1 lags behind the other three sites, getting to about 16 mg/l above background 5 hours after Unit 1 flow begins. The TSS increases at SMP-2L and K-PHCOMM-2 are more than 25 mg/l above background over a period of about 75-95 minutes. The TSS at SMP-2L and K-PHCOMM-2 declines rapidly after the peak, dropping below 10 mg/l after 4.5 hours and below 5 mg/l after 6 hours. After that, the TSS declines gradually, dropping to

[2] *Keeyask Hydropower Limited Partnership (KHLP). 2019. Keeyask Generation Project, Physical Environment Monitoring Plan 2018-2019 Physical Environment Monitoring Report: Year 5 Construction. June 2019. Winnipeg, Manitoba*

about 1 mg/l 35 hours after Unit 1 flow is initiated. A similar rapid decline is seen at site SMP-2R, but the TSS effect drops to about 1 mg/l above background after only about 7 hours since the site is nearer the edge of the plume. Site K-PHCOMM-1 also shows a similar gradual decline but lagging behind the other sites, dropping to about 2 mg/l above background after 35 hours. The 24-hour moving average increase at SMP-2L peaks at about 5 mg/l.

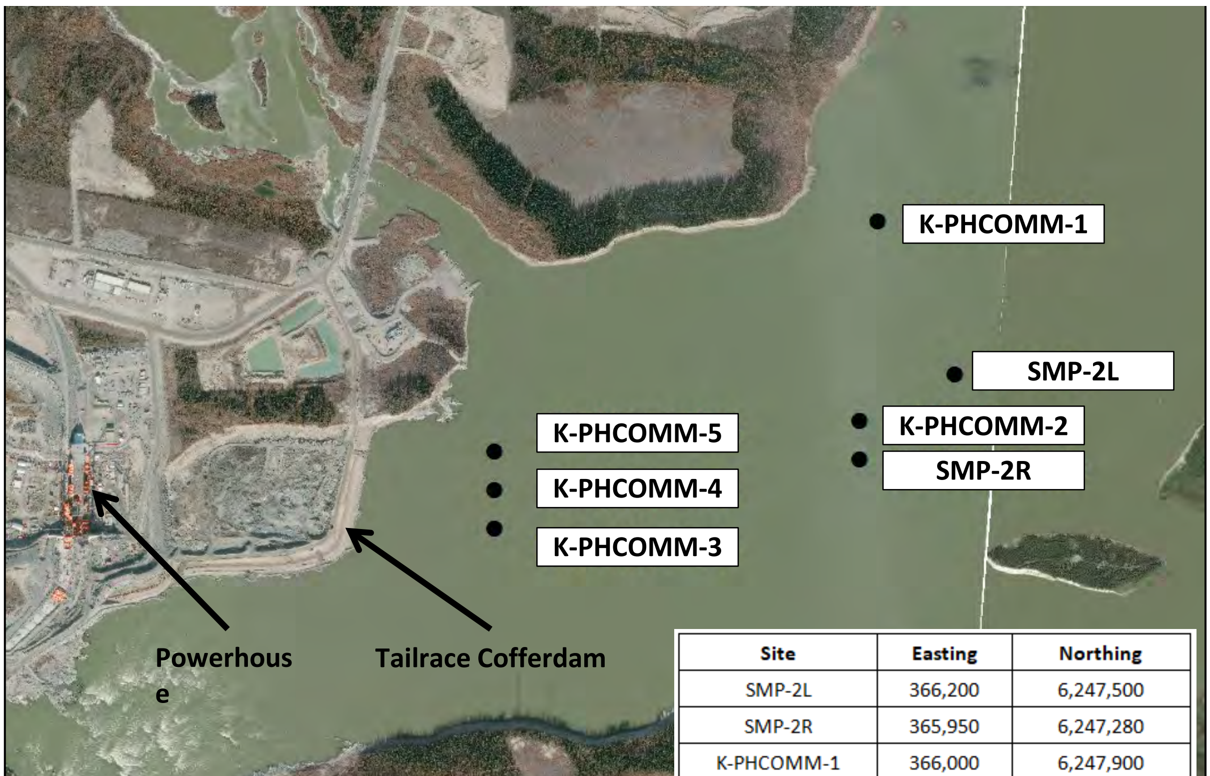
Near the TRCD the model results show a high spike in TSS up to about 210 mg/l above background at location K-PHCOMM-4, which is on the center of the sediment plume (Figure 5). Laterally from K-PHCOMM-4 the concentrations in the plume drop off rapidly with a peak of about 44 mg/l at location K-PHCOMM-5 100 m to the north, and a peak of about 22 mg/l at location K-PHCOMM-3 100 m to the south. As noted for the sites at the SMP-2 location, these concentrations drop off rapidly as the peak effect passes. By about 6 hours after initial operation, the increase above background drops below 2 mg/l at K-PHCOMM-5 and K-PHCOMM-3, while at K-PHCOMM-4 on the center of the plume the TSS effect drops below 2 mg/l after about 14 hours.

Snapshots of the sediment plume were obtained from the model at 2, 4, 6, 10 and 18 hours after Unit 1 flow begins (Maps 4 to 8). The results show the high TSS levels from the initial Unit 1 operation cause elevated TSS levels to extend into areas of Stephens Lake north of SMP-2 and north of the main flow path (Map 4). This occurs due to the loading being introduced at the north edge of the flow so that part of the plume disperses into Stephens Lake to the north rather than continuing along the main flow. That part of the plume that disperses south into the main flow is rapidly mixed so that increases along the main flow remain below 5 mg/l. The plume shown on Map 5, 4 hours after Unit 1 flow starts, shows the effect of the back eddy that influences site K-PHCOMM-1 where the plume is wrapping back in the upstream direction. The sediment plume to the north of the main flow dissipates slowly because there is little flow into this area so it does not disperse and get mixed all that rapidly. However, by about 18 hours after Unit 1 first operation (Map 8), the TSS has dispersed to the point that only a small area has TSS exceeding 5 mg/l above background conditions. In reality, the mixing may occur somewhat quicker as the model does not fully account for other circulating currents that likely exist in the lake (e.g., due to local inflows).

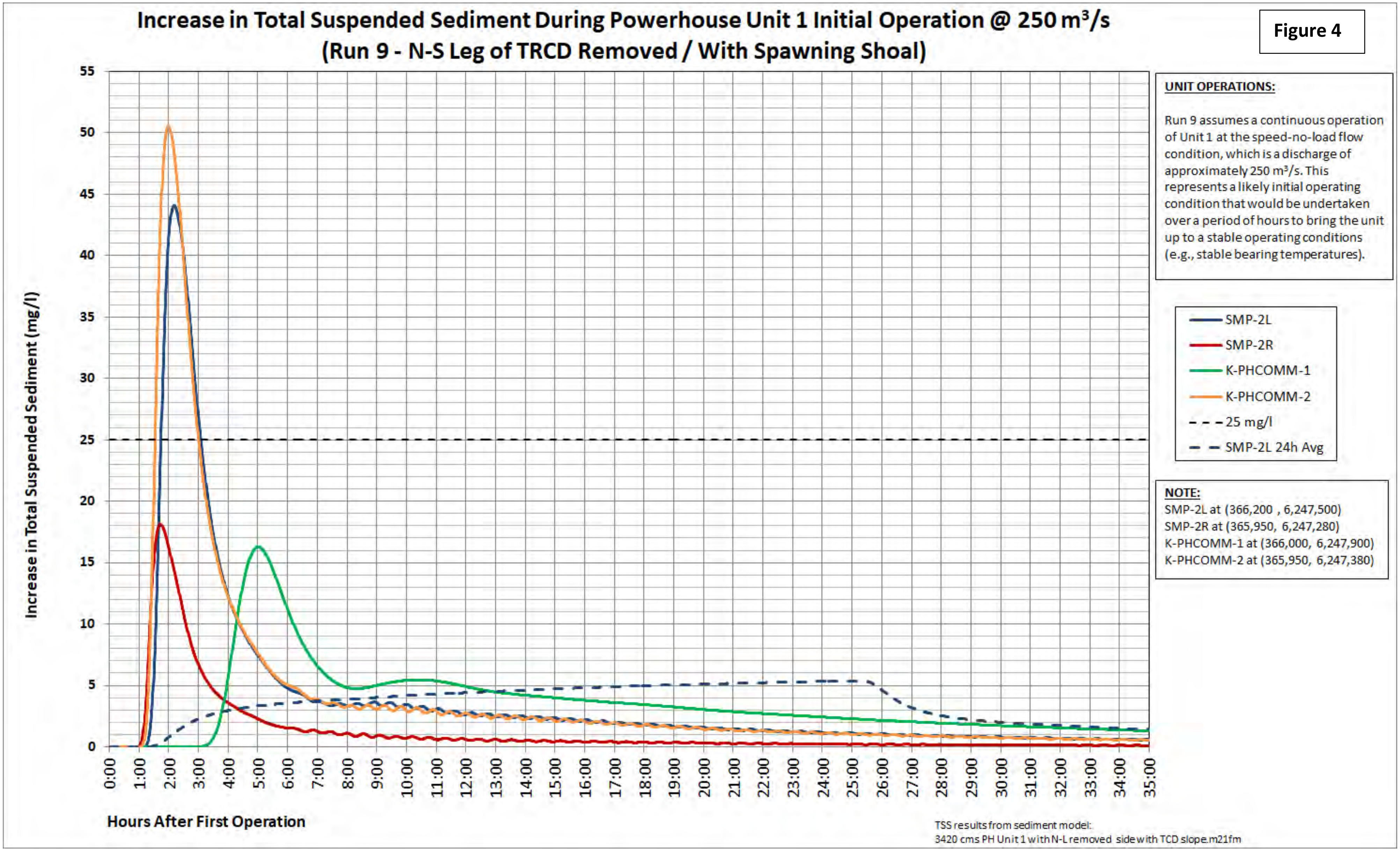
Approximately 25% of the sediment initially present in the tailrace channel was displaced by the model due to the first flow from Unit 1. As Unit 1 flows are incrementally increased over a period of a few weeks up to its maximum flow it is expected to result in diminishing effects on TSS. Similarly, as more units are commissioned (approximately 2 months between each unit) and total discharge from the Powerhouse increases, the effects on downstream TSS will continue to diminish. Additionally, as Powerhouse discharge increases and flow through the Spillway decreases, the diminishing sediment plume will mix more rapidly in the flow and will progressively be directed more along the main flow path. As a result, there will be less dispersion of sediment into Stephens Lake north of SMP-2 as more units are brought on line.

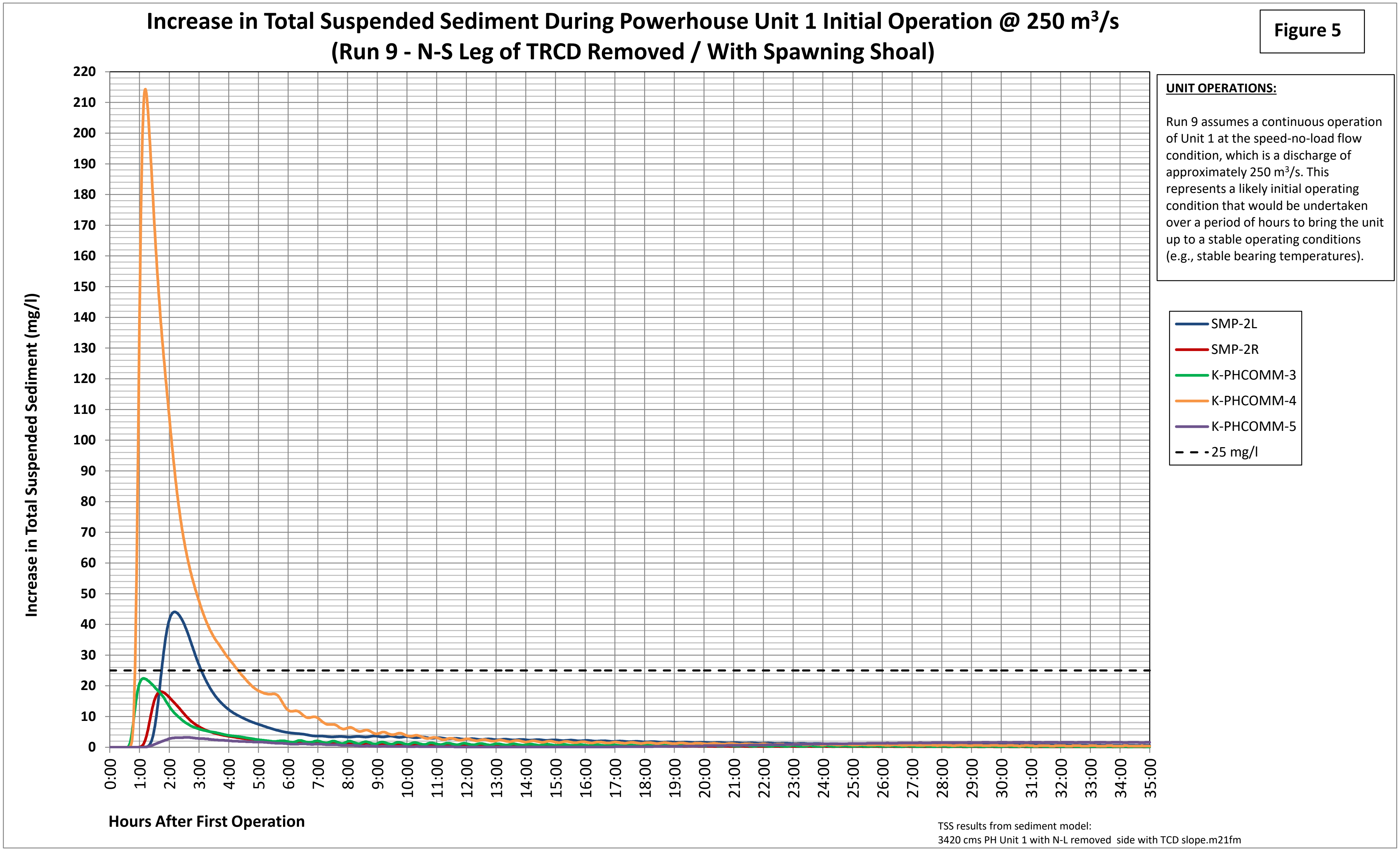
As noted above, the effects from Unit 1 initial commissioning are greater with the north-south leg removed versus the case with only a 100 m opening near the southeast corner of the TRCD. Model results show that with a 100 m TRCD opening, the peak TSS increases at locations SMP-2L and K-PHCOMM-2 (i.e., the two sites at the center of the plume) are about 6 mg/l lower than the peaks with the TRCD north-south leg removed (Figure 6). However, the TSS declines less rapidly for the case with a 100 m opening versus complete removal. Ultimately, in both cases, about 25% of the remnant sediment initially available in the Tailrace Channel is displaced due to the initial flow from Unit 1 commissioning. Overall, the difference between the two conditions is not large and there is no apparent benefit in reducing the size of the TRCD opening to reduce the peak effects on TSS increases above background downstream of the Powerhouse.

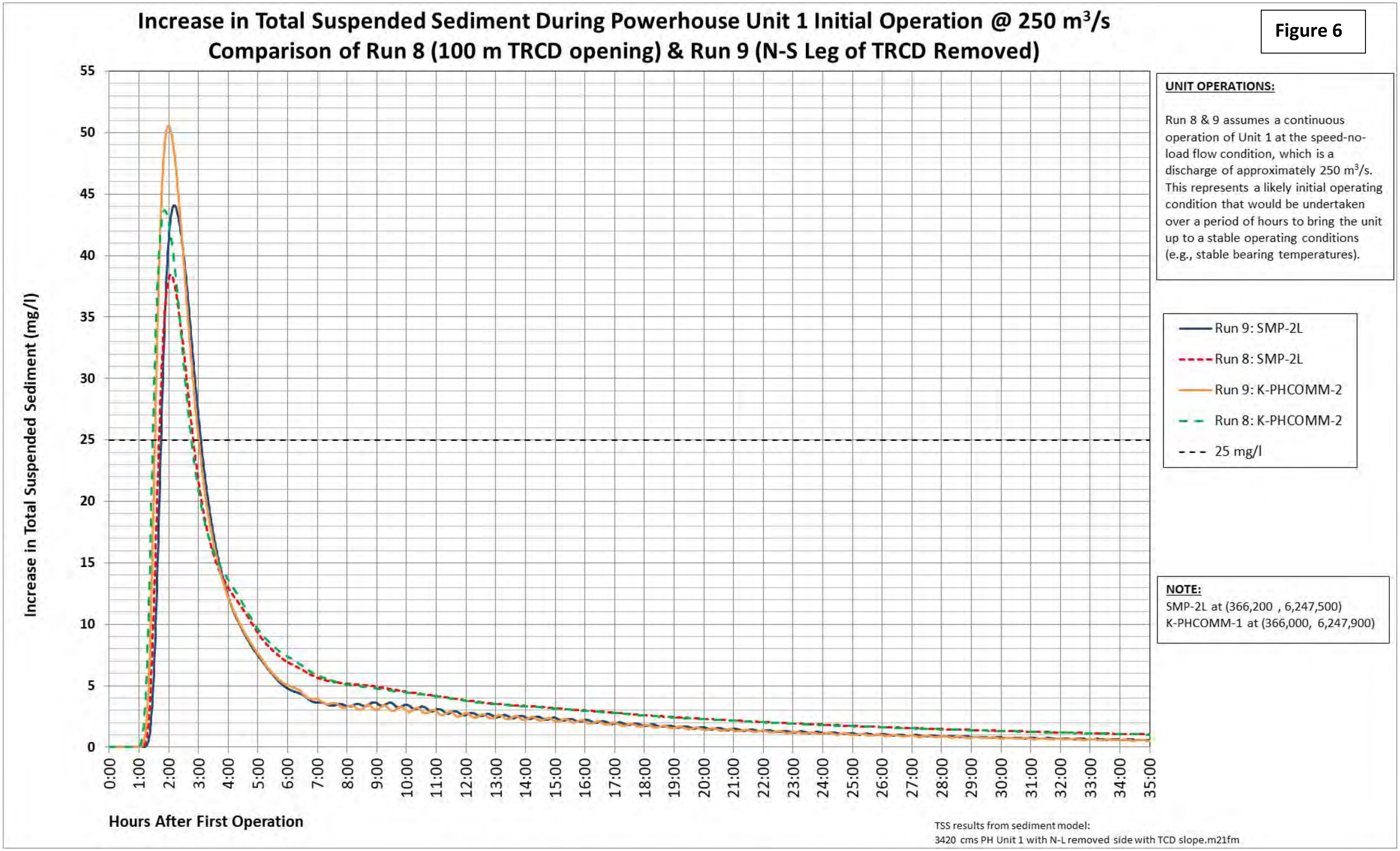
Figure 3: Locations where Powerhouse TSS model results were extracted



Site	Easting	Northing
SMP-2L	366,200	6,247,500
SMP-2R	365,950	6,247,280
K-PHCOMM-1	366,000	6,247,900
K-PHCOMM-2	365,950	6,247,380
K-PHCOMM-3	365,000	6,247,100
K-PHCOMM-4	365,000	6,247,200
K-PHCOMM-5	365,000	6,247,300


Increase in Total Suspended Sediment During Powerhouse Unit 1 Initial Operation @ 250 m³/s
(Run 9 - N-S Leg of TRCD Removed / With Spawning Shoal)
Figure 4
Increase in Total Suspended Sediment (mg/l)
Hours After First Operation
UNIT OPERATIONS:
Run 9 assumes a continuous operation of Unit 1 at the speed-no-load flow condition, which is a discharge of approximately 250 m³/s. This represents a likely initial operating condition that would be undertaken over a period of hours to bring the unit up to a stable operating conditions (e.g., stable bearing temperatures).
SMP-2L
SMP-2R
K-PHCOMM-1
K-PHCOMM-2
25 mg/l
SMP-2L 24h Avg
NOTE:
SMP-2L at (366,200 , 6,247,500)
SMP-2R at (365,950, 6,247,280)
K-PHCOMM-1 at (366,000, 6,247,900)
K-PHCOMM-2 at (365,950, 6,247,380)
TSS results from sediment model:
3420 cms PH Unit 1 with N-L removed side with TCD slope.m21fm


Increase in Total Suspended Sediment During Powerhouse Unit 1 Initial Operation @ 250 m³/s
(Run 9 - N-S Leg of TRCD Removed / With Spawning Shoal)
Figure 5
Increase in Total Suspended Sediment (mg/l)
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
24:00
25:00
26:00
27:00
28:00
29:00
30:00
31:00
32:00
33:00
34:00
35:00
Hours After First Operation
UNIT OPERATIONS:
Run 9 assumes a continuous operation of Unit 1 at the speed-no-load flow condition, which is a discharge of approximately 250 m³/s. This represents a likely initial operating condition that would be undertaken over a period of hours to bring the unit up to a stable operating conditions (e.g., stable bearing temperatures).
SMP-2L
SMP-2R
K-PHCOMM-3
K-PHCOMM-4
K-PHCOMM-5
25 mg/l
TSS results from sediment model:
3420 cms PH Unit 1 with N-L removed side with TCD slope.m21fm


Increase in Total Suspended Sediment During Powerhouse Unit 1 Initial Operation @ 250 m³/s
Comparison of Run 8 (100 m TRCD opening) & Run 9 (N-S Leg of TRCD Removed)
Figure 6
Increase in Total Suspended Sediment (mg/l)
0
5
10
15
20
25
30
35
40
45
50
55
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
24:00
25:00
26:00
27:00
28:00
29:00
30:00
31:00
32:00
33:00
34:00
35:00
Hours After First Operation
UNIT OPERATIONS:
Run 8 & 9 assumes a continuous operation of Unit 1 at the speed-no-load flow condition, which is a discharge of approximately 250 m³/s. This represents a likely initial operating condition that would be undertaken over a period of hours to bring the unit up to a stable operating conditions (e.g., stable bearing temperatures).
Run 9: SMP-2L
Run 8: SMP-2L
Run 9: K-PHCOMM-2
Run 8: K-PHCOMM-2
25 mg/l
NOTE:
SMP-2L at (366,200 , 6,247,500)
K-PHCOMM-1 at (366,000, 6,247,900)
TSS results from sediment model:
3420 cms PH Unit 1 with N-L removed side with TCD slope.m21fm

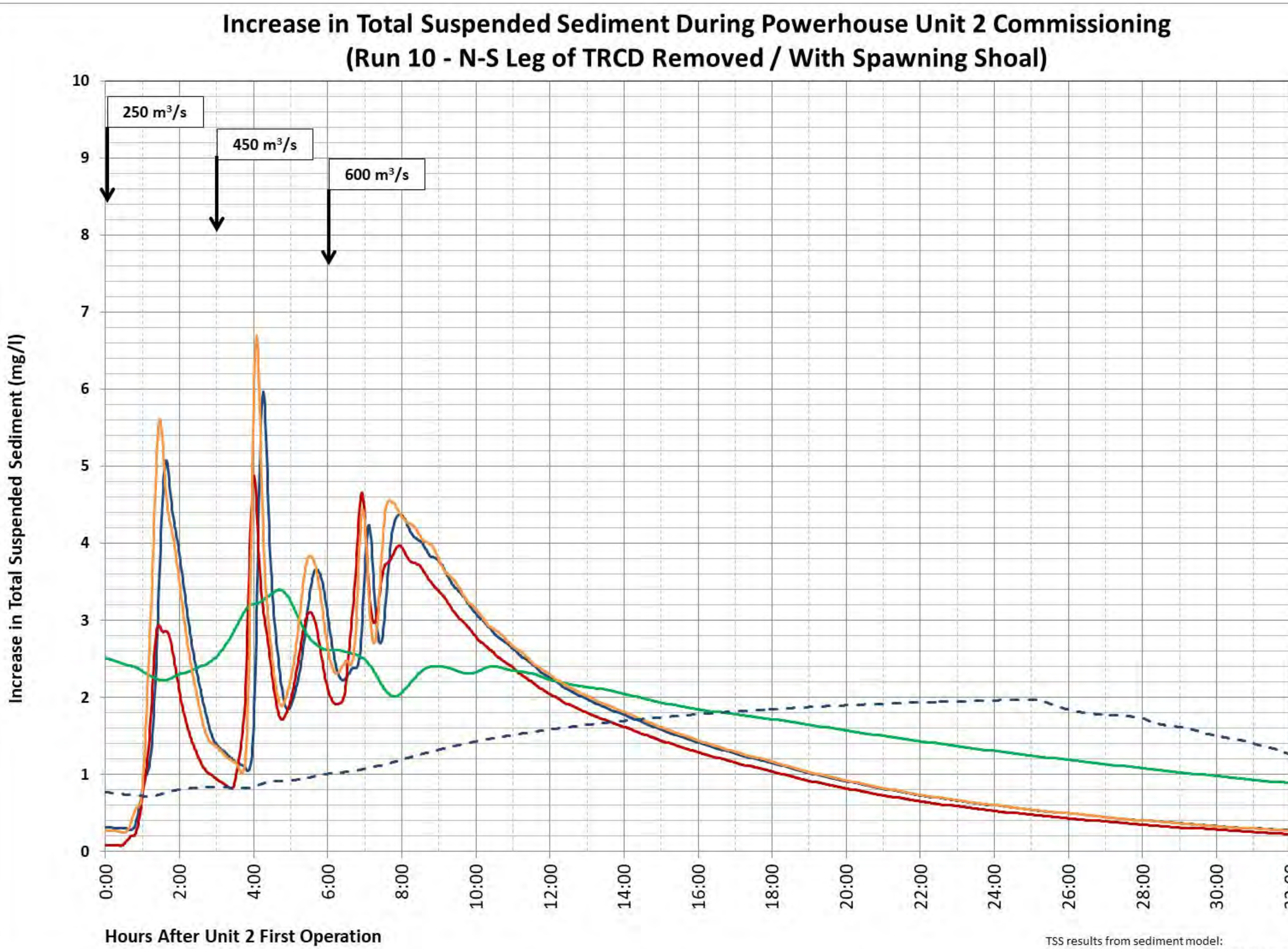
4.3. Unit 2 Commissioning TSS Model Results & Expected Effects of Unit 3-7 Commissioning

As noted above, a model was also run to consider the potential TSS effects when Unit 2 commissioning starts about 2 months after Unit 1 commissioning started. In this simulation, Unit 1 is brought up to full flow (600 m^3/s) in only a few hours rather than a few weeks. Flow through Unit 2 starts 44 hours after Unit 1 is at full flow to let the effects from Unit 1 dissipate. Unit 2 is brought up to capacity in three flow steps with a three hour interval between steps (i.e., in 6 hours). Model results for Unit 2 commissioning show TSS increases above background peak between 4-7 mg/l at sites SMP-2L, SMP-2R and K-PHCOMM-3 (Figure 7). The results show a larger peak increase when Unit 2 flow is raised to 450 m^3/s than for the first flow increase to 250 m^3/s. Because the model does not let the effect of the first Unit 2 flow dissipate as it likely will during actual commissioning, there is an overlapping effect between the first and second flow increments. It is expected that the effect of the increase to 450 m^3/s will be smaller than indicated. Similarly, the effects of the increase to 600 m^3/s would likely be smaller than shown if the effects of the previous flow steps were fully dissipated as would be expected during the actual commissioning. The results also show two secondary TSS peaks, with the first at about 5.5 hours after Unit 2 initial flow, and the second about 8 hours after Unit 2 initial flow. These secondary peaks result from the dynamics of a back eddy between the Powerhouse and the TRCD, and actual peak TSS increase above background would likely be smaller without the overlapping of effects that occurs in the model.

Results for location K-PHCOMM-2, which is affected by the back eddy in the lake, show TSS at 2.5 mg/l above background when Unit 2 flow starts, which occurs because effects from the rapid startup of Unit 1 were not fully dissipated when Unit 2 flows began. The effects of Unit 2 commissioning, however, only cause TSS at this site to rise to about 3 mg/l before continuing to gradually decline. The overlapping effect from Unit 1 would not occur when Unit 2 is commissioned. The effect from Unit 2 at this site is negligible.

Regardless of the overlapping effects between Unit 1 & 2 operations in this model, the TSS increases above background from Unit 2 commissioning are much smaller than the effects from Unit 1 startup. The peak effects are greater than 5 mg/l above background for less than an hour and drop to less than 1 mg/l above background in about 18-20 hours for sites SMP-2L, SMP-2R and K-PHCOMM-2 while K-PHCOMM-1 in the back eddy lags by about 8 hours. Snapshots of the sediment plume from Unit 2 commissioning were taken from the model at 1.5, 4, 8 and 16 hours after Unit 2 startup (Figure 8). The results show that the sediment plume resulting from rapidly bringing Unit 2 up to full capacity (i.e., in 6 hours rather than several weeks) are significantly smaller than the sediment plume resulting from the initial flow through Unit 1 (Maps 4 to 8).

It is expected that effects from commissioning Unit 3 would be much lower than those from Unit 2 just as Unit 2 had much smaller effects than Unit 1, and effects would continue to diminish with each subsequent unit. By the time Unit 2 was finished commissioning, the model had displaced most of the remnant sediment from the Tailrace Channel. Given these results, it is possible that effects from Unit 3 commissioning due to remnant material in the Tailrace Channel would not be discernable at the SMP-2 monitoring location and it is unlikely that effects from commissioning Units 4-7 due to remnant material would be discernable at SMP-2.



UNIT OPERATIONS:

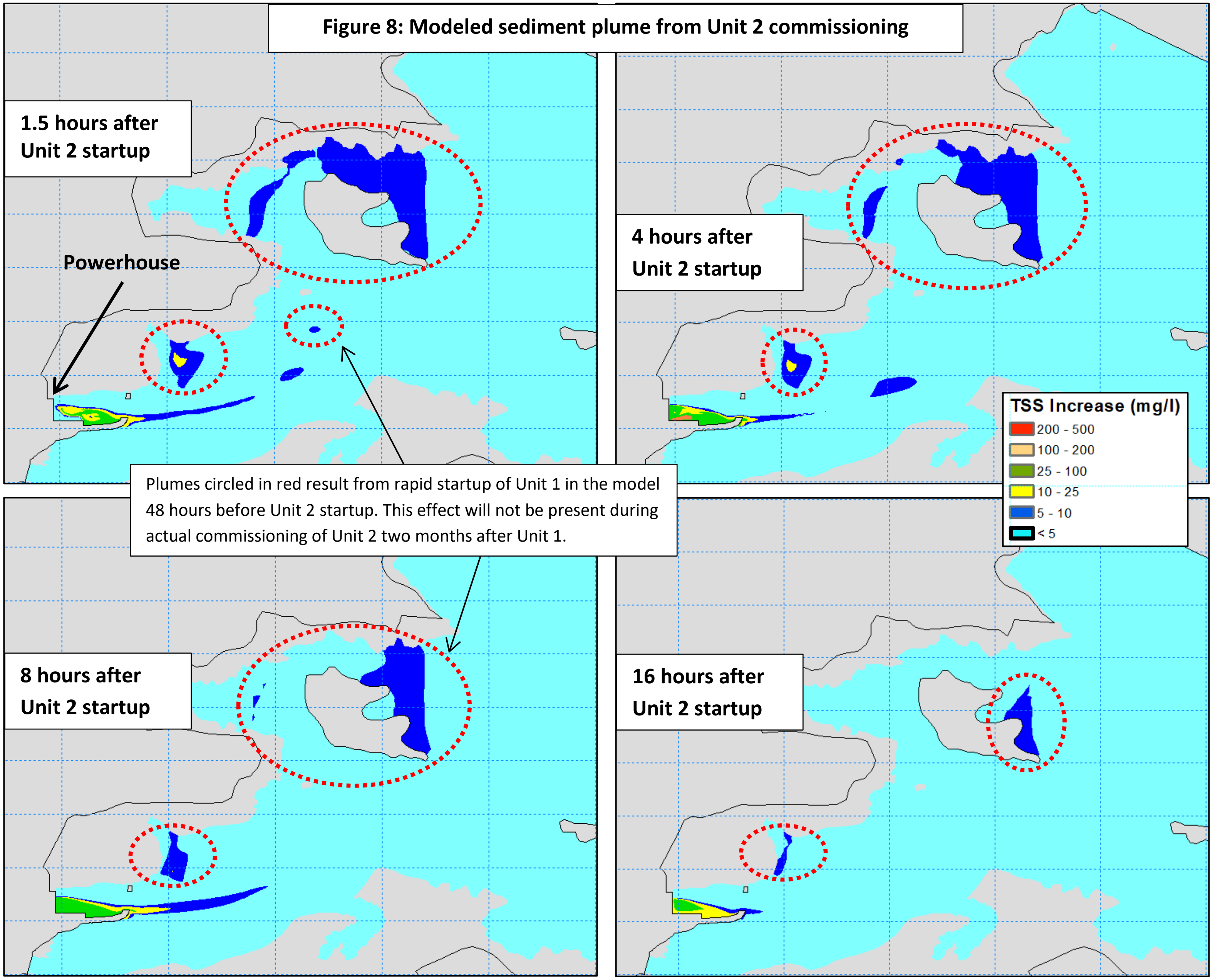
Run 10 was performed to consider the potential effects on TSS during commissioning of Unit 2. In this model, Unit 1 is brough to full capacity (600 cms) in 4 hours and then runs 44 hours before Unit 2 flow begins so that effects from Unit 1 can dissipate. Unit 2 is brough up to full capacity in 3 steps (250 cms, 450 cms, 600 cms) with 3 hour intervals between the flow increases. Under actual commissioning conditions, Unit 2 would be incrementally brought up to capcity over a period of several weeks and not over a few hours so effects would be more spread out than modeled and peaks would likely be somewhat lower.

NOTE:

SMP-2L at (366,200 , 6,247,500)
SMP-2R at (365,950, 6,247,280)
K-PHCOMM-1 at (366,000, 6,247,900)
K-PHCOMM-2 at (365,950, 6,247,380)

TSS results from sediment model:
Run10_3420 cms PH Unit 1 and 2 with N-L removed with TCD slope.m21fm

Figure 8: Modeled sediment plume from Unit 2 commissioning



4.4. Water Level Changes During Unit 1 & 2 Commissioning

Commissioning of the Powerhouse units will necessarily result in corresponding cutbacks in flow through the Spillway. In the model, when Unit 1 is at full capacity, the flow through the Spillway is reduced by 600 m^3/s and after Unit 2 is commissioned the flow is reduced by 1,200 m^3/s. With both units at capacity, the model indicated water levels in the vicinity of the Spillway will be about 0.5 m to 0.7 m lower as compared with levels before commissioning begins (general area indicated in Figure 9), with about half the decrease due to Unit 1 commissioning and half due to Unit 2. Note also that, as each unit is commissioned, flow through the unit may vary between its minimum output to full capacity, with intermittent periods of no flow. As a result, flows through the Spillway may also vary causing water levels in the vicinity downstream of the spillway to fluctuate as well. It is noted that there is uncertainty in the accuracy of these results due to uncertainty in the bathymetry used in the model due to the inability to survey the channel bottom in this high flow area.

Figure 9: General area in which water levels will vary due to Spillway flow changes

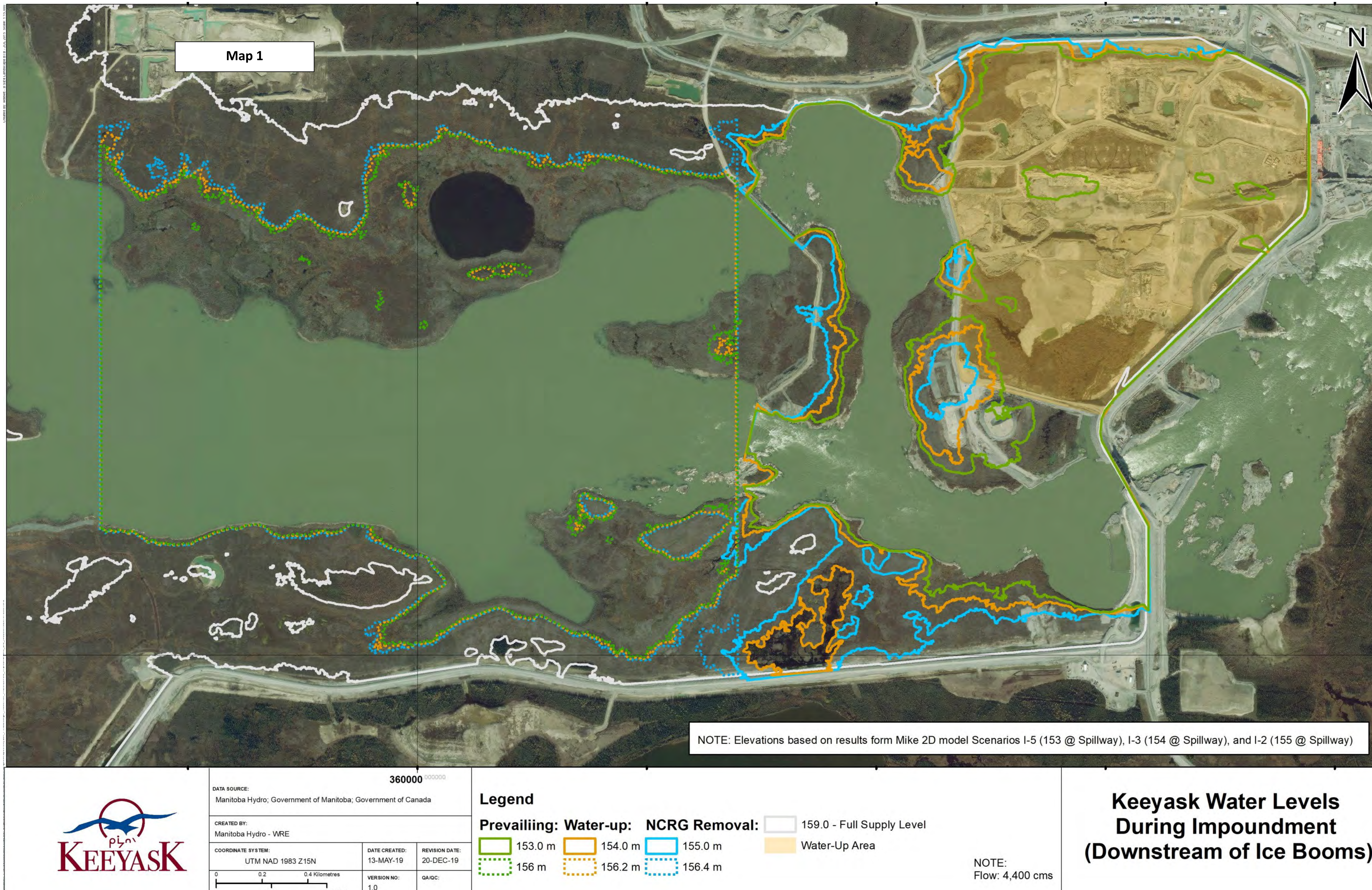
4.5. Comparison With Pre-Construction Estimate of Commissioning TSS Effects

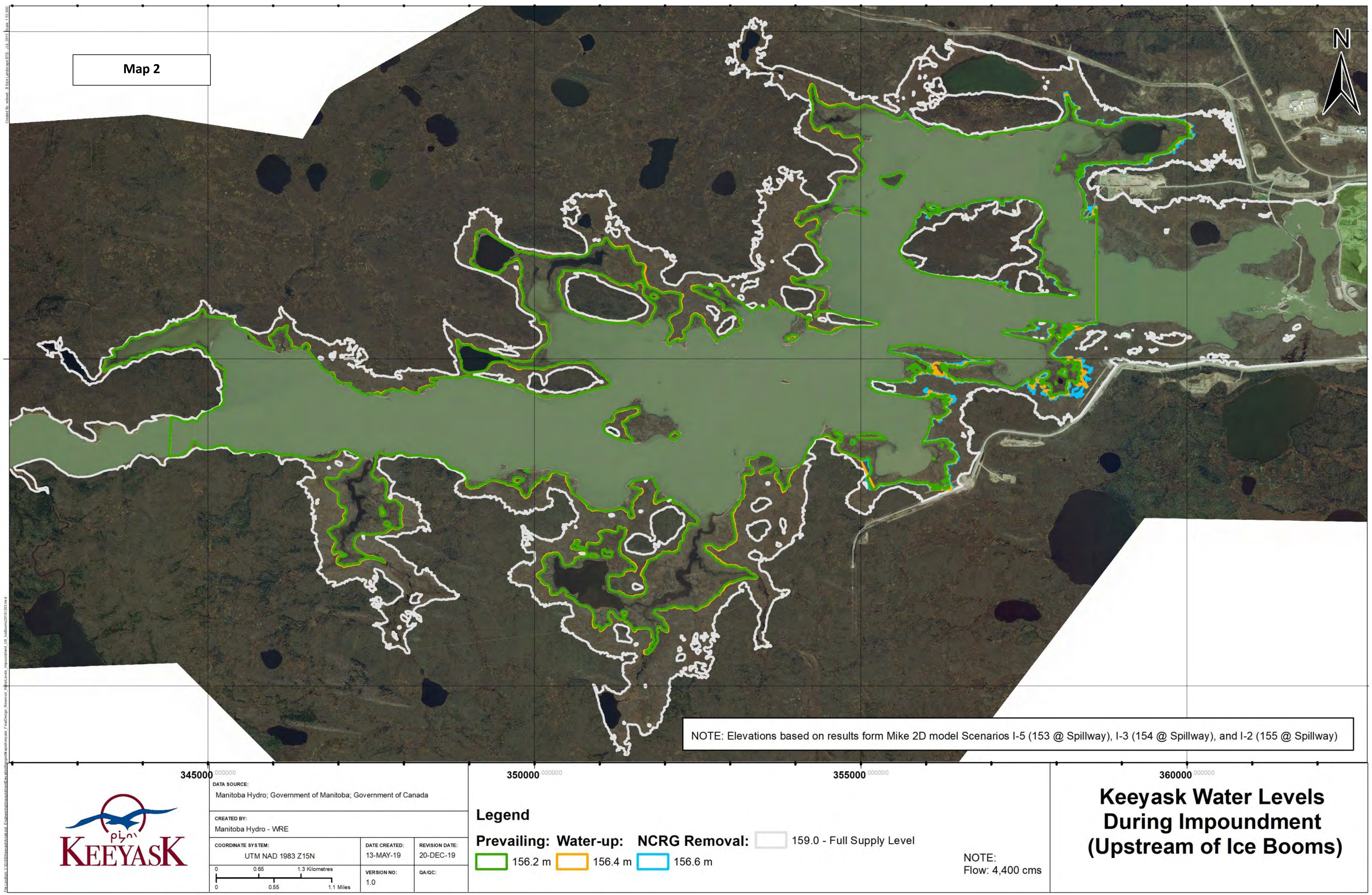
Prior to construction, the potential increase in TSS due to Powerhouse commissioning was estimated without numerical modeling based on an estimated rate of sediment entrainment and complete mixing in the entire flow across the entire river (in the Keeyask Sediment Management Plan for In-stream Construction[3]). That analysis estimated that TSS might increase by about 41 mg/l within the entire river flow over a 5-minute averaging period in the vicinity of SMP-2 for a short duration. The two dimensional MIKE21 model shows a peak increase of about 45-50 mg/l at locations SMP-2L and K-PHCOMM-2 at the center of the plume. However, at the time of peak effect, the sediment plume does not affect the entire width or flow of the river (Map 4). Concentrations drop off sharply laterally from the center of the plume. For example, although it is located only 100 m south, the peak TSS increase above background at SMP-2L (18 mg/l) is almost 1/3rd the peak increase at K-PHCOMM-2 (50 mg/l). The model also shows a more protracted rise and decline in TSS than the pre-construction analysis as the model better captures the sediment entrainment, transport and dispersion processes.

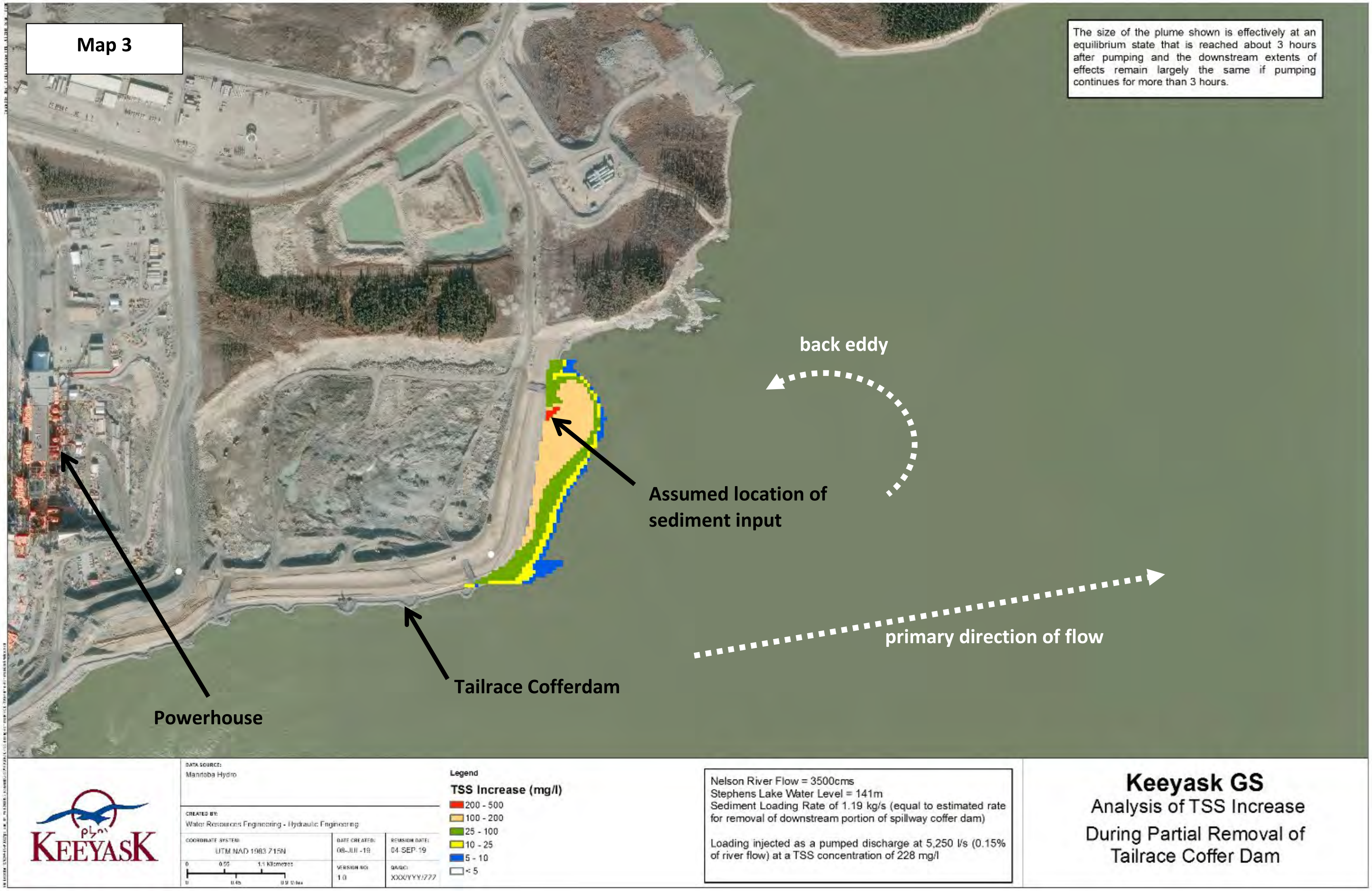
/wjd

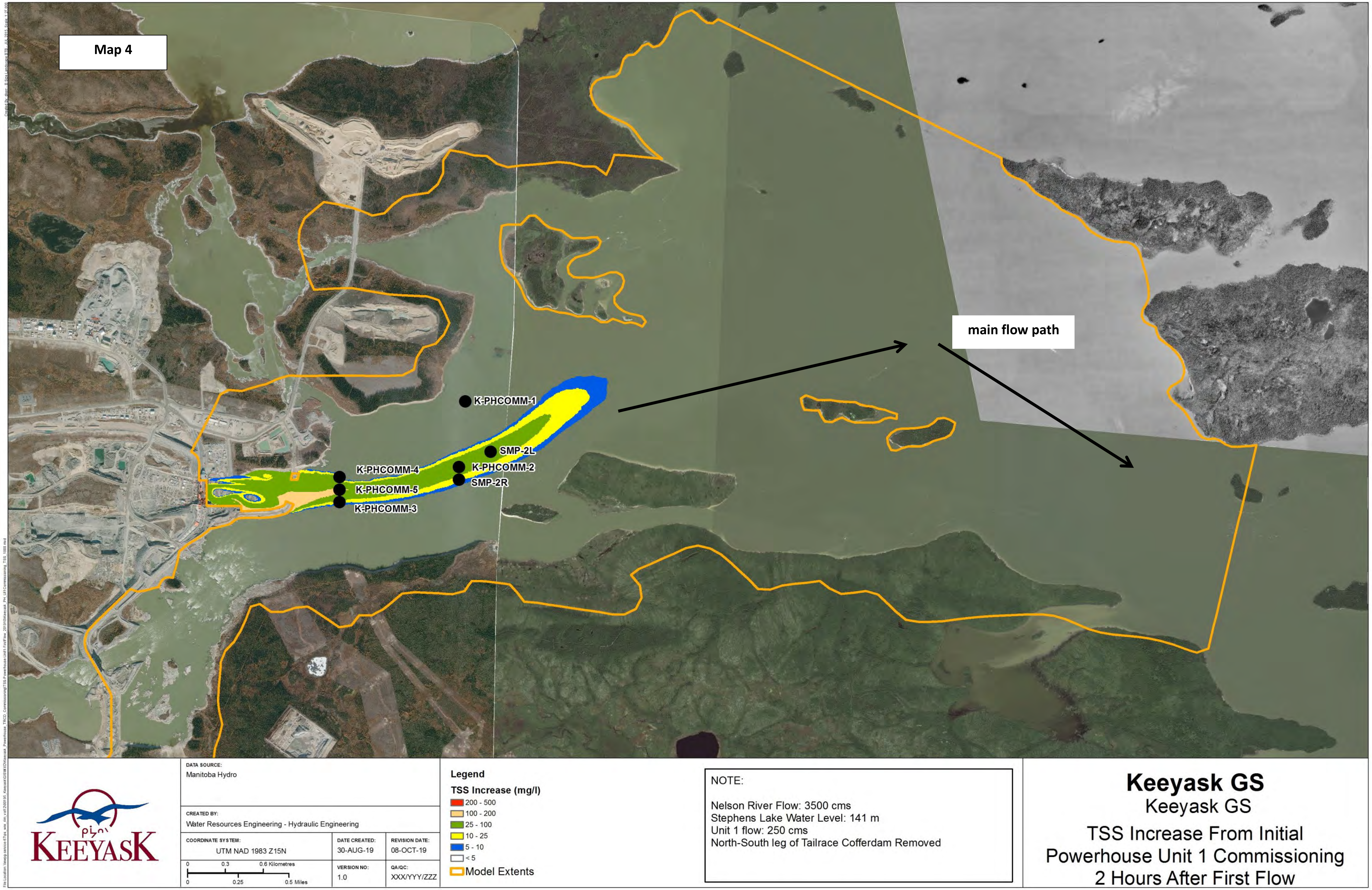
cc:
Manitoba Hydro: J. Malenchak, J. MacDuff, S. Wakelin
Ecostem: J. Ehnes
NorthSouth Consultants: F. Schneider-Vieira
Wildlife Resource Consulting Services: R. Berger

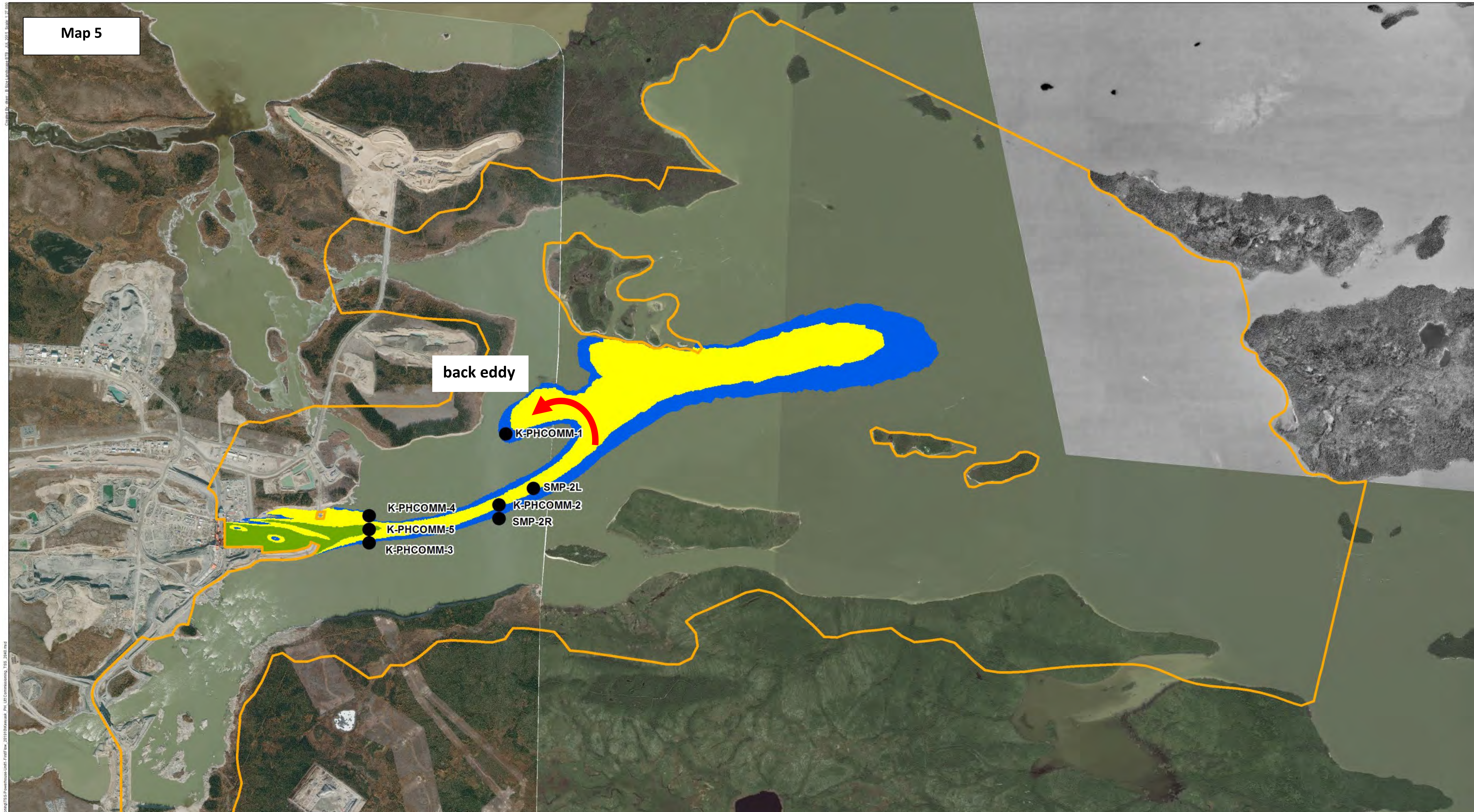
[3] *Keeyask Hydropower Limited Partnership (KHLP). 2014. Keeyask Generation Project: Sediment Management Plan for In-stream Construction. July 2014. Winnipeg, Manitoba*


Map 1
N
NOTE: Elevations based on results form Mike 2D model Scenarios I-5 (153 @ Spillway), I-3 (154 @ Spillway), and I-2 (155 @ Spillway)
360000
KEEYASK
DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada
CREATED BY:
Manitoba Hydro - WRE
COORDINATE SYSTEM:
UTM NAD 1983 Z15N
DATE CREATED:
13-MAY-19
REVISION DATE:
20-DEC-19
VERSION NO:
1.0
QA/QC:
0 0.2 0.4 Kilometres
0 0.15 0.3 Miles
Legend
Prevailiing: 153.0 m 156 m
Water-up: 154.0 m 156.2 m
NCRG Removal: 155.0 m 156.4 m
159.0 - Full Supply Level
Water-Up Area
NOTE:
Flow: 4,400 cms
Keeyask Water Levels During Impoundment (Downstream of Ice Booms)


Map 2
N
NOTE: Elevations based on results form Mike 2D model Scenarios I-5 (153 @ Spillway), I-3 (154 @ Spillway), and I-2 (155 @ Spillway)
345000
350000
355000
360000
KEEYASK
DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada
CREATED BY:
Manitoba Hydro - WRE
COORDINATE SYSTEM:
UTM NAD 1983 Z15N
DATE CREATED:
13-MAY-19
REVISION DATE:
20-DEC-19
VERSION NO:
1.0
QA/QC:
0 0.65 1.3 Kilometres
0 0.55 1.1 Miles
Legend
Prevailing: 156.2 m
Water-up: 156.4 m
NCRG Removal: 156.6 m
159.0 - Full Supply Level
NOTE:
Flow: 4,400 cms
Keeyask Water Levels During Impoundment (Upstream of Ice Booms)


Map 3
The size of the plume shown is effectively at an equilibrium state that is reached about 3 hours after pumping and the downstream extents of effects remain largely the same if pumping continues for more than 3 hours.
back eddy
Assumed location of sediment input
primary direction of flow
Tailrace Cofferdam
Powerhouse
KEEYASK
DATA SOURCE:
Manitoba Hydro
CREATED BY:
Water Resources Engineering - Hydraulic Engineering
COORDINATE SYSTEM:
UTM NAD 1983 Z15N
DATE CREATED:
08-JUL-19
REVISION DATE:
04-SEP-19
VERSION NO:
1.0
QA/QC:
XXX/YYY/ZZZ
0 0.55 1.1 Kilometres
0 0.45 0.9 Miles
Legend
TSS Increase (mg/l)
200 - 500
100 - 200
25 - 100
10 - 25
5 - 10
< 5
Nelson River Flow = 3500cms
Stephens Lake Water Level = 141m
Sediment Loading Rate of 1.19 kg/s (equal to estimated rate for removal of downstream portion of spillway coffer dam)
Loading injected as a pumped discharge at 5,250 l/s (0.15% of river flow) at a TSS concentration of 228 mg/l
Keeyask GS
Analysis of TSS Increase
During Partial Removal of
Tailrace Coffer Dam


Map 4
main flow path
K-PHCOMM-1
SMP-2L
K-PHCOMM-4
K-PHCOMM-2
SMP-2R
K-PHCOMM-5
K-PHCOMM-3
DATA SOURCE:
Manitoba Hydro
CREATED BY:
Water Resources Engineering - Hydraulic Engineering
COORDINATE SYSTEM:
UTM NAD 1983 Z15N
DATE CREATED:
30-AUG-19
REVISION DATE:
08-OCT-19
VERSION NO:
1.0
QA/QC:
XXX/YYY/ZZZ
0 0.3 0.6 Kilometres
0 0.25 0.5 Miles
Legend
TSS Increase (mg/l)
200 - 500
100 - 200
25 - 100
10 - 25
5 - 10
< 5
Model Extents
NOTE:
Nelson River Flow: 3500 cms
Stephens Lake Water Level: 141 m
Unit 1 flow: 250 cms
North-South leg of Tailrace Cofferdam Removed
Keeyask GS
Keeyask GS
TSS Increase From Initial
Powerhouse Unit 1 Commissioning
2 Hours After First Flow



KEEYASK

DATA SOURCE: Manitoba Hydro

CREATED BY: Water Resources Engineering - Hydraulic Engineering

COORDINATE SYSTEM: UTM NAD 1983 Z15N

DATE CREATED: 30-AUG-19

REVISION DATE: 08-OCT-19

VERSION NO: 1.0

QA/QC: XXX/YYY/ZZZ

0 0.3 0.6 Kilometres
0 0.25 0.5 Miles

Legend

TSS Increase (mg/l)

- 200 - 500
- 100 - 200
- 25 - 100
- 10 - 25
- 5 - 10
- < 5
- Model Extents

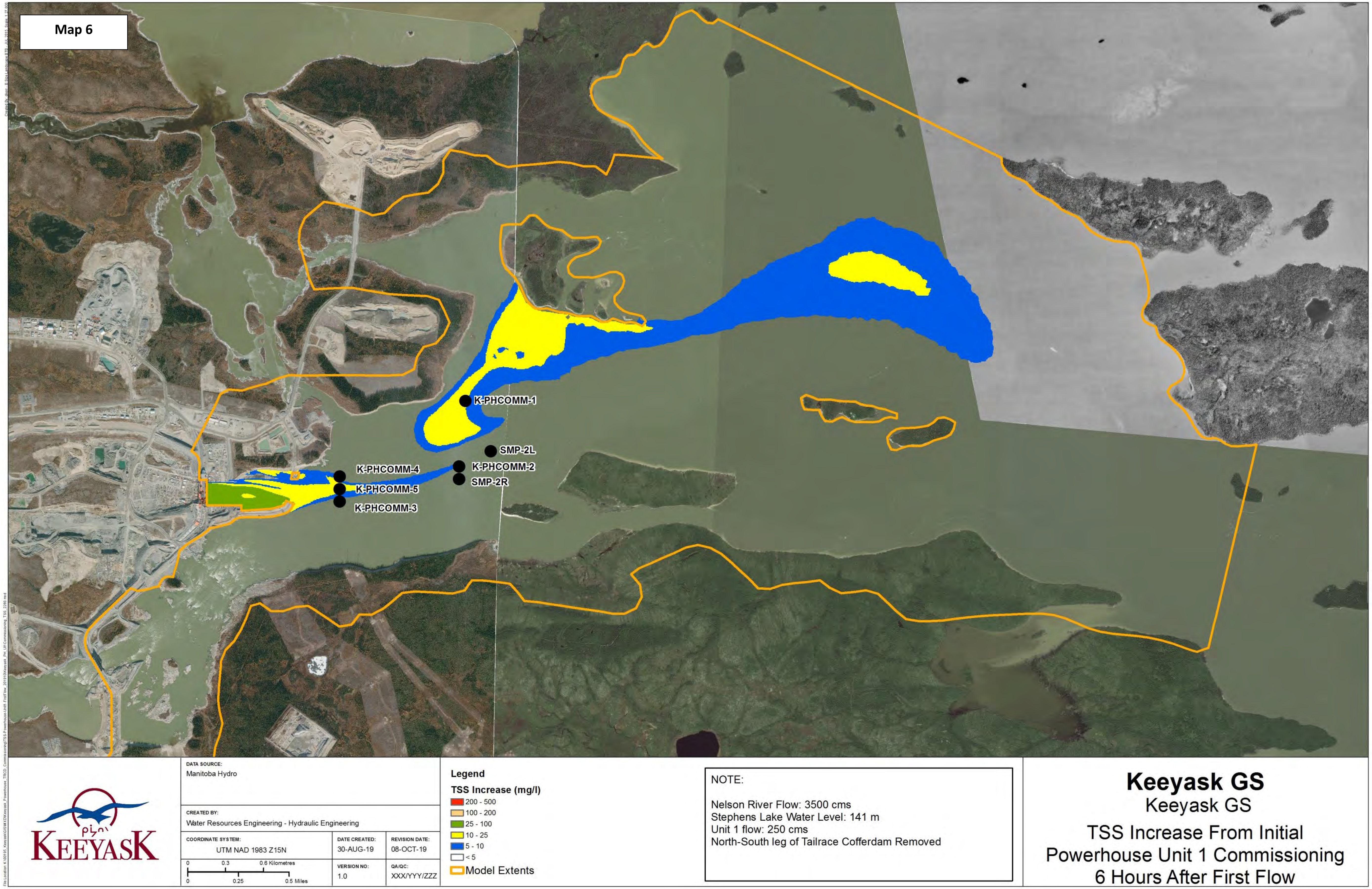
NOTE:

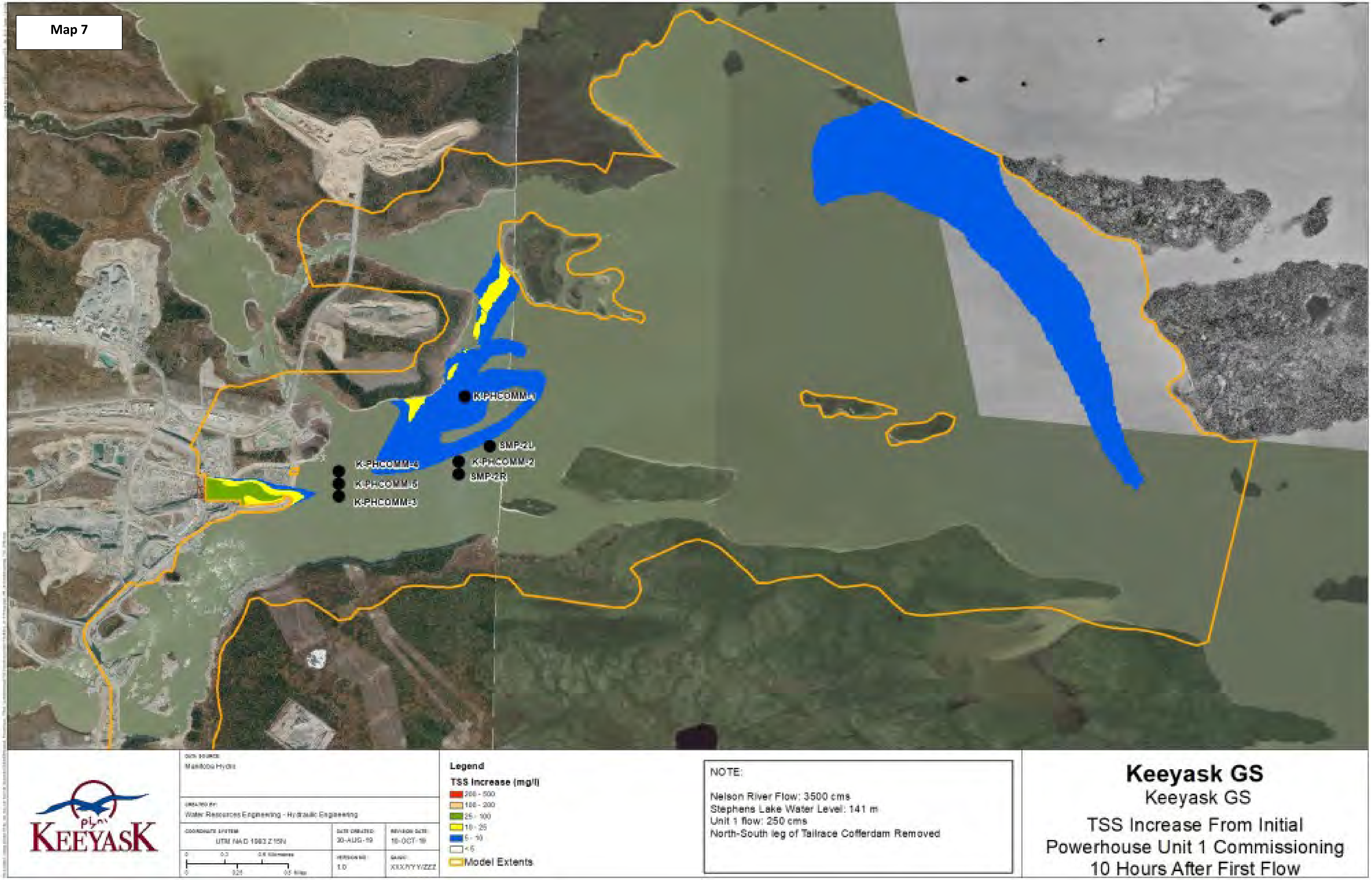
Nelson River Flow: 3500 cms
Stephens Lake Water Level: 141 m
Unit 1 flow: 250 cms
North-South leg of Tailrace Cofferdam Removed

Keeyask GS

Keeyask GS

TSS Increase From Initial Powerhouse Unit 1 Commissioning 4 Hours After First Flow


Map 6
K-PHCOMM-1
SMP-2L
K-PHCOMM-2
SMP-2R
K-PHCOMM-4
K-PHCOMM-5
K-PHCOMM-3
DATA SOURCE:
Manitoba Hydro
CREATED BY:
Water Resources Engineering - Hydraulic Engineering
COORDINATE SYSTEM:
UTM NAD 1983 Z15N
DATE CREATED:
30-AUG-19
REVISION DATE:
08-OCT-19
VERSION NO:
1.0
QA/QC:
XXX/YYY/ZZZ
0 0.3 0.6 Kilometres
0 0.25 0.5 Miles
Legend
TSS Increase (mg/l)
200 - 500
100 - 200
25 - 100
10 - 25
5 - 10
< 5
Model Extents
NOTE:
Nelson River Flow: 3500 cms
Stephens Lake Water Level: 141 m
Unit 1 flow: 250 cms
North-South leg of Tailrace Cofferdam Removed
KEEYASK
Keeyask GS
Keeyask GS
TSS Increase From Initial
Powerhouse Unit 1 Commissioning
6 Hours After First Flow


Map 7
K-PHCOMM-1
SMP-2L
K-PHCOMM-2
SMP-2R
K-PHCOMM-4
K-PHCOMM-5
K-PHCOMM-3
KEEYASK
Manitoba Hydro
Water Resources Engineering - Hydraulic Engineering
UTM NAD 1983 Z 15N
30-AUG-19
16-OCT-19
1.0
XXX/YYYY/ZZZ
Legend
TSS Increase (mg/l)
200 - 500
100 - 200
25 - 100
10 - 25
5 - 10
< 5
Model Extents
NOTE:
Nelson River Flow: 3500 cms
Stephens Lake Water Level: 141 m
Unit 1 flow: 250 cms
North-South leg of Tailrace Cofferdam Removed
Keeyask GS
Keeyask GS
TSS Increase From Initial
Powerhouse Unit 1 Commissioning
10 Hours After First Flow

KEEYASK

DATA SOURCE:
Manitoba Hydro

CREATED BY:
Water Resources Engineering - Hydraulic Engineering

COORDINATE SYSTEM: UTM NAD 1983 Z15N

DATE CREATED: 30-AUG-19

REVISION DATE: 08-OCT-19

VERSION NO: 1.0

QA/QC: XXX/YYY/ZZZ

0 0.3 0.6 Kilometres
0 0.25 0.5 Miles

Legend

TSS Increase (mg/l)
- 200 - 500
- 100 - 200
- 25 - 100
- 10 - 25
- 5 - 10
- < 5
- Model Extents

NOTE:

Nelson River Flow: 3500 cms
Stephens Lake Water Level: 141 m
Unit 1 flow: 250 cms
North-South leg of Tailrace Cofferdam Removed

Keeyask GS
Keeyask GS
TSS Increase From Initial Powerhouse Unit 1 Commissioning
18 Hours After First Flow

Appendix 3

KEEYASK GENERATION PROJECT
TECHNICAL MEMORANDUM

Subject: **Effects of Winter Impoundment on Fish**

To: Carolyne Northover
Manitoba Hydro

From: Friederike Schneider-Vieira, Claire Hrenchuk
North/South Consultants Inc.

Date: December 9, 2019

Background

The Keeyask EIS stated that impoundment would occur between August 2 and October 3, 2019; however, based on the current schedule, impoundment will not occur until winter 2020.

The Keeyask EIS identified the following effects occurring in the first year of impoundment:

- A short term increase in total suspended solids (TSS) immediately downstream of the generating station during cofferdam removal and initial operation of the tailrace;
- Effects to water quality in the reservoir, notably a reduction in dissolved oxygen (DO) and an increase in TSS in sheltered areas of the nearshore. Water quality in the mainstem during the initial year of impoundment is anticipated to be similar to pre-Project;
- A reduction in velocity and increase in depth at existing spawning locations in both the mainstem and shallow bays/tributaries of the reservoir. Over several years there may be a change in substrate at some locations; and

- Loss of spawning habitat in Gull Rapids (when flows in the spillway cease) and wetting of the constructed spawning shoal in the tailrace.

The current construction schedule is as follows:

- Impoundment to full supply level of 159 m before the end of April 2020. Water level increases would be staged throughout the winter, but the portion of the river flow utilized will not exceed 10% of the inflow;
- Removal/lowering of cofferdams/groins in the reservoir (i.e., North Channel and Stage II Island cofferdams and North Channel Rock Groin);
- Water up and removal of the Tailrace Cofferdam (TRCD) between January and mid May 2020;
- Commissioning of powerhouse Unit 1 beginning during winter 2020 and ending by mid June, at the latest (a total of 60 days at some time during this period). After commissioning is complete, Unit 1 would remain in operation; and
- Commissioning of Unit 2 during spring or summer (a total of 60 days at some point during this period but starting at least 30 days after commissioning of Unit 1 is complete).

The purpose of this memo is to identify whether the change in the timing of impoundment from that described in the EIS would result in a marked increase in adverse effects in comparison to those assessed in the EIS. With respect to the effect that the timing of impoundment would have on the impacts identified in the EIS, the following can be noted:

- If the short term increase in TSS immediately downstream of the generating station during cofferdam removal and initial operation of the tailrace occurs during sensitive periods (i.e., spawning) and the elevated TSS occurs in spawning habitat, incremental adverse effects may occur. The potential for adverse effects is discussed below;
- Effects to water quality in the reservoir as a whole, which would be greatest in the first year of operation, would not be altered by the timing of impoundment and, therefore, are not considered further in this memo. Removal of upstream cofferdams during winter may contribute additional sediments but these effects

are expected to be small in relation to the overall effect to water quality of flooding the reservoir;

- The EIS assumed that the reduction in velocity and increase in depth at existing spawning locations would affect fish populations beginning in fall 2019. At that time, fish would need to find alternate spawning locations if conditions were no longer suitable at existing sites. Therefore, the loss of spawning habitat was assessed in the EIS and the incremental effect as a result of a change in the timing of impoundment would disrupt eggs/larvae that had been deposited prior to impoundment/commissioning at locations that became unsuitable for egg/larval survival. The potential for this effect is discussed below; and

- Similar to the preceding point, the EIS assumed that the loss of spawning habitat in Gull Rapids (when flows in the spillway cease) and wetting of the constructed spawning shoal in the tailrace would occur in fall 2019. The effect of the change in timing of impoundment and commissioning is also discussed below.

This memo provides the following information:

- A description of the timing and locations of the spawning of four key species, Lake Sturgeon, Walleye, Northern Pike, and Lake Whitefish in the Keeyask reservoir and the Nelson River below the GS under current conditions (i.e., Stage 2 diversion);

- An evaluation of the potential for overlap with the impoundment/commissioning scenarios outlined above; and

- An assessment of whether resulting effects to fish populations would be greater than those described in the EIS, given that the EIS was based on the fall impoundment scenario.

Spawning Timing and Location of Key Species

Lake Sturgeon

The timing of Lake Sturgeon reproduction is temperature dependent, generally starting when the water temperature reaches 10˚C (Scott and Crossman 1973). Spawning has been recorded to continue to temperatures in the low teens and may occur for several weeks. After 5–10 days, eggs hatch and the larval fish remain in the spawning substrate until their yolk sacs are absorbed, after which they emerge and drift downstream. The timing of egg hatch and larval development is also temperature dependent. In general, approximately 6 weeks elapse from the time of first spawning until the last larval fish emerge from the substrate and drift downstream.

Although the timing of spawn in the Nelson River varies slightly each year, 10˚C is the lowest temperature that a Lake Sturgeon in spawning condition has been captured in the vicinity of Gull Rapids, and likely represents a conservative estimate of the temperature at which egg deposition begins. The Nelson River generally does not reach these temperatures until the end of May or early June.

Upstream of the Keeyask construction site, Lake Sturgeon spawn primarily in the vicinity of Birthday Rapids, as evidenced by the capture of numerous fish in spawning condition during spring gillnetting studies conducted between 2001 and 2018. More recently, a small unnamed set of rapids approximately 19.5 km upstream of the construction site has been identified as a potential spawning area (Holm and Hrenchuk 2019).

In Stephens Lake, sturgeon in spawning condition are captured below Gull Rapids, both along the south and north shores of the Nelson River, as well as along the eastern wall of the TRCD. Gillnetting studies suggest that the number of fish spawning in these areas may be increasing (Holm and Hrenchuk 2019), however, the exact location of spawning is not known. Potential Lake Sturgeon spawning locations can be inferred from the distribution of turbulent flow and water velocity. Velocity in the Nelson River during Stage 2 diversion was modelled at a river discharge of 3,500 m^3/s (Figure 1). Based on our understanding of Lake Sturgeon spawning, fish seeking an area to spawn are not expected to move upstream of where water velocity is consistently greater than 2 m/s. Sturgeon seeking spawning habitat along the north shore of the Nelson River, therefore, are expected to spawn downstream near the south-east corner of the TRCD (Figure 1). It is possible that Lake Sturgeon may move slightly further upstream along the face of the southern groin of the TRCD, but would not be expected to move upstream as far as the Central Dam Cofferdam due to high flows (i.e., > 3 m/s).

Walleye

Walleye spawn in the spring generally close to ice break-up (water temperature 6 to 9˚C), and in northern Manitoba have a sensitive timing window set out by DFO of April 15 to June 30. Spawning typically occurs in shallow inshore areas (water depth < 2 m) over gravel, boulder, or rubble substrates where flow is adequate for oxygenation and to remove waste products. Upstream of Gull Rapids, Walleye spawning locations are difficult to define. Data collected during movement studies between 2013 and 2018 have not detected large congregations of Walleye during the spring spawning window (Hrenchuk and Lacho 2019b). Walleye appear to spawn wherever suitable habitat is located within both the Nelson River and Gull Lake rather than congregating in one location (KHLP 2012). The Keeyask EIS identified Birthday Rapids as the only known spawning area between Clark Lake and Gull Rapids, while identifying several additional locations as potential spawning sites, including the area around Caribou Island (KHLP 2012). In Stephens Lake, acoustic telemetry studies conducted between 2013 and 2018 show that Walleye continue to be detected downstream of Gull Rapids (approximately 1.5 km downstream) (Hrenchuk and Lacho 2019b). Although specific spawning locations have not been identified, Walleye are expected to seek lower velocity habitat and would likely spawn further downstream than Lake Sturgeon.

Northern Pike

Northern Pike spawn immediately after ice-off when water temperatures range from 4 to 11˚C (Scott and Crossman 1973). The northern Manitoba sensitive timing window set out by DFO is April 15 to June 30. Northern Pike spawn in shallow water over heavily vegetated areas in rivers, marshes, and bays of larger lakes. They are broadcast spawners, scattering eggs that adhere to vegetation. Eggs generally hatch within 12 to 14 days depending on water temperature and larval fish remain within the spawning grounds, often attached to vegetation, for an additional 6 to 10 days (Scott and Crossman 1973). Upstream of the Keeyask GS construction site, there is suitable spawning habitat for northern pike between Birthday Rapids and Gull Rapids, notably at tributary mouths and in off-current bays. Studies conducted during the Keeyask EIS suggest that Northern Pike spawn at several locations within Stephens Lake, including at Gull Rapids (KHLP 2012). As Northern Pike spawn in off-current areas with vegetation, it is likely that they spawn along the shores of Gull Rapids.

Lake Whitefish

Lake Whitefish is the only species targeted in local fisheries that spawns in fall. Lake Whitefish spawning areas are particularly sensitive habitat, as eggs remain on the substrate until the following spring. During the winter, eggs are susceptible to water level fluctuations, oxygen depletion, and sediment deposition. Larval Lake Whitefish hatch in early spring, generally corresponding with ice-off, and the associated elevation of light and temperature levels (Schneider-Vieira and Hrenchuk 2019). Lake Whitefish are classified as a fall spawner, with a sensitive timing window set by DFO of September 1 to May 15. Lake Whitefish in the vicinity of Gull Rapids appear to begin spawning when water temperature reaches 8˚C and continues until 3˚C (Schneider-Vieira and Holm 2018).

Upstream of the Keeyask GS, Lake Whitefish spawn at Birthday Rapids and upstream of Caribou Island. Lake Whitefish from Stephens Lake spawn in or downstream of Gull Rapids. Acoustic telemetry studies conducted between 2014 and 2018 show that Lake Whitefish are detected by the receivers closest to Gull Rapids (approximately 1.5 km downstream) starting mid-September. Fish are thought to be staging for spawning in lower velocity areas immediately downstream of the TRCD as well as along the south bank of the Nelson River.

As with the other fish species, the precise location of egg deposition at Gull Rapids is not known. In addition, Lake Whitefish may spawn on the sides of the TRCD itself, given that the substrate is suitable (cobble and boulder) and the range of depths and water velocities along the TRCD include those suitable for spawning. However, it is not known whether the Lake Whitefish captured in the low velocity area downstream of the TRCD spawned at that location, or moved into higher velocity waters off of the southern side of the cofferdam or into the main channel of the Nelson River.

Potential Effects Related to Winter Impoundment

Removal/lowering of upstream cofferdams and impoundment to the full supply level (159 m) is planned to be completed prior to the end of April. Full impoundment will likely begin when there is a full ice cover on Gull Lake. Overall effects would be similar to what was indicated in the Keeyask EIS. The change in water level upstream of the GS would occur prior to ice off and the start of spawning by species such as Northern Pike and Walleye in mid to late May and Lake Sturgeon in late May to early June. The timing of upstream inundation overlaps with the expected period of egg incubation and early larval development for Lake Whitefish; however, adverse effects as a result of a decrease in water velocity and increase in sedimentation would be the same as associated with the fall impoundment assessed in the EIS. Impoundment will also cause a small decrease in the amount of flow passing downstream through the spillway, potentially affecting eggs deposited below Gull Rapids. Similar effects would have occurred during the fall impoundment scenario assessed in the EIS.

Potential impacts to fish species downstream of the Keeyask construction site may occur due to the removal of the north-south leg of the TRCD during the winter months. Any Lake Whitefish eggs deposited on the TRCD would be destroyed. Modelling of sediment releases during TRCD removal indicates that increases in TSS >5 mg/L would be confined to a narrow band (<100 m wide) along the eastern margin of the north-south leg (memo from W. DeWit). Therefore, adverse effects to eggs would be limited to those laid on and in close proximity to the TRCD. The EIS did not explicitly consider whether removal of the TRCD in fall 2019 would disrupt Lake Whitefish eggs as spawning by this species on the cofferdam was not anticipated. However, the EIS predicted that spawning in Gull Rapids would be disrupted during the construction period, with a decrease in year class strength of Lake Whitefish. The TRCD will be removed prior to mid May and therefore its removal would not overlap with spawning by Northern Pike, Walleye or Lake Sturgeon.

Commissioning of units 1 and 2 will be associated with periodic flow reductions in the spillway and varying flows in the tailrace, as units are tested. However, water level variation in the tailrace during commissioning of Unit 1 will be negligible, given that the tailrace is within the backwater of Stephens Lake. Even when all seven units are in operation, the water level in the tailrace would only be 0.2 m higher than Stephens Lake (email from W. Dewit, November 14, 2019). It is not known whether spring spawning species, in particular Lake Sturgeon, will be attracted to spawn within the tailrace when one or two units are operating and flows are fluctuating. If eggs are laid within the tailrace, they would not be vulnerable to dewatering, although water velocity would vary as the units are tested. Natural river flow in spring is expected to be sufficient to inundate the entire spillway, despite diversion of some flow through the powerhouse (M. Hunt, pers. com.); therefore, no adverse effect to fish that spawn at the base of the spillway is anticipated.

Commissioning of Unit 1 is associated with the release of a sediment plume that extends from within the tailrace downstream initially in an easterly and then a north-easterly direction (memo from W. DeWit). This plume does not overlap with locations where Lake Sturgeon are thought to spawn during the construction period (i.e., near the south-east corner of the TRCD and at the base of the spillway channel (i.e., former Gull Rapids)). If Lake Sturgeon are attracted into the tailrace by flows during commissioning, the sediment plume would have dissipated prior to the onset of spawning activity. The sediment plume may overlap with spawning habitat of other species such as Walleye and Northern Pike; however the plume will remain above 5 mg/L above background for only

7 hours after initial operation (memo from W. DeWit). This short term increase in suspended sediments is not expected to adversely affect eggs that may be present. Increases in TSS during the commissioning of Unit 2 are expected to generally remain below 5 mg/L.

Conclusion

The proposed impoundment and commissioning schedule has little potential to increase effects to fish species above those described in the EIS. Effects to fall spawning fish (i.e., Lake Whitefish) are the same whether impoundment occurs in fall (as per the EIS) or in winter (as per the current schedule). Spring spawning species such as Walleye, Northern Pike and Lake Sturgeon will experience a changed environment, but the planned schedule does not result in adverse affects beyond what were discussed in the EIS.

References

Holm, J. and C.L. Hrenchuk. 2019. Adult Lake Sturgeon population monitoring in the future Keeyask reservoir and Stephens Lake, 2018. Keeyask Generation Project Aquatic Effects Monitoring Plan Report #AEMP-2019-05. A report prepared for Manitoba Hydro by North/South Consultants Inc., June 2019. xv + 99 pp.

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Keeyask Hydropower Limited Partnership (KHLP). 2012. Keeyask generation project environmental impact statement aquatic environment supporting volume. Canadian Environmental Assessment Registry Reference Number: 11-03-64144.

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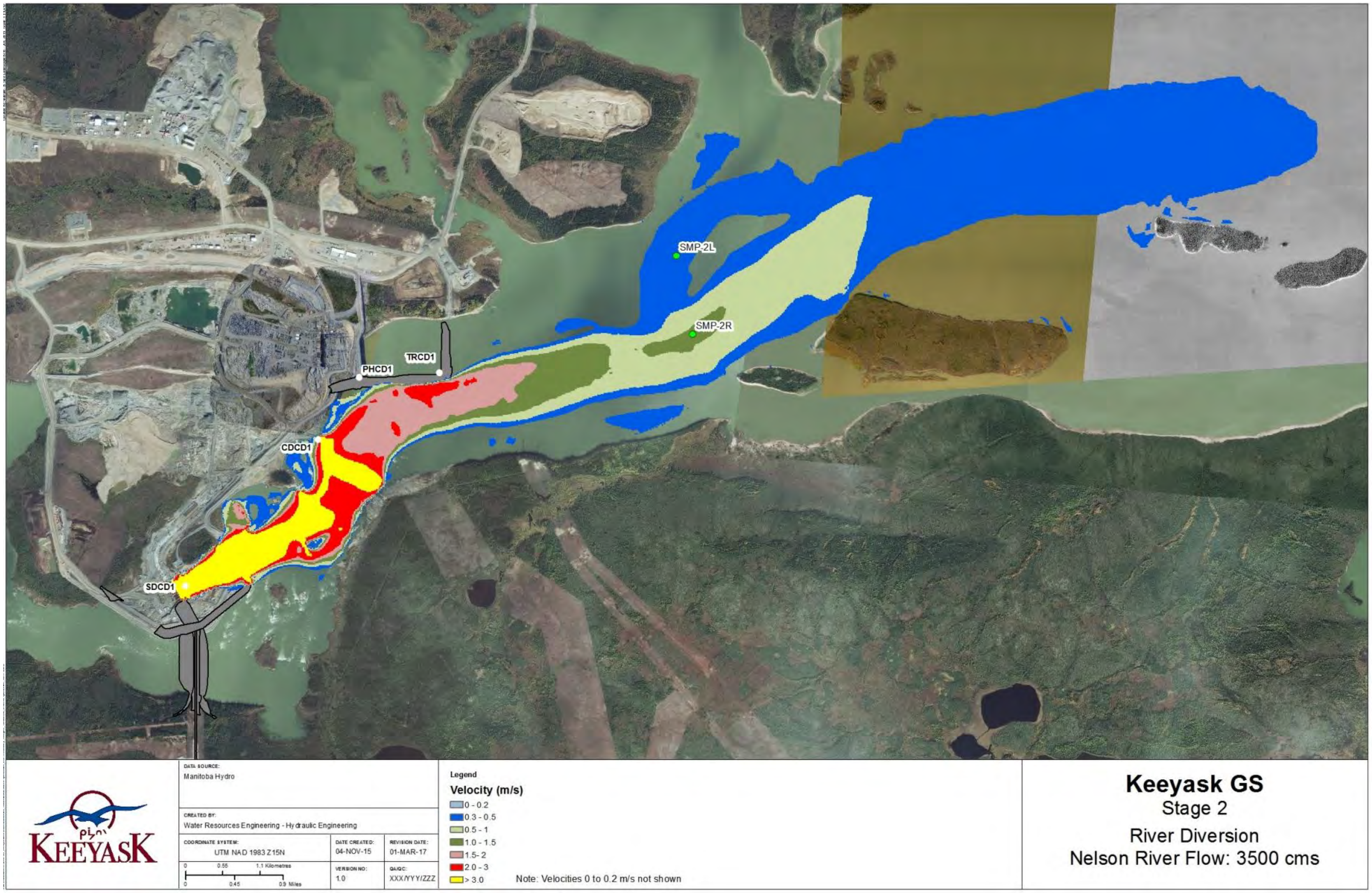


Figure 1: Modeled water velocity downstream of the Keeyask GS construction area during Stage 2 diversion.

Appendix 4

MEMORANDUM

To: Carolyne Northover, Environmental Licensing and Protection Date: October 22, 2019

From: Dr. James Ehnes, ECOSTEM Ltd.

Subject: **Impoundment Timing Effects on Terrestrial Habitat, Ecosystems and Plants**

Background

Predictions regarding the effects of the Keeyask Generation Project (the Project) on the terrestrial environment were provided in the Project's Environmental Impact Statement (the EIS; see Terrestrial Environment Supporting Volume (TE SV); KHLP 2012). The terrestrial assessment had assumed that reservoir impoundment would occur over approximately one or two months in fall, 2019 when the ground was frozen (EIS scenario). The current construction schedule for the Project has reservoir impoundment occurring during the winter of 2020, with water-up behind the cofferdams starting as early as January 3 and full impoundment being achieved as late as April 13, 2020 (current scenario).

This memo evaluates whether any of the predicted Project effects on terrestrial habitat, ecosystems and plants that are contained in the EIS would be changed by the revised impoundment timing.

The primary new information source for this evaluation is a memorandum entitled "Keeyask Generation Project, Review of Potential Physical Effects: Reservoir Impoundment; Removal of Upstream Earth Structures and Tailrace Cofferdam, and; Powerhouse Commissioning" (DeWit 2019), which provides the predicted Project effects on the physical environment due to revised impoundment timing. Additionally, this evaluation assumes that the Project description for how impoundment is carried out does not differ in any material way beyond what is described in DeWit (2019).

Evaluation

The revised impoundment schedule (DeWit 2019) is not expected to alter any of the predicted Project effects on terrestrial habitat, ecosystems and plants. The following provides the explanation for this conclusion.

As described in the terrestrial assessment (TE SV Section 1.3.2), the Project components relevant for the terrestrial habitat, ecosystems and plants assessments include:

1. Physical components that could directly remove or alter terrestrial habitat and/or ecosystems, including effects on wildlife and/or their habitat;
2. Components that could indirectly remove or alter terrestrial habitat and/or ecosystems, including effects on wildlife and/or their habitat;
3. Improved access since it could increase disturbance, mortality or resource harvesting;

4. Conditions that could increase the risk that diseases or invasive species are introduced or further spread; and,
5. Conditions that increase fragmentation or otherwise reduce regional intactness.

As noted above, all of the following conclusions consider that the Project description for how impoundment is carried out does not differ in any material way beyond what is described in DeWit (2019).

Regarding components 1 and 2 above, the predicted spatial extents of all Project impacts during revised impoundment timing (DeWit 2019) remain within the limits assumed for the EIS assessment (see Section 1.5 of the TE SV). As there are no changes to the spatial extents of Project impacts, the predicted direct and indirect Project effects on terrestrial habitat, ecosystems and plants do not change for this influence.

The revised construction schedule shifts reservoir impoundment from the fall (EIS scenario) to following winter (current scenario). This timing change does not alter predicted effects on terrestrial habitat and plants because soils are frozen and plants are not growing in both scenarios.

For components 3 and 4 listed above, the revised impoundment timing is not expected to alter the assumed nature of access since the Project description for how impoundment is carried out does not differ in any material way beyond what is described in DeWit (2019). On this basis, the influences of access on expected Project effects remain the same.

Predicted Project effects on intactness (component 5 above) remain the same since the nature of access (see previous paragraph), habitat loss and habitat alteration are the same as assumed in the EIS.

<u>Literature Cited</u>

KHLP. 2012. Keeyask Generation Project Environmental Impact Statement: Terrestrial Environment Supporting Volume. 1346 pp.

DeWit, W. 2019. Keeyask Generation Project, Review of Potential Physical Effects: Reservoir Impoundment; Removal of Upstream Earth Structures and Tailrace Cofferdam, and; Powerhouse Commissioning. A memorandum prepared for Environmental Licensing & Protection, Manitoba Hydro.

cc: Jodine MacDuff, Keeyask Project Generation & Wholesale
Rachel Boone, Environmental Licensing and Protection

Appendix 5

Date: January 9, 2020

MEMORANDUM

To: Carolyne Northover
Environmental Licensing and Protection, Manitoba Hydro

From: Robert Berger
Wildlife Resource Consulting Services MB Inc.

Re: Review of Impoundment Timing Effects on Mammals in the Keeyask Reservoir

BACKGROUND

As described in the *Keeyask Generation Project Response to EIS Guidelines* (the EIS) and the *Keeyask Generation Project Environmental Impact Statement Terrestrial Supporting Volume* (TE SV), completed in June 2012, the assessment of potential Project effects on caribou, moose, beaver, furbearers, large carnivores, and small mammals (including rare or regionally rare species) was based on reservoir impoundment occurring in fall. In general, predicted Project effects on mammals were:

- Habitat loss, alteration, and fragmentation;
- Project-related disturbances from sensory disturbances (blasting, machinery, traffic, and people) and potential wildlife-vehicle collisions due to increased traffic on the access roads; and
- Access effects from potential increases in predation and harvest.

The current Keeyask Generation Project (the Project) construction schedule has water up of the construction areas beginning as early as January 16 and reservoir impoundment ending as late as April 25, 2020. This memo evaluates whether any of the predicted Project effects described above for mammals would be changed by the current impoundment timing.

The primary sources of new information for this evaluation included “Keeyask Generation Project, Review of Potential Physical Effects: Reservoir Impoundment; Removal of Upstream Earth Structures and Tailrace Cofferdam, and; Powerhouse Commissioning” (DeWit 2019), the 2013, 2016, and 2019 caribou aerial survey monitoring studies that included observations of river crossings (LaPorte et al. 2013; Wildlife Resource Consulting Services MB Inc. [WRCS] 2016; WRCS 2019a), and unpublished Manitoba Sustainable Development (MSD) radio-collaring data for caribou (a joint project with the Fox Lake, Split Lake, and York Factory Resource Management

Boards, with support from Manitoba Hydro). This evaluation assumes that the impoundment process will be substantively similar to that described in the EIS, and the only elements that will differ are described by DeWit (2019).

CARIBOU IN THE KEEYASK REGION

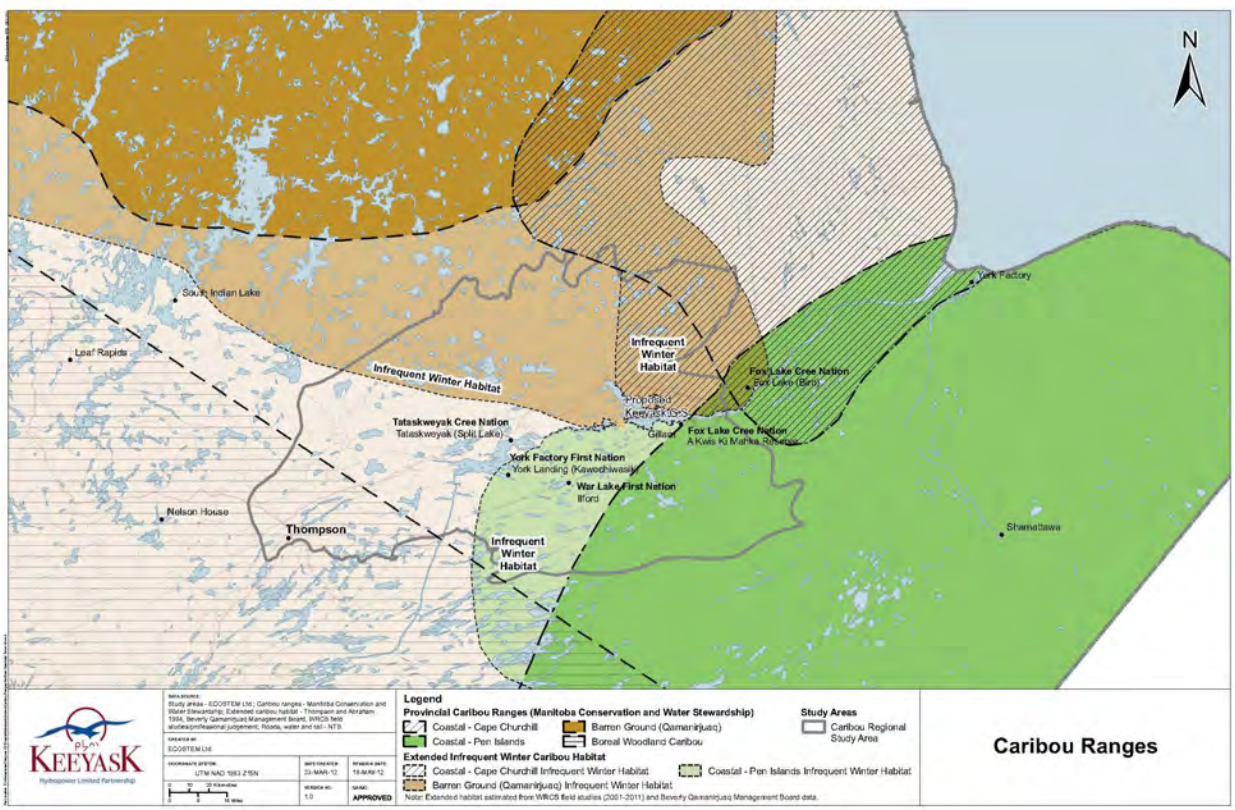
Within the Keeyask Region, caribou are present at different times of the year. Migratory woodland caribou, also known as coastal caribou (i.e., the forest-tundra ecotype) typically show long-distance migratory patterns and calve in groups ("en masse") near the coastline. Two coastal caribou herds may move into the Keeyask Region during their winter migrations. The Pen Islands herd usually moves into the Keeyask Region in winter and moves back up to the coast to calve in the spring. It is unusual for large numbers of coastal caribou from the Cape Churchill herd, which moves south from its calving grounds near Hudson Bay in fall, to reach the Keeyask Region. Forest-tundra caribou have most recently been referred to as the Eastern Migratory population, and the Pen Islands herd is now called the Southern Hudson Bay subpopulation (COSEWIC 2017).

Currently, there are no recognized herds of boreal woodland caribou (i.e., the forest-dwelling ecotype) near the Keeyask site. At one time, Manitoba Sustainable Development (MSD) recognized a subpopulation of Boreal caribou that existed on what was previously referred to as the Nelson-Hayes range; however, it now appears that over time this herd has merged with the coastal Pen Islands population and no longer exists as a discrete population.

Some caribou stay in the Keeyask Region during the spring/summer and calve on islands in Stephens Lake and in surrounding peatland complexes – these animals were referred to as "summer residents" in the EIS. These animals are likely a mixture of some coastal caribou that have changed their calving behavior (as documented by unpublished data from MSD's recent radio-collaring study), and some remnant animals from the Boreal caribou herd that was historically in the area (more than 20 years ago). Movements to calving islands in Stephens and Gull lakes and movements across the Nelson River to peatland complexes on the mainland tend to occur between mid-April and late May. At this time of year, summer resident caribou could either be crossing ice or swimming.

Barren-ground caribou from the Qamanirjuaq herd, which calve in large groups on the tundra in Nunavut, migrate southward in fall and early winter. Very infrequently, the herd moves far enough south into Manitoba that they enter the Keeyask Region. Like coastal caribou, Qamanirjuaq Barren-ground caribou depart for their calving grounds in spring. Map 1 shows the current understanding of caribou ranges in the Keeyask Region.

Caribou can be found in or near the Keeyask Region throughout the year. The Pen Islands coastal caribou herd generally arrives between December and February. Its movements vary annually, and large numbers do not always reach the Keeyask site. The herd typically begins its northward migration to the calving grounds in spring and is gone by early April. Because the Cape Churchill coastal caribou herd rarely reaches the Keeyask Region there is no typical timing of movements. Recent unpublished radio-collaring data (2010–2018) from a program led by MSD indicate that most of the Cape Churchill herd's activity is north of the Nelson River and they do not typically cross the Nelson River to the south, while the majority of the Pen Islands herd's activity is south of the river. Some animals do cross the river, but this is not typical of the entire herd. While the Nelson River generally serves as a physical boundary for both Pen Islands and Cape Churchill caribou in the Keeyask Region, river crossing locations have been observed on the Nelson River and on Gull and Stephens lakes, described in further detail below. Like Cape Churchill coastal caribou, the Qamanirjuaq Barren-ground caribou herd is also uncommon in the Keeyask Region. It migrates southward from the tundra from October to December and typically reaches the forest by November. However, the timing of its movements can vary depending on snow conditions. The Qamanirjuaq herd migrates northward to the calving grounds in spring. Summer residents can be found in or near the Keeyask Region year-round, but some move outside for part of the year.



Map 1: Caribou ranges in the lower Nelson River area

As part of Project monitoring, aerial surveys for caribou were conducted in January or February 2013, 2016, and 2019, when groups of Pen Islands animals were reported to have migrated into the Keeyask Region. Several thousand individuals were counted in 2013 and 2019 (Table 1) and the population estimates were substantially higher than the observations listed (i.e., 13,985 ± 18.17%, 95% CI LaPorte et al. 2013). Although no aerial survey for caribou was conducted in early 2018, there were local reports of large numbers of caribou moving through the Keeyask Region in that year as well, including 911 that were incidentally observed during a moose aerial survey. Some of these caribou had also crossed the Nelson River upstream of the Keeyask site. A relatively large proportion (40%) of the caribou observed in 2013 were north of the Nelson River between Split Lake and the Long Spruce Generating Station. Considerably fewer caribou (< 10%) had crossed the river during subsequent surveys. Caribou crossings observed in the potentially affected area were all upstream of Caribou Island (Appendix 1, Maps 2 and 3). However, caribou could attempt to cross frozen waterbodies or watercourses elsewhere, including downstream of Caribou Island.

Table 1. Observations of migratory caribou in the Keeyask Region during winter aerial surveys in 2013, 2016, and 2019

Year	Number of Groups Observed	Total Number of Caribou Observed	Percentage Observed North of Nelson River
2013	262	4,169	40
2016	13	81	1
2019	280	3,684	8

A review of radio-collared caribou movements from the MSD-led program showed a high degree of variability in movement within and between years from 2010 to 2018 (MSD unpubl. data). Some collared individuals were present in the Keeyask Region in March 2010, January 2011, December 2012, February 2013, December 2013, December 2014 and January 2015. No collared caribou were in the region in winter 2011–2012 and none reached the Keeyask site in the winters of 2013–2014, 2014–2015, and 2016–2017. Radio-collared caribou crossed the Nelson River between Split Lake and the Keewatinohk Converter Station during all seasons. Four migratory caribou crossed upstream of the Keeyask site in mid-February 2013 and a summer resident crossed in March 2015. Summer residents also crossed from late April to mid-May 2015 and from late March to late April 2016, likely to reach their spring calving sites. This represents the minimum number of crossings by radio-collared caribou in winter and spring; greater detail could be provided with GIS-based trajectory path analyses. Generally, radio-collared migratory caribou had left the Keeyask Region by the end of March, but summer residents remained in spring and summer each year. Radio-collared individuals provide an indication of the movements of migratory caribou in the region; however, they are a small fraction of the herd whose greater movements may not be represented adequately.

CURRENT IMPOUNDMENT SCHEDULE AND REVIEW OF POTENTIAL EFFECTS ON MAMMALS

Effects Summary on EIS predictions

- No additional loss, alteration, or fragmentation of habitat for mammals because the Project footprint is unchanged;
- No additional Project-related disturbances from sensory disturbances because water-up and impoundment will occur outside of the sensitive breeding period for caribou and moose, and no effect on potential wildlife-vehicle collisions because there will be no additional traffic;
- No additional access effects because there will be no change to Project infrastructure such as roads and trails;
- Potential changes in ice crossings for caribou during winter impoundment could result in significant population-level mortality from injury, hypothermia and drownings. However, delaying the final stage of impoundment if migratory caribou are present in the region would substantially reduce the risk of this potential effect; and,
- Potential changes in ice crossings for moose during winter impoundment are unlikely to result in changes to the predicted direct and indirect Project effects on the moose population.

Evaluation

Unchanged Potential Effects

Loss, alteration or fragmentation of mammal habitat

The predicted spatial extents of all Project impacts during the current impoundment timing (DeWit 2019) remain within the limits assumed for the EIS assessment (KHLP 2012). As there are no changes to the spatial extents of Project impacts, the predicted direct and indirect Project effects on habitat (ECOSTEM 2019) and mammals do not change for this influence.

Sensory disturbance and vehicle collisions

The predicted extents of all Project impacts during the current impoundment timing (DeWit 2019) remain within the limits assumed for the EIS assessment (KHLP 2012). As there are no changes to the extents of Project impacts (i.e., disturbances will not occur during the sensitive breeding period for caribou and moose), the predicted direct and indirect Project effects of sensory disturbances on mammals do not change for this influence. Similarly, wildlife and vehicle collisions are not expected to change as a result of the new timing schedule.

Access effects

The predicted spatial extents of all Project impacts during the current impoundment timing (DeWit 2019) remain within the limits assumed for the EIS assessment (KHLP 2012). As there are no changes to the spatial extents of Project impacts, the predicted direct and indirect Project effects on habitat (ECOSTEM 2019) and mammals do not change for this influence.

Additional Potential Effects

Potential caribou mortality

No increase in caribou drowning as a direct result of the Project was anticipated when the reservoir was to be impounded in fall (EIS schedule). The current schedule of winter impoundment may result in hazardous ice conditions (see DeWit 2019) for caribou crossing the reservoir and create a higher risk of drowning or death due to injury and/or hypothermia. Some summer resident caribou that occupy the Keeyask Region year-round could be affected, as well as the large numbers of Pen Islands caribou that occasionally migrate through the area in winter. Animals from both groups have been known to cross Gull Lake or the Nelson River upstream of the Keeyask site. Within the future reservoir area Pen Islands caribou arrive from the east and typically cross the river from south to north. The Qamanirjuaq subpopulation of Barren-ground caribou is less commonly found in the region during its winter migration from Nunavut. Large numbers of Qamanirjuaq caribou were last observed in the Keeyask Region in the winter of 2004–2005 (KHLP 2012) and a few individuals crossed the river from north to south. If large-scale caribou mortality were to occur due to caribou trying to cross the river during impoundment, the originally predicted long-term effects of Project operation described in the EIS would no longer apply and would have to be modified. Because Qamanirjuaq caribou occur infrequently in the Keeyask Region, effects of the current impoundment timing are described mainly for Pen Islands and summer resident caribou. However, the same would be expected for Qamanirjuaq caribou if they were to migrate into the region during winter impoundment in early 2020.

During initial water up to the prevailing river level (approximately 153–154 m) in the dewatered work area, open water and slush ice up to 0.2 m deep may develop along the shoreline over frozen ground and on the existing ice along hinge cracks in upstream areas. These effects will be limited given the limited extent of areas affected by this water level increase (DeWit 2019). Caribou that approach these areas may become temporarily or permanently hindered in the slush, increasing the risk of injury and possibly hypothermia. Migratory caribou would only be affected if they are present near the future reservoir area when initial water-up occurs, but summer residents could be affected regardless of the presence of migratory caribou. It is unknown how caribou will react to slush ice along the shorelines; however, animals have most likely encountered these conditions before, considering that the 0.2 m water level increase is within the variability of winter water levels observed near the site during the construction period (DeWit 2019). These conditions may or may not discourage them from attempting to access or cross Gull Lake, especially if full ice cover will be in place upstream of the ice boom up to Birthday Rapids, as expected (DeWit 2019).

Similar effects may be expected upstream of the NCRG during the first stage of impoundment once the level upstream of the spillway is brought to the prevailing water level (155 m). The upstream ice cover will rise with a 0.2 m water level increase (also in the range of winter water levels observed near the site during the construction period) and result in additional flooding, creating areas of slush ice over frozen ground or on the existing ice cover to a depth of approximately 0.2 m, assuming that areas affected during water-up are frozen (DeWit 2019). Because there are no scientific studies of specific ice and water conditions that correlate with any direct (and/or indirect) mortality from injury, hypothermia or drowning, it is not scientifically credible to identify a specific depth of slush ice (or potentially other ice conditions) where or when caribou effects might start to occur. Depth of slush ice or poor ice conditions where effects could occur are likely to depend on the length and width of slush ice areas, flow conditions, weather, the age, sex and nutritional status of individual animals, the behavior of the animals during a crossing attempt, and other additional factors that have not yet been considered. The risks of injury and/or hypothermia are expected to be low during initial water up and the first stage of impoundment; however, because there is a moderate level of uncertainty with the predictions, monitoring is required.

Upstream of Gull Lake, ice conditions will likely be similar to those throughout the Project construction period (DeWit 2019). The current pattern of a shifting and re-forming ice cover is expected to result in the formation of thick, rough ice over the winter (DeWit 2019). Although thick, rough ice is generally not conducive to caribou movements, and this physical state may prevent animals from attempting to cross at these locations, caribou have successfully crossed here in the past under similar conditions. The risks of injury, hypothermia and/or drowning death are expected to be negligible to low in areas upstream of Gull Lake during initial water up and the first stage of impoundment.

During the final stage of impoundment, where water levels are raised on Gull Lake from 155 m to 156 m and then to 159 m in February or March (depending on when water up starts), the timing may overlap the arrival of migratory caribou in the area (which generally occurs between December and February). This could increase the risk of drowning mortality for any caribou present near the future reservoir. In addition to large extents of open water and slush ice along shorelines, which increases the risk of injury, hypothermia and death, impounding the reservoir in winter will also result in thinner and weaker ice re-forming on Gull Lake, and the ability for larger animals to cross the newly formed ice is uncertain (DeWit 2019). Even though caribou are sensitive to crossing thin ice and are good swimmers, the risks of injury, hypothermia and/or drowning death are expected to be high during the final stage of impoundment and could result in the deaths of a few, or up to thousands of caribou here at this time.

Movements of a few (i.e., one to three) summer resident caribou onto calving islands in Gull Lake or across the Nelson River to calving areas between mid-April and late May are unlikely to be affected by impoundment. Impoundment in March should allow for ice to form by mid-April and the melting and/or ice break-up conditions should be typical for mid to late May. It was noted in DeWit (2019), that the formation of ice after impoundment will depend on the start of final impoundment, air temperature, longer days, increased solar radiation and actual weather conditions (e.g., snow cover atop of new ice would slow down ice formation). Based on variables such as ice conditions that coincide with the timing of movements over the ice, there is a moderate level of uncertainty with possible affects to a few summer resident caribou.

Mitigation: Because detailed migration routes of caribou are unpredictable (i.e., highly variable from year to year), reconnaissance aerial surveys for migratory caribou, combined with frequent communications with partner First Nations resource users, will be conducted starting in December 2019 to monitor their migration path and to evaluate the need for mitigation.

There are numerous examples in the literature of obstructions and sensory disturbances causing the deflection of caribou movements. However, the efficacy of such measures as a mitigation approach for the Project is highly uncertain as the obstructions studied typically include linear features such as roads and transmission lines, which are semi-permeable barriers to movements. Long barriers such as above-ground pipelines have been known to deflect, and in some cases, prevent Barren-ground caribou from crossing. Mitigation options that could be applied, if needed, to reduce the risk of caribou injury or drowning include the following measures:

- Delay impoundment - if migratory caribou move through the Keeyask Region in winter 2020, and are still present in the area during the final stage of impoundment (from 155 to 159 m planned for March 21 or later), this last stage could be delayed until caribou move through the region and head back towards their coastal or inland calving habitats east of the Hayes River.[1]
- Physical/auditory measures - temporary barriers along the Nelson River such as slash piles, snow windrows, or snow fencing could be used to impede crossing at Gull Lake and possibly upstream to Birthday Rapids. However, implementing physical barriers in an area as large as the Project's future reservoir area may not be practicable, given that river crossing locations change from year to year. Periodic noises such as sirens or horns may repel some caribou from the river. The efficacy of hazing (i.e., potentially including the use of aircraft or vehicles) or barrier measures to direct caribou away

[1] Delaying impoundment may conflict with effects on birds (WRCS 2019b)

from the impoundment area is highly uncertain and may not be supported by Provincial wildlife managers and/or the Keeyask Hydropower Limited Partnership.

Conclusion: Hazardous ice conditions on Gull Lake and possibly upstream towards Birthday Rapids will increase the risk of injury, hypothermia and/or drowning mortality if any caribou attempt to cross the Nelson River at these locations. The potential effects should be small during water-up, but because there is a moderate degree of uncertainty with these predictions, monitoring ice conditions in the reservoir along with the presence/absence of caribou in the Keeyask region is required. The potential effects during the final stage of impoundment could be large and significant for large numbers of migratory caribou, should they migrate into the Keeyask Region in early 2020 and remain during this time, and are negligible to low for the few summer resident caribou that attempt to reach calving grounds upstream of Keeyask in spring. Beyond delaying impoundment until caribou have left the area, the efficacy of other potential mitigation measures to impede river crossings by caribou is highly uncertain and may not be practicable. No change in the EIS predictions is anticipated if caribou are not present near the future reservoir area at the time of impoundment, if they do not attempt to cross hazardous ice in winter and early spring 2020, or if impoundment is delayed until migratory caribou have moved out of the Keeyask Region.

Potential moose mortality

During initial water-up to the prevailing river level (approximately 153–154 m) in the dewatered work area, open water and slush ice up to 0.2 m deep may develop along the shoreline over frozen ground and on the existing ice along hinge cracks in upstream areas. These effects will be limited given the limited extent of areas affected by this water level increase (DeWit 2019). Moose that approach the formerly dewatered area may be slowed by the slush, increasing the risk of injury and hypothermia. It is unknown how moose will react to slush ice at the shorelines; these conditions may or may not discourage them from attempting to access Gull Lake or from walking along the shorelines, especially if full ice cover will be in place upstream of the ice boom up to Birthday Rapids, as expected (DeWit 2019).

Similar effects may be expected once the level upstream of the spillway is brought to the prevailing level (155 m), when the upstream ice cover will rise with the changing water level and result in additional flooding, creating areas of slush over frozen ground or on the existing ice cover to a depth of approximately 0.2 m, assuming areas affected during water-up are frozen (DeWit 2019). The risk of injury and hypothermia is expected to be relatively small, but with a moderate level of uncertainty associated with this prediction.

Upstream of Gull Lake, ice conditions will likely be similar to those throughout the Project construction period (DeWit 2019). The current pattern of a shifting and re-forming ice cover is expected to result in the formation of thick, rough ice over the winter (DeWit 2019), which may or may not discourage moose from attempting to cross.

Increasing water levels on Gull Lake to 155 m to 156 m and then to 159 m in winter could increase the risk of drowning mortality. In addition to open water and slush ice along shorelines, impounding the reservoir in winter will result in thinner and weaker ice re-forming on Gull Lake, and the ability for larger animals to eventually cross the newly formed ice is uncertain (DeWit 2019). Even though moose can extract themselves after breaking through ice, the potential mortality risk from injury, hypothermia and/or drowning is high if animals attempt to cross reservoir conditions such as these.

Moose occupy the Keeyask Region year-round; it is unknown if their movements typically include crossing Gull Lake in winter. Moose tend to inhabit forested areas in winter but occasionally move to shorelines to feed on willow and other shrubs. The number of moose potentially affected by winter impoundment is uncertain but will likely be limited to only a few individuals whose home ranges overlap Gull Lake.

Mitigation: Options that could be applied to reduce the chances of moose injury or drownings include the following measure:

- Temporary barriers proposed for caribou could also reduce the risk of moose drownings. However, implementing physical barriers in an area as large as the future reservoir area may not be practicable, and the efficacy is highly uncertain.

Conclusion: Ice conditions on Gull Lake and possibly upstream during winter impoundment could increase the risk of moose drowning mortality and death due to injury and hypothermia. The efficacy of measures that may be used to impede ice crossings by moose is moderately uncertain. Because relatively few individuals in the regional moose population are expected to be affected however, the predicted direct and indirect Project effects in the EIS are unlikely to change.

SUMMARY AND CONCLUSIONS

Potential Effect on EIS Predictions	Mitigation	Conclusion
Loss, alteration, or fragmentation of mammal habitat	None required.	No change in direct or indirect project effects predicted in EIS.
Sensory disturbances	None required.	No change in direct or indirect project effects predicted in EIS.
Access effects	None required.	No change in direct or indirect project effects predicted in EIS.
Changes in ice crossings for caribou	Delaying the final stage of impoundment (155-159) if caribou reach the Keeyask Region in early 2020 when impoundment is planned. Temporary barriers or hazing to impede crossing at Gull Lake and possibly upstream to Birthday Rapids. However, these practices may not be practicable or effective and are unlikely to be accepted by Provincial wildlife managers and/or the Keeyask Hydropower Limited Partnership.	Increased risk of caribou injury, hypothermia or drowning could be significant at the population level for migratory caribou and negligible to low for a few summer resident caribou during the final stage of impoundment. Potential effects could be reduced to negligible with delaying the timing of impoundment if migratory caribou are present in the Keeyask Region. It is highly uncertain as to what extent barriers or hazing would have on reducing the risk of injury or drownings.
Changes in ice crossings for moose	Temporary barriers to impede crossing, as noted above.	Increased risk of moose injury, hypothermia or drowning is unlikely to be measurable at the population level. Potential effects of individual drownings could be reduced with barriers or hazing, but it is unclear to what extent the risk would be reduced.

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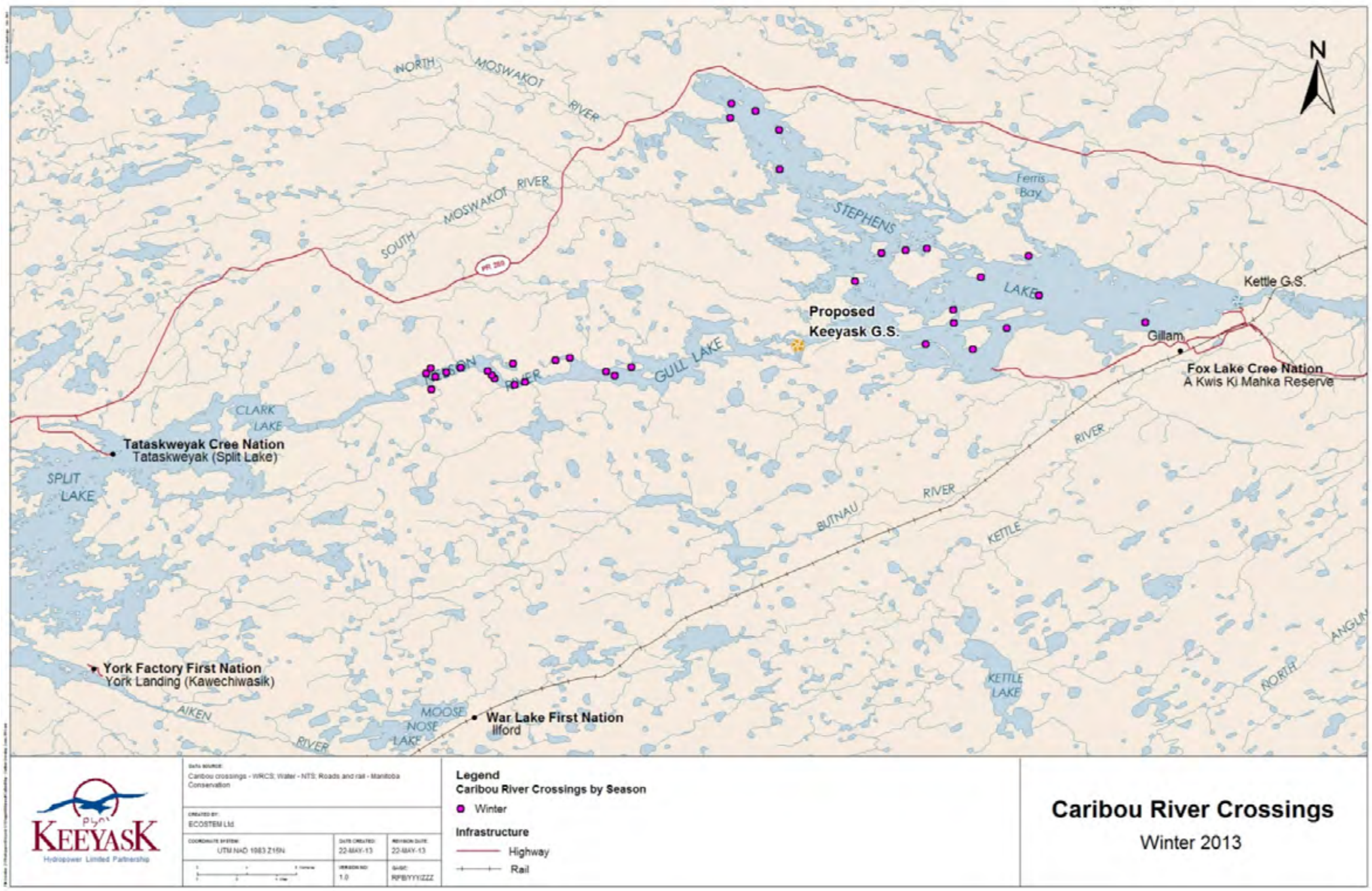
Appendix 1 - Caribou crossing sites (2013 and 2019)



Map 2. **Caribou Ice Crossing Sites, January and February 2013**

Map 3. **Caribou Ice Crossing Sites, February 2019**

Appendix 6

Draft for Discussion

Monitoring Plan for Impoundment – Water Levels, Ice Conditions and Sedimentation

Aerial Surveys of Landscape Conditions

KCN members have suggested that there is benefit in MH and ATK staff undertaking an aerial survey of the Keeyask area before, during and after impoundment. In early January efforts will get underway to plan the aerial survey for the before period. This survey will likely occur mid to late January.

Helicopter capacity is limited to 3 to 4 passengers (depending on helicopter) at a time. Multiple trips will be required to ensure all communities have a chance to have their ATK staff participate. One MH representative will participate in each flight to talk with community members about where the changes will occur and where monitoring equipment is located.

Water-up Monitoring

The current planned schedule for monitoring under the Physical Environment program before and during impoundment is as follows:

- December 17 and 19 – install cameras on Nelson River and Caribou Island (Gull Lake), possibly maintain water level gauge.
- Jan 14-17 – Installation or winter turbidity equipment and water sampling/water level gauge maintenance.
- Feb 10-14 – maintain winter turbidity equipment and water sampling/water level gauge maintenance.

Community Participation Opportunities

There will be capacity to have one additional passenger during each trip for routine maintenance work. Efforts will be made to ensure an ATK rep from each community has a chance to participate. The passenger may be required to spend extended time at a site.

Note, all water level gauges in the Keeyask area have been put on high level status. If a gauge goes down (poor data) efforts will be made to restore the gauge within 3 days (conditions permitting). If a trip is required, there could be the potential for 1 passenger to join the crew on a day's notice.

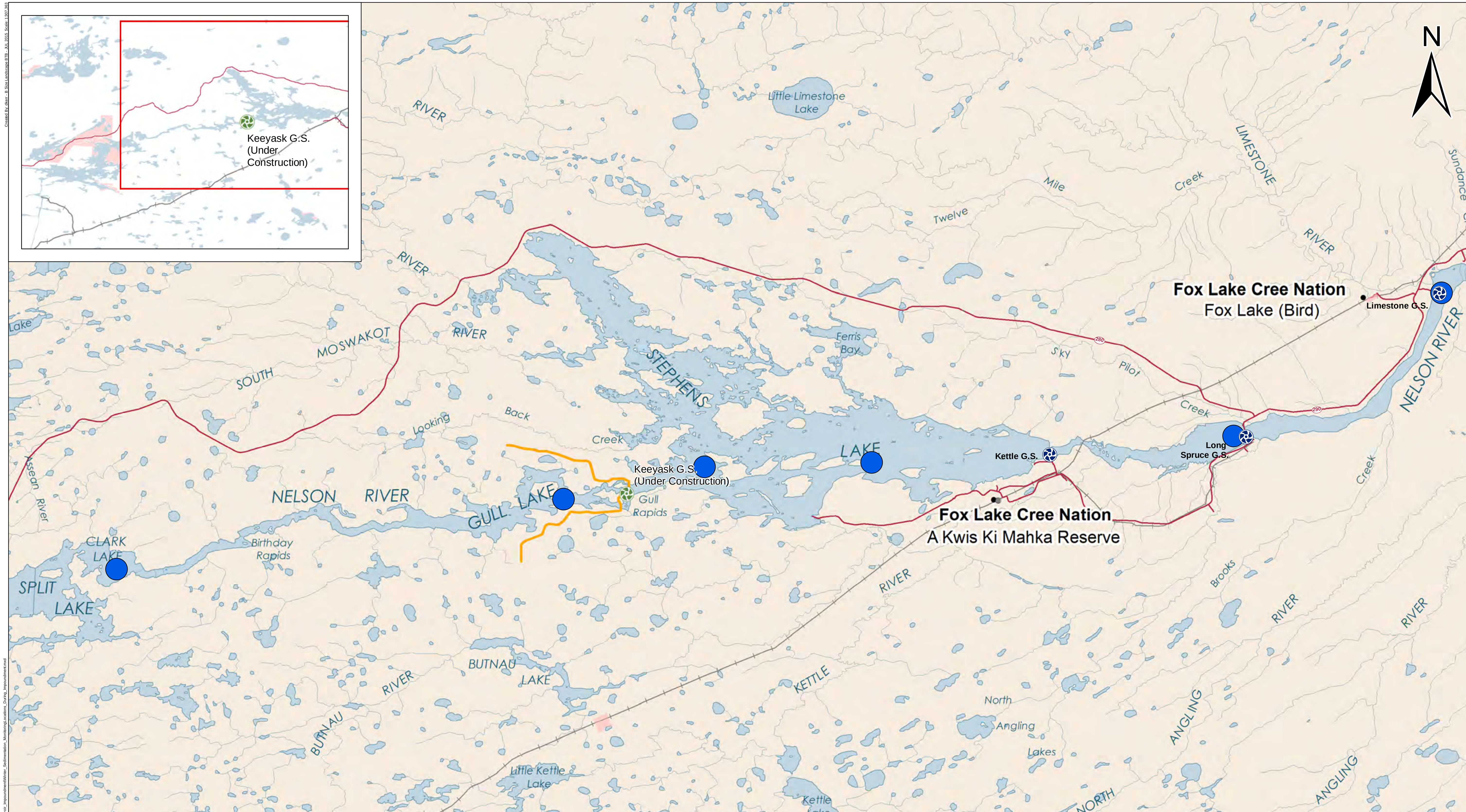
Impoundment Monitoring (March – exact timing TBD)

During the final impoundment (approx. 10 days), a MH crew will be at Keeyask and likely doing daily trips to monitor/photograph ice conditions and maintain water level gauges as necessary.

Data from turbidity stations at Clark Lake, Gull Lake, Stephens Lake, Long Spruce forebay and Limestone Generating Station (See attached map) will be monitored and sites visited as required to maintain the equipment if conditions permit (weather or poor ice conditions can limit access to the sites).

Community Participation Opportunities

The goal is to maximize the opportunities for ATK staff to participate in this monitoring. Efforts will be made to ensure all communities are provided an opportunity to participate and share observations in the field.



KEEYASK

DATA SOURCE:
Company, Source, Etc.

CREATED BY:
Department - Section

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	DD-MMM-YY	10-DEC-19
0 3.5 7 Kilometres / 0 3 6 Miles	VERSION NO: 1.0	QA/QC: XXX/YYY/ZZZ

Legend

- Monitoring Locations
- Keeyask Principal Structures
- Access Road
- Access Road

NOTE: Exact locations for monitoring sites may vary depending on ice conditions at the time of installation.

Impoundment

Winter Sedimentation

Monitoring Locations

Appendix 7

DRAFT for Discussion

Monitoring Plan for Impoundment - Caribou

Keeyask Caribou Coordination Committee (KCCC) Communication Network:

Starting in December, the Keeyask partner First Nations will be documenting observations made on the land by community members on where caribou are in the Keeyask region, the numbers being observed, and the direction caribou are travelling (where possible). Within each partner community, there will be a main point of contact established, who will share information with the Chair of the Keeyask Caribou Coordination Committee (KCCC), a sub-committee of the Keeyask Monitoring Advisory Committee (MAC).

Partner First Nations – Aboriginal Traditional Knowledge (ATK) Monitoring Plans:

Each of the partner First Nations (TCN, FLCN, YFFN and WLFN) has ATK monitoring programs in place to monitor a range of topics of importance to them.

Terrestrial Effects Monitoring Plan (TEMP):

If caribou are present in the Keeyask region in January, prior to water up beginning, reconnaissance aerial surveys for caribou will be carried out in the Keeyask Region. Information received from partner First Nations and the Province will be used to determine when aerial surveys should begin. If caribou remain in the area when water up begins (currently planned for Feb. 1), aerial surveys will continue as required to monitor where caribou are within the region throughout the months of February and March, for as long as caribou remain in the region. Participation in the aerial surveys by ATK Monitoring staff and the Province is planned.

There may also be on-the-ground surveys carried out around the reservoir perimeter during the final stage of impoundment, or in early April following impoundment, if deemed safe. Opportunities will be available to ATK staff to participate in the ground surveys.

Trail cameras and ground transects will be set up on potential calving islands in Gull Lake in early April, as part of planned TEMP fieldwork (part of the Summer Resident Caribou Sensory Disturbance study). This field study involves numerous partner First Nation community members, and will also help monitor if caribou are able to travel out to calving islands safely in late April/early March.

Observations at the Keeyask Site:

The Keeyask Site Liaison Team will document any observations made of caribou presence within the Keeyask site, including by MH staff and contractors.

Compilation of All Monitoring Information:

All caribou monitoring information collected on behalf of the Partnership, as outlined above, will be compiled by Manitoba Hydro's Environmental Licensing & Protection Department and shared with the

MAC/KCCC members and key Project staff on a weekly basis. This weekly monitoring summary will also be shared with Vicki Trim (Caribou Biologist with the NE Region, Manitoba Agriculture and Natural Resources) and Andrew Szklaruk (Gillam Conservation Officer, Manitoba Agriculture and Natural Resources).

The KCCC will meet in Thompson at the end of January, prior to the beginning of water-up and impoundment, to allow the Partnership to review winter observations of caribou in the Keeyask region up to that point, including information gathered through the KCCC caribou monitoring network, ATK monitoring activities, technical science monitoring activities, and the Province's wildlife staff. The Province's Wildlife Branch will also be invited to attend this meeting.

Another KCCC meeting will occur in mid-March, prior to the final stage of impoundment occurring, so the Partnership can again review and discuss the most recent status of caribou in the Keeyask region. Based on the caribou distribution within the Keeyask region at this time, a decision will be made on whether the final stage of impoundment can proceed as planned, or whether it needs to be delayed to avoid a potential impact to caribou. Representation from the Project's Senior Leadership Team at this meeting will allow a decision to be made on how impoundment is to proceed. The Province's Wildlife Branch will also be invited to attend this meeting.

A high-level summary of the caribou monitoring information collected (i.e., not including detailed information on where caribou are located, or the numbers, but rather whether caribou are still present within the Keeyask region) will also be produced for inclusion in the Project's broader impoundment communication plan that will be shared with partner First Nations on a weekly basis during water up and impoundment, along with updates on construction activities and water level and ice condition monitoring. These weekly communications will also be posted on Keeyask.com.