Keeyask Generation Project

Environmental Impact Statement

Responses to Requests for Additional Information from TAC & Public Reviewers, Round 3

Keeyask Hydropower Limited Partnership

August 2013

Keeyask Hydropower Limited Partnership

2013 08 23

Ms. Tracey Braun
Environmental Assessment & Licensing Branch
Manitoba Conservation and Water Stewardship
Suite 160 – 123 Main Street
Winnipeg, MB R3C 1A5

Dear Ms. Braun:

Re: RESPONSES TO THIRD ROUND OF SUPPLEMENTAL INFORMATION REQUESTS REGARDING THE KEEYASK GENERATION PROJECT

The Keeyask Hydropower Limited Partnership submitted the Keeyask Generation Project Environmental Impact Statement on July 6, 2012. Subsequent to this submission, Manitoba Conservation and Water Stewardship invited comments from the public and Manitoba government departments, and the Canadian Environmental Assessment Agency coordinated comments from the federal review team. From these comments, and in a manner consistent with the Canada-Manitoba Agreement on Environmental Assessment Coordination, Manitoba Conservation and Water Stewardship provided the Partnership with the first round of requests for additional information on September 26, 2012 and October 5, 2012. On November 19, 2012, the Partnership provided a formal response to Requests for Additional Information from Manitoba Conservation and Water Stewardship, which had considered comments received from Manitoba government departments, the federal review team and the public.

A second round of requests was received from the Canadian Environmental Assessment Agency on December 28, 2012 and on January 29 and 30, 2013, Manitoba Conservation and Water Stewardship also provided additional requests to the Partnership. A formal response to these requests was provided on April 26, 2013, with the exception of six requests. The response to CEAA-0009 and CEAA-0015 was provided on July 2nd. The response to CEAA-0014, EC-0026, EC-0027 and EC-0031 was provided on July 12, 2013.

On June 10, 2013, a third round of requests was received and the Partnership is pleased to respond. Our responses are contained in the attached binder titled *Responses to Requests for Additional Information from TAC and Public Reviewers, Round 3*.

Also included with this filing is:

- Errata: Errata and related corrections from the July 2012 Keeyask Generation Project EIS Project. This errata is further to the list submitted April 26, 2013.

Should you have any questions or require additional assistance, please feel free to contact Vicky Cole at (204) 360-4621.

Yours truly,

5900345 Manitoba Ltd.
as general partner of the
Keeyask Hydropower Limited Partnership

for K.R.F. Adams

K.R.F. Adams, P. Eng
President

Enclosure
c: Ms. Shauna Sigurdson

Requests for Additional Information - Federal Reviewers

Comment Number	Department	Volume / Document	Section	Page	Topic	Preamble (e.g. provide applicable background/rationale for providing the comment)	TAC Rd 1 Question	TAC Rd 2 Follow-up/New Question	TAC Rd 3 Follow-up/New Question	Proponent Response
Department of Fisheries and Oceans										
1	DFO	AE SV	Section 3.3.2.3.1	3-15	Aquatic Environment	"Biological components of the aquatic habitat were based on the period during which field studies conducted in the area, generally between 1997 and 2006. This period included both high and low flows, and therefore would indicate interannual variability related to flows."	Detailed background reports to support statements regarding interannaul variability have not been provided in the EIS. These should be made available for review.	Requested reports not provided.	Would the Proponent please provide a summary of the quantity, type, and sensitivity of aquatic habitat to be directly and indirectly impacted by construction and operation of the GS and associated infrastructure, and the expected changes to these habitats? In addition, would the Proponent please provide a summary of the quantity, type, and quality of measures to offset fish habitat impacts? DFO knows that the Proponent has started on this in its Fish Habitat Compensation Plan - presently under discussion and scheduled for release by end of June 2013. Description of the hydraulic zone of influence/aquatic habitat study areas may be the best approach to meeting this need including reasons for subdivisions, areas, and habitat quality changes. Pre-Project versus construction phases versus Post-Project operational ranges in habitat e.g., as 5th to 95th percentiles should meet assessment needs. Despite detailed review of information provided to date, DFO is not able to find this information in a clearly summarized form. To reduce uncertainty in making an EA determination, clear quantification of habitat, how it will change, and residual habitat quantity after mitigation is applied is required. DFO needs to look at changes, impacts and mitigation - upstream of the station, at the station, and downstream of the station – as they will occur over time.	**see TAC Rd 3 DFO-0001**
2	DFO	AE SV	Section 3.3.1 Section 3.3.2	3-11 3-12	Aquatic Environment	"No analysis of trends in aquatic habitat was conducted, since the water regime was established in 1977 and has been operated within set bounds since that time."	However, has aquatic habitat and changes in fish stocks changed since 1977, despite apparent constancy in water regime? Moreover, habitat changes were not actually assessed to support this claim. Can the existing environment be adequately portrayed if not assessed/sampled? This also does not account for natural changes in habitat with flow events outside of regulation. For example, a flow/ice event approximately 10 years ago changed the flow patterns at Gull Rapids, creating a new channel that flows northeast to Stephens Lake. Please consider the entire period of record for analyses.	No additional information provided.	Please see DFO-0001. While pre-CRD conditions may not be quantifiable, qualitative descriptions of areas in the hydraulic zone of influence/aquatic impact study area can perhaps be summarized	**see TAC Rd 3 DFO-0002**

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3	DFO	AE SV	Map 3A-3	N/A	Aquatic Environment	"Substrate composition could not be determined immediately upstream, within, or downstream of rapid sections due to safety concerns. "	Please define "immediately". Substrate composition be should be confirmed in the dewatered areas in Gull Rapids prior to any construction. Resolution should be similar to that already conducted in the vicinity of Gull Rapids. This information is crucial for proper accounting of habitat destruction in the rapids.	Physical area "immediately" downstream of Gull Rapids is not defined.	Please see DFO-0001. While habitat and substrate conditions in the rapids cannot be determined pre-project due to unsafe working conditions (fast water), they could be described as these areas (or parts of them) might be safely worked on as they become isolated and dewatered during construction. The information might be used to describe more accurate impacts, to make more accurate predictions, and to design offsetting measures for lost habitat. This would contribute to DFO's making a determination with more confidence. Can the proponent provide additional information about how this might be carried out and if they would be willing to incorporate this into their habitat inventory and mitigation planning?	**see TAC Rd 3 DFO-0003**
4	DFO	AE SV	Section 3.3.2.3.1	3-15	Aquatic Environment	"For the purposes of predicting habitat conditions in the post-Project environment and quantifying areal changes in habitat area between the pre and post-Project environments, conditions at 95th percentile flow (pre-Project) and full supply level (FSL) in the reservoir post-Project were used. "	This analysis is incomplete. While the 95th percentile accommodates the majority of flows, changes in fish habitat at lower flows are not shown and may be more crucial. Moreover, the 95th percentile flow will be relatively uncommon. The 50th percentile would represent a more normal flow condition and changes in this habitat are not presented. Please provide the results of this analysis which includes the 5th and 50th percentile flows.	Results of percentile flows not provided. As further clarification to the proponent, request pertains to the period of record.	Would the Proponent please summarize the present flow environment throughout the project area, variation in flow (e.g., 5th and 95th percentiles), how it will change, and the anticipated effects on fish and fish habitat including: 1. the magnitude of monthly flows; 2. the magnitude and duration of annual extreme water conditions (such as annual minimums and maximums for 1, 3, 7.30, and 90 day durations); 3. the timing of annual extreme water conditions; 4. the frequency and duration of high and low pulses in flow; 5. the rate and frequency of water condition changes (especially within day changes) Please note that while this is related to DFO-0001, it should be maintained as a separate item.	**see TAC Rd 3 DFO-0004**
7	DFO	AE SV	Appendix 3A	N/A	Aquatic Environment	Depth Zones Section	In reviewing methods for aquatic habitat assessment in Appendix 3A, while the bathymetric surveying was very detailed, the validation of sonar data does not appear to be structured and repeated such that there is statistical confidence in the results obtained. There in no description of a comparison between the results expected and results observed and therefore the fidelity of the observations. Can the proponent present this sensitivity analysis or point the reviewer to the report which document this? Alternatively, can a study be proposed to test repeatability of bathymetric data collection (test areas beyond the survey area could be tested in the upcoming field season)?	Question may not have been clear. Was direct substrate sampling conducted for each point of sonar data? If not, for areas modelled or extrapolated, how was "modelled" substrate confirmed. Areas of high habitat value are important, but its unclear how this would be known a priori (that is, before sampling)?	Please see DFO-0001. In general, information, such as substrate, is presented in the EIS as if it is known with complete confidence. To reduce uncertainty in decision making, the precision of the estimates, such as 95% confidence intervals or corresponding percentiles should be considered. For example, a tabled estimate of cobble/gravel based on sampling or modelling should qualify the point estimate with something like a confidence interval. While information on substate is valuable it should be presented in the context of its value as fish habitat.	**see TAC Rd 3 DFO-0007**

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14	DFO	AE SV	Section 3.4.2.2.3	3-34 3-36	Aquatic Environment		Depositional areas and changes described on pages 3-34 to 3-36, but does not talk about changes to specific habitats. Please provide details on how, specifically, proposed deposition will impact fish habitats and how this will be monitored.	HADD description and accounting as requested was not provided.	Please see DFO-0001. Where possible, an idea of the state of the aquatic habitat at completion of construction and how it might develop over time to the year 30 state would reduce uncertainty in making decisions. For this question, change in substrate types needs to be cross-referenced to expected value as fish habitat and for fishing. DFO notes the proponent's direction to the AE SV regarding spawning of walleye and whitefish and rearing of sturgeon - also for deposition on plants and benthic invertebrates. However, overall changes and impacts need to be cross-referenced as effects on quantity, type, and quality of fish habitat and fishing. In addition, mitigation, residual effects, and offsetting measures need to be quantified.	**see TAC Rd 3 DFO-0014**
24	DFO	AE SV	Appendix 6D	N/A	Aquatic Environment	Appendix 6D	Please present Habitat Units (HU's) for all tables in section 6D.	Requested HU's not provided.	Please see DFO-0001. The primary interest is to describe the quantity, type and sensitivity of aquatic habitat in the hydraulic zone of influence/aquatic study area. Very specific habitat suitability analyses may then be used to augment the assessment of area impacts. However, HSI bins should likely reflect actual areas not WUA or HUs that fall within the composite suitability bins.	**see TAC Rd 3 DFO-0024**
25	DFO	AE SV	Section 6.0	N/A	Aquatic Environment	Chapter 6	For all HSI maps, outline of existing environment (the shorelines of the Nelson River and Stephens Lake) should be shown in the post project environment maps. The additional aquatic area gained by creation of the forebay should be illustrated and given a suitability of 0, recognizing that this is terrestrial habitat that will undergo substantial change before it becomes productive aquatic habitat (EIS suggests at least 5 years). Please provide revised maps showing these changes.	Revised maps not provided.	Please see DFO-0001	**see TAC Rd 3 DFO-0025**
26	DFO	AE SV	Appendix 1A	N/A	Aquatic Environment	Maps 6-48, 6-49	Unclear as to how sand/gravel habitat will be created post project in the forebay, particularly in years 1-5. Does this include compensatory measures proposed in Appendix 1A? Please provide detailed information/model which demonstrates the creation of sand post project.	Requested details on sand habitat creation not provided.	Please see DFO-0001	**see TAC Rd 3 DFO-0026**

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33	DFO	AE SV	Section 6.3.2.7.2	6-27	Aquatic Environment	Fish Movements – Importance of Movements.	Acoustic and telemetry tagging clearly show movement of Lake sturgeon through Gull Rapids. However, due to the limited number of telemetry data, conclusions on habitat use and the types of migration (e.g. spawning) are not practical. Please provide detailed reports showing movement.	Detailed reports not provided	Would the Proponent please summarize its present information on passage or migration, expected impacts, and measures to offset impacts? DFO needs a clear understanding of expected passage or migration impacts. DFO would appreciate seeing the Proponent's 2012 data movement analysis report. In addition, an Aquatic Effects Monitoring Plan (AEMP) - referred to by the proponent as providing additional movement information, is presently under discussion and is scheduled for public release by the Proponent in the second quarter of 2013. DFO would like to ensure that fish movements are understood, that impacts on movements are understood, mitigated to the extent practical, that residual impacts are known, and that monitoring will clarify uncertainty for adaptive management . DFO believes that the proponent has provided information but is uncertain about the degree to which the provided information is complete. DFO would like the proponent to ensure that all pertinent information has been provided to reduce uncertainty in decision making.	**see TAC Rd 3 DFO-0033**
43	DFO	AE SV	Section 6.4.2.2.2	6-37	Aquatic Environment	"The majority of the lake sturgeon captured in the Long Spruce and Limestone reservoirs are taken in the upper end of the reservoirs where conditions are more characteristic of riverine habitat (NSC 2012). These observations suggest that, while the amount of usable foraging habitat (i.e., WUA) upstream of the Keeyask GS will be higher in the post-Project environment, not all this habitat may be selected by either sub-adult or adult fish."	This suggests that post the project environment WUA for these life stages may need to be modified using this system specific observations. Please consider these changes in the WUA tables and discuss this in the EIS.	WUA, in practice, is the combination of suitabilities.	Please see DFO-0001	**see TAC Rd 3 DFO-0043**
44	DFO	AE SV	Section 6.4.2.3.1	6-40	Aquatic Environment	"To compensate for the loss of spawning habitat, several areas will be developed to provide suitable spawning habit"	All proposed compensation works should have relevant suitability curves applied and commensurate WUA and HU's calculated.	DFO will require confirmation that methods/analysis for delineation of HADD's are commensurate with the proposed compensation (i.e. HSI or area based descriptions).	Please see DFO-0001	**see TAC Rd 23DFO-0044**
45	DFO	AE SV	Section 6.4.2.3.1	6-41	Aquatic Environment	"Lake sturgeon could also use habitat in the river below the spillway in years when the spillway is operating at sufficient discharges during the spawning and egg incubation period"	Please provide details on performance/success of lake sturgeon spawning habitat use and successful hatch from similar structures developed at the Grand Rapids and Limestone GS's.	Experimental spawning habitat has been developed at Point du Bois generating station. Please provide the results.	Please see DFO-0001	**see TAC Rd 2 DFO-0045**
47	DFO	AE SV	Section 6.4.2.3.1	6-41	Aquatic Environment	"Because the number of lake sturgeon residing downstream of Gull Rapids is considerably reduced compared to historic levels, a stocking program will be implemented to avoid possible effects of a temporary reduction in rearing habitat should it occur"	Given the loss of known high quality YOY habitat north of Caribou Island (future forebay), the known YOY rearing habitat below Gull Rapids must be protected. What measures will be taken to ensure that this habitat will not change, both during construction and operation?	The EIS describes, at best an expected small change in habitat composition at this location. At worst, predictions may be wrong and this critical habitat is lost.	Please see DFO-0001	**see TAC Rd 3 DFO-0047**

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48	DFO	AE SV	Section 6.4.2.3.2	6-43	Aquatic Environment	"The phased approach to fish passage.....will permit trial implementation of fish passage for lake sturgeon with minimal risk to the Stephens Lake population."	The stated risk to the Stephens Lake sturgeon population is not identified. Note, the proponent has been requested to investigate the cost/benefits of various fish passage designs, including cost, environmental cost/benefit, etc. The proponent has retained a consultant for this investigation, which has produced a preliminary report on this comparison. The detailed results of this report should be made available in the EIS for review.	A detailed report on options and/or an agreement on post-project fish movement/behaviour have not been provided and/or concluded.	Please see DFO-0033	**see TAC Rd 3 DFO-0048**
49	DFO	AE SV	Section 6.4.2.3.2	6-43	Aquatic Environment	"The phased approach to fish passage.....will permit trial implementation of fish passage for lake sturgeon with minimal risk to the Stephens Lake population."	Trap and truck was identified as the fish passage option for Keeyask, this method has traditionally been used at high head dams and information behind the rational for the selection of this option would be helpful. What criteria will be used to determine if and when trap and truck should be implemented?	While DFO has been provided a summary report on November 29th, 2012, this report has not (to DFO's knowledge) been made available to the federal review team or the public. Moreover, release of the full report on fish passage options at Keeyask would be ideal.	Please see DFO-0033	**see TAC Rd 3 DFO-0049**
51	DFO	AE SV	Section 6.4.2.3.2	6-43	Aquatic Environment	"There is no information available on turbine mortality rates for sturgeon. "	Mortality rate for sturgeon should be based on: 1) known mortality for species of a similar size (e.g. pike) for both spillway and turbine and 2) the number of individuals passing the turbines can be calculated based on fish passage studies (e.g. Missi Falls) and a commensurate relative abundance estimates.	Unclear as to why northern pike cannot be used as a surrogate for lake sturgeon - please clarify. Are mortality rates available for white sturgeon for comparable turbine designs?	Would the Proponent please summarize its present information on expected sources and estimates of fish mortality from passage of fish through the Keeyask turbines and spillway? DFO needs a clear understanding of expected sources and estimates of fish mortality. DFO notes that Table 2 on page 1A-81 AE SV does not include anticipated physical and hydraulic characteristics for the proposed Keeyask turbines - can this be provided? The turbine design description gives an anticipated survival rate for fish up to 500 mm as over 90%. However, Table 1 on page 1A-101 indicates that pike, walleye, and sturgeon larger than 500 mm could pass the trash racks and go through the turbines. What are the survival rates anticipated for fish greater than 500 mm up to the maximum expected sizes estimated to be? Can survival estimates be made for whitefish? Although a population model for sturgeon, estimating the population trajectory, is given with anticipated effects for general changes in survival, this is not related to the estimated additional mortality the population might experience from turbine passage. Given the proponent's knowledge of sturgeon population structure and movements through the rapids can this information be provided? Information is only provided for sturgeon - can it be provided for other VEC species. Can it be assumed that eggs, larvae, smaller life stages, and small bodied forage species passing downstream will not be significantly affected? Little or no information has been provided for spillway characteristics and potential impacts - can the proponent describe anticipated impacts for downstream passage at the spillway? In addition, an Aquatic Effects Monitoring Plan (AEMP) - referred to by the proponent as providing additional information, is presently under discussion and is scheduled for public release by the Proponent in the second quarter of 2013.	**see TAC Rd 3 DFO-0051**

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54	DFO	AE SV	Appendix 6B.1	6B-1	Aquatic Environment	Appendix 6B Field Data Collection and Analysis	Details on mark recapture information is lacking in terms of annual movements. Raw data used for population estimates should be made available.	Proponent plan still in production and not available for review.	Please see DFO-0033	**see TAC Rd 3 DFO-0054**
55	DFO	PD SV	Section 3.10.2	3-32	Project Description	Management Plans to be Developed	All cited management plans should be provided as part of the EIS submission.	Proponent plans still in production and not available for review.	DFO would appreciate seeing reports in preparation such as the Physical Environment Monitoring Plan (PEMP) as this is frequently referred to as having information that will help answer DFO's questions.	**see TAC Rd 3 DFO-0055**
57	DFO	R-EIS Gdlines	Section 4.3.3	4-14	Physical Environment	Construction Mitigation - DFO notes that timing for the majority of in-stream work is scheduled between July 16 to September 15	Please provide detailed contingency plans for construction techniques proposed should a request to extend construction beyond proposed dates occur. DFO would appreciate the opportunity to review contingency plans in advance to ensure appropriate decisions with a timely response can be provided.	Pre-emptive planning and design required for exemption to time restrictions	The question was about construction scheduling changes and the mitigation that could occur if the schedule changes - using construction suspended sediment inputs as one example. The Proponent's response focused on construction sediment which should now be captured in the Sediment Management Plan. However, other potential effects were not discussed. For example, contingency planning for prevention of fish kills in cofferdam dewatering. DFO needs a clear understanding of expected sources and estimates of fish mortality. DFO is aware of occasions when a construction schedule change from open water to winter prevented the capture and downstream release of fish isolated behind the cofferdam during dewatering. This was for staff safety and there was no option available to regulators to advise a delay in dewatering. DFO believes there is some risk of this potentially occurring at Keeyask. Can the proponent provide additional information about its action plan for assessment/prevention/mitigation of fish kills. To date, the proponent suggests that they will provide a risk assessment and ask for approval from regulators - as problems arise. Ideally, DFO would like to know that the potential fish kill for any given scenario is likely to be insignificant in relation to any serious harm that might be incurred by fish that support a fishery - significantly in advance of situations arising. Could the Proponent, for example, calculate the areas and other characteristics of cofferdam impoundments, compare this with any previous fish rescue information it may have, look at any possible mitigation, and assess the potential risk of not being able to carry out rescues?	**see TAC Rd 3 DFO-0057**
58	DFO	R-EIS Gdlines	Section 8.0	N/A	Physical Environment	Monitoring	DFO notes that there are no monitoring plans submitted within the EIS. We look forward to reviewing the following management and monitoring plans (as proposed to be developed in chapter 8 of the EIS): o Sediment Management Plan o Fish Habitat Compensation Plan o Waterways Management Plan o Aquatic Effects Monitoring Plan o Physical Environment Monitoring Plan	See DFO-0055	AEMP and Habitat Compensation Plan still under discussion. DFO would appreciate seeing the draft PEMP as soon as it is available	**see TAC Rd 3 DFO-0058**

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59	DFO	R-EIS Gdlines	Section 8.0	N/A	Physical Environment	Monitoring	How will peat deposition be monitored? And assumptions in the EIS verified? (ex. Estimate only 1% of peat will be transported downstream)	Proponent plan still in production and not available for review.	Please see DFO-0058	**see TAC Rd 3 DFO-0059**
60	DFO	PE SV	Appendix 7C Appendix 7D	N/A	Physical Environment	Monitoring	Please provide a detailed map of baseline sedimentation sampling sites and proposed monitoring sites? Ideally, future monitoring sites should be located near the baseline sampling sites for accurate comparisons.	Proponent plan still in production and not available for review.	Please see DFO-0058	**see TAC Rd 3 DFO-0060**
61	DFO	PE SV	Appendix 7B	N/A	Physical Environment	Bed Load	Between 2005-2007, approximately 350 bedload samples were collected, but this yielded few measurable samples (Appendix 7B). The EIS reports an estimated an average bedload of 4 g/m/s. How reasonable is this estimate given the insufficient samples to estimate the annual bedload discharge? What method(s) will be used to monitor bedload?	Proponent plan still in production and not available for review.	Please see DFO-0058	**see TAC Rd 2 DFO-0061**
65	DFO	PE SV	Section 7.2.5.1 Appendix 7A.2.2	7-11 7A-25	Physical Environment	Sedimentation - TSS	Assumption that 70% of all fine particles will remain in suspension past Kettle GS. How can they determine this? Has this been modelled? How will the model/assumptions be tested?	Proponent plan still in production and not available for review.	Please see DFO-0058	**see TAC Rd 3 DFO-0065**
70	DFO	PE SV	Section 4.0	N/A	Physical Environment	Sedimentation - TSS	Existing environment sedimentation models based on low, med and high flows (2059, 3032 and 4,327 cms). Do these relate to percentile flows? Post-project sedimentation modelling simulated under 50th percentile for year 1, 5, 15 and 30 years after impoundment, and under 5th and 95th percentile flow for 1 and 5 years after impoundment. Why different flow regimes for different time periods? The post-project sedimentation environment was also simulated under the 50th and 95th percentile flows using the eroded shore mineral volumes as estimated, considering peaking mode of operation for the time frames of 1 and 5 years after impoundment. Proposed monitoring to valid models?	Proponent plan still in production and not available for review.	Please see DFO-0001 A proposed Physical Environment Monitoring Plan (PEMP) was not available for review. The Proponent notes that a draft may be available by end June 2013. The plan is to monitor "sedimentation during the construction and operation phases." The plan is required for review to determine if sediment deposition predictions can be validated, if it will be possible to determine if mitigation is successful, and to determine if it will be possible to adaptively manage unexpected sediment deposition impacts	**see TAC Rd 3 DFO-0070**

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71	DFO	PE SV	Appendix 7A	N/A	Physical Environment	Peatland Erosion.	Did not look at peat downstream of the generating station, claiming that peat would not go past the GS (only 1% would get past the GS – is this reasonable?). What monitoring is proposed to confirm this?	Would the proponent please extract those parts of the EIS referred to that provide an assessment of the risk to fish, fisheries, and fish habitat of peat deposition from peat passing through the GS?	Please see DFO-0001	**see TAC Rd 3 DFO-0071**
72	DFO	PE SV and AE SV	Section 7.4.2.3 Section 3.4.2.2	7-35	Physical Environment	Peatland Erosion.	Visual distribution (maps) of peatland deposition not presented in the EIS. How will peat deposition impact on known/suspected areas of fish habitat in the future forebay?	Would the proponent please provide a GIS or similar analysis of peatland deposition in fish habitat in the future forebay? Would the proponent please provide an analysis, including a table of areas, of impact, given a biologically significant risk threshold, of impact area?	Please see DFO-0001	**see TAC Rd 3 DFO-0072**
73	DFO	R-EIS Gdlines	Section 6.3.8	6-215	Physical Environment	Deposition - EIS states deposition loads will not change post project – about 3cm/year, based on about 30cm of sediment deposited in ten years since Kettle GS was built. "Based on extensive modelling (using Stephens Lake) and field verification", the majority of mineral sediments resulting from shoreline erosion are predicted to deposit in near shore areas…after year 1, rates predicted at 0-3 cm/y. Offshore = 0-1 cm/y after year 1. The south nearshore areas in gull lake predicted to experience highest deposition rate of 4-6 cm/y for year 1 under baseloaded conditions.	Do not provide sedimentation rates based on a range of flows. No detail on sampling conducted to establish baseline other than at Kettle GS. How will the sedimentation model be tested for accuracy? What monitoring will be conducted to validate model assumptions?	Would the proponent now provide details from documents not provided with the EIS that were to follow (e.g., physical environment monitoring plan for second quarter 2013) that answer this question? Can the proponent provide information on thresholds for risk of sediment deposition (e.g., are 1-4 cm sediment thickness of concern or some other thickness)? Can the proponent carry out a GIS, or other, risk based assessment that delineates areas of pre-project sediment types of biological interest compared with post-project critical deposition thicknesses? Can the proponent provide a table of total areas by impact zone (e.g., upstream and downstream) of area affected by biologically significant deposition? Proponent plan still in production and not available for review.	Please see DFO-0001	**see TAC Rd 3 DFO-0073**
74	DFO	PE SV	Appendix 7A.1.1.3	7A-6	Physical Environment	Sedimentation	Given the variation in sedimentation rates over time and the challenges in estimating sedimentation level, does the sedimentation analysis include a sensitivity analysis to reflect possible ranges in sedimentation and the effects on fish and fish habitat both upstream and downstream?	Sensitivity analysis not provided.	Please see DFO-0001	**see TAC Rd 3 DFO-0074**

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86	DFO	AE SV	N/A	N/A	Aquatic Environment	"Keeyask Generation Project Environmental Impact Statement Supporting Volume Aquatic Environment June 2012" (disc 2), p1A-2ff... Restricted activity timing windows...DFO...In northern Manitoba, no in-water or shoreline work is allowed during the 15 April – 30 June, 15 May – 15 July, and 1 September -15 May periods where spring, summer, and fall spawning fish respectively are present, except under site- or project-specific review and with...implementation of protective measures...Based on data from Keeyask field investigations...proposed area-specific timing windows for restricted in-water construction activities are...15 May – 15 July for spring and summer spawning fish and 15 September – 15 May for fall spawning fish...scheduling of construction activities that require working in water have been developed and modified to the extent practicable to avoid or minimize the potential for disturbance to fish in the Keeyask area during spawning, and egg an fry development periods...Adjustments to scheduling...to restrict construction and removal of structures to times of ...year when sensitive life stages of fish are least likely to be present are summarized in Table 1A-2..." A summary listing shows these are mostly for cofferdam construction and removal "To the extent possible, work in water has been scheduled to avoid interaction with fish and fish habitat during the spring and fall spawning periods...When avoidance of both spring and fall spawning periods was not possible due to critical construction sequences, avoidance of spring spawning periods was given priority over avoidance of the fall spawning period...Additional mitigation of potential disturbances to fish and fish habitat will be gained by constructing each cofferdam in a sequence that minimizes the exposure of readily-transported fines to flowing water..."	A key mitigation is timing of in-water activity to avoid impacts on VEC fish species. Can the Proponent describe its contingency plans for unavoidable changes in scheduling. E.g., if a TSS episode exceeding the CCME guidelines is relatively benign for adult whitefish migration to spawning areas, is the same episode when delayed due to schedule changes similarly benign for incubating whitefish eggs? What sort of information would be available to rapidly assess the potential risk of a schedule change? What criteria would the Proponent use to trade-off costs to the project and costs to a VEC fish species?	The proponent's answer refers to action plans yet to be developed. Would the proponent provide details of action plans for unanticipated scheduling changes that are protective of fish, fisheries, and fish habitat?	The question was about construction scheduling changes and the mitigation that could occur if the schedule changes - using construction suspended sediment inputs as one example. The Proponent's response focused on construction sediment which should now be captured in the Sediment Management Plan. However, other potential effects were not discussed. For example, contingency planning for prevention of fish kills in cofferdam dewatering. DFO needs a clear understanding of expected sources and estimates of fish mortality. DFO is aware of occasions when a construction schedule change to winter prevented the capture and downstream release of fish isolated behind the cofferdam during dewatering. This was for staff safety and there was no option available to regulators to advise a delay in dewatering. DFO believes there is some risk of this potentially occurring at Keeyask. Can the proponent provide additional information about its action plan for assessment/prevention/mitigation of fish kills. To date, the proponent suggests that they will provide a risk assessment and ask for approval from regulators - as problems arise. Ideally, DFO would like to know that the potential fish kill for any given scenario is likely to be insignificant in relation to any serious harm that might be incurred by fish that support a fishery - significantly in advance of situations arising. Would the Proponent, for example, calculate the areas and other characteristics of cofferdam impoundments, compare this with any previous fish rescue information it may have, look at any possible mitigation, and assess the potential risk of not being able to carry out rescues.	**see TAC Rd 3 DFO-0086**
93	DFO	AE SV	Appendix 1A, Part 2	N/A	Aquatic Environment	Appendix 1A - Part2	Should the original population be decimated, how will the population within the Gull Reach be maintained?	Proponent's answer asks reader to re-read sections of the EIS. Would the proponent please extract the appropriate information from the EIS or provide additional information to answer the question?	Please see also DFO-0001. The Proponent notes that "genetic analyses presently being conducted...will be provided when available." When can the Proponent provide the second "Bernatchez" report on genetics to reduce uncertainty in decision making?	**see TAC Rd 3 DFO-0093**

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Comment Number	Department	Volume / Document	Section	Page	Topic	Preamble (e.g. provide applicable background/rationale for providing the comment)	TAC Rd 1 Question	TAC Rd 2 Follow-up/New Question	TAC Rd 3 Follow-up/New Question	Proponent Response
98	DFO	AE SV	Appendix 1A, Part 2	N/A	Aquatic Environment	Appendix 1A - Part2	Given predications of accumulated sedimentation/peat accumulation and subsequent influences in water chemistry (including decreasing oxygen and increasing mercury levels) is stocking the forebay with sturgeon a rational option?	DFO is interested in knowing more detail about the amount of change in the reservoir. The Proponent's answer talks about the post-project but does not compare it to the pre-project. Would the proponent please provide a pre- versus post-project comparison? "Stocking lake sturgeon into the Keeyask Reservoir is a rational option to recover populations" Please provide publications in support for this conclusion, given mercury in fish tissue significantly elevate post project.	Please see DFO-0001. In addition, the proponent acknowledges that it may take up to 30 years for mercury levels to return to pre-project levels. DFO notes that models applied after the EIS to estimate mean mercury concentrations in sturgeon "are only based on 13 fish from one location (Gull Lake)" (Human Health Risk Assessment...April 2013..." in Supplemental Filing #1) . Mercury levels in sturgeon are less than the 0.5 ppm limit for commercial sale and are not expected to increase significantly - but no commercial sturgeon fisheries can be considered in any case due to the small populations. Human health advisories that are still under development could affect subsistence (ceremonial) fishing. Further, the proponent acknowledges that no known studies exist that specifically address the effects of mercury on Lake Sturgeon health. DFO is not aware of any information that may have been provided on mercury in sturgeon dietary items and the potential effect on sturgeon health. Can the Proponent provide additional information on the effects of methylmercury on sturgeon health?	**see TAC Rd 3 DFO-0098**
100	DFO	AE SV	Appendix 1A, Part 2	N/A	Aquatic Environment	Appendix 1A - Part2	Given the challenges of detecting changes in sturgeon (growth, age, etc) over the short term, how will success/failure be determined?	To date, sample sizes for lake sturgeon in the study area has been challenging due to population size. Will sample sizes be sufficient to detect statistical change in life history parameters post project?	Please see also DFO-0001. DFO notes that additional discussions with the Proponent on sturgeon stocking as an offsetting measure have been suggested. In addition, the Proponent notes that "genetic analyses presently being conducted...will be provided when available." When can the Proponent provide the second "Bernatchez" report on genetics to reduce uncertainty in decision making?	**see TAC Rd 3 DFO-0100**
103	DFO	PD SV	Section 6.7	6-13	Aquatic Environment		The EIS indicates 90 % survival for fish up to 500mm. Can this be further broken down into species, sex, maturity and length for the VEC fish species within the Keeyask Study area. An analysis/graphs of survival rates and injury rates should be provided.	A failure of the Franke analysis is the lack of size and age specific mortality rates, which are crucial for assessing impacts to populations and predicting change.	Please see DFO-0051	**see TAC Rd 3 DFO-0103**

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Comment Number	Department	Volume / Document	Section	Page	Topic	Preamble (e.g. provide applicable background/rationale for providing the comment)	TAC Rd 1 Question	TAC Rd 2 Follow-up/New Question	TAC Rd 3 Follow-up/New Question	Proponent Response
104	DFO	PD SV	Section 6.7	6-13	Aquatic Environment		Several recommendations to minimize mortality that can be incorporated into hydro facilities include: using trashracks with reduced bar spacing while preventing further impingement, using temporary overlays with the existing trashracks to reduce clear spacing during migration periods, use of partial depth curtain wall over existing trash rack, installation of an inclined or skewed bar rack system upstream of the intake, barrier or stop nets set upstream in the forebay, and use of partial depth guide walls or an angled louver system upstream of the intakes coupled with a bypass system. Will the powerhouse be designed to incorporate some of these features if monitoring indicates that fish mortality is higher than predicted? Additional biological data and studies will be required post construction to better assess the requirements and potential mitigation for both potential downstream passage and protection. Also, these studies should determine the overall number of fish expected to pass through the turbines.	DFO should be provided with an operating regime and an estimate of mortality under various flow/seasonal conditions. Mortality rates for fish over 500mm required.	Please see DFO-0051	**see TAC Rd 3 DFO-0104**
105	DFO	PD SV	Section 6.7	6-13	Aquatic Environment		Survival rates can be maximized for entrained fish if operation of the turbines is at maximum efficiency. How will Keeyask be operated to minimize mortality?	Elaboration required. Could turbine operation mitigate impacts to fish during critical life stages (e.g. -Y-O-Y drift)?	Please see DFO-0051	**see TAC Rd 3 DFO-0105**
106	DFO	PD SV	Section 6.7	6-13	Aquatic Environment		What are acceptable mortality rates based on the fish community and population in the Keeyask study area?	Information on acceptable mortality rates not provided (e.g. literature).	Please see DFO-0051	**see TAC Rd 3 DFO-0106**
107	DFO	PD SV	Section 6.7	6-13	Aquatic Environment		A detailed monitoring plan should be developed to assess mortality of fish passing through the station and spillway. How will this impact the fish community?	See DFO-0015	Please see also DFO-0051. In addition, an Aquatic Effects Monitoring Plan (AEMP) is presently under discussion and is scheduled for public release by the Proponent in the second quarter of 2013. DFO would like to ensure that the potential for injury and death of fish passing downstream through the station has been estimated, mitigated to the extent practical, that residual impacts are known, and that monitoring will clarify uncertainty for adaptive management . Would the Proponent describe the monitoring that wil be provided to address concerns about monitoring for downstream fish passage mortality?	**see TAC Rd 3 DFO-0107**

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Comment Number	Department	Volume / Document	Section	Page	Topic	Preamble (e.g. provide applicable background/rationale for providing the comment)	TAC Rd 1 Question	TAC Rd 2 Follow-up/New Question	TAC Rd 3 Follow-up/New Question	Proponent Response
Environment Canada										
19	EC	R-EIS Guidelines	Section 6.5.7.7.3	6-362	Terrestrial Environment	In this section the Proponent has proposed the following mitigation in response to the loss of gull and tern breeding habitat: "Deployment of artificial gull and tern nesting platforms (e.g., reef rafts), breeding habitat enhancements to existing islands (e.g., predator fencing or placement of suitable surface substrate), and/or development of an artificial island, or a combination of these measures, will be implemented to off-set the loss of gull and tern nesting habitat at Gull Rapids and areas upstream."	EC requests that the Proponent provide additional information regarding each mitigation measure (i.e., for artificial nesting platforms, island enhancements, or development of artificial islands), including information regarding the design, placement, development and implementation of each measure. EC also requests that the Proponent identify the decision-making process by and situations in which they would choose to a) deploy an artificial nesting platform, b) enhance an existing island, c) develop an artificial island, or d) implement a combination of these measures.	As the proponent has indicated in their response, details about the mitigation measures to offset the loss of gull and tern nesting habitat at Gull Rapids and areas upstream are limited at this time. EC requests the opportunity to review detailed plans (complete with design, placement, development, and implementation information for each proposed mitigation measure) as they are developed. With respect to the Artificial Nesting Platforms, EC recommends that the developed plan 1) address the recommendations in the studies cited, and their implementation for this project; and 2) include plans to maintain the rafts and make any necessary repairs to the platforms prior to each breeding season. To the extent possible, EC recommends constructing platforms such that the total available area for nesting waterbirds is equivalent to the area of the natural islands that will be lost, such that equivalent breeding populations might be maintained.With respect to the Nesting Island (or Peninsula) Enhancements downstream, EC recommends that the developed plan address the expected variability of the water level below the Generation Station, and provide the rationale behind enhancing nesting sites downstream if the variation in water level will be greater than which would occur naturally during the breeding season. Terns and other waterbirds often nest at sites that are only a few inches to a couple of feet above water and frequent changes to the water level during the breeding season may render this mitigation option futile. EC also recommends that the plan address the feasibility of fencing off portions of land to limit predator access, and describe any plans to monitor and maintain the fencing. Colonial nesting birds have an innate preference for sites that mammalian predators cannot access and it would be preferential to work with islands. Moreover, maintaining the fencing and ensuring that it did not become a hazard to breeding colonial species or other wildlife would require frequent monitoring and maintenance throughout the year. With respect to the proponent's response regarding the development of Artificial Nesting Islands, EC questions how monitoring annually during the first 3 years of operations will confirm the necessity and feasibility of these nesting islands. More specifically, EC is unsure how the construction could take place prior to filling the reservoir considering monitoring will only occur after operation has commenced. EC requests clarification.	EC's questions regarding the decision-making process by which, and situations in which, the proponent would choose to a) deploy an artificial nesting platform, b) enhance an existing island, c) develop an artificial island, or d) implement a combination of these measures, are still outstanding. These questions may be addressed within the Terrestrial Mitigation Implementation Plan, however the proponent indicates that this "will be developped once construction is underway". EC notes that in the referenced section of the Terrestrial Environment Supporting Volume (Section 6.4.2.3) and the proponent's current response, it remains unclear if each of the proposed mitigation measures will be employed, and under which circumstances each may or may not be used (e.g., "The preferred time to build an artificial island is prior to filling the reservoir and this is the current plan if such an island is built" and "This Plan will include detailed design, placement, development, and implementation information for the gull and tern-nest habitat creation and/or enhancement.") EC requests clarification. EC also requests the opportunity to review both the Terrestrial Mitigation Implementation Plan and the Terrestrial Effects Monitoring Plan, prior to project approval.	**see TAC Rd 3 EC-0019**

KEEYASK Hydropower Limited Partnership

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Comment Number	Department	Volume / Document	Section	Page	Topic	Preamble (e.g. provide applicable background/rationale for providing the comment)	TAC Rd 1 Question	TAC Rd 2 Follow-up/New Question	TAC Rd 3 Follow-up/New Question	Proponent Response
Health Canada										
7	HC	AE SV 2	Section 7.2.4	7-16		Project Effects, Mitigation and Monitoring: HC understands that the proponent has proposed to monitor mercury in fish tissue on an annual basis until maximum concentrations are reached, and every 3 years thereafter until concentrations are stable. HC does not have any objections to this approach; however, the EIS does not provided a clear determinant of what constitutes "maximum concentration" and "stable". Mercury levels in fish are expected to steadily increase over a number of years, reach a maximum, and decline steadily thereafter but may fluctuate slightly over the course of this time. The number of years in which a decrease in mercury levels is observed to conclude that a maximum concentration has been reached, does not appear to have been determined. The EIS includes an outline of monitoring planned for the mercury in fish tissue. However, the detailed monitoring program that will be provided in the Aquatic Effects Monitoring Plan (AEMP) is not yet provided and is related to regulatory licensing with DFO and Manitoba Conservation.	HC advises that the proponent provide a clear determinant in the EIS of what will constitute a "maximum concentration" and "stable" condition at which point fish tissue monitoring will be reduced to a frequency of every third year. When the AEMP is available for review, HC is able to provide advice regarding potential effects and review of additional HHRAs to ensure fish consumption advisories remain protective of human health.	HC is satisfied with the explanation of "maximum concentration" and "stable" for post-project monitoring of mercury concentrations in fish. Draft Aquatic Effects Monitoring Plan HC was provided with a copy of the draft Aquatic Effects Monitoring Plan on October 29, 2012. HC has the following comments: Section 6.1.2.1.3 Parameters In the core monitoring of lake sturgeon, methyl mercury is not listed as a parameter that will be measured. Because draft risk communication products advise consuming lake sturgeon, please confirm that methyl mercury is included in the monitoring plan. Section 7.0 Mercury in Fish Flesh In Section 7.2 Monitoring During Operation, HC advises that lake sturgeon be added to the large-bodied fish species that will sampled for mercury concentrations. HC advises that all fish species that will be consumed be included in the monitoring plan (including lake sturgeon, cisco, rainbow smelt, lake trout, etc.). HC is available to review results of the AEMP, upon request.	It would appear from the proponent's SIR response (for DFO), that supplementary field studies for lake sturgeon [File Name: 11-02 Lake Sturgeon population estimates Keeyask 1995-2011.pdf] include long term monitoring of mercury levels in lake sturgeon. If this is the case, HC advises that data originating from this monitoring may also be used to support the development of the Environmental Management Plan and the conclusions of the HHRA.	**see TAC Rd 3 HC-0007**

KEEYASK Hydropower Limited Partnership

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Natural Resources Canada										
5	NRCan	R-EIS Gdlines	Section 6.2.3.2.9	6-50	Physical Environment	The proponent discusses baseline groundwater quality based on reference to the literature. They also mention that on-site groundwater analyses confirm this and discuss elevated zinc concentrations. However, there is no information provided with respect to on-site sampling. It is unclear how many on-site samples were collected and what parameters they were analyzed for. The analytical results are not presented. The absence of this information makes it impossible to assess if baseline conditions of groundwater quality have been adequately determined.	Provide the location of on-site groundwater monitoring well sampling sites. Provide information on the frequency of groundwater sampling from these sites. Provide information on sampling and laboratory methodologies, including a discussion of quality assurance and quality control. Present the analytical results of all field-derived and laboratory analyses. Provide a direct comparison, by means of a table, of groundwater quality determined from on-site measurements versus groundwater quality gleaned from the literature. It is recommended the following physical and chemical parameters be tested for in groundwater: alkalinity, temperature, pH, Eh, electrical conductivity (EC), major ions, nutrients, minor and trace constituents, and metals (including methyl mercury).	The proponent mentions that two groundwater sampling trips were conducted- one for the camp well investigation and one for the groundwater investigation. Are the results presented in the Keeyask Response to IR's just for the groundwater investigation? Please clarify. If camp well data has not been presented, please do so. Also, on Map 8.2-2 of the Physical Environment Supporting Volume Groundwater, there are 5 other wells (G-0556, G-5086, G-0561, 03-042, 03-045). Please clarify if these wells were sampled and provide any data for these wells.	NRCan is generally satisfied with the proponent's response to IR-0005. However, NRCan would like to request a further clarification. In the November 2012 IR responses provided by the proponent, the proponent mentions that the camp well investigation and groundwater investigation include testing of water quality for metals, and they specify that this would include testing for mercury. In the updated response to IR-0095, there are results for other metals, but not for mercury. Could the proponent confirm if groundwater in the vicinity of the camp site was analyzed for mercury, and if not, justification for the omission is requested.	**see TAC Rd 3 NRCan-0005**

ACRONYMS

Submitter Name	Full Name
DFO	Department of Fisheries and Oceans
EC	Environment Canada
HC	Health Canada
NRCan	Natural Resources Canada

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 3.3.2.3.1 Description of the Mainstem; Page No.: 3-15

TAC Public Rd 3 DFO-0001

ROUND 1 PREAMBLE AND QUESTION:

"Biological components of the aquatic habitat were based on the period during which field studies conducted in the area, generally between 1997 and 2006. This period included both high and low flows, and therefore would indicate interannual variability related to flows."

Detailed background reports to support statements regarding interannual variability have not been provided in the EIS. These should be made available for review.

ROUND 2 PREAMBLE AND QUESTION:

Requested reports not provided.

FOLLOW-UP QUESTION:

Would the Proponent please provide a summary of the quantity, type, and sensitivity of aquatic habitat to be directly and indirectly impacted by construction and operation of the GS and associated infrastructure, and the expected changes to these habitats? In addition, would the Proponent please provide a summary of the quantity, type, and quality of measures to offset fish habitat impacts? DFO knows that the Proponent has started on this in its Fish Habitat Compensation Plan - presently under discussion and scheduled for release by end of June 2013. Description of the hydraulic zone of influence/aquatic habitat study areas may be the best approach to meeting this need including reasons for subdivisions, areas, and habitat quality changes. Pre-Project versus construction phases versus Post-Project operational ranges in habitat e.g., as 5th to 95th percentiles should meet assessment needs. Despite detailed review of information provided to date, DFO is not able to find this information in a clearly summarized form. To reduce uncertainty in making an EA determination, clear quantification of habitat, how it will change, and residual habitat quantity after mitigation is applied is required. DFO needs to look at changes, impacts and mitigation - upstream of the station, at the station, and downstream of the station – as they will occur over time.

RESPONSE:

The fisheries component of the environmental assessment for the Keeyask Generation Project (the Project) focused on the following four Valued Environmental Component (VEC) fish species:

- Lake Sturgeon
- Walleye
- Northern Pike
- Lake Whitefish

These species were identified by Manitoba Conservation and Water Stewardship (MCWS) in the Fisheries Management Objectives (FMOs) developed by MCWS for the Project. The FMOs state that Walleye, Northern Pike, and Lake Whitefish populations upstream and downstream of the Project should be able to sustain a fishery. The objective for Lake Sturgeon was to recover the population and, in the long term, be able to sustain a well-managed domestic fishery. Lake Sturgeon has also been assessed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and are currently being considered for listing under the federal Species at Risk Act (SARA).

The attached table provides areas of habitat alteration and destruction in the existing and post Project environment, as well as a summary description of effects to the VEC fish species and proposed mitigation/compensation. A summary addressing the following points is provided below:

- Habitat loss and alteration and effect of these changes on the sustainability of affected fish populations;
- Expected impacts of flow changes;
- Effect of the Keeyask GS on movements of VEC species and relevance to sustainable populations;
- Expected sources of mortality;
- A summary of proposed mitigation and compensation measures; and
- A description of monitoring and adaptive management.

<u>Habitat Loss and Alteration</u>

Construction of the Project will alter fish habitat in the Nelson River between Long Rapids and Stephens Lake, an existing area of approximately 5,600 ha of river and lake habitat. In summary, the alterations will consist of:

- Loss of Gull Raids, which today comprise approximately 500 ha. The majority of the rapids will be converted into deep water reservoir habitat while 116 ha will be dewatered by the GS structures or dam;
- An increase in depth and decrease in velocity, most notably in the area of present day Gull Lake, where water depths will generally increase 6-7 m and velocity will decrease;
- An increase in depth of 1-2 m at Birthday Rapids, resulting in the loss of white water conditions;

- Flooding of lower sections of eight small creeks;
- Loss of existing macrophyte beds (amount ranges from 150-350 ha depending on year); and
- Deposition of silt over coarse substrates in Gull Lake, including approximately 40 ha of sand in a deep channel that is known to provide habitat to young-of-the-year (YOY) Lake Sturgeon.

The loss of Gull Rapids will eliminate all spawning habitat for Lake Sturgeon in Stephens Lake and reduce the amount of spawning habitat available for Walleye and Lake Whitefish, though habitat for these species occurs in other parts of the lake. The habitat changes upstream of Gull Rapids may adversely affect existing Lake Sturgeon spawning habitat at Birthday Rapids and YOY habitat in Gull Lake. Spawning habitat for Walleye and Lake Whitefish will be present in the riverine section of the reservoir upstream of present-day Gull Lake, but areas of existing habitat (e.g., at Morris Point) are expected to be lost. Northern Pike spawning habitat in macrophyte beds will be lost, but this species is known to spawn on flooded vegetation. Foraging and overwintering habitat for all species will continue to be present.

The inundated terrestrial habitat will evolve into productive habitat over time. Key considerations are as follows:

- A total of approximately 5,100 ha of terrestrial habitat will be flooded by Year 30;
- In the initial 10-15 years of impoundment, backwater bays will be less suitable for fish and other aquatic life due to the erosion and breakdown of peat, resulting in elevated concentrations of total suspended solids and periodic depletion of dissolved oxygen, in particular during winter under ice; and
- Flooded habitat will be suitable for foraging by Walleye, Northern Pike, Lake Whitefish and adult Lake Sturgeon, but is not expected to be highly suitable for young-of-the-year and sub adult Lake Sturgeon.

Habitat compensation measures to provide habitat to support all life history stages upstream and downstream of the GS are as follows:

- Construction of a spawning shoal in the tailrace to provide spawning habitat for Lake Sturgeon, as well as additional habitat for Walleye;
- Construction of a spawning shoal in Stephens Lake to provide additional spawning habitat for Lake Whitefish;
- Modification of the river bank near Birthday Rapids to create conditions to attract spawning sturgeon if monitoring indicates that Lake Sturgeon no longer spawn in the vicinity. This option would entail adding large boulders/structures at locations slightly upstream of the current spawning site at Birthday Rapids. While this would be difficult during the construction phase due to lack of access, access would be improved during the operation period. The design of these measures cannot be

developed until after an assessment of site conditions occurs during the operation phase;

- Placement of sand on the riverbed at the upper end of present day Gull Lake if monitoring indicates that no habitat suitable for YOY sturgeon is present and accessible post-impoundment; and
- Creation of spawning shoals near areas of existing spawning habitat for Walleye and Lake Whitefish in the lower section of the reservoir.

Additional information on the compensation measures is provided in a subsequent section.

Walleye, Northern Pike and Lake Whitefish populations in Stephens Lake and the reservoir are expected to remain sustainable. There is a high degree of certainty with respect to this prediction given that suitable habitat will be present to support all life history stages (even in the absence of constructed spawning shoals spawning habitat will be present in the riverine section of the Keeyask reservoir and in Stephens Lake). In addition, surveys in existing reservoirs, in particular Stephens Lake, have demonstrated that reservoirs on the lower Nelson River provide suitable habitat even in the absence of compensation measures.

Lake Sturgeon populations in the reservoir are expected to become/remain sustainable if there is adequate spawning and young-of-the-year habitat and/or if planned compensation measures are effective. There is less certainty with these predictions since similar habitat creation, in particular in relation to YOY habitat, has not been conducted elsewhere. The current population in Stephens Lake is not considered sustainable. In addition, sustainable sturgeon populations have not been maintained in reservoirs on the lower Nelson River, although sustainable populations have been maintained in other reservoirs (e.g., Winnipeg River).

As discussed below, implementation of the Lake Sturgeon stocking strategy is expected to increase the certainty with respect to maintaining a sturgeon population in the Keeyask reservoir and creating a sustainable population in Stephens Lake.

Expected Impacts of Flow Changes

The water level variation on the Keeyask reservoir will be a maximum of 1 m; this variation could occur within one day. A portion of the flooded terrestrial habitat would be dewatered when the reservoir is drawn down to the minimum operating level; however, effects to existing aquatic habitat are minimal. Operation of the station in a continuous cycling mode would reduce the increase in production of species such as Walleye that is predicted if the flooded area is permanently wetted; however, production would not be less than in the existing environment. Direct effects to Lake Sturgeon are not expected since this species does not use the shallow habitats that would be affected by cycling (i.e., flooded margins of reservoir).

Downstream of the GS, cycling would cause up to a 0.1 m change in the elevation of the tailrace. Water level changes caused by operation of the Keeyask GS are all well within the operating range of Stephens Lake, which is controlled by the Kettle GS.

Operation of the spillway will temporarily wet dewatered areas of Gull Rapids, and fish in this area would be vulnerable to stranding when spillway operation ceases. This effect will be mitigated through the creation of channels connecting to permanently wetted habitat or other measures to avoid fish becoming trapped in isolated ponds.

Effects on Movements of Fish

Construction of the GS will alter downstream movements of fish over Gull Rapids and block upstream movements (in the absence of a measure to provide fish passage). Fish will move downstream through either the turbines or over the spillway when it is in operation. The turbines were designed to reduce fish mortality and are estimated to provide over 90% survival to fish up to 500 mm in length, which includes the majority of VEC fish, with the exception of large adult Northern Pike and most Lake Sturgeon over 5-7 years in age. Large fish would likely be able to avoid impingement at the initial encounter with trashracks, though if fish persist in attempting to move downstream it is expected that they would eventually become exhausted and impinged on the trashracks or pass by them and be vulnerable to turbine mortality.

The spillway does not have features that are associated with elevated mortality at other facilities (e.g., plunge pools, baffle blocks) and is expected to provide downstream passage to all sizes of fish when it is in operation.

Uncertainty with respect to effects of downstream passage will be addressed through monitoring the movements of tagged fish in the reservoir to determine: (i) the proportion of fish that move downstream; and (ii) whether these fish survive. More detailed mortality estimates will be obtained for selected species by experimentally introducing fish marked with balloon tags or other markers to the turbines.

Analysis of population level effects to Lake Sturgeon indicated that increased mortality associated with passage by the turbines (assuming 100% mortality) increased the probability that the population is in decline (i.e., a negative population size trajectory) from 11% (existing environment) to 32%. This analysis does not consider increased recruitment that would occur as a result of the Lake Sturgeon stocking strategy (discussed below). The probability of the long term persistence of the population considering various recruitment/mortality scenarios will be further investigated through application of a population model similar to that used for DFO's Recovery Potential Assessment, adjusted for site specific recruitment and mortality estimates.

Based on the small proportion of tagged Walleye, Northern Pike, and Lake Whitefish that move from Gull to Stephens lakes, turbine mortality is not expect to affect the sustainability of populations of these species.

Blocking upstream movements of fish from Stephens Lake to the Keeyask reservoir is not expected to affect the sustainability of fish populations either upstream or downstream of the GS due to the number and timing of recorded fish movements (indicating that not for an essential life history requirement) and because habitat for all life history stages will be present upstream and downstream of the GS.

To address uncertainty with respect to the need for upstream and downstream passage, the Partnership, in consultation with DFO and MCWS, will undertake monitoring to examine fish movements in the existing and post-Project environments. Results of this program, in conjunction with other targeted studies (e.g., potential fish translocation experiments, measures of post Project recruitment) will provide DFO and MCWS with the information required to determine the long term need for fish passage. The Partnership has committed to retrofitting fish passage, if required to sustain fish populations.

Expected Sources of Fish Mortality

Potential sources of fish mortality include stranding after spillway operation and downstream passage via the turbines and spillway. These were discussed in preceding sections.

Habitat Compensation

The following works will be constructed for fish habitat compensation:

- A spawning structure below/adjacent to the tailrace area with provision for modification of additional areas (~5.0 ha). This habitat would offset the loss of spawning habitat in Gull Rapids for Lake Sturgeon and other spring spawning species such as Walleye.

The design of this structure is based on successful spawning structures constructed elsewhere (e.g., Quebec) and results of experimental shoals constructed at the Pointe du Bois GS on the Winnipeg River. Use of designs tested in other systems increases the certainty that the spawning structure will be successful;

- A spawning shoal downstream of the Keeyask spillway at the upstream end of Stephens Lake suitable for Lake Whitefish (~0.1 ha). This shoal is based on the current understanding of Lake Whitefish spawning habitat;
- Spawning shoals for Walleye and Lake Whitefish in the reservoir to provide spawning habitat immediately post-impoundment in the lower section of the reservoir (~3 ha). These shoals are based on the current understanding of spawning requirements for these species and are situated close to existing spawning habitat, which increases the probability that they will be used;
- Young-of-the-year sturgeon rearing habitat (~20-40 ha), if monitoring indicates that suitable habitat for this life stage is not formed within the reservoir in the first years

of impoundment. This habitat would also be suitable for juvenile and sub-adult sturgeon. This measure is based on the current understanding of YOY habitat, which is a rapidly evolving, and should be considered experimental, as similar work has not been conducted elsewhere; and

- Installation of structures to create conditions to attract sturgeon to spawning habitat in Birthday Rapids, if sturgeon do not return to spawn in this area within five years of impoundment. Potential measures would mimic conditions observed along other rivers where Lake Sturgeon are known to spawn, increasing the probability of success. As indicated above, site access and designs would not be available until the operations phase.

In addition, the Partnership would set aside a fund for the development of a habitat work to offset the dewatered area of Gull Rapids (in addition to the spawning structures identified above). One option is to increase flows through new wetlands in Gull Rapids Creek and create a series of small dams and fishways that would create pool/riffle habitat in a portion of the dewatered river bed. This measure would directly benefit Northern Pike, and Lake Sturgeon, Lake Whitefish and Walleye would indirectly benefit through increased inputs of aquatic invertebrates and forage fish into Stephens Lake. Alternate suitable options that could directly benefit all the target species will be identified in discussions with DFO and MCWS. Selection of the measures will be based on evaluation of: a) likely benefit to target species in terms of the FMOs; and b) proximity to the Project site.

A conservation stocking program for Lake Sturgeon[1] will form an important part of the compensation plan. Based on field studies, sturgeon use of habitat falls into three partially distinct areas of the Nelson River: the upper end of Split Lake including the lower sections of the Burntwood, Nelson and Grass rivers; the reach of the Nelson River between Long and Gull Rapids (Keeyask area); and the Gull Rapids and Stephens Lake. Populations in all three areas appear to be depleted from historic numbers. Reproduction is occurring (at least sporadically) in the upper Split Lake and Keeyask areas, but the populations are depleted and available habitat would support more sturgeon. The few sturgeon in Stephens Lake do not appear to be part of a self-sustaining population. A conservation stocking program into the Keeyask reservoir and Stephens Lake for at least one complete generation (25 years) will be conducted to compensate for temporary declines in productivity related to habitat disruption during construction and the initial post-impoundment period, and restoration of the historically depleted population to self-sustaining numbers. The long term objective of the stocking program is to re-establish self-sustaining stocks that could support subsistence harvest

[1] A conservation stocking program has the objective of assisting in the recovery of a population under conditions where it can be self-sustaining and is not intended to be continued in perpetuity or support a "put and take" fishery.

without the requirement for continued stocking. It is recognized that developing such a population might require stocking to extend beyond the initial 25 year period.

The fish habitat compensation program during the operation period will be comprised of the following:

- Continuation of the stocking program initiated during the construction phase in the Keeyask area (future reservoir) and Stephens Lake;
- Stocking in waters immediately upstream of the Project area where habitat surveys have identified suitable spawning and rearing habitat, but few sturgeon occur. Target areas include the Grass River, the Nelson River between the Kelsey GS and Split Lake, and the Burntwood River downstream of First Rapids. The stocking program will continue for at least one generation (25 years), until the population has reached target levels for recovery; and
- Manitoba Hydro, TCN, WLFN, YFFN, FLCN, SFN, and the KHLP have negotiated a Lower Nelson River Sturgeon Stewardship Agreement, which has the goal to conserve and enhance the present population of lake sturgeon in the lower Nelson River from Kelsey GS to Hudson Bay. Implementation of this agreement began May 2013. While the potential listing of sturgeon under SARA would be expected to increase lake sturgeon numbers, the implementation of the Lake Sturgeon Stewardship Agreement would provide a more effective initiative for sturgeon recovery. The agreement focuses on enhancing the overall population while considering existing and future uses for the river. In contrast, reducing the mortality of individuals within an overall population has become the focus of species listed under SARA in other jurisdictions.

Monitoring and Adaptive Management

The Project will include an Aquatic Effects Monitoring Program (AEMP). As part of the draft AEMP, it is proposed that monitoring of the fish habitat compensation measures will be conducted to:

- Determine the effectiveness of the habitat compensation works and determine if works need to be modified and/or additional ones added as per the Project's Authorization under the *Fisheries Act*;
- Confirm the effectiveness of the stocking program on lake sturgeon populations and modify as appropriate; and
- Confirm that the post-Project effects are as predicted in the environmental assessment and, if not, determine what other mitigation or compensation measures may be required.

Proposed adaptive management would involve an ongoing process of engagement between KHLP, DFO and MCWS. Some specific elements in the process would be the following:

- Annual monitoring reports by KHLP;
- Annual meetings between KHLP, DFO and MCWS to review and discuss annual monitoring results, and stewardship and monitoring plans for the upcoming year; and
- An initial formal review of the fish habitat compensation works four years post-impoundment to determine whether installed works are functioning as intended and whether additional mitigation and/or compensation are required. A second review 10 years post-impoundment would determine whether reservoir conditions are evolving as anticipated, or whether other works are required.

Proposed Keeyask GS fish habitat changes

Area	Sub-Area	Activity/Concern	Existing Environment (wetted ha)			Post-Project (wetted ha)		Type of Change	Nature of Change	Duration	Rationale/Explanation	Mitigation	Proposed offsets
			Minimum	Median	Maximum	Minimum	Maximum[1]						
Upstream	Gull Rapids		251.17	267.1	286.01								
		Inlet Channels[2]	-	-	-	-	7.09	• Loss of spawning habitat for Lake Whitefish (LKWH), Walleye (WALL) and Lake Sturgeon (LKST)[3]	Harmful	Operation Phase: Permanent	Habitat in Gull Rapids will no longer be suitable for spawning by these species. Loss of Gull Rapids will eliminate all spawning habitat for LKST and a portion of available spawning habitat for WALL and LKWH in Stephens Lake.	In those years when flow downstream of the spillway may attract spawning LKST, egg deposition will be monitored; in cases of successful deposition, the minimum amount of spillway discharge necessary to permit survival and hatch of the eggs and drift of larval LKST from the site will be maintained.	Approximately 5 ha of replacement LKST spawning habitat will be constructed along the north shore of the tailrace. A reef of coarse material will be constructed along the south shore to create approximately 0.1 ha of spawning habitat for LKWH. WALL are expected to use both spawning habitats. LKST will be stocked into Stephens Lake to offset any lost year classes that may result if the spawning structure requires modification to make it more suitable.
								• Loss/alteration of foraging habitat for LKWH, WALL and LKST[4]	Neutral	Operation Phase: Permanent	Construction of GS/impoundment will substantially alter/destroy habitat for foraging. However, effect to populations will be neutral since existing habitat is little used (based on movement studies that show fish such as LKST move through quickly). Fish that move into dewatered areas of Gull Rapids during spillway operation could be stranded when spillway operation ceases	Potential for stranding of fish that move in to forage during spillway operatoin will be mitigated through the construction of channels to connect isolated pools to a channel connected to Stephens Lake or other appropriate measures	None
								• Alteration of downstream movement corridor for all VEC fish species	Neutral/Harmful	Operation Phase: Permanent	Alteration of of flow patterns as a result of impoundment and presence of GS structures will result in changes in the downstream movement of larval, juvenile and adult fish. Net effect to population not known but is expected to be negligible for LKWH, NRPK and WALL due to large reproducing populations of these species in Stephens Lake. Effect to LKST may occur since there is little, if any reproduction in Stephens Lake.	Selection of turbine design that reduced mortality to adult fish (>90% survival of fish up to 500 mm in length). Spillway design does not include features commonly associated with increased mortality; therfore survival expected to be similar to existing river channel. The need for an alternate form of downstream fish passage/fish exclusion measures at the trashracks will be determined by DFO in consultation with MCWS after consideration of results of post-Project monitoring.[5]	Stocking of LKST in Stephens Lake will compensate for the loss of any larval/YOY fish that may enter from upstream in the existing environment
								• Loss of upstream movement corridor for all VEC fish species	Uncertain[5]	Operation Phase: Permanent	Presence of the GS will block upstream movements. The magnitude, timing and importance of these movements to maintaining a sustainable fishery has not been adequately defined for this site.[5]	Given incomplete knowledge, it is premature to warrant installation of a permanent upstream fish passage facility. The requirement for fish passage facilities will be determined by DFO, in consultation with MCWS, based on the results of monitoring conducted after the generating station is in operation.[5]	None
		Construction and Removal of Cofferdams and Rock Groins	-	-	-	-	90.38*	• Partial loss of spawning habitat for LKWH, WALL, and LKST[3]	Harmful	Construction Phase: Short term (up to 5.5 y)	Dewatered parts of Gull Rapids habitat will no longer be suitable for spawning by these species, and remaining wetted areas will experience a significant change in velocities and depth during certain periods of construction.	Avoidance of instream construction during sensitive spawning periods, where practicable; fish salvage prior to dewatering; application of blasting guidelines; measures to reduce effects to water quality	LKST stocking and habitat creation will take place during the construction and operation phases.
								• Partial loss/alteration of foraging habitat for LKWH, WALL and LKST[4]	Neutral	Construction Phase: Short term (up to 5.5 y)	Construction of GS/impoundment will substantially alter/destroy habitat for foraging. However, effect to populations will be neutral since existing habitat is little used (based on movement studies that show fish such as LKST move through quickly). Fish that move into dewatered areas of Gull Rapids during spillway operation could be stranded when spillway operation ceases.	Fish salvage prior to dewatering; application of blasting guidelines; measures to reduce effects to water quality	None
								• Partial alteration of downstream movement corridor for all VEC fish species	Neutral	Construction Phase: Short term (up to 5.5 y)	Fish are expected to still be able to move downstream through Gull Rapids during the construction phase.	None	None
								• Partial loss of upstream movement corridor for all VEC fish species	Uncertain[5]	Construction Phase: Short term (up to 5.5 y)	Presence of the GS and associated construction infrastructure will block upstream movements during certain periods of construction. The magnitude, timing and importance of these movements to maintaining a sustainable fishery has not been adequately defined for this site.[5]	Given incomplete knowledge, it is premature to warrant installation of a permanent upstream fish passage facility. The requirement for fish passage facilities will be determined by DFO, in consultation with MCWS, based on the results of monitoring conducted after the generating station is in operation.[5]	None

Area	Sub-Area	Activity/Concern	Existing Environment (wetted ha)			Post-Project (wetted ha)		Type of Change	Nature of Change	Duration	Rationale/Explanation	Mitigation	Proposed offsets
			Minimum	Median	Maximum	Minimum	Maximum[1]						
		Forebay - flooded Existing Environment aquatic habitat	-	-	-	-	278.92	• Loss of spawning habitat for LKWH, WALL and LKST[3]	Harmful	Operation Phase: Permanent	Habitat in Gull Rapids will no longer be suitable for spawning by these species. Loss of Gull Rapids will eliminate all spawning habitat for LKST and a portion of available spawning habitat for WALL and LKWH in Stephens Lake.	In those years when flow downstream of the spillway may attract spawning LKST, egg deposition will be monitored; in cases of successful deposition, the minimum amount of spillway discharge necessary to permit survival and hatch of the eggs and drift of larval LKST from the site will be maintained.	Approximately 5 ha of replacement LKST spawning habitat will be constructed along the north shore of the tailrace. A reef of coarse material will be constructed along the south shore to create approximately 0.1 ha of spawning habitat for LKWH. WALL are expected to use both spawning habitats. LKST will be stocked into Stephens Lake to offset any lost year classes that may result if the spawning structure requires modification to make it more suitable.
								• Loss/alteration of foraging habitat for LKWH, WALL and LKST[4]	Neutral	Operation Phase: Permanent	Construction of GS/impoundment will substantially alter/destroy habitat for foraging. However, effect to populations will be neutral since existing habitat is little used (based on movement studies that show fish such as LKST move through quickly). Fish that move into dewatered areas of Gull Rapids during spillway operation could be stranded when spillway operation ceases	Potential for stranding of fish that move in to forage during spillway operation will be mitigated through the construction of channels to connect isolated pools to a channel connected to Stephens Lake or other appropriate measures	None
								• Alteration of downstream movement corridor for all VEC fish species	Neutral/Harmful	Operation Phase: Permanent	Alteration of of flow patterns as a result of impoundment and presence of GS structures will result in changes in the downstream movement of larval, juvenile and adult fish. Net effect to population not known but is expected to be negligible for LKWH, NRPK and WALL due to large reproducing populations of these species in Stephens Lake. Effect to LKST may occur since there is little, if any reproduction in Stephens Lake.	Selection of turbine design that reduced mortality to adult fish (>90% survival of fish up to 500 mm in length). Spillway design does not include features commonly associated with increased mortality; therfore survival expected to be similar to existing river channel. The need for an alternate form of downstream fish passage/fish exclusion measures at the trashracks will be determined by DFO in consultation with MCWS after consideration of results of post-Project monitoring.[5]	Stocking of LKST in Stephens Lake will compensate for the loss of any larval/YOY fish that may enter from upstream in the existing environment
								• Loss of upstream movement corridor for all VEC fish species	Uncertain[5]	Operation Phase: Permanent	Presence of the GS will block upstream movements. The magnitude, timing and importance of these movements to maintaining a sustainable fishery has not been adequately defined for this site.[5]	Given incomplete knowledge, it is premature to warrant installation of a permanent upstream fish passage facility. The requirement for fish passage facilities will be determined by DFO, in consultation with MCWS, based on the results of monitoring conducted after the generating station is in operation.[5]	None
		Forebay - flooded Existing Environment land				-	462.93 (480.17 by Year 30)	• Gain in foraging and overwintering habitat for all VEC fish species	Positive	Operation Phase: Permanent	Creation of new permanently wetted fish habitat due to impoundment	None	None
	Gull to Birthday		3504.84	3787.15	4062.4	6965.43	8042.18						
								• Substrate in the reservoir shifts from 65% coarse, 35% fines in the Existing Environment to 18% coarse, 82% fines in the post-Project environment					
								• 146 – 359 ha of habitat with macrophytes will be lost from the reservoir immediately following impoundment. By Year 30, macrophytes are predicted to occupy 139.6 – 187.8 ha of the reservoir					

Area	Sub-Area	Activity/Concern	Existing Environment (wetted ha)			Post-Project (wetted ha)		Type of Change	Nature of Change	Duration	Rationale/Explanation	Mitigation	Proposed offsets
			Minimum	Median	Maximum	Minimum	Maximum[1]						
								• Alteration and loss of access to existing LKST YOY rearing habitat Area of habitat alteration/loss = 44 ha	Harmful	Operation Phase: Permanent	Decreased water velocities in Gull Lake as a result of impoundment will result in silt deposition over existing sandy areas of YOY rearing habitat and prevent larval LKST from accessing these areas. Decreased velocity at the entrance to present day Gull Lake may create an alternate suitable location for YOY that would be accessible to larval sturgeon spawned in Birthday Rapids and further upstream	None	Stocking of LKST into Gull Lake will help offset potential effects of reduced YOY habitat accessibilty. If monitoring reveals that LKST YOY have not found other suitable rearing habitat in the reservoir, 20-40 ha of habitat will be created through the placement of sand substrate in an area of Gull Lake with suitable velocities
								• Loss of foraging and spawning habitat for NRPK	Harmful	Operation Phase: Short term (up to 15 y)	Loss of macrophyte beds as a result of impoundment; these beds will re-establish within 5-15 years	None	None
								• Loss of spawning habitat for LKWH and WALL in Gull Lake	Harmful	Operation Phase: Permanent	Homongenization of habitat conditions in reservoir, particularly reduction in shoal habitat. Effects to LKWH and WALL will last only until proposed offset habitat is constructed	None	Coarse materials placed in areas with suitable flows to create approximately 3 ha of spawning shoals for LKWH and WALL
								• Alteration of sub-adult LKST foraging habitat	Neutral	Operation Phase: Permanent	Silt deposition through much of the present-day Gull Lake will reduce amount of preferred habitat for sub-adult LKST. Loss of preferred habitat will be offset by a general increase in the amount of habitat in the reservoir due to reduced water velocity.	None	None
								• Alteration of adult LKST foraging habitat	Harmful	Operation Phase: Medium term	The noise and increase in water level associated with construction may cause LKST to move either upstream or downstream out of the area	None	Stocking of LKST into Gull Lake will help offset population loss that results from emigration.
									Neutral	Operation Phase: Permanent	Impoundment will change water depth and velocity but foraging habitat in the original river channel/ Gull Lake will still be suitable and accessible	None	None
								• Creation of low quality fish habitat in flooded terrestrial habitat for all VEC fish species (immediately following impoundment) Area of habitat creation = 3969.26 ha	Neutral	Operation Phase: Medium term (10-15 y)	Flooding of terrestrial vegetation and peat erosion, resurfacing and deposition will create poor DO and TSS conditions in backbay areas of reservoir, limiting value of fish habitat for 10-15 years following impoundment.	None	None
									Harmful/Uncertian	Operation Phase: Medium term (varies depending on species)	Flooding of terrestrial vegetation and peat erosion, resurfacing and deposition will lead to increased bioavailability of mercury, which will result in increased mercury concentrations in fish. Increased mercury levels in NRPK and WALL will negatively impact the domestic and potential commercial fisheries for approximately 20-30 years due to concerns regarding human health. Increased dietary mercury concentrations for predatory fish species may also affect their health.	Education of the public regarding the potential risks of consuming fish with high concentrations of mercury in their flesh, and the provision of local domestic resource users with access to off-system waterbodies for fishing. Monitoring will be conducted to determine post-Project levels of mercury in the flesh of forage fish species, and assess potential effects to predatory species.	None
								• Gain in foraging and overwintering habitat for all VEC fish species (by Year 30) Area of habitat creation = 4627.05 ha[6]	Positive	Operation Phase: Permanent	Creation of new permanently wetted fish habitat due to impoundment	None	None
	Little Gull Lake[7]		no value	no value	0.30	no value	included in "Gull to Birthday" post-Project area, as creek becomes part of the reservoir	• Potential trapping of NRPK during winter	Harmful	Operation Phase: Long term	Fish may become trapped in a northern bay (formerly Little Gull Lake) when ice freezes to bottom over shallow areas and may be susceptible to winterkill if low DO conditions develop. Species such as NRPK, which favour shallow, vegetated habitat, would be most at risk.	Construction of escape channels to maintain year-round connection to main reservoir	None
	Effie Creek[7]		no value	no value	0.51	no value	included in "Gull to Birthday" post-Project area, as creek becomes part of the reservoir	• Alteration of spawning habitat for NRPK	Neutral	Operation Phase: Long term	Flooding of lower reaches will result in loss of suitable NRPK spawning habitat, but habitat will continue to be available around flooded tributary mouths	Access to tributaries will be maintained by removing accumulations of debris	None
	Seebeesis Creek[7]		no value	no value	5.82	no value	included in "Gull to Birthday" post-Project area, as creek becomes part of the reservoir	• Alteration of spawning habitat for NRPK	Neutral	Operation Phase: Long term	Flooding of lower reaches will result in loss of suitable NRPK spawning habitat, but habitat will continue to be available around flooded tributary mouths	Access to tributaries will be maintained by removing accumulations of debris	None
	Hidden Creek[7]		no value	no value	0.32	no value	included in "Gull to Birthday" post-Project area, as creek becomes part of the reservoir	• Alteration of spawning habitat for NRPK	Neutral	Operation Phase: Long term	Flooding of lower reaches will result in loss of suitable NRPK spawning habitat, but habitat will continue to be available around flooded tributary mouths and in upstream unflooded reaches	Access to tributaries will be maintained by removing accumulations of debris	None
	Rabbit Creek[7]		no value	no value	2.79	no value	included in "Gull to Birthday" post-Project area, as creek becomes part of the reservoir	• Alteration of spawning habitat for NRPK	Neutral	Operation Phase: Long term	Flooding of lower reaches will result in loss of suitable NRPK spawning habitat, but habitat will continue to be available around flooded tributary mouths	Access to tributaries will be maintained by removing accumulations of debris	None

Area	Sub-Area	Activity/Concern	Existing Environment (wetted ha)			Post-Project (wetted ha)		Type of Change	Nature of Change	Duration	Rationale/Explanation	Mitigation	Proposed offsets
			Minimum	Median	Maximum	Minimum	Maximum[1]						
	Trickle Creek[7]		no value	no value	0.13	no value	included in "Gull to Birthday" post-Project area, as creek becomes part of the reservoir	• Alteration of spawning habitat for NRPK	Neutral	Operation Phase: Long term	Flooding of lower reaches will result in loss of suitable NRPK spawning habitat, but habitat will continue to be available around flooded tributary mouths and in upstream unflooded reaches	Access to tributaries will be maintained by removing accumulations of debris	None
	Portage Creek[7]		no value	no value	0.48	no value	included in "Gull to Birthday" post-Project area, as creek becomes part of the reservoir	• Alteration of spawning habitat for NRPK	Neutral	Operation Phase: Long term	Flooding of lower reaches will result in loss of suitable NRPK spawning habitat, but habitat will continue to be available around flooded tributary mouths and in upstream unflooded reaches	Access to tributaries will be maintained by removing accumulations of debris	None
								• Loss of diversity of habitat for forage fish species Area of habitat alteration = 0.48 ha	Neutral	Operation Phase: Long term	Flooding of riffle and run habitat in lower reaches due to impoundment; habitat will continue to be available in unflooded upstream reaches	Access to tributaries will be maintained by removing accumulations of debris	None
	Two Goose Creek[7]		no value	no value	0.07	no value	included in "Gull to Birthday" post-Project area, as creek becomes part of the reservoir	• Alteration of spawning habitat for NRPK	Neutral	Operation Phase: Long term	Flooding of lower reaches will result in loss of suitable NRPK spawning habitat, but habitat will continue to be available around flooded tributary mouths and in upstream unflooded reaches	Access to tributaries will be maintained by removing accumulations of debris	None
								• Loss of diversity of habitat for forage fish species Area of habitat alteration = 0.07 ha	Neutral	Operation Phase: Long term	Flooding of riffle and run habitat in lower reaches due to impoundment; habitat will continue to be available in unflooded upstream reaches	Access to tributaries will be maintained by removing accumulations of debris	None
	Nap Creek[7]		no value	no value	0.10	no value	included in "Gull to Birthday" post-Project area, as creek becomes part of the reservoir	• Alteration of spawning habitat for NRPK	Neutral	Operation Phase: Long term	Flooding of lower reaches will result in loss of suitable NRPK spawning habitat, but habitat will continue to be available around flooded tributary mouths and in upstream unflooded reaches	Access to tributaries will be maintained by removing accumulations of debris	None
	Birthday Rapids		5.33	6.10	6.59	6.19	7.01	• Alteration of movement corridor for all VEC fish species	Neutral	Operation Phase: Permanent	Changes in depth and flow patterns at Birthday Rapids could faciliate the movement of fish over the rapids	None	None
								• Alteration of spawning habitat for LKWH and WALL	Neutral	Operation Phase: Permanent	Alteration of habitat due to increased depth and changes in flow patterns as a result of impoundment; alternate suitable habitat will still be available	None	None
								• Alteration of spawning habitat for LKST	Neutral/Harmful	Operation Phase: Permanent	Changes in depth and flow patterns at Birthday Rapids, particularly the loss of white water, may create conditions that are no longer attractive to spawning LKST.	Monitoring to determine whether LKST continue to spawn at Birthday Rapids	An option is being considered to create white water at Birthday Rapids to attract spawning fish if monitoring indicates that sturgeon no longer spawn in the vicinity of Birthday Rapids. The option entails adding large boulders/structures at locations slightly upstream of the current spawning site at Birthday Rapids.
	Birthday to Long Rapids		428.30	447.25	463.17	436.71	469.85	• No/minimal change					
	Fork Creek[8]		no value	no value	no value	no value	no value	• No change					
	Long Rapids[9]		186.65	192.30	200.14	186.75	201.18	• No change					
At the Station	Gull Rapids		14.9	14.9	14.9								
		Cofferdams	-	-	-	-	14.9*	• Partial loss of spawning habitat for LKWH, WALL, and LKST[3]	Harmful	Construction Phase: Short term (up to 5.5 y)	Dewatered parts of Gull Rapids habitat will no longer be suitable for spawning by these species, and remaining wetted areas will experience a significant change in velocities and depth during certain periods of construction.	Avoidance of instream construction during sensitive spawning periods, where practicable; fish salvage prior to dewatering; application of blasting guidelines; measures to reduce effects to water quality	LKST stocking and habitat creation will take place during the construction and operation phases.
								• Partial loss/alteration of foraging habitat for LKWH, WALL and LKST[4]	Neutral	Construction Phase: Short term (up to 5.5 y)	Construction of GS/impoundment will substantially alter/destroy habitat for foraging. However, effect to populations will be neutral since existing habitat is little used (based on movement studies that show fish such as LKST move through quickly). Fish that move into dewatered areas of Gull Rapids during spillway operation could be stranded when spillway operation ceases	Fish salvage prior to dewatering; application of blasting guidelines; measures to reduce effects to water quality	None
								• Partial alteration of downstream movement corridor for all VEC fish species	Neutral	Construction Phase: Short term (up to 5.5 y)	Fish are expected to still be able to move downstream through Gull Rapids during the construction phase	None	None
								• Partial loss of upstream movement corridor for all VEC fish species	Uncertain[5]	Construction Phase: Short term (up to 5.5 y)	Presence of the GS and associated construction infrastructure will block upstream movements during certain periods of construction. The magnitude, timing and importance of these movements to maintaining a sustainable fishery has not been adequately defined for this site.[5]	Given incomplete knowledge, it is premature to warrant installation of a permanent upstream fish passage facility. The requirement for fish passage facilities will be determined by DFO, in consultation with MCWS, based on the results of monitoring conducted after the generating station is in operation.[5]	None

Area	Sub-Area	Activity/Concern	Existing Environment (wetted ha)			Post-Project (wetted ha)		Type of Change	Nature of Change	Duration	Rationale/Explanation	Mitigation	Proposed offsets
			Minimum	Median	Maximum	Minimum	Maximum[1]						
		Powerhouse/ancillary facilities/spillway/dams/dykes	-	-	-	-	14.9	• Loss of spawning habitat for LKWH, WALL and LKST[3]	Harmful	Operation Phase: Permanent	Habitat in Gull Rapids will no longer be suitable for spawning by these species. Loss of Gull Rapids will eliminate all spawning habitat for LKST and a portion of available spawning habitat for WALL and LKWH in Stephens Lake.	In those years when flow downstream of the spillway may attract spawning LKST, egg deposition will be monitored; in cases of successful deposition, the minimum amount of spillway discharge necessary to permit survival and hatch of the eggs and drift of larval LKST from the site will be maintained.	Approximately 5 ha of replacement LKST spawning habitat will be constructed along the north shore of the tailrace. A reef of coarse material will be constructed along the south shore to create approximately 0.1 ha of spawning habitat for LKWH. WALL are expected to use both spawning habitats. LKST will be stocked into Stephens Lake to offset any lost year classes that may result if the spawning structure requires modification to make it more suitable.
								• Loss/alteration of foraging habitat for LKWH, WALL and LKST[4]	Neutral	Operation Phase: Permanent	Construction of GS/impoundment will substantially alter/destroy habitat for foraging. However, effect to populations will be neutral since existing habitat is little used (based on movement studies that show fish such as LKST move through quickly). Fish that move into dewatered areas of Gull Rapids during spillway operation could be stranded when spillway operation ceases	Potential for stranding of fish that move in to forage during spillway operatoin will be mitigated through the construction of channels to connect isolated pools to a channel connected to Stephens Lake or other appropriate measures	None
								• Alteration of downstream movement corridor for all VEC fish species	Neutral/Harmful	Operation Phase: Permanent	Alteration of of flow patterns as a result of impoundment and presence of GS structures will result in changes in the downstream movement of larval, juvenile and adult fish. Net effect to population not known but is expected to be negligible for LKWH, NRPK and WALL due to large reproducing populations of these species in Stephens Lake. Effect to LKST may occur since there is little, if any reproduction in Stephens Lake.	Selection of turbine design that reduced mortality to adult fish (>90% survival of fish up to 500 mm in length). Spillway design does not include features commonly associated with increased mortality; therfore survival expected to be similar to existing river channel. The need for an alternate form of downstream fish passage/fish exclusion measures at the trashracks will be determined by DFO in consultation with MCWS after consideration of results of post-Project monitoring.[5]	Stocking of LKST in Stephens Lake will compensate for the loss of any larval/YOY fish that may enter from upstream in the existing environment
								• Loss of upstream movement corridor for all VEC fish species	Uncertain[5]	Operation Phase: Permanent	Presence of the GS will block upstream movements. The magnitude, timing and importance of these movements to maintaining a sustainable fishery has not been adequately defined for this site.[5]	Given incomplete knowledge, it is premature to warrant installation of a permanent upstream fish passage facility. The requirement for fish passage facilities will be determined by DFO, in consultation with MCWS, based on the results of monitoring conducted after the generating station is in operation.[5]	None
		Forebay	-	-	-	-	5.91	• Creation of fish habitat over permanent structures built on land	Neutral	Operation Phase: Permanent	Upstream side of permanent structures built on land "At the Station" will be flooded following impoundment, creating fish habitat	None	None
Downstream	Gull Rapids		169.27	175.46	186.84								

Area	Sub-Area	Activity/Concern	Existing Environment (wetted ha)			Post-Project (wetted ha)		Type of Change	Nature of Change	Duration	Rationale/Explanation	Mitigation	Proposed offsets
			Minimum	Median	Maximum	Minimum	Maximum[1]						
		Outlet channels[2,10]	-	-	-	-	9.97	• Loss of spawning habitat for LKWH, WALL and LKST[3]	Harmful	Operation Phase: Permanent	Habitat in Gull Rapids will no longer be suitable for spawning by these species. Loss of Gull Rapids will eliminate all spawning habitat for LKST and a portion of available spawning habitat for WALL and LKWH in Stephens Lake.	In those years when flow downstream of the spillway may attract spawning LKST, egg deposition will be monitored; in cases of successful deposition, the minimum amount of spillway discharge necessary to permit survival and hatch of the eggs and drift of larval LKST from the site will be maintained.	Approximately 5 ha of replacement LKST spawning habitat will be constructed along the north shore of the tailrace. A reef of coarse material will be constructed along the south shore to create approximately 0.1 ha of spawning habitat for LKWH. WALL are expected to use both spawning habitats. LKST will be stocked into Stephens Lake to offset any lost year classes that may result if the spawning structure requires modification to make it more suitable.
								• Loss/alteration of foraging habitat for LKWH, WALL and LKST[4]	Neutral	Operation Phase: Permanent	Construction of GS/impoundment will substantially alter/destroy habitat for foraging. However, effect to populations will be neutral since existing habitat is little used (based on movement studies that show fish such as LKST move through quickly). Fish that move into dewatered areas of Gull Rapids during spillway operation could be stranded when spillway operation ceases	Potential for stranding of fish that move in to forage during spillway operatoin will be mitigated through the construction of channels to connect isolated pools to a channel connected to Stephens Lake or other appropriate measures	None
								• Alteration of downstream movement corridor for all VEC fish species	Neutral/Harmful	Operation Phase: Permanent	Alteration of of flow patterns as a result of impoundment and presence of GS structures will result in changes in the downstream movement of larval, juvenile and adult fish. Net effect to population not known but is expected to be negligible for LKWH, NRPK and WALL due to large reproducing populations of these species in Stephens Lake. Effect to LKST may occur since there is little, if any reproduction in Stephens Lake.	Selection of turbine design that reduced mortality to adult fish (>90% survival of fish up to 500 mm in length). Spillway design does not include features commonly associated with increased mortality; therfore survival expected to be similar to existing river channel. The need for an alternate form of downstream fish passage/fish exclusion measures at the trashracks will be determined by DFO in consultation with MCWS after consideration of results of post-Project monitoring.[5]	Stocking of LKST in Stephens Lake will compensate for the loss of any larval/YOY fish that may enter from upstream in the existing environment
								• Loss of upstream movement corridor for all VEC fish species	Uncertain[5]	Operation Phase: Permanent	Presence of the GS will block upstream movements. The magnitude, timing and importance of these movements to maintaining a sustainable fishery has not been adequately defined for this site.[5]	Given incomplete knowledge, it is premature to warrant installation of a permanent upstream fish passage facility. The requirement for fish passage facilities will be determined by DFO, in consultation with MCWS, based on the results of monitoring conducted after the generating station is in operation.[5]	None
		Cofferdams/Downstream Dewatered Area	-	-	-	-	120.69*	• Partial loss of spawning habitat for LKWH, WALL, and LKST[3]	Harmful	Construction Phase: Short term (up to 5.5 y)	Dewatered parts of Gull Rapids habitat will no longer be suitable for spawning by these species, and remaining wetted areas will experience a significant change in velocities and depth during certain periods of construction.	Avoidance of instream construction during sensitive spawning periods, where practicable; fish salvage prior to dewatering; application of blasting guidelines; measures to reduce effects to water quality	LKST stocking and habitat creation will take place during the construction and operation phases.
								• Partial loss/alteration of foraging habitat for LKWH, WALL and LKST[4]	Neutral	Construction Phase: Short term (up to 5.5 y)	Construction of GS/impoundment will substantially alter/destroy habitat for foraging. However, effect to populations will be neutral since existing habitat is little used (based on movement studies that show fish such as LKST move through quickly). Fish that move into dewatered areas of Gull Rapids during spillway operation could be stranded when spillway operation ceases	Fish salvage prior to dewatering; application of blasting guidelines; measures to reduce effects to water quality	None
								• Partial alteration of downstream movement corridor for all VEC fish species	Neutral	Construction Phase: Short term (up to 5.5 y)	Fish are expected to still be able to move downstream through Gull Rapids during the construction phase	None	None
								• Partial loss of upstream movement corridor for all VEC fish species	Uncertain[5]	Construction Phase: Short term (up to 5.5 y)	Presence of the GS and associated construction infrastructure will block upstream movements during certain periods of construction. The magnitude, timing and importance of these movements to maintaining a sustainable fishery has not been adequately defined for this site.[5]	Given incomplete knowledge, it is premature to warrant installation of a permanent upstream fish passage facility. The requirement for fish passage facilities will be determined by DFO, in consultation with MCWS, based on the results of monitoring conducted after the generating station is in operation.[5]	None

Area	Sub-Area	Activity/Concern	Existing Environment (wetted ha)			Post-Project (wetted ha)		Type of Change	Nature of Change	Duration	Rationale/Explanation	Mitigation	Proposed offsets
			Minimum	Median	Maximum	Minimum	Maximum[1]						
		Permanently Dewatered Area/Spillway Outlet Channel	-	-	-	-	101.34	• Loss of spawning habitat for LKWH, WALL, and LKST[3]	Harmful	Operation Phase: Permanent	Habitat in Gull Rapids will no longer be suitable for spawning by these species. Loss of Gull Rapids will eliminate all spawning habitat for LKST and a portion of available spawning habitat for WALL and LKWH in Stephens Lake.	In those years when flow downstream of the spillway may attract spawning LKST, egg deposition will be monitored; in cases of successful deposition, the minimum amount of spillway discharge necessary to permit survival and hatch of the eggs and drift of larval LKST from the site will be maintained.	Approximately 5 ha of replacement LKST spawning habitat will be constructed along the north shore of the tailrace. A reef of coarse material will be constructed along the south shore to create approximately 0.1 ha of spawning habitat for LKWH. WALL are expected to use both spawning habitats. LKST will be stocked into Stephens Lake to offset any lost year classes that may result if the spawning structure requires modification to make it more suitable. Additional measures specifically targeting habitat loss in permanently dewatered area as specificed in attached document.
								• Loss/alteration of foraging habitat for LKWH, WALL and LKST[4]	Neutral	Operation Phase: Permanent	Construction of GS/impoundment will substantially alter/destroy habitat for foraging. However, effect to populations will be neutral since existing habitat is little used (based on movement studies that show fish such as LKST move through quickly). Fish that move into dewatered areas of Gull Rapids during spillway operation could be stranded when spillway operation ceases	Potential for stranding of fish that move in to forage during spillway operation will be mitigated through the construction of channels to connect isolated pools to a channel connected to Stephens Lake or other appropriate measures	None
								• Alteration of downstream movement corridor for all VEC fish species	Neutral/Harmful	Operation Phase: Permanent	Alteration of of flow patterns as a result of impoundment and presence of GS structures will result in changes in the downstream movement of larval, juvenile and adult fish. Net effect to population not known but is expected to be negligible for LKWH, NRPK and WALL due to large reproducing populations of these species in Stephens Lake. Effect to LKST may occur since there is little, if any reproduction in Stephens Lake.	Selection of turbine design that reduced mortality to adult fish (>90% survival of fish up to 500 mm in length). Spillway design does not include features commonly associated with increased mortality; therfore survival expected to be similar to existing river channel. The need for an alternate form of downstream fish passage/fish exclusion measures at the trashracks will be determined by DFO in consultation with MCWS after consideration of results of post-Project monitoring.[5]	Stocking of LKST in Stephens Lake will compensate for the loss of any larval/YOY fish that may enter from upstream in the existing environment
								• Loss of upstream movement corridor for all VEC fish species	Uncertain[5]	Operation Phase: Permanent	Presence of the GS will block upstream movements. The magnitude, timing and importance of these movements to maintaining a sustainable fishery has not been adequately defined for this site.[5]	Given incomplete knowledge, it is premature to warrant installation of a permanent upstream fish passage facility. The requirement for fish passage facilities will be determined by DFO, in consultation with MCWS, based on the results of monitoring conducted after the generating station is in operation.[5]	None
		Altered flows	-	-	-	-	72.92	• Loss of spawning habitat for LKWH, WALL, and LKST[3]	Neutral/Harmful	Operation Phase: Permanent	Habitat in Gull Rapids will no longer be suitable for spawning by these species. Loss of Gull Rapids will eliminate all spawning habitat for LKST and a portion of available spawning habitat for WALL and LKWH in Stephens Lake.	In those years when flow downstream of the spillway may attract spawning LKST, egg deposition will be monitored; in cases of successful deposition, the minimum amount of spillway discharge necessary to permit survival and hatch of the eggs and drift of larval LKST from the site will be maintained.	Approximately 5 ha of replacement LKST spawning habitat will be constructed along the north shore of the tailrace. A reef of coarse material will be constructed along the south shore to create approximately 0.1 ha of spawning habitat for LKWH. WALL are expected to use both spawning habitats. LKST will be stocked into Stephens Lake to offset any lost year classes that may result if the spawning structure requires modification to make it more suitable.
								• Loss/alteration of foraging habitat for LKWH, WALL and LKST[4]	Neutral	Operation Phase: Permanent	Construction of GS/impoundment will substantially alter/destroy habitat for foraging. However, effect to populations will be neutral since existing habitat is little used (based on movement studies that show fish such as LKST move through quickly). Fish that move into dewatered areas of Gull Rapids during spillway operation could be stranded when spillway operation ceases	Potential for stranding of fish that move in to forage during spillway operatoin will be mitigated through the construction of channels to connect isolated pools to a channel connected to Stephens Lake or other appropriate measures	None
		Flooded Existing Environment land (within tailrace outlet channel)	-	-	-	-	2.27	• Creation of fish habitat over permanent structures built on land	Neutral	Operation Phase: Permanent	Portion of the tailrace outlet channel built on land that will be flooded following impoundment, creating fish habitat	None	None

Area	Sub-Area	Activity/Concern	Existing Environment (wetted ha)			Post-Project (wetted ha)		Type of Change	Nature of Change	Duration	Rationale/Explanation	Mitigation	Proposed offsets
			Minimum	Median	Maximum	Minimum	Maximum[1]						
	Gull Rapids Creek[7]		no value	no value	0.53	no value	0.53	• Loss of movement corridor at Gull Rapids Creek for forage fish	Neutral	Operation Phase: Permanent	Dewatering of a portion of the south channel of Gull Rapids will result in the isolation of Gull Rapids Creek from the Nelson River. Current contribution of forage fish from Gull Rapids Creek to Stephens Lake is negligible.	None	None
	Gull Rapids to Stephens Lake[9]		560.17	560.16	560.23	no value	560.08	• Alteration of foraging habitat for WALL, NRPK, LKST and forage fish Due to deposition along shorlines, substrate in this reach shifts from 68% coarse, 32% fines in the Existing Environment to 48% coarse, 52% fines in the post-Project environment[11]	Neutral	Operation Phase: Permanent	Changes in the distribution of velocity downstream of the GS are not expected to have an effect on fish foraging. Small areas of sediment deposition are expected along shorelines due to resdistribution of flows. No change is expected to the sand lens at the inlet to Stephens Lake that currently provides habitat for YOY LKST. Cycling of the GS will cause small daily changes in water levels in the tailrace which will not result in fish stranding due to the steep shorelines in the tailrace area	No effects to habitat expected but will be monitored to confirm	None
	Stephens Lake		no values[12]					There will be no change in fish habitat in Stephens Lake. Deposition of a 0.1 to 0.6 centimetre layer of sediment in Stephens Lake, mostly near the inflow of the Nelson River, is not expected to change the substrate composition (i.e., sand will settle on sand, silt on silt)	N/A	N/A	While there is no change to habitat in Stephens Lake, fish populations in Stephens Lake may be affected by changes at Gull Rapids and the Gull Rapids to Stephens Lake reach of the Nelson River. These are addressed in the sections above.	None	None
		Causeways[13]	-	-	-	-	1.02	• South causeway crosses movement corridor for WALL and a few NRPK and LKWH; limited potential for other uses as primarily scoured bedrock. North causeway crosses backwater channel that provides habitat for NRPK and forage fish.	Neutral	Short term (up to 5.5 y)	The north and south causeways will be built in channels that are undergoing active shoreline change. In 2001, Pond 13 was a small waterbody connected to the Nelson River downstream of Gull Rapids by a braided channel and connected to O'Neil Bay of Stephens Lake through a channel near the mouth of Looking Back Creek. Since 2004, both channels have eroded due to ice dam formation in Stephens Lake and subsequent back flooding from the lake into the channel. As a result, there is a year-round connection between the Nelson River and O'Neil Bay through Pond 13 under high Stephens Lake water levels. Construction of south causeway will disrupt movement by WALL from Nelson River to bays of Stephens Lake/Looking Back Creek (alternate access available); construction of north causeway will temporarily fill low sensitivity backwater habitat.	Installation of culverts to maintain fish passage; avoidance of instream construction during sensitive spawning periods, where practicable; measures to reduce effects to water quality	Rocky shoal habitat creation using remnants from the causeways will diversify habitat within the 1.02 ha footprint of the causeways, and create conditions suitable for WALL spawning at south causeway

Footnotes:

* - the areas included within the Construction Phase (cofferdams) are always subsets of the Operation Phase areas of effect
1 - areas of effect for structures were only calculated at 95th percentile flows, as areas would be very similar under all flows.
2 - area provided includes only the portions of the channels that are within existing aquatic habitat
3 - only a portion of the habitat within Gull Rapids is suitable for LKWH, WALL or LKST spawning, but due to site conditions a more precise assessment is not feasible
4 - only a portion of the habitat within Gull Rapids is suitbale for LKWH, WALL or LKST foraging, and available habitat appears to be used rarely
5 - As per correspondence from Dale Nicholson, Juy 12, 2013
6 - includes 3969.26 ha of fish habitat that is low quality immediately following impoundment but becomes suitable over time
7 - tributary areas were not modelled under different percentile flows; the single EE wetted area was calculated based on measured wetted width during 2003 habitat studies times length of innundated area
8 - area measurements not available for this creek
9 - slight differences in area between the EE and PP are due to the fact that the existing environment and post-Project shoreline calculations were based on two different input flow files. No actual change to habitat area is predicted.
10 - this area includes only the tailrace; the spillway channel has been included in the "Permanently Dewatered Area"
11 - substrate data were not collected for 80 ha of the "Gull Rapids to Stephens Lake" area, and were therefore excluded from the percent substrate composition calculation
12 - surface areas of Stephens Lake under different flow regimes are not available
13 - areas were calculated using 2004 Quickbird shorline imagery; discussions with DFO will determine whether area calculations for the purpose of the Fisheries Act Authorization should be calculated using 2010 shoreline data

DFO impact questions

1 expected quantity, type and sensitivity of fish habitat to be changed
2 expected sources and estimates of fish mortality
3 expected impacts from flow changes
4 expected passage or migration impacts

notes

Special emphasis on Lake Sturgeon as a COSEWIC endangered species and potential SARA endangered species
VEC aquatic species are Lake Sturgeon, Lake Whitefish, Walleye, and Northern Pike
Thirty-three other species are known to occur

REFERENCE: Volume: N/A; Section: N/A; Page No.: N/A

TAC Public Rd 3 DFO-0002

ROUND 1 PREAMBLE AND QUESTION:

"No analysis of trends in aquatic habitat was conducted, since the water regime was established in 1977 and has been operated within set bounds since that time."

However, has aquatic habitat and changes in fish stocks changed since 1977, despite apparent constancy in water regime? Moreover, habitat changes were not actually assessed to support this claim. Can the existing environment be adequately portrayed if not assessed/sampled? This also does not account for natural changes in habitat with flow events outside of regulation. For example, a flow/ice event approximately 10 years ago changed the flow patterns at Gull Rapids, creating a new channel that flows northeast to Stephens Lake. Please consider the entire period of record for analyses.

ROUND 2 PREAMBLE AND QUESTION:

No additional information provided.

FOLLOW-UP QUESTION:

Please see DFO-0001. While pre-CRD conditions may not be quantifiable, qualitative descriptions of areas in the hydraulic zone of influence/aquatic impact study area can perhaps be summarized.

RESPONSE:

Water regime data is at the end of this response.

As stated in Section 7.5.1.1.2 of the 'Response to EIS Guidelines' (p. 7-16):

> "Changes to the aquatic environment began with the first hydroelectric station, completed in 1961 at the Kelsey Rapids on the Nelson River upstream of Split Lake. The CRD and LWR, completed in the mid-1970s, altered the aquatic environment of the entire Nelson River. The reach of the river between Gull Rapids and Kettle Rapids was converted to a reservoir environment by construction of the Kettle GS, which was completed in 1974."

A summary of changes to water levels and flows in the Nelson River as a result of CRD and LWR and existing environment inflows are provided in the attached pdf.

The remainder of this submission provides an overview of effects of previous hydroelectric development on aquatic habitat, fish populations, and fisheries.

A description of the changes to aquatic habitat caused by the Kelsey GS, the Kettle GS, and CRD/LWR is provided in Section 3.3.1 of the 'Aquatic Environment Supporting Volume (p. 3-11 to 3-12):

Split Lake Area

The Kelsey GS (completed in 1961) did not significantly affect Split Lake because the station is operated as a run-of-the-river GS and did not alter flows from the upper Nelson River (Split Lake Cree - Manitoba Hydro Joint Study Group 1996b). Schlick (1968) calculated the total lake area of Split Lake to be 283.9 square kilometres (km^2) and described the lake as relatively shallow, with an average depth of 7.0 m and a maximum depth of 29.9 m. After 1976, LWR resulted in a seasonal reversal of flows and levels on the lake and CRD increased flows entering from the Burntwood River. CRD resulted in an eight-fold increase in average annual flows on the Burntwood River upstream of First Rapids (Split Lake Cree - Manitoba Hydro Joint Study Group 1996b). Water levels on Split Lake prior to CRD/LWR were higher in summer, while in the post-project, they average 0.7 m higher (at the community of Split Lake) in winter. During the post-project period, water levels on Split Lake decreased by an average of 0.2 m during the summer and increased by 0.8 m during winter; however the range of water levels did not change noticeably. Annual flows in Split Lake increased by about 167 cubic metres per second (m^3/s). In 1989, Cherepak (1990) reported that the post-CRD/LWR water area of Split Lake was 269.8 km^2 and the mean and maximum depths of the lake were 4.5 and 23 m, respectively.

Keeyask Area

Impoundment of the Kettle GS reservoir in 1970 resulted in a backwater effect at Gull Rapids that typically ranges from 141.1 m ASL in winter to 139.2 m ASL in summer (Split Lake Cree - Manitoba Hydro Joint Study Group 1996b). CRD increased the average flow through the reach by 246 m^3/s, an increase of approximately 8%, and water levels increased marginally. LWR reversed the seasonal pattern of flow such that average flows are more similar during the summer and winter, with winter flows averaging about 194 m^3/s more than summer flows. Prior to regulation, average summer flows had been 892 m^3/s higher than winter flows. In the post-project period, there is now a greater range in water fluctuations.

Stephens Lake Area

Crowe (1973) estimated the surface area of the Nelson River between lower Gull Rapids and the Kettle dam prior to construction of the Kettle GS at

101.5 km^2. The impoundment of the Kettle GS reservoir resulted in the formation of Stephens Lake by flooding the existing river and lakes. Stephens Lake attained the full supply water level of the reservoir for the first time in 1971 when the water level immediately upstream of the GS increased by approximately 31.5 m (Split Lake Cree - Manitoba Hydro Joint Study Group 1996b). The reservoir surface area increased by about 263 km^2, or about 3.6 times that of surface area found within the extent of the reservoir before flooding (Cherepak 1990). In 1989, Cherepak (1990) reported that the post-CRD/LWR water surface area of Stephens Lake was 364.7 km^2 and the mean and maximum depths of the lake were 7.6 and 35 m, respectively. Changes in the shape of the shoreline in Stephens Lake during the period 1971–1997 are apparent from topographic mapping or aerial photography due to erosion of mineral soils and/or degradation or movement of organic soils within the reservoir. The changes in the shape, extent, and number of islands apparent in topographic maps are most notable in shallow bays.

Operation of the Kettle GS can noticeably affect short-term water levels on Stephens Lake. It is typically drawn down over a week, and has been drawn down by as much as 2.4 m in a one-month period (Split Lake Cree - Manitoba Hydro Joint Study Group 1996b). Although LWR resulted in a reversal of seasonal flows and water levels, these effects are not discernible due to the operation of the Kettle GS. Prior to regulation, average water levels were typically 0.9 m higher in summer compared to winter, whereas the reservoir is now operated such that winter levels are approximately 0.4 m higher than summer levels. CRD resulted in an increase of flows such that the average flow out of Stephens Lake has increased by 227 m^3/s.

KCNs Members have witnessed these changes to aquatic habitat first-hand:

“Beginning with CRD/LWR, seasonal flows and water levels changed such that high flows generally occur in the winter instead of the spring (CNP Keeyask Environmental Evaluation Report; FLCN Environment Evaluation Report (Draft)), and flooding has created some islands while destroying others (FLCN Environment Evaluation Report (Draft)). A visible reduction in the beaches on Split Lake has occurred (YFFN Evaluation Report [*Kipekiskwaywinan*]), shoreline erosion has been observed on Split, Clark, Gull and Stephens lakes (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c; YFFN Evaluation Report [*Kipekiskwaywinan*]; FLCN Environment Evaluation Report (Draft)), and increased levels of sedimentation have been reported in Split, Clark, and Gull lakes (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c). Finally, an increased amount of debris has been noted in the water and in fishing nets

> (Split Lake Cree – Manitoba Hydro Joint Study Group 1996a; FLCN 2008 Draft; CNP Keeyask Environmental Evaluation Report; YFFN Evaluation Report [*Kipekiskwaywinan*]; FLCN Environment Evaluation Report (Draft); SE SV), and deadheads and logs have settled on lake and river bottoms, further changing the nature of the bottom type (FLCN 2010 Draft)." *From Section 6.2.3.3.2. of the Response to EIS Guidelines (p. 6-61).*

Changes to aquatic habitat in the Kelsey to Kettle reach of the Nelson River directly affected fish populations in the area. Historical information on fish communities in the study area is largely limited to Split Lake and Stephens Lake (effects to Lake Sturgeon populations described separately below):

Split Lake Area

> "Operation of CRD has been linked to a reduction in walleye and an increase in sauger in Split Lake from 1973 to 1980 (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c). FLCN Members reported that prior to construction of the Kettle GS, Gull Rapids was a good location to harvest walleye and lake whitefish (FLCN Environmental Evaluation Report (Draft)). YFFN Members also noted a general decline in mooneye populations (YFFN and HTFC 2002). In Stephens Lake, construction of the Kettle GS, combined with CRD, are thought to have disturbed fish migration patterns and to have resulted in an increase in sucker populations (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c). Members of TCN and YFFN reported that hydroelectric development has resulted in fewer fish in Split and Clark lakes (except for sucker) and the Burntwood and Aiken rivers (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c; YFFN Evaluation Report [Kipekiskwaywinan]). YFFN Members also noted a general decline in mooneye populations (YFFN and HTFC 2002)." *From 'Response to EIS Guidelines' Section 6.2.3.3.5 (p. 6-67).*

> "Split Lake has been commercially fished since 1954. Since this time, the fishery has been an entirely summer operation, with lake whitefish being the dominant species. The fish community in Split Lake was first described by Schlick (1968) in 1966. By this time, the lake had already been affected by the Kelsey GS, which was constructed between 1957 and 1961." *From 'Aquatic Environment Supporting Volume' Section 5.3.1 (p. 5-4 and 5-6).*

> "An increase in walleye populations in Split Lake during the early 1970s was attributed to a reduction in fishing pressure resulting from the 1971 closure of the Split Lake commercial fishery for walleye and northern pike due to elevated mercury concentrations (unrelated to hydroelectric development; Ayles et al. 1974).""TCN Members stated that fishing on Split Lake has become increasingly

difficult due to high water levels and debris that fouls the nets (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c)." *From 'Response to EIS Guidelines' Section 6.2.3.3.5 (p. 6-67 to 6-69).*

Stephens Lake Area

"A commercial fishery operated intermittently on Stephens Lake between 1979 and 1994. No information was located describing the fish community of the pre-Stephens Lake waterbodies. In 1973, the Kettle Reservoir had among the poorest production of commercially important species of the Nelson River lakes, which was attributed to the recent development of the reservoir (Ayles et al. 1974). The dominant species at this time was lake whitefish, followed by walleye and cisco." *From 'Aquatic Environment Supporting Volume' Section 5.3.1 (p. 5-4 and 5-6).* "Currently, a walleye fishery operates under special permit on Stephens Lake." *From 'Response to EIS Guidelines' Section 6.2.3.3.5 (p. 6-69).*

"Domestic fishing occurs throughout the area, although KCN Members have indicated that they prefer to harvest in waters other than those along the Nelson River. Members reported greater numbers of fish with external lesions and growths and an increase in parasites following northern hydroelectric development (Split Lake – Manitoba Hydro Joint Study Group 1996a, 1996c; YFFN and HTFC 2002; FLCN 2010 Draft; YFFN Evaluation Report [Kipekiskwaywinan]; FLCN Environment Evaluation Report (Draft))." *From 'Response to EIS Guidelines' Section 6.2.3.3.5 (p. 6-67 to 6-69).*

"Recreational fishing occurs in locations that are easily accessible by boat or road (e.g., on Stephens Lake by the Gillam marina, North and South Moswakot rivers by the highway)." *From 'Response to EIS Guidelines' Section 6.2.3.3.5 (p. 6-69).*

Population trends for the fish communities in Split and Stephens Lake were evaluated and if was determined that:

"Comparison of historic and recent catch per unit effort (CUE; number of fish per set) values shows a decline in the total catch at both lakes (Figure 5-1). Whether this difference is due to variations in sampling methodologies or change in fish populations is unknown. There also appears to have been a shift in the fish community in both lakes since the 1980s. Although the CUE of several species have declined in both lakes (including cisco, lake whitefish, longnose sucker, and mooneye), the CUE of walleye and northern pike has increased substantially. The abundance of white sucker in Stephens Lake has remained relatively constant, with a slight increase in CUE in recent years, but has declined somewhat in Split Lake. In contrast to walleye populations, there has

> been little change observed in sauger abundance since the 1980s. In both lakes, the overall trend has been a shift in the fish community favouring those species that prefer lacustrine conditions (e.g., walleye, northern pike) with a reduction in the abundance of those that are adapted to riverine conditions (e.g., longnose sucker). Studies conducted as part of the Limestone GS Monitoring Program (Bretecher and MacDonell 2000; Johnson et al. 2004) have demonstrated that adaptation of fish populations to habitat changes can require decades.
>
> In addition to habitat-related changed caused by hydroelectric development (i.e., CRD/LWR, Kettle GS, Kelsey GS), fish populations in the study area have more recently been affected by the introduction of rainbow smelt. Rainbow smelt were first detected in Split and Stephens lakes in 1996 and currently account for up to 40% of the catch at Split Lake in small mesh gill nets and up to 12% of the catch in Stephens Lake. In addition to changing species composition, rainbow smelt are also affecting the diet of predatory species in these lakes. At present, rainbow smelt occur in up to 60% of the stomachs of predatory fish captured in standard gangs in Split Lake, and up to 30% of the piscivores captured in Stephens Lake.
>
> Due to the amount of time that fish populations require to adapt to habitat changes, combined with the ongoing effects of rainbow smelt introduction, it is expected that the fish populations in the study area are still evolving." *From 'Aquatic Environment Supporting Volume' Section 5.3.2.7 (p. 5-44).*

By the time that hydroelectric development came to the Nelson River, the Lake Sturgeon populations in the Kelsey to Kettle reach of the Nelson River had already been greatly affected by commercial fishing.

> "Commercial fishing of lake sturgeon on the Nelson River severely depleted populations both upstream and downstream of the Kelsey GS. Precise estimates of commercial harvest for the area directly affected by the Keeyask GS are not available as catches were recorded by river reach, but interviews with resource users indicate a substantial commercial harvest in Gull Lake in the late 1950s and that harvest continued in Stephens Lake following construction of the Kettle GS into the 1980s.)." *From 'Response to EIS Guidelines' Section 7.5.1.1.2 (p. 7-18).* The lake sturgeon commercial fishery in Manitoba was closed permanently in 1992. *From 'Response to EIS Guidelines" Section 6.2.3.3.5 (p. 6-71).*
>
> In addition to harvest, lake sturgeon in the Nelson River have been adversely affected by hydroelectric development. Both CRD and LWR were reported to have caused a decline in lake sturgeon numbers (Split Lake Cree – Manitoba

Hydro Joint Study Group 1996c). FLCN members stated that critical habitats were lost with each dam and fish could no longer move as freely within their natural habitat as they were able to prior to dam construction (FLCN 2009 Draft).” *From ‘Response to EIS Guidelines’ Section 7.5.1.1.2 (p. 7-18).*

“FLCN Members stated that prior to hydroelectric development lake sturgeon were plentiful and were harvested by Cree Nations along the entire stretch of the lower Nelson River system, particularly at the mouths of the larger tributaries (FLCN 2008 Draft). Notable fishing locations included Kettle Rapids (now the site of the Kettle GS; FLCN 2008 Draft), a former creek called Oskotowi Sipi (Moose Nose Lake area; FLCN 2009 Draft), and former rapids at “Indian Grave Channel” (FLCN 2009 Draft), which is located near the Moswakot rivers/Nelson River junction in Stephens Lake (FLCN 2010 Draft). Rapids between Gull Rapids and the Kettle GS (now flooded) were also important fishing areas for lake sturgeon (FLCN 2010 Draft). Lake sturgeon spawned at Kettle and Gull rapids, and the Butnau River provided important lake sturgeon habitat (FLCN 2009 Draft).

TCN Members reported that both CRD and LWR caused a decline in lake sturgeon abundance (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c). FLCN Members stated that critical habitats were lost with each dam and fish could no longer move as freely within their natural habitat as they were able to prior to dam construction (FLCN 2009 Draft). As each successive dam was built, there were fewer lake sturgeon (FLCN 2009 Draft), and populations downstream of generating stations declined sharply following impoundment (FLCN 2010 Draft).” “Overall, there are now fewer lake sturgeon in Stephens, Gull, and Clark lakes (Split Lake Cree – Manitoba Hydro Joint Study Group 1996c). In response to directions from WLFN Elders, lake sturgeon are now harvested in lower quantities to preserve their populations (CNP, YFFN and FLCN 2011), and only the occasional lake sturgeon is captured and used by the York Factory community (SE SV).” *From ‘Response to EIS Guidelines” Section 6.2.3.3.5 (p. 6-71 to 6-72).*

“Due to historic declines and concerns about a continuing decline in population numbers, COSEWIC designated lake sturgeon in the Nelson River as endangered, and this species is currently being considered for listing under the Species at Risk Act (SARA*).” From ‘Response to EIS Guidelines’ Section 7.5.1.1.2 (p. 7-18)*

“Certain characteristics of the lake sturgeon’s life history, such as a variable spawning interval for males and females, long time to maturity, and longevity (greater than 60 y), make it difficult to determine current population trends over the relatively short period during which investigations were conducted.

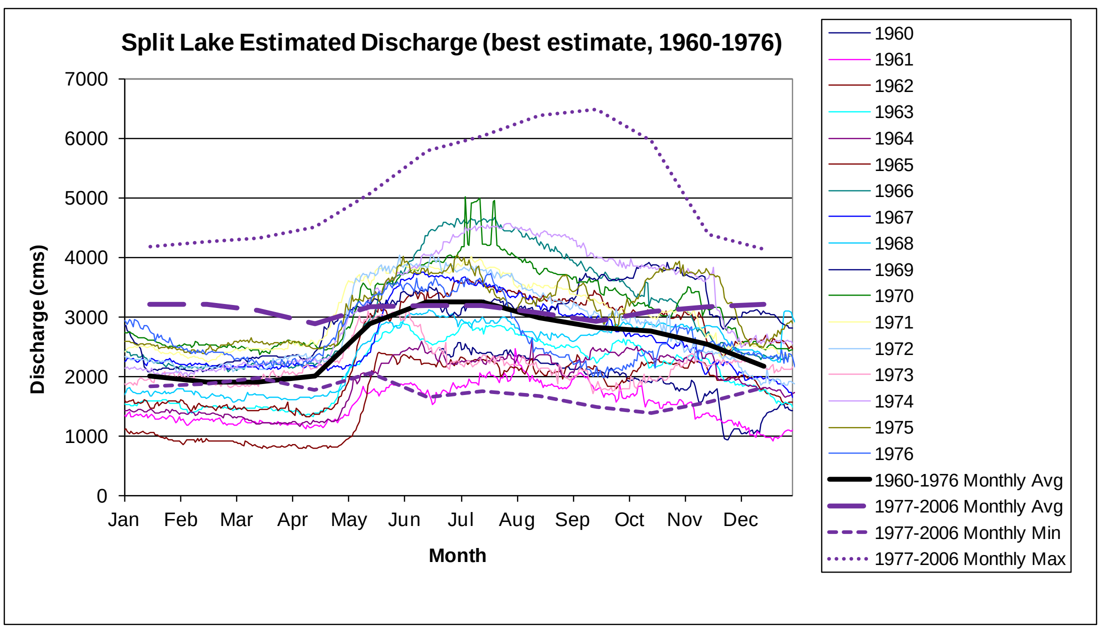
The presence of young fish indicates that recruitment is occurring. However, although habitat in the Clark Lake to Stephens Lake area currently supports all the life history requirements for lake sturgeon, population estimates are low, and the long-term sustainability of this population is uncertain. Numbers may be increasing in the Split Lake area, increasing the likelihood of the persistence of this population, if other factors (such as mortality) remain constant. The extremely small numbers of spawning sturgeon at Gull Rapids makes it unlikely that the Stephens Lake group is presently a self-sustaining population." *From 'Aquatic Environment Supporting Volume' Section 6.3.3 (p. 6-28).*

Below is the requested water regime data.

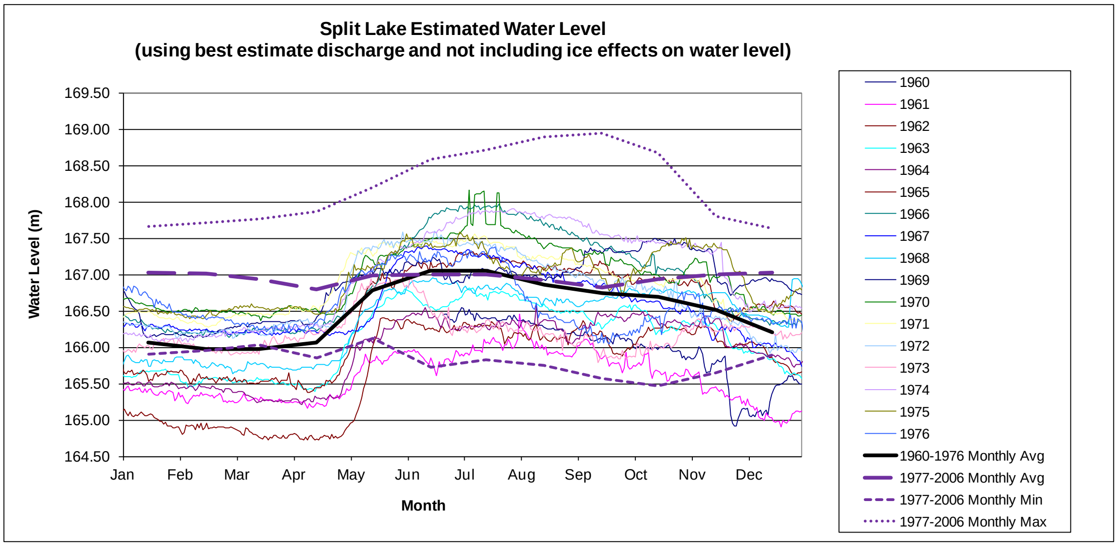
At the request of DFO, a best estimate of Split Lake inflows were developed for the time period 1960 to 1976 for the purpose of comparing the water regime during this time period to that of the time period used to characterize the existing environment water regime for the Keeyask EIS (1977-2006).

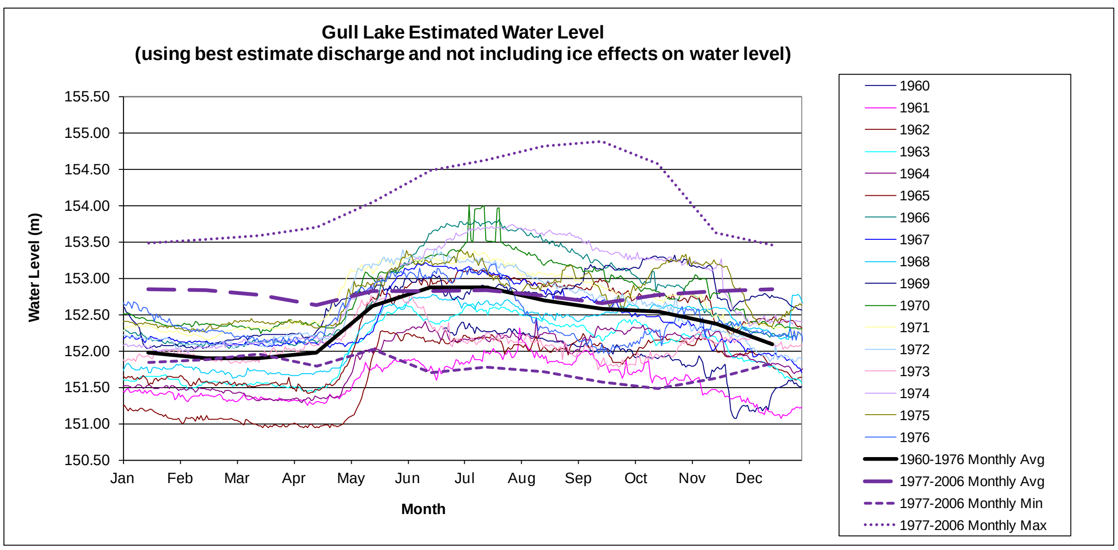
The Split Lake inflows shown in the figure below for the individual years (1960-1976) were estimated through a summation of the Kelsey GS outflows, Burntwood River flows at Thompson, and the addition of local inflows that were available for this time period. The data presented below did not take into account any flood routing effects or winter ice condition effects on flows or water levels. It is not expected that these effects would have a substantial influence on the comparative aspects of this data (open water vs. open water). While it should be acknowledged that there is uncertainty in the data for this time period assembled in this manner, the data below is considered a best estimate at this point in time and is subject to revision or change in the future.

The first figure below presents the daily inflow data to Split Lake that was calculated using the method described above for each year from 1960-1976. Also plotted for comparison is the monthly average inflows for the same time period (1960-1976) as well as the monthly average, monthly minimum, and monthly maximum for the 1977-2006 time period.



The above discharge data was then translated to water levels on both Split Lake and Gull Lake using the open water rating curves for these locations developed during the Stage IV engineering and Physical Environment studies for the Keeyask GS. It is appropriate to note again the open water rating curve was used to generate the water levels, This rating curve does not consider the staging effects of ice process which can be 0.5 m or more on Split Lake and 1.0 m or more on Gull Lake depending on flow and meteorological conditions over the winter (see DFO-0004 water regime information for more details).





REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Map 3A-3 Substratum Data Collection Index Map; Page No.: N/A

TAC Public Rd 3 DFO-0003

ROUND 1 PREAMBLE AND QUESTION:

"Substrate composition could not be determined immediately upstream, within, or downstream of rapid sections due to safety concerns. "

Please define "immediately". Substrate composition be should be confirmed in the dewatered areas in Gull Rapids prior to any construction. Resolution should be similar to that already conducted in the vicinity of Gull Rapids. This information is crucial for proper accounting of habitat destruction in the rapids.

ROUND 2 PREAMBLE AND QUESTION:

Physical area "immediately" downstream of Gull Rapids is not defined.

FOLLOW-UP QUESTION:

Please see DFO-0001. While habitat and substrate conditions in the rapids cannot be determined pre-project due to unsafe working conditions (fast water), they could be described as these areas (or parts of them) might be safely worked on as they become isolated and dewatered during construction. The information might be used to describe more accurate impacts, to make more accurate predictions, and to design offsetting measures for lost habitat. This would contribute to DFO's making a determination with more confidence. Can the proponent provide additional information about how this might be carried out and if they would be willing to incorporate this into their habitat inventory and mitigation planning?

RESPONSE:

Manitoba Hydro will collect information on substrate within Gull Rapids (likely including photographs taken from a helicopter) as areas become safe to work in/exposed during construction. Emphasis will be placed on locating areas where substrate is not cobble/boulder/bedrock, since the environmental assessment was based on the assumption the majority of the rapids that could not be directly surveyed are comprised of these substrates (see AE SV Map 3-15).

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 3.3.2.3.1 Description of Mainstream; Page No.: 3-15

TAC Public Rd 3 DFO-0004

ROUND 1 PREAMBLE AND QUESTION:

"For the purposes of predicting habitat conditions in the post-Project environment and quantifying areal changes in habitat area between the pre and post-Project environments, conditions at 95th percentile flow (pre-Project) and full supply level (FSL) in the reservoir post-Project were used. "

This analysis is incomplete. While the 95th percentile accommodates the majority of flows, changes in fish habitat at lower flows are not shown and may be more crucial. Moreover, the 95th percentile flow will be relatively uncommon. The 50th percentile would represent a more normal flow condition and changes in this habitat are not presented. Please provide the results of this analysis which includes the 5th and 50th percentile flows.

ROUND 2 PREAMBLE AND QUESTION:

Results of percentile flows not provided. As further clarification to the proponent, request pertains to the period of record.

FOLLOW-UP QUESTION:

Would the Proponent please summarize the present flow environment throughout the project area, variation in flow (e.g., 5th and 95th percentiles), how it will change, and the anticipated effects on fish and fish habitat including:

1. the magnitude of monthly flows;
2. the magnitude and duration of annual extreme water conditions (such as annual minimums and maximums for 1, 3, 7.30, and 90 day durations);
3. the timing of annual extreme water conditions;
4. the frequency and duration of high and low pulses in flow;
5. the rate and frequency of water condition changes (especially within day changes)

Please note that while this is related to DFO-0001, it should be maintained as a separate item.

RESPONSE:

The water regime data for questions 1-5 can be found at the end of this response.

Effects of changes to the frequency and extent of water level fluctuations in the reservoir and immediately downstream of the Project were described for aquatic habitat (AE SV Section 3) and then, where relevant, were considered in the assessment of effects to the fish community (AE SV Section 5) and Lake Sturgeon (AE SV Section 6).

The following description of water level fluctuations in relation to habitat in the reservoir (specifically the intermittently exposed zone or IEZ) is provided in the AE SV p. 3-33:

> *"The range in the IEZ before the Project (IEZ_{ee}) and after the Project (IEZ_{pp}) for the study reaches are found in Table 3-8. The depth of the IEZ_{pp} will be slightly larger than the IEZ_{ee} above Birthday Rapids, but will be smaller below. The range of the IEZ_{pp} will continue to have a pattern similar to that of the IEZ_{ee}, where stage variation in the riverine section (Reaches 2B–5) exceeds that of the more open reaches downriver likely due to the confines of the river channel. The IEZ_{pp}, and Deep/Shallow zones (i.e., IEZ and Predominantly Wetted zones) are shown in Map 3-29.*
>
> *The frequency of water level changes will be altered under the Project (PE SV, Section 4.4.2.2). Under the base loaded scenario, the one day and seven day water level variation during open water will remain at 0. However, under the Peaking mode of operation, one day water level variations could be as large as 0.8–1.0 m at Gull Lake, diminishing to 0.4 m upstream of Birthday Rapids. Over seven days, water levels in Gull Lake would vary up to 1 m, reducing slightly to a variation of 0.9 m downstream of Birthday Rapids."*

Water level fluctuations would affect aquatic plants in the reservoir, as discussed in the AE SV (p. 3-35 to 3-36):

> *"The availability of potential and suitable macrophyte habitat in the proposed reservoir (reaches 2B–9A) varies by mode of operation. Under a base loaded mode of operation scenario, when the Keeyask GS operates at 159 m ASL continuously, the amount of habitat that is suitable is equal to the potential (i.e., all potential habitat is permanently wetted). Conversely, under a peaking mode of operation, the area of suitable habitat is expected to be less than the potential due to dewatering from daily and weekly draw down.*
>
> *For the Base loaded mode of operation at the 95th percentile and 159 m ASL reservoir stage, the area of potential macrophyte habitat in the reservoir is estimated to be 1,878.1 ha (Map 3-35), or 1.6 times more than the 1,197 ha of potential macrophyte habitat present in reaches 2A–9A in the existing environment. For the peaking mode of operation, the area of suitable*

macrophyte habitat (i.e., assuming half of the post-Project IEZ is suitable), is 1,396 ha or about 26% less than the Base loaded mode of operation. The suitable macrophyte habitat of the peaking mode of operation is about 1.2 times more than exists in the same area under present day conditions.

The actual area occupied by plants in the reservoir may range widely in space and time, given that Keeyask environmental studies have shown the area of potential habitat actually occupied varied from a low of 11.5% at Stephens Lake (regulated reservoir) to a maximum of 31% in the unregulated river/lake environment of the Keeyask area (Table 3-4). At present, it remains uncertain if the range of habitat occupied by macrophytes arises from intrinsic differences between habitats in a reservoir and large river, or if the area occupied by macrophytes is attributable to incomplete colonization of the potential habitat available in Stephens Lake. In addition, the Stephens Lake reservoir experienced high water conditions during the Keeyask environmental studies, which may suggest plants could have been depth (i.e., light) limited and so had lower areas of occupation. Consequently, as a highly conservative approach, it was assumed that 10% of the potential habitat at Year 30 would be occupied by rooted macrophytes. Estimates suggest that the area occupied by rooted macrophytes at Year 30 is 187.8 ha under Base loaded mode of operation or 139.6 ha for peaking. When compared to the average area occupied in reaches 2B–9A (i.e., 208 ha) in the existing environment, this equates to a loss of 10.7% under a Base loaded scenario or 48.9% under peaking."

Water level fluctuations downstream of the generating station and effects to aquatic habitat are discussed in the AE SV (p. 3-40):

"Effects to the water regime downstream of the Keeyask GS are described in the PE SV, Section 4.4.2.3 and Section 4.4.2.5. The water level downstream of the GS tailrace will be determined mainly by the level of Stephens Lake. There will be a drop in water level ranging from 0.1 to 0.2 m over a 3 km long reach between the powerhouse tailrace and Stephens Lake, depending on the magnitude of the GS discharge and the level of Stephens Lake. The magnitude of water level fluctuations within this 3 km long reach will depend on plant discharge, the amount of cycling at the Keeyask GS, and Stephens Lake water level fluctuations. Stephens Lake water levels will not be affected by operation of the Keeyask GS. The maximum water level changes in this reach due to cycling at the station are expected to be less than 0.1 m (PE SV, Table 4.4-3). However, during the open water season, in addition to the effect of cycling, this reach will continue to experience changes in water levels related to differences in inflow and regulation on Stephens Lake. This will result in an overall range in the order of 2 m, with

daily and weekly water level fluctuations in the order of 0.3 m and 1 m, respectively. During winter, changes in water level due to lack of formation of an ice dam, and the formation of new channels will no longer occur (e.g. the channel that connects the Nelson River to Pond 13). "

The effects of water level fluctuations were considered in the assessment of fish community. The assessment notes that spawning habitat will be available for all VEC species. However, with respect to other fish species and individuals spawning in shallow areas (AE SV p. 5-52):

"*Aquatic habitat modelling showed that weekly cycling during operation of the GS would result in approximately 1,200 to 1,800 ha (Year 1 and 30 time steps, respectively; Table 3D-1) of the newly flooded habitat to be exposed intermittently. This fluctuation could result in the exposure and subsequent mortality of some fish eggs or larvae for those species spawning in less than 1 m of water if a period of stable water levels is followed by cycling during a spawning period.*"

The habitat-based model of fish abundance based on foraging habitat addressed the periodic availability of habitat in the intermittently exposed zone by reducing the productive area of the zone in the calculation of total foraging habitat available (AE SV p. 3D-4):

"This area of periodic exposure or IEZ was calculated as the difference between the size of the reservoir operating at FSL (159 m) and MOL (158 m) at each of the Year 1, 5, 15, and 30 time steps. Because the reservoir expands over time at FSL (described in previous section) due to shoreline erosion and peat disintegration processes, but was assumed to maintain a relatively constant area over time at the MOL, all predicted increases in reservoir area at each time step were attributed to an increase in area of the IEZ.

For the peaking mode of operation, shallow water habitat areas that would be available to fish were calculated for each Year 1, 5, 15, and 30 time step by adding 50% of a habitat's area within the IEZ to that habitat's area at MOL."

The effect of water level fluctuations on fish downstream of the GS were assessed as follows (AE SV, p. 5-59):

"Given that the elevation of the tailrace of the GS is within the operating range of Stephens Lake, water levels in the river channel downstream of the GS are largely controlled by water levels on Stephens Lake and only a minimal amount of habitat is subject to dewatering due to cycling at the GS. As this habitat is

Keeyask Hydropower Limited Partnership

> *already within the intermittently expose zone created by regulation of Stephens Lake, cycling from the GS is not expected to change its suitability as fish habitat."*

Given that Lake Sturgeon do not typically occupy shallow water where effects of drawdown (in the reservoir) or cycling (downstream of the GS) have a marked effect, the Lake Sturgeon assessment did not generally address the effect of water level fluctuations. The exception is the potential effect of cycling at the GS on use of the spawning structure; as discussed in AE SV Section 6.4.2.3.1, operation at the GS will be modified during the spawning period to provide an adequate flow of water over the structure (AE SV p. 6-40):

> *"During the lake sturgeon spawning and egg incubation period (late May to mid-July), operation of the GS will be constrained to include continuous operation of the two units immediately upstream of the structure to ensure adequate flows (PD SV Section 6.6). The structure will be monitored to determine whether successful spawning is occurring and, if not, it will be modified as required."*

The suitability of the Keeyask Reservoir as fish habitat, and indirectly the adverse effect of increased water level fluctuations, can also be examined using other Nelson River hydroelectric reservoirs as models. These reservoirs currently experience similar or greater variation in water levels than will occur in the Keeyask reservoir.

Maximum water level range (highest recorded – lowest recorded during period of record)

Location	Stephens Lake	Long Spruce Forebay	Limestone Forebay
Lowest Recorded	137.52	106.132	83.325
5th Percentile	139.16	109.210	84.644
50th Percentile	140.22	109.947	85.008
95th Percentile	141.05	110.270	85.228
Highest Recorded	141.21	110.521	85.454
Range (m)	3.69	4.389	2.129
Period of Record	**1977-2006**	**1978-2006**	**1993-2006**

Stephens Lake — 1 day variations for the month of...

Percentile	1 day	7 day	31 day	seasonal	annual	January	February	March	April	May	June	July	August	September	October	November	December
min	0	0	0.03	0.08	1.03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.01	0.06	0.187	0.856	1.63	0.010	0.010	0.010	0.010	0.005	0.000	0.000	0.000	0.010	0.005	0.010	0.010
50	0.08	0.4	1.01	1.99	2.46	0.080	0.090	0.100	0.080	0.080	0.070	0.060	0.070	0.080	0.070	0.080	0.080
95	0.29	0.94	2.04	2.911	3.02	0.266	0.310	0.310	0.320	0.310	0.280	0.280	0.280	0.290	0.280	0.271	0.290
max	0.66	2.11	2.716	3.54	3.6	0.660	0.530	0.540	0.600	0.640	0.660	0.590	0.570	0.590	0.660	0.640	0.570

Long Spruce Forebay — 1 day variations for the month of....

Percentile	1 day	7 day	31 day	January	February	March	April	May	June	July	August	September	October	November	December
min	0.02	0.13	0.22	0.048	0.070	0.040	0.045	0.040	0.056	0.030	0.043	0.049	0.050	0.056	0.020
5	0.12	0.27	0.42	0.120	0.122	0.120	0.120	0.115	0.120	0.120	0.120	0.120	0.110	0.122	0.122
50	0.25	0.487	0.718	0.244	0.244	0.267	0.250	0.256	0.250	0.244	0.270	0.260	0.244	0.260	0.244
95	0.549	0.914	1.433	0.548	0.509	0.549	0.548	0.549	0.567	0.518	0.579	0.579	0.579	0.579	0.518
max	2.591	3.278	3.81	1.097	0.793	1.128	0.884	0.928	1.524	1.433	1.184	1.372	2.591	1.341	0.976

Limestone Forebay — 1 day variations for the month of...

Percentile	1 day	7 day	31 day	January	February	March	April	May	June	July	August	September	October	November	December
min	0.041	0.048	0.048	0.048	0.096	0.062	0.055	0.055	0.096	0.041	0.083	0.055	0.082	0.069	0.096
5	0.178	0.384	0.556	0.220	0.193	0.179	0.178	0.179	0.172	0.171	0.158	0.172	0.144	0.185	0.207
50	0.385	0.666	0.893	0.412	0.384	0.371	0.357	0.337	0.371	0.378	0.405	0.426	0.378	0.385	0.419
95	0.777	1.134	1.374	0.777	0.769	0.810	0.728	0.735	0.783	0.749	0.749	0.817	0.783	0.776	0.832
max	1.951	2.026	2.033	1.408	1.106	1.951	1.037	1.724	1.278	1.271	1.340	1.710	1.134	1.229	1.154

To summarize the water level changes presented above, the maximum water level range in the Kettle GS reservoir, the Long Spruce GS forebay, and the Limestone GS forebay is 3.69 m, 4.39 m, and 2.13 m, respectively. The 50th percentile daily and weekly water level fluctuations for Stephens Lake are 0.4 and 1.01 m, respectively, and the 95th percentile daily and weekly water level fluctuations are 0.94 and 2.04 m. The 50th percentile daily and weekly water level fluctuations for Long Spruce Forebay are 0.49 and 0.72 m, respectively, and the 95th percentile daily and weekly water level fluctuations are 0.91 and 1.43 m. The 50th percentile daily and weekly water level fluctuations for Limestone Forebay are 0.67 and 0.89 m, respectively, and the 95th percentile daily and weekly water level fluctuations are 1.13 and 1.37 m.

In comparison, the total range in the Keeyask reservoir will be lower, at 1 m; though the one day and seven day change will be at the upper end of the range observed in the existing reservoirs.

Total catch per unit effort (CPUE) in the Kettle GS reservoir (Stephens Lake) during 2002 and 2003 was 23.5 fish/100 m of net/24 hours, including a CPUE of 1.8 Lake Whitefish, 7.9 Northern Pike, and 7.9 Walleye (Table 5-2, AE SV). Between 1992 and 2003, CPUE in the Long Spruce forebay ranged from a low of approximately 13 fish/100 m of net/24 hours in 1992 to a high of approximately 24 fish in 2003, while the CPUE in the Limestone forebay ranged from a low of approximately 11 fish in 1993 to a high of approximately 26 fish in 1999 (Figure 7-28; NSC 2012 [Limestone Synthesis Report]) with an overall CPUE of 17.9 fish/100 m of net/24 hours (Table 5-2, AE SV). The majority of the catch in 2003 in these two forebays was Walleye, Longnose Sucker, Northern Pike, and White Sucker (Figure 7-30; NSC 2012 [Limestone Synthesis Report]). In both forebays, a general increase in CPUE over time was observed.

For comparative purposes, the overall CPUE of Split and Gull lakes was 35.0 and 24.8 fish/100 m of net/24 hours, while the CPUE of off-system water bodies ranged from a low of 21. 2 fish for War Lake to a high of 112.8 for Leftrook Lake (Table 5-2, AE SV). When looking at VEC species individually, using Table 5-2 of the AE SV, the CPUE for Stephens Lake Walleye (7.9) falls within those of Split (9.9) and Gull (6.3) lakes, and also falls within the range of those of off-system water bodies (0 to 57.7). The CPUE for Stephens Lake Northern Pike (7.9) also falls within those of Gull (8.7) and Split (6.0) lakes, and within the range of those of off-system water bodies (3.1 to 21.9). The CPUE for Lake Whitefish within Stephens Lake (1.8) was comparable to those of both Split (1.9) and Gull (1.8) lakes and within the range of those of off-system water bodies (0 to 33.0).

Despite relatively large weekly and monthly water level fluctuations, Stephens Lake supports a relatively abundant and diverse fish community. The abundance of the fish communities of both Long Spruce and Limestone Forebay have generally increased over time with general a shift from species that prefer lotic environments (e.g., Longnose Sucker) to those that prefer more lacustrine environments (e.g., Walleye) (Figures 7-26 – 7-28; NSC 2012 [Limestone Synthesis Report]). Although the CPUE for both these forebays remained lower than that of Stephens Lake as of 2003, the general increase in CPUE over time shows that the fish communities of these forebays are able to succeed in environments with relatively large daily, weekly, and monthly water level fluctuations.

The following is the water regime data requested in questions 1-5:

Existing Environment

Flows

Split Lake Daily Outflow Percentiles

	Percentile				
Type of Data	Min	5	50	95	Max
All Data	1328	1926	3062	4855	6600
Seasonal					
Open Water	1328	1858	2863	5282	6600
Winter	1383	2076	3183	4072	5078
Monthly					
January	1800	2221	3262	4024	4347
February	1791	2189	3222	4222	4361
March	1842	2098	3084	4130	4471
April	1749	1888	2914	4197	4863
May	1765	2041	2934	5087	5538
June	1600	1836	2771	5426	6012
July	1691	1806	2747	5398	6589
August	1626	1901	2736	5024	6605
September	1432	1701	2795	4167	6594
October	1328	1862	3075	4077	6403
November	1383	2252	3175	3981	5080
December	1600	2308	3276	3925	4347

Split Lake Monthly Average Outflow Percentiles

Percentile (%)	Open Water	Winter	All Season
Min	1401	1574	1401
5	1882	2019	1971
50	2866	3181	3064
95	5266	4103	4727
Max	6491	4521	6491

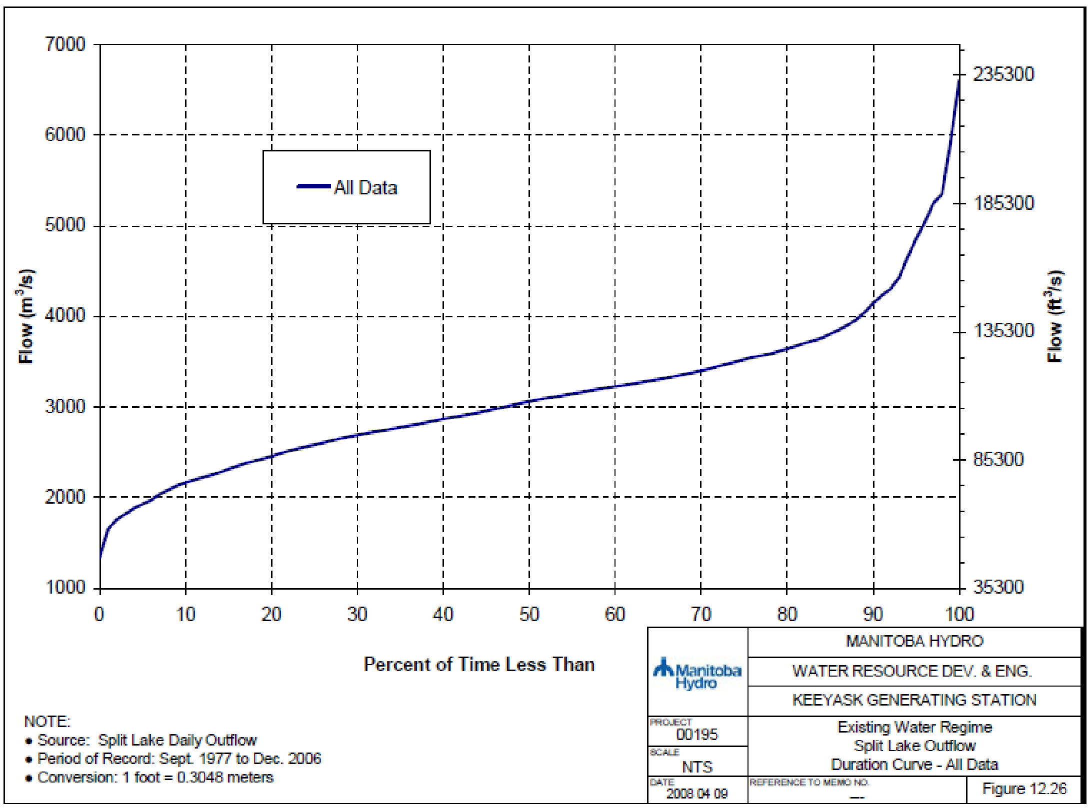
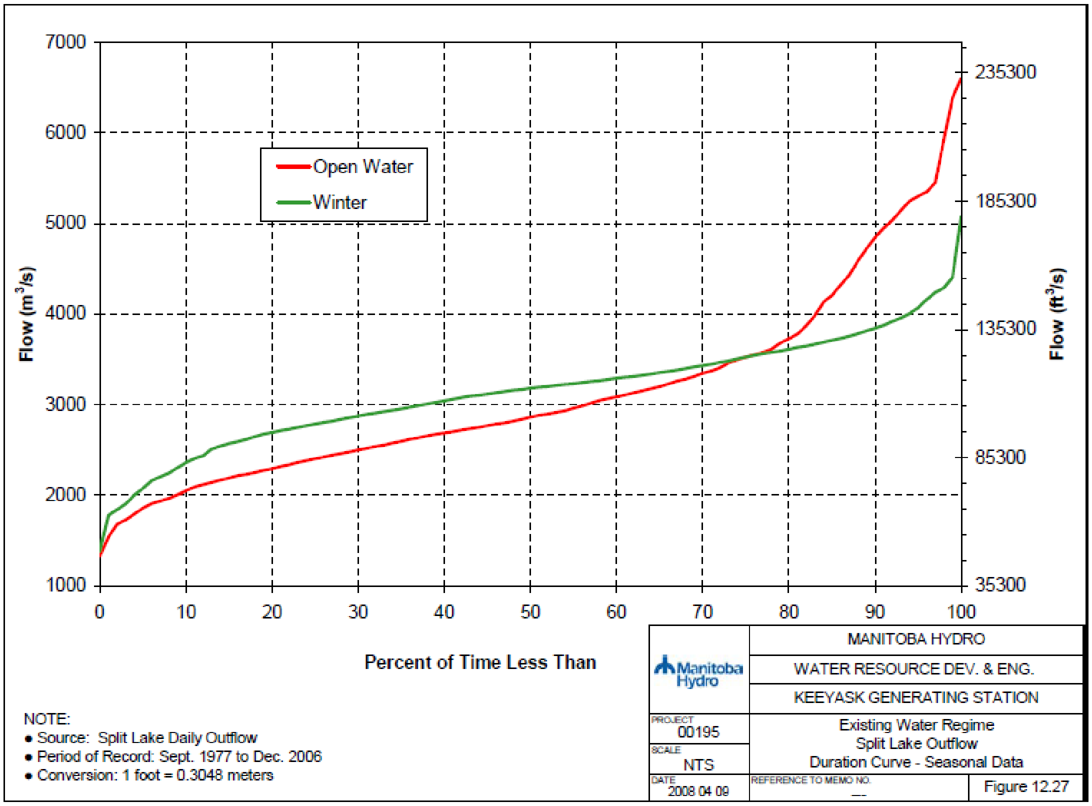


Figure 12.26 - Split Lake Flow Duration Curve – All Data



52

Figure 12.27 - Split Lake Flow Duration Curve – Seasonal Data

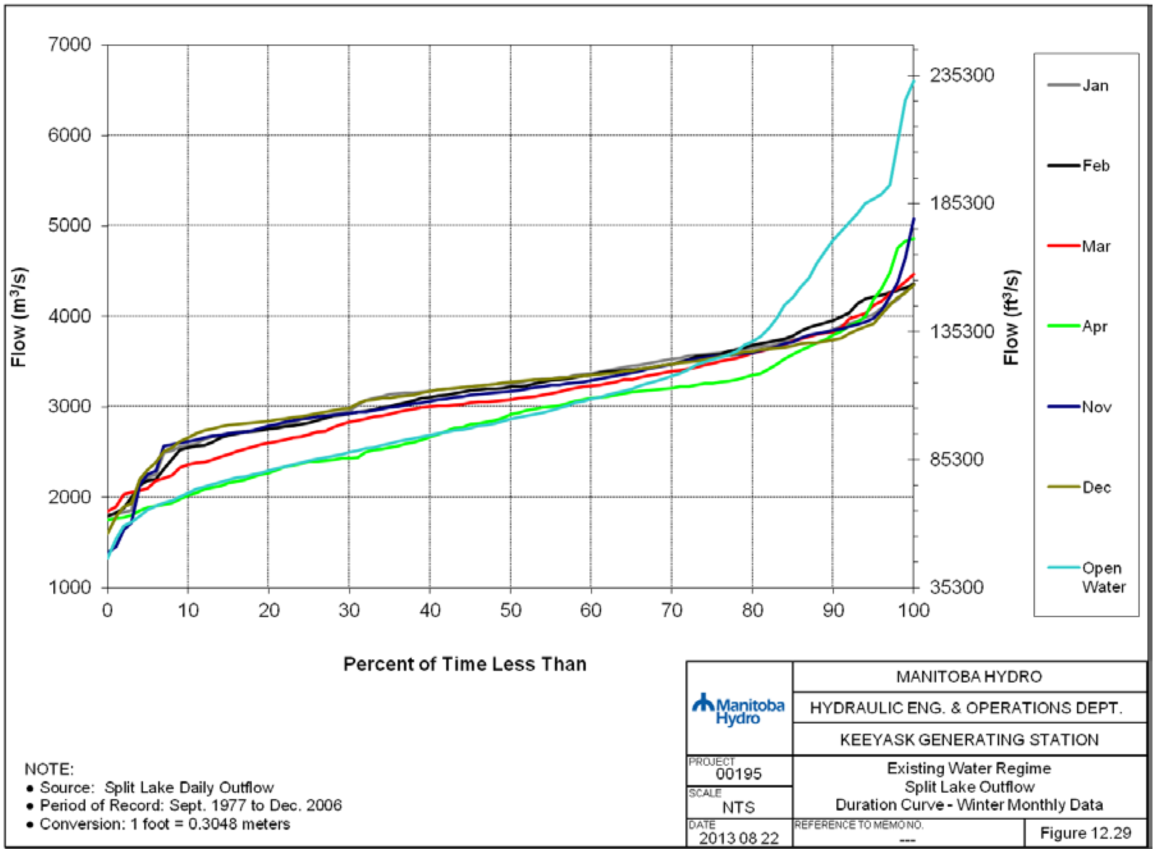
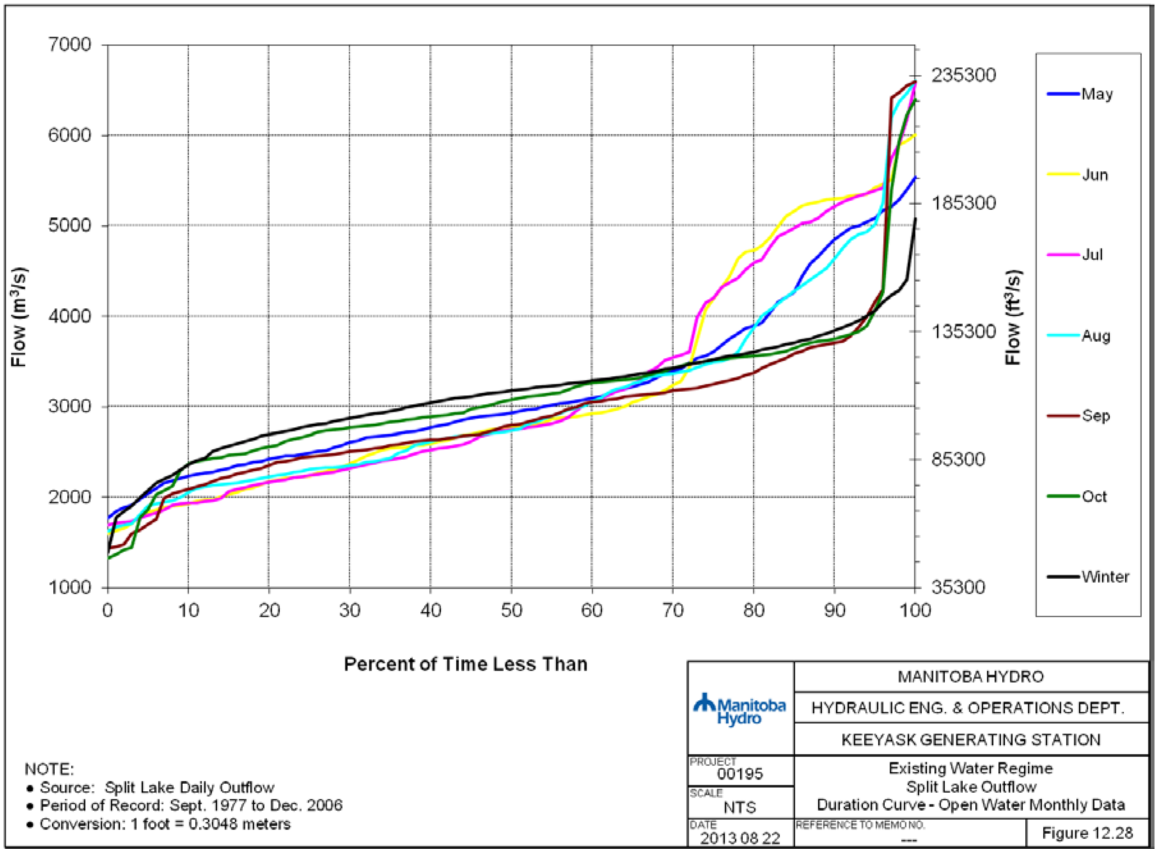
53 
7000
6000
5000
4000
3000
2000
1000
Flow (m³/s)
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Less Than
235300
185300
135300
85300
35300
Flow (ft³/s)
Jan
Feb
Mar
Apr
Nov
Dec
Open Water
MANITOBA HYDRO
Manitoba Hydro
HYDRAULIC ENG. & OPERATIONS DEPT.
KEEYASK GENERATING STATION
PROJECT
00195
SCALE
NTS
DATE
2013 08 22
Existing Water Regime
Split Lake Outflow
Duration Curve - Winter Monthly Data
REFERENCE TO MEMO NO.

Figure 12.29
NOTE:
• Source: Split Lake Daily Outflow
• Period of Record: Sept. 1977 to Dec. 2006
• Conversion: 1 foot = 0.3048 meters

54 
7000
6000
5000
4000
3000
2000
1000
Flow (m³/s)
235300
185300
135300
85300
35300
Flow (ft³/s)
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Less Than
May
Jun
Jul
Aug
Sep
Oct
Winter
NOTE:
• Source: Split Lake Daily Outflow
• Period of Record: Sept. 1977 to Dec. 2006
• Conversion: 1 foot = 0.3048 meters
Manitoba Hydro
MANITOBA HYDRO
HYDRAULIC ENG. & OPERATIONS DEPT.
KEEYASK GENERATING STATION
PROJECT 00195
SCALE NTS
DATE 2013 08 22
Existing Water Regime
Split Lake Outflow
Duration Curve - Open Water Monthly Data
REFERENCE TO MEMO NO. ---
Figure 12.28

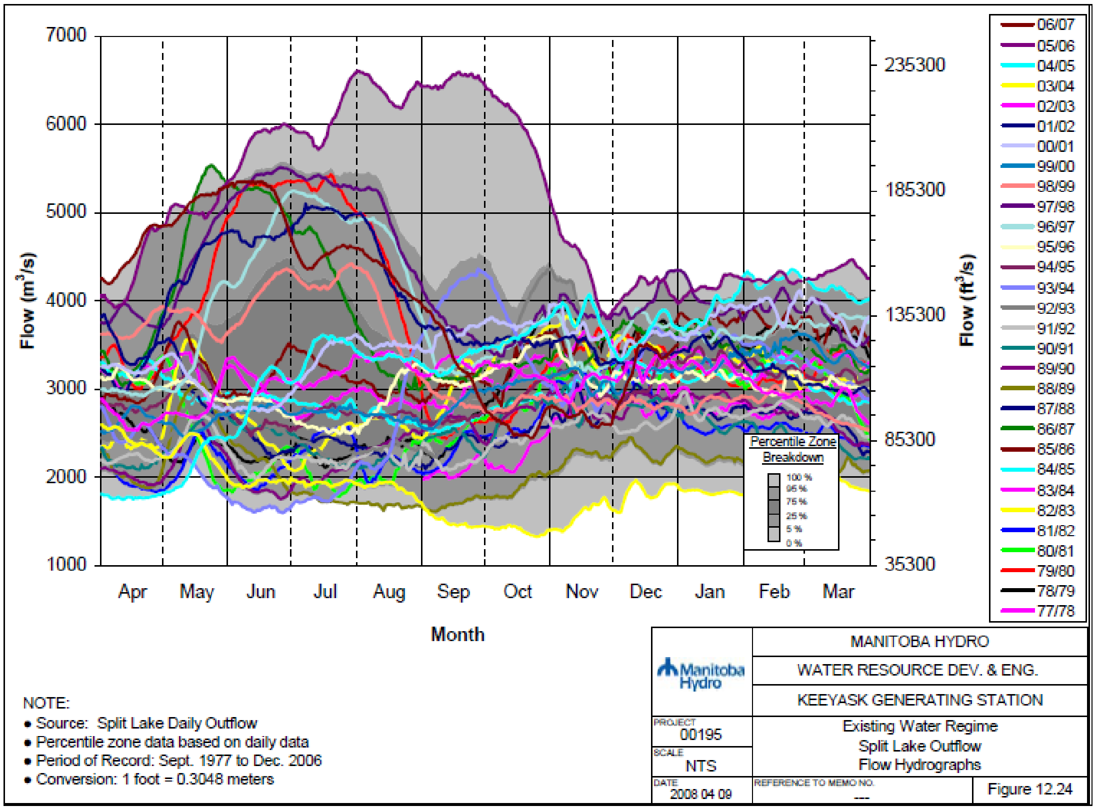


Figure 12.24 - Split Lake Flow Spaghetti Hydrographs

As evidenced in the above hydrographs, the variations in existing environment Split Lake outflow are typically small in the hourly and daily time scale (less than 50-100 m^3/s) and much larger on the seasonal and annual time scales. Weekly variations can be in the order of a few hundred m^3/s and monthly outflow variations from Split Lake can be more than 1000 m^3/s during the rising or falling limb of the flood hydrograph (see chart above).

62 **Gull Lake Water Levels and Variations**

Gull Lake Water Surface Elevation Percentiles (m)

	Percentile				
Type of Data	Min	5	50	95	Max
All Data	151.426	152.010	153.160	154.841	156.668
Seasonal					
Open Water	151.426	151.860	152.610	154.180	154.941
Winter	151.660	152.589	153.713	155.231	156.668
Monthly					
January	152.673	152.963	154.105	154.888	155.536
February	152.709	153.016	154.020	155.358	156.326
March	152.380	152.706	153.806	155.671	156.668
April	152.016	152.238	153.359	155.396	156.141
May	151.780	152.080	152.760	154.188	154.530
June	151.650	151.840	152.540	154.250	154.597
July	151.720	151.820	152.520	154.240	154.932
August	151.670	151.891	152.510	154.013	154.941
September	151.514	151.730	152.550	153.476	154.934
October	151.426	151.790	152.730	153.511	154.825
November	151.660	152.592	153.339	154.027	154.513
December	152.648	152.974	153.895	154.689	155.076

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Gull Lake Water Surface Elevation Variations (m)

Time Scale of Variation	Percentile				
	min	5	50	95	max
1 Day	0.000	0.000	0.019	0.060	0.181
7 Day	0.000	0.020	0.090	0.292	0.659
31 Day	0.030	0.108	0.360	0.956	1.620
Seasonal	0.350	0.563	1.414	2.322	2.916
Annual	1.231	1.411	2.201	3.384	4.415
1 Day Variations by Month					
January	0.000	0.002	0.016	0.056	0.123
February	0.000	0.002	0.019	0.066	0.175
March	0.000	0.003	0.023	0.067	0.150
April	0.000	0.002	0.019	0.063	0.114
May	0.000	0.000	0.02	0.060	0.100
June	0.000	0.000	0.01	0.040	0.070
July	0.000	0.000	0.01	0.040	0.080
August	0.000	0.000	0.01	0.050	0.140
September	0.000	0.000	0.01	0.040	0.080
October	0.000	0.000	0.01	0.050	0.110
November	0.000	0.003	0.032	0.079	0.144
December	0.000	0.002	0.023	0.081	0.181

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Stephens Lake Water Levels and Variations

Stephens Lake Water Surface Elevation Percentiles (m)

			Percentile		
Type of Data	Min	5	50	95	Max
All Data	137.520	139.160	140.220	141.050	141.210
Seasonal					
Open Water	137.520	139.050	140.140	141.086	141.180
Winter	138.160	139.270	140.350	141.000	141.210
Monthly					
January	139.010	139.570	140.530	141.010	141.150
February	138.530	139.244	140.400	140.946	141.180
March	138.399	138.967	140.080	140.820	141.120
April	138.160	139.179	140.160	141.076	141.180
May	138.540	139.231	140.420	141.110	141.180
June	138.290	139.150	140.170	141.090	141.130
July	138.380	139.204	140.160	141.080	141.120
August	138.380	139.117	140.110	141.070	141.130
September	137.920	138.812	139.985	140.940	141.130
October	137.520	138.720	140.040	140.920	141.120
November	138.560	139.504	140.490	141.040	141.210
December	138.500	139.460	140.435	141.000	141.170

Stephens Lake Water Surface Elevation Variations (m)

Time Scale of Variation	Percentile min	5	50	95	max
1 Day	0	0.01	0.08	0.29	0.66
7 Day	0	0.06	0.4	0.94	2.11
31 Day	0.03	0.187	1.01	2.04	2.716
Seasonal	0.08	0.856	1.99	2.911	3.54
Annual	1.03	1.63	2.46	3.02	3.6
1 Day Variations by Month					
January	0.000	0.010	0.080	0.266	0.660
February	0.000	0.010	0.090	0.310	0.530
March	0.000	0.010	0.100	0.310	0.540
April	0.000	0.010	0.080	0.320	0.600
May	0.000	0.005	0.080	0.310	0.640
June	0.000	0.000	0.070	0.280	0.660
July	0.000	0.000	0.060	0.280	0.590
August	0.000	0.000	0.070	0.280	0.570
September	0.000	0.010	0.080	0.290	0.590
October	0.000	0.005	0.070	0.280	0.660
November	0.000	0.010	0.080	0.271	0.640
December	0.000	0.010	0.080	0.290	0.570

Future Environment

Gull Lake Water Levels

Gull Lake Water Surface Elevation Percentiles (m)

Water Surface Level		Percentile		
Type of Data		5	50	95
Open Water - Without Project		151.9	152.8	154.1
Open Water - With Project	Base Loaded	159.0	159.0	159.1
	Peaking	158.1	158.6	159.1
Winter - Without Project		152.9	153.8	154.7
Winter - With Project	Base Loaded	159.0	159.0	159.1
	Peaking	158.1	158.5	159.0

Gull Lake Water Surface Elevation Variations (m)

1-day Surface Level Variation		Percentile		
Type of Data		5	50	95
Open Water - Without Project		0.0	0.0	0.0
Open Water - With Project	Base Loaded	0.0	0.0	0.0
	Peaking	0.0	0.5	0.8
Winter - Without Project		0.0	<0.1	<0.1
Winter - With Project	Base Loaded	0.0	0.0	0.0
	Peaking	0.1	0.5	0.8
7-day Surface Level Variation		**Percentile**		
Type of Data		5	50	95
Open Water - Without Project		0.0	0.0	0.0
Open Water - With Project	Base Loaded	0.0	0.0	0.0
	Peaking	0.0	1.0	1.0
Winter - Without Project		<0.1	0.1	0.2
Winter - With Project	Base Loaded	0.0	0.0	0.0
	Peaking	1.0	1.0	1.0

Stephens Lake Water Levels

Stephens Lake Water Surface Elevation Percentiles (m)

Water Surface Level		Percentile		
Type of Data		5	50	95
Open Water - Without Project		139.1	140.1	141.1
Open Water - With Project	Base Loaded	139.1	140.1	141.1
	Peaking	139.1	140.1	141.1
Winter - Without Project		139.3	140.4	141.0
Winter - With Project	Base Loaded	139.3	140.4	141.0
	Peaking	139.3	140.4	141.0

Stephens Lake Water Surface Elevation Variations

The 1-day and 7-day water level variations on Stephens Lake are expected to be the same post project as in the existing environment (see tables above).

Keeyask Outflow Hydrographs – Future Environment

The following graphs show the outflow hydrographs for Keeyask over a typical week beginning approximately 6AM Monday morning. Flows exceeding the plant capacity of 4000 cms are routed through the spillway. The graphs assume a constant inflow into the forebay over the entire 1 week period for each scenario.

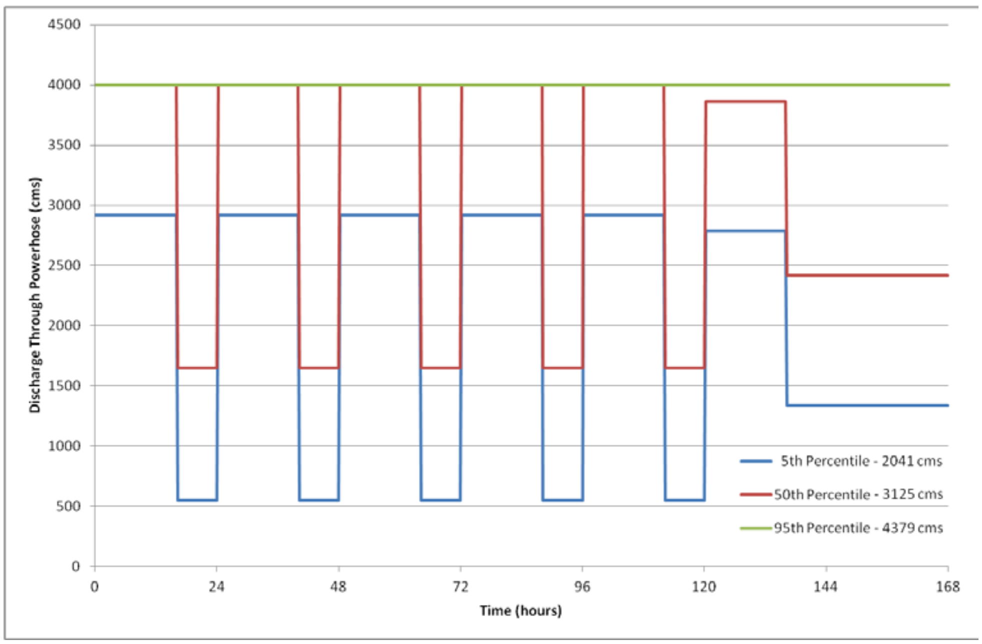


Figure 1: Discharge through Keeyask powerhouse for 5th, 50th and 95th percentile flows - Peaking

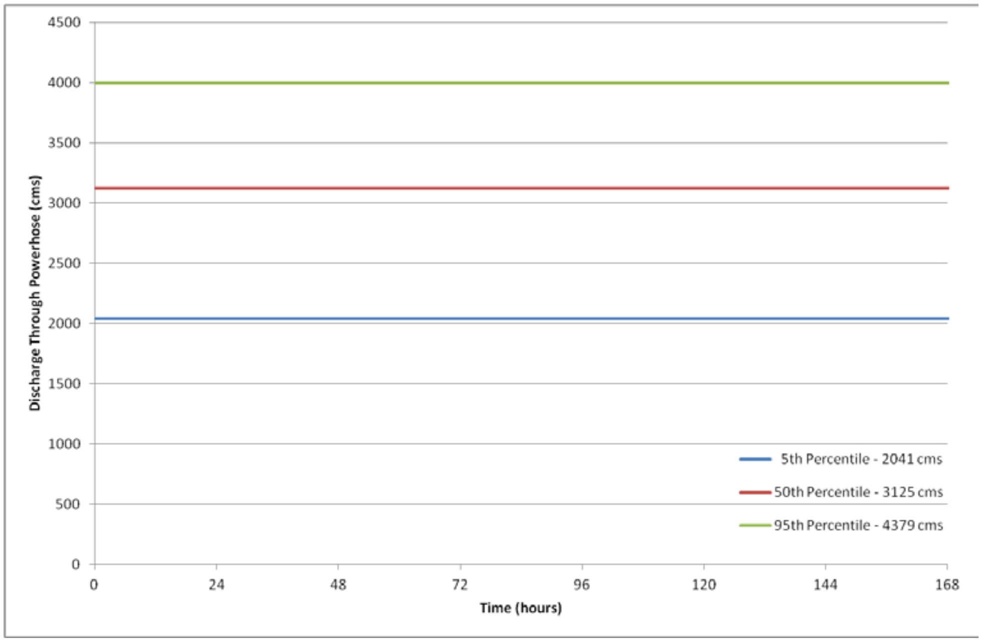


Figure 2: Discharge through Keeyask powerhouse for 5th, 50th, and 95th percentile flows - Base Load

Keeyask Forebay Level

The following graph shows the typical water surface elevation of the Keeyask Forebay over a one week period beginning at approximately 6AM on Monday for the 5th, 25th, 50th, 75th, and 95th percentile flows. The graphs assume a constant flow into the forebay over the entire 1 week period for each scenario. It should be noted that "the magnitude of water level fluctuations at any given time for Post-project conditions depends on the hydrological and meteorological conditions as well as the requirements of the Manitoba Hydro integrated generation and transmission system (Project Description Supporting Volume)" [PESV 4.4.2.2.3 Page 4-75]

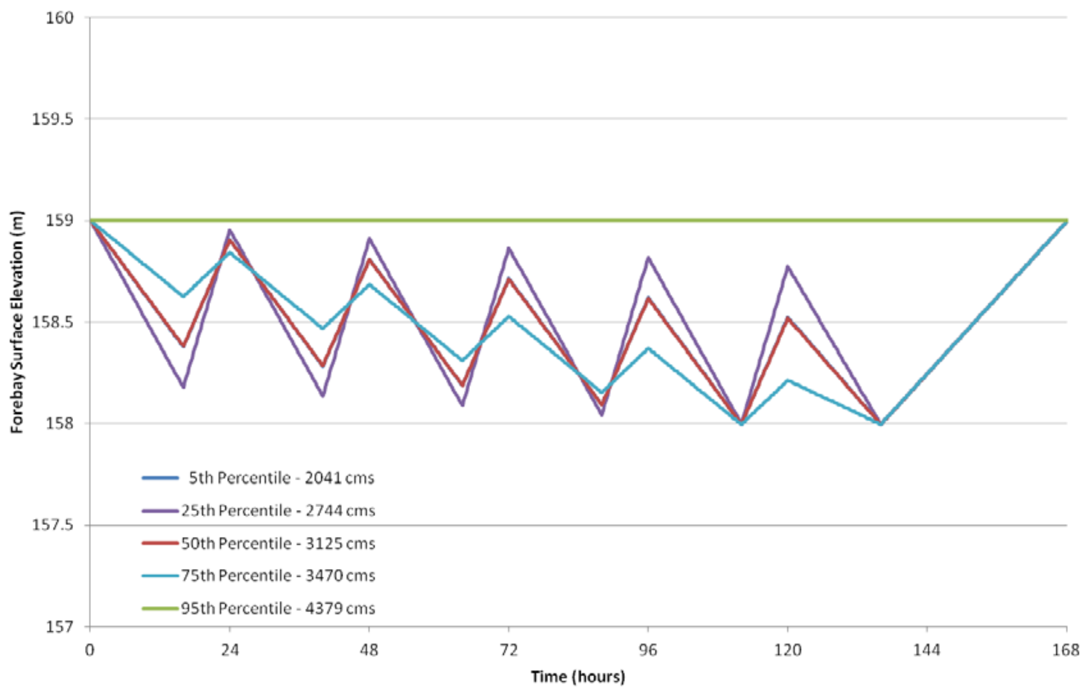


Figure 3: Forebay Elevation for 5th, 25th, 50th, 75th and 95th percentile flows - Peaking

Note: 5th and 50th percentile elevations overlap

The graph for the base loaded case is not shown as all scenarios would overlap at a constant 159.0m for the duration of the week.

Below are graphs showing a juxtaposition of powerhouse outflows for the peaking mode of operation with the respective forebay elevation for the 5th, 25th, 50th, 75th, and 95th percentile flows. Discharge is shown in red, forebay level in blue, and the extents of the normal operating range of the forebay in pink. The 95th percentile graph is shown as having a flow of 4000 cms which represents only the portion of the flow that passes through the powerhouse. The forebay level for the 95th percentile is a horizontal line at 159.0 m, obscured by overlap with the limits of the normal operating range.

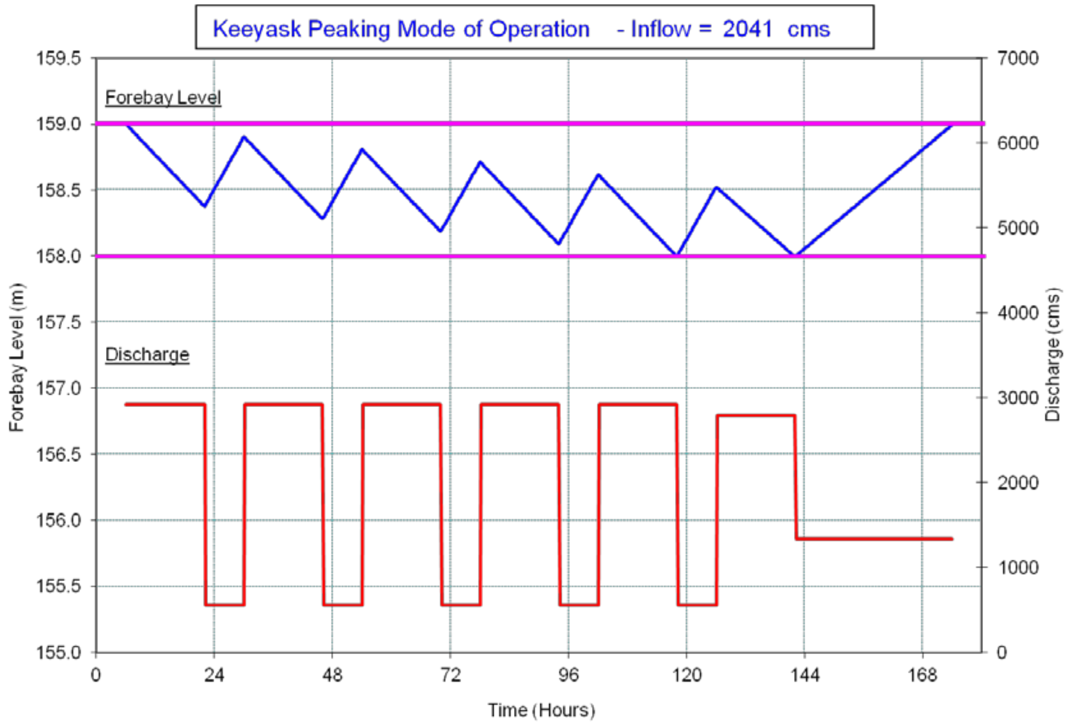


Figure 4: 5th Percentile

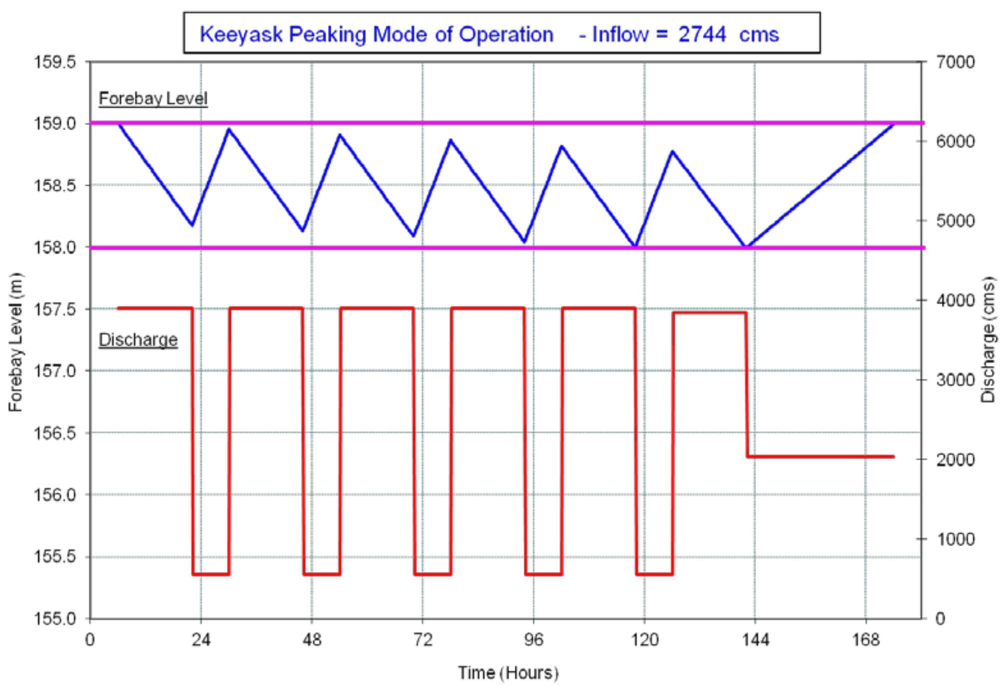


Figure 5: 25th Percentile

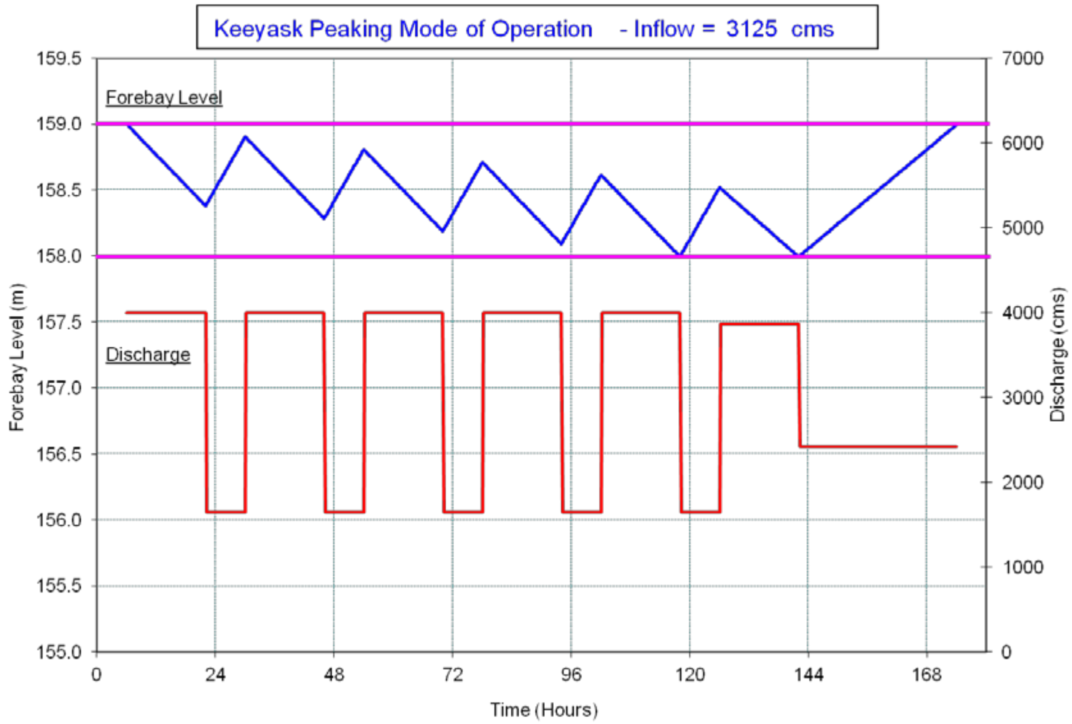


Figure 6: 50th Percentile

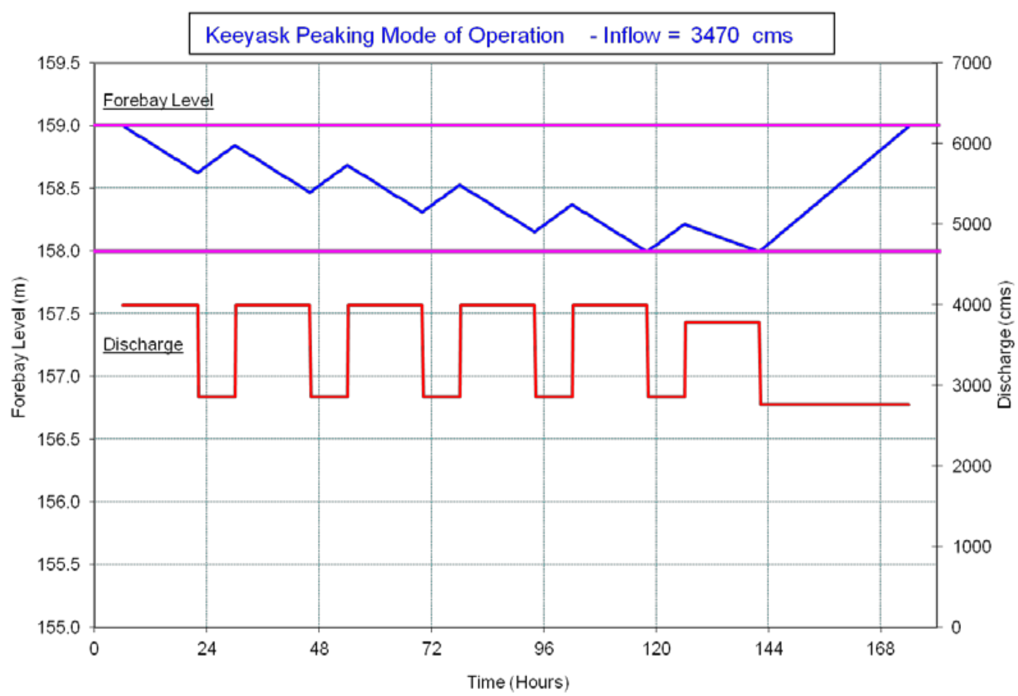


Figure 7: 75th Percentile

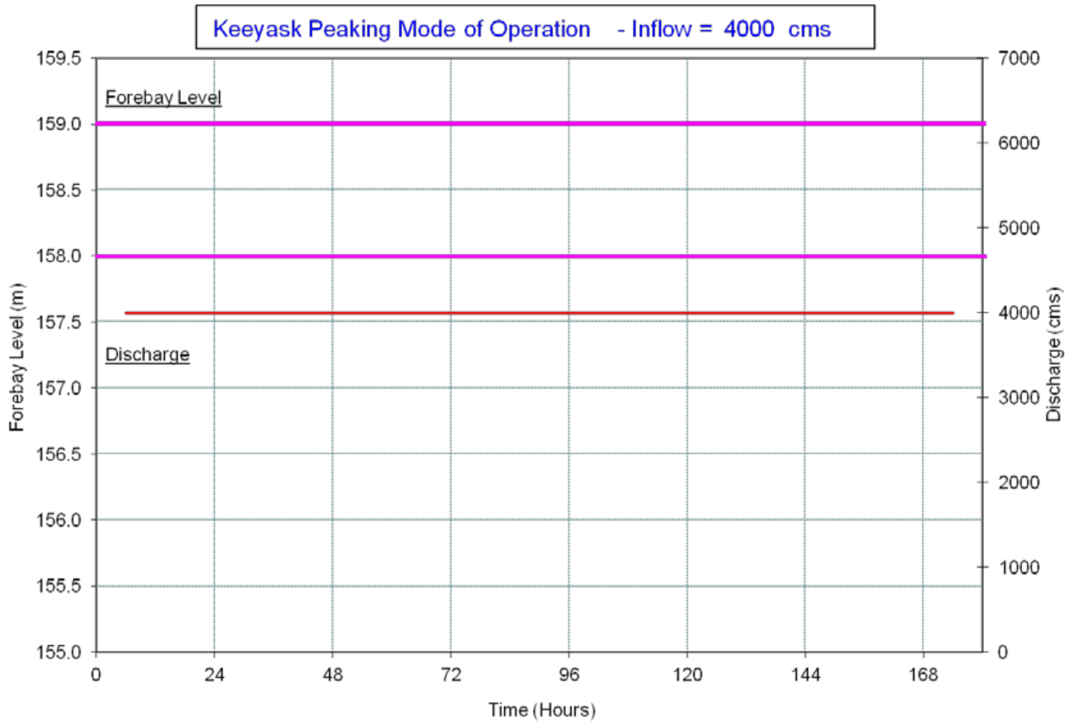


Figure 8: 95th Percentile (Total Flow = 4379 m^3/s, Powerhouse Flow = 4000 m^3/s)

Inflow Hydrographs

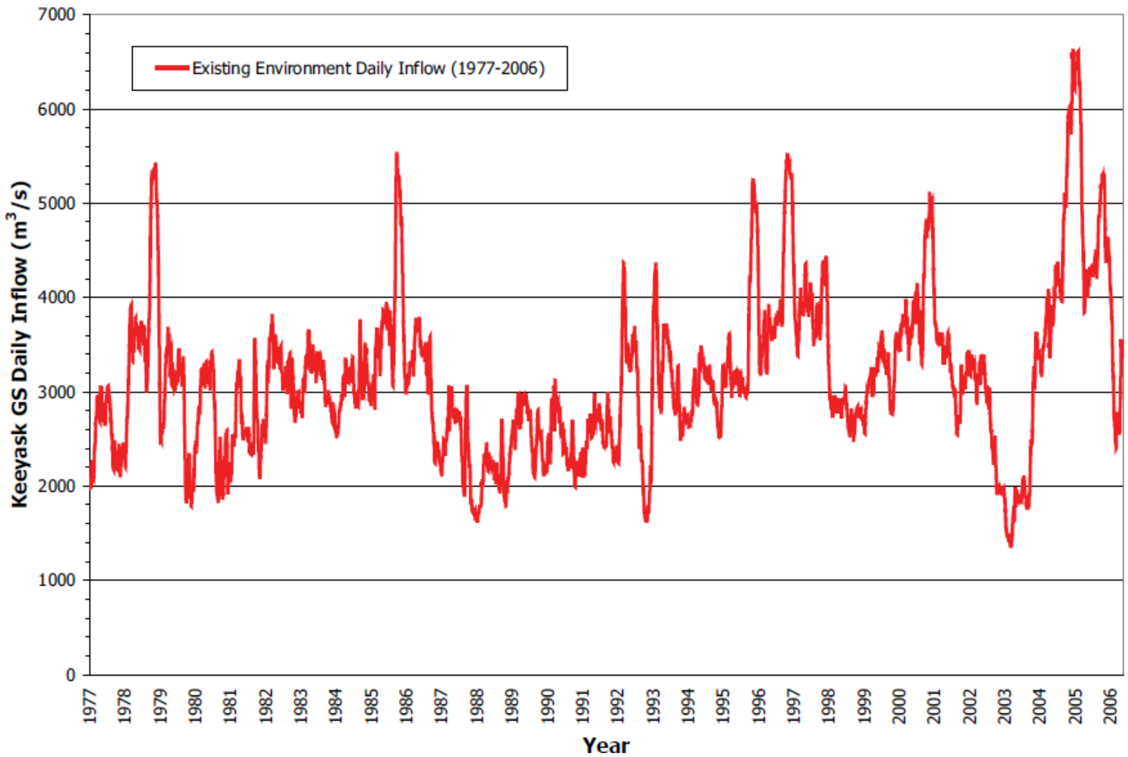


Figure 9: Existing Environment Inflow Hydrograph (1977-2006)

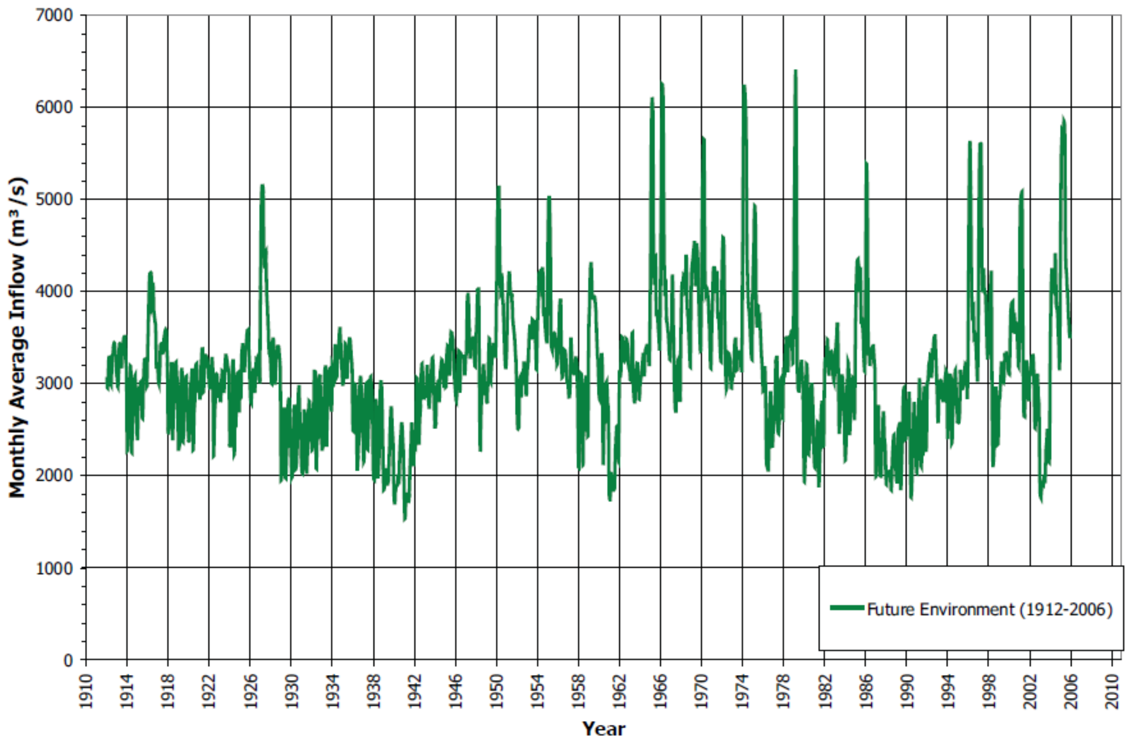


Figure 10: Future Environment Inflow Hydrograph (1912-2006)

Existing and Future Environment Monthly Average Flow - Percentiles

Open Water

Percentile (%)	Existing Environment Flow (cms)	Future Environment Flow (cms)	Difference
Min	1401	1538	9.8%
5	1882	1949	3.5%
50	2866	3112	8.6%
95	5266	5088	3.4%
Max	6491	6415	1.2%

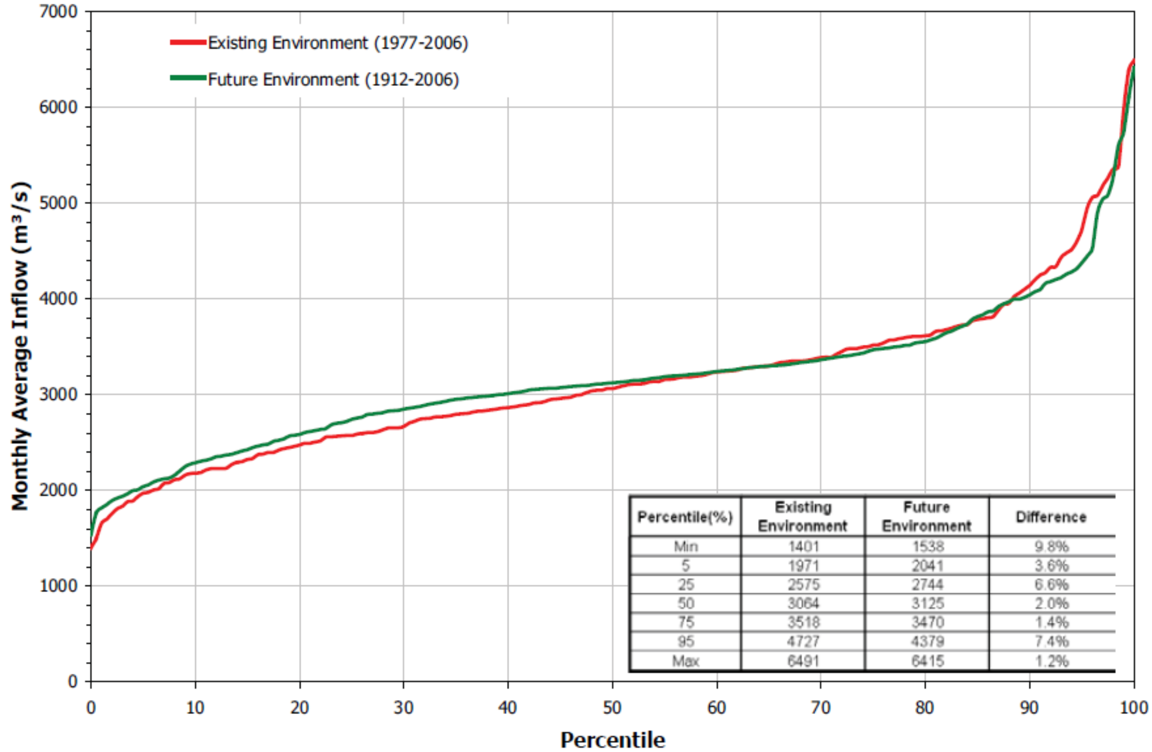
Winter

Percentile (%)	Existing Environment Flow (cms)	Future Environment Flow (cms)	Difference
Min	1574	1766	12.2%
5	2019	2264	12.2%
50	3181	3143	1.2%
95	4103	3867	5.7%
Max	4521	4438	1.8%

All Season

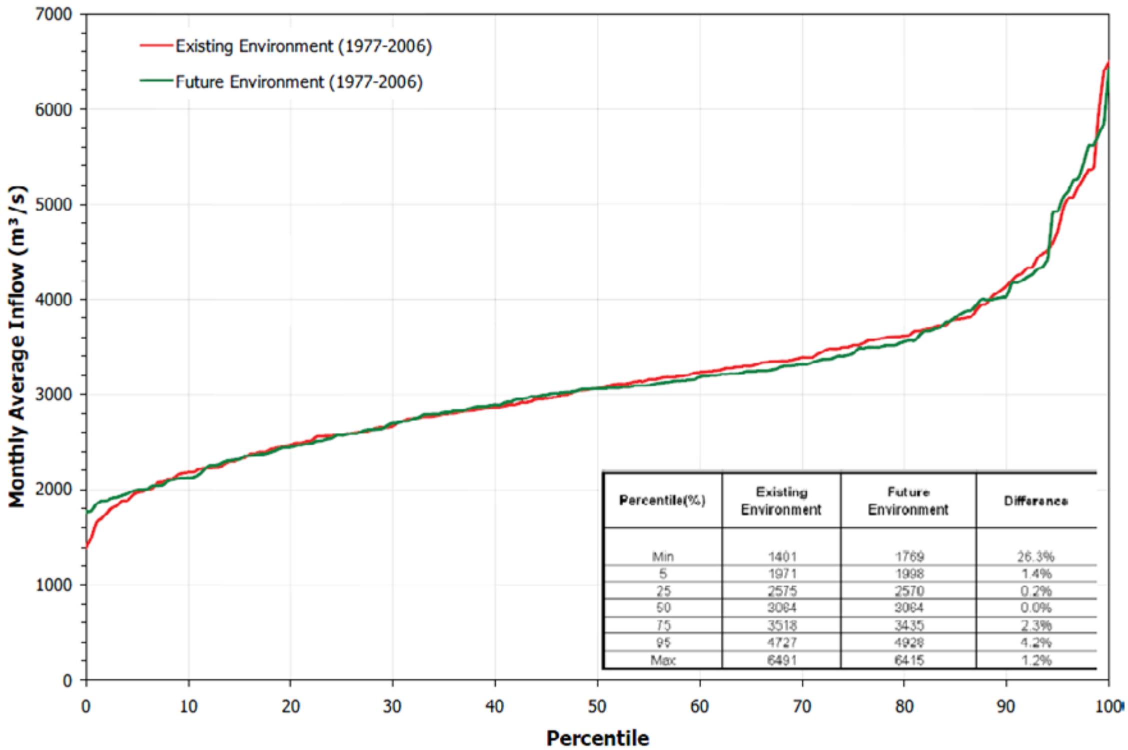
Percentile (%)	Existing Environment Flow (cms)	Future Environment Flow (cms)	Difference
Min	1401	1538	9.8%
5	1971	2041	3.0%
50	3064	3125	2.0%
95	4727	4379	7.4%
Max	6491	6415	1.2%

Inflow Duration Curves – Existing Environment and Future Environment



Percentile(%)	Existing Environment	Future Environment	Difference
Min	1401	1538	9.8%
5	1971	2041	3.6%
25	2575	2744	6.6%
50	3064	3125	2.0%
75	3518	3470	1.4%
95	4727	4379	7.4%
Max	6491	6415	1.2%

Figure 11: Existing Environment v. Future Environment Duration Curves - All season



Percentile(%)	Existing Environment	Future Environment	Differance
Min	1401	1769	26.3%
5	1971	1998	1.4%
25	2575	2570	0.2%
50	3064	3064	0.0%
75	3518	3435	2.3%
95	4727	4928	4.2%
Max	6491	6415	1.2%

Figure 12: Existing Environment v. Future Environment Duration Curves - All Season

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Appendix 3A Aquatic Habitat Methods; Page No.: N/A

TAC Public Rd 3 DFO-0007

ROUND 1 PREAMBLE AND QUESTION:

Depth Zones Section

In reviewing methods for aquatic habitat assessment in Appendix 3A, while the bathymetric surveying was very detailed, the validation of sonar data does not appear to be structured and repeated such that there is statistical confidence in the results obtained. There is no description of a comparison between the results expected and results observed and therefore the fidelity of the observations. Can the proponent present this sensitivity analysis or point the reviewer to the report which document this? Alternatively, can a study be proposed to test repeatability of bathymetric data collection (test areas beyond the survey area could be tested in the upcoming field season)?

ROUND 2 PREAMBLE AND QUESTION:

Question may not have been clear. Was direct substrate sampling conducted for each point of sonar data? If not, for areas modelled or extrapolated, how was "modelled" substrate confirmed. Areas of high habitat value are important, but its unclear how this would be known a priori (that is, before sampling)?

FOLLOW-UP QUESTION:

Please see DFO-0001. In general, information, such as substrate, is presented in the EIS as if it is known with complete confidence. To reduce uncertainty in decision making, the precision of the estimates, such as 95% confidence intervals or corresponding percentiles should be considered. For example, a tabled estimate of cobble/gravel based on sampling or modelling should qualify the point estimate with something like a confidence interval. While information on substate is valuable it should be presented in the context of its value as fish habitat.

RESPONSE:

The Partnership recognizes the importance of substrate information with respect to the conduct of the environmental assessment. Therefore, the substrate sampling program was designed to reduce uncertainty by collecting and observing a relatively large number of real samples. Acoustic technology was used to augment the substrate sampling programs and to direct the selection of sites for future substrate sample validation through the identification of boundaries in substrate type. There is limited error in the identification of samples observed directly. The bottom type in areas of extremely fast flow such Gull Rapids does, however, remain uncertain and will be addressed through monitoring during dewatering of the rapids, as requested by DFO (see TAC Public Rd 3 DFO-0003).

Based on the field program and analysis we are confident that the patterns shown in our data during the period of the environmental studies reflect the main material size distributions evident in the river. Micro-scale heterogeneity may be present in some areas that were not observed, but this is unlikely in the main channel of a large and fast flowing river dominated by large bed material.

With respect to post-Project monitoring, the primary uncertainty that will be addressed regarding substrate pertains to the persistence of the boundaries already observed in areas where no change in substrate type is predicted, and the development of areas of fine grained materials over existing coarse substrates in the reservoir, as described in the AE SV Section 3.4.2.2.5.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 3.4.2.2.3 Aquatic Habitat at Year 30; Page No.: 3-34 to 3-36

TAC Public Rd 3 DFO-0014

ROUND 1 PREAMBLE AND QUESTION:

Pages 3-34 to 3-36

Depositional areas and changes described on pages 3-34 to 3-36, but does not talk about changes to specific habitats. Please provide details on how, specifically, proposed deposition will impact fish habitats and how this will be monitored.

ROUND 2 PREAMBLE AND QUESTION:

HADD description and accounting as requested was not provided.

FOLLOW-UP QUESTION:

Please see DFO-0001. Where possible, an idea of the state of the aquatic habitat at completion of construction and how it might develop over time to the year 30 state would reduce uncertainty in making decisions. For this question, change in substrate types needs to be cross-referenced to expected value as fish habitat and for fishing. DFO notes the proponent's direction to the AE SV regarding spawning of walleye and whitefish and rearing of sturgeon - also for deposition on plants and benthic invertebrates. However, overall changes and impacts need to be cross-referenced as effects on quantity, type, and quality of fish habitat and fishing. In addition, mitigation, residual effects, and offsetting measures need to be quantified.

RESPONSE:

Please see the response to TAC Public Rd 3 DFO-0001. The table provided in TAC Public Rd 3 DFO-0001 addresses changes over time in the reservoir by providing a range of durations for habitat effects (i.e., 10-15 years for transition, permanent for conditions after 30 years). Coarse-scale changes in substrate type in major reaches are also provided in the accounting of habitat change. Mitigation and compensation measures are summarized in the appropriate columns, with an indication of uncertainty of the effectiveness of these measures.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Appendix 6D Lake Sturgeon Habitat Suitability Index Modelling Results; Page No.: N/A

TAC Public Rd 3 DFO-0024

ROUND 1 PREAMBLE AND QUESTION:

Appendix 6D

Please present Habitat Units (HU's) for all tables in section 6D.

ROUND 2 PREAMBLE AND QUESTION:

Requested HU's not provided.

FOLLOW-UP QUESTION:

Please see DFO-0001. The primary interest is to describe the quantity, type and sensitivity of aquatic habitat in the hydraulic zone of influence/aquatic study area. Very specific habitat suitability analyses may then be used to augment the assessment of area impacts. However, HSI bins should likely reflect actual areas not WUA or HUs that fall within the composite suitability bins.

RESPONSE:

Please see the response to TAC Public Rd 3 DFO-0001. As discussed with DFO, the table provided in this response will provide overall areas of habitat change with an indication of use by VEC species. If a more detailed quantification of habitat suitability (based on an HSI analysis) is required for completion of Authorizations under the Fisheries Act, this will be discussed with DFO.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 6.0 Lake Sturgeon; Page No.: N/A

TAC Public Rd 3 DFO-0025

ROUND 1 PREAMBLE AND QUESTION:

Chapter 6

For all HSI maps, outline of existing environment (the shorelines of the Nelson River and Stephens Lake) should be shown in the post project environment maps. The additional aquatic area gained by creation of the forebay should be illustrated and given a suitability of 0, recognizing that this is terrestrial habitat that will undergo substantial change before it becomes productive aquatic habitat (EIS suggests at least 5 years). Please provide revised maps showing these changes.

ROUND 2 PREAMBLE AND QUESTION:

Revised maps not provided.

FOLLOW-UP QUESTION:

Please see DFO-0001.

RESPONSE:

Please see the response to TAC Public Rd 3 DFO-0001.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Appendix 1A Aquatic Mitigation and Compensation Measures: Evaluation of Alternatives and Rationale for Selected Measures; Page No.: N/A

TAC Public Rd 3 DFO-0026

ROUND 1 PREAMBLE AND QUESTION:

Maps 6-48, 6-49

Unclear as to how sand/gravel habitat will be created post project in the forebay, particularly in years 1-5. Does this include compensatory measures proposed in Appendix 1A? Please provide detailed information/model which demonstrates the creation of sand post project.

ROUND 2 PREAMBLE AND QUESTION:

Requested details on sand habitat creation not provided.

FOLLOW-UP QUESTION:

Please see DFO-0001.

RESPONSE:

Please see the response to TAC Public Rd 3 DFO-0001.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 6.3.2.7.2 Movements Through Large Rapids; Page No.: 6-27

TAC Public Rd 3 DFO-0033

ROUND 1 PREAMBLE AND QUESTION:

Fish Movements – Importance of Movements.

Acoustic and telemetry tagging clearly show movement of Lake sturgeon through Gull Rapids. However, due to the limited number of telemetry data, conclusions on habitat use and the types of migration (e.g. spawning) are not practical. Please provide detailed reports showing movement.

ROUND 2 PREAMBLE AND QUESTION:

Detailed reports not provided

FOLLOW-UP QUESTION:

Would the Proponent please summarize its present information on passage or migration, expected impacts, and measures to offset impacts? DFO needs a clear understanding of expected passage or migration impacts. DFO would appreciate seeing the Proponent's 2012 data movement analysis report. In addition, an Aquatic Effects Monitoring Plan (AEMP) - referred to by the proponent as providing additional movement information, is presently under discussion and is scheduled for public release by the Proponent in the second quarter of 2013. DFO would like to ensure that fish movements are understood, that impacts on movements are understood, mitigated to the extent practical, that residual impacts are known, and that monitoring will clarify uncertainty for adaptive management . DFO believes that the proponent has provided information but is uncertain about the degree to which the provided information is complete. DFO would like the proponent to ensure that all pertinent information has been provided to reduce uncertainty in decision making.

RESPONSE:

The reviewer requests a summary on (i) fish passage or migration; (ii) expected impacts; and (iii) measures to offset impacts?

Current Information on Fish Passage and Migration and Expected Impacts

A memo titled “Adult Lake Sturgeon Movements in the Clark Lake to Kettle Generating Station Reach of the Nelson River” was provided in CEC Rd2 CEC-099 and is provided in the CD of technical reports with this submission. This memo provides an overview of the current understanding of adult Lake Sturgeon movements, observed movements recorded in the Keeyask area during the environmental studies and in subsequent investigations, and potential effects of blocking movements at Gull Rapids.

A data report providing the results of pre-construction monitoring in 2011– 2012 entitled “Results of Adult Lake Sturgeon Movement Monitoring in the Nelson River between Clark Lake and the Long Spruce Generating Station, October 2011 to October 2012” was provided to DFO in an email sent by C. Barth on 18-July-2013. It is also provided in the CD of technical reports with this response.

A memo titled “Movements of Walleye, Northern Pike and Lake Whitefish in the Clark Lake to Kettle Generating Station Reach of the Nelson River” was prepared to summarize movement information for the other VEC fish species. It is provided in the CD of technical reports with this response.

Plan to Mitigate Effects to Fish Passage and Address Uncertainty

As described in CEC Rd 1 CEC-0026, fish passage has been discussed with Fisheries and Oceans Canada (DFO) and Manitoba Conservation and Water Stewardship (MCWS) over a period reaching back to 2011. The final position by DFO in this regard was provided in correspondence (2013 July 10) from Mr. Dale Nicholson (Regional Director, Ecosystems Management, Central and Arctic Region, Fisheries and Oceans Canada) to Mr. Ken Adams (President, Keeyask Hydropower Limited Partnership).

As per the correspondence, DFO’s position is that there is insufficient information at this time to determine the importance of fish movements to a sustainable fishery. However, in the absence of evidence to the contrary, DFO’s position is that the movement of Lake Sturgeon, Walleye and Lake Whitefish at the proposed project site should be considered as important to the lifecycle and ongoing productivity of these fishes[3]. The requirement for fish passage facilities will be determined by DFO, in consultation with MCWS, based on the results of monitoring, established fisheries management objectives, and support for ongoing fisheries productivity. DFO will not require the installation of fish passage facilities if DFO, in consultation with MCWS, determines that all fish management objectives can be met and ongoing productivity can be supported without installation of these facilities.

[3] It should be noted that the Partnership is of the opinion that movements of adult fish are not required for sustainable fish populations, as per the EIS, due to the presence of habitat required to fulfill all life history requirements upstream and downstream of the generating station. See memo attached to CEC Rd 2 CEC–0099 for more information with respect to Lake Sturgeon movements.

The Partnership will work with DFO and MCWS to develop and implement monitoring programs that will provide the required information to address the uncertainty identified by DFO and MCWS. If DFO and MCWS determine that fish passage is required to meet Fisheries Management Objectives, then the Partnership has identified fish passage options that can be installed at the GS as a retrofit and will implement these measures.

Monitoring to Address Uncertainty

A phased approach will be used to conduct fish movement research in relation to the Project. The initial phase has been implemented and involves collecting pre-construction data on the movements of adult and sub-adult Lake Sturgeon and adult Walleye. Details related to these studies are as follows:

- Sixty adult Lake Sturgeon were tagged in 2011 and 2012. Transmitters used during this study have a 10-year battery life. Results from the initial two-years study are discussed in the Lake Sturgeon movement memorandum referenced in the preceding text;
- Eighty walleye are to be tagged during the open-water period of 2013. Transmitters have a three-year battery life (for a description of this study please see attachment); and
- Forty subadult Lake Sturgeon are to be tagged during the open-water period of 2013. Transmitters have a three-year battery life.

It is anticipated that the number of tagged fish will be maintained through the construction period to provide information on movements prior to construction and during construction and the first period of impoundment.

Following analysis of these data additional research studies will be considered with input from DFO and MCWS.

Keeyask Project: quantifying pre-project movements of Walleye in the Keeyask Study Area

Background

Movement studies conducted for the Keeyask Environmental Assessment found that all Valued Ecosystem Component (VEC) fish species (lake sturgeon, northern pike, walleye and lake whitefish) move upstream and downstream over Gull Rapids. However, for the VEC fish species other than lake sturgeon, data collected to date indicates that the proportion of the population that moves through Gull Rapids (in either the upstream or downstream direction) is small. To better understand the approach to fish passage, additional existing environment movement studies are being undertaken. For lake sturgeon, these began in 2011, and movement studies focused on one or more of the other VEC species are proposed for 2013.

Objective

The broad objective of the proposed study is to gain a better understanding of present day movements and habitat use in the Keeyask Study Area, with particular focus on movements in the vicinity of Gull Rapids, including, but not limited to, upstream and downstream passage. Walleye was selected as the target species for the initial phase of study as it is a species of commercial and domestic importance, abundant in the Keeyask area, known to pass through Gull Rapids in either direction, and survives acoustic tag implantation well.

Specific objectives are as follows:

- Quantify how many (or what proportion of) adult Walleye present in the river immediately downstream of Gull Rapids move upstream over the rapids on an annual basis;
- Quantify how many (or what proportion of) adult Walleye resident in the riverine habitat from Birthday to Gull Rapids move downstream over Gull Rapids on an annual basis;
- Determine the frequency of long range movements (e.g. >5 km) across the rapids versus the frequency of those that do not result in passage; and
- Determine the timing of movements.

Supplemental objectives include:

- Quantify movement patterns and spatial utilization of the Keeyask Study Area by walleye which frequent the Nelson River mainstem.

Methodology overview

The study will use acoustic telemetry to monitor fish movements. Walleye (n=80) will be captured and implanted with Vemco V13 transmitters (3 year battery life). A 50+ receiver VR2W array, currently being used to monitor movements of Lake Sturgeon within the Keeyask Study Area (Figure 1), will be supplemented with receiver "gates" deployed in several key areas (upstream and downstream of Gull Rapids, upstream and downstream of Birthday Rapids, upstream of Kettle GS). For reference, "gates" refer to simultaneous use of two or more acoustic receivers oriented perpendicular to the primary flow axis to provide complete coverage for a cross section of river. Theoretically, this should result in 100% detection of passing fish and allow for directionality of movements to be ascertained. Movements of tagged fish will be monitored over a 3 year period, throughout the open-water and to a lesser extent during the ice covered season (it is not feasible to monitor in some locations due to ice scouring). The methodologies employed will achieve a high level temporal resolution associated with large scale movements between or through key locations (i.e. Gull Rapids). In addition to addressing movements over the rapids, the data will increase understanding of walleye movement patterns (i.e., typical distances moved and spatial patterns associated with spawning and foraging), as well as relative utilization of the different reaches of the Study Area.

Field study program

It is recommended that walleye measuring between 400 – 600 mm in fork length be targeted to ensure that all individuals tagged are adults and large enough to support V13 tags without compromising behaviour (i.e., aiming for tag weight of <3.0% of fish weight). Exceptionally large fish would not be tagged, since these fish are more likely to be susceptible to handling induced mortality. Tagging would be conducted during the post-spawn/early summer period (June-July 2013) when water temperatures range from 10 – 14ºC to avoid stressing/handling fish when they are spawning.

Acoustic tagging stratification

Walleye (n=40) will be tagged in the upper 6 km portion of Stephens Lake. To the extent possible, transmitters will be applied at various distances from Gull Rapids, recognizing that locations to set nets effectively, without harming fish may be limited in this area. Another 40 walleye will be tagged upstream of Gull Rapids, focusing on edges of mainstem riverine habitat in Gull Lake. Here also, tagging will be stratified by the three basins in Gull Lake. .

Analytical approach

Sample sizes (US: n=40, DS: n=40) would allow for χ^2 (or Fisher's Exact Test) examinations of pooled upstream versus downstream movements over Gull Rapids (and potentially Birthday Rapids). This analysis would indicate if there is an inherent directionality associated with passage events of adult walleye, or if upstream and downstream movements occur in relative proportion (see Welsh and McLeod 2010). The same statistical framework could be used to test if rate of movement over the rapids varies by season, which may be an important question given that it is yet unclear if walleye movements in the Study Area are "motivated" by spawning site fidelity, or if they occur as a result of non-directional foraging movements. Incorporation of a "random-walk" framework (which would be supplemented by coarse-scale movement rate data generated from the telemetry array) will be used to see if there is a true pattern to movements over Gull Rapids outside of the spawning period.

Data analysis will identify if certain individuals are "prone" to repeated passage events, or if all individuals have an equal probability of moving over the rapids at any given time. This is anticipated to be assessed using a modified version of equal catchability (as employed in mark-recapture history methodologies). It could also be hypothesized that these data (which are essentially count data by individual) might follow a Poisson or Negative Binomial distribution, and could be tested versus a standard null hypothesis *a priori*. This analysis would be conducted with all passage events pooled, as well as separated into upstream and downstream events.

From a broader movement perspective, individual based approaches such as home-range (linear river kilometers and/or XY minimum convex polygons), coarse-scale utilization distributions (by season), and residency at receivers (see Shaw et al. 2013) will be investigated. Population based approaches such as proportional distribution (see McDougall 2011), and capture-recapture estimates of spatial utilization (see Danancher et al. 2004) could also be incorporated depending on the nature of the data collected. Fish length could be employed as a predictor variable, although as noted above, the approach would be to focus on a fairly narrow size range. Tagging would be conducted post-spawn, so it is unclear if sex/maturity can be ascertained via endoscopic examination during tag implantation. Again, it should be noted that while there are objectives, directed hypothesis are not the focus. As such, it is anticipated that additional analysis and data summary will be conducted based on *post hoc* observations.

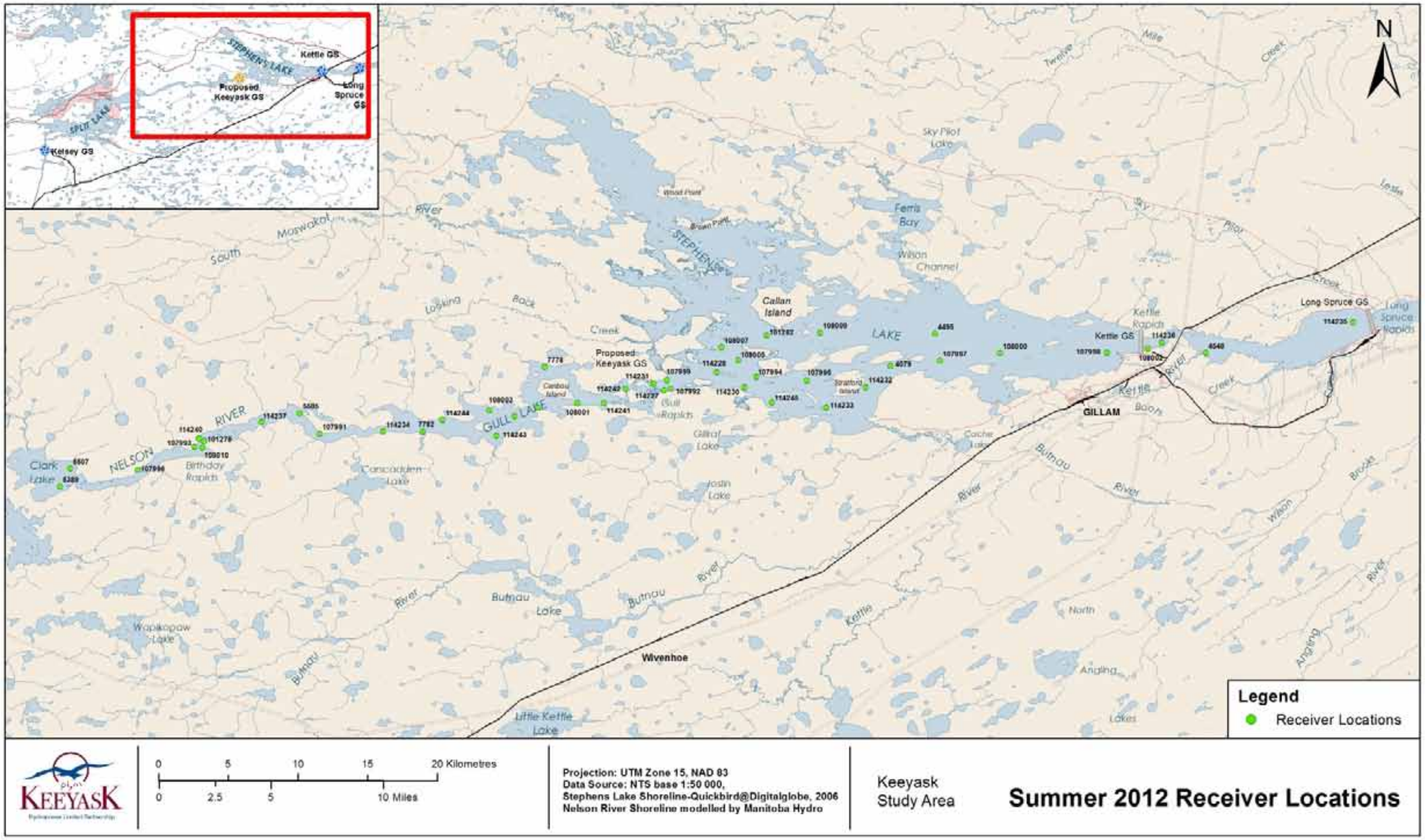


Figure 1. Representative stationary acoustic receiver coverage (circa June 2012) in the Keeyask Study Area, which would approximate "base" coverage going forward with Walleye movement monitoring project. It should be noted supplemental gates have yet to be incorporated.

Keeyask Generation Project
Fish Movement Studies
August 2013
MEMORANDUM

Subject: Movements of Walleye, Northern Pike and Lake Whitefish in the Clark Lake to Kettle Generating Station Reach of the Nelson River

To: Dr. Friederike Schneider-Vieira
North/South Consultants Inc.

From: Jodi Holm
North/South Consultants Inc.

Date: August 21, 2013

1.0 Purpose of Memorandum

The purpose of this memorandum is to provide:

1. a description of the movements of adult Valued Environmental Component (VEC) species (Walleye, Northern Pike, and Lake Whitefish) in the Clark Lake to Kettle Generating Station (GS) reach of the Nelson River, and the significance of those movements in fulfilling life history requirements;
2. a brief summary of the results of movement studies at existing Manitoba Hydro facilities in northern Manitoba; and
3. a discussion of potential effects to upstream and downstream fish populations of altering movements at the Keeyask GS.

The information discussed in this memo has been synthesized from Keeyask GS fish community studies and supplemented by additional information from Floy-tag recaptures recorded since the Keeyask Generation Project Aquatic Environment Supporting Volume (AE SV) was prepared. Information with respect to movements past existing facilities in northern Manitoba was obtained from long-term monitoring studies of the Limestone GS (NSC 2012), baseline studies for the Conawapa GS (NSC unpubl. analysis), hydroacoustic studies of fish passage at the Missi Falls Control Structure (CS; NSC and BioSonics 2008, 2009, 2010, 2011), and acoustic telemetry studies conducted within the Limestone GS forebay (Pisiak 2009).

2.0 Movement of VEC Fish Species in the Keeyask Area

General movement patterns of Walleye include a spring migration to spawning grounds, daily movement in the water column, and daily or seasonal movements in response to temperature and/or food availability (Scott and Crossman 1998). Walleye generally move little in the summer, but movements of 100 km or more have been observed (Scott and Crossman 1998). Walleye are known to migrate out of tributaries during the fall, presumably moving into deeper water as water temperatures decrease.

Northern Pike are generally described as fairly sedentary within an area with adequate cover and food, but are known to undertake extensive migration in the spring and fall in some systems (Scott and Crossman 1998).

Lake Whitefish populations in the Keeyask Study Area are strictly freshwater and do not migrate to Hudson Bay as part of their lifecycle. During fall, Lake Whitefish typically move into shallower waters to spawn (Scott and Crossman 1998).

Information on the movement of Walleye, Northern Pike, and Lake Whitefish specific to the Keeyask Study Area was obtained from the recapture of large numbers of individually Floy-tagged fish between 1999 and 2012 (15,179 fish; Tables 1, 2, and 3). It should be noted, that since 2004, Floy-tagging effort has been directed almost exclusively towards Lake Sturgeon. Fish movements have also been studied through the repeated tracking of 74 fish (30 Walleye, 14 Pike and 30 Whitefish) implanted with radio- and acoustic-transmitters between 2001 and 2004. A pre-construction monitoring program using acoustic tags in Walleye was initiated in 2013, but results are not available for incorporation in this memo.

"Mark-recapture studies have shown that there is substantial movement of the VEC species within, but little movement among, the local study areas (i.e., Split Lake and its tributaries, the Nelson River between Clark Lake and Gull Rapids, and Stephens Lake and its tributaries). These studies have shown that all three species are capable of moving both upstream and downstream over all the major rapids (Long Rapids, Birthday Rapids, and Gull Rapids), but the incidence of such movements is low. Fish from Gull Lake do not appear to migrate downstream to access spawning habitat in Gull Rapids. Likewise, the studies did not record spring or fall spawning migrations of fish moving from Gull Lake to Split Lake, or from Stephens Lake to Gull Lake." (p 6-69 Response to EIS Guidelines).

There is currently little movement of VEC fish species across Gull Rapids and any such movements are incidental and do not reflect a migration. None of the Walleye, Lake Whitefish, or Northern Pike Floy-tagged and recaptured during the spring and fall of 2001 and 2002 that were tagged within 15 km of Gull Rapids were observed to have moved over Gull Rapids (summarized in tables 5-21, 5-26, 5-31 of the AE SV). When the dataset is expanded to include all fish Floy-tagged and recaptured in the Keeyask Study Area to 2012, less than 1% of the fish moved over Gull Rapids (as indicated by orange and green highlights in Tables 1-3). The movements of individual fish over Gull Rapids are discussed in Section 5.3.2.6 of the AE SV. Approximately 5% of the fish implanted with acoustic or radio-transmitters were observed to move over the rapids during the lifespan of the transmitters (summarized in tables 5-19, 5-24, 5-29 of the AE SV).

3.0 Downstream Fish Movement at Existing Facilities in Northern Manitoba

Limestone GS and Long Spruce GS

Floy-tag mark recapture studies have been conducted in the Limestone and Long Spruce study areas since 1989 as part of monitoring studies for the Limestone GS and baseline studies for the Conawapa GS. Nearly 1% of the Longnose Sucker and White Sucker Floy-tagged in the Limestone reservoir (2,625 and 118 fish, respectively) moved downstream during the first year following impoundment (NSC 2012, unpubl. data). However, there was little evidence of downstream movement thereafter. It has been speculated that downstream movement decreased once the reservoir operating level was attained and construction-related spills were terminated. One White Sucker and none of the Longnose Sucker (111 and 20 fish, respectively) that were tagged in the Long Spruce reservoir moved downstream into the Limestone reservoir. None of the Walleye or Northern Pike Floy-tagged in the Limestone or Long Spruce reservoirs (273 fish) have been observed to have moved downstream through a GS (NSC unpubl. data).

Movements of 34 Walleye, 29 Northern Pike, 14 Lake Whitefish, 12 White Sucker, and one Lake Sturgeon implanted with an acoustic transmitter and released in the Limestone reservoir were monitored from 2005-2007 (Pisiak 2009). By the end of the study, less than 3% of the Walleye and approximately 14% of the Northern Pike and Lake Whitefish potentially passed downstream through the GS or spillway, and all of the White Sucker and the only Lake Sturgeon remained in the Limestone reservoir. The majority of the Walleye, Northern Pike, and Lake Whitefish that remained in the reservoir showed a preference for the upper reach, which would minimize the potential of these species to pass downstream through the Limestone GS.

Missi Falls CS

The number and size of fish that leave Southern Indian Lake through the Missi Falls CS gates was estimated using hydroacoustic transducers over a range of flow rates during the open-water seasons of 2007-2010 (NSC and Biosonics 2011). The study showed that fewer fish are vulnerable to entrainment during high flow conditions as fewer fish occupied the forebay channel during these periods. However, during high flows, a greater proportion of those fish that did enter the channel were entrained in the flows. Data suggest that under low flow conditions large-bodied fish species have the swimming ability to avoid entrainment. The majority of fish that are entrained by the Missi Falls CS are small-bodied species or the young life stages (< 10 cm) and likely include Emerald

Shiner and Spottail Shiner, as well as Cisco. Most of the fish that passed through the CS did so at night.

4.0 Movements past the Keeyask GS – Long Term Implications for Fish Populations

Construction of the Keeyask GS will disrupt existing movements over Gull Rapids by VEC fish species. The GS will block any upstream movement of fish and could reduce the number of fish that move downstream into Stephens Lake by reducing the number that attempt to move or by increasing the mortality of those that do move. As described in this memorandum, the proportion of VEC fish species that currently move over Gull Rapids is small, ranging from <1 to 5% based on the recapture of Floy-tagged fish and monitoring of radio/acoustic transmitters. The timing of these movements suggests that they are not spawning migrations.

Keeyask will create a barrier to upstream movements, thus preventing spawning VECs from accessing the reservoir or its tributaries. Such a barrier would have little to no impact to populations in Stephens Lake since Walleye, Northern Pike, and Lake Whitefish populations in Stephens Lake do not appear to use habitat in the Nelson River above Gull Rapids or its tributaries for spawning. With mitigation (creation of spawning habitat below GS), resident populations in Stephens Lake are not expected to be impacted by the Project since habitat to fulfill all life history stages will be available.

Studies conducted in the Limestone reservoir, suggest that the number of resident fish that would move out of the reservoir through the Keeyask GS over the long-term would continue to be small (Pisiak 2009). Given the estimated low number of fish that move currently, it is unlikely that Stephens Lake populations will be substantively affected by the small loss of upstream emigrants as downstream passage for fish will be provided via the turbines and the spillway. Considerable effort has gone into optimizing the Keeyask turbine design to reduce fish mortality and allow fish to move downstream (AE SV Appendix 1A-Part 1, Section 1A.3.2.2.2). The spillway does not include features that are associated with increased fish mortality (summarized in Table 6.3 of the PD SV Table 6.3).

Based on the small number of fish that currently move upstream over Gull Rapids, it is unlikely that a barrier to such movements would affect the long-term sustainability of the upstream populations. Habitat changes upstream of the GS are expected to result in an increase in the relative abundance of the resident population of Walleye and Lake Whitefish in the Keeyask reservoir as has been seen in other impoundments in North America (summarized in Section 5.4.2.2.9 of the AE SV). The relative abundance of the resident population of northern pike in the Keeyask reservoir is expected to remain similar to that currently in the mainstem.

5.0 References

NSC (North/South Consultants Incorporated). 2012. Limestone Generating Station: Aquatic environment monitoring – a synthesis of results 1985-2003. North/South Consultants Inc., Winnipeg, MB.

NSC and BioSonics Inc. 2011. An assessment of fish movement through Missi Falls Control Structure Southern Indian Lake, Manitoba 2010. A report prepared for The South Indian Lake Environmental Steering Committee.

Pisiak, D.J. 2009. Limestone Generating Station forebay movements study: 2005-2007 synthesis report. A report prepared for Manitoba Hydro by North/South Consultants Inc.

Scott, W.B., and E.J. Crossman. 1998. Freshwater fishes of Canada. Bulletin Fisheries Research Board of Canada No. 184.

Table 1: Number of Walleye marked with Floy®-tags and recaptured in Keeyask Study area waterbodies between 1999 and 2012

Tagging Waterbody	Location Code	Number Tagged	Number Recaptured[1]/Location: Split Lake Area													Keeyask Area			Gull Rapids Area	Stephens Lake Area				Downstream of Study Area	Total Number Recaptured[3]	Individual Recapture Rate (%)
			1	2	3	4	5			8	9	10	11	?	Total[2]	12	13	Total[2]	14	15	16	17	Total[2]			
Split Lake Area																										
Split Lake	1	225	15	11	9	-	-	-	-	-	-	-	1	16	37	-	-	-	-	-	-	-	-	-	52	23.1
Aiken River	2	1752	137	301	71	12	-	-	-	-	-	-	1	59	566	-	-	-	-	-	-	-	-	-	566	32.3
Mistuska River	3	1020	60	8	69	-	-	-	-	-	-	-	-	67	200	-	-	-	-	-	-	-	-	-	200	19.6
Ripple River	4	18	4	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	4	22.2
Assean River	5	310	5	-	-	-	11	1	3	2	2	-	1	2	28	-	-	-	-	-	-	-	-	-	28	9.0
Crying River	6	53	-	-	-	-	-	1	-	4	-	-	-	-	5	-	-	-	-	-	-	-	-	-	5	9.4
Hunting River	7	107	-	-	-	-	1	-	-	1	-	-	-	-	2	-	-	-	-	-	1	-	1	-	3	2.8
Assean Lake	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clark Lake (CL)	9	172	2	-	-	-	1	-	1	-	1	-	-	2	5	1	-	1	-	-	-	-	-	-	8	4.7
Burntwood/Odei River	10	58	8	-	-	-	-	-	-	-	-	1	-	1	2	-	-	-	-	-	-	-	-	-	10	17.2
Kelsey GS	11	126	-	-	-	-	-	-	-	-	-	-	4	1	5	-	-	-	-	-	-	-	-	-	5	4.0
Keeyask Area																										
Nelson River (CL-GL)	12	269	1	-	-	-	-	-	-	-	-	2	-	2	3	3	4	8	1	-	-	-	-	-	13	4.8
Gull Lake (GL)	13	239	-	-	-	-	-	-	-	-	-	1	-	-	1	-	10	10	1	-	-	-	-	1	13	5.4
Gull Rapids Area	14	878	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	66	15	-	1	16	-	82	9.3
Stephens Lake Area																										
Stephens Lake	15	161	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	2	-	-	2	-	7	4.3
North Moswakot River	16	74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	4	-	6	-	6	8.1
South Moswakot River	17	39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	2	-	3	7.7
Looking Back Creek	18	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		5508	232	320	149	12	13	2	4	7	3	4	7	150	854	4	15	20	74	21	5	1	27	1	1005	18.2

? Unknown whether Split Lake, Assean Lake, or Aiken, Ripple, Mistuska or Assean Rivers.

1. Does not include fish recaptured multiple times in a waterbody at any time.
2. Does not include fish recaptured multiple times within an area at any time.
3. Does not include fish recaptured multiple times anywhere in the study area at any time.

Table 2: Number of Northern Pike marked with Floy®-tags and recaptured in Keeyask Study area waterbodies between 1999 and 2012

Tagging Waterbody	Location Code	Number Tagged	Number Recaptured[1] / Location																				Total Number Recaptured[3]	Individual Recapture Rate (%)
			Split Lake Area											Keeyask Area			Gull Rapids Area	Stephens Lake Area				Downstream of Study Area		
			1	2	3	4	5	8	9	10	11	?	Total[2]	12	13	Total[2]	14	15	16	17	Total[2]			
Split Lake Area																								
Split Lake	1	291	11	5	4	1	-	-	-	-	1	1	23	-	-	-	-	-	-	-	-	-	23	7.9
Aiken River	2	533	11	24	7	4	-	-	-	-	-	4	50	-	-	-	-	-	-	-	-	-	50	9.4
Mistuska River	3	1217	21	2	75	2	-	-	-	-	1	8	107	-	-	-	-	-	-	-	-	-	107	8.8
Ripple River	4	342	11	5	11	6	-	-	-	-	-	4	37	-	-	-	-	-	-	-	-	-	37	10.8
Assean River	5	520	6	-	-	-	11	3	3	-	-	-	23	1	-	1	-	-	-	-	-	-	24	4.6
Crying River	6	71	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1.4
Hunting River	7	60	-	1	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	2	3.3
Assean Lake	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clark Lake (CL)	9	490	-	-	-	-	1	-	7	-	-	-	8	-	-	-	-	-	-	-	-	1	9	1.8
Burntwood/Odei River	10	67	2	-	1	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3	4.5
Kelsey GS	11	184	2	-	-	-	-	-	-	-	1	-	3	-	-	-	-	-	-	-	-	-	3	1.6
Keeyask Area																								
Nelson River (CL-GL)	12	1066	3	-	1	-	1	-	-	-	1	2	8	18	6	24	-	-	-	-	-	-	32	3.0
Gull Lake (GL)	13	1031	-	-	-	-	-	-	-	1	-	-	1	4	14	18	5	1	-	-	1	-	25	2.4
Gull Rapids Area	14	880	1	-	-	-	-	-	-	-	-	-	1	-	-	-	32	3	-	-	3	1	37	4.2
Stephens Lake Area																								
Stephens Lake	15	122	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.8
North Moswakot River	16	554	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	27	-	30	-	30	5.4
South Moswakot River	17	457	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	26	28	-	28	6.1
Looking Back Creek	18	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		7939	68	37	99	13	14	3	10	1	4	20	267	23	20	43	38	7	29	26	62	2	412	5.2

? Unknown whether Split Lake, Assean Lake, or Assean, Aiken, Ripple, or Mistuska Rivers

1. Does not include fish recaptured multiple times in a waterbody at any time
2. Does not include fish recaptured multiple times within an area at any time
3. Does not include fish recaptured multiple times anywhere in the study area at any time

Table 3: Number of Lake Whitefish marked with Floy®-tags and recaptured in Keeyask study area waterbodies between 1999 and 2012

Tagging Waterbody	Location Code	Number Tagged	Number Recaptured[1] / Location																		Total Number Recaptured[3]	Individual Recapture Rate (%)
			Split Lake Area								Keeyask Area			Gull Rapids Area	Stephens Lake Area				Downstream of Study Area		
			1	2	3	5	8	9	?	Total[2]	12	13	Total[2]	14	15	16	17	Total[2]			
Split Lake Area																					
Split Lake	1	61	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	1.6
Aiken River	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mistuska River	3	119	11	1	4	-	-	-	1	17	-	-	-	-	-	-	-	-	-	17	14.3
Ripple River	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Assean River	5	304	-	-	-	68	2	1	2	73	-	1	1	1	-	-	-	-	-	75	24.7
Assean Lake	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clark Lake (CL)	9	33	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1	3.0
Burntwood/Odei River	10	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kelsey GS	11	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Keeyask Area																					
Nelson River (CL-GL)	12	66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gull Lake (GL)	13	101	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	1	1.0
Gull Rapids Area	14	739	-	-	-	-	-	-	-	-	-	-	-	15	2	2	1	5	1	21	2.8
Stephens Lake Area																					
Stephens Lake	15	47	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	1	-
North Moswakot River	16	111	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1	0.9
South Moswakot River	17	118	-	-	-	-	-	-	-	-	-	-	-	2	-	1	3	4	-	6	5.1
Total		1732	11	1	5	69	2	1	3	92	-	2	2	18	3	4	4	11	1	124	7.2

? Unknown whether Split Lake, Assean Lake, or Assean River

1. Does not include fish recaptured multiple times in a waterbody at any time
2. Does not include fish recaptured multiple times within an area at any time
3. Does not include fish recaptured multiple times anywhere in the study area at any time

KEEYASK PROJECT
Generating Station

June 2013 | Report # 12-08

Results of Adult Lake Sturgeon Movement Monitoring in the Nelson River between Clark Lake and the Long Spruce Generating Station, October 2011 to October 2012

Draft

ENVIRONMENTAL STUDIES PROGRAM

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RESULTS OF ADULT LAKE STURGEON MOVEMENT MONITORING IN THE NELSON RIVER BETWEEN CLARK LAKE AND THE LONG SPRUCE GENERATING STATION, OCTOBER 2011 TO OCTOBER 2012.

Draft Report Prepared for Manitoba Hydro

by
C.L. Hrenchuk and C.C. Barth
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North/South Consultants Inc.
Aquatic Environment Specialists

83 Scurfield Blvd.
Winnipeg, Manitoba, R3Y 1G4
Website: www.nscons.ca

Tel.: (204) 284-3366
Fax: (204) 477-4173
E-mail: nscons@nscons.ca

OVERVIEW

In June 2012, the Keeyask Hydropower Limited Partnership (KHLP) filed an Environmental Impact Statement (EIS) in support of the Keeyask Generation Project, a 695 megawatt hydroelectric generating station (GS) that is proposed to be built at Gull Rapids on the Nelson River. An initial, intensive round of Keeyask environmental studies conducted between 1999 and 2006 provided the majority of the baseline information used in EIS descriptions of the existing environment and the predicted effects of the Project. Supplementary field studies were conducted starting in 2007 in order to: i) continue to collect long-term datasets on topics such as fish movements and mercury in fish flesh; and ii) address additional baseline information needs identified in the final phases of EIS preparation. Separate reports are being issued for each topic and for each year of updated long-term data.

This report presents results of an adult Lake Sturgeon acoustic telemetry study initiated in the Keeyask Study Area in June 2011. Movements of adult Lake Sturgeon tagged with acoustic transmitters were monitored in the Nelson River between Clark Lake and the Long Spruce GS. The year I report (Hrenchuk and McDougall 2012) presents movement information from June 2011 to October 2011. The report herein details movement information from October 2011 to October 2012. It is anticipated that 10 years of movement data will be collected from the Lake Sturgeon tagged during this study.

TECHNICAL SUMMARY

In June 2012, the Keeyask Hydropower Limited Partnership (KHLP) filed an Environmental Impact Statement (EIS) in support of the Keeyask Generation Project (the Project), a 695 megawatt hydroelectric generating station (GS) that is proposed to be built at Gull Rapids on the Nelson River (Figure 1).

The Keeyask environmental studies program was designed to investigate and document interrelated components of the Burntwood, Nelson, Aiken, and Assean rivers as well as the associated lakes (Split, Stephens, Clark, Gull, and Assean). Investigations in support of the environmental assessment were undertaken from 1999 to 2006. Supplementary field studies were conducted starting in 2007 in order to: i) continue to collect long-term datasets on topics such as fish movements and mercury in fish flesh; and ii) address additional baseline information needs identified in the final phases of EIS preparation. Separate reports are being issued for each topic and for each year of updated long-term data.

The following report presents results of an adult Lake Sturgeon acoustic telemetry study conducted in the Nelson River between Clark Lake and the Long Spruce GS. Acoustic transmitters having a 10-year battery life were applied to 49 adult Lake Sturgeon in 2011 and an additional 11 transmitters were applied in 2012. Therefore, 60 acoustic transmitters have been applied to adult Lake Sturgeon in the Keeyask Study Area, 31 upstream and 29 downstream of Gull Rapids. Movements of tagged sturgeon from 5 June, 2011 to 24 October, 2011 were reported in Hrenchuk and McDougall (2012) and movements from 25 October, 2011 to 15 October, 2012 are provided in this report.

Objectives of the study were as follows:

- to describe coarse-scale movements of adult Lake Sturgeon in the Keeyask Study Area;
- to gather additional information on the frequency and timing of adult Lake Sturgeon movements through Gull Rapids;
- to increase the understanding of adult Lake Sturgeon movements during winter in the Keeyask Study Area; and,

- to provide additional baseline data on adult Lake Sturgeon movements in the Keeyask Study Area that will help to assess the potential impacts of construction and operation of the Keeyask GS on Lake Sturgeon, should the project proceed.

This study marks the first attempt at monitoring adult Lake Sturgeon movements in the Nelson River during winter. In October 2011, an array of 10 acoustic receivers was deployed in the Nelson River between Clark Lake and Gull Rapids (CL – GR), and 21 receivers were deployed in Stephens Lake. Receivers were submersed without an attached float in > 6 m of water and left under the ice for the entire winter period.

Attempts to retrieve the receivers that were deployed during the winter occurred throughout the open-water period of 2012, however, ten receivers were not recovered, six from the Nelson River (CL – GR) and four from Stephens Lake. Although several receivers were not recovered, 34 of the 49 acoustically tagged Lake Sturgeon were detected at least once during winter 2011/2012. In the Nelson River (CL – GR), 17 of the 31 adult Lake Sturgeon last located in this river reach were located. Data indicate that an area of Gull Lake, located between rkm -7.0 and -11.0, is an important overwintering area as 12 of the 17 located Lake Sturgeon were detected in this area for >100 days of the total 187 days between 25 October and 1 May, 2012. In Stephens Lake, 17 of 18 Lake Sturgeon were relocated. Movements of the 17 adult Lake Sturgeon were grouped into three categories: (a) frequent relocation only in the upper portion of Stephens Lake (rkm 6.6 to 10.5), exhibited by nine tagged Lake Sturgeon; (b) relocation in the lower reaches of Stephens Lake (rkm 14.8 to 35.8), exhibited by four tagged Lake Sturgeon; and (c) infrequent winter relocations, exhibited by four tagged Lake Sturgeon. Of note, two Lake Sturgeon tagged in Stephens Lake moved through the Kettle GS between January, 2012 and mid-July, 2012.

During the open-water period of 2012, 30 tagged Lake Sturgeon last located in the Nelson River between Clark Lake and Gull Rapids were detected as follows: (a) six were relocated exclusively in the riverine portion between Clark Lake and Gull Lake; (b) one (#16029) moved upstream from Stephens Lake into Gull Lake in 2011 and likely spawned in the Nelson River between Birthday Rapids (rkm -29.5) and rkm -17.2 in 2012; (c) one (#16067) was relocated consistently in Gull Lake from June 2011, to early July 2012, when it moved upstream into Clark Lake; and (d) 22 were relocated almost exclusively in Gull Lake.

Twenty-eight tagged Lake Sturgeon last located in Stephens Lake were detected during the open-water period of 2012 as follows: (a) two fish were infrequently detected; (b) one

Lake Sturgeon moved downstream after being tagged and was last detected immediately upstream of the Kettle GS; (c) four moved upstream through Gull Rapids between 4 July, 2012 and 13 September, 2012; (d) nineteen were relocated regularly in Stephens Lake almost exclusively between rkm 0 and rkm 20; and (e) as previously discussed, two moved downstream into the Long Spruce Reservoir.

The implanted acoustic transmitters have a life expectancy of 10 years therefore the opportunity exists for eight additional years of data to be collected from these tagged Lake Sturgeon.

ACKNOWLEDGEMENTS

We would like to thank Manitoba Hydro for the opportunity and resources to conduct this study.

Chief and Council of Tataskweyak Cree Nation (TCN), War Lake First Nation (WLFN), York Factory First Nation (YFFN), and Fox Lake Cree Nation (FLCN) are gratefully acknowledged for their support of this program. We would also like to thank Clayton Flett and Douglas Kitchekeesik of TCN, Phillip Morris of WLFN, Evelyn Beardy of YFFN, and Ray Mayham of FLCN for arranging logistic support and personnel needed to conduct the field work.

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The Fox Lake Resource Users Group is acknowledged for their input in selecting stationary receiver sites in Stephens Lake and within Gull Rapids.

The collection of biological samples described in this report was authorized by Manitoba Conservation and Water Stewardship, Fisheries Branch, under terms of the Scientific Collection permit # 24-12.

NORTH/SOUTH CONSULTANTS INC. STUDY TEAM

Data Collection

Cameron Barth

Claire Hrenchuk

Christian Lavergne

Craig McDougall

Yhana Michaluk

Mike Legge

Jonathan Peake

Tobie Savard

Dave Szczepanski

Data Analysis, Report Preparation, and Report Review

Claire Hrenchuk

Cameron Barth

Elena Fishkin

Darcy Pisiak

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1.0 INTRODUCTION

In June 2012, the Keeyask Hydropower Limited Partnership (KHLP[1]) filed an Environmental Impact Statement (EIS) in support of the Keeyask Generation Project (the Project), a 695 megawatt hydroelectric generating station (GS) that is proposed to be built at Gull Rapids on the Nelson River (Figure 1).

Collection of baseline information on the aquatic environment required for an environmental impact assessment was initiated at the Project site in 1999. Manitoba Hydro expanded the program in 2001, and again in 2002, in response to concerns raised by the Keeyask Cree Nations to include a broader geographic area to better characterize all aspects of the environment that may be affected by development at Gull Rapids. This included the reach of the Nelson River between, and including, Split Lake to Stephens Lake, the Burntwood, Aiken, and Assean rivers, as well as the associated lakes (Split, Stephens, Clark, Gull, and Assean). Biological investigations conducted during the initial round of Keeyask Environmental Studies from 1999-2006 included measurements of physical habitat, water quality, detritus, algae, aquatic macrophytes, aquatic invertebrates, and fish.

Supplementary field studies were conducted starting in 2007 in order to: i) continue to collect long-term datasets on topics such as fish movements and mercury in fish flesh; and ii) address additional baseline information needs identified in the final phases of EIS preparation. Separate reports are being issued for each topic and for each year of updated long-term data.

The following report describing results of a long-term (10 yr) adult Lake Sturgeon movement monitoring study conducted in the Keeyask Study Area in 2012 is one of a series of reports produced from the Keeyask Environmental Studies Program. The objectives of this study were as follows:

- to describe coarse-scale movements of adult Lake Sturgeon in the Keeyask Study Area;

[1] *The Keeyask Hydropower Limited Partnership is comprised of four limited partners and one general partner. The limited partners are Manitoba Hydro, Cree Nation Partners Limited Partnership (CNP; controlled by TCN and WLFN), York Factory First Nation Limited Partnership (controlled by YFFN), and Fox Lake Cree Nation Keeyask Investments Inc. (controlled by FLCN). The four Cree Nations together are referred to as the Keeyask Cree Nations (KCNs). The general partner is 5900345 Manitoba Ltd., a corporation wholly owned by Manitoba Hydro.*

- to gather additional information on the frequency and timing of adult Lake Sturgeon movements through Gull Rapids;
- to increase the understanding of adult Lake Sturgeon movements during winter in the Keeyask Study Area; and,
- to provide additional baseline data on adult Lake Sturgeon movements in the Keeyask Study Area that will help to assess the potential impacts of construction and operation of the Keeyask GS on Lake Sturgeon, should the project proceed.

This long-term (10 yr) telemetry study began in June, 2011, when 44 adult Lake Sturgeon (30 in the Nelson River between Clark Lake (CL) and Gull Rapids (GR) and 14 in Stephens Lake) were tagged with acoustic transmitters that had a 10-year battery life. Throughout the open-water period of 2011, movements of these tagged fish were monitored using a combination of stationary and portable acoustic receivers. In September 2011, an additional five Lake Sturgeon were tagged with transmitters in Stephens Lake, bringing the total number of fish tagged in Stephens Lake to 19. Also in September, one of the sturgeon tagged in Stephens Lake moved upstream over Gull Rapids into Gull Lake. Therefore, by the end of the 2011 open-water period on 24 October, 2011, 49 adult Lake Sturgeon were tagged with acoustic transmitters in the Keeyask Study Area, 31 of which were last located in the Nelson River (CL – GR) and 18 of which were last located in Stephens Lake. Movements of these fish between 6 June and 24 October, 2011 were described in Hrenchuk and McDougall (2012).

Monitoring movements of these 49 acoustically tagged fish continued through the winter 2011/2012 period (October 2011 through April 2012) with an array of 31 acoustic receivers deployed prior to ice formation. Ten of these receivers were deployed in the Nelson River (CL - GR) and 21 were deployed in Stephens Lake. Data collected on Lake Sturgeon movements during this period are presented in this report.

In June 2012, 11 additional transmitters were applied to adult Lake Sturgeon in the Study Area, 10 in Stephens Lake and one in Gull Lake. With the addition of these transmitters, a total of 60 transmitters (31 in the Nelson River (CL – GR) and 29 in Stephens Lake) have been applied to adult Lake Sturgeon in the Keeyask Study Area since this study began in 2011. Movements of these 60 fish were monitored throughout the open-water period in 2012 with an array of 44 stationary receivers; 20 deployed in the Nelson River (CL – GR), 20 in Stephens Lake, and four deployed in the Long Spruce Forebay between the Kettle and Long Spruce GSs. Data collected on Lake Sturgeon movements during this time period are also presented in this report.

Movement monitoring will continue over the winter period in 2012/13, with 25 receivers that were deployed in the Nelson River between Clark Lake and the Long Spruce GS on 16 October, 2012. Data collected during this period will be presented in a subsequent report.

2.0 THE KEEYASK STUDY SETTING

2.1 STUDY AREA

The Keeyask Study Area includes the reach of the Nelson River from Kelsey Generating Station (GS) to Kettle GS, including Split, Clark, Gull, and Stephens lakes; the Burntwood River downstream of First Rapids; the Grass River downstream of Witchai Lake Falls; the Assean River watershed, including Assean Lake; and all other tributaries to the above stated reach of the Nelson River (Figure 1).

The entire Study Area lies within the High Boreal Land Region characterized by a mean annual temperature of –3.4ºC and an annual precipitation range of 415 to 560 mm. Topography is bedrock controlled overlain with fine-grained glacio-lacustrine deposits of clays and gravels. Depressional areas have peat plateaus and patterned fens with permafrost present. Black spruce/moss/sedge associations are the dominant vegetation (Canada-Manitoba Soil Survey 1976).

Split Lake, which is immediately downstream of the Kelsey GS at the confluence of the Burntwood and Nelson rivers, is the second largest waterbody in the Study Area. Due to the large inflows from the Nelson and Burntwood rivers, the lake has detectable current in several locations. Split Lake has maximum and mean depths of 28.0 m and 3.9 m, respectively, at a water surface elevation of 167.0 m above sea level (ASL) (Lawrence et al. 1999). The surface area of Split Lake was determined to be 26,100 ha (excluding islands), with a total shoreline length, including islands, of 940.0 km (Lawrence et al. 1999). The numerous islands in Split Lake represent 411.6 km of the total shoreline.

The reach of the Nelson River between Split Lake and Stephens Lake is characterized by: i) narrow sections with swiftly flowing water (including Birthday and Gull rapids); and ii) wider more lacustrine sections, including Clark and Gull lakes. Mean winter flow in the reach is 3,006 m^3/s and mean summer flow is 2,812 m^3/s (Manitoba Hydro 1996a).

The Assean River system is north of Split Lake and drains into Clark Lake (Figure 1). Except for the mouth of the Assean River, the hydrology of the watershed has not been affected by hydroelectric development.

Stephens Lake, the largest lake in the Study Area, is located downstream of Gull Rapids and was created through the development of the Kettle GS. Stephens Lake has a surface area of 29,930 ha (excluding islands) and a total shoreline length, including islands, of 740.8 km. The numerous islands encompass an area of 3,340 ha and 336.2 km of shoreline. There is no detectable current throughout most of this large lake, except for the old Nelson River channel.

Communities in the Study Area include the First Nations communities of Split Lake (TCN) and York Landing (YFFN), both located on Split Lake (Figure 1). Members of WLFN reside in Ilford south of the Nelson River while some members of FLCN reside in Gillam on the south shore of Stephens Lake. Gillam, the largest community in the Study Area, is the regional headquarters for Manitoba Hydro's northern operations.

The names assigned to some of the features described in Section 2.3 and illustrated in Figure 1 may be inconsistent with local names, topographic maps, and/or the Gazetteer of Canada. When field programs were initiated in spring, 2001, names of several features within the Study Area were unknown to North/South Consultants Inc. (NSC) biologists and First Nation assistants. Therefore, some features for which no name was known were assigned names by field personnel. Chief and council of TCN, YFFN, WLFN, and FLCN or the Canadian Permanent Committee on Geographical Names have not approved names of features described within this document.

2.2 PREVIOUS HYDROELECTRIC DEVELOPMENT

The Study Area is bounded by two Manitoba Hydro hydroelectric generating stations on the Nelson River: the Kelsey GS just upstream of Split Lake and Kettle GS downstream of Stephens Lake. The Kelsey GS came into service in 1961 and is operated as a run-of-river plant with very little storage or re-regulation of flows (Manitoba Hydro 1996a).

The Kettle GS was completed in 1974, which raised the water level at the structure by 30.0 m and created a backwater effect upstream to Gull Rapids. Approximately 22,055 ha of land were flooded in creating Stephens Lake (Manitoba Hydro 1996a). Kettle GS is operated as a peaking-type plant, cycling its **Forebay**[2] on a daily, weekly, and seasonal basis. The Forebay is operated within an annual water level range of 139 m to 141 m ASL (Manitoba Hydro 1996a).

Since 1976, two water management projects, the Churchill River Diversion (CRD) and Lake Winnipeg Regulation (LWR), have influenced water levels and flows within the Study Area.

[2] *Definitions for words appearing in bold are provided in the glossary (see Section 5.0).*

These two projects augment and alter flows to generating stations on the lower Nelson River by diverting additional water into the drainage from the Churchill River (CRD) (Manitoba Hydro 1996b) and managing outflow from Lake Winnipeg (LWR). The CRD and LWR projects reversed the Nelson River pre-Project seasonal water level and flow patterns in the Keeyask Study Area by increasing water levels and flow during periods of ice cover and reducing flows during the open-water period. Overall, there has been a net increase of 246 m^3/s in average annual flow at Gull Rapids since CRD and LWR (Manitoba Hydro 1996a). The historic and current flow regimes are described in "History and First Order Effects, Split Lake Cree Post-Project Environmental Review", Volume Two (Manitoba Hydro 1996a).

2.3 REPORT SPECIFIC STUDY AREA

2.3.1 Nelson River: Clark Lake to Birthday Rapids

The land adjacent to Clark Lake and the Nelson River downstream to Birthday Rapids is well drained and dominated by black spruce forest, with stands of trembling aspen sporadically distributed. Mineral soils are predominant in the area with permafrost distributed sporadically and bedrock outcrops near Birthday Rapids (Agriculture and Agri-Food Canada 2003).

Clark Lake is located immediately downstream of Split Lake, and approximately 42 km upstream of Gull Rapids on the Nelson River (Figure 1). Current is restricted to the main section of the lake, with off-current bays outside the main channel. Lake substrates are composed of fine mineral sediments and areas of bedrock. The shoreline is stable and largely bedrock with areas of mineral and organic sediments. **Riparian** vegetation includes willow, alder, and black spruce. Aquatic vegetation is restricted to and abundant in shallow off-current bays. The Assean River is the only major tributary to Clark Lake, flowing into the north side of the lake. Two small ephemeral creeks also flow into the north shore of Clark Lake.

Downstream from the outlet of Clark Lake, the Nelson River narrows and water velocity increases significantly for a 3 km stretch, with numerous rapids that are largely confined within bedrock shorelines. The substrate and shoreline features of this section of the river are largely bedrock and boulder/cobble. For the next 7 km, the river widens, water velocities decrease to medium, and coarse substrates predominate. Five small ephemeral creeks drain into the Nelson River between Clark Lake and Birthday Rapids.

2.3.2 Nelson River: Birthday Rapids to Gull Lake

The majority of the reach of the Nelson River between Birthday Rapids and Gull Lake lies within a landscape of well-drained mineral soils, dominated by black spruce forest. Immediately upstream of Gull Lake, the land adjacent to the south shore of the Nelson River is generally poorly drained, and is dominated by organic soils, and black spruce bogs, peatlands, and fens. Trembling aspen occurs occasionally along the shores of the Nelson River in areas that are well-drained. Exposed bedrock occurs along the north shore and upstream portions of the south shore of the Nelson River, particularly within the first 2 km downstream of Birthday Rapids. Permafrost is discontinuous to sporadic adjacent to this section of the river (Agriculture and Agri-Food Canada 2003).

Birthday Rapids is located approximately 10 km downstream of Clark Lake and 30 km upstream of Gull Rapids on the Nelson River (Figure 1). The drop in elevation from the upstream to downstream side of Birthday Rapids is approximately 5 m. The 14 km reach of the Nelson River between Birthday Rapids and Gull Lake is characterized as a large somewhat uniform channel with medium to high water velocity. A series of exposed shoals and boulders are located within the first 7 km downstream of Birthday Rapids, after which run habitat dominates the river. There are a few large bays with reduced water velocity and a number of small tributaries that drain into the Nelson River between Birthday Rapids and Gull Lake. River substrates are typically bedrock, boulder, cobble, and sand, with some fine sediment in areas with reduced current. The shoreline in this section of the river contains large sections of bedrock and some areas of fine sediments. Riparian vegetation includes willow and alder, black spruce, tamarack, and trembling aspen. Aquatic vegetation is restricted to bays that are removed from the major river current.

2.3.3 Nelson River: Gull Lake

Gull Lake is situated within a landscape of well-drained mineral soils, dominated by black spruce forest. Trembling aspen occurs sporadically along the shores of Gull Lake and in areas that are well drained. Permafrost is sporadically distributed along this section of the river (Agriculture and Agri-Food Canada 2003).

Gull Lake is a section of the Nelson River where the river widens and is lacustrine in nature with moderate to low water velocity featuring numerous bays. Gull Lake is herein defined as the reach of the Nelson River beginning approximately 17 km upstream of Gull Rapids and 14 km downstream of Birthday Rapids, where the river widens to the north into a bay around a large point of land (Figure 1), and extending to the downstream end of Caribou Island, approximately 3 km upstream of Gull Rapids. Gull Lake has three distinct basins, the first extending from the upstream end of the lake downstream approximately 6 km to a large island; the second extending from the large island to Morris Point (a constriction in the river immediately upstream of Caribou Island); and the third extending from Morris Point to the downstream end of Caribou Island. Water velocity in the third basin is somewhat faster than in the first two, particularly under low flow scenarios, as the river channel flows around Caribou Island. Gull Lake has numerous small tributaries, with the majority being ephemeral. Lake substrates are predominantly silt and sand with some cobble and boulder in the first two basins where current is slow, and predominantly cobble, boulder, and bedrock in the third basin, with soft substrates in off-current areas. Riparian vegetation includes willow and alder, black spruce, tamarack, and trembling aspen. Aquatic vegetation is restricted to bays that are removed from the major river channel.

2.3.4 Nelson River: Gull Lake to Gull Rapids

The landscape between Gull Lake and Gull Rapids consists of well-drained mineral soils, with bedrock outcrops. Black spruce is the dominant forest cover, with trembling aspen occurring sporadically along the shore. Permafrost is sporadically distributed adjacent to this section of the river (Agriculture and Agri-Food Canada 2003).

This 3 km reach of the Nelson River is characterized by a steep gradient with high water velocity. The river channel is separated into two by a large island at the upstream end of Gull Rapids (Figure 1). The substrate is bedrock, boulder, and cobble with small amounts of clay and silt in off current bays. Aquatic vegetation is restricted to a bay on the south shore.

2.3.5 Nelson River: Gull Rapids

Gull Rapids is located approximately 3 km downstream of Caribou Island on the Nelson River (Figure 1). Two large islands and several small islands occur within the rapids, prior to the river narrowing. The rapids are approximately 2 km in length, and the river elevation drops approximately 19 m from the downstream end of Gull Lake to the downstream end of Gull Rapids. The substrate and shoreline of Gull Rapids are composed of bedrock and boulders. One small tributary flows into the south side of Gull Rapids, approximately 1 km downstream from the upstream end of Gull Rapids. This tributary is approximately 2.5 km long, and is fed by bogs and fens. The most downstream 300 m of this tributary feature a diversity of pool, run, and riffle habitats and are characterized by boulder, gravel, and sand substrate with small amounts of organic material. The upper reach of this tributary is slower moving, dominated by marshy habitat and organic substrate.

2.3.6 Stephens Lake

The land bordering Stephens Lake includes areas of poor, moderate, and well-drained soils, dominated by black spruce forest in upland areas and black spruce bogs, peatlands, and fens in lowland areas. Trembling aspen occurs sporadically along the shoreline of Stephens Lake in areas that are well-drained. Soils are predominantly organic along the north shore, but include a section of mineral soil surrounding the north arm, and both mineral and organic soils along the south shore. Permafrost is discontinuous and sporadic, and exposed bedrock occurs at the west end of the lake (Agriculture and Agri-Food Canada 2003).

As discussed in Section 2.2, construction of the Kettle GS resulted in extensive flooding immediately upstream of the GS. Moose Nose Lake (north arm) and several other small lakes that previously drained into the Nelson River became continuous with the Nelson River to form Stephens Lake. Flooded terrestrial habitats compose a large portion of the existing lake substrates, and include organic sediments as well as areas of clay and silt. Woody debris is abundant due to the extensive flooding of treed areas. Outside the flooded terrestrial areas, substrates are dominated by fine clay and silt. Sand, gravel, and cobble, and areas of organic material dominate the shoreline, with much of the shoreline being prone to erosion. Riparian vegetation includes willow and alder, black spruce, tamarack, and scattered stands of trembling aspen.

Major tributaries of Stephens Lake include the North and South Moswakot rivers that enter the north arm of the lake. The only other major tributary of Stephens Lake was the Butnau River. However, during construction of the Kettle GS, an earth dyke was constructed at the inlet of the Butnau River at Stephens Lake, and a channel developed to divert the Butnau River through Cache Lake into the Kettle River (Manitoba Hydro 1996a). Looking Back Creek is a second order stream that drains into the north arm of Stephens Lake (Figure 1). The creek is approximately 4 m wide at the mouth, and contains large amounts of woody debris due to flooding in Stephens Lake.

2.3.7 Long Spruce Forebay

Long Spruce Forebay was formed in 1979 by the construction of the Long Spruce Generating Station (GS). It is a 16 km reach of the Nelson River extending from Long Spruce GS upstream to Kettle GS (Manitoba Hydro 1999).

Long Spruce GS is the second largest producer of electricity on the Nelson River (Manitoba Hydro 1999). Due to power demand, large and rapid daily fluctuations in discharge are characteristic of Long Spruce GS. The Forebay has limited storage capacity and, as a result, water entering the reservoir from Kettle GS must be discharged relatively quickly. Water levels in Long Spruce Forebay range from 109.0 m ASL in the summer to 110.4 m ASL in the winter, with normal water levels of 110.033 m and 110.330 m, respectively (Manitoba Hydro 1999). During the winter months a stable ice sheet forms over the Forebay to within 1 km of Kettle GS. The Forebay is completely mixed without vertical stratification of temperature (Baker and Schneider 1993). Long Spruce Forebay is located within the discontinuous permafrost zone.

Approximately 13 km of dykes border the downstream section of the Long Spruce GS (Manitoba Hydro 1999). Aquatic habitat within the upstream portion of the Forebay is riverine while the downstream portion is more similar to a lake environment. Along approximately 3 km of the north shore of the Forebay, there are extensive beds of emergent vegetation covering approximately 90% of this area. In this same location, approximately 10% to 20% of the littoral zone supports submergent aquatic macrophytes. In the remainder of the Forebay, emergent vegetation covers only about 5% to 10% of the shoreline, while less than 1% of the littoral zone supports submergent vegetation. Kettle River and Boots Creek are the only major tributaries flowing into Long Spruce Forebay, with both tributaries entering the Forebay on the south shore.

3.0 METHODS

3.1 PHYSICAL MONITORING

Water temperature was measured at 10 minute intervals with a HOBO Water Temperature Pro data logger (± 0.2°C) deployed in the Nelson River mainstem adjacent to the main current in Gull Lake. The data logger was set approximately 1-2 m above the bottom. Prior to deployment, the launch date, time, and measurement interval was set using a laptop computer. The logger was set on 29 May, 2012, and was removed prior to ice formation on 15 October, 2012.

3.2 ACOUSTIC TELEMETRY

3.2.1 Spring Gillnetting

Large mesh gillnet gangs were used to capture adult Lake Sturgeon in Stephens Lake and the Nelson River (CL – GR) during spring, 2012. Gangs consisted of two or four 25 yd (22.9 m) long, 2.7 yd (2.5 m) deep panels of a combination of 8, 9, 10, and 12” (203, 229, 254, and 305 mm) twisted nylon stretched mesh. Typically, two-panel gangs contained either 8 and 10” mesh or 9 and 12” mesh, and four-panel gangs contained one panel of each mesh size. Gill nets were checked approximately every 24 hours, weather permitting. At each gillnetting site, UTM coordinates were taken using a hand-held GPS receiver (Garmin Limited, Olathe, Kansas).

3.2.2 Acoustic Transmitters and Application

Transmitters were applied to captured Lake Sturgeon through surgical implantation in the **coelomic cavity,** as described in Hrenchuk and McDougall (2012). Sixty V16-4x coded pinger acoustic transmitters manufactured by VEMCO Ltd. (Shad Bay, Nova Scotia) were used in this study. Forty-nine transmitters were applied to Lake Sturgeon in 2011 and 11 were applied in 2012.

In spring 2012, acoustic transmitters were surgically implanted into adult Lake Sturgeon (measuring > 800 mm FL) in two areas: Stephens Lake downstream of Gull Rapids (GR; n = 10), and in Gull Lake (n = 1). With the addition of these transmitters, a total of 31 transmitters were applied to Lake Sturgeon in the Nelson River (CL – GR) and 29 in Stephens Lake.

3.2.3 Acoustic Receivers and Deployment

Acoustically-tagged Lake Sturgeon were monitored using two methods: 1) stationary receivers (model VR2 and VR2W, VEMCO, Shad Bay, Nova Scotia); and 2) manual tracking using a portable receiver (model VR-100, VEMCO, Shad Bay, Nova Scotia).

Vemco VR2 and VR2W receivers were used to monitor coarse-scale movements of tagged Lake Sturgeon throughout the Keeyask Study Area (i.e. the Nelson River from CL to GR, Stephens Lake, and the Long Spruce Forebay). With the exception of the VR2W having the capability to be downloaded wirelessly, the two models are functionally identical, as described in Hrenchuk and McDougall (2012).

3.2.3.1 Winter period 2011/12

To monitor Lake Sturgeon movements during the winter period (defined as the period from 20 October, 2011 to 1 May, 2012) receivers were affixed to a custom mooring (~25 kg) designed to maintain stability in the current and eliminate receiver sway (Figure 2). The mooring was equipped with a 2 m long loop of airline cable attached to a buoy. From an anchored boat, the receiver/mooring was lowered to the river bottom using rope so as to ensure proper orientation. Geographic location was recorded using a Garmin Etrex handheld GPS unit, and depth was recorded using a Humminbird PiranhaMax 150 fishfinder (Johnson Outdoors Inc., Eufaula, Alabama). When deployed, the hydrophone of each receiver was situated approximately 1 m above the river bottom, oriented towards the surface.

The Nelson River (CL-GR) array consisted of 10 receivers, deployed on 24 October, 2011 (Figure 3; Table 1). The Stephens Lake array consisted of 21 receivers, deployed between 19 and 22 October, 2011 (Figure 3; Table 1). It should be noted that receivers were not deployed within 6.6 rkm of Gull Rapids during the winter period due to predictions made by Manitoba Hydro Engineers of ice-scouring in the area (J. Malenchak, pers comm). The location of each deployed receiver in relation to several landmarks is provided in Figure 4.

3.2.3.2 Open-water period 2012

Stationary receivers deployed during the open-water period (defined as the period from 1 May, 2012 to 15 October, 2012), were affixed to custom moorings, as described in section 3.2.3.1 (Figure 2). Surface floats were attached to each mooring to facilitate retrieval. Geographic position of each receiver was taken using a Garmin Etrex handheld GPS receiver, and depth at each site was recorded using a Humminbird PiranhaMax 150 fishfinder.

The Nelson River (CL – GR) array consisted of 20 acoustic receivers, deployed between 29 May and 15 October, 2012 (Figure 5; Table 2). Receivers were set in low current areas in Clark Lake, below sets of rapids (Long Rapids and Birthday Rapids), in off-current areas of the Nelson River (such as in bays), and throughout Gull Lake. Twenty stationary receivers were deployed in Stephens Lake between the upstream end of Gull Rapids and Kettle GS (Figure 6; Table 2). Four stationary receivers were deployed in the Long Spruce Forebay (Figure 7; Table 2). The location of each deployed receiver in relation to several landmarks is provided in Figure 8.

3.2.4 Acoustic Receiver Retrieval

During spring 2012, after returning to the GPS-logged location, a Lowrance HDS-5 Sonar (Lowrance Electronics Inc.,Tulsa, Oklahoma) was used to locate acoustic receivers submerged over the winter of 2011/12 based on a characteristic signature produced by the moorings and suspended buoy. Once located, a 2 m long rake (15 cm tine spacing) was lowered to the bottom and back-trolled until the the buoy or airline cable attached to each receiver mooring was snagged. Once snagged, each receiver was raised to the surface and data were downloaded using Vemco VUE software. Retrieval attempts were conducted from June to September, 2012.

3.2.5 Manual Tracking

Manual tracking was conducted from a boat using a battery powered Vemco VR100 receiver in the Nelson River between Birthday Rapids and Gull Rapids. The VR100 is designed to detect signals from Vemco acoustic transmitters (i.e., those used in the current study), display any detected codes, and log tag identification data. During tracking, the boat was anchored and the VR100 hydrophone was lowered approximately 1 m under the water's surface for a period of 10 minutes. Tracking was conducted in areas of calm water, out of the main river channel, spaced approximately every 1 km (Figure 9). The date, time, and location associated with each transmitter detection was recorded manually.

3.2.6 Data Analysis

To filter out false detections, a Lake Sturgeon was required to be detected at least two times within a 30 minute interval at a given stationary receiver for the detections to be deemed valid. Single detections were filtered, and not used in analyses. In addition, a small number of suspicious outlier detections were filtered manually, considering all other spatiotemporal detection data available.

Coarse-scale movements of adult Lake Sturgeon were analysed in terms of river kilometer distance (rkm), with Gull Rapids representing a distance of 0 rkm. The area located downstream of Gull Rapids (i.e. Stephens Lake, Long Spruce Forebay) was considered positive (+) distance from Gull Rapids, while the area located upstream (i.e., Gull and Clark lakes) was considered negative (-) distance.

To facilitate this analysis, each individual receiver's rkm distance from Gull Rapids was measured using ArcGIS (Environmental Systems Research Institute, Redlands, California). A translation table was then generated in Excel to assign receiver distances to all detections. A positioning algorithm, adapted from McDougall (2011), was employed to calculate the average detection distance of each individual fish, based on a 4-hour interval according to the following equation:

$$\overline{D}_{\Delta t} = \frac{\sum_{i=1}^{n} R_i D_i}{\sum_{i=1}^{n} R_i}$$

Where: n = the number of receivers in the array;

R_i = the number of detections at the i^{th} receiver during the ΔT time period; and

D_i = the linear river kilometre distance of the i^{th} receiver from Gull Rapids.

Average detection distance versus time was plotted by fish for the duration of the study period.

4.0 RESULTS

4.1 WINTER 2011/2012

4.1.1 Receiver Retrieval

Four of the 10 receivers deployed in the Nelson River between Birthday and Gull Rapids during the winter period were successfully retrieved. These receivers were located at rkm -7.5, -10.5, -17.2, and -26.5 (Figure 10; Table 1). Six receivers, located at rkm -2.1, -7.1, -7.9, -13.8, -19.0, and -29.0, were not found. In Stephens Lake, 17 of the 21 receivers deployed during the winter period were retrieved. Of the four receivers that were not retrieved, one could not be located and three were covered by silt (Figure 11). Notably, one of the retrieved receivers (#4495), set in Stephens Lake in 15 m of water approximately 6.6 rkm downstream of Gull Rapids, was damaged during winter, as the rebar that attached the receiver to the cement base was bent to a near 90 degree angle (Photo 1).

4.1.2 Lake Sturgeon Movement

4.1.2.1 Nelson River (CL to GR)

Although only four of the ten deployed receivers were retrieved, 17 of the 31[3] Lake Sturgeon last located in the Nelson River (CL-GR) during fall, 2011, were detected during the 2011/2012 winter period. In total, 105,874 detections were logged (Appendix 1), eighty-five percent (n = 89,502) of which were logged by the receiver located at rkm -7.5 (Gull Lake, zone GL-B) (Figure 12). Movements of each individual fish initially tagged in the Nelson River (CL – GR) from the date of transmitter application to 15 October, 2012 are summarized graphically in Appendix 2.

Data indicate that many adult Lake Sturgeon overwintered in zone GL-B in Gull Lake. Twelve of the 17 located during the winter period were detected in zone GL-B for >100 days of the 187 days period between 25 October and 1 May, 2012 (Appendix 1-1). For example, Lake Sturgeon #16056 (Appendix 2-11) and #16070 (Appendix 2-25) were located on 174 and 179 days

[3] 30 of the 31 Lake Sturgeon were tagged in the Nelson River between Clark Lake and Gull Rapids and 1 of the sturgeon had moved upstream from Stephens Lake in September 2011.

respectively, at rkm -7.5. Although only four receivers were retrieved, Lake Sturgeon in this reach of the Nelson River generally exhibited limited movement during the winter months, as evidenced by consistent detections of individual fish by one receiver for extended periods.

4.1.2.2 Stephens Lake

Seventeen of the 18 acoustically-tagged Lake Sturgeon that were last located in Stephens Lake during fall 2011 were detected by stationary receivers during the 2011/2012 winter period. A total of 242,567 detections were logged by the 17 acoustic receivers (Appendix 1-2). Notably, receivers deployed upstream of rkm 10.5 did not log any fish between 19 December, 2011 and mid-May, 2012, and there were no detections logged by any receiver in Stephens Lake in April 2012. Movements of each individual fish initially tagged in Stephens Lake from the date of transmitter application to 15 October, 2012 are summarized graphically in Appendix 3. Movements of the 17 adult Lake Sturgeon may be categorized as follows:

a) Frequent relocation only in the upper portion of Stephens Lake (rkm 6.6 to rkm 10.5):

Nine Lake Sturgeon (#16030, #16032, #16035, #16037, #16038, #16040, #16046, #16049, and #16053) were relocated regularly in upper Stephens Lake from 25 October, 2011, to mid-March, 2012 (Appendix 3). However, after 15 December, 2012, with the exception of #16038, Lake Sturgeon were exclusively detected at rkm 10.5, often for extended periods. Lake Sturgeon #16038 was the only individual of this group to be relocated further downstream of rkm 10.5 in Stephens Lake during the winter period, being detected for several days near rkm 17.1 (Appendix 3-18).

b) Relocation in the lower reaches of Stephens Lake:

Four Lake Sturgeon (#16021, #16034, #16043 and #16044) moved downstream into the lower portion of Stephens Lake (Appendix 3). Fish #16043 briefly moved downstream to rkm 27.6 in late December and subsequently moved back upstream to rkm 10.7 by 12 January, 2012 (Appendix 3-20). Lake Sturgeon #16044 moved downstream during winter from rkm 6.6 – 9.6 in November and December, 2011, to rkm 17.1 in January and February, 2012, and to rkm 27.6 in March (Appendix 3-22). This fish was subsequently relocated in upper Stephens Lake during spring, 2012. The remaining two Lake Sturgeon (#16021 and #16034) moved downstream from upper Stephens Lake into lower Stephens Lake during winter and were subsequently relocated in the Long Spruce Reservoir during spring, 2012. Lake Sturgeon #16021 (Appendix 3-4) was relocated from October, 2011, to January, 2012, within 15 km of Gull Rapids. It then moved downstream into lower Stephens Lake and was detected by the receiver located directly upstream of the Kettle GS (rkm 35.8) several times on 20 March, 2012. The next known location of this fish was immediately downstream of the Kettle GS on 17 June, 2012, when it was captured in a gill net in good condition (Lavergne 2012). Although the exact date that this fish moved downstream through the Kettle GS is unknown, based on spatiotemporal detection data available, the movement must have occurred between 20 March and 17 June, 2012. It should be noted that between these dates, the spillway was open only for one hour on 13 April, 2012. The second Lake Sturgeon (#16034) that moved downstream into the Long Spruce Reservoir was detected within 15 rkm of Gull Rapids until mid-December, 2012 (Appendix 3-15). It then moved downstream into lower Stephens Lake and was detected by receivers at rkms 17.1 and 27.6, between 2 and 8 January, 2012. The next detection of this fish occurred in the Long Spruce Reservoir on 13 July, 2012. The exact date that this fish moved downstream into the Long Spruce Reservoir is unknown.

c) Infrequent winter relocations:

Four Lake Sturgeon (#16033, #16041, #16050, and #16052) were detected less than 15 days in total between 20 October, 2011, and 1 May, 2012. These fish likely overwintered out of the range of any of the receivers in Stephens Lake (Appendix 3).

4.2 OPEN-WATER PERIOD 2012

4.2.1 Physical Data

On 1 June, 2012, water temperature in the Nelson River mainstem was ~10.1°C (Figure 13). By 13 July, water temperature plateaued at ~21°C. In September, the water temperature began to steadily decline, and reached ~5.2°C by 15 October, 2012.

4.2.2 Acoustic Tagging

One Lake Sturgeon was implanted with an acoustic transmitter in the Nelson River (CL-GR) on 19 June, 2012 (Appendix 4-1). It had a fork length of 955 mm, weighed 7,711 g, and had a condition factor of 0.89. With the addition of this transmitter, a total of 31 Lake Sturgeon have been tagged in this reach of the Nelson River since the beginning of the study.

In Stephens Lake, ten Lake Sturgeon were captured in gill nets and implanted with acoustic transmitters between 8 and 16 June, 2012 (Appendix 4-2). These Lake Sturgeon had a mean fork length of 961 mm (range: 810 – 1,176 mm), a mean weight of 8,139 g (range: 5,216 – 14,969 g), and a mean condition factor of 0.90 (range: 0.7 – 1.1). A total of 29 Lake Sturgeon have been tagged in Stephens Lake throughout this study. Additional information on all Lake Sturgeon and other fish species captured in gill nets set to capture fish for acoustic transmitter implantation during spring 2012 can be found in Hrenchuk (2013).

4.2.3 Receiver deployment and retrieval

Nineteen of 20 stationary receivers were successfully retrieved from the Nelson River (CL – GR) (receiver #114234 was not located) (Figure 5). In Stephens Lake, 18 of the 20 deployed receivers were successfully retrieved. Receiver #114231 was lost near Gull Rapids in June, 2012, and receiver #107997 was lost in Stephens Lake (Figure 6). All four stationary receivers were retrieved from the Long Spruce Reservoir at the end of the study period (Figure 7).

4.2.4 Lake Sturgeon Movement

4.2.4.1 Nelson River (CL - GR)

Thirty of 32[4] tagged Lake Sturgeon last located in the Nelson River (CL – GR) were relocated between Clark Lake and Gull Rapids during the open-water period. Two tagged Lake Sturgeon (#16045 and #16077) were not detected by any method during this period (Appendix 2-6; Appendix 2-32). A total of 171,672 detections were logged (Appendix 1-3), with the majority of the detections occurring in zones BR-D (n = 78,295; 46%), and GL-B (n = 64,517; 38%). Manual tracking was conducted at 38 sites between Birthday Rapids and Gull Rapids from 3 to 5 August, 2012 (Figure 9). Twelve Lake Sturgeon were detected including one Lake Sturgeon (tag #16075) not detected previously by any stationary receiver (Appendix 5-1). The 30 acoustic-tagged Lake Sturgeon detected during the open-water period of 2012 can be categorized as follows:

a) Six Lake Sturgeon were detected exclusively in the riverine portion of the Nelson River between Clark Lake and Gull Lake:

Of these six fish, two (#16042 and #16048) were detected only at the outlet of Clark Lake (rkm -40). Three Lake Sturgeon (#16026, #16069, and #16074), were detected exclusively between Birthday Rapids and Gull Lake. One fish (#16058) moved between rkm -24.5 and rkm -34.2,

[4] 31 of 32 Lake Sturgeon were tagged in the Nelson River (CL – GR) in 2011 or 2012 and 1 was originally tagged in Stephens Lake and moved upstream over Gull Rapids in 2011.

then downstream over Birthday Rapids in August 2011 and back upstream over Birthday Rapids in August 2012 (Appendix 2).

b) One Lake Sturgeon (#16029) moved upstream from Gull Rapids in 2011:

Lake Sturgeon #16029 was identified as a female one year away from spawning when it was tagged in Stephens Lake in June 2011 (Appendix 2-2). This fish moved upstream into Gull Lake on 2 August, 2011 and moved as far upstream as the base of Long Rapids by late August. It subsequently moved downstream into Gull Lake where it overwintered. During spring 2012, this fish moved upstream from rkm -7.5 to rkm -17.2 on 23 May, 2012, to rkm -26.5 on 24 May. This movement encompasses a distance of approximately 19 rkm in approximately 41 hours (Appendix 6-10). After spending approximately one day in the vicinity of the receiver at rkm -26.5, this fish was relocated each day at rkm -17.2 from 26 May to 19 June, 2012, with the exception of 30 May and 15 June, 2012. Lake Sturgeon gillnetting was conducted in the Nelson River between Clark Lake and Gull Rapids during spring 2012 (Hrenchuk 2013) and data suggest that ripe male Lake Sturgeon were captured at Birthday Rapids from 1 to 3 June, 2012, when water temperatures were between 13 and 14ºC. Given that water temperatures associated with the Lake Sturgeon spawning window (8 – 14 ºC) occurred from 25 May to 20 June, 2012, it can be reasoned that this fish likely spawned in the Nelson River between rkm -17.2 and rkm -29.5 (Birthday Rapids) during this time.

c) Lake Sturgeon (#16067) was detected consistently in Gull Lake from June 2011 to early July 2012 when it moved upstream into Clark Lake:

Lake Sturgeon #16067 was regularly detected in Gull Lake from June 2011, to 3 June, 2012 (Appendix 2-22). This fish moved upstream on 3 June, 2012 and was relocated at rkm -17.2 regularly from 7 - 12 June, 2012, and 17 – 23 June, 2012, after which it continued to move upstream over Birthday Rapids (rkm -29.5) on 30 June, 2012, prior to being last detected in Clark Lake (rkm -39.2) on 1 July, 2012 (Appendix 2-22). The sex and state of maturity of this fish is unknown, but as previously discussed the movements of this fish into the riverine section between Birthday Rapids and Gull Lake when water temperatures were appropriate for spawning raise the possibility that this fish may have spawned in 2012.

d) The remaining 22 Lake Sturgeon were detected almost exclusively in Gull Lake:

The remaining 22 Lake Sturgeon were regularly detected in Gull Lake throughout the 2012 open-water period. During spring, 11 of these Lake Sturgeon (#16039, #16051, #16054, #16056, #16057, #16061, #16065, #16066, #16068, #16070, and #16072) displayed distinct upstream movements between 12 May and 7 June, moving from Gull Lake upstream to rkm -17.2

(Appendix 2). Additionally, Lake Sturgeon #16065 was detected for a single day at rkm -19.8 on 16 June, 2012 (Appendix 2-20). All 11 Lake Sturgeon moved downstream to Gull Lake; six in June, two in July, and three in August. During acoustic tag implantation, sex and maturity was identified for #16039 (female, spawned in 2011), #16056 (male, spawned in 2011), #16070 (male, spawned in 2011), and #16066 (female, spawned in 2011). Based on the scientific literature it seems highly unlikely that female Lake Sturgeon spawn in consecutive years (Roussow 1957; Harkness and Dymond 1963), therefore, for at least two fish (#16039 and #16066), these movements were likely not related to spawning.

4.2.4.2 Stephens Lake and the Long Spruce Reservoir

All 18 acoustically-tagged Lake Sturgeon last detected in Stephens Lake during 2011 and 2012, as well as the 10 Lake Sturgeon tagged in Stephens Lake during spring 2012, were located by stationary receivers set in either Stephens Lake or the Long Spruce reservoir during the 2012 open-water period (Appendix 3-2). A total of 188,950 detections were logged by the receivers in Stephens Lake and 19,913 detections were logged by the four acoustic receivers monitoring the Long Spruce Reservoir between 1 May and 15 October, 2012 (Appendix 1-4). A general movement summary of the 28 acoustic-tagged Lake Sturgeon in Stephens Lake is as follows:

a) Two Lake Sturgeon were infrequently detected:

Two Lake Sturgeon (#16024 and #16047) were infrequently detected. Lake Sturgeon #16024 was detected between 16 and 24 June, 2012, and was last located in upper Stephens Lake at rkm 6.7 (Appendix 3-7). Lake Sturgeon #16047 was detected on seven days between 27 July and 25 August, 2012. It was last detected close to Gull Rapids at rkm 3.2 (Appendix 3-24).

b) One Lake Sturgeon moved downstream after being tagged and was last detected immediately upstream of the Kettle GS:

Lake Sturgeon #16018 was tagged on 13 June, 2012, downstream of Gull Rapids (Appendix 4-2). It was subsequently detected at rkm 3.2 and rkm 7.5 in the first 3 days after being tagged. The next location and last known location of this fish was immediately upstream of the Kettle GS on 2 July, 2013 (Appendix 3-1).

c) Four Lake Sturgeon moved upstream through Gull Rapids between 4 July and 13 September, 2012:

Four Lake Sturgeon (#16025, #16033, #16038, and #16046) moved upstream through Gull Rapids during summer, 2012 (Appendix 3). Three fish were tagged in June 2011, while the fourth (#16025) was tagged on 16 June, 2012. During tagging, this fish was identified as a male of unknown maturity. It remained in Stephens Lake within 10 rkm downstream of Gull Rapids prior to moving upstream through Gull Rapids on 22 August, 2012. It subsequently moved as far as rkm -24.5 prior to moving downstream into Gull Lake where it remained until the receivers were last downloaded on 15 October, 2012 (Appendix 3-8).

Lake Sturgeon #16033 was detected within Gull Rapids at rkm 0 between 26 and 28 July, 2012. It moved upstream into Gull Lake on 29 July, 2012. Soon after this movement, it was harvested by a local fisherman (last detected on 30 July), and the transmitter was returned to North/South Consultants Inc. (Appendix 3-14).

Lake Sturgeon #16038 was located within 15 rkm downstream of Gull Rapids from 16 June to 16 July, 2012. It then moved upstream to within 3 rkm of Gull Rapids, where it remained until moving upstream through Gull Rapids on 13 September, 2012. It then remained in Gull Lake within 13 rkm upstream of Gull Rapids until 15 October, 2012 (Appendix 3-18).

Lake Sturgeon #16046 was detected between rkms 3.2 and 7.5 downstream of Gull Rapids until it moved upstream into the rapids on 27 June, 2012. It was first detected in Gull Lake on 4 July, and was consistently detected between rkms -8.4 and -14.4 until the end of the study period (Appendix 3-23). When tagged in Stephens Lake on 11 June, 2011, this fish was identified as a male of unknown maturity.

d) Nineteen Lake Sturgeon were regularly detected in Stephens Lake almost exclusively between rkm 1.3 and rkm 17.2:

Many of these fish moved between the base of Gull Rapids (rkm 1.3) and rkm 14.6, however, there was no observable pattern among fish. Of this group the only fish that moved further downstream than rkm 17.2 were Lake Sturgeon #16019 and #16049. Lake Sturgeon # 16019 was tagged on 13 June, 2012, downstream of Gull Rapids (Appendix 4-2). Post-tagging, it moved downstream and was detected at rkm 29.6 by 15 July, 2012. It remained in lower Stephens Lake until 1 August, 2012, after which it remained within 14.6 rkm of Gull Rapids (Appendix 3-2). Lake Sturgeon #16049 was located within 10.5 rkm of Gull Rapids between 3 and 16 June, 2012. It then moved downstream and was located at rkm 29.6 on 16 and 17 July, 2012, after which it moved upstream and was detected within 17.2 rkm of Gull Rapids until the end of the study period (Appendix 3-25).

e) Two Lake Sturgeon moved downstream into the Long Spruce Reservoir:

Two Lake Sturgeon (#16021 and #16034) moved past the Kettle GS into the Longspruce Reservoir, as previously discussed in section 4.1.2.2. Movements of these fish are provided in appendices 3-4 and 3-15.

5.0 DISCUSSION

5.1 WINTER 2011/12

This report presents movement data from Lake Sturgeon tagged with acoustic transmitters (10 year-long battery life) in the Nelson River between Clark Lake and the Long Spruce GS from June 2011 to October 2012. Prior to this study, monitoring Lake Sturgeon movements during winter using acoustic telemetry had not been attempted in the Nelson River due to concerns that a high proportion of stationary receivers deployed beneath the ice would be lost. During this study, 60% (n=6) of the receivers deployed in the Nelson River between Clark Lake and Gull Rapids during winter were lost. Attempts to recover the receivers were unsuccessful because the receivers had been moved (likely by ice) over the course of the winter. One factor that may have contributed to the loss of receivers was the decrease in water level (2 m) that occurred between the time receivers were deployed in October and ice breakup in May. The drop in water level corresponded to a drop in river flow of 2,615 cms during the winter period which likely increased the susceptibility of receivers to being moved by ice. Receivers that were successfully retrieved were those placed in deeper areas (> 7 m) which were likely less susceptible to ice scouring.

Although the recovery of receivers was relatively poor in the Nelson River between Clark Lake and Gull Rapids, considerable data were collected from several tagged Lake Sturgeon. Results suggest that a large proportion (17 of 31; 55% of tagged fish last located in this reach during fall) of Lake Sturgeon that reside in this area may overwinter in zone GL-B of Gull Lake. This location was also suggested as an important overwintering location based on detections of acoustically tagged Lake Sturgeon during late fall from 2001 – 2004 (Barth and Mochnacz 2004; Barth 2005; Barth and Murray 2005; Barth and Ambrose 2006). Lake Sturgeon are reported to seek out moderate to deep water depths and low water velocities to minimize energy expenditure during winter (Harkness and Dymond 1961; Scott and Crossman 1973; Hay-Chmielewski and Whelan 1997). In zone GL-B, these habitat characteristics are present along the south channel margins in the vicinity of receivers located at rkm -10.5 and -7.5. Further, the relocation of 10 Lake Sturgeon by the receiver located at rkm -7.5 for over 50% of the winter period suggests that Lake Sturgeon in Gull Lake are either relatively sedentary (near the receiver) during winter, or move over a narrow spatial range in Gull Lake during the winter months. The observed reduction in movements during winter is consistent with what has been reported in literature (Harkness and Dymond 1961; Hay-Chmielewski and Whelan 1997; Rusak and Mosindy 1997; Scott and Crossman 1998; Shaw et al. 2013).

In Stephens Lake, a higher proportion (17 of 21; 81%) of receivers deployed during winter 2011/2012 were recovered. This can mainly be attributed to the river characteristics at the receiver locations (i.e., water depths > 15 m and water velocities < 0.1 m/s). Additionally, receivers were not deployed within 6.6 rkm of Gull Rapids as it was predicted by Manitoba Hydro engineers that **frazil** ice, created continually over the winter above and throughout Gull Rapids, may buildup to depths > 15 m and scour the river bottom between rkm 4 and rkm 6. Despite these precautions, one receiver, located 6.6 km downstream of Gull Rapids set at 15 m depth, was damaged during the winter period. This suggests that frazil ice may be present and ice scouring of the river bottom likely occurs in this area.

Analyses of acoustic receiver data from Stephens Lake during winter reveals several gaps in the detection of tagged fish, most notably during April for all the receivers set in Stephens Lake and between approximately mid-December and late-May for receivers located nearest to Gull Rapids (i.e., within 6.6 – 9.2 rkm). The lack of detections by receivers set nearest to Gull Rapids between mid-December and late-May may be explained by either the lack of fish in this area, or by the continual frazil ice buildup that possibly obstructs transmitted signals and/or creates noise that interferes with transmitted signals. The complete lack of detections during April for any receiver in Stephens Lake is more difficult to explain as it is unlikely that not a single fish would enter the detection range of any receiver over this time period. Therefore, a more likely explanation is that noise associated with ice movement is interfering with transmitted signals.

Data indicate that upper Stephens Lake between rkm 6.6 and rkm 10.5 may be most frequently utilized by Lake Sturgeon during early winter (late-October to mid-December) and that Lake Sturgeon may move further downstream as winter progresses. Habitat in this area consists of depths of up to 20 m and standing/low water velocities with silt/clay substrate which, as previously discussed, is consistent with the winter habitat preferences reported for this species. It is unknown if Lake Sturgeon utilize the upper 6.6 rkm of Stephens Lake during winter because there were no receivers deployed in this area, however, frequent and in many cases consistent relocations of individual sturgeon between rkm 6.6 and 10.5 between October and mid-December, and frequent relocations of many fish at rkm 10.5 from mid-December to mid-March, suggests that utilization of the upper 6 rkm of Stephens Lake during winter is rare. Considering the available habitat in this area (i.e., moderate-high water velocities) does not match the prescribed winter habitat preferences for this species, and that frazil ice buildup and ice scouring may influence use of this habitat during winter (i.e., may make it largely uninhabitable), it is perhaps not surprising that Lake Sturgeon may effectively limit their use of upper Stephens Lake during winter.

Although the majority of Lake Sturgeon tagged in this study moved over a limited spatial extent during winter, there were four exceptions in Stephens Lake. As presented in the results (section 4.1.2.2), four Lake Sturgeon moved into lower Stephens Lake during the winter period travelling distances > 20 rkm, and two of these (#16021 and #16034; unknown sex at the time of tagging) moved through the Kettle GS between January 2012 and July 2012. Although the exact date that these fish moved through the Kettle GS is not known, the spillway was only in operation on one day between 4 January and 4 August, 2012. For this reason, it is likely that both of these fish survived passage through the Kettle GS powerhouse. Trash racks are thought to prevent large fish from entering the turbine units, however, the size of Lake Sturgeon that may be excluded by trash racks is poorly understood. In this study, Lake Sturgeon #16021 was 880 mm FL and 6804 g when tagged on 18 June, 2011, and Lake Sturgeon #16034 was 796 mm FL and 4082 g when tagged on 28 September, 2011. In a related study conducted in the Limestone Forebay from 2007 - 2010, five of eight tagged Lake Sturgeon that were known to have moved through the Limestone GS, passed via the powerhouse, with 100% survival. These fish ranged in FL from 593 – 890 mm and weight from 1,175 – 4,100 g (Ambrose et al. 2010a; Ambrose et al. 2010b).

5.2 OPEN-WATER 2012

This study reports on the second year of data collected for tagged Lake Sturgeon during the open-water period. Although results are preliminary, given that 10 years of data will be collected from these tagged fish, general movement patterns based on data collected to date are discussed below.

During the open-water period, general movement patterns of Lake Sturgeon residing in the Nelson River between Clark Lake and Gull Rapids appear to fit into three groups. The first group displayed (spring, summer, fall, winter) fidelity for the riverine portion of the Nelson River between Clark Lake and Gull Lake. Six of the 31 (19%) Lake Sturgeon tagged upstream of Gull Rapids were relocated exclusively in this reach since being tagged. These results are similar to results of acoustic telemetry studies conducted between 2001 and 2004 when 2 of 15 (13%) tagged Lake Sturgeon were relocated almost exclusively in this river reach over a four-year tracking period (Barth and Mochnacz 2004; Barth 2005; Barth and Murray 2005; Barth and Ambrose 2006). The second group, which appears to be a larger proportion of this population (22 of 31, 71% in this study and 10 of 15, 67% in the 2001 – 2004 study), displayed fidelity for Gull Lake during summer, fall and winter, moving upstream periodically, primarily during spring. In the present study, 11 of the 22 (50%) Lake Sturgeon in this group were relocated exclusively in Gull Lake in 2012, and the remaining 11 (50%) were relocated exclusively in Gull Lake with the exception of upstream movement during May or June and their return in June, July or August. The third group is comprised of a small proportion of the tagged fish that deviate from either of the above prescribed patterns. For example, one of the 31 (3%) tagged Lake Sturgeon moved from Gull Lake upstream at least as far as Clark Lake during summer and did not return in 2012.

The finding that some individuals within the Clark Lake to Gull Rapids Lake Sturgeon population appear to show affinity for either riverine or lacustrine areas is not unique. Rusak and Mosindy (1997) monitored movements of 26 radio-tagged adult Lake Sturgeon in the southern portion of Lake of the Woods and the Rainy River over a three year period. These authors identified two "populations" of Lake Sturgeon in this area, a "lake" and "river" type, distinguishable by seasonal movements, seasonal habitat use and timing of spawning. For example, the "lake" Lake Sturgeon population consistently overwintered in lentic environments whereas the "river" population consistently inhabited the river during the winter months. As data from this study are considered preliminary, additional years of data from the Clark Lake to Gull Rapids population will further confirm or refute the observed trends.

For Lake Sturgeon tagged in Stephens Lake, data collected during the open-water period in 2011 and 2012, and data collected from 2001 – 2004, suggest that Lake Sturgeon are frequently located at the base of Gull Rapids during spring, summer and fall (Barth and Mochnacz 2004; Barth 2005; Barth and Murray 2005; Barth and Ambrose 2006). During the current study, many Lake Sturgeon exhibited daily small-scale upstream and downstream movements in upper Stephens Lake between rkm 1.3 and rkm 17.2; however, movements were not synchronous among fish. During the open-water period Lake Sturgeon in Stephens Lake generally remained within the upper 17.2 rkm of Stephens Lake and rarely moved into Lower Stephens Lake or the North Arm of Stephens Lake.

Since inception of this study, five of the 29 (17%) Lake Sturgeon tagged in Stephens Lake (one in 2011 and four in 2012), have moved upstream through Gull Rapids. Similarly, in an acoustic telemetry study conducted from 2001 to 2004, two Lake Sturgeon, one tagged in Stephens Lake and one tagged in Gull Lake, moved upstream over Gull Rapids. It is interesting to note that all seven of these movements occurred outside of the suspected spawning periods (i.e., between 27 June and 13 September) suggesting that the upstream movements documented were not related to current year spawning. Two step spawning migrations, described as upstream movement during fall to overwintering locations more proximate to spawning areas, have been observed in many species of sturgeon (Bemis and Kynard 1997). Because the maturity status of six of the seven fish that moved over Gull Rapids is unknown, it is impossible to conclusively classify these movements as two step spawning migrations. However, the movement of female Lake Sturgeon #16029 that moved over Gull Rapids in spring 2011, and was suspected to have spawned between rkm -17.2 and rkm -26.5, does indeed fit the description of a two-step spawning migration.

In summary, since the initiation of the study in 2011, of the 31 Lake Sturgeon tagged in the Nelson River (CL – GR), none have passed downstream through Gull Rapids, and at least one has been harvested by a local resource user. Of the 29 Lake Sturgeon tagged in Stephens Lake, five have moved upstream through Gull Rapids, while two have passed downstream through the Kettle GS. Therefore, as of October 2012, 34 of the 60 tagged Lake Sturgeon were last located in the Nelson River (CL – GR), 22 were last located in Stephens Lake, and 2 were last located in the Long Spruce Reservoir.

The implanted acoustic transmitters have a life expectancy of ten years, therefore eight additional years of data may potentially be collected from these tagged fish.

6.0 GLOSSARY

Coelomic cavity – body cavity.

Forebay – the portion of a reservoir immediately upstream of a hydroelectric facility.

Frazil Ice - Fine spicules or plates of ice suspended in water.

Riparian – along the banks of rivers and streams.

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TABLES

Table 1. Dates of deployment and rkm locations of stationary receivers in the Nelson River between Clark Lake and Gull Rapids, and in Stephens Lake during winter 2011/12.

Nelson River (CL - GR)			Stephens Lake		
Receiver	Deployment	Position (rkm)	Receiver	Deployment	Position (rkm)
4496	24-Oct-12	-29.0	4495	22-Oct-12	6.6
114244	24-Oct-12	-26.5	107994	22-Oct-12	7.4
6000	24-Oct-12	-19.0	107998	22-Oct-12	7.4
7782	24-Oct-12	-17.2	108007	22-Oct-12	7.5
7022	24-Oct-12	-13.8	108008	22-Oct-12	7.5
4638	24-Oct-12	-10.5	101281	22-Oct-12	7.7
8216	24-Oct-12	-7.9	101279	22-Oct-12	7.9
5505	24-Oct-12	-7.5	114229	20-Oct-12	7.9
5323	24-Oct-12	-7.1	107997	22-Oct-12	8.2
6001	24-Oct-12	-2.1	101282	22-Oct-12	8.2
-	-	-	108005	22-Oct-12	8.7
-	-	-	107995	22-Oct-12	8.7
-	-	-	108000	22-Oct-12	8.8
-	-	-	108002	22-Oct-12	9.2
-	-	-	114236	20-Oct-12	10.5
-	-	-	4079	20-Oct-12	10.5
-	-	-	4075	20-Oct-12	14.8
-	-	-	7779	20-Oct-12	17.1
-	-	-	114235	19-Oct-12	27.6
-	-	-	7021	19-Oct-12	27.6
-	-	-	4548	19-Oct-12	35.8

Table 2. Dates of deployment and rkm locations of stationary receivers in the Nelson River between Clark Lake and Gull Rapids, within Gull Rapids, within Stephens Lake, and in the Long Spruce Reservoir, during the open-water period, 2012.

Nelson River (CL - GR)			Gull Rapids			Stephens Lake			Long Spruce Forebay		
Receiver	Deployment	Position (rkm)	Receiver	Deployment	Position (rkm)	Receiver	Deployment	Position (rkm)	Receiver	Deployment	Position (rkm)
5389	29-May-12	-40.0	114242	13-Jun-12	0	114231	6-Jun-12	2.1	108002	2-Jul-12	39.5
5507	29-May-12	-39.2	-	-	-	114227	6-Jun-12	2.7	114236	2-Jul-12	40.5
107996	29-May-12	-34.2	-	-	-	107999	6-Jun-12	3.0	4548	8-Sep-12	44.5
107993	29-May-12	-29.9	-	-	-	107992	3-Jun-12	3.2	114235	8-Sep-12	49.5
108010	20-Jun-12	-29.4	-	-	-	114228	16-Jun-12	6.7	-	-	-
114240	19-Jun-12	-29.2	-	-	-	108009	16-Jun-12	7.5	-	-	-
101278	29-May-12	-28.9	-	-	-	108005	2-Jul-12	8.4	-	-	-
114237	4-Jul-12	-24.5	-	-	-	114230	16-Jun-12	8.5	-	-	-
5505	5-Aug-12	-22.0	-	-	-	107994	2-Jul-12	9.5	-	-	-
107991	29-May-12	-19.8	-	-	-	114245	16-Jun-12	10.7	-	-	-
114234	4-Jul-12	-17.2	-	-	-	101282	2-Jul-12	12.7	-	-	-
7782	4-Jul-12	-16.0	-	-	-	107995	2-Jul-12	13.0	-	-	-
114244	4-Jul-12	-14.4	-	-	-	114233	16-Jun-12	14.6	-	-	-
108003	29-May-12	-12.3	-	-	-	108007	2-Jul-12	16.5	-	-	-
114243	4-Jul-12	-10.4	-	-	-	114232	15-Jun-12	17.6	-	-	-
114239	4-Jul-12	-8.4	-	-	-	4079	2-Jul-12	19.0	-	-	-
7778	4-Jul-12	-7.4	-	-	-	107997	2-Jul-12	23.3	-	-	-
114226	4-Jul-12	-6.6	-	-	-	4495	2-Jul-12	24.9	-	-	-
108001	29-May-12	-3.6	-	-	-	108000	2-Jul-12	29.6	-	-	-
114241	4-Jul-12	-1.9	-	-	-	107998	2-Jul-12	37.2	-	-	-

FIGURES

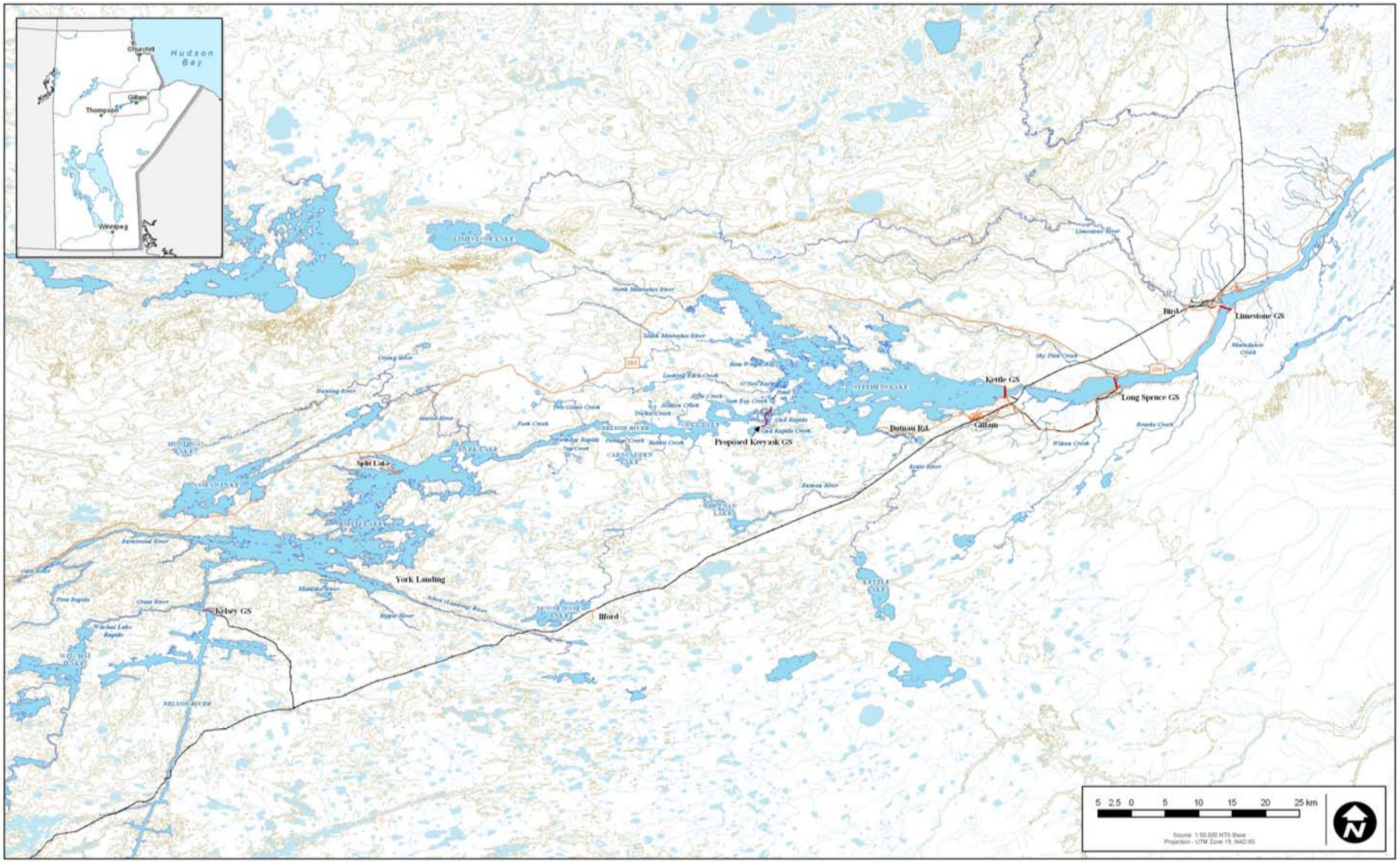

Figure 1. Map of the Keeyask Study Area showing proposed and existing hydroelectric development.